# csda™ 2017–2018 RESOURCE GUIDE

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# Seven Reasons to Specify CSDA Contractors

## 1 Safety

Methods employed by CSDA Contractors are non-disruptive, vibration-free and allow for job completion with reduced noise, dust and debris. Professional cutting, polishing and imaging operators are committed to safety and follow all appropriate procedures.

## 2 Time Savings

Cutting or polishing with diamond tools and imaging with GPR is faster than comparable survey, renovation or demolition methods. Professional cutting, polishing and imaging contractors have the knowledge to evaluate each unique job situation and determine the best approach. They are efficient and skilled, and they get the job done right the first time.

## 3 Cost Savings

The systems used by CSDA contractors provide significant cost advantages over conventional methods. These include increased productivity, reduced downtime and fewer operators needed to accomplish the job. These professionals are well prepared to bring projects in on time and within budget.

## 4 Reduction of Liability

General contractors and other specifiers can reduce their liability by entrusting their jobs to trained professionals who are experts in their field. These professionals have the training and experience to select the best procedures to employ at any stage of a project.

## 5 Quality of Work

CSDA contractors know which types of tools and equipement are best for each application, and they have a good understanding of working clearance, disposal and other construction site issues. They complete tasks to the specified tolerances while overcoming challenges such as heavily reinforced concrete, confined spaces and time constraints.

## 6 Latest Technology

Modern, efficient equipment can be used for a wide range of applications. The equipment provides many capabilities while allowing for precision work and the safeguard of structural integrity. This equipment is also designed to create minimal disruption to the surrounding jobsite.

## 7 Access to CSDA Resources

Specifiers have access to professional CSDA cutting, polishing and imaging contractors, including those who have achieved Certified Operator status or have attained Company Certification by completing industry-specific certification programs.

# Specification

**Title:** Core Drilling
**Specification No:** CSDA-C-101
**Effective Date:** Jun 1, 1998
**Revised:** Jan 20, 2012

## 1. Codes, Standards & Definitions

1.1 Occupational Safety and Health Administration - Safety and Health Standards Digest Construction Industry (OSHA) - 3149/1996)
1.2 ANSI B-7.1 and B-7.5 Standards
1.3 The Cutting Contractor shall adhere to all applicable safety guidelines in accordance with Federal, State and local ordinances.
1.4 Definitions
- 1.4.1 Owner – Legal owner of the structure being cut and consequently, the owner of the holes or openings created by the cutting contractor.
- 1.4.2 Contracting agency – The contractor hired directly or indirectly by the owner that is sub-letting the cutting requirements to a cutting contractor.
- 1.4.3 Cutting contractor – The contractor hired to perform the actual cutting operation.
- 1.4.4 Slurry – The liquid material comprised of water and cuttings generated when the owner's structure is cut using a water coolant.
- 1.4.5 Embedments – Objects within or immediately adjacent to the cutting area that could be damaged during cutting. Example of embedments are reinforcing rod and cable and utilities such as electrical power and telephone lines.
- 1.4.6 Holes and openings – the voids resulting from the core drilling or cutting operations of the cutting contractor. Ownership of the holes or openings rests with the owner or contracting agency; not with the cutting contractor.

## 2. Prerequisites

2.1 Normal and customary equipment used on a core drill job include:
- 2.1.1 Provided by contractor:
  - 2.1.1.1 Power unit
  - 2.1.1.2 Core drill base, column, carriage and motor assembly
  - 2.1.1.3 Properly sized drill motor and rig for the hole sizes requested
  - 2.1.1.4 Core drill bits with enough segment life to complete the assigned work.
  - 2.1.1.5 Proper mounting equipment and tools (anchors, rotary hammer, vacuum pad, pump and vacuum cleaner).
- 2.1.2 Provided by owner or contracting agency:
  - 2.1.2.1 Engineering controls for water, slurry and dust protection of adjacent structures and facilities
  - 2.1.2.2 Scaffolding
  - 2.1.2.3 Storage for water or slurry
  - 2.1.2.4 Shoring, rigging and rigging equipment for handling or managing the piece to be removed.
  - 2.1.2.5 Sump area and sump pump
  - 2.1.2.6 Fall protection in accordance with OSHA standard 1926.501(b)(4) for all holes and openings created by the cutting contractor.

2.2 It is the responsibility of the owner or contracting agency to have the location of the area to be cut reviewed, approved and all cut lines clearly marked prior to the start of any cutting operations. Additionally, it is the responsibility of the owner of contracting agency to clearly mark the location and type of all Embedments both on the cut lines and near the cutting area.
2.3 It is the responsibility of the owner or contracting agency to provide water and power for the cutting contractor.
2.4 It is the responsibility of the owner or contracting agency to provide fall protection in accordance with OSHA standard 1926.501(b)(4) for all holes or openings created by the cutting contractor.
2.5 It is recommended that a pre-job meeting be held with the owner or contracting agency to determine the following information relating to steel reinforcing bar or other embedments:
- 2.5.1 Are there steel reinforcing bars or other embedments within the structure to be cut?
- 2.5.2 What is the size and location of the steel reinforcing bars or other Embedments?
- 2.5.3 Is it permissible to cut the steel reinforcing bars or other embedments in the course of the drilling operation?
- 2.5.4 Is it possible to lay out the holes in such a way that minimizes or avoids the cutting of the steel reinforcing bars or other embedments?
- 2.5.5 After drilling begins is it permissible to move the hole to stop splitting a steel reinforcing bar or embedment?

2.6 Any scaffolding required shall be designed, provided by and erected by competent personnel.
2.7 The owner or contracting agency must determine if there are utility lines contained within, adjacent to or secured to the structure being drilled. If utility lines are present as described, the owner or contracting agency must take the necessary action to have all services cut off to these utilities.

If the utilities are buried, the owner or contracting agent must call the appropriate agency for accurate utility location as state or local regulation may require. The cutting contractor must be named on the permit.

2.7.1 If the owner or contracting agency directs that an embedment be intentionally cut whether or not service is turned off, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.7.2 If the layout provided by the owner or contracting agency causes an Embedment to be unintentionally cut, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.8 It is the owner or contracting agency's responsibility to provide protection to persons and property from potential water or slurry damage. The cutting contractor shall not be deemed an owner or generator of slurry and the owner and contracting agency shall protect the cutting contractor from all loss and expense associated with such claims.

2.9 The owner or contracting agency shall be responsible for providing proper, safe, and appropriate disposal of slurry.

2.9.1 Collection and disposal of the slurry must be planned for by agreement with the owner of the structure or the contracting agency before work commences.

2.10 Adequate safety provisions must be provided by the owner or contracting agency to protect the operator's work area, as well as below, above, and adjacent to the area being drilled.

2.10.1 Safe access to and from the work area shall also be provided by the owner or contracting agency.

2.10.2 Barricades, cones, "warning" tape or other devises as appropriate to keep unauthorized people out of the work area shall be provided by the owner or contracting agency.

2.11 It is the responsibility of the owner or contracting agency to notify the contractor if the cores to be drilled are on a slab on grade. If the holes are above open space, it is the owners or contracting agency's responsibility to provide damage control and protect for human life.

2.12 The owner or the contracting agency shall be responsible for designing and installing any bracing or shoring required. The material being drilled free should be supported in a safe and effective manner so that when the opening is drilled free, it is retained in place causing no damage to persons, equipment or adjacent structures.

2.13 Notification procedures, regarding the completion of a hole or opening within the work area, should be defined and agreed upon prior to the start of the job. This is so that the owner of the hole or a contracting agency can provide fall protection in a timely manner in accordance with OSHA standard 1926.501(b)(4).

## 3. Drilling Set-up Procedures

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

3.1 Equipment used in the drilling operations must meet all OSHA standards and specifications as to plugs, noise, wiring, and fume pollution.

3.2 Specifications for minimum and maximum clearance requirements between the pipe and core hole is the sole responsibility of the owner or contracting agency and should be determined prior to starting work.

3.3 The owner should provide labor to catch core(s) and water when the core is cut free on a suspended slab.

3.4 For large holes over 24" (610 mm) in diameter the owner or contracting agency should provide mechanical means to move bit(s) to the drilling area.

3.5 Inspect diamond core drill bits for damage to the hub area that could cause improper seating of the back of the bit against the drill shaft.

3.6 Check to confirm drill bits are of proper specification for the material being cut.

3.7 The owner or contracting agency should prohibit access and clear machinery or equipment directly under the area to be core drilled so that falling cores do not injure any persons or damage any property.

3.8 The owner or contracting agency should provide fall protection for all holes or openings created by the cutting contractor.

## 4. Drilling Operation

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

4.1 If any of the core drilling operations are performed without water as a coolant then additional safety precautions may apply. Consult the diamond tool manufacturer or the core drill manufacturer for specification information.

4.2 If any of the core drilling operations are performed with hand held core drilling equipment then additional safety precautions may apply. Consult the core drill manufacturer for specification information.

4.3 Never operate a core drill assembly unattended unless the equipment has been designed specifically for this purpose.

4.4 The core drilling equipment should be operated in accordance with the manufacturer's specifications.

4.5 When needed, place partitions, barricades or caution tape around the work area to prevent unauthorized personnel from having access to the work area.

# Specification

**Title:** Flat Sawing
**Specification No:** CSDA-F-102
**Effective Date:** Jun 1, 1998
**Revised:** Dec 14, 2012

## 1. Codes, Standards & Definitions

1.1 Occupational Safety and Health Administration - Safety and Health Standards Digest Construction Industry (OSHA) - 3149/1996).
1.2 ANSI B-7.1 and B-7.5 Standards.
1.3 The cutting contractor shall adhere to all applicable safety guidelines in accordance with Federal, State and local ordinances.
1.4 Definitions:
- 1.4.1 Owner – Legal owner of the structure being cut and consequently, the owner of the holes/openings created by the cutting contractor.
- 1.4.2 Contracting agency – The contractor hired directly or indirectly by the owner that is sub-letting the cutting requirements to a cutting contractor.
- 1.4.3 Cutting contractor – The contractor hired to perform the actual cutting operation.
- 1.4.4 Slurry – The liquid material comprised of water and cuttings generated when the owner's structure is cut using a water coolant.
- 1.4.5 Embedments – Objects within or immediately adjacent to the cutting area that could be damaged during cutting. Examples of embedments are reinforcing rod and cable and utilities such as electrical power and telephone lines.
- 1.4.6 Holes / openings – the voids resulting from the core drilling/cutting operations of the cutting contractor. Ownership of the holes / openings rests with the owner, not with the cutting contractor.

## 2. Prerequisites

2.1 Normal and customary equipment used on a flat saw job include:
- 2.1.1 Provided by cutting contractor for normal outside work:
  - 2.1.1.1 Flat saw powered by gas, propane or diesel of the appropriate horsepower and design to accomplish the job requirements
  - 2.1.1.2 Diamond blades and blade guards of sufficient sizes to complete the job
  - 2.1.1.3 Layout, marking, and measuring equipment adequate for the job
  - 2.1.1.4 Hand tools pertinent to the saw being used
  - 2.1.1.5 Vacuuming equipment for slurry control
  - 2.1.1.6 Equipment adequate to cut corners if over cuts are not allowed. i.e. core drill, chain saw, hand saw, etc.
- 2.1.2 Provided by cutting contractor for normal inside work:
  - 2.1.2.1 Flat saw powered by electric or air power of the appropriate horsepower and design to accomplish the job requirements
  - 2.1.2.2 Diamond blades and blade guards of sufficient sizes to complete the job
  - 2.1.2.3 Layout, marking, and measuring equipment adequate for the job
  - 2.1.2.4 Hand tools pertinent to the saw being used
  - 2.1.2.5 Vacuuming equipment for slurry control
  - 2.1.2.6 Equipment adequate to cut corners if over cuts are not allowed (i.e. core drill, chain saw, hand saw, etc.)
  - 2.1.2.7 Fall protection in accordance with OSHA standard 1926.501(b) for all holes / openings created by the cutting contractor.
- 2.1.3 Provided by owner or contracting agency:
  - 2.1.3.1 Plastic sheeting
  - 2.1.3.2 Storage for water or slurry
  - 2.1.3.3 Shoring for managing the piece to be removed
  - 2.1.3.4 Sump area and sump pump
  - 2.1.3.5 Ventilation appropriate for the saws used by the cutting contractor
  - 2.1.3.6 Supplies to shore or hold openings securely in place after cutting

2.2 It is the responsibility of the owner or contracting agency to have the location of the area to be cut reviewed, approved and all cut lines clearly marked prior to the start of any cutting operations. Additionally, it is the responsibility of the owner of contracting agency to clearly mark the location and type of all Embedments both on the cut lines and near the cutting area.
2.3 It is the responsibility of the owner or owner's agent to provide water and power for the cutting contractor.
2.4 It the responsibility of the owner or contracting agency to provide fall protection in accordance with OSHA standard 1926.501(b) for all holes/openings created by the cutting contractor.
2.5 It is recommended that a pre-job meeting be held with the owner or contracting agency to determine the following information relating to steel reinforcing bar or other embedments:
- 2.5.1 Are there steel reinforcing bars or other embedments within the structure to be cut?
- 2.5.2 What is the size and location of the steel reinforcing bars or other embedments?
- 2.5.3 Is it permissible to cut the steel reinforcing bars or other embedments in the course of the sawing operation?
- 2.5.4 Is it possible to lay out the cut line in such a way that minimizes or avoids the cutting of the steel reinforcing bars or other embedments?
- 2.5.5 After cutting begins is it permissible to move the cut line to stop splitting a steel reinforcing bar or embedment?

2.6 It is the responsibility of the owner or contracting agent to notify the cutting contractor if the saw cuts are to be made on a slab on grade. If the cuts are to be above open space, it is the owner or contracting agency responsibility to provide damage control and protect for human life.

2.7 The owner or contracting agency must determine if there are utility lines contained within, adjacent to or secured to the structure being cut. If utility lines are present as described, the owner or contracting agency must take the necessary action to have all services cut off to these utilities. If the utilities are buried, the owner or contracting agent must call the appropriate agency for accurate utility location as state or local regulation may require. The cutting contractor must be named on the permit.

2.8 If the owner or contracting agency directs that an embedment be intentionally cut whether or not service is turned off, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.8.1 If the layout provided by the owner or contracting agency causes an embedment to be unintentionally cut, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.9 It is the owner or contracting agency's responsibility to provide protection to persons and property from potential water or slurry damage. The cutting contractor shall not be deemed an owner or generator of slurry and the owner and contracting agency shall protect the cutting contractor from all loss and expense associated with such claims.

2.10 The owner or contracting agency shall be responsible for providing proper, safe, and appropriate disposal of slurry.

2.10.1 Collection and disposal of the slurry must be planned for by agreement with the owner of the structure or the owner's agent before work commences.

2.1. Adequate safety provisions must be provided by the owner or contracting agency to protect the operator's work area, as well as below, above, and adjacent to the area being cut.

2.11.1 Safe access to and from the work area shall also be provided by the owner or contracting agency.

2.11.2 Barricades, cones, and/or red "warning" tape as appropriate to keep unauthorized people out of the work area shall be provided by the owner or contracting agency.

2.12 In the case where cuts are to be made above an open space, the owner or contracting agency shall be responsible for designing and installing any bracing or shoring required to make sure that the material being sawn free is supported in a safe and effective manner so that when the opening is cut free, it is retained, in place, causing no damage to persons, equipment or adjacent structures.

2.13 The owner or contracting agency shall isolate or protect the other structures or facilities that are part of or adjacent to the structure being cut.

## 3. Sawing Set-up Procedures

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

3.1 A concrete flat saw (slab saw, pavement saw, floor saw) of the correct type and horsepower and diamond blades and blade guards of the correct size shall be supplied by the cutting contractor.

3.1.1 The cutting contractor's equipment must comply with all applicable OSHA standards.

3.2 Clean and inspect the blade flanges and arbor for damage before mounting any blade.

3.3 Inspect diamond blade for the condition of the segments and core. Do not use the blade if any of the following conditions exist: core cracks or missing or broken segments or loss of tension.

3.4 Check to confirm blades are of proper specification for the material being cut.

3.5 When sawing interior slabs with internal combustion powered saws, precautions must be taken by the owner or contracting agency to provide adequate ventilation, air circulation, and/or oxygen replacement that meet OSHA standards. Other options for interior sawing include electric, hydraulic, or air powered saws.

3.6 Inspect any air, hydraulic, electric or water lines or cords attached to the flat saw for proper condition and fit. Repair or replace as required.

3.7 Should bracing of the concrete section to be removed be required, it must be installed prior to the completion of the sawing operation. If opening to be removed is to stay in place for an extended period, adequate support is required. The owner or contracting agency shall provide all bracing and engineering required for safe removal unless otherwise agreed to in writing by the cutting contractor.

3.8 The owner or contracting agency shall provide fall protection for all holes/openings created by the cutting contractor.

## 4. Cutting Operation

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

4.1 Blades and blade guards should be properly fastened to the saw as per saw manufacturer's specifications.

4.2 The saw should be operated according to the saw manufacturer's specifications.

4.3 When needed, place partitions, barricades or caution tape around work areas to prevent un-authorized personnel from having access to the work area.

4.4 Allow no personnel to be in-line with the blade while it is rotating.

4.5 Never allow the saw to run un-attended.

4.6 Notify the owner or contracting agency when the hole/opening is completed so that they can provide fall protection in accordance with OSHA standard 1926.501(b).

# Specification

**Title:** Track Mounted Wall Sawing
**Specification No:** CSDA-W-104
**Effective Date:** Jun 1, 1998
**Revised:** Dec 14, 2012

## 1. Codes, Standards & Definitions

1.1 Occupational Safety and Health Administration - Safety and Health Standards Digest Construction Industry (OSHA) - 3149/1996)
1.2 ANSI B-7.1 and B-7.5 Standards
1.3 The cutting contractor shall adhere to all applicable safety guidelines in accordance with Federal, State and local ordinances.
1.4 Definitions
- 1.4.1 Owner – Legal owner of the structure being cut and consequently, the owner of the holes/openings created by the cutting contractor.
- 1.4.2 Contracting agency – The contractor hired directly or indirectly by the owner who is sub-letting the cutting requirements to a cutting contractor.
- 1.4.3 Cutting contractor – The contractor hired to perform the actual cutting operation.
- 1.4.4 Slurry – The liquid material comprised of water and cuttings generated when the owner's structure is cut using a water coolant.
- 1.4.5 Embedments – Objects within or immediately adjacent to the cutting area that could be damaged during cutting. Examples of embedments are reinforcing rod and cable and utilities such as electrical power and telephone lines.
- 1.4.6 Holes/openings – the voids resulting from the core drilling/cutting operations of the cutting contractor. Ownership of the holes/openings rests with the owner; not the cutting contractor.

## 2. Prerequisites

2.1 Normal and customary equipment used on a wall saw job include:
- 2.1.1 Provided by cutting contractor:
  - 2.1.1.1 Power unit
  - 2.1.1.2 Wall saw drive and carriage assemblies
  - 2.1.1.3 Wall saw rails or track
  - 2.1.1.4 Diamond blades and guards
  - 2.1.1.5 Wall saw mounting supplies, hand tools and miscellaneous equipment pertinent to a particular wall saw.
  - 2.1.1.6 Equipment necessary to cut back-side corners if required if no over cuts are specified. i.e. core drill, chain saw, hand saw, etc.
  - 2.1.1.7 Supplies to shore or hold openings securely in place after cutting.
- 2.1.2 Provided by owner or contracting agency:
  - 2.1.2.1 Plastic sheeting
  - 2.1.2.2 Scaffolding for personnel access
  - 2.1.2.3 Storage containers for water or slurry
  - 2.1.2.4 Shoring, scaffolding, rigging and rigging equipment for managing the piece to be removed
  - 2.1.2.5 Sump area and sump pump
  - 2.1.2.6 Fall protection in accordance with OSHA standard 1926.501(b) for all holes/openings created by the cutting contractor.

2.2 It is the responsibility of the owner or contracting agency to have the location of the area to be cut reviewed, approved and all cut lines clearly marked prior to the start of any cutting operation. A determination should be made by the owner or contracting agency as to whether over cuts are allowed. In addition, it is the responsibility of the owner or contracting agency to clearly mark the location and type of all embedments both on the cut lines and near the cutting area.
2.3 It is the responsibility of the owner or contracting agency to provide water and power for the cutting contractor.
2.4 It is the responsibility of the owner or contracting agency to provide fall protection in accordance with OSHA standard 1926.501(b) for all holes/openings creating by the cutting contractor.
2.5 It is recommended that a pre-job meeting be held with the owner or contracting agency to determine the following information relating to steel reinforcing bar or other embedments:
- 2.5.1 Are there steel reinforcing bars or other embedments within the structure to be cut?
- 2.5.2 What is the size and location of the steel reinforcing bars or other embedments?
- 2.5.3 Is it permissible to cut the steel reinforcing bars or other embedments in the course of the sawing operation?
- 2.5.4 Is it possible to lay out the cut line in such a way that minimizes or avoids the cutting of the steel reinforcing bars or other embedments?
- 2.5.5 After cutting begins, is it permissible to move the cut line to stop splitting a steel reinforcing bar or embedment?

2.6 Any scaffolding required by the owner, contracting agency or cutting contractor shall be designed, provided by and erected by competent personnel and according to code requirements.
2.7 The owner or contracting agency must determine if there are utility lines contained within, adjacent to or secured to the structure being cut. If utility lines are present as described, the owner or contracting agency must take the necessary action

to have all services for these utilities cut off. If the utilities are buried, the owner or contracting agent must call the appropriate agency for accurate utility location as state or local regulation may require. The cutting contractor must be named on the permit.

2.8 If the owner or contracting agency directs that an embedment be intentionally cut whether or not service is turned off, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.8.1 If the layout provided by the owner or contracting agency causes an embedment to be unintentionally cut, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.9 It is the responsibility of the owner or contracting agency to provide protection to persons and property from potential water or slurry damage. The cutting contractor shall not be deemed an owner or generator of slurry and the owner and contracting agency shall protect the cutting contractor from all loss and expense associated with such claims.

2.10 The owner or contracting agency shall be responsible for providing proper, safe, and appropriate disposal of slurry.

2.10.1 Collection and disposal of the slurry must be planned for by agreement with the owner or contracting agency before work commences.

2.11 Adequate safety provisions must be provided by the owner or contracting agency to protect the operator's work area, as well as below, above, and adjacent to the area being cut.

2.11.1 The owner or contracting agency shall provide safe access to and from the work area.

2.11.2 Barricades, cones, warning tape or other devices used to keep unauthorized people out of the work area shall be provided by the owner or contracting agency.

2.12 The owner or the contracting agency shall be responsible for the design and installation of any bracing or shoring required to make sure that the material being sawed free is supported in a safe and effective manner so that when the piece is cut free, it is retained in place, causing no damage to persons, equipment or adjacent structures.

2.13 The owner or contracting agency shall isolate or protect the other structures or facilities that are part of or adjacent to the structure being cut.

## 3. Sawing Set-up Procedures

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

3.1 Install the appropriate number of anchors according to the anchor manufacturer's installation instructions as well as the wall saw manufacturer's installation instructions.

3.2 Make sure the tracks are securely attached to the wall by the anchors through hold-down plates or brackets and/or according to the wall saw manufacturer's instructions.

3.3 Inspect the complete saw including the roller assembly and blade guard for damage or improper functioning before applying the saw to the track. Repair or replace as required.

3.4 Clean and inspect the blade flanges and arbor for damage before mounting any blade. Repair or replace as required.

3.5 Inspect any air, hydraulic, electric or water lines or cords attaching to the wall saw for proper condition and fit. Repair or replace as required.

3.6 Should bracing of the concrete section to be removed be required, it must be installed prior to the completion of the sawing operation. If cut piece to be removed is to stay in place for an extended period, adequate support is required. The owner or contracting agency shall provide all bracing and engineering required for safe removal unless otherwise agreed to in writing by the cutting contractor. Wedging is not acceptable as a bracing technique.

3.7 Inspect diamond blade for the condition of the segments and core. Do not use the blade if any of the following conditions exist: core cracks, missing or broken segments, loss of tension or any other condition as mentioned in the blade manufacturer's instructions.

3.8 Check to confirm that the blades are of a proper specification for the material being cut.

3.9 The owner or contracting agency shall provide fall protection for all holes/openings creating by the cutting contractor.

## 4. Cutting Operation

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

4.1 When needed, place partitions or screens between wall saw operations and the personnel area to prevent any flying objects from contacting any worksite personnel.

4.2 Allow no personnel to be in-line with the blade while it is rotating.

4.3 On applications requiring a bottom horizontal cut, sequence the cut or shore the work piece so that the weight of the work piece is prevented from jamming, pinching and/or crushing the diamond blade.

4.4 Blades and blade guards should be properly fastened to the saw as per the saw manufacturer's specifications.

4.5 The saw should be operated according to the saw manufacturer's specifications.

4.6 Before commencing sawing operations, determine whether the piece being removed needs to be cut into smaller, more manageable pieces.

4.7 Notify the owner or contracting agency when the hole/opening is completed so that they can provide fall protection in accordance with OSHA standard 1926.501(b).

# Specification

**Title:** Wire Sawing
**Specification No:** CSDA-WS-106
**Effective Date:** Nov 11, 2002
**Revised:** Dec 14, 2012

## 1. Codes, Standards & Definitions

1.1 Occupational Safety and Health Administration–Safety and Health Standards Digest Construction Industry. (OSHA - 3149/1996).

1.2 The cutting contractor shall adhere to all applicable safety guidelines in accordance with federal, state and local ordinances.

1.3 Definitions:

1.3.1 Owner – Legal owner of the structure or object being cut and consequently, the owner of the holes/openings created by the cutting contractor.

1.3.2 Contracting agency – The contractor hired directly or indirectly by the owner that is sub-letting the cutting requirements to a cutting contractor.

1.3.3 Cutting contractor – The contractor hired to perform the actual cutting operation.

1.3.4 Slurry – The liquid material comprised of water and cuttings generated when the owner's structure is cut using a water coolant.

1.3.5 Embedments – Objects within or immediately adjacent to the cutting area that could be damaged or severed during cutting. Examples of embedments are reinforcing rods, cables and utilities such as electrical power and telephone lines.

1.3.6 Holes/openings – the voids resulting from the core drilling/cutting operations of the cutting contractor. Ownership of the holes/openings rests with the owner, not with the cutting contractor.

## 2. Prerequisites

2.1 Normal and customary equipment used on wire saw job include:

2.1.1 Provided by cutting contractor:

2.1.1.1 Power unit
2.1.1.2 Drive wheel assembly
2.1.1.3 Control station, if required
2.1.1.. Idler wheels and universal brackets
2.1.1.5 Diamond wire
2.1.1.6 Safety shielding for wire and drive wheel
2.1.1.7 Core drilling equipment, roto hammers, bits, anchors and miscellaneous hand tools
2.1.1.8 Fall protection in accordance with OSHA standard 1926.501(b) for all holes/openings created by the cutting contractor.

2.1.2 Provided by owner or contracting agency:

2.1.2.1 Plastic sheeting
2.1.2.2 Scaffolding for personnel access
2.1.2.3 Storage containers for water or slurry
2.1.2.4 Shoring, scaffolding, rigging and rigging equipment for managing the piece to be removed.
2.1.2.5 Sump area and sump pump
2.1.2.6 Trucks and disposal methods

2.2 It is the responsibility of the owner or contracting agency to have the location of the area to be cut reviewed, approved and all cut lines clearly marked prior to the start of any cutting operations. Additionally, it is the responsibility of the owner or contracting agency to clearly mark the location and type of all embedments both on the cut lines and near the cutting area.

2.3 It is the responsibility of the owner or contracting agency to provide air, water and power for the cutting contractor.

2.4 It is the responsibility of the owner or contracting agency to provide fall protection in accordance with OSHA standard 1926.501(b) for all holes/openings created by the cutting contractor.

2.5 It is recommended that a pre-job meeting be held with the owner or contracting agency to determine the following information relating to steel reinforcing bar or other embedments:

2.5.1 Are there steel reinforcing bars or other embedments within the structure to be cut?
2.5.2 What is the size and location of the steel reinforcing bars or other embedments?
2.5.3 Is it permissible to cut the steel reinforcing bars or other embedments in the course of the sawing operation?
2.5.4 Is it possible to lay out the cut line in such a way that minimizes or avoids the cutting of the steel reinforcing bars or other embedments?
2.5.5 After cutting begins is it permissible to move the cut line to stop splitting a steel reinforcing bar or embedment?

2.6 Any scaffolding required by the cutting contractor should be designed, provided by and erected by competent personnel and according to code requirements.

2.7 The owner or contracting agency must determine if there are utility lines contained within, adjacent to or secured to the structure being cut. If utility lines are present as described, the owner or contracting agency must take the necessary action to have all services for these utilities cut off. If the utilities are buried, the owner or contracting agent must call the appropriate agency for accurate utility location as state or local regulation may require. The cutting contractor must be named on the permit.

2.8 Embedments:
- 2.8.1 If the owner or contracting agency directs that an embedment be intentionally cut whether or not service is turned off, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment. If the layout provided by the owner or contracting agency causes an embedment to be unintentionally cut, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.9 It is the owner or contracting agency's responsibility to provide protection to persons and property from potential water or slurry damage. The cutting contractor shall not be deemed an owner or generator of slurry and the owner and contracting agency shall protect the cutting contractor from all loss and expense associated with such claims.

2.10 The owner or contracting agency shall be responsible for providing proper, safe and appropriate disposal of slurry.
- 2.10.1 Collection and disposal of the slurry must be planned for by agreement with the owner or contracting agency before work commences.

2.11 Adequate safety provisions must be provided by the owner or contracting agency to protect the operator's work area, as well as below, above and adjacent to the area being cut.
- 2.11.1 The owner or contracting agency shall provide safe access to and from the work area.
- 2.11.2 Barricades, cones, "warning" tape or other devices shall be used as appropriate to keep unauthorized people out of the work area and shall be provided by the owner or contracting agency.

2.12 The owner or contracting agency shall be responsible for designing and installing any bracing or shoring required to make sure that the material being cut free is supported in a safe and effective manner so that when the structure is cut free, it is retained, in place, causing no damage to persons, equipment or adjacent structures.

2.13 The owner or contracting agency shall isolate or protect the other structures or facilities that are part of or adjacent to the structure being cut.

## 3. Sawing Set-up Procedures

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

3.1 Core drill the wire access and rigging holes into the concrete structure in accordance with the work plan as required for wire access and/or work piece removal.

3.2 Utilize the sump area for water/slurry collection and secure the wire saw in a proper location. Place/drape plastic sheeting around drive wheel and idlers, if required, to minimize or contain water dripping or slinging from equipment.

3.3 Place the saw control station at a location which allows the operator to view as much of the drive wheel and cutting area as possible, but not in line with the drive wheel or wire. (unless appropriate additional safety precautions are taken).

3.4 Drape a plastic or wooden splash shield, if required, over the active cut area.

3.5 The owner or contracting agency should provide fall protection for all holes/openings created by the cutting contractor.

## 4. Cutting Operation

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

4.1. The cutting contractor shall:
- 4.1.1 Inspect diamond wire for the condition of the joints as well as the base cable.
- 4.1.2 Ensure the proper splicing or joining of the diamond wire ends when forming a loop. (pre-twisting wire as required).
- 4.1.3 When needed, place partitions or screens between wire operating area and the personnel work area to minimize the chance of any flying objects contacting any work site personnel.
- 4.1.4 Stop or drastically slow wire rotation prior to anyone entering the vicinity of the wire operation for any reason such as wire guide adjustment or water spray adjustment.
- 4.1.5 Allow no personnel to be in-line with the wire while rotating (unless appropriate additional safety precautions are taken).
- 4.1.6 On applications requiring a bottom horizontal cut, sequence the cut or shore the work piece so that the weight of the work piece is prevented from jamming, pinching and/or crushing the diamond wire.
- 4.1.7 Never allow the wire saw to run unattended.
- 4.1.8 The wire saw should be operated in accordance with the saw manufacturer's specifications.
- 4.1.9 Notify the owner or contracting agency when the hole/opening is completed so that they can provide fall protection in accordance with OSHA standard 1926.501(b).

# Specification

**Title:** Hand Sawing
**Specification No:** CSDA-HS-108
**Effective Date:** Jun 1, 1998
**Revised:** Mar 30, 2004

## 1. Codes, Standards & Definitions

1.1. Occupational Safety and Health Administration - Safety and Health Standards Digest Construction Industry (OSHA) - 3149/1996
1.2. The Cutting Contractor shall adhere to all applicable safety guidelines in accordance with Federal, State and local ordinances.
1.3. Definitions
  1.3.1. Owner – Legal owner of the structure being cut and consequently, the owner of the holes / openings created by the cutting contractor.
  1.3.2. Contracting Agency – The contractor hired directly or indirectly by the owner that is sub-letting the cutting requirements to a Cutting Contractor.
  1.3.3. Cutting Contractor – The contractor hired to perform the actual cutting operation.
  1.3.4. Slurry – The liquid material generated when the owner's structure is cut using a water coolant.
  1.3.5. Embedments – Objects within or immediately adjacent to the cutting area that could be damaged during cutting. Examples of embedments are reinforcing rod and cable and utilities such as electrical power and telephone lines.
  1.3.6. Holes / Openings – the voids resulting from the core drilling / cutting operations of the cutting contractor. Ownership of the holes / openings rests with the owner; not the cutting contractor.

## 2. Prerequisites

2.1. Normal and customary equipment on a hand saw job include:
  2.1.1. Provided by cutting contractor:
    2.1.1.1. Hand saw powered by gas, hydraulics, pneumatics, or electricity. Note: Due to exhaust considerations, gas powered hand saws are normally used for outside jobs.
    2.1.1.2. Diamond blades of sufficient sizes to complete the job.
    2.1.1.3. Hand tools pertinent to the saw being used.
    2.1.1.4. Vacuuming equipment for Slurry control.
  2.1.2. Provided by owner or contracting agency:
    2.1.2.1. Plastic sheeting
    2.1.2.2. Scaffolding
    2.1.2.3. Storage for water or slurry
    2.1.2.4. Shoring, rigging and rigging equipment for handling or managing the piece to be removed.
    2.1.2.5. Sump area and sump pump
    2.1.2.6. Proper ventilation equipment if gas powered hand saw is to be operated indoors or in a confined space.
    2.1.2.7. Fall protection in accordance with OSHA standard 1926.501(b)(4) for all holes / openings created by the cutting contractor.
2.2. It is the responsibility of the owner or contracting agency to have the location of the area to be cut reviewed, approved and all cut lines clearly marked prior to the start of any cutting operation. A determination should be made by the owner or contracting agency as to whether over cuts are allowed. In addition, it is the responsibility of the owner or contracting agency to clearly mark the location and type of all embedments both on the cut lines and near the cutting area.
2.3. It is the responsibility of the owner or contracting agency to provide water and power for the cutting contractor.
2.4. It is the responsibility of the owner or contracting agency to provide fall protection in accordance with OSHA standard 1926.501(b) for all holes / openings creating by the cutting contractor.
2.5. It is recommended that a pre-job meeting be held with the owner or contracting agency to determine the following information relating to steel reinforcing bar or other embedments:
  2.5.1. Are there steel reinforcing bars or other embedments within the structure to be cut?
  2.5.2. What is the size and location of the steel reinforcing bars or other embedments?
  2.5.3. Is it permissible to cut the steel reinforcing bars or other embedments in the course of the sawing operation?
  2.5.4. Is it possible to lay out the cut line in such a way that minimizes or avoids the cutting of the steel reinforcing bars or other embedments?
  2.5.5. After cutting begins is it permissible to move the cut line to stop splitting a steel reinforcing bar, cutting pre or post stressed cable or other embedments?
2.6. Any scaffolding required by the owner, contracting agency or cutting contractor shall be designed, provided by and erected by competent personnel and according to code requirements.
2.7. The owner or contracting agency must determine if there are utility lines contained within, adjacent to or secured to the structure being cut. If utility lines are present as described, the owner or contracting agency must take the necessary action to have all services cut off to these utilities. If the utilities are buried, the owner or contracting agent must call the appropriate agency for accurate utility location as state or local regulation may require. The cutting contractor must be named on the permit.

2.7.1. If the owner or contracting agency directs that an embedment be intentionally cut whether or not service is turned off, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.7.2. If the layout provided by the owner or contracting agency causes an embedment to be unintentionally cut, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.8. It is the owner or contracting agency's responsibility to provide protection to persons and property from potential water or slurry damage. The cutting contractor shall not be deemed an owner or generator of slurry and the owner and contracting agency shall protect the cutting contractor from all loss and expense associated with such claims.

2.9. The owner or contracting agency shall be responsible for providing proper, safe, and appropriate disposal of slurry.

2.9.1. Collection and disposal of the slurry must be planned for by agreement with the owner of the structure or the owner's agent before work commences.

2.9.2. Barricades, cones, caution tape or other devises as appropriate to keep unauthorized people out of the work area shall be provided by the owner or contracting agency.

2.10. It is the responsibility of the owner or contracting agency to notify the cutting contractor if the saw cuts are to be made on a slab on grade. If the cuts are to be above open space, it is the owner or contracting agency's responsibility to provide damage control and protection for human life.

2.11. Should bracing of the concrete section to be removed be required, it must be installed prior to the completion of the sawing operation. If opening to be removed is to stay in place for an extended period, adequate support is required. The owner or contracting agency shall provide all bracing and engineering required for safe removal unless otherwise agreed to in writing by the cutting contractor.

## 3. Hand Sawing Set-up Procedures

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

3.1 The cutting contractor's equipment must comply with all applicable OSHA standards.

3.2 Clean and inspect the saw, blade and blade guard for damage before mounting. Never use a blade with cracks in the core or missing segments.

3.3 The side cover and blade guard should be properly fastened to the saw as per saw manufacturer's specifications.

3.4 Inspect any air, hydraulic or water hoses or electric cords attached to the hand saw for proper condition and fit. Repair or replace as required.

3.5 Confirm the blade is of the proper specification for the material being cut.

3.6 Insure the blade is mounted properly.

3.7 When sawing interior walls or slabs with internal combustion powered saws, precautions must be taken by the owner or contracting agency to provide adequate ventilation, air circulation, and/or oxygen replacement that meet OSHA standards. Other options for interior sawing include electric, hydraulic, or pneumatic powered saws.

3.8 Create rigging holes if necessary into the concrete structure in accordance with work plan.

3.9 The owner or contracting agency shall provide fall protection for all holes / openings creating by the cutting contractor.

## 4. Cutting Operation

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

4.1 Do not cut with personnel directly in line with the blade.

4.2 Plan the cutting sequence so that the bottom horizontal cut is not the last one to be completed to prevent the work piece from settling on and causing damage to the saw or blade.

4.3 Notify the owner or contracting agency when the hole/ opening is completed so that they can provide fall protection in accordance with OSHA standard 1926.501(b).

# Specification

**Title:** Chain Sawing
**Specification No:** CSDA-CS-109
**Effective Date:** May 30, 2003
**Revised:** Mar 30, 2004

## 1. Codes, Standards & Definitions

1.1. Occupational Safety and Health Administration - Safety and Health Standards Digest Construction Industry (OSHA) - 3149/1996
1.2. The Cutting Contractor shall adhere to all applicable safety guidelines in accordance with Federal, State and local ordinances.
1.3. Definitions
  1.3.1. Owner – Legal owner of the structure being cut and consequently, the owner of the holes / openings created by the cutting contractor.
  1.3.2. Contracting Agency – The contractor hired directly or indirectly by the owner that is sub-letting the cutting requirements to a Cutting Contractor.
  1.3.3. Cutting Contractor – The contractor hired to perform the actual cutting operation.
  1.3.4. Slurry – The liquid material generated when the owner's structure is cut using a water coolant.
  1.3.5. Embedments – Objects within or immediately adjacent to the cutting area that could be damaged during cutting. Examples of embedments are reinforcing rod and cable and utilities such as electrical power and telephone lines.
  1.3.6. Holes / Openings – the voids resulting from the core drilling / cutting operations of the cutting contractor. Ownership of the holes / openings rests with the owner; not the cutting contractor.

## 2. Prerequisites

2.1. Normal and customary equipment on a chain saw job include:
  2.1.1. Provided by cutting contractor:
    2.1.1.1. Hand saw powered by gas, hydraulics, pneumatics, or electricity. Note: Due to exhaust considerations, gas powered chain saws are normally used for outside jobs.
    2.1.1.2. Diamond chains and bars of sufficient sizes to complete the job.
    2.1.1.3. Hand tools pertinent to the saw being used.
    2.1.1.4. Vacuuming equipment for Slurry control.
  2.1.2. Provided by owner or contracting agency:
    2.1.2.1. Plastic sheeting
    2.1.2.2. Scaffolding
    2.1.2.3. Storage for water or slurry
    2.1.2.4. Shoring, rigging and rigging equipment for handling or managing the piece to be removed.
    2.1.2.5. Sump area and sump pump
    2.1.2.6. Proper ventilation equipment if gas powered chain saw is to be operated indoors or in a confined space.
    2.1.2.7. Fall protection in accordance with OSHA standard 1926.501(b)(4) for all holes / openings created by the cutting contractor.
2.2. It is the responsibility of the owner or contracting agency to have the location of the area to be cut reviewed, approved and all cut lines clearly marked prior to the start of any cutting operation. A determination should be made by the owner or contracting agency as to whether over cuts are allowed. In addition, it is the responsibility of the owner or contracting agency to clearly mark the location and type of all embedments both on the cut lines and near the cutting area.
2.3. It is the responsibility of the owner or contracting agency to provide water and power for the cutting contractor.
2.4. It is the responsibility of the owner or contracting agency to provide fall protection in accordance with OSHA standard 1926.501(b) for all holes / openings creating by the cutting contractor.
2.5. It is recommended that a pre-job meeting be held with the owner or contracting agency to determine the following information relating to steel reinforcing bar or other embedments:
  2.5.1. Are there steel reinforcing bars or other embedments within the structure to be cut?
  2.5.2. What is the size and location of the steel reinforcing bars or other embedments?
  2.5.3. Is it permissible to cut the steel reinforcing bars or other embedments in the course of the sawing operation?
  2.5.4. Is it possible to lay out the cut line in such a way that minimizes or avoids the cutting of the steel reinforcing bars or other embedments?
  2.5.5. After cutting begins is it permissible to move the cut line to stop splitting a steel reinforcing bar, cutting pre or post stressed cable or other embedments?
2.6. Any scaffolding required by the owner, contracting agency or cutting contractor shall be designed, provided by and erected by competent personnel and according to code requirements.
2.7. The owner or contracting agency must determine if there are utility lines contained within, adjacent to or secured to the structure being cut. If utility lines are present as described, the owner or contracting agency must take the necessary action to have all services cut off to these utilities. If the utilities are buried, the owner or contracting agent must call the appropriate agency for accurate utility location as state or local regulation may require. The cutting contractor must be named on the permit.

2.7.1. If the owner or contracting agency directs that an embedment be intentionally cut whether or not service is turned off, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.7.2. If the layout provided by the owner or contracting agency causes an embedment to be unintentionally cut, then the owner and contracting agency shall protect the cutting contractor from all claims for damages arising from the cutting of the embedment.

2.8. It is the owner or contracting agency's responsibility to provide protection to persons and property from potential water or slurry damage. The cutting contractor shall not be deemed an owner or generator of slurry and the owner and contracting agency shall protect the cutting contractor from all loss and expense associated with such claims.

2.9. The owner or contracting agency shall be responsible for providing proper, safe, and appropriate disposal of slurry.

2.9.1. Collection and disposal of the slurry must be planned for by agreement with the owner of the structure or the owner's agent before work commences.

2.9.2. Barricades, cones, caution tape or other devises as appropriate to keep unauthorized people out of the work area shall be provided by the owner or contracting agency.

2.10. It is the responsibility of the owner or contracting agency to notify the cutting contractor if the saw cuts are to be made on a slab on grade. If the cuts are to be above open space, it is the owner or contracting agency's responsibility to provide damage control and protection for human life.

2.11. Should bracing of the concrete section to be removed be required, it must be installed prior to the completion of the sawing operation. If opening to be removed is to stay in place for an extended period, adequate support is required. The owner or contracting agency shall provide all bracing and engineering required for safe removal unless otherwise agreed to in writing by the cutting contractor.

## 3. Chain Sawing Set-up Procedures

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

3.1 The cutting contractor's equipment must comply with all applicable OSHA standards.

3.2 Clean and inspect the saw, bar and diamond chain for damage before mounting. Never use a saw with a missing, modified or broken side cover.

3.3 The side cover and guard flap should be properly fastened to the saw as per saw manufacturer's specifications.

3.4 Inspect any air, hydraulic or water hoses or electric cords attached to the chain saw for proper condition and fit. Repair or replace as required.

3.5 Confirm the chain is of the proper specification for the material being cut.

3.6 Insure the chain mounted properly. The bumpers provide frontal protection for the diamond segments and should lead the segment into the cut.

3.7 When sawing interior walls or slabs with internal combustion powered saws, precautions must be taken by the owner or contracting agency to provide adequate ventilation, air circulation, and/or oxygen replacement that meet OSHA standards. Other options for interior sawing include electric, hydraulic, or pneumatic powered saws.

3.8 Create rigging holes if necessary into the concrete structure in accordance with work plan.

3.9 The owner or contracting agency shall provide fall protection for all holes / openings creating by the cutting contractor.

## 4. Cutting Operation

Except when the cutting contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

4.1 Do not cut with personnel directly in line with the chain.

4.2 Plan the cutting sequence so that the bottom horizontal cut is not the last one to be completed to prevent the work piece from settling on and causing damage to the saw, bar or chain.

4.3 Notify the owner or contracting agency when the hole/opening is completed so that they can provide fall protection in accordance with OSHA standard 1926.501(b).

# Specification

**Title:** Diamond Blade
**Standard No:** CSDA-DB-112
**Effective Date:** Sep 15, 2006

## 1. General

This specification details the appropriate components involved in the design of a diamond blade. There are many variables in the cutting equation that can affect the performance of a diamond blade including machine horsepower, blade shaft rpm, size of aggregate used in concrete, hardness of aggregate, the strength of the concrete, the depth of cut attempted per pass and the experience and capabilities of the operator. A blade manufacturer must consider all of these variables and more when designing a diamond blade for specific and general purpose applications.

## 2. Table

The table on the next page provides general guidelines for the design specifications of diamond blades, taking into account some of the variables mentioned above.

## CSDA—DB-112 Diamond Blade Specification

| Saw Horsepower (HP) | Blade Diameter (inches) | Segment Thickness (inches) | Moh's Hardness of Aggregate | Diamond Concentration[1] | Diamond Size[1] (mesh) | Diamond Grade[2] | Segment Coverage of Blade Periphery (%) | Diamond Depth of Segment (inches) |
|---|---|---|---|---|---|---|---|---|
| 5 to 18 | 14 to 20 | 0.125 to 0.140 | 4 to 6 | 15 - 20 | 30-50 | low - med | 75 - 80 | 0.300 to 0.400 |
| 5 to 18 | 14 to 20 | 0.125 to 0.140 | 7 to 9 | 17 - 22 | 35-50 | med - high | 75 - 80 | 0.300 to 0.400 |
| 20 to 35 | 14 to 20 | 0.125 to 0.140 | 4 to 6 | 16 - 35 | 30-50 | med - high | 78 - 85 | 0.300 to 0.400 |
| 20 to 35 | 14 to 20 | 0.125 to 0.140 | 7 to 9 | 25 - 40 | 35-50 | high | 78 - 85 | 0.300 to 0.400 |
| 20 to 35 | 14 to 20 | 0.165 to 0.250 | 4 to 6 | 16 - 35 | 30-50 | med - high | 78 - 85 | 0.300 to 0.400 |
| 20 to 35 | 14 to 20 | 0.165 to 0.250 | 7 to 9 | 25 - 40 | 35-50 | high | 78 - 85 | 0.300 to 0.400 |
| 20 to 35 | 24 to 32 | 0.155 to 0.187 | 4 to 6 | 16 - 35 | 30-50 | med - high | 75 - 82 | 0.300 to 0.400 |
| 20 to 35 | 24 to 32 | 0.155 to 0.187 | 7 to 9 | 25 - 40 | 35-50 | high | 75 - 82 | 0.300 to 0.400 |
| 20 to 35 | 24 to 32 | 0.210 to 0.250 | 4 to 6 | 16 - 35 | 30-50 | med - high | 75 - 82 | 0.300 to 0.400 |
| 20 to 35 | 24 to 32 | 0.210 to 0.250 | 7 to 9 | 25 - 40 | 35-50 | high | 75 - 82 | 0.300 to 0.400 |
| 37 and up | 14 to 20 | 0.125 to 0.155 | 4 to 6 | 28 - 45 | 30-50 | med - high | 80 - 85 | 0.300 to 0.450 |
| 37 and up | 14 to 20 | 0.125 to 0.155 | 7 to 9 | 40 - 70 | 35-50 | high | 80 - 85 | 0.300 to 0.450 |
| 37 and up | 14 to 20 | 0.165 to 0.250 | 4 to 6 | 28 - 45 | 30-50 | med - high | 80 - 85 | 0.300 to 0.450 |
| 37 and up | 14 to 20 | 0.165 to 0.250 | 7 to 9 | 40 - 70 | 35-50 | high | 80 - 85 | 0.300 to 0.450 |
| 37 and up | 20 to 32 | 0.155 to 0.187 | 4 to 6 | 28 - 45 | 30-50 | med - high | 75 - 82 | 0.300 to 0.450 |
| 37 and up | 20 to 32 | 0.155 to 0.187 | 7 to 9 | 40 - 70 | 35-50 | high | 75 - 82 | 0.300 to 0.450 |
| 37 and up | 34 to 48 | 0.187 to 0.250 | 4 to 6 | 28 - 45 | 30-50 | med - high | 60 - 75 | 0.300 to 0.450 |
| 37 and up | 34 to 48 | 0.187 to 0.250 | 7 to 9 | 40 - 70 | 35-50 | high | 60 - 75 | 0.300 to 0.450 |

**Notes:**

**1. Concentration/Size:** Based on 100 con = 72 carats of diamond per cubic inch of segment

**2. Diamond Grade:**
High = MBS 960 or SDB 1100
Med = MBS 940 or SDB 1075
Low = MBS 920 or SDB 1045

**3. Steel Core:**
Grade: 4130 or 4135 steel or equivalent
Hardness: RC 36 - 42
ID 1.005" + 0.002/-0.000
Tension: Min 0.002 inch and max 0.008 inch (45lbs @ 90 degrees)
Side run-out: 0.0005 inch per diameter inch
OD run-out 0.005 inch

# Specification

**Title:** Polishing Concrete
**Specification No:** CSDA-PC-113
**Effective Date:** Jun 5, 2008

## 1. Codes, Standards & Definitions

1.1 The polishing contractor shall adhere to all applicable safety guidelines in accordance with Federal, State and local ordinances.
1.2 ASTM C779 – Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces
1.3 ASTM F609 – Standard Test Method for Using a Horizontal Pull Slipmeter (HPS)
1.4 CSDA-ST-115 – Measuring Surface Texture
1.5 Definitions
- 1.5.1 Owner – Legal owner of the slab surface being polished
- 1.5.2 Contracting agency – The Contractor hired directly or indirectly by the owner that is sub-letting the polishing requirements to a polishing contractor.
- 1.5.3 Polishing contractor – The contractor hired to perform the actual polishing operation and is thoroughly trained with the equipment, accessories and chemicals used to perform the work.
- 1.5.4 Surface prep – The work needed to get the slab prepared for the polishing steps.
- 1.5.5 Densifier – clear colorless liquid that has a chemical formulation to penetrate the concrete slab surface to create a synergistic breathable skin in the concrete surface that will increase the hardness, abrasion resistance and 'dust-proofing' qualities.
- 1.5.6 Grinding Methods:
  - 1.5.6.1 Wet Grind – A polishing or grinding step that is performed using water as a coolant. A slurry is created from the water and the grinding debris.
  - 1.5.6.2 Dry Grind - A polishing or grinding step that is performed dry using diamond tools made for dry grinding. The dust is collected using a vacuum and a HEPA equivalent or greater filtering system which collects the dry debris for proper disposal.
- 1.5.7 Accessory Bond:
  - 1.5.7.1 Brazed Diamond – The diamond grit is directly adhered to a tooling plate and does not use any matrix.
  - 1.5.7.2 Metal bond – The metallic matrix holding the diamonds. The properties of the matrix can be designed to alter the performance characteristics for a specific slab surface.
  - 1.5.7.3 Semimetal bond – A hybrid matrix consisting of resin and metals.
  - 1.5.7.4 Resin bond – A polymer and/or resin matrix holding the diamonds.

## 2. Prerequisites

2.1 Normal and customary equipment used on a polishing job include:
- 2.1.1 Grinder/polisher machine, either Rotary or Planetary, typically with an Electric Motor due to exhaust emissions in that most polished concrete floors are indoors.
- 2.1.2 Grinding and polishing accessories. These accessories are used in progressive quantum steps, from course grits to fine grits, and are appropriately sized so each step will remove scratches generated by the previous step. The steps start with a diamond grit size large enough to remove the specified amount of surface damage and inclusions in the concrete slab, and progress to a point where the scratches created by the accessory are no longer visible. Typically, the progression is 40 grit metal bond, 80 grit metal bond, 150 grit metal bond, 100 grit resin, 200 grit resin, 400 grit resin, 800 grit resin, and 1,500 grit resin.
- 2.1.3 Concrete densifier and the appropriate supplies and equipment to properly apply the densifier.
- 2.1.4 Equipment, such as a vacuum, to clean between each step and to control slurry and/or dust generated during the grinding/polishing steps. It is important to clean between each step to prevent debris in the dust or slurry to create additional scratches in the slab surface.
- 2.1.5 Equipment necessary to finish the edges and near obstructions or slab discontinuities.

2.2 It is the responsibility of the owner or contracting agency to have the area to be polished properly identified.
2.3 It is the responsibility of the owner or contracting agency to provide water and power for the polishing contractor.
2.4 It is recommended that a pre-job meeting be held with the owner or contracting agency to determine the following information relating to the overall job:
- 2.4.1 How are the edges to be finished? How close to the wall or vertical surfaces?
- 2.4.2 If the polished floor needs to go beyond 1,200 grit to a 3,000 grit level, that the proper slip tests will be preformed.
- 2.4.3 That all agree on the amount and level of surface prep before the polishing steps.

2.4.4 How are cracks, slab discolorations, oil saturation spots (that will inhibit the use of the densifier), non-uniform exposure of aggregate from the surface prep or early grinding steps are to be handled.

2.5 It is the responsibility of the polishing contractor to clean between each step. If the contractor is wet grinding, the slurry must be collected and properly contained.

2.6 It is the responsibility of the owner or contracting agency for providing proper, safe, and appropriate disposal of slurry.

2.7 Adequate safety provisions must be provided by the owner or contracting agency to protect the operator's work area.

2.7.1 The owner or contracting agency shall provide safe access to and from the work area.

2.7.2 Barricade, cones, warning tape or other devices used to keep unauthorized people out of the work area shall be provided by the owner or contracting agency.

## 3. Polishing Set-up Procedures

Except when the polishing contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

3.1 The polishing contractor's equipment must comply with all applicable OSHA standards.

3.2 Be certain that the proper type and amount of surface prep is done before the polishing of the slab surface begins.

3.3 The diamond grit progression for the job needs to be followed in order. If a step is missed, it is important to start on that step and continue forward in order. When changing from Metal bond to resin, it is important to keep the grit size the same or step back one step on the resin (i.e. from 200 grit metal to the next step as either 200 grit Resin bond or 100 grit Resin bond).

3.4 The machine size, weight and rotational speed, as well as, the slab conditions and properties, will influence the selection of accessories and densifier. Be certain to follow the recommendations of the manufacturer(s).

3.5 The densifier must be applied at a specific point in the polishing process per the chemical manufacture's instructions to maximize the effectiveness and performance.

3.5.1 The densifier should be delivered to the job site in unopened containers and properly labeled/identified with the product name, manufacturer and safety warnings.

3.5.2 Store the densifier properly per the manufacturer instructions. Keep the product from freezing.

3.5.3 Do not apply the product when the air and slab surface temperatures do not fall within the manufacturer recommendations.

3.5.4 The densifier might damage some surfaces including some aluminum and glass surfaces. Be certain to follow the manufacturer instructions.

3.5.5 Properly rinse and neutralize the chemicals used before moving to the next step in the process.

## 4. Polishing Operation

Except when the polishing contractor determines that any of the following steps do not apply to a particular work or that other steps are appropriate:

4.1. Do not operate the polishing machine in an unsafe manner. The surface conditions with wet slurry on a smooth surface can be very slippery during the polishing operation.

# Standard

**Title:** Blade Application Code for Diamond Saw Blades
**Standard No:** CSDA-BC-107
**Effective Date:** Sep 13, 2002
**Revised:** Mar 30, 2004

## 1. General

1.1 This standard establishes an application code for diamond saw blades to help end users identify the intended use of the product.
1.2 The standard applies to specifically to diamond blades 12 inches in diameter or larger but can also be applied to smaller diameters.
1.3 The blades shall be permanently marked with this code by stamp, laser or similar process.
1.4 Blade manufacturers' participation is voluntary.
1.5 This standard is recognized and endorsed by the Masonry and Concrete Saw Manufacturers Institute (SMI), a product-specific group of the Association of Equipment Manufacturers (AEM).

## 2. Format

The code consists of three positions separated by dashes using unique code characters per the chart below.

Additionally, if a blade has multiple applications, it is acceptable to use several characters.

**Examples:**

D-C-H is a blade that can be used wet or dry for cutting cured concrete with a hand-held saw.

W-GAB-F is a wet blade that can cut green concrete, asphalt, brick, block, masonries and refractories and is intended for use on a flat saw.

| Position | Description | Application | Code |
|---|---|---|---|
| 1 | Wet or Dry | Wet Use Only | W |
| | | Wet or Dry Use | D |
| 2 | Media Type | Cured Concrete | C |
| | | Green Concrete | G |
| | | Asphalt | A |
| | | Asphalt over Concrete | O |
| | | Brick, Block, Masonries, Refractories | B |
| | | Tile, Ceramic, Stone | T |
| 3 | Saw Type | Flat Saw | F |
| | | Wall Saw | W |
| | | Hand-held Saw | H |
| | | Stationary Saw | S |
| | | Masonry or Tile Saw | M |

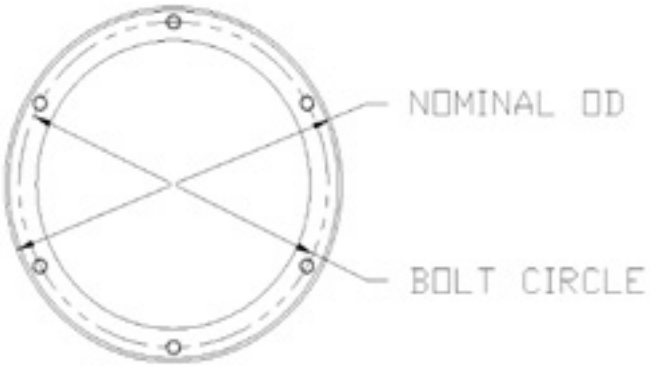
# Standard

**Title:** Bolt Together Core Bits
**Specification No:** CSDA-BB-110
**Effective Date:** Mar 30, 2004

## 1. General

1.1 This document standardizes the bolt circle, number of bolts and bolt threads of “light weight”, 1-inch inner ring, bolt together core bits. The bolts are equally spaced.

1.2 All dimensions are inches.




| NOMINAL OD | BOLT CIRCLE | NUMBER of BOLTS | BOLT THREADS |
|---|---|---|---|
| 12 | 11 | 6 | 1/2-20 |
| 13 | 12 | 6 | 1/2-20 |
| 14 | 13 | 6 | 1/2-20 |
| 15 | 14 | 6 | 1/2-20 |
| 16 | 15 | 6 | 1/2-20 |
| 17 | 16 | 6 | 1/2-20 |
| 18 | 17 | 6 | 1/2-20 |
| 19 | 18 | 6 | 1/2-20 |
| 20 | 19 | 6 | 1/2-20 |
| 22 | 21 | 6 | 1/2-20 |
| 3 | 22 | 6 | 1/2-20 |
| 24 | 23 | 6 | 1/2-20 |
| 25 | 24 | 6 | 1/2-20 |
| 26 | 25 | 6 | 1/2-20 |
| 28 | 27 | 6 | 1/2-20 |
| 30 | 29 | 6 | 1/2-20 |
| 32 | 31 | 8 | 5/8-18 |
| 34 | 33 | 8 | 5/8-18 |
| 36 | 35 | 8 | 5/8-18 |
| 38 | 37 | 8 | 5/8-18 |
| 40 | 39 | 8 | 5/8-18 |
| 44 | 43 | 8 | 5/8-18 |
| 46 | 45 | 8 | 5/8-18 |
| 48 | 47 | 8 | 5/8-18 |

# Standard

**Title:** Continuous Tube Threads
**Specification No:** CSDA-CT-111
**Effective Date:** Mar 30, 2004

## 1. General

1.1 This document standardizes the thread type, pitch and length on continuous tube and continental core bits.
1.2 All threads are right hand, 5-degree modified square threads.
1.3 All dimensions are inches.

| Nominal Diameter | Wall Thickness | Thread Length | Threads per Inch |
|---|---|---|---|
| 1 to 6 | 0.120 | 1.75 | 4 |
| 1 to 6 | 0.156 | 1.75 | 4 |
| 1 to 10 | 0.188 | 1.94 | 3 |
| 6 to 10 | 0.250 | 1.94 | 3 |

# Standard

**Title:** Measuring Concrete Micro Surface Texture
**Specification No:** CSDA-ST-115
**Effective Date:** Jun 12, 2014

## Foreword

This is the first CSDA standard for measuring concrete surfaces for their surface texture value. This specification is the culmination of a major effort and input by members of various committees related to the industries of concrete and surface metrology from ASME, ASTM, ACI and CSDA. A considerable amount of information regarding surface measurement techniques and surface parameters in practical use has been considered and taken into account. Surface metrology is the study of surface geometry, also called surface texture or surface roughness. It examines the real value of the measurement of small-scale features on surfaces.

The approach is to measure and analyze the surface texture in order to understand how the texture is influenced by the finishing process, and how the surface texture influences its behavior with regards to gloss, friction and sustainability. The vision for this standard is to obtain a quantitative measure of concrete surface profile by contact instruments. It is also important to keep abreast of the latest developments in contact profiling techniques, where the degree of measurement control becomes more highly advanced, and encompass a filtered range of other techniques that present valid and useful descriptions of surface texture.

The measurement parameter for the basis of this standard is Ra (roughness average) by contact stylus instruments. Many surface finish height parameters are currently in use and measure various surfaces materials. They distinguish certain characteristics about the working part, the ways in which the surface was processed and finally how it was finished. These characteristics include waviness, lay and process direction.

This standard is concerned with numerically quantifying geometric irregularities of the machined and processed finish that is produced as a result of a particular specified level of surface refinement of concrete finishes. Particular means and methods of producing polished concrete surfaces are not suggested nor are they recommended for any specified level of finish in this document.

The terms in this Standard relate directly to concrete surfaces produced by such means as abrading, cutting, grinding, milling, honing and polishing.

This Standard is not concerned with error of form and flaws of concrete substrates, but discusses these two factors to distinguish them from surface texture metering. This standard is not concerned with luster, appearance, color, corrosion resistance, wear resistance, hardness, subsurface microstructure, surface integrity and other characteristics which may govern functional considerations in specific applications. However, historical data with similar specifications and standards has proven reflective value, performance characteristics and sustainability due to its processed level of specified finish. This section does not recommend specific surface texture suitable for specific purposes, nor does it specify the means by which these irregularities may be produced.

Criteria for the selection of surface qualities and information on techniques and methods for producing, controlling and inspecting surfaces are included in Specification CSDA-PC-113 Polishing Concrete and Best Practice CSDA-BP-008 Polished Concrete Floors. Surface texture designations, as delineated in this standard, may not provide a sufficient set of indexes for describing performance of a concrete surface. A range of variable components can severely compromise the integrity of mass concrete, such as water to cement ratios, density, geometrical characteristics, design mix materials and structural stability.

## References


ASME B46.1-2009 (R2002), Surface Texture (Surface Roughness, Waviness, and Lay)

ASME B89.6.2-1973 (R2003), Temperature and Humidity Environment for Dimensional Measurement

ASME Y14.5M-1994 (R2004), Dimensioning and Tolerancing, Engineering Drawings and Related Documentation Practices

ISO 1302:2002, Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation

ASTM C805/C805M-13 (R2013), Standard Test Method for Rebound Number of Hardened Concrete

## Table of Contents



## 1. Executive Summary

This document is a guide to measure various levels of surface texture for the concrete finishing and concrete polishing industry. It establishes a uniform system for the identification and specification of the geometric irregularities of concrete surfaces. It also provides, through the use of numerical classifications, a means for accurately expressing surface roughness and surface texture on drawings, specifications and verbal expressions.

**Scope:** This standard covers surface irregularities with respect to their height and width. It shall replace all former documentation for specifying concrete finishes and shall apply to any concrete surface of sufficient hardness to be evaluated in terms of micro inches under the provisions herein specified.

**Materials and Processes:** This document is not concerned with the concrete materials integrity or analysis, microstructure, corrosion resistance, appearance, luster, color or like characteristics except when specified for a particular application.

**Surface Refinement and Processing Methods:** Surface roughness and surface texture designation is not intended to be directly associated with any method of producing a surface texture. Therefore, unless otherwise specified, the surface refinement activity may use any available manufacturing or proprietary method that will produce the specified finish grade.

**Cleanliness:** Surfaces to be measured should be free of any foreign material that would interfere with the measurement.

**Units of Measure:** Values of quantities stated in this document are indicated in units of SI (metric) or US measurement standards and noted as such.

**Ra is the average roughness and is the parameter used as the basis of this document.**

**Filtering:** Modern surface texture measuring instruments record the stylus movement over the evaluation length electronically and can produce output readings to a significant level of detail. The instruments measure the roughness variations and the waviness variations. There are three characteristics of filtering that should be acknowledged to understand the parameter values that an instrument may calculate. Filtering is necessary to separate roughness from waviness or waviness from form error. Separating the roughness and waviness is achieved by using filter cut-offs.

$\lambda c$ = the roughness long wavelength cut-off. This filter specifies the long spatial wavelength cut-off and is defined as the wavelength where the filter will attenuate the true profile by 50%. In the roughness requirement, this value is the sampling length. Spatial wavelengths substantially greater than $\lambda c$ are severely attenuated and minimally contribute to the roughness measurement.

$\lambda s$ = the roughness short wavelength cut-off. This filter specifies the short spatial wavelength cut-off and is defined as the wavelength where the filter will attenuate the true profile by 50%. This filter defines the wavelength where the filter will attenuate the true profile by 50%. Spatial wavelengths substantially less than $\lambda s$ are severely attenuated and minimally contribute to the roughness measurement.

**Stylus Tip Radius:** The stylus tip radius may be chosen by the designer or metrologist based on the value of $\lambda s$ (i.e., the short wave cut-off). For $\lambda s$ equal to 2.5 µm, the tip radius should typically be 2 µm or less.

For λs equal to 8 µm, the tip radius should typically be 5 µm or less. For λs equal to 25 µm, the tip radius should typically be 10 µm or less.

**Stylus Force:** The maximum static measuring force is determined by the radius of the stylus. It is chosen to assure minimal damage to the surface and that constant contact is maintained with the surface. Specific recommendations for stylus force are the responsibility of the manufacturer and the processor. The established stylus force must fall within the parameters of ASME B46.1-2009 (R2002), Surface Texture (Surface Roughness, Waviness, and Lay).

**Measurement Parameters:** Many surface finish height parameters are currently in use. From the simplest specification of a single roughness parameter to multiple roughness and waviness parameter specifications of a given surface, product designers have many options for specifying surface texture to control surface function. Ra (Average Roughness) is the base parameter of the surface texture standard. Average roughness is the arithmetic average of the absolute profile deviations from the mean line within the evaluation length. Graphically, this is the area between the roughness profile and the mean line divided by the evaluation length.

## Terms and Definitions

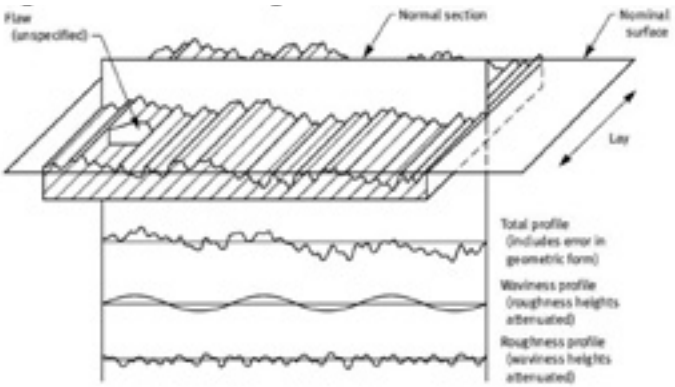
***surface:*** the boundary that separates an object from another object, substance or space.

***nominal surface:*** the intended surface boundary (exclusive of any intended surface roughness), the shape and extent of which is usually shown and dimensioned on a drawing or descriptive specification (see Fig. 1-1).

***real surface:*** the actual boundary of an object. Its deviations from the nominal surface stem from the processes that produce the surface.

***measured surface:*** a representation of the real surface obtained by the use of a measuring instrument.

Fig. 1-1 Schematic Diagram of Surface Characteristics




**Components of the Real Surface** – The real surface differs from the nominal surface to the extent that it exhibits surface texture, flaws, and errors of form. It is considered as the linear superposition of roughness, waviness and form with the addition of flaws.

***surface texture:*** the composite of certain deviations that are typical of the real surface. It includes roughness and waviness.

***roughness:*** the finer spaced irregularities of the surface texture that usually result from the inherent action of the production process or material condition.

***waviness:*** the more widely spaced component of the surface texture. Waviness may be caused by such factors as machine or workpiece deflections, vibration and chatter. Roughness may be considered as superimposed on a wavy surface.

***lay:*** the predominant direction of the surface pattern, ordinarily determined by the production method used.

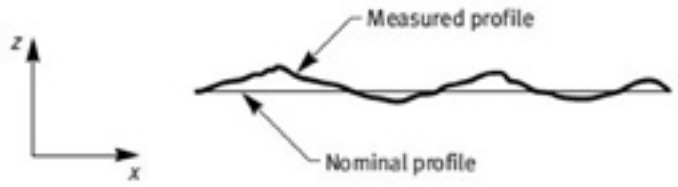
***error of form:*** widely spaced deviations of the real surface from the nominal surface, which are not included in surface texture. The term is applied to deviations caused by such factors as errors in machine tool ways, guides or spindles, insecure clamping or incorrect alignment of the working surface, or uneven wear. Out-of-flatness is a typical example.

***flaws:*** unintentional, unexpected and unwanted interruptions in the topography typical of a surface. These topographical interruptions are considered to be flaws only when agreed upon in advance by buyer and seller.

If flaws are specified, the surface should be inspected by a mutually-agreed method to determine whether flaws are present and are to be rejected or accepted prior to performing final surface finishing measurements. If specified flaws are not present, or if flaws are not specified, then interruptions in the surface topography of an engineering component may be included in roughness measurements.

**Definitions Related to the Measurement of Surface Texture by Profiling Methods –** The features defined above are inherent to surfaces and are independent of the method of measurement. Methods of measurement of surface texture can be classified generally as contact or noncontact methods and as three-dimensional (area) or two-dimensional (profile) methods.

Fig. 1-2 Measured Versus Nominal Profile




***profile:*** the curve of intersection of a normal sectioning plane with the surface (see Fig. 1-2).

***profiling method:*** a surface scanning measurement technique that produces a two-dimensional graph or profile of the surface irregularities as measurement data.

***nominal profile:*** a profile of the nominal surface; a straight line or smooth curve (see Fig. 1-2).

***real profile:*** a profile of the real surface.

***measured profile:*** a representation of the real profile obtained by a measuring instrument (see Fig. 1-2). The profile is usually drawn in a x-z coordinate system.

***primary profile:*** primary profile; a modified profile after the application of the short wavelength filter, ls.

**NOTE:** This corresponds to the primary profile as per ISO 3274:1996.

***roughness profile:*** the modified profile obtained by filtering to attenuate the longer spatial wavelengths associated with waviness.

***waviness profile:*** the modified profile obtained by filtering to attenuate the shorter spatial wavelengths associated with roughness and the longer spatial wavelengths.

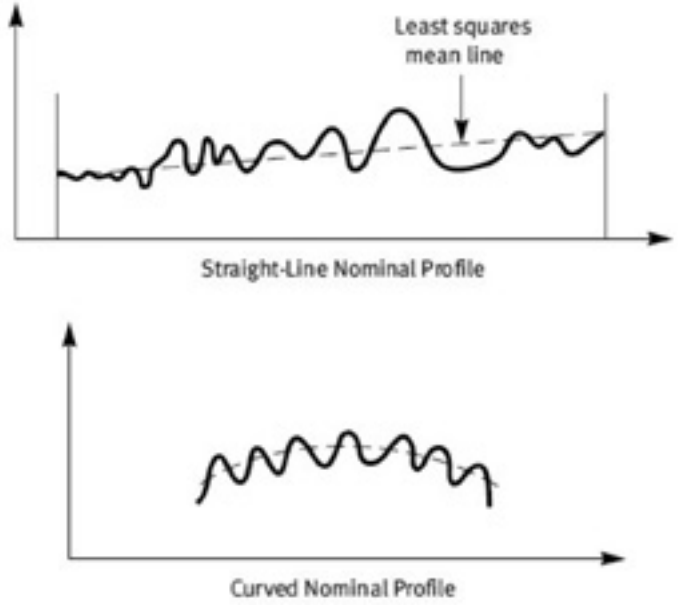



Fig. 1-4 Examples of Nominal Profiles

**Aspect Ratio –** In displays of surface profiles generated by instruments, heights are usually magnified many times more than distances along the profile. The sharp peaks and valleys and the steep slopes seen on such profile representations of surfaces are thus greatly distorted images of the relatively gentle slopes characteristic of actual measured profiles.

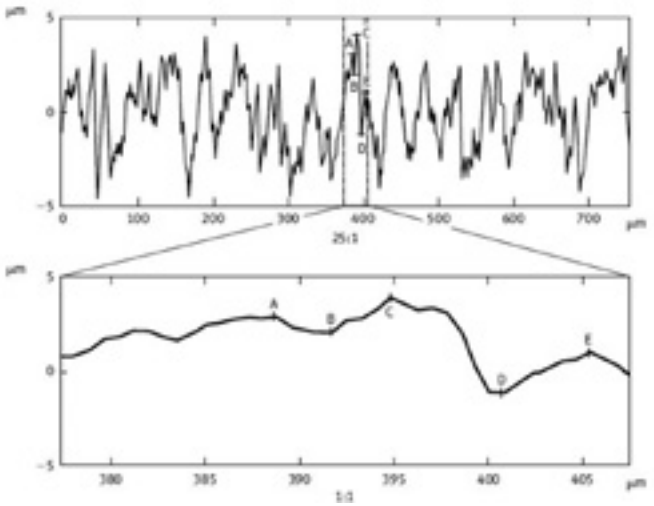



Fig. 1-3 Stylus Profile Displayed With Two Different Aspect Ratios

***profile peak:*** the point of maximum height on a portion of a profile that lies above the mean line and between two intersections of the profile with the mean line (see Fig. 1-6).

***profile valley:*** the point of maximum depth on a portion of a profile that lies below the mean line and between two intersections of the profile with the mean line (see Fig. 1-6).

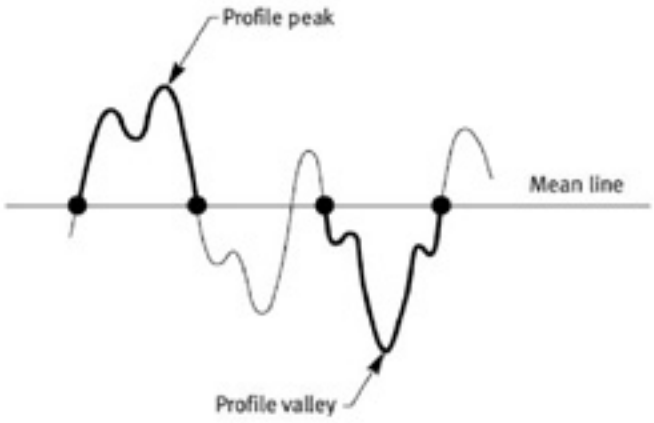



Fig. 1-6 Profile Peak and Valley

***spacing:*** the distance between specified points on the profile measured along the nominal profile.

***roughness spacing:*** the average spacing between adjacent peaks of the measured roughness profile within the roughness sampling length.

***waviness spacing:*** the average spacing between adjacent peaks of the measured waviness profile within the waviness long-wavelength cut-off.

***spatial wavelength,*** λ: the lateral spacing between adjacent peaks of a purely sinusoidal profile.

***spatial (x) resolution:*** for an instrument, the smallest surface spatial wavelength that can be resolved to 50% of its actual amplitude. This is determined by such characteristics of the measuring instrument as the sampling interval (defined below), radius of the stylus tip or optical probe size. This is a key specification for a measuring instrument.

**NOTE:** Concerning resolution, the sensitivity of an instrument to measure the heights of small surface features may depend on the combination of the spatial resolution and the feature spacing, as well as the system height resolution.

***sampling interval:*** the lateral point-to-point spacing of a digitized profile (see Fig. 1-8). The minimum spatial wavelength to be included in the profile analysis should be at least five times the sampling interval.

***traversing length:*** the length of profile, which is traversed by a profiling instrument to establish a representative evaluation length. Because of end effects in profile measurements, the traversing length must be longer than the evaluation length (see Fig. 1-7).

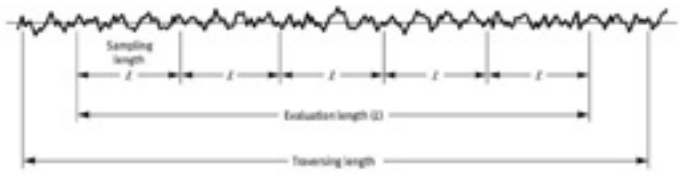



Fig. 1-7 Surface Profile Measurement Lengths

***evaluation length (L):*** length in the direction of the X-axis used for assessing the profile under evaluation. The evaluation length for roughness is termed Lr and the evaluation length for waviness is termed Lw.

***sampling length (l):*** length in the direction of the X-axis used for identifying the widest irregularities that are of interest for the profile under evaluation. The sampling length is always less than or equal to the evaluation length. The sampling length for roughness is termed lr and the sampling length for waviness is termed lw.

***roughness sampling length, lr:*** the sampling length specified to separate the profile irregularities designated as roughness from those irregularities designated as waviness. The roughness sampling length may be determined by electrical analog filtering, digital filtering or geometrical truncation of the profile into the appropriate lengths.

***roughness long-wavelength cut-off, λc:*** the nominal rating in millimeters (mm) of the electrical or digital filter that attenuates the long wavelengths of the surface profile to yield the roughness profile. When an electrical or digital filter is used, the roughness long-wavelength cut-off value determines and is equal to the roughness sampling length (i.e., Lr p λc). The range of selectable roughness long-wavelength cut-offs is a key specification for a surface measuring instrument.

***roughness short-wavelength cut-off, λs:*** the spatial wavelength shorter than which the fine asperities for the surface roughness profile are attenuated. The nominal values of this parameter are expressed in micrometers (λm). This attenuation may be realized in three ways: mechanically because of the finite tip radius, electrically by an antialiasing filter or digitally by smoothing the data points.

***waviness sampling length, lw:*** the sampling length specified to separate the profile irregularities designated as waviness from those irregularities designated as form. The waviness sampling length may be determined by electrical analog filtering, digital filtering or geometrical truncation of the profile into the appropriate lengths.

***waviness long-wavelength cut-off, λcw:*** the spatial wavelength longer than which the widely spaced undulations of the surface profile are attenuated to separate form from waviness. When an electrical or digital filter is used, the waviness long-wavelength cut-off value determines and is equal to the waviness sampling length (i.e., Lw=λcw). The range of selectable waviness long wavelength cut-offs is a key specification for a surface measuring instrument.

***waviness short-wavelength cut-off, λsw:*** the spatial wavelength shorter than which the roughness profile fluctuations of the surface profile are attenuated by electrical or digital filters. This rating is generally set equal in value to the corresponding roughness long-wavelength cut-off (λsw p lc).

**Misc Definitions**

**abrasive grain:** a small, hard particle or crystal of abrasive material used to machine, grind or finish a work piece.

**amplified:** to make something larger, to exaggerate detail. A profilometer amplifies surface roughness.

**average roughness:** The arithmetic mean of the absolute deviations from the mean profile over the evaluation length.

**calibration:** the comparison of a device with unknown accuracy to a device with a known, accurate standard to eliminate any variation in the device being checked.

**comparison measurement:** a measurement that compares the surface of a machined part with a standard surface. Inspectors often use their sense of sight and touch to perform comparison measurements.

**cut-off:** the sample length on the surface of a part that a stylus-type instrument measures. The cut-off length is often specified on a part drawing.

**diamond stylus:** a cone-shaped spherical point made of diamond that contacts and measures surface roughness. Diamond is the hardest available material and is wear resistant.

**dimensional properties:** the characteristics of a surface that affect the way it performs. Rough surface texture can cause a surface to prematurely wear and does not have reflective value.

**direct measurement:** a measurement that calculates the average roughness value by tracing the surface with a stylus-type instrument.

**lay:** the overall direction of the pattern created by the production process.

**machining:** the process of removing necessary damage and stock from the cementicous surface to form a specified finish, by means of methods such as: cutting, grinding, milling, honing or polishing.

**measured surface:** the surface that represents the real surface after it has been measured. The measured surface determines how much the real surface deviates from the nominal surface.

**microinches:** one-millionth (.000001) of the U.S. standard inch. Microinch is abbreviated µ.

**nominal surface:** the surface that represents the desired specifications on a part drawing. The nominal surface does not have surface irregularities and is geometrically perfect.

**peak:** the point of maximum height on the surface of a part that lies above the average line.

**physical properties:** the characteristics of a surface that affect the way it performs a task. Physical properties affect the way a surface bonds, coats or resists corrosion.

**precision reference specimen:** a small, square plate that has standard surface characteristics. Precision reference specimens are used to calibrate profilometers.

**probe:** a device attached to a measuring instrument that uses a stylus tip to contact the surface of a part.

**process stability:** The consistency of a process over a period of time.

**profilometer:** a device that uses a stylus to trace the profile of the part to determine average roughness.

**real surface:** The actual surface produced by a machining process. The real surface contains imperfections.

**roughness:** the inherent, fine, closely-spaced irregularities created by the production process.

**skid:** a metal rest that is attached to the probe on a profilometer. The skid moves with the stylus to measure the average roughness of the surface.

**skidded gage:** a type of profilometer that has a metal rest pad, or skid, that rests on the part. The stylus and skid move together to measure the average roughness.

**skidless gage:** a type of profilometer that moves relative to an internal reference surface. Skidless gages measure the entire profile of the part.

**stylus-type device:** a measuring instrument with a cone-shaped spherical tip connected to a probe. The stylus contacts the part and traces its surface irregularities.

**surface finish:** the smoothness of a machined surface after it has been measured. Surface finish is the complete, desired surface.

**surface texture:** the combination of the imperfections on the surface of a part. Roughness, waviness, lay, and flaws make up surface texture.

**tolerance:** an unwanted but acceptable deviation from a given dimension. Tolerances indicate the allowable difference between a physical feature and its intended design.

**valley:** the point of maximum depth on the surface of a part that lies below the average line. Inspectors often measure the height from the valley to the peak.

**variation:** a difference between two or more similar things.

## 3. Approved Instruments for Surface Texture Measurement

### Scope

Contact, skidded instruments and procedures used to determine roughness values of a given surface are the basis of this document. They shall comply with the specifications in this section with consideration upon the effective size of the skid relative to the surface spatial wavelengths and amplitudes to be measured. Waviness is not accurately measured with a skidded instrument but is not the basis parameter of this document. Therefore, it is generally recommended that waviness be measured with a skidless instrument. The importance of specifying a portable device with accurate results, remote operation and economic considerations have been taken into account with this standard document.

**Types IV and V Instruments –** Many instruments for measuring surface roughness depend on electrical processing of the signal produced by the vertical motion of a contacting probe traversed along the surface, in general, perpendicular to the lay direction. A convenient means of providing a reference surface for measuring probe movement is to support the tracer containing the probe on skids whose radii are large compared to the height and spacing of the irregularities being measured. This document is concerned only with such tracer type instruments using skidded, contact probes (see Fig. 4-1).

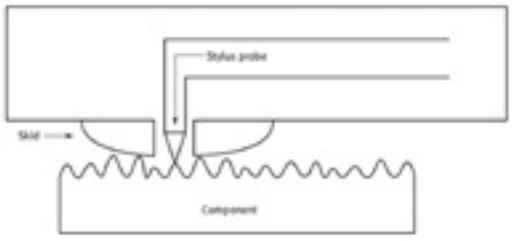



Fig. 4-1 Schematic Diagrams of a Typical Stylus Probe and Fringe-Field Capacitance Probe

### Purpose

The purpose of this section is to foster the uniformity of surface roughness evaluation among contact, skidded instruments and to allow the specification of desired surface texture values with assurance of securing repeatable results. Special configurations of instruments for special purposes such as small radius skids, long styli, non-contact, fast response and special cut-off characteristics do not meet the requirements of this section but are useful for comparative purposes. The instrument manufacturer shall supply information where deviations exist.

## 4. Instrumentation

**Roughness Average Value Ra From Averaging and Digital Readout Instruments –** (a) The readout device shall display the average deviation from the filtered mean line in lin (lm.). This quantity is the roughness average Ra, formerly known as arithmetic average (AA) and centerline average (CLA). The filtered mean line is also described in an earlier Section.

(b) For uniform interpretation of readings from contact type instruments of the averaging type, it should be understood that the reading which is considered significant is the mean reading around which the value tends to dwell or fluctuate with a small amplitude.

Analog meters are damped to minimize acute deflections; nevertheless, extremely high and low momentary readings often occur. These anomalous readings are not representative of the average surface condition, and such readings should not be used in determining roughness average. An instrument with a digital readout integrates these high and low momentary readings and displays the surface roughness averaged over a significant length of surface profile.

**Cut-off Selection. –** In all cases, the cut-off (λc) Values and reference table must comply with ASME B46 Standard.

**Recommendation to Settle Interpretation Disputes –** In cases of disagreement regarding the interpretation of surface texture measurements, it is recommended that measurements with a Type I (skidless) instrument with Gaussian (50%) filtering to be used as the basis for interpretation.

**Profile Filter –** The profile filter is the filter which separates the roughness (R) from the waviness (W) and form error (F) components of the primary profile (P). This filter consists of either an analog or a digital implementation of a 2RC or a Gaussian filter.

**Profile Filter Evaluation Length –** Typically the evaluation length is chosen to include at least five roughness long-wavelength cut-off lengths (lc). However, depending on the size of the measurement area, it may be necessary to limit the evaluation length to include less than five roughness cut-off lengths (lc). In this case, the evaluation length used should be noted on the appropriate documentation. Some instruments may automatically change the roughness long-wavelength cut-off to maintain five cut-off lengths within the evaluation length. Therefore, care must be taken to ensure that the proper roughness cutoff length (lc) is used.

**Profile Recording and Display –** After filtering, the measured profile is typically plotted on a graph, documentation or drawings for visual interpretation. Digital instruments can also store the discrete data points

for further numerical analysis and graphical display. Refer to specific performance based specifications for detailed instruction of proper recording requirements.

## 5. Measurement Procedure

The following section provides guidelines for the use of Skidded instruments in the measurement of concrete surfaces.

**Stylus Visual Inspection –** Prior to its use, the stylus should be visually inspected for cleanliness and mechanical integrity. If the stylus tip is loose, if the shaft is bent or if the mounting surfaces (for a detachable stylus) appear to have excessive wear, the stylus should be repaired or replaced. The stylus must also be clean and free from any lint or residual film left from the cleaning process.

**Magnified Inspection –** The stylus tip should also be inspected with the aid of a magnification device (for example, a microscope, optical comparator, jewelers loop). Once again, a broken or worn stylus should be repaired or replaced.

**Instrument Calibration –** The instrument should be calibrated according to the instrument manufacturer's specifications using a precision reference specimen traceable to the SI unit of length. This specimen should also be clean and free from signs of wear, which may affect the calibration of the instrument. Measurements of the precision reference specimen must be within the stated uncertainty of the precision reference specimen.

**Testing Surface Cleanliness –** The concrete surface to be assessed should be cleaned with a non-damaging solvent and is to be free from any residual film or other debris prior to measurement. If measuring a surface for Surface Texture Grade Compliance, metering results must be recorded prior to application of topically applied sealers and/or performance enhancement coatings.

**Surface Integrity –** A visual assessment of the concrete surface should be made to determine a representative portion of the surface on which the trace is to be made. Concrete by nature and design is a product inherent of flaws and irregularity. The quantity of paste removed will ultimately determine the amount of damage such as air voids, craze cracks and roll out that is exposed and potentially metered.

It is quite possible that the specified finish was achieved after the surface was processed, but the damage at the new surface and the concrete matrix will impede a complying finish. It is important to heed this detail and plan accordingly. Designated sampling areas that need to be filled with grouting systems or epoxy fillers should be installed before the last grinding step with a metal bond abrasive disc. Grouting agents and epoxy fillers are not products intended to be above the mean line of the profile. Any readings taken where these filling agents are above the mean profile line are automatically disqualified.

**Surface Hardness Consistency Testing (Reading the Real Profile) –** It may be determined that a grouting system needs to be applied to the sampling area to comply with the specified texture finish because excessive form and flaw has been identified in the sub-surface of the concrete. In this case, it will be necessary to test the designated sampling areas for hardness to ensure the sample area is a true reading of the profile produced by the refinement process. It should not be a reading of a grouting agent or topical coating.

Grouting systems and filling agents are understood to be necessary to conform with texture assignments, though they are also intended to be used only as fillers that reside below the mean line of the profile and adhere to the matrix of the concrete. The surface hardness consistency is verified by performing rebound tests using ASTM Standard C805 with a Schmidt hammer in two testing zones. One located adjacent to and within 1 square foot of the designated testing zone, and the other within the testing zone. Testing results inside the test zone are deemed acceptable if the variance is no less than 10% of the adjacent hardness average of the two rebound test areas. If tests within the designated testing zone fall outside of the allowable 10% variance, additional grinding will be required to remove excessive grouting agents or fillers that reside above the mean line.

**Instrument/Surface Leveling and Alignment –** The instrument and surface should be aligned so that the underlying geometry of the surface under test, and its relationship to the traverse, minimize total stylus displacement during measurement over the evaluation length. For flat surfaces, this requires the surface under test to be leveled relative to the instrument traverse unit.

**Assessment of the Finished Surface –** Upon fulfilling the above requirements, the stylus may be positioned and the measurement made. If a parameter measurement is required, for example the roughness parameter Ra, the value can be obtained after proper filtering.

**Quantity of Meter Readings –** 1 texture sample zone reading shall be designated taken for every 500 square feet of the specified finish to take mean readings. If the project is less than 500 total square feet then, 1 texture sample zone reading shall be designated taken for every 100 square feet. Ready mixed concrete is produced off site in batches of approximately 10 cubic yards and delivered to the site with a mixer truck. Slabs placed at 6 inches will yield 525 total square feet.

This measurement process of mean readings will provide more complete data to the relative surface texture produced in particular areas if adjustments have been made to the concrete design mix that inherently effects that overall hardness of the concrete design mixture. Measurement readings shall be taken by means of: average of statistical measurements.

**Statistical Average or Mean Readings –** The mean value is also referred to and called the "average." Calculate the mean in each designated sample zone by adding eight total texture measurements in a group and then dividing the sum by eight to achieve the mean average result. Record the final resulting reading by either STG code designation or Ra, or both if not clearly specified on the engineering plans or architectural specification documents.

**Instrument Accuracy –** The Ra indication of an instrument to a sinusoidal mechanical input of known amplitude and frequency within the amplitude and the cut-off range of the instrument shall not deviate by more than ±5% from the true Ra value of the input.

**Operational Accuracy –** Instrument calibration for Ra measurement should be checked using precision roughness specimens at one or two points in the measurement range, depending on the manufacturer's instructions. If two precision reference specimens are used, one should be characterized by a large Ra for checking calibration and the second by a small Ra for checking linearity. Stylus check specimens should not be used for this purpose. If the Ra measurement on either specimen differs by more than 10% of the calibrated value, instrument recalibration is required.

## 6. Production and Process of Surface Texture

This document is intended to organize the language and narrow the perception of finishes produced on newly-placed and post-cure finishing systems of cast-in-place concrete using a numerical designation code and representative symbol for the specified level of finish. Surface texture should not be controlled on a drawing or specification unless such control is essential to the functional performance or appearance of the concrete surface. Unnecessary specifications may increase processing costs and reduce the emphasis on other more critical surface specifications.

Concrete surfaces such as those in high impact/high traffic conditions are typical of surfaces that require control of the surface characteristics to perform optimally. Non-performance surfaces such as tilt wall panels and vertical structural concrete seldom require any surface texture control. Experimentation or experience with surfaces performing similar functions is the best criterion on which to base selection of optimum surface characteristics.

Determination of required characteristics for finished surfaces may involve consideration of such conditions as the area of contact, the load, speed, direction of motion and material and physical characteristics of concrete design mixes. Variations in any one of the conditions may require changes in the specified surface characteristics.

## 7. Production

Surface texture is a result of the processing method. Surfaces obtained from polishing or burnishing have undergone some plastic deformation. For surfaces that are milled, ground or honed, the texture is the result of the action of cutting tools, abrasives or other forces. It is important to understand that surfaces with similar roughness average ratings may not have the same performance due to tool transfer, subsurface effects or different profile characteristics. The ability of a processing operation to produce a specific surface texture depends on many factors. For example, in surface grinding the final surface depends on the peripheral speed of the abrasive disc, the speed of the traverse, the rate of feed, the grit size, bonding material and condition of the abrasive tool, the amount and type of lubrication at the point of cutting and the mechanical properties of the concrete surface being ground. A small change in any of the above factors may have a marked effect on the surface produced.

## 8. Inspection and Test Pilots

Although this document permits considerable latitude in the method of producing and inspecting a surface, it specifies limits on the characteristics of measuring instruments, roughness comparison specimens and precision reference specimens. These specifications are essential for the reliable measurement of surface parameters and are thus necessary for establishing and maintaining control of surface texture. The instruments permit the accurate measurement of characterization parameters for surfaces generated in production.

The precision reference specimens provide an accurate means of calibrating the measuring instruments.

The texture comparison specimens allow engineers or designers to obtain an approximate idea of the surface textures produced by various finishing processes. One of the methods of control and inspection is the use of pilot specimens. These are actual finished surfaces from the production setup that conform to the surface requirements specified on the drawings and related specifications.

To assure reasonable accuracy, the surface texture of pilot specimens should be measured by calibrated instruments. Pilot specimens are can be used as a tool to manage the expectation of the specified finish as a calibrated and approved finish. This is done before normal finishing production begins on the project, insuring the same machine setup is used.

This way, it may be possible to determine through physical characteristics, like sight or touch, if a finish deviates significantly from the established norm indicated by the pilot specimen. If control is required in more than one zone of the project, multiple pilot specimens may be placed as long as the same measuring device is used and all pilot specimens possess the same texture finish. Fabricated replicas of the pilot specimen are only approved for the submittal process of the project and are not acceptable to be used for on-site comparisons.

Optical reflectivity is not necessarily a reliable index of surface texture. This is because reflectivity is dependent on such factors as the specular properties of the material, the lighting conditions, viewing angle, roughness, irregularity spacing and color, as well as roughness height. There is no reliable numerical value between surface texture and gloss metrology that can provide a consistent parallel of results between gloss readings and surface texture readings on the same calibrated finish. In addition, a gloss meter cannot differentiate between a finish produced at high quality standards of refinement and a finish produced by applying a coat of wax.

## 9. Documenting & Recording Surface Texture Readings

When encountering the CSDA-ST-115 in a construction specification or construction document, it is required that all corresponding Grade Symbols located on floor plans or legend charts be properly documented. The resulting reading by the authorized field recorder and last known calibration by identification of date, time and initials of the authorized recorder should be recorded on approved record keeping forms. These reports shall be submitted to the responsible commissioning party or parties.

Surface Texture Finishes Chart

| (STG) Surface Texture Grade | Unit of Measure = Ra | | Surface Grade |
|---|---|---|---|
| | µin | µm | |
| A-1 | 2 | 0.0508 | Finish by Design Spec. |
| A-2 | 4 | 0.1016 | Finish by Design Spec. |
| A-3 | 8 | 0.2032 | High Polish |
| B-1 | 16 | 0.4064 | Medium Polish |
| B-2 | 32 | 0.8128 | Low Polish |
| B-3 | 64 | 1.6256 | Honed Smooth |
| C-1 | 125 | 3.175 | Honed |
| C-2 | 250 | 6.35 | Ground |
| C-3 | 500 | 12.7 | Heavy Texture |

Comparative Analysis Reference Chart

| (STG) Surface Texture Grade | Comparative Industry Averages | | Produced Finish |
|---|---|---|---|
| | Gloss Reading | DOI | |
| A-1 | Finish by Design Spec. | | Ultimate Finish |
| A-2 | Finish by Design Spec. | | Super Finish |
| A-3 | 75-80 | 0.2032 | 3000 Grit |
| B-1 | 65-75 | 0.4064 | 1500 Grit |
| B-2 | 40-65 | 0.8128 | 800 Grit |
| B-3 | 30-40 | 1.6256 | 400 Grit |
| C-1 | 25 and less | 3.175 | 200 Grit |
| C-2 | 15 and less | 6.35 | 100 Grit |
| C-3 | 5 and less | 12.7 | 50 Grit |

*This reference chart is for comparative analysis only and is not a suggested parameter to be used as a basis for a polished concrete specification.

## 10. Control of Surface Texture

It is typical for specifiers of concrete surfaces to require control of surface characteristics to achieve optimum performance, but should be in accordance with the procedure outlined in this document. In general, concrete surfaces and those requiring a high degree of smoothness for appearance and duty, should be controlled in accordance with this document.

In the mechanical field of surface texture, it is a result of the processing method; a machined concrete surface may be relatively smooth or relatively rough for the purpose intended. The surface obtained from high speed polishing and burnishing is the result of plastic deformation. If the surface is ground or honed, it is the result of the tearing action from the cutting tools or abrasive grains.

Regardless of how the surface characteristics evolve, magnified profiles in all instances consist of a series of peaks and valleys which deviate in a more-or-less irregular fashion above and below a mean surface. Superimposed on these major peaks and valleys are irregularities of lesser magnitude. Experience has shown that the ideal surface characteristics for concrete surfaces may involve such operating conditions as the area in contact, the load, speed, direction of cut, type and amount of lubrication, temperature, material and physical characteristics of concrete design mixes. Variations of any one of these conditions may require a change in the specified surface characteristics.

Experimentation or experience with surfaces is, therefore, the only criteria on which selection and specification for a given surface characteristic can be based. Once the required surface characteristics have been established, the requirement should be documented on the engineering drawings and specifications. Detail should be limited only to the characteristics that have definitive processes and are essential to the specific application. The responsibility for achieving the desired surface is thereby transferred to the producer. Interpretation of surface requirements specified on drawings is explained in this document. However, this document also permits considerable latitude in the method or procedure for controlling production of the surfaces and establishing their conformity with the specified drawing requirements.

# Standard

**Title:** Flat Saw Arbor Configurations
**Specification No:** CSDA-SA-116
**Effective Date:** Apr 14, 2016

## 1. General

1.1 This document standardizes hole mounting patterns of common arbor configurations within the concrete sawing and drilling industry, with particular focus on standard patterns.

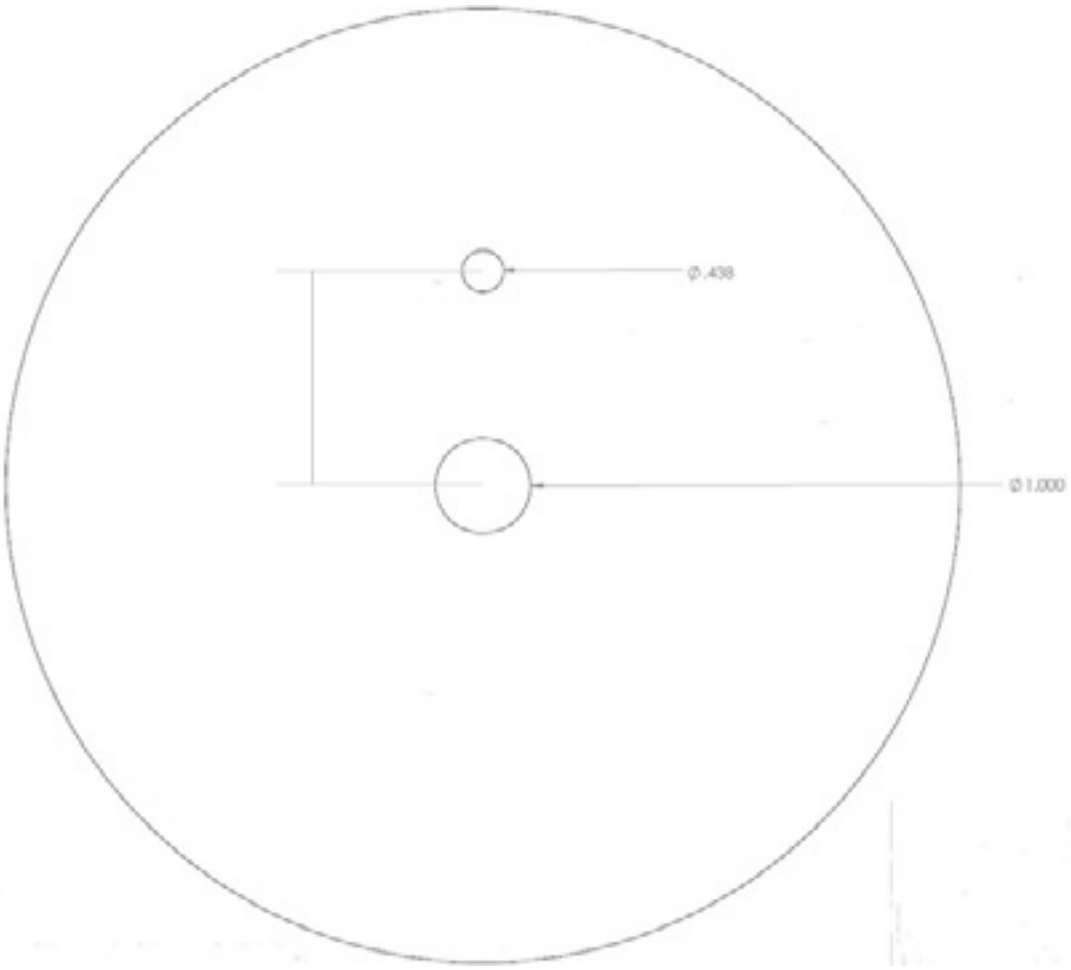
1.2 All dimensions are inches.

1.3 Tolerances:

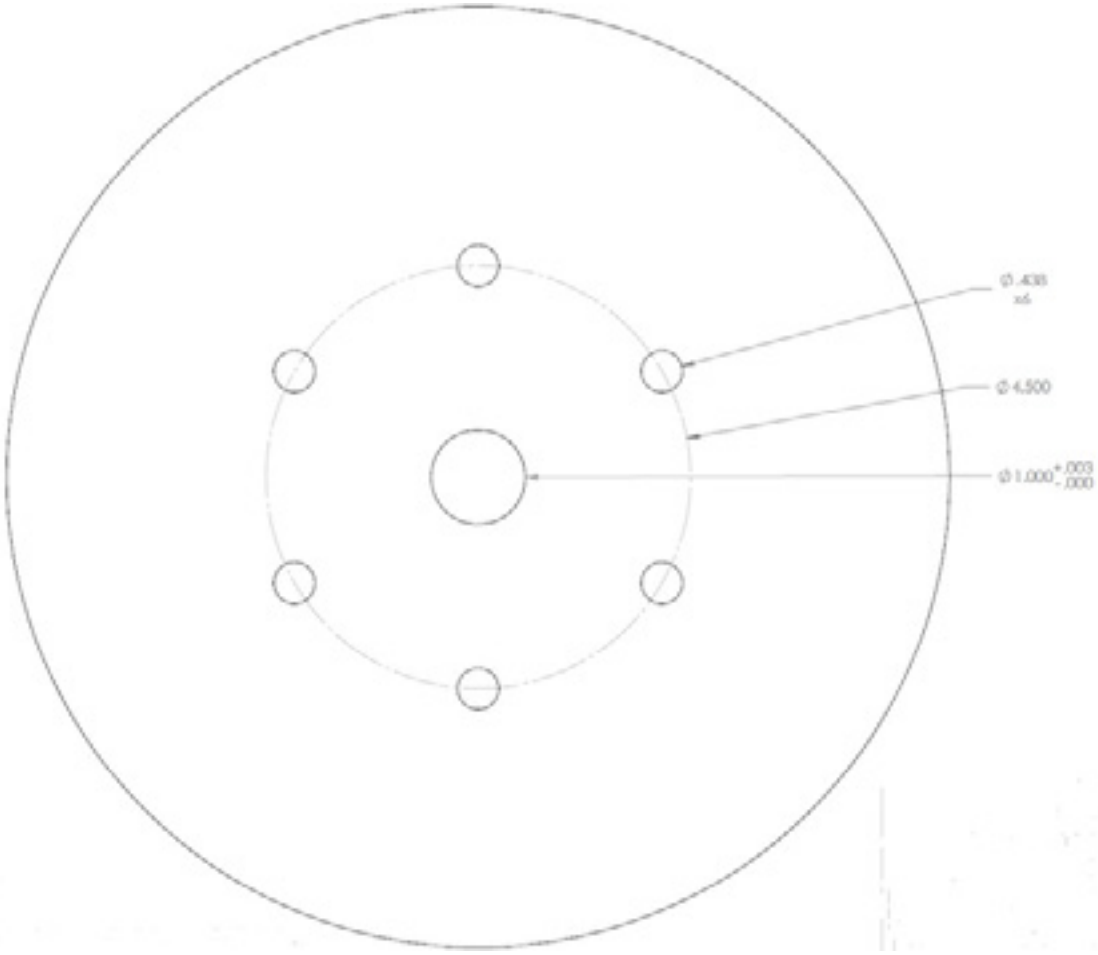
| | |
|---|---|
| XX | ± 0.30 |
| XXX | ± 0.010 |
| XXXX | ± 0.001 |

## 2. Standard Patterns

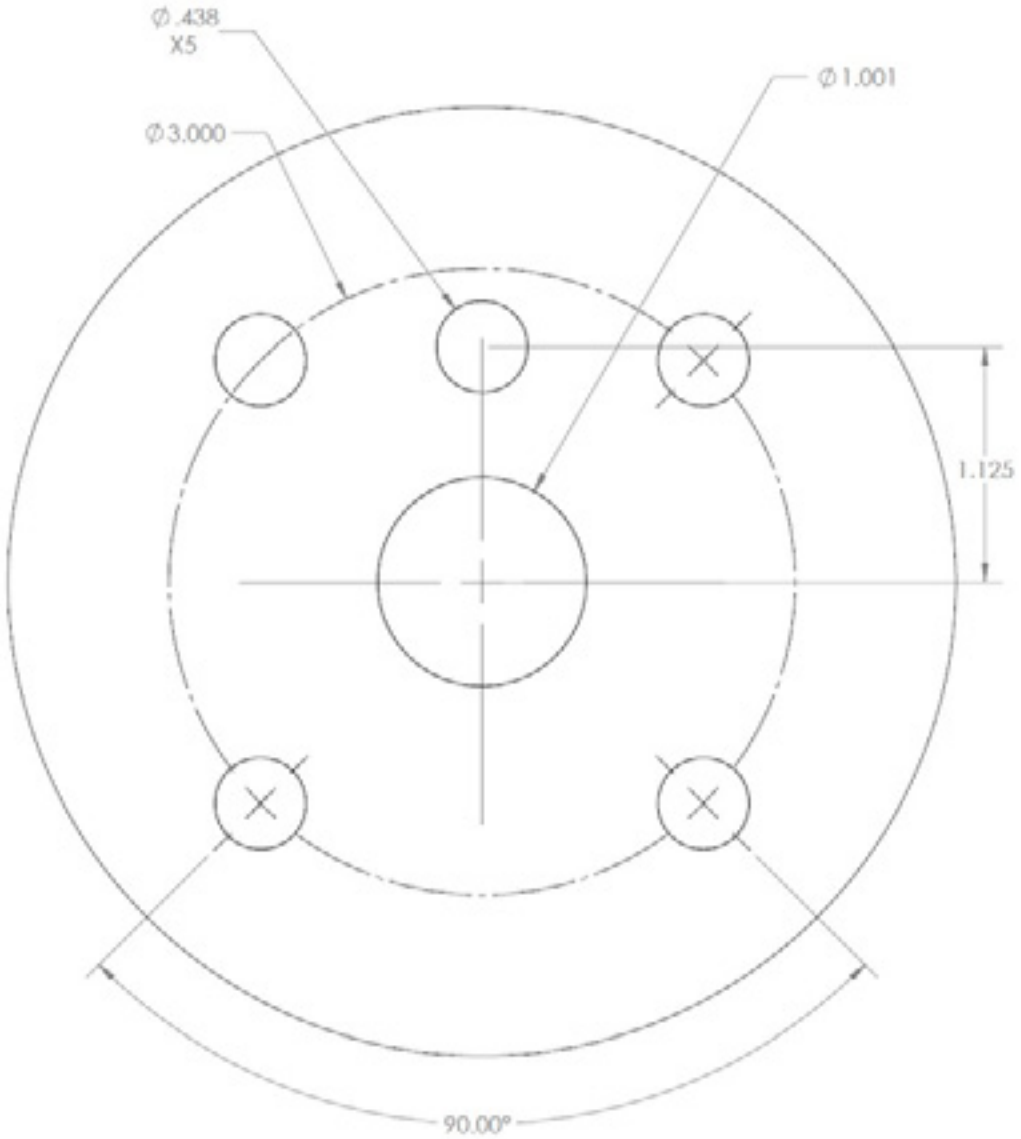
2.1 Basic Arbor Configuration



2.2 “George” Arbor Configuration



## 2.3 “Louie” Arbor Configuration



# Standard

**Title:** Flushcut Arbor Configurations
**Specification No:** CSDA-FA-117
**Effective Date:** Apr 14, 2016

## 1. General

1.1 This document standardizes hole mounting patterns of common arbor configurations within the concrete sawing and drilling industry, with particular focus on wall saw/curb saw flushcut patterns.

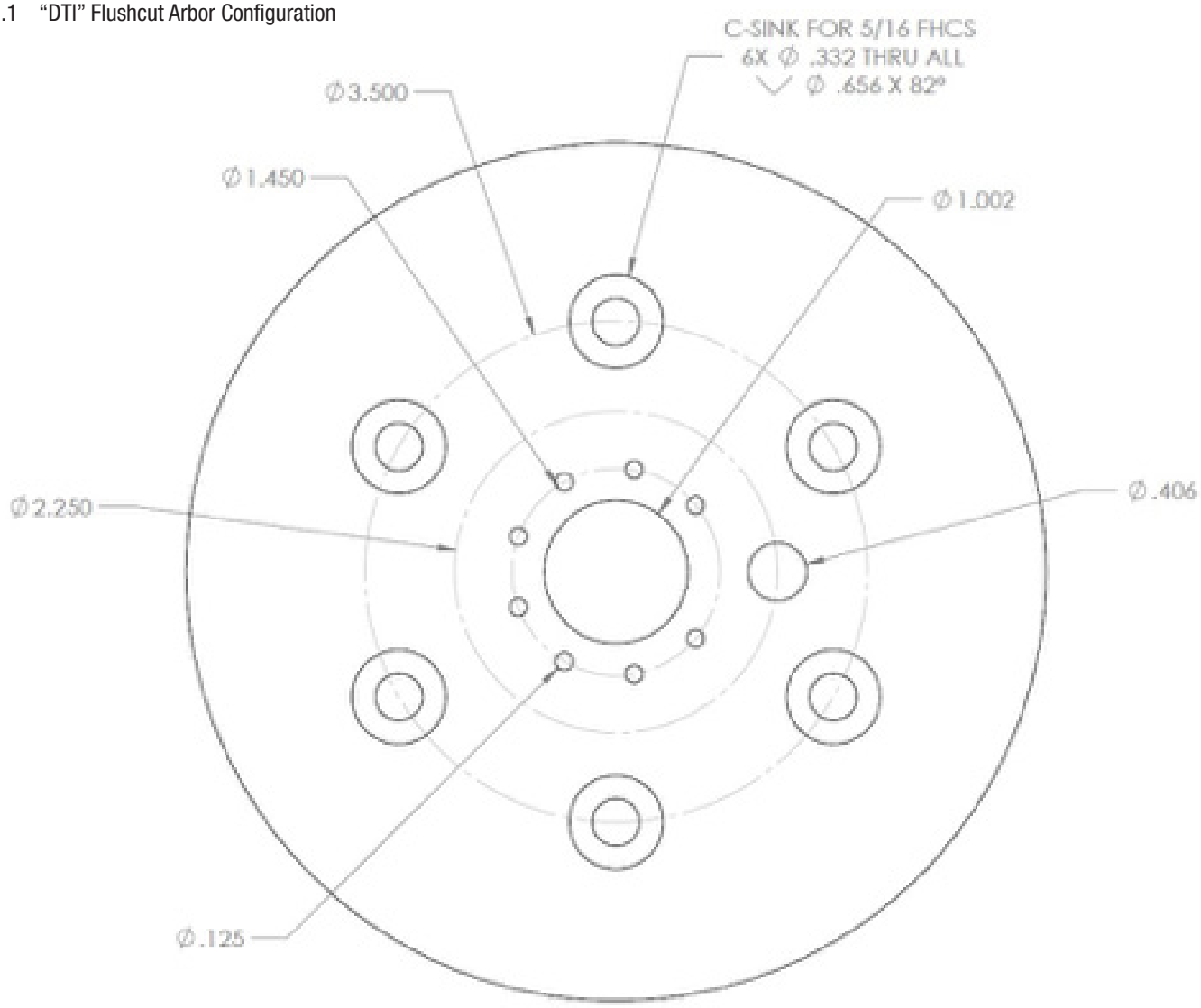
1.2 All dimensions are inches.

1.3 Tolerances:

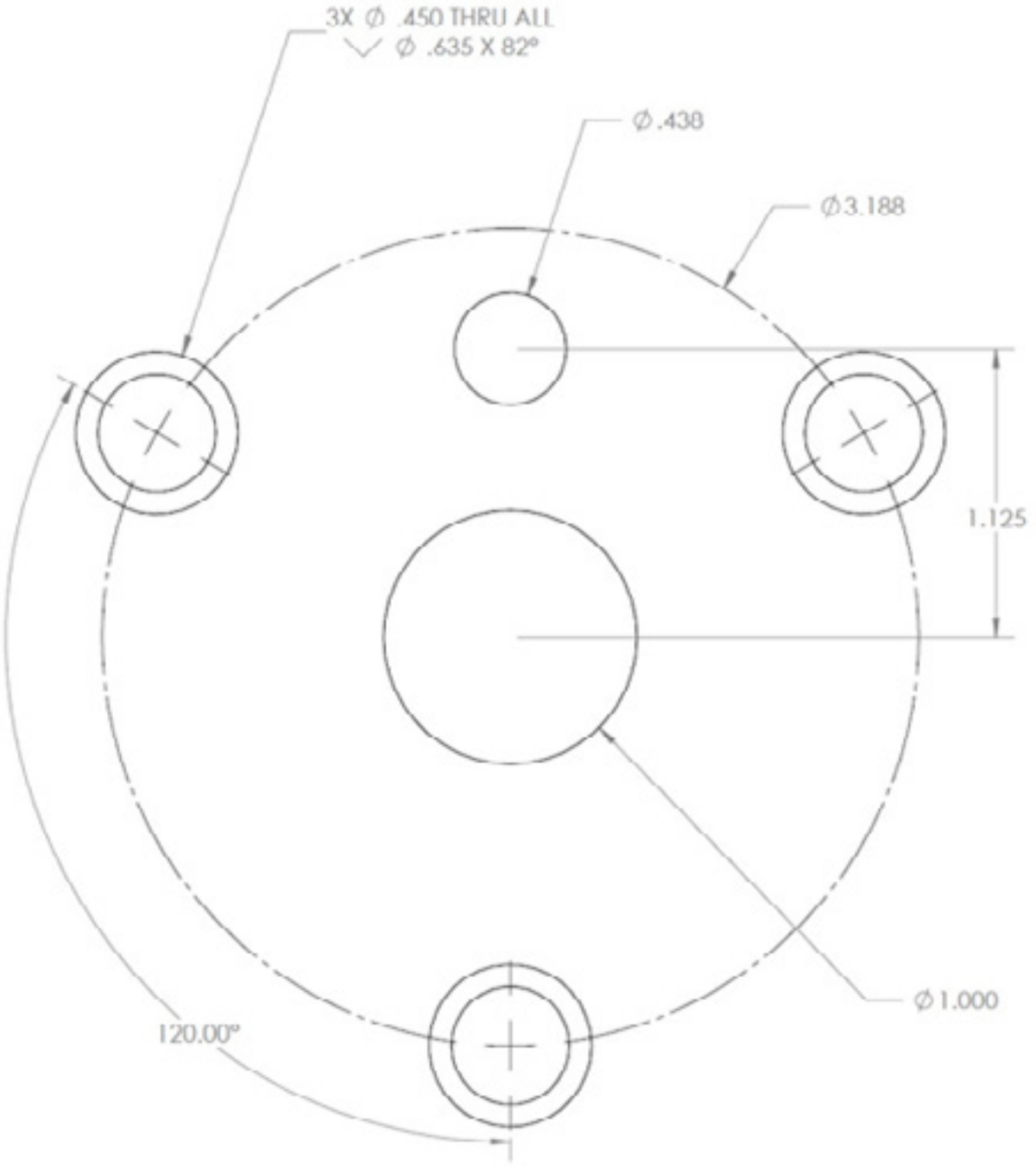
| | |
|---|---|
| XX | ± 0.30 |
| XXX | ± 0.010 |
| XXXX | ± 0.001 |

## 2. Standard Patterns

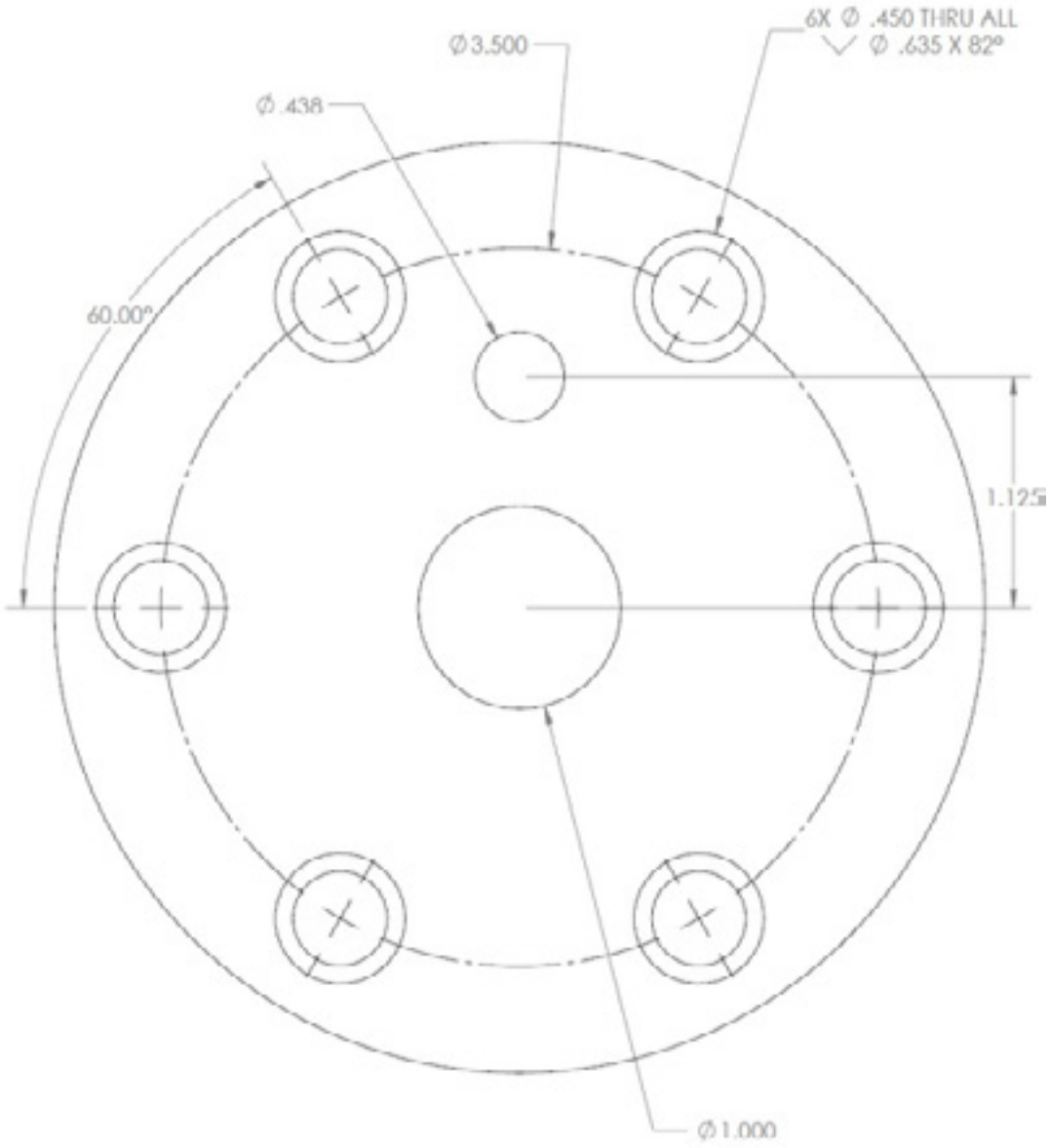
2.1 "DTI" Flushcut Arbor Configuration



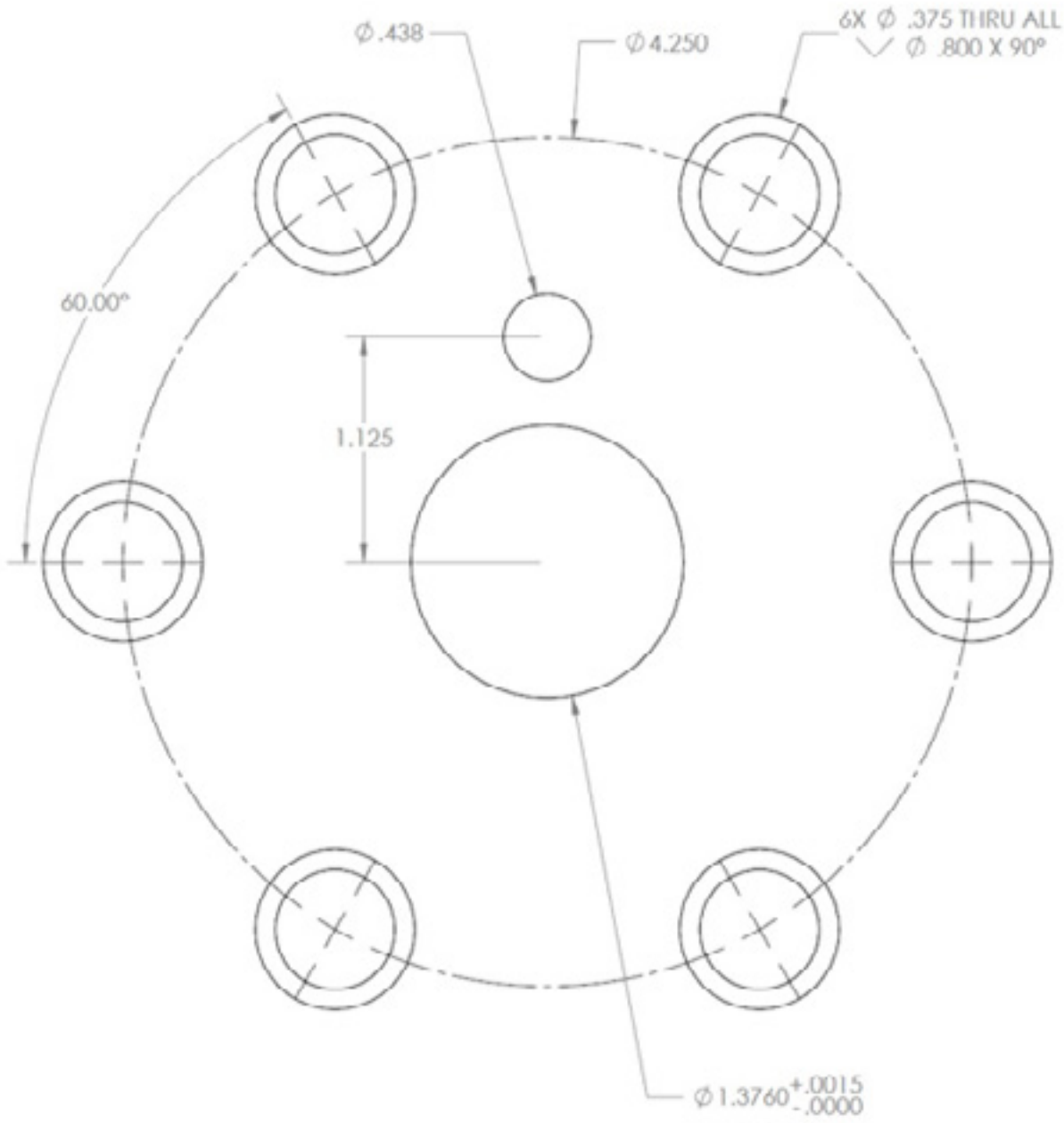
2.2 “GDM” Flushcut Arbor Configuration



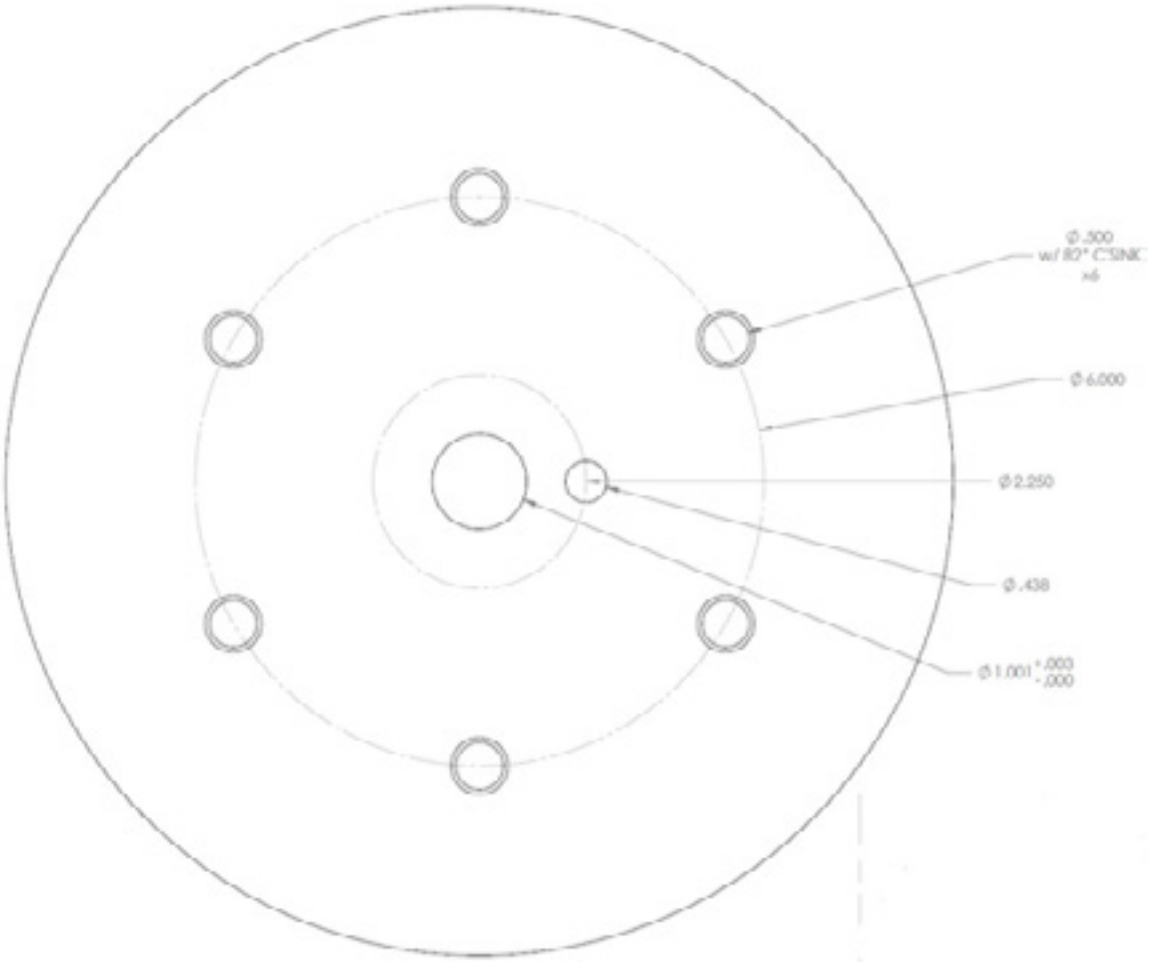
2.3 “Longyear” Flushcut Arbor Configuration



2.4 “Pentruder” Flushcut Arbor Configuration



## 2.5 “Roger” Flushcut Arbor Configuration



# Tolerances

**Title:** U.S. Tolerances for Sawing and Core Drilling
**Specification No.:** CSDA-TL-001
**Effective Date:** Mar 14, 2017

## 1. General

Professional concrete sawing and drilling professionals have documented these dimensional tolerances for use by industry specifiers to develop clear statements of work for competitive bids. These tolerances are recognized as normal industry accepted tolerances that are reasonably achievable. If tolerances for the work to be performed need to be made tighter or, conversely, if the tolerances can be relaxed from the tolerances identified in this document, the specifier should make certain the tolerances in the scope of work are clearly understood.

Most demolition type work, tolerances would only add to the cost of the overall project and would not normally apply to this document.

The tolerances in this document are based on current technologies and industry accepted practices, therefore future revisions to this document will reflect advancements that will change what is agreed to be normal acceptable tolerances for the work performed in sawing and drilling concrete. It is also very important that this document uses datums and tolerances that can be easily measured and verified in the field where the work is performed.

There are seven distinctly separate types (or methods) of work in sawing and drilling (also known as cutting and coring) concrete, each with a unique tolerance band. They include (1) non track-mounted sawing, which includes hand saws, ring saws and chainsaws; (2) track-mounted sawing that includes wall saws and guided hand saws using rail guides; (3) flat/slab sawing using walk-behind or self-propelled saws on wheels; (4) handheld core drilling; (5) rig-mounted core drilling, which includes depths less than 36 inches deep; (6) deep core drilling, which includes depths over 36 inches and (7) wire sawing.

If the scope of work (SOW) specifies the method for which the work is to be performed, then the tolerances associated with that method would apply to that SOW. If multiple methods can be used to complete the job, the tolerances of the method in the SOW would need to be applied to the alternative method used or an exception addressed in the final contract before the start of work.

## 2. Measurement Limitations and Discussion Points

Some job requirements have critical dimensional tolerances that may require more extensive setup and control to hold tighter tolerances. It is important to identify the critical tolerances in the statement of work if they exceed these industry accepted tolerance bands.

All angles are measured with respect to absolute vertical and horizontal, as established with a bubble level or plumb-bob.

The depth of the cut or core drilled hole can vary with respect to the diamond wear, the depth lock adjustment points and the roughness of the slab surface to establish an accurate datum reference plane.

The width of the slot is typically defined by the width of the segment. The segment width can change based on the side clearance wear. Segments are made in mass quantity using fixed tooling molds, thus unlimited width dimensions are not practical. It should also be noted that practical limits should be applied on the narrow width of deep slots based on the core thickness for the larger diameter blades. This will help maintain safe, structurally sound blades.

If the blade or bit is rotated eccentrically (off axis) it will result in a measurable runout, causing a sweeping grinding path that is wider than the blade much like a dado saw blade for cutting wider slots in wood and the result is the creation of a wider slot or larger diameter hole.

If a core bit is out of round (egg shaped) it will result is a larger diameter hole than a perfectly round bit. The core drilling operation is a grinding process and the diameter of the rotation point of the further tip of the elliptical bit will be the outside diameter of the created hole.

Measurements of the depth of a pocket for core drilled holes must be made at the edges of the hole where the diamond segments where working. The operator can't control the bottom of the hole when the core is snapped off.

Step cutting should be used to create a guiding cut to hold more accurate cuts following a marked line before a deeper cut is made. Deep single pass cuts can be harder to maintain tighter tolerances from the marked line.

## 3. Non Track-Mounted Sawing

Non track-mounted sawing is typically performed by handheld saws including concrete hand saws, ring saws and chainsaws. It is difficult to hold tight tolerances on hand-guided machinery that has large gyroscopic forces, high horsepower in a small lightweight package with high depth of cuts. Embedment's in the concrete like rebar and hard aggregate can greatly increase the difficulty in holding a tight tolerance with hand-held saws.

Hand saws designed to cut concrete are frequently used with water for wet cutting. The water spray, coupled with a small lightweight compact saw that lacks large cumbersome guides, can make it difficult to accurately follow a marked line.

Many hand saws lack physical depth guides to easily maintain a predetermined depth of cut.

For tighter tolerances, one should consider using track-mounted saws.

| Depth of Cut Range (D) | Depth (D) | Angle off Axis (A) | Marked Line (L) |
|---|---|---|---|
| Up to and including 10" Deep (250mm) | +/- 1/2" (+/- 12mm) | ½" in 1' (12mm in 300mm) | Fraction +/- 1/4" (+/- 6mm) |

## 4. Track-Mounted Sawing

When properly mounted, track-mounted sawing is one of the most accurate means to hold dimensional tolerances while cutting concrete.

| Depth of Cut Range (D) | Depth (D) | Angle off Axis (A) | Marked Line (L) |
|---|---|---|---|
| Tolerance based on a 'per foot of depth' | 1/4" (6mm) | 1/4" in 1' (6mm in 300mm) | +/- 1/8" (+/- 3mm) |

## 5. Flat/Slab Sawing

This type of saw is set on wheels, with models that are self-propelled or manually pushed. These saws can be upcut or downcut. Downcut saws are more difficult to hold specific depth of cut tolerances because the saw blade may ride up in the cut.

Because these saws are on wheels, the angle off axis of the slot cut can be dependent on slab surface conditions or the angle of the plane on which the saw is travelling. Many saws, especially with larger diameter blades for deeper depths of cutting, have the saw blade out in front of the saw body and wheel footprint thus the surface conditions under the wheels is amplified at the contact point of the blade making it more difficult to hold a depth of cut tolerance with larger diameter blades.

To hold tighter tolerances, it is recommended to step cut. This is because the first pass can be an accurately located shallow cut to create a guide for the subsequent passes. It is suggested to maintain the same direction of cut for each pass so the angle of the slot, as defined by the surface plane the wheels are rolling on, is consistent from pass to pass.

Many flat/slab saws have an adjustable pointer to help guide the operator by having them accurately following a marked line.

The tolerances in this document for flat/slab sawing generally do not apply for jobs like decorative cutting or cutting for the installation of special electronic sensor runs in a slab or highway jobs with long runs. The scope of work in the contract should spell out the appropriate tolerances for the specific job. Conversely, for demolition sawing, tolerances may not be needed and only increase the overall cost of the job.

| Depth of Cut Range (D) | Depth (D) | Marked Line (L) |
|---|---|---|
| Tolerance based on a 'per foot of depth' | +/- 1/2" (+/- 12mm) | +/- 1/4" (+/- 6mm) |

## 6. Handheld Core Drilling

Handheld core drilling is usually limited to creating openings no larger than 6 inches in diameter. Equipment for bits over this diameter exist, but is not standard equipment. Any such equipment must be able to safely clutch the drill from kicking back on larger diameter bits while still providing enough torque to properly core in concrete. Tolerances need to be defined specific to the job because bits larger than 6 inches in diameter on handheld core drills are also very heavy and cumbersome, impacting the operator's ability to maintain tight tolerances.

Handheld core drilling is not as precise as using rig-mounted units, particularly when an accurate center point location must be achieved for the openings. A piece of handheld equipment does not have a rigid mount to start the coring operation, and until the hole is established the bit can have a tendency to walk.

| Core Hole Diameter (d) | Depth (D) | Angle off Axis (A) | Marked Lines-crosshairs (L) |
|---|---|---|---|
| Up to 6" Diameter (150mm) | +/- ¼" (+/- 6mm) | ½" in 1' (12mm in 300mm) | +/- ½" (+/- 12mm) |

## 7. Rig-Mounted Core Drilling

Rig-mounted core drilling can be performed with mechanical fasteners to mount the drill rig to a slab surface or to a trailer or other vehicle. Stitch drilling, the process of creating a series of adjacent holes in a set shape through a surface to remove the central area, uses rails similar to the ones employed for track-mounted sawing and is a popular method. Rigs with vacuum systems incorporated into the base can be used in conjunction with fastening anchors for highly secure mounting.

| Core Hole Diameter (d) | Depth (D) | Angle off Axis (A) | Marked Lines-crosshairs (L) |
|---|---|---|---|
| Up to 12" Diameter | +/- ¼" per foot (+/- 6mm) | ½" in 1' (12mm in 300mm) | +/- 1/8" (+/- 3mm) |
| Over 12" Diameter | +/- ½" per foot (+/- 12mm) | ¼" in 1' (6mm in 300mm) | +/- ¼" (+/- 6mm) |

## 8. Deep Core Drilling

Deep core drilling techniques are typically used to create openings that are less than 10 inches in diameter. The physical weight of the equipment and bit together with the weight of the core created by deep hole drilling adds a new level of complexity to holding tight tolerances. Tolerances for deep holes over 10 inches in diameter need to be established on a case-by-case basis as defined by jobsite specific requirements and goals.

Deep core drilling is performed with special equipment, tooling, and engineered setups. There are many factors such as the weight of the bit and core, rebar in the concrete that is not evenly distributed across the face of the bit that can impact the tolerances.

| Depth of the hole (d) | Angle off Axis (A) |
|---|---|
| 36” to 72” deep (1 to 2m) | +/- 1deg |
| Over 72” (2m) | +/- 1deg |

## 9. Wire Sawing

Wire sawing projects can have a wide range of complexity depending on jobsite requirements. This makes it very difficult to offer published tolerance values across the board. Diamond wire runs can be set up using any combination of sheaves, pulleys or cored holes. The longer the wire run, the more difficult it is to control the dimensions of the cut line throughout the workpiece. Short wire loops run through fixed mechanical arms are by far the simplest wire sawing setups. The use of diamond wire swing techniques on underwater structures or stone quarries, for example, typically have much more complex setups to cut and remove larger volumes of material.

Wire will follow the path of least resistance. Hard aggregate or rebar can greatly vary the interior path in the cut plane as well as the final cut line. Efforts can be made in the setup to cut on the marked line on the edge of the piece being cut, but the cut plane in the middle of the piece being cut is difficult to tolerance.

The tolerances in this document do not apply to demolition cutting.

| Length of Wire in Meters | Marked Line (L) |
|---|---|
| Up to 12m (up to 36’) | 2 centimeters per meter (1” in 3’) |
| Over 12m (over 36’) | 4 centimeters per meter (2” in 3’) |

# Tolerances

**Title:** Tolerances and Limits for Construction Drilling and Sawing
**Edition:** Second
**Effective Date:** Aug 2002
**Revised:** May 2006

**Table of Contents**

## I. Explanation of Terms

1. **Angle accuracy**
   Measured from walls, floors or ceilings of the directly adjoining components, applicable in cases in which the angle of the cutting or coring direction is not at right angles to the plane of the fixing device. Unit of measurement for deviations:
   mm per $m^1$ / inch per $ft^1$.
2. **Directional accuracy**
   Maximum deviation from the given direction of the coring or the cut. Unit of measurement for deviations:
   mm per $m^1$ / inch per $ft^1$.
3. **Vertical level, vertical:**
   Maximum deviation in mm per $m^1$ / inch per $ft^1$.
4. **Horizontal level, horizontal:**
   Maximum deviation in mm per $m^1$ / inch per $ft^1$.
5. **Surface roughing:**
   Flatness of the drilled hole or cut surface. Precondition: To a large extent uniform structure of the body to be worked. Maximum deviation in mm / inch.
6. **Section width or drill-hole diameter. Passage in**
   a. Hollow cylinder or hole diameter. Maximum deviation in mm / inch.
   b. Thickness of cut, width of joint. Maximum deviation in % from target value.
7. **Target depth of pocket hole or joint:**
   Maximum deviation in mm / inch.

## II. Index, Definitions, Exceptions

| Definition | Explanation |
|---|---|
| > | Greater than |
| < | Smaller than |
| ≥ | Equal or greater than |
| d | Dimension of the structure to work on |
| t | Drilling depth, depth of cut |
| Ø | Diameter |
| m | Meter; 39.37 in |
| Max. | Maximum |
| mm | Millimeter; 0.0394 in |
| In | Inch; 25.4 mm (rounded from mm) |
| Ft | Feet; 304.8 mm (rounded from mm) |
| Pocket hole | Blind hole |
| Crushing | Crushing a concrete part by means of hydraulically-operated crusher jaws |
| Bursting | Predetermined fracture lines created by perforating a body with hydraulically-operated burster heads introduced into auxiliary core drills |
| Diving saws / plunge sawing | Special cutting method: Diamond blades are lowered into an auxiliary core drill. Usual method today is push cutting with wire saws (Chapter VII) |

**Exceptions:**

1. These limits are not valid for work that has to be executed with hand-held machinery (e.g. chain saw, hand saw, etc.).
2. According to the operation procedure enough space and load capacity must be ensured depending upon equipment specifications.
3. Coring and drilling depths are not unlimited. They depend upon the diameter of the tools, the material to be worked on and the local conditions. They must therefore be pre-defined.

## III. What is the Purpose of the Standard?

**Principle:**

1. The standard is intended to create trust, clarity and certainty between planners, contractors and building owners.
2. Planners should be able to rely on the fact that minimum tolerances are maintained in the concrete cutting industry at the quoted prices. The standard represents the minimum. If planners require more accuracy this must be clearly stated in the tender specification documents. Tolerances tighter than those specified in the standard will justify charging a higher price. These must be quoted individually.

**Each Country:**

1. Each national association shall endeavour to have the standard integrated in its national standards.
2. It is recommended that members should make the standard a constituent part of their general conditions of business. Members are recommended at least to append this standard to every quotation or tender and by doing so make it an integral part of their offer.

## IV. Maximum Tolerances for Concrete Core Drilling with Diamond Tools in Horizontal and Vertical Structures

Alignment accuracy for all core drilling diameters and lengths: Center of circle to be drilled: ± 5 mm (0.2 in) plus 2.5% of the diameter

| Core Drilling | Ø < 300 mm (11.8 in) | | | |
|---|---|---|---|---|
| | d < 1000 mm (39.4 in) | | d ≥ 1000 mm (39.4 in) | |
| 1. Angle accuracy | ± 85 mm/m[1] | ± 1 in/ft[1] | ± 85 mm/m[1] | ± 1 in/ft[1] |
| 2. Directional accuracy in oblique drilling | ± 60 mm/m[1] | ± 0.7 in/ft[1] | ± 60 mm/m[1] | ± 0.7 in/ft[1] |
| 3. Vertical | ± 60 mm/m[1] | ± 0.7 in/ft[1] | ± 60 mm/m[1] | ± 0.7 in/ft[1] |
| 4. Horizontal | ± 60 mm/m[1] | ± 0.7 in/ft[1] | ± 60 mm/m[1] | ± 0.7 in/ft[1] |
| 5. Surface roughing drilled wall (evenness) | ± 5 mm | ± 0.2 in | ± 15 mm | ± 0.6 in |
| 6. Diameter of deviation from specified Dimension | ± 3 mm | ± 0.12 in | ± 15 mm | ± 0.6 in |
| 7. Specified depth for pocket hole | ± 10 mm | ± 0.4 in | ± 15 mm | ± 0.6 in |

| Core Drilling (cont.) | Ø 301 mm—1000 mm (11.8 in—39.4 in) | | | |
|---|---|---|---|---|
| | d < 1000 mm (39.4 in) | | d ≥ 1000 mm (39.4 in) to max | |
| 1. Angle accuracy | ± 85 mm/m[1] | ± 1 in/ft[1] | ± 85 mm/m[1] | ± 1 in/ft[1] |
| 2. Directional accuracy in oblique drilling | ± 60 mm/m[1] | ± 0.7 in/ft[1] | ± 60 mm/m[1] | ± 0.7 in/ft[1] |
| 3. Vertical | ± 60 mm/m[1] | ± 0.7 in/ft[1] | ± 60 mm/m[1] | ± 0.7 in/ft[1] |
| 4. Horizontal | ± 60 mm/m[1] | ± 0.7 in/ft[1] | ± 60 mm/m[1] | ± 0.7 in/ft[1] |
| 5. Surface roughing of drilled wall (evenness) | ± 10 mm | ± 0.4 in | ± 20 mm | ± 0.8 in |
| 6. Diameter of deviation from specified dimension | ± 10 mm | ± 0.4 in | ± 20 mm | ± 0.8 in |
| 7. Specified depth for pocket hole | ± 10 mm | ± 0.4 in | ± 20 mm | ± 0.8 in |

## V. Maximum Tolerances for Diamond Sawing with Rail-mounted Wall and Plunge Blade Saws in Horizontal and Vertical Concrete Structures

Alignment accuracy for all wall and diving blade saws: ± 10 mm (0.4 in) from target line

| Diamond Cutting Ceilings & Walls | Ceiling or Wall Thickness | | | |
|---|---|---|---|---|
| | d < 300 mm (11.8 in) | | d ≥ 300 - 600 mm (11.8-19.7 in) | |
| **Remark:** Tolerances are only valid for ceiling cuts from above. | | | | |
| 1. Angle accuracy | ± 35 mm/m[1] | ± 0.42 in/ft[1] | ± 70 mm/m[1] | ± 0.85 in/ft[1] |
| 2. Directional accuracy in relation to specified dimension in longitudinal direction | ± 10 mm/m[1] | ± 0.12 in/ft[1] | ± 20 mm/m[1] | ± 0.25 in/ft[1] |
| 3. Vertical | ± 35 mm/m[1] | ± 0.42 in/ft[1] | ± 85 mm/m[1] | ± 1 in/ft[1] |
| 4. Horizontal | ± 35 mm/m[1] | ± 0.42 in/ft[1] | ± 85 mm/m[1] | ± 1 in/ft[1] |
| 5. Surface roughing of cut surface (evenness) | ± 5 mm | ± 0.2 in | ± 10 mm | ± 0.4 in |
| 6. Cut width, deviation from specified dimension | ± 10 % from target value | | ± 10 % from target value | |
| 7. Specified depth | ± 10 mm | ± 0.4 in | ± 15 mm | ± 0.6 in |

## VI. Maximum Tolerances for Diamond Cutting with Rail-mounted (Track-mounted) Floor Saws in Horizontal Concrete Structures

Alignment accuracy for all rail-mounted floor saws: ± 10 mm (0.4 in) from target line

| Diamond Cutting of Floors | Thickness, Cutting Depth | | | |
|---|---|---|---|---|
| | d = <100 mm (3.9 in) | | d ≥ 100 - 500 mm (3.9-19.7 in) | |
| **Remark:** Unevenness of the floor can't be compensated. | | | | |
| 1. Angle accuracy | ± 85 mm/m[1] | ± 1 in/ft[1] | ± 85 mm/m[1] | ± 1 in/ft[1] |
| 2. Directional accuracy in relation to specified dimension in longitudinal direction | ± 10 mm/m[1] | ± 0.12 in/ft[1] | ± 20 mm/m[1] | ± 0.25 in/ft[1] |
| 3. Vertical | ± 60 mm/m[1] | ± 0.7 in/ft[1] | ± 85 mm/m[1] | ± 1 in/ft[1] |
| 4. Horizontal | -- | -- | | |
| 5. Surface roughing of cut surface (evenness) | ± 5 mm | ± 0.2 in | ± 8 mm | ± 0.3 in |
| 6. Cut width, deviation from specified dimension | ± 10 % from target value | | ± 10 % from target value | |
| 7. Specified depth at joint depth | ± 10 mm | ± 0.4 in | ± 15 mm | ± 0.6 in |

## Maximum Tolerances for Diamond Cutting with Wheel Driven Floor Saws in Horizontal Concrete Structures

Alignment accuracy for all wheel driven floor saws: ± 10 mm (0.4 in) from target line

| Diamond Cutting of Floors | Thickness, Cutting Depth | | | |
|---|---|---|---|---|
| | d < 100 mm (3.9 in) | | d ≥ 100 - 500 mm (3.9-19.7 in) | |
| **Precondition:** A level track next to the cut to cater for the width of the equipment to be used (max. 1.3 m, 51.2 in) is necessary to ensure that the scheduled requirement figures can be achieved. **Remark:** Manually driven machines can be more accurate than motor driven machines. | | | | |
| 1. Angle accuracy | ± 85 mm/m[1] | ± 1 in/ft[1] | ± 85 mm/m[1] | ± 1 in/ft[1] |
| 2. Directional accuracy in relation to specified dimension in longitudinal direction, cut 4 meters long | ± 15 mm/m[1] | ± 0.18 in/ft[1] | ± 25 mm/m[1] | ± 0.3 in/ft[1] |
| 3. Vertical | ± 60 mm/m[1] | ± 0.7 in/ft[1] | ± 85 mm/m[1] | ± 1 in/ft[1] |
| 4. Horizontal | - | - | | |
| 5. Surface roughing of cut surface (evenness) | ± 5 mm | ± 0.2 in | ± 10 mm | ± 0.4 in |
| 6. Cut width, deviation from specified dimension | ± 10 % from target value | | ± 10 % from target value | |
| 7. Specified depth at joint depth | ± 10 mm | ± 0.4 in | ± 15 mm | ± 0.6 in |

## VII. Maximum Tolerances for Diamond Wire Saws in Horizontal and Vertical Concrete Structures

| Wire Sawing | Body Thickness | | | | |
|---|---|---|---|---|---|
| | d < 150 cm (59.0 in) | | d ≥ 150 - 300 cm (59.0—118.1 in) | | d ≥ 300cm (118.1 in) |
| **Remark:** Work carried out in stone quarries or under water is not included. | | | | | No tolerances fixed yet |
| 1. Angle accuracy | ±100 mm/m[1] | ± 1.2 in/ft[1] | ±150 mm/m[1] | ± 1.8 in/ft[1] | |
| 2. Directional accuracy in relation to specified dimension in longitudinal direction | ± 70 mm/m[1] | ± 0.85 in/ft[1] | ± 100 mm/m[1] | ± 1.2 in/ft[1] | |
| 3. Vertical | ± 50 mm/m[1] | ± 0. 6 in/ft[1] | ± 50 mm/m[1] | ± 0.6 in/ft[1] | |
| 4. Horizontal | ± 50 mm/m[1] | ± 0. 6 in/ft[1] | ± 50 mm/m[1] | ± 0.6 in/ft[1] | |
| 5. Surface roughing of cut surface (evenness) | ± 20 mm | ± 0.8 in | ± 30 mm | ± 1.2 in | |
| 6. Width of cut | ± 10 % from target value | | ± 10 % from target value | | |

## VIII. Maximum Tolerances in Concrete Crushing in Horizontal and Vertical Concrete Structures

| Crushing | Body Thickness | | | | | |
|---|---|---|---|---|---|---|
| | d < 150 mm (5.9 in) | | d ≥ 150 mm - 300 mm (5.9 in - 11.8 in) | | d > 300 mm - 600 mm (11.8 - 23.6 in) | |
| 1. Angle accuracy | ±100 mm/m1 | ±1.2 in/ft[1] | ±100 mm/m[1] | ± 1.2 in/ft[1] | ±100 mm/m[1] | ± 1.2 in/ft[1] |
| 2. Directional accuracy in relation to specified dimension in longitudinal direction | ±300 mm/m[1] | ± 3.6 in/ft[1] | ±300 mm/m[1] | ± 3.6 in/ft[1] | ±300 mm/m[1] | ± 3.6in/ft[1] |
| 3. Vertical | ±100 mm/m[1] | ±1.2 in/ft[1] | ±100 mm/m[1] | ± 1.2 in/ft[1] | ±100 mm/m[1] | ± 1.2 in/ft[1] |
| 4. Horizontal | ±100 mm/m[1] | ±1.2 in/ft[1] | ±100 mm/m[1] | ± 1.2 in/ft[1] | ±100 mm/m[1] | ± 1.2 in/ft[1] |
| 5. Flatness of the surface crushed | ± 100 mm | ± 3.95 in | ± 100 mm | ± 3.95 in | ± 150 mm | ± 5.9 in |
| 6. Width of fracture | ---- | ----- | ----- | | | |
| 7. Specified depth | ---- | ----- | ----- | | | |

## IX. Maximum Tolerances in Concrete Bursting in Horizontal and Vertical Concrete Structures

| Bursting | Wall Thickness | | | |
|---|---|---|---|---|
| | d < 600 mm (23.6 in) | | d ≥ 600 mm (23.6 in) to max | |
| 1. Angle accuracy | ±150 mm/m[1] | ± 1.8 in/ft[1] | ±150 mm/m[1] | ± 1.8 in/ft[1] |
| 2. Directional accuracy in relation to specified dimension in longitudinal direction | ±300 mm/m[1] | ± 3.6 in/ft[1] | ±300 mm/m[1] | ± 3.6 in/ft[1] |
| 3. Vertical | ±150 mm/m[1] | ± 1.8 in/ft[1] | ±150 mm/m[1] | ± 1.8 in/ft[1] |
| 4. Horizontal | ±150 mm/m[1] | ± 1.8 in/ft[1] | ±150 mm/m[1] | ± 1.8 in/ft[1] |
| 5. Evenness of burst item | ± 100 mm | ± 3.95 in | ± 150 mm | ± 5.9 in |
| 6. Bursting width | - | - | | |
| 7. Specified depth | - | - | | |

# Tolerances

**Title:** Basic Parameters for Concrete Drilling and Sawing Equipment
**Edition:** First
**Effective Date:** May 2007

| Compulsory Parameters for Machines (example EU) to be modified in other countries | |
|---|---|
| **applicable to** | **standard** |
| Safety rules | DIN/ISO 3744 |
| Wire and wall saws | prEN 15027 |
| Core drilling machines on drill rigs | EN 12348 |
| Safety requirements for grinding tools with diamond or boron nitride (includes diamond saw blades and diamond wires) | EN 13236 |

| Power Packs (hydraulic units) | |
|---|---|
| **parameter** | **example** |
| connected load / power input | 400 V / 32 A / 18,0 kW |
| hydraulic power output | 13,7 kW (l/min x bar / 600) |
| kind of pump | piston pump - variable |
| | geared pump - constant |
| | multiple geared pump, 3-stage |
| pump capacity | 0 - 60 l/min / 0 - 260 bar (variable displacement pump) |
| | 45 l/min / 210 bar (fixed displacement pump ) |
| Weight (including oil and fixed cables) | 139,0 kg |

| Wall Saws and Floor Saws | |
|---|---|
| **parameter** | **example** |
| max. saw blade diameter | 1500 mm |
| without precut | 900 mm |
| max. cutting depth | 620 mm |
| motor for saw blade drive | hydraulic geared motor |
| on electric motors input (P1) and output power (P2) at the saw blade rating mode (S1) and speed | hydraulic piston motor |
| | three phase AC motor P1: 10 kW -S1; 2.850 rpm; P2: 7,5 kW-S1; 2.850 rpm |
| | high-cycle-motor P1: 20 kW-S1; 0 - 30.000 rpm; P2: 14,7 kW-S1; 0 - 30.000 rpm |
| power train | gears |
| | belt |
| | chain |
| | direct drive |
| output speed | 0 - 1200 rpm |
| max.drive torque at the saw blade | 190 Nm @rpm |
| starting torque | 120 Nm @ 0 rpm |
| feeding system / control | electric / fully automated |
| | electric / manual |
| | hydraulic / manual |
| | manual operated / manual |
| weight | 32,0 kg |

| Wire Saws | |
|---|---|
| **parameter** | **example** |
| motor for wire drive | hydraulic geared motor |
| on electric motors input (P1) and output power (P2) at the drive wheel rating mode (S1) and speed | hydraulic piston motor |
| | three phase AC motor P1: 10 kW -S1; 2.850 rpm; P2: 7,5 kW-S1; 2.850 rpm |
| | high-cycle-motor P1: 20 kW-S1; 0 - 30.000 rpm; P2: 14,7 kW-S1; 0 - 30.000 rpm |
| circumferential speed at the drive wheel | 0 - 30 m/s |
| max. drive torque at the drive wheel | 230 Nm @ 20000 rpm |
| starting torque | 180 Nm @ 0 rpm |
| feeding system / control | electric / fully automated |
| | electric / manual |
| | hydraulic / manual |
| | pneumatic / fully automated |
| | pneumatic / manual |
| wire storage capacity | 12 linear meter |
| weight | 138,0 kg |

| Drill Rigs | |
|---|---|
| **parameter** | **example** |
| max. core bit diameter | 250 mm |
| usable feeding length | 660 mm |
| recommended drilling motor | electric motors: DK 2203, Diamant 9, ..... |
| (drive power max.) | hydraulic motors: OMR 100, ..... |
| | 2300 W |
| system of infeed / control | gear rack / manually operated |
| | thread spindle / manually operated |
| | chain / manually operated |
| | hydraulic / manually operated |
| | electric / fully automated |
| weight | 19,0 kg |

| Electric Drilling Motors | |
|---|---|
| **parameter** | **example** |
| type of motor | single phase 110 V |
| on electric motors input (P1) and output power | 3-phase 400 V / 16 A |
| (P2) at the core bit rating mode (S1) and speed | high-cycle-motor P1: 20 kW-S1; 0 - 30.000 rpm; P2: 14,7 kW-S1; 0 - 30.000 rpm |
| output power | 2100 W |
| drive torque per gear (under load) | 87/42/23 Nm |
| speeds / gears (under load) | 230/480/720 rpm |
| max. / min. core bit diameter | 55 - 350 mm |
| Tool fixture | 1 1/4 UNC |
| Foot fastening | Standard 4 x M8 with groove 10 mm |
| | ..... quick fastening system |
| weight | 11,9 kg |

| Hydraulic Drilling Motors | |
|---|---|
| **parameter** | **example** |
| kind of motor | geared motor |
| | torque motor |
| | piston motor |
| geometric displacement | 160 ccm |
| speeds / gears (under load) | 230/480/720 rpm |
| max. pressure / torque per gear (load) | 180 bar 460/230/160 Nm |
| speed at l/min / transmission | 32l / 200 rpm / direct drive |
| max. / min. core bit diameter | 150 - 350 mm |
| Tool fixture | 1 1/4 UNC |
| weight (whole unit) | 18,9 kg |

# Best Practice

**Title:** Slurry
**Issue No:** CSDA-BP-001
**Effective Date:** Jun 21, 2006
**Revised Date:** Jan 21, 2008

## Introduction

Water/slurry collection, disposal and recycling for concrete sawing and drilling are becoming more of an issue for the industry. Each city, county, state, province and country is developing its own regulations and means to enforce them. Since there is no single standard to deal with water and concrete slurry, it is important for our association to take proactive efforts in dealing with our tools, techniques and procedures as well as with a growing list of regulations and enforcement groups who want to oversee them.

The purpose of this best practice document for slurry is to start a database of tools and ideas for dealing with concrete slurry and to address industry and environmental concerns. With the aid of our members reviewing and contributing to this database, hopefully we, as an association, can gain a better understanding of the issues relating to water usage, runoff and slurry. With this understanding, we will then be able to use the right tools and techniques to improve slurry collection, recycling and proper disposal.

## Table of Contents

## Slurry Tips

### 1. Pre-Bid Considerations

a. What does the prime contractor and/or owner require?
b. Are criteria documented in specifications or proposed contract?
c. What regulations are in force for this project?
d. Is there an approved dumpsite?
e. Who is responsible for collection, handling and disposal?
f. Are you adding tools, materials and labor to your bid to handle slurry?
g. Is there construction water available?
h. Can you let slurry/water "run off"?

### 2. Pre-Job Planning

a. Does your firm and prime/owner agree on slurry control?
b. Do your operators know what is required?
c. Will "slurry controls" interfere with other work?
d. Will slurry controls improve the safety of your workers?
e. What special tools and supplies do you need for the job?
f. Check out the supplies available at websites like www.newpig.com.
g. Get your collection system set up prior to sawing or drilling.

### 3. Collection and Control Devices

a. Determine "low point" of specific work area and let "gravity help out."
b. Enclose work areas with poly, to what level is required, if any.
c. Clearly mark "wet areas" with caution tape and restrict access by others.
d. Use "pigs" gutters etc to direct slurry to collection point.
e. Squeegees, mops, brooms will likely be needed, especially for sawing.
f. Vacuums can be big or small, but 55-gallon drum vacs are very common and facilitate the settling of slurry and later handling of sludge.
g. Attachments to vacuum hoses can really help collect water/slurry when core drilling. "Slurry Slurp" circular plastic devices allow suction to the wall or floor, along with sending effluent to wet-vac drum. Some contractors modify plastic containers for core drilling collection.
h. There are some attachments for saws, including "trial system" by Husqvarna.
i. Some collection devices are designed to recycle at the core drill.
j. Dry drilling and sawing systems are available but add the need to control dust.
k. Large vacuum trucks and other mobile devices are available to handle road jobs. Some large systems utilize centrifuges.
l. Gutters around wire cut lines can reduce water needs and ease the means of properly wetting the wire, along with controlling the spray and making collection more efficient.

### 4. Water Collection Tips and Additives

a. Reduce water input to tool, within manufacturer guidelines.
b. Spray water versus constant flow.
c. Blade water delivered at the flange claims to reduce water needs.
d. Limit water to cut point of contact.
e. Utilize full blade guard to maximize use of water and limit spray.
f. Surfactants will make water "wetter" and allow reduction of water needed.
g. Softeners and soap will improve "water tension" and reduce volume needs.
h. When recirculating or recycling, acidic products will be needed to control high pH. Note that high pH or highly alkaline solutions are irritating to skin. The more you recirculate, the higher the pH can get.

### 5. Storage Containers

a. 55-gallon drums are very common and water may be decanted off after settling. Drum dollies help movement of barrels.
b. Large (200-500 gallon or more) plastic containers are readily available. If located below tool location, they can be gravity filled. You may wish to perform initial collection with drum-vacs, then pump to the larger container.
c. Vacuum truck services are available in many areas.
d. 20- and 40-yard dumpsters are utilized on large projects and can be divided into 2-4 sections to allow slurry water to move from one end to the other, causing much of the solids to settle out.
e. Spoil areas may be provided by owner to temporary or permanent storage.
f. Note: Regardless of how you collect or store the slurry, you need a plan for where it is properly disposed.

### 6. Hauling Tips

a. Decant the water prior to moving.
b. Use a large truck-mounted container / plastic tank.
c. Subcontract to waste hauler / super-sucker trucks.
d. Solidify first (see following sections).

### 7. Filtration Devices and Techniques

a. Use weirs in a large container, or drain from one barrel to the next, until enough solids have settled out.
b. Merely let water or slurry settle in a barrel, then suck off clear water with a vacuum (removing water with a pump will reagitate the slurry).
c. Many types of filter cloths and screens are available to protect all drains, as a minimum.
d. Hay bails can be used in your run-off area or even within a large container to collect some of the slurry.
e. "Pigs" and other media are available from vendors like www.newpig.com.
f. Flocculants are available to accelerate settling of solids.

## 8. Recycle Tools and Systems

a. Core drill recycle kits are available from Diamond Products, Hilti and others.
b. "Do-it-yourself" via filters and devices previously listed.
c. Truck-mounted systems are available to handle large jobs.
d. Subcontract out to a specialist.
e. Skid-mounted systems are being used by some members, combining gravity drained barrels with diaphragm pumps and standard filter tanks; filters are easily replaceable and currently take solids down to 5 microns.

## 9. How To Dry Out Slurry

a. Evaporation–only if large area and time are available.
b. Add fly ash, which is readily available from coal power plants and some stores.
c. SP400 water crystals are commercially available.
d. Cement is used but is more expensive than fly ash.
e. Heated drum evaporators are fairly common at nuclear facilities.

## 10. Disposal Options and Considerations

a. Ask before dumping on your client's site or anywhere else.
b. Utilize a regulated landfill.
c. Dispose on your own property, if within regulations.
d. Treat slurry for high alkalinity (low pH) prior to disposal.
e. Avoid runoff into streams, lakes or drain systems.
f. Some concrete batch plants will accept the slurry.
g. Solidify or dry out prior to disposal.

## 11. Regulations and Fines

a. The list of local, county, state and federal regulations is growing, but enforcement is currently limited.
b. Fines in Australia and New Zealand are much more common than in the USA, but Western USA states are becoming more strict.
c. The National Pollutant Discharge Elimination System (NPDES) standard, issued by the U.S. Environmental Protection Agency, sets stringent standards on disposing of potential pollutants. It addresses regulations for handling debris that ends up on land and waterways. (cfpub.epa.gov/npdes/about.cfm)

## 12. Testimonials

a. A New Zealand CSDA contractor operates his own vacuum trucks and charges 30% of job cost to dump at a controlled location if one is not readily available on the job site.
b. A U.S. contractor is located next to a concrete batch plant and has an agreement to dump all his slurry there.
c. Another member subcontracts large slurry jobs out to a specialist. He cautioned on checking for license of hauler as any lawsuits will name all parties involved.
d. Some areas or times of year have water shortages and recycling of water is needed to meet requirements.
e. One member uses air-powered misters to cool wires for cutting metal structures. Very small amounts of water are drawn into mister with a thin plastic tube.
f. Another member puts silt curtains in the water around cutting area to control movement of solids.

## 13. Results of October 14, 2004 CSDA Standards and Specifications Meeting Survey

An informal survey was filled out by 17 participants at the October 14, 2004, CSDA quarterly Board and committee meetings. Questions and results were as follows:

1. I have (little, a lot) need for slurry collection devices.
   Little = 8, A Lot =7, Blank = 2 participants
2. I need (little, a lot) of assistance with recycle of water/slurry.
   Little = 10, A Lot = 5, Blank = 2 participants
3. I would like CSDA to further this topic and make input available to our members (Yes, No).
   Yes = all 17 participants
4. Quiz: "Highly alkaline solutions" have a low pH value. (True, False).
   True = 2, False = 15 (correct answer is False)
5. I would rather settle water and slurry with drums or containers than deal with filter systems (True, False).
   True = 5, False = 10, no answer = 2
6. I am a (contractor, manufacturer, other).
   Contractors = 7, Manufacturer = 8, Other = 2
7. I am not aware of local, state or federal regulations for water and slurry controls (True, False).
   True = 8, False = 9
8. It is not likely that I will ever be fined for water/slurry controls (True, False).
   True = 5, False = 12
9. This topic should be a (low, medium, high) priority for CSDA.
   Low = 0, Medium = 8, High = 9

## 14. Concrete Slurry Analysis, an Engineering Report

CSDA offers a 62-page report entitled Chemical Characterization of Concrete Slurry Samples and Development of Guidelines for Slurry Management from an independent engineering firm. The study was conducted to initiate a compilation of baseline criteria to assist in the establishment of guidelines for management of slurry as a hazardous or non-hazardous waste material. For information or to place an order, call CSDA at 727-577-5004.

# Best Practice

**Title:** Equipment Maintenance Management for Contractors
**Issue No:** CSDA-BP-002
**Effective Date:** Jun 21, 2006

## 1. Creating A Preventive Maintenance Program

Why do people start contracting businesses? Probably to perform a trade and hopefully to become successful as a company owner. Most definitely, people don't go into business to perform maintenance on their equipment. Generally, concrete cutters are not a group of equipment maintenance experts, but a group of hard working individuals who enjoy practicing the craft of sawing and drilling.

When a concrete contracting business is started, the focus is on the short-term direct costs of contracting, mostly tools, trucks and labor. The long-term costs of maintenance are probably, at least initially, not a top priority. However, over time, maintenance costs continue to increase to a point where they are cutting into profits at a rate that was probably never anticipated. This is the point where controlling maintenance costs is unavoidable and it must become an integral part of the operation of a business.

For concrete cutting contractors and most other contractors as well, the challenges are the same. Equipment must be well maintained for the business to succeed. In addition, for employees to succeed in the field, they must be issued reliable, properly performing equipment. This is the only way an owner can successfully control maintenance costs.

In an industry that relies so heavily on the performance of the equipment that it uses, it becomes apparent how the performance of an equipment fleet is directly related to the overall performance of a company. There are many issues to consider relative to the performance of a fleet. Some, but certainly not all, of the issues included are:

- The company's reputation for on-time, reliable service.
- Morale of the personnel who work with the equipment on a daily basis.
- Safety/Liability concerns related to improperly functioning equipment.
- Financial performance of the company.

However, since the cost of maintaining a fleet plays an integral part in the success of an operation, controlling these costs is paramount to success. To control these costs, a comprehensive preventive maintenance program must be initiated and sustained.

Unfortunately, many operators in the concrete sawing and drilling industry don't fully understand the negative impact poor maintenance practices can have on operations. In addition, many operators simply don't know how to implement a properly managed maintenance program. However, to succeed in any equipment intensive business, operators and owners must become maintenance managers.

## 2. Setting up a Preventive Maintenance Program

The process of setting up a preventive maintenance program will require multiple steps. In actuality, the steps are quite easy to implement. First, start with a simple base. Then, as the program gains momentum levels of sophistication can be added to improve the capabilities of the PM (preventive maintenance) program.

### 2.1 Step 1—Identify and Issue Equipment Numbers

Issue equipment numbers for all pieces of equipment. This step is very important, as it will become the means of tracking all information related to a specific piece of equipment, including cost of operation. Even hand-operated power tools should be given an equipment number. Following are two examples of how the equipment numbers can be established.

| Equipment Type | Equipment # | | Alternate Equipment # |
|---|---|---|---|
| Flat Saws | FS-01 and up | or | 101 and up |
| Wall Saws | WS-01 and up | or | 201 and up |
| Core Drills | CD-01 and up | or | 301 and up |
| Hyd. Power Units | HPU-01 and up | or | 401 and up |
| Hand Saws | HS-01 and up | or | 501 and up |
| Chain Saws | CS-01 and up | or | 601 and up |
| Trucks | TR –01 and up | or | 701 and up |
| Trailers | TRL-01 and up | or | 801 and up |
| Backhoes | BH-01 and up | or | 901 and up |
| Skid Steers | SS-01 and up | or | 1011 and up |
| Generators | GEN-01 and up | or | 1101 and up |

### 2.2 Step 2—Create a Maintenance History System

Gather all information for each piece of equipment in a central location. Create individual file folders for every piece of equipment in the fleet. The information should be updated regularly and maintained in a manner that is easily accessible. Following are examples of the type of information that should be maintained in individual equipment files.

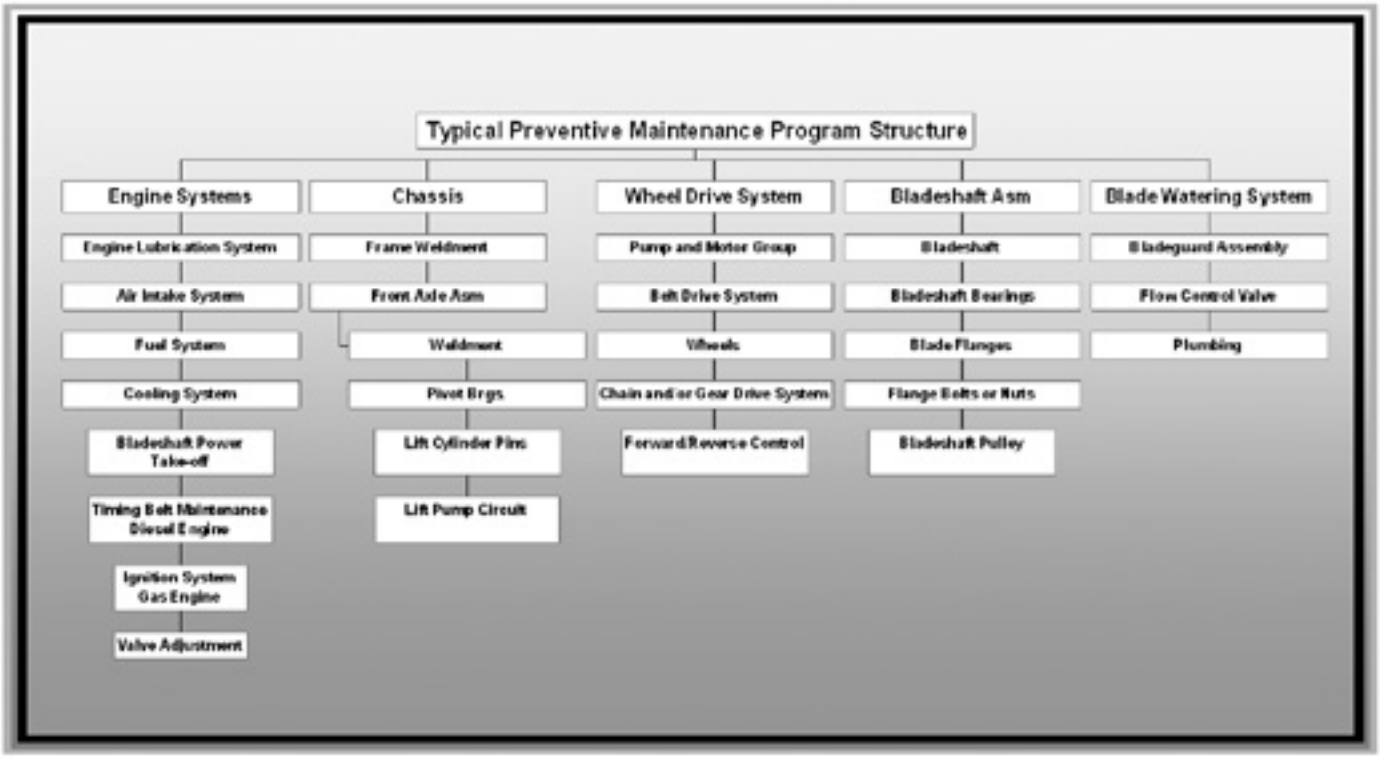
- Manufacturer
- Model Number
- Serial Number
- Date of Purchase
- Purchase Price
- Special Configuration Information
- Local Service Dealer and Contact Info

### 2.3 Step 3—Create Preventative Maintenance (PM) Inspection Reports.

It is important to create forms tailored to each line of equipment, as each type of equipment will have maintenance requirements

specific to it. For example, a pavement saw would require a different inspection report than a core drill. If your fleet includes different models of a particular type of equipment, you may require different PM inspection forms for each model. A common practice is to include all possible configurations for a particular type of equipment on the inspection report. During regularly scheduled preventative maintenance, the technician performing the inspection will simply mark the line items that do not apply as "not applicable."

The chart below represents systems and components of a typical pavement saw that requires inspection or service during regularly scheduled preventative maintenance.




## 2.4 Step 4—Create Multiple Levels of Service

One of the keys to minimizing maintenance costs is to structure PM service intervals that match the maintenance requirements of each individual component or system as closely as possible. Since service interval requirements for different components vary, it would not make sense to service every component or system at every service interval so you need to establish multiple levels of service. First, identify the proper service intervals for each component or system. Then make sure that the interval for the upper level of service is divisible by the lowest level of service. For example, if an adequate service level for a diesel saw is 125 hours and the interval for its wheel drive system is 500 hours, then the levels of maintenance would be 125 hours, 250 hours, 375 hours, 500 hours and so on. Most equipment will require 4 levels of PM service or less, although some equipment might require more. It is important to understand that the Level 1 service interval has to be set to the component with the lowest service interval requirement, which is generally the engine.

## 2.5 Step 5—Creating Work Orders

This operation ties back into steps three and four, which are creating PM inspection reports. When creating a work order it will be necessary to know which level of service is due. This will be determined by the odometer, hour-meter reading or time intervals. Once the level of service is determined, the work order should start with the appropriate PM inspection tasks. As each item is inspected, it should be indicated as pass or fail. If an inspected item fails inspection, the deficiency needs to be indicated on the report. At this point, a decision will be made by the maintenance manager whether to repair the deficiency at the time of inspection or schedule the repair for a later date. The next step in creating the work order is to apply the labor functions required for the level of service being performed. Finally, material requirements need to be added to the work order.

The following illustration is an example of a level-4 work order for a pavement saw with 600+ hours of use. In this example, the saw was scheduled for a level-4 service. First, the PM inspection tasks for a pavement saw level-4 service were added to the work order. After the PM inspection was performed, the additional labor and material requirements were added. In this example, all items that failed inspection were repaired during the PM service. Note the comments and technician signature columns. These items are a very important part of the work order, since all information feedback is generated from these fields.

**Equipment Maintenance**
**Work Order**

| | | | | | |
|---|---|---|---|---|---|
| **Equip. Type:** | Flatsaw | **W.O. TYPE** | | **Page 1 OF 2** | |
| **Equip. #:** | FS-100 | **Preventive Maintenance:** | **x** | **W.O. #:** | EXAMPLE |
| **Model#:** | FS-60HP Diesel | **PM Service Level:** | **4** | **Start Date:** | 6/20/05 |
| **Mfr. Serial #:** | FS-010105 | **On-Demand (Emergency):** | N/A | **Due Date:** | 6/22/05 |
| **Mfr. Name:** | Generic | **Hr. Meter:** | 620 | **Odometer:** | N/A |

| Operation, PM Inspection | Comments | Condition |
|---|---|---|
| **ENGINE-** | | |
| Inspect for oil leaks | | **Pass_x__Fail_____** |
| Inspect for coolant leaks | | **Pass_x__Fail_____** |
| Inspect radiator/cooler for plugging | Partially plugged, service required | **Pass____Fail_x___** |
| Inspect turbo condition | | **Pass_x__Fail_____** |
| Inspect fan belt condition | Worn | **Pass____Fail_x___** |
| Inspect air cleaner system for leaks/wear | Hose has spot partially worn through | **Pass____Fail_x___** |
| Inspect condition of fuel tank and cap | | **Pass_x__Fail_____** |
| Inspect condition of fuel lines and valve | | **Pass_x__Fail_____** |
| **POWER TAKE-OFF SYSTEM-** | | |
| Inspect condition of pulleys | Note: pulleys should be replaced @ next PM service | **Pass_x__Fail_____** |
| Inspect condition of bearings | | **Pass_x__Fail_____** |
| Inspect condition of drive plate and comp. | | **Pass_x__Fail_____** |
| Inspect condition of bladeshaft drive belts | Worn | **Pass____Fail_x___** |
| **BLADESHAFT ASSEMBLY-** | | |
| Inspect cond. of Brgs. w/dial indicator | Bearings have .030" radial freeply | **Pass____Fail_x___** |
| Inspect cond. of bladeshaft w/dial indicator | Shaft is worn @ location where blade rides | **Pass____Fail_x___** |
| Inspect cond. of blade flanges w/dial ind. | Worn undersize | **Pass____Fail_x___** |
| Inspect threads @ ea. end of bladeshaft | | **Pass_x__Fail_____** |
| Inspect threads of flange nuts or bolts | | **Pass_x__Fail_____** |
| **CHASSIS-** | | |
| Inspect cond. of front axle assembly | | **Pass_x__Fail_____** |
| Inspect cond. of front wheels and brgs. | Note: wheels should be replaced @ next PM service | **Pass_x__Fail_____** |
| Inspect cond. of axle bearings | | **Pass_x__Fail_____** |
| Inspect cond. of lift cylinder and pins | | **Pass_x__Fail_____** |
| Inspect cond. of lift pump-load test | 150 amps @ 12.2 VDC | **Pass_x__Fail_____** |
| Inspect cond. of depth stop system | | **Pass_x__Fail_____** |
| Inspect cond. of rear wheels and brgs. | Wheels worn | **Pass____Fail_x___** |
| Inspect cond. of rear drive system | Chains loose, adjustment required | **Pass____Fail_x___** |
| Inspect cond. of all chassis welments | Small crack LF corner of main platform frame | **Pass____Fail_x___** |
| **ELECTRICAL AND CONTROLS-** | | |
| Inspect general condition of wiring harness | | **Pass_x__Fail_____** |
| Inspect condition of switches | | **Pass_x__Fail_____** |
| Inspect condition of instruments | | **Pass_x__Fail_____** |
| Inspect cond. of Forward/Reverse control | Linkage ends worn | **Pass____Fail_x___** |
| Test battery condition-load test | | **Pass_x__Fail_____** |
| Test starter amp draw | | **Pass_x__Fail_____** |
| Inspect battery cables/terminals condition | | **Pass_x__Fail_____** |
| Inspect alternator-load test for max. output | 60 amps ourput @ 13.8 VDC | **Pass_x__Fail_____** |
| **MISC. OTHER-** | | |
| | | **Pass____Fail_____** |
| | | **Pass____Fail_____** |
| | | **Pass____Fail_____** |
| | | **Pass____Fail_____** |

## Equipment Maintenance

| | | | | | |
|---|---|---|---|---|---|
| **Equip. Type:** | Flatsaw | **W.O. TYPE** | | **Page 2 OF 2** | |
| **Equip. #:** | FS-100 | **Preventive Maintenance:** | **x** | **W.O. #:** | EXAMPLE |
| **Model#:** | FS-60HP Diesel | **PM Service Level:** | **4** | **Start Date:** | 6/20/05 |
| **Mfr. Serial #:** | FS-010105 | **On-Demand (Emergency):** | N/A | **Due Date:** | 6/22/05 |
| **Mfr. Name:** | Generic | **Hr. Meter:** | 620 | **Odometer:** | N/A |

| Operation, Labor Functions | Comments | Work performed by |
|---|---|---|
| Change engine oil | | **Tech Initials here** |
| Take engine oil sample | | **Tech Initials here** |
| Replace engine oil, air, and fuel filters | | **Tech Initials here** |
| Lube all grease points | | **Tech Initials here** |
| Replace lift pump fluid | | **Tech Initials here** |
| Replace wheel drive fluid and filter | | **Tech Initials here** |
| Pressure wash entire unit | | **Tech Initials here** |
| | | |
| **Operation, Additional Labor Functions from Inspection** | | |
| Replace engine fan belt | | **Tech Initials here** |
| Clean radiator/cooler | | **Tech Initials here** |
| Replace worn air intake hose | | **Tech Initials here** |
| Replace bladeshaft drive belts | | **Tech Initials here** |
| Replace entire bladeshaft assembly | | **Tech Initials here** |
| Replace rear wheels | | **Tech Initials here** |
| Adjust wheel drive chains | | **Tech Initials here** |
| Weld crack @ LF corner of platform | | **Tech Initials here** |
| Replace worn forward/reverse control linkage ends and adjust | | **Tech Initials here** |
| | | |
| **Material Requirements** | | **Materials Installed** |
| 15W-40 Motor Oil, 16 Qts. | | **Tech Initials here** |
| Oil sample kit, PN 12345, Qty. 1 | | **Tech Initials here** |
| Air filter, PN 23456, Qty. 1 | | **Tech Initials here** |
| Oil filter, PN 34567, Qty. 1 | | **Tech Initials here** |
| Fuel filter, PN 45678, Qty. 1 | | **Tech Initials here** |
| 4 oz. HP waterproof grease | | **Tech Initials here** |
| 5-30W motor oil, 1 Qt. | | **Tech Initials here** |
| Hydraulic filter, wheel drive, PN 56789, Qty. 1 | | **Tech Initials here** |
| Fan belt, PN 67890, Qty. 1 | | **Tech Initials here** |
| Hose, air intake, PN 78901, Qty. 1 | | **Tech Initials here** |
| Belt, 5G3VX530, Qty. 2 | | **Tech Initials here** |
| Bearings, Bladeshaft, PN 89012, Qty. 2 | | **Tech Initials here** |
| Bladeshaft, PN 90123, Qty. 1 | | **Tech Initials here** |
| Inner flanges, blade, PN 01234, Qty. 2 | | **Tech Initials here** |
| Outer flanges, blade, PN 98765, Qty. 2 | | **Tech Initials here** |
| Bolts, bladeshaft, PN 87654, Qty. 2 | | **Tech Initials here** |
| Wheels, rear, PN 76543, Qty. 2 | | **Tech Initials here** |
| Linkage ends, PN 65432, Qty. 2 | | **Tech Initials here** |
| | | |
| | | |
| | | |

## 3. Preventive Maintenance Scheduling Techniques

Due to time constraints or other considerations, it is not always possible to repair all failed inspection items during the scheduled PM service. It is at this point that scheduled maintenance practices come into play. If it is determined the item that failed inspection is still serviceable for a reasonable period then the repair can be re-scheduled for an interim repair or at the next PM service. Notice that two items (pulleys and front wheels) were given a pass rating, but in the comments column it was noted that they should be replaced at the next scheduled PM. This approach will allow the maintenance department to procure the needed materials at the best pricing, minimal freight cost and without spending extra labor for emergency purchases.

A very important activity that is often overlooked and under-utilized in the scheduling of equipment maintenance is the constant gathering of information regarding the condition of the equipment between regularly scheduled preventive maintenance intervals. Through constant gathering of information and updating of maintenance files, the effectiveness of preventive maintenance scheduling can be greatly enhanced. This process informs the maintenance department beforehand of the service requirements of a given piece of equipment, allowing all materials and labor resources to be available for the next scheduled PM service. Again, by preparing before the maintenance is due, equipment downtime and expense is minimized.

## 4. Communicating Maintenance Needs

Without a doubt, the most effective way to gather information regarding the condition of the equipment is from the employees using the equipment. How do we open the lines of communication between the operators in the field and the maintenance department? First, it is necessary to develop a work environment where the importance of equipment maintenance is appreciated by the field personnel. It is also important that everyone understands that the success of each employee and the success of the company as a whole are dependent on the performance of the equipment that is used in daily operations activities. Ways in which to improve communication between the field and maintenance departments include:

4.1 Maintenance Department:
- Make it easy for the operators to report equipment deficiencies
- Create equipment deficiency forms/reports for operators to use to communicate with the maintenance department
- Create OUT OF SERVICE tags
- Create READY FOR SERVICE tags
- Create a system where operators can report problems with their equipment even if maintenance personnel are not present

4.2 Field Operators:
- Take responsibility for communicating equipment deficiencies
- Perform daily routine inspections of assigned equipment
- Turn in equipment deficiency reports to maintenance department
- Whenever possible, give the maintenance department as much advance warning as possible

## 5. Improving Communication Systems

Most operators are not as likely to report problems with the equipment if there is not a procedure in place to do so. There are only two basic kinds of reports. The first is non-emergency information that allows the maintenance department to prepare in advance for the needed maintenance. The second is on-demand or emergency maintenance requirements. A very simple, yet effective system to use for reporting on-demand deficiencies are heavy manila tags with wire ties built onto the tag. These inexpensive tags can be printed with whatever information is needed. These kinds of tags can also be pre-formatted. All an operator has to do is complete the tag and tie the tag to the piece of equipment that requires service. This information will assist the maintenance personnel in determining what repairs are required for that particular piece of equipment. This is especially helpful if the equipment was brought back to the shop while maintenance personnel were absent. Tags can fall into two categories, out of service and ready for service. The out-of-service tag will also prevent another operator from attempting to use the equipment before it has been serviced.


**OUT OF SERVICE**
**Employee:**
**Date:**
**Equipment Number/Description:**
**Hour-meter Reading:**
**Description of Deficiency:**


**READY FOR SERVICE**
**Technician:**
**Date:**
**Equipment Number/Description:**
**Hour-meter Reading:**
**Description of Service/Repair:**

## 6. Visual Aids for Identifying In-Service and Out-of-Service Equipment

An effective method for identifying out-of-service and ready-for-service equipment is to have an area of the shop that is dedicated for incoming equipment (out of service). This equipment should be red tagged. After the equipment has been repaired it should be green tagged and taken back to the ready for service area. If the layout of your facility allows, these areas should be as far apart as possible to reduce any confusion about status of the equipment. This system will minimize the risk of operators taking an unserviced piece of equipment to the field. It will also help alert maintenance personnel to current service requirements.

## 7. Measuring Performance

Availability is the unit of measurement for rating how well a maintenance program is performing. The term “equipment availability” refers to what percentage of time a piece of equipment is available when there is scheduled demand for it. This is not to be confused with total downtime of a piece of equipment but only unscheduled downtime that occurs when the equipment is needed in the field. It is acceptable for a piece of equipment to be out of service, but only if it

is not needed in the field. Equipment availability ratings of less than 95 percent will have devastating effects on the profitability of any sawing and drilling operation.

There is a domino effect in terms of the costs associated with unscheduled downtime. Some of the costs are intangible, like customer dissatisfaction due to non-performance. Other costs are more readily identified such as re-scheduling labor and equipment resources back to a project that wasn't completed on time. This is a double hit, since the equipment and personnel that would be generating revenue today are consumed completing yesterday's work. In addition to inefficiencies related to production, the costs of emergency maintenance are estimated to be 3-5 times that of regularly scheduled maintenance.

Properly maintained equipment rarely fails unexpectedly. By performing preventive maintenance, unscheduled downtime can be reduced to almost zero percent. Bear in mind that preventive maintenance involves a bit of a different mindset than dealing with mechanical problems after the failure. Remember too that all equipment will eventually require maintenance. A PM program allows the maintenance to be performed under specific, planned and controlled conditions. In addition, it is important to have periodic meetings with employees to discuss what is working well with the PM program and what needs to be improved. For the program to work well, everyone has to participate.

## 8. Making the Move from Reactive to Proactive Maintenance

Most sawing and drilling contractor maintenance departments consist of a single person. The benefits for a small contractor are the same as a large one. A contractor does not require a large maintenance department to take advantage of PM practices. Preventive maintenance has to become part of the culture of your company and this culture has to be created and cultivated by management. Without the support of management, the program will break down and reactive emergency maintenance practices will prevail. By utilizing preventive maintenance practices in your business, you will ultimately have the ability to reduce and control maintenance cost as a predictable ratio of revenue.

# Best Practice

**Title:** Hazard Identification and Debris Removal
**Issue No:** CSDA-BP-003
**Effective Date:** Oct 31, 2007
**Revised Date:** Jan 21, 2008

## 1. Evaluate work area and job site conditions

- 1.1 Investigate and identify job site hazards.
  - 1.1.1 Look for oil or fuel tanks, lead, respirable silica, asbestos.
  - 1.1.2 Determine if hazards are hidden or buried and not obvious like underground utilities, asbestos-coated blocks, flitch plates, biohazards like septic fields or dead animals.
  - 1.1.3 Look for hazards on site or in close proximity to the job site such as overhead power lines, electric transformers, explosive or flammable materials (gaseous, fluid or dust), nearby excavation or terrain issues such as sink holes, deep pits, falling rocks, exposed electrical cords or high pressure hydraulic hoses.
  - 1.1.4 Be aware of vehicular traffic patterns, operating speeds, stopping distances.
- 1.2 Determine environmental concerns.
  - 1.2.1 Noise
    - 1.2.1.1 Noise on the job site that could impede communication or require hearing protection
    - 1.2.1.2 Noise generated by the equipment over the threshold levels set by local laws or ordinances
  - 1.2.2 Vibration
    - 1.2.2.1 Vibration to the body of the machinery operator
    - 1.2.2.2 Vibration on the job site having an impact on structures, work platforms or other areas on or near the job site
  - 1.2.3 Air quality
    - 1.2.3.1 Dust
    - 1.2.3.2 Fumes
    - 1.2.3.3 Carbon monoxide and hydrocarbons such as exhaust gases
  - 1.2.4 Hydraulic oil, fuel or other hazardous fluid leaks or spills
    - 1.2.4.1 Weather Conditions—Temperature, either extreme heat or cold, humidity, slippery footing, ice, mud, visibility
- 1.3 Prevent contamination of nearby bodies of water and ground water sources.
  - 1.3.1 Slurry management
  - 1.3.2 Sediment control
  - 1.3.3 Can slurry be left onsite or does it need to be hauled away?

## 2. Determine structural issues

- 2.1 Slope or grade of the material.
- 2.2 Evaluation of the material.
- 2.3 Structural integrity of the elevated work area.
  - 2.3.1 Cutting through pre- or post-tension cables
- 2.4 Falling hazards.
  - 2.4.1 Items falling from the work area onto personnel
  - 2.4.2 Vehicular traffic below
- 2.5 Openings in the slab surface.
  - 2.5.1 Properly supporting an opening that is being cut
  - 2.5.2 Proper dunnage underneath support
  - 2.5.3 Proper wedging techniques
  - 2.5.4 Proper rigging and supporting overhead
  - 2.5.5 Cutting taking place on secure work surface
  - 2.5.6 Appropriate barricades or covering of opening to keep skid steers, loaders, trucks and other pieces of equipment from falling through the opening
  - 2.5.7 Cold joints
  - 2.5.8 Steel patterns
- 2.6 Determine method for lifting limitations and path of egress for removing debris.
  - 2.6.1 Weight limitations
  - 2.6.2 Size limitations
  - 2.6.3 Egress limitations
  - 2.6.4 Expansion anchors for lifting
  - 2.6.5 Thru-bolting for lifting
- 2.7. Determine disposal requirements.
  - 2.7.1 On-site
  - 2.7.2 Dumpsters
  - 2.7.3 Truck and trailer
  - 2.7.4 Hazmat
  - 2.7.5 Recycling
  - 2.7.6 Reclamation of concrete

## 3. Select an appropriate cutting method for the work area and job site conditions

- 3.6 Cutting
  - 3.6.1 Type of concrete or asphalt saw
    - 3.6.1.1 Chain saw
    - 3.6.1.2 Cutoff saw
    - 3.6.1.3 Wire saw
    - 3.6.1.4 Ring saw
    - 3.6.1.5 Wall saw
- 3.7 Size of the saw.
  - 3.7.1 Horsepower or torque
  - 3.7.2 Weight
  - 3.7.3 Depth of cut
- 3.8 Power option for the saw.
  - 3.8.1 Gasoline engine
  - 3.8.2 Liquid propane
  - 3.8.3 Diesel
  - 3.8.4 Electric
  - 3.8.5 Hydraulic
  - 3.8.6 Pneumatic
- 3.9 Breaking
  - 3.9.1 Hammers
    - 3.9.1.1 Dust and noise
    - 3.9.1.2 Splitters
    - 3.9.1.3 Expansive agent

## 4. Estimate the amount of debris to be generated

- 4.1 Debris might need to be sorted by 'type' for reclamation, recycling, special handling (EPA, OSHA, hazmat) or landfill regulations.

## 5. Establish administrative and engineering controls for the job

- 5.1 Determine regulations for recycling, special handling (EPA, OSHA, Hazmat) or landfill.
- 5.2 Secure the required permits and job site approvals.
- 5.3 Have general contractor sign off on work order.
- 5.4 Define a safe work zone with appropriate barriers and marking techniques.
- 5.5 Educating the work site personnel as to the job site hazards.
- 5.6 Post and provide the appropriate Personal Protective Equipment (PPE) for the work zone including eye protection, steel toe boots, hard hats, gloves, respirator, electrical insulating boot/gloves, back support/brace, visible vest and any other appropriate PPE.
- 5.7 Provide proper ventilation with fans and ventilators to minimize carbon monoxide levels and reduce airborne dust.
- 5.8 Monitor exposure levels for noise, carbon monoxide and silica.
- 5.9 Protect existing facilities below the new opening.

# Best Practice

**Title:** Introduction to Remote Control
**Issue No:** CSDA-BP-004
**Effective Date:** Mar 14, 2008

## Introduction

Concrete cutting equipment has become more advanced in recent years and some of this equipment can now be controlled at a distance via "remote control." The equipment to be operated may be electric, hydraulic or electric over hydraulic, pneumatic, and may contain a remote control feature that enables the user to stay at a safe operating distance. Wall saws, small flat saws and gas or electric hydraulic power packs are some of the types of equipment that can now be operated by remote control.

The purpose of this best practice document is to explain some of the different types of remote controls used and to provide some tips with regards to operating them in a safe manner.

## 1. Wired Remote Controls

A wired remote control is a device used by an operator that is usually hand-held or waist-mounted. It is connected to the piece of equipment by a power cord that is generally between 30 and 100 feet in length. The cord can contain as few as three electrical conductors or as many as 25 conductors. Switches on the remote control send electrical signals through the conductors to operate the equipment. Simple remote controls may contain as few as one or two switches while more complex remotes can contain six to ten switches or any combination of switches and speed control devices.

Remote controls can be low voltage DC or high voltage AC.

1.1 Low voltage DC remotes use signals that operate from 12-30V DC. Since the operator is always in contact with the remote, these voltages are, by far, the safest with regards to electrical shock in the event of a failure in the device. In addition, because of the low voltage range, there is less likelihood of interference with other electrical devices in the work area.

1.2 High voltage AC remotes use signals that operate from 110-125V AC. Greater care is required when using this type of remote because there is a higher risk of electrical shock to the operator in the event of a failure. The likelihood of electrical interference with other devices is also greater.

1.3 Safety considerations when using remote controls:

- 1.3.1 Check cords for nicks or cuts. Replace or repair if needed.
- 1.3.2 Protect cords from being damaged during operation of the equipment.
- 1.3.3 Make sure all equipment is properly grounded.
- 1.3.4 Keep all controls away from water and concrete slurry.
- 1.3.5 Maintain visual contact with the cutting equipment at all times while in operation.
- 1.3.6 Protect work area from entry of unauthorized personnel.

## 2. Wireless Remote Controls

Wireless remote controls operate on a predetermined radio frequency powered by a battery to control a piece of equipment. As with the wired remotes, wireless remote controls are usually hand-held or waist-mounted. When an operator activates switches on the remote control, radio control signals are sent to the receiver. The receiver then processes the signals to activate different functions for the piece of equipment. These radio signals can be transmitted on frequencies as high as 2.4GHz and can be sent as far as 800 feet depending on the design of the system. Wireless remote systems typically incorporate a disconnect safety feature that shut down all machine functions if the battery in the transmitter is low or if the effective range has been exceeded. This feature is designed to protect the equipment from damage.

Since wireless remote control systems operate over the airwaves, it is possible for them to cause unwanted interference with other electronic or electrical devices in the work area. Wireless devices can also receive unwanted signals from other remote control systems that may cause undesired equipment operation.

2.1 Operating tips for wireless remote control systems:

- 2.1.1 Make sure that wireless devices are allowed to be used on the job site. Some job sites like hospitals may ban or oversee their use.
- 2.1.2 Check battery condition of transmitter and charge if needed.
- 2.1.3 Know the range of the transmitter and stay within this range.
- 2.1.4 Maintain visual contact with the cutting equipment at all times while in operation.
- 2.1.5 Protect work area from entry of unauthorized personnel.

## 3. Hydraulic Remote Controls

Hydraulic remote controls need no wires or electricity to operate. Typically, they are miniature valve stations connected by hoses routed back to a main hydraulic pump. These stations contain lever- or rotary-actuated valves that control the hydraulic fluid to the equipment being operated. Hydraulic remotes provide individual control functions such as power travel, power arm and blade rotation at distances up to 100 feet from the power unit. These mini stations are most commonly used when there are only limited control
(i.e.; blade rotation only) functions from the power unit itself.

3.1 Operating tips:
- 3.1.1 Inspect all hoses and fittings and repair if needed.
- 3.1.2 Keep fittings clean of dirt and concrete grit.
- 3.1.3 Keep a container on hand in case of an oil leak.
- 3.1.4 Maintain visual contact with the cutting equipment at all times while in operation.
- 3.1.5 Protect work area from entry of unauthorized personnel.

## 4. Pneumatic Remote Controls

These controls are similar to the hydraulic remote systems in that hoses are needed between the "remote" and the equipment to be controlled. An air compressor is needed to provide the air to operate the equipment. The compressor must be sized so that the equipment being used receives the correct volume of air (CFM/Cubic Feet per Minute) and the correct air pressure (PSI/Pounds per Square Inch). Check with the equipment manufacturer for specifications and air requirements.

4.1 Operating tips:
- 4.1.1 Inspect all hoses and fittings and repair if needed.
- 4.1.2 Keep fittings clean of dirt and concrete grit.
- 4.1.3 Maintain visual contact with the cutting equipment at all times while in operation.
- 4.1.4 Protect work area from entry of unauthorized personnel.

## 5. General Safety Tips

- Always wear the appropriate PPE for the job conditions.
- Follow all OSHA rules and regulations.
- Never leave any piece of equipment that is in operation unattended.
- Stay alert and anticipate potential unsafe hazards.

# Best Practice

**Title:** Diamond Cutting Tools for ADA
**Issue No:** CSDA-BP-005
**Effective Date:** Jun 13, 2008

## Purpose

The purpose of this document is to provide a quick overview of the Americans with Disabilities Act (ADA) standard as it applies to the sawing and drilling industry and to outline the types of cutting machines that could be employed to perform the tasks necessary to be in compliance to the standard.

## Introduction

The United States government has issued a series of guidelines and regulations in order to allow a standard level of accessibility by individuals with disabilities. These guidelines are to be followed during the design, construction and alteration of buildings as required by regulations issued by Federal government agencies, including the Department of Justice. These guidelines have been written as a result of the Americans with Disabilities Act (ADA) of 1990.


These guidelines are titled: Code of Federal Regulations—ADA Standards for Accessible Design—28 CFR Part 36 and can be viewed in their entirety via the Internet. Certain specifications in this standard (technical specifications 4.2 and 4.35) are similar to the American National Standard Institute's document A117.1-1980. Sections 4.1.1 through 4.1.7 and sections 5 through 10 are different from the ANSI document.

The standards have been developed to allow safe and convenient access to areas and structured for persons with disabilities. When performing work related to these standards, one should be familiar with the regulations in their entirety. This document will highlight the requirements and examine diamond cutting tools that could be used in specific applications.

Section 4.1.1 of the standard states which types of structures must meet these requirements.

Section 4.1.2 of the standard deals with exterior features and requirements for handicap accessibility. The standard specifically states the number and type of handicap accessible parking spaces that are required for various applications.

In order to achieve this compliance, curbs may need to be cut or ground and the parking lot itself may need to be altered. If altering a flat surface a flat or slab saw could be used. When altering curbing there are a number of tools can be employed. Curb-cutters are machines specifically designed for this purpose. These machines are very efficient at cutting openings into curbs.

A track mounted wall saw could also be employed to cut an access opening into a curb. These wall saws could be hydraulically or electrically powered.

A floor grinder could then be employed to remove any high spots or inconsistencies in the surface.

Flat saw making a cut.

The standard is broken down into sections dealing with different types of construction:

Section 4.1.3 addresses the application of this standard to new construction.

Section 4.1.5 addresses the application of this standard to additions.

Section 4.1.6 addresses the application of this standard to alterations.

Section 4.1.7 addresses the application of this standard to historic preservation.

These sections make specific references to feature requirements that are outlined in Section 4.2 Space Allowance and Reach Ranges.

1.1.1 Wheelchair passage width. The minimum clear width for a single wheelchair passage shall be 32 inch (815 mm) at a point and 36 inch (915mm) continuously.

1.1.2 Width for wheelchair passing. The minimum width for two wheelchairs to pass is 60 inch (1525 mm).

1.1.3 Wheelchair turning space. The space required for a wheelchair to make a 180-degree turn is a clear space of 60 inch (1525 mm) diameter or a T-shaped space.

1.1.4 Clear floor or ground space for wheelchairs.

1.1.4.1 Size and approach. The minimum clear floor space required to accommodate a single, stationary wheelchair and occupant is 30 inch by 48 inch (760 mm by 1220 mm).

1.2 Accessible Route.

1.2.2 General. All walks, halls, corridors, aisles, skywalks, tunnels, and other spaces that are part of an accessible route shall comply with 4.3.

1.2.3 Location. At least one accessible route shall connect parking lots with all buildings, dwellings, etc.

1.2.4 Width. The minimum clear width of an accessible route shall be 36 inch (915 mm) except at doors.

1.2.5 Passing Space. If an accessible route has less than 60 inch (1525 mm) clear width, then passing spaces at least 60 inch by 60 inch (1525 mm by 1525 mm) shall be located at reasonable intervals not to exceed 200 feet (61 m).

In order to make changes to a structure that would ensure compliance, walls may need to be removed or doorways and accesses may need to be increased. This could be accomplished by using the following:

- A track mounted wall saw could be employed to make the cuts. To avoid over-cutting, corners would be completed with the use of a track mounted or hand held chain saw. A flush cutting saw would be needed to make the cut along the floor on a doorway in order to minimize grinding afterwards.
- A wire saw could be employed to make the cut. A core drill or a rotary hammer would be employed to drill holes to start the wire. The wire saw has the advantage of cutting square corners as well as being quieter, causing less structural damage and being able to cut deeper than a wall saw. This is sometimes important in environments such as hospitals. The wire saw is generally more expensive to operate.

1.1.8 Changes in levels. Changes in levels along an accessible route shall comply with 4.5.2.

Wall saw preparing to make a cut.

For making the flush cut along the floor, a flush cut hand saw on a cart could be used instead of a flush cut wall saw.

The finished product—a clean cut.

Corner cut chain saw preparing to finish the cut.

A wire saw could be used to create an opening in concrete instead of a wall saw.

4.5 Ground and Floor Surfaces

4.5.2 Changes in level. Changes in level up to ¼ inch (6 mm) may be vertical and without edge treatment. Changes in level between ¼ inch and ½ inch (6 mm and 13 mm) shall be beveled with a slope no greater than 1:2. Changes in level greater than ½ inch (13 mm) shall be accomplished by means of a ramp that complies with 4.7 or 4.8.

In order to make changes to a structure or facility that would ensure compliance, floors may need to be ground to eliminate any changes in level that may cause a hazard. This could be accomplished by using the following:

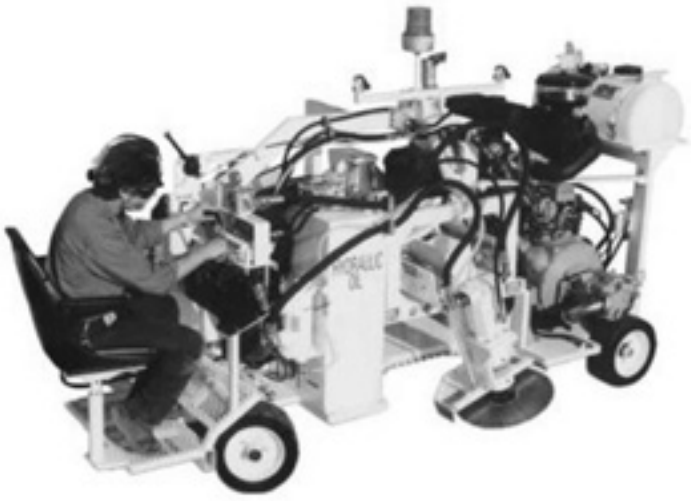
- A floor grinder could be employed to minimize any changes in floor level.

4.8 Ramps

To make a ramp in an existing sidewalk and curb, the existing sidewalk would be cut out and removed using a flat saw. The curb could be cut with a curb cutter or wall saw. The concrete would then be poured to comply with the maximum slope of 1:12 along the center and 1:10 to the sides with a minimum center width of 36 inch.

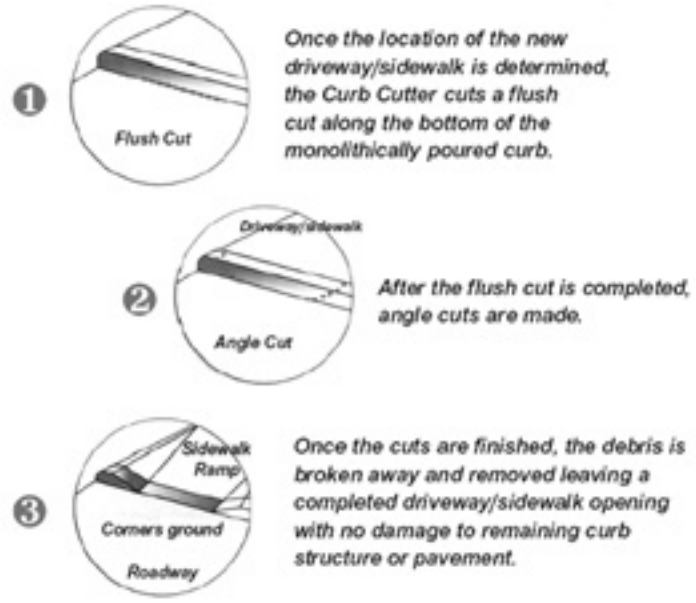
- A curb cutting machine quickly and efficiently cuts curbs. Remember to always check for the latest updates to this standard and any other standard prior to quoting or starting any project. Also check for any local regulations that may be applicable to this type of work.





A curb cutting machine quickly and efficiently cuts curbs.

Floor Grinders can be used to quickly fix high spots on a variety surfaces.




How a curb cutting machine makes curbs.

# Best Practice

**Title:** Hydraulic Concrete Cutting Equipment
**Issue No:** CSDA-BP-006
**Effective Date:** Nov 1, 2008

## Introduction

Hydraulic powered tools are quite common in the concrete cutting industry powering a full range of cutting tools including wall saws, core drills, hand held saws, chain saws and even flat saws. While hydraulics are a low-cost and dependable way to transmit power, there are a multitude of ways to design a system for optimum performance in specific applications. This Best Practice will focus on a few design considerations or options, general maintenance issues and some troubleshooting guidelines.

## Table of Contents

## 1. Horsepower Rating

1.1 Calculation of hydraulic Power In English Units
The formula for determining the horsepower rating of any hydraulic operating system in English units is as follows: Flow (in gallons per minute) x operating psi divided by 1,714 equals the Theoretical Horsepower.
Most systems are only 80 to 90% efficient, depending on the distance from the pump to the motor, the condition of the main system components, the design of the hose couplings and general system design.

**Example:**
A 25 gpm system operating under load at 1,800 psi at the motor (even though max psi of the system pump is 2,500) is:

25 x 1,800 = 45,000
Divided by 1,714 = 26
Times 0.85 efficiency = 22 horsepower

If the flow is being diverted for the operation of another system component then the actual horsepower to the main drive will be less.

1.2 Calculation of Hydraulic Power in Metric Units

$$\text{Hydraulic Power (kW)} = \frac{\text{Flow volume (liter/min)} \times \text{Pressure (bar)}}{600}$$

**Example:**

Delivery of the pump Q = 40 liter/min

Operating Pressure P = 180 bar

Power output of the hydraulic pump $P = \frac{Q \times P}{600} = \frac{40 \times 80}{600} = 12$ kW

**Pressure Drop**

Friction between the fluid flowing through a conductor (hoses, valves, fittings or QDs) and its inside walls will cause losses, which are quantified as pressure drop. Pressure drop in conductors is an important consideration for the designer, especially in systems where long pipe or hose runs are necessary. The pressure drop over a length of pipe or hose is shown in the chart below.

Before proceeding to the pressure drop chart, the following variables need to be determined.

a. The inside diameter of the hose.
b. The length of the hose.
c. The flow rate.
d. Condition of the hoses in use. (Not crushed or kinked)

| Hose Diameter (Inch) | Oil Flow (liters/min) | Per Meter | Pressure Drop (Bar) 10M x 2 | 20M x 2 |
|---|---|---|---|---|
| 0.5 | 40 | 0.60 | 12.0 | 24.0 |
| 0.5 | 60 | 1.30 | 26.0 | 52.0 |
| 0.75 | 40 | 0.17 | 3.4 | 6.8 |
| 0.75 | 60 | 0.35 | 7.0 | 14.0 |

The pressure drop in one pair of quick disconnect couplings results in 3-5 bar 44-72 psi.

It is vital to inspect the hoses on a daily basis for damage due to kinking or being crushed. Unrolling the hoses completely from the hose reel will decrease the chance that when the hoses are pressurized, they will not crush the inner windings of the hose left on the reel. This will also allow more heat to escape from the surface of the hoses.

**The loss of efficiency up to the saw blade on a 18.8 kW power pack.**

- Hydraulic power pack 18.8 kW (25 hp)
- Losses in the hoses - 2.2 kW (-3 hp)
- Losses in the hydraulic motor - 2.2 kW (-3 hp)
- Losses in the transmission - 0.7 kW (-1 hp)

(18 hp)

**Power on the saw blade 13.7 kW**

## 2. Cleanliness and Filtration

Dirt or other contaminants in a hydraulic system will cause serious damage to the components very quickly. Because of the close tolerances and high forces under which the components operate, contaminants will cause a high degree of wear resulting in a less efficient system rapidly. This lowers productivity and increases heat generated due to the less efficient system. It is wise to follow the system designer's specific instructions for filter and oil specifications as well as the specific maintenance advice provided. Listed below are some of the possible actions:

a. Keep hose couplings out of contact with slurry. The fittings nearest the motor that are frequently disconnected and reconnected should be washed down thoroughly before disconnecting and reconnecting and then wiped dry with a clean cloth.
b. Change filters regularly and clean strainers regularly. Use filters with element condition indicators if possible.
c. Perform any system maintenance or work including filter changes in a clean location using "clean practices."
d. Keep all connections throughout the entire system tight so that air (and contaminants it may contain) is excluded from the system.
e. Make sure the air breathers and reservoir covers are properly installed and tightly secured at all times.
f. Stop any leakage of water into the system from coolers or to other sources. It is best to keep the reservoir filled to the recommended fill line to minimize condensation in the tank.
g. Use a portable filtration unit with at least a 25-micron filter for filling and emptying the hydraulic reservoir.
h. Flush all new systems and any that have undergone major repair before starting the unit.

i. Take fluid samples and have them analyzed occasionally so that you know what the most common contaminants that are in the system. This will help you locate and minimize them.
j. Change fluid regularly. Degraded fluid can result in contamination due to oxidation or the formation of gummy deposits that can break loose and clog control valve orifices.
k. Before draining the system the system should be started and the fluid allowed to heat up before draining. This will lower the draining time and help many impurities to become suspended in the fluid before draining.

## 3. Hydraulic Fluid

Hydraulic fluid is the "life" of the hydraulic circuit. It is usually petroleum oil with various additives. In addition to transferring energy, hydraulic fluid needs to lubricate components, suspend contaminants and metal filing for transport to the filter, and to function well to several hundred degrees Fahrenheit.

Most hydraulic systems will operate satisfactorily using a variety of fluids. These include multigrade engine oil, automatic transmission fluid and more conventional antiwear hydraulic oil. But which type of fluid is best for a particular application? While it is not possible to make one definitive recommendation that covers all types of hydraulic equipment in all applications, the following are some of the factors to consider when selecting a hydraulic fluid.

3.1 Multigrade or Monograde

Viscosity is the single most important factor when selecting a hydraulic fluid. It doesn't matter how good the other properties of the oil are if the viscosity grade is not correctly matched to the operating temperature range of the hydraulic system. In this situation, maximum component life will not be achieved. Defining the correct fluid viscosity grade for a particular hydraulic system involves consideration of several interdependent variables. These include:

a. Starting viscosity at minimum ambient temperature.
b. Maximum expected operating temperature which is influenced by maximum ambient temperature.
c. Permissible and optimum viscosity range for the systems components.

If the hydraulic system is required to operate in freezing temperatures in winter and tropical conditions in summer, then it is likely that mulitgrade oil will be required to maintain viscosity within permissible limits across a wide operating temperature range. If fluid viscosity can be maintained in the optimum range, typically 25 to 36 centistokes, the overall efficiency of the hydraulic system is maximized (less input power is given up to heat). This means that under certain conditions, the use of a multigrade oil can reduce the power consumption of the hydraulic system. For mobile hydraulic equipment users this translates to reduced fuel consumption.

3.2 Detergent or No Detergent

DIN 51524; HLP-D fluids are a class of anitwear hydraulic fluids that contain detergents and dispersants. The use of these fluids is approved by most major hydraulic component manufacturers. Detergent oils have the ability to emulsify water, and disperse and suspend other contaminants such as varnish and sludge. This keeps components free from deposits, however, it also means that contaminants do not settle out—they must be filtered out. These can be desirable properties in mobile hydraulic systems, which unlike industrial systems, have little opportunity for settling and precipitation of contaminants at the reservoir.

As far as hydraulic oil recommendations go, for commercial reasons relating to warranty, it is wise to follow the equipment manufacturers recommendations. However in some applications, the use of a different type of fluid to that originally specified by the equipment manufacturer may increase hydraulic system performance and reliability. Always discuss the application with a technical specialist from your oil supplier and the equipment manufacturer before switching to different type of fluid.

## 4. Aeration

Aeration is a condition caused when air bubbles are somehow introduced into the hydraulic oil. You can generally tell if the system you are operating is suffering from aeration by the noise coming from the pump caused by "cavitation" which can produce a light to strong "pounding" effect. Aeration caused by small bubbles causes extreme and rapid ring wear and vane tip wear. Large bubbles cause the vanes to collapse and pound. With extreme aeration cases, the wear is so rapid that the ring and vanes can be destroyed within an hour, so this is a condition that should definitely be avoided.

4.1 Possible Causes

a. Leaking inlet lines.
b. Control valve o-rings leaking.
c. Shaft seal leakage.
d. Turbulence or sloshing in the fluid reservoir.
e. Vortexing fluid in the reservoir.
f. Release of air naturally suspended in the fluid.
g. Shaft misalignment in pump.

4.2 Cures

a. Use an approved type of pipe thread sealer on all pipe threads.
b. Check to see if the pump inlet flanges are rough, porous or mutilated. Air leakage past the o-ring seal can result.
c. Check alignment of shaft and correct if necessary.
d. Make sure that the fluid return line discharges the flow below the fluid level in the tank.
e. Make sure the fluid return is not directly up against a wall of the tank causing vortexting.

## 5. Hydraulic Pumps

Hydraulic pumps deliver high-pressure fluid flow to the pump outlet. Hydraulic pumps are powered by a mechanical energy source to pressurize fluid. A hydraulic pump, when powered by pressurized fluid, can rotate in a reverse direction and act as a motor. Operating specifications, housing materials and features are all important specifications to consider when searching for hydraulic pumps.

Pump type and pump stages are the most important operating specification to consider when searching for hydraulic pumps. Choices for hydraulic pump types include axial piston, radial piston, internal gear, external gear and vane. An axial piston pump uses an axially-mounted piston to pressurize the fluid. Mechanical motion from the pumps power

source moves the piston through a chamber, pressurizing the fluid it comes in contact with. A radial piston pump uses pistons mounted radially about a central axis to pressurizing fluid. An alternate form of radial piston pump uses multiple interconnected pistons, usually in a star pattern. The hydraulic pump's power source causes the pistons to move, forcing the pistons through the chambers and pressurizing fluid. An internal gear pump uses internal gears to pressurize fluid. The pumps power source causes the internal gears to turn, which forces fluid through the pump outlet. An external gear pump uses external gears to pressurize fluid. The pumps power source causes external gears to turn, which forces fluid through the pump outlet. A vane pump uses a vane to pressurize fluid. The pump's power source causes the vane to rotate. As the vane rotates, blades on the vane push fluid out the pump's outlet. Pump stages include single stage, double stage, triple stage and four or more pump stages.

Additional operating specifications to consider for hydraulic pumps include continuous operating pressure, maximum operating pressure, operating speed, operating horsepower, operating temperature, maximum fluid flow, maximum fluid viscosity, displacement per revolution, and pump weight. The continuous operating pressure is the maximum pressure available at the pump outlet. The maximum operating pressure refers to the maximum peak pressure available at the pump outlet on a noncontiguous (intermittent) basis. The operating speed is the speed at which the pump's moving parts rotate is expressed in revolutions per minute, or similar terms. The operating horsepower is the amount of power the pump is capable of delivering. Horsepower is dependent on the pressure and flow of the fluid through the pump. The operating temperature is the fluid temperature range the pump can accommodate. Maximum and minimum fluid temperature is dependent upon internal component materials, and varies greatly between manufacturers. The maximum volumetric flow through the pump is expressed in terms of gallons per minute, or similar units. The maximum fluid viscosity the hydraulic pump can accommodate is a measure of the fluid's resistance to shear, and is measured in centipoise. Centipoise is a common metric unit of dynamic viscosity equal to 0.01 poise or 1 millipascal second. The dynamic viscosity of water at 20 degrees C is about 1 centipoise. The correct unit is cP, but cPs and cPo are sometimes used. The fluid volume displaced per revolution of the pump is measured in cubic centimeters (cc) per revolution, or similar units. The weight of the hydraulic pump is measured in pounds or similar units.

5.1 Radial Piston Pumps
Radial piston pumps (fixed displacement) are used especially for high pressure and relatively small flows. Pressures of up to 650 bar are normal. In fact variable displacement is not possible, but sometimes the pump is designed is such a way that the plungers can be switched off one by one, so that a sort of variable displacement pump is obtained.

5.2 Pumps for Open and Closed Systems
Most pumps are working in open systems. The pump draws oil from a reservoir at atmospheric pressure. It is very important that there is no cavitation at the suction side of the pump. For this reason the connection of the suction side of the pump is larger in diameter than the connection of the pressure side. In case of the use of multi-pump assemblies, the suction connection of the pump is often combined.
It is preferred to have free flow to the pump (pressure at inlet of pump at least 0.8 bars). The body of the pump is often in open connection with the suction of the pump. In a closed loop systems, both sides of the pump can be at high pressure. The reservoir is pressurized with 2-20 bars of boost pressure. For closed loop systems normally axial pumps are used.

## 6. Hydraulic Motors

Hydraulic motors are powered by pressurized hydraulic fluid and transfer rotational kinetic energy to mechanical devices. Hydraulic motors, when powered by a mechanical source, can rotate in reverse direction and act as a pump. Operating specifications and features are the most important parameters to consider when searching for hydraulic motors.

The most important operating specification to consider when searching for hydraulic motors is the motor type. Choices for motor type include axial piston, radial piston, internal gear, external gear and vane. An axial piston motor uses an axially-mounted piston to generate mechanical energy. High pressure flow into the motor forces the piston to move in the chamber, generating output torque. A radial piston hydraulic motor uses pistons mounted radially about a central axis to generate energy. An alternate-form radial piston motor uses multiple interconnected pistons, usually in a star pattern, to generate energy. Oil supply enters piston chambers, moving each individual piston and generating torque. Multiple pistons increase the displacement per revolution through the motor, increasing the output torque. An internal gear motor uses internal gears to produce mechanical energy. Pressurized fluid turns the internal gears, producing output torque. An external gear motor uses externally-mounted gears to produce mechanical energy. Pressurized fluid forces the external gears to turn, producing output torque. A vane motor uses a vane to generate mechanical energy. Pressurized fluid strikes the blades in the vane, causing it to rotate and produce output torque.

Additional operating specifications to consider for hydraulic motors include operating torque, operating pressure, operating speed, operating temperature, power, maximum fluid flow, maximum fluid viscosity, displacement per revolution and motor weight. The operating torque is the torque the motor is capable of delivering. Operating torque depends directly on the pressure of the working fluid delivered to the motor. The operating pressure is the pressure of the working fluid delivered to the hydraulic motor. Working fluid is pressurized by an outside source before it is delivered to the motor. Working pressure affects operating torque, speed, flow and horsepower of the motor. The operating speed is the speed at which the hydraulic motor's moving parts rotate. Operating speed is expressed in revolutions per minute, or similar terms. The operating temperature is the fluid temperature range the motor can accommodate. Minimum and maximum operating temperatures are dependent on internal component materials of the motor and can very greatly between products. The power the motor is capable of delivering is dependent on the pressure and flow of the fluid through the motor. The maximum volumetric flow through the motor is expressed in terms of gallons per minute, or similar units. The maximum fluid volumetric the motor can accommodate is a measure of the fluids resistance to shear, and is measured in centipoise. Centipoise is a common metric unit of dynamic viscosity equal to 0.01 poise or 1 millipascal second. The dynamic viscosity of water at 20 degrees C is about 1 centipoise. The correct unit is cP, but cPs and cPo are sometimes used. The fluid volume displaced per revolution of the motor in cubic centimeters (cc)

per revolution, or similar units. The weight of the motor is measured in pounds or similar units.

Additional features to consider when searching for hydraulic motors include mounting in any position, rated for continuous duty and quiet operation.

## 7. Fittings, Piping and Cost of Hydraulic Leaks

7.1 Reliable Connections

Leak-free reliability begins at the design stage, when the type of hydraulic fitting is selected for port, tube-end and hose-end connections.

Ports—Connectors that incorporate an elastomeric seal such as UNO, BSPP and SAE 4-bolt flange offer the highest seal reliability. NPT is the least reliable type of connector for high pressure hydraulic systems because the thread itself provides a leak path. The threads are deformed when tightened and as a result, and subsequent loosening or tightening increases the potential for leaks. In existing systems, pipe thread connections should be replaced with UNO or BSPP for leak free reliability.

Tube and Hose Ends—ORFS (Face Seal) tube and hose end connections feature the high seal reliability afforded by an elastomeric seal but, due to the cost, ORFS is not as widely used as compression fittings and JIC 37-degree flare.

Flared connections have gained widespread acceptance due to their simplicity and low cost. However, the metal-to-metal seal of the flare means that a permanent, leak-free joint is not always achieved, particularly in the case of tube-end connections.

Leaking flare joints can be eliminated using a purpose-built seal developed by Flaretite. The Flaretite seal is a stainless stamping shaped like the JIC nose, with concentric ribs that contain pre-added sealant. When tightened, the ribs crush between the two faces of the joint, eliminating and misalignment any surface imperfections. The combination of the crush on the ribs and the sealant insure that a leak-free joint is achieved.

Incorrect Torque—A common cause of leaks from flare joints is incorrect torque. Insufficient torque results in inadequate seat contact, while excessive torque can result in damage to the tube and fitting through cold working.

The following is a simple method to ensure flare joints are correctly torqued:

a. Finger tighten the flare nut until it bottoms on the seat.
b. Using a permanent marker, draw a line lengthwise across the nut and fitting.
c. Wrench tighten the nut until it has been rotated the number of flats listed in the following table.

| Tube Dash Size | Hex Flats |
|---|---|
| 4 | 2.5 |
| 5 | 2.5 |
| 6 | 2.0 |
| 8 | 2.0 |
| 10 | 1.5 - 2.0 |
| 12 | 1.0 |
| 16 | 0.75 - 1.0 |
| 20 | 0.75 - 1.0 |
| 24 | 0.5 - 0.75 |

7.2 Vibration

Vibration can stress plumbing, affecting hydraulic fitting torque and causing fatigue. Tube is more susceptible than hose. If vibration is excessive, the root cause and if necessary, replace problematic tubes with hoses.

7.3 Seal Damage

Having outlined the benefits of hydraulic fittings that incorporate an elastomeric seal, it is important to note that their reliability is contingent on fluid temperature being maintained with acceptable limits. A single over-temperature event of sufficient magnitude can damage all the seals in a hydraulic system, resulting in numerous leaks.

7.4 Conclusion

A leak-free hydraulic system should be considered the norm for modern hydraulic machines, not the exception. But the proper selection, installation and maintenance of hydraulic plumbing are essential to ensure leak-free reliability.

## 8. Operating Instructions for a Hydraulic Power Pack

8.1 Operating Instructions for a Typical Low Pressure—High Volume Hydraulic System

Most hydraulic systems operating in North America are low pressure, high volume systems. Many European hydraulic systems are high pressure low volume systems. Either system has its own set of advantages and disadvantages as the system is applied to our concrete cutting industry. The example used for our best practice is a low pressure, high volume system. For best practice do's and don'ts for high pressure, low volume systems please consult your manufacturer's operating manual.

The pressure compensated, flow control valve on this example unit allows full flow control while the gas engine remains at its optimum wide-open throttle. This allows a higher pressure at all flows. For low flow or low pressure situations, the engine may be throttled back to reduce noise, heat generation and fuel consumption, but it is not necessary.

Valve settings for both gas and electric units are: 0-2, all flow routed to tank; 8-10, all flow routed to tool; 2-8, adjustable range. If the gas engine is run at a lower speed, the "all flow to tool" range will increase, and the "adjustable range" will decrease i.e.: the "8" will drift toward 7, 6 and so on.

IMPORTANT: The power units are equipped with positive displacement gear pumps. All tools must be equipped with a control valve that allows flow directly to return ports when not in use. Blocking flow or abruptly disconnecting the tool can send all flow over relief and potentially overheat the system.

The following procedure must be adhered to when starting and operating the power unit.

a. Set the flow control valve to zero (all flow to tank).
b. Connect hydraulic hoses to the power unit. Push couplings together until you hear it click. Turn locking ring of coupling to the secured position.
c. Connect tool at the properly selected quick disconnects. Excess flow will return to the tank.
d. Start engine. For gas, choke if necessary (Refer to engine manual for details of control functions).
e. Idle gas engine at 1,000 rpm, gradually increasing speed to max 3,450 rpm over two to three minutes to warm engine.
f. Rotate lever on valve toward 10 to direct required flow to tool.
g. To stop tool operation and unload the system prior to shutdown, rotate lever to zero position.
h. Running the power unit for extended periods with the tool off, or the power unit in the zero position, still heats the hydraulic oil. It is best to shut the system down to avoid heating and conserve energy.

Heating cold oil: Forcing the oil over relief will quickly increase the oil temperature. With the supply ports closed, move the valve setting toward 10. This will force an increased percentage of oil over relief. The supply ports are normally closed until a tool is connected to them. Cold oil greatly increases pressure loss in hoses and fittings.

IMPORTANT: Setting the control valve to 10 in a deadheaded system will force all flow over relief and lock the internal spool in the relief position even if the valve is returned to zero. The unit must then be shut down to allow this pressure lock to bleed off.

DANGER: Do not operate the engine within enclosed or confined spaces. Exhaust from the engine contains carbon monoxide, a poisonous, odorless, invisible gas, which if breathed by the operator or other occupants of the enclosed space can cause serious illness or possible death. Enclosed spaces include all areas where natural ventilation is restricted, such as buildings, truck enclosures and access paths between buildings. Open skyways, windows, and doorways are not sufficient for preventing this hazard.

8.2 Hydraulic Oil Cooler

The power unit is equipped with a 4-pass-type oil cooler. Water is frequently passed through the cooler before it is used for dust control or blade and bit cooling. Some tools will automatically shut off water flow when not actively cutting or drilling. This may result in high oil temperatures if the power unit continues to run for long periods.

IMPORTANT: If there is a risk of frost, the water must be drained after use to prevent damage by freezing.

8.3 Preparing the Unit

Unpack the power unit carefully to prevent damage. The power unit should be inspected and operated before shipment, and should not require any additional adjustments prior to its initial use.

8.4 Hydraulic System

IMPORTANT: Introduction of contaminants into the system will reduce component service life and void any warranty.

HYDRAULIC FLUID: The reservoir of the hydraulic power unit must be filled with fluid prior to start-up. The use of high quality petroleum-based hydraulic oil with the following properties is recommended,

a. Anti-wear
b. Low foaming
c. Rust and oxidation inhibitors
d. Wide temperature range

It should have fluid viscosity approximately 300 SSU at 100 degrees Fahrenheit (ISO 68). For use in higher ambient temperature climates regularly above 80 degrees Fahrenheit, the oil should have fluid viscosity of approximately 225 SSU at 100 degrees Fahrenheit (ISO 46). Check with local oil suppliers for availability. The oil must be kept free of contamination to avoid damage to system components. The strainer in the filler tube must always be in place when adding oil. Quick disconnects must be cleaned before connections are made. The hydraulic system is compatible with most hydraulically driven sawing and drilling components. The system may not be compatible with components, however some manufacturers may be able to supply information as to operational capabilities if sufficient specifications are available.

IMPORTANT: Maximum recommended oil temperature is 180 degrees Fahrenheit (82 degrees Celsius).

HOSES: Large diameters and short lengths are preferred, and offer the highest system efficiency. If one is operating 100 feet from the power source, there is also a 100 feet return for 200 feet total hose length. With oil at 100 degrees Fahrenheit, this could result in a 600 psi pressure loss with a ½-inch hose and a 200 psi loss with 5/8-inch hose. Pressure loss will change dramatically with oil temperature.

8.5 Engine

Make sure that the engine crankcase is filled with oil to the proper level. Refer to your engine for oil checking and changing procedures, along with oil specifications, etc.

IMPORTANT: Operating the engine without oil will ruin the engine.

FUEL: Use regular grade unleaded gasoline to fuel the engine. Premium grade may be used if necessary. Only add fuel to the tank when the engine is not running and has been allowed to cool. Care should be taken to prevent spilling fuel over any part of the equipment. The operator is advised to drain the tank during storage within an enclosed area, as this will reduce the chance of a fire.

IMPORTANT: Do not overfill the fuel tank. Always leave enough space for expansion due to environmental heating.

WARNING: In the event of fuel spillage, do not attempt to start the engine or operate any electrical component until the spillage has been removed.

8.6 General Safety Precautions

Tool operators and maintenance personnel must always comply with the safety precautions stated in this document, and on any stickers and tags attached to the equipment. These safety precautions are provided for your safety. Review them carefully before operating the tool and before performing general maintenance or repairs. Supervisors should develop additional precautions relating to the specific work area and local safety regulations.

The hydraulic power unit will provide safe and dependable service if it is operated in accordance with the instructions in this document. Failure to do so could result in personal injury or equipment damage.

a. Operators must start work in the work area without bystanders. The operator must be familiar with all prohibited work areas such as excessive slopes and dangerous terrains.
b. Establish a training program for all operators to ensure safe operation.
c. Do not operate the power unit unless thoroughly trained, or under the supervision of an instructor.
d. Always wear safety equipment such as goggles, ear and head protection and safety shoes at all times when operating the power unit and/or a hydraulic tool.
e. Do not inspect or clean the power unit while it is running.
f. Always use hoses and fittings rated at a minimum 2,500 psi. (172 bar) with a four to one safety factor for pressure lines.
g. Be sure all hose connections are tightly fastened.
h. Make sure all hoses are connected for correct flow direction to and from the tool being used.
i. Do not inspect hoses and fittings for leaks by using bare hands. “Pin-hole” leaks can penetrate the skin.
j. Never operate the gas power unit in a closed space. Inhalation of engine exhaust can be fatal.
k. Do not operate a damaged or improperly-powered unit.
l. Never wear loose clothing that can become entangled in the working parts of the power unit.
m. Keep all bodily parts away from the working parts of the power unit.
n. Always wear appropriate Personal Protective Equipment (PPE) such as goggles, ear protection, and toe guards. Certain tools used in conjunction with the power unit may require other safety equipment such as breathing filters.
o. Keep clear of hot engine exhaust.
p. Do not add fuel to the power unit while the power unit is running or is hot.
q. Do not operate the power unit if gasoline odor is present.
r. Do not use flammable solvents around the power unit engine.
s. Do not operate the power unit within 3.3 feet. (1 meter) of buildings, obstructions or flammable objects.
t. Allow the engine to cool before storing the power unit.

To avoid personal injury or equipment damage, all tool repair, maintenance and service must only be performed by authorized and properly trained person.

## 9. Hydraulic Troubleshooting

Prevention is the best medicine. Proper maintenance of your hydraulic system will prolong the life of your system. Here are a few tips to keep your system in optimum operating condition.

a. It is recommended to drain, flush and clean your hydraulic system every 200 to 300 hours. This will prevent varnish buildup, viscosity breakdown that will damage your pump and other components of your hydraulic system.
b. Utilizing an offline, oil-filtering system that pulls the hydraulic oil from your tank, filters it and returns it to the tank will remove water, varnish and particulate buildup which prolongs the life of your hydraulic oil.
c. Always monitor the temperature of the hydraulic oil while operating the system. It is recommended to utilize either an air-to-oil or water-to-oil type of cooler to keep the hydraulic oil within the operating limits designated by the manufacturer of the particular hydraulic system.
d. Monitoring the water content of the oil is very important in any hydraulic system. Water can enter a system in various ways.
    - Water can enter the system through self-contamination by power washing the tank and not protecting the fill cap.
    - The water cooler can possibly have a small leak allowing water to enter the system.
    - A hot hydraulic system expands the hydraulic oil and when the system cools down it will draw in moisture and humidity through the fill cap and add water to the oil.
    - Always warm up the hydraulic system prior to operating any hydraulic tools. This especially important in cooler temperatures. When the hydraulic oil is cold, this will increase the return pressure on the hydraulic system and damage internal components of the tool as well as the operating efficiency.

Using the proper viscosity hydraulic oil in the various temperature regions will keep your system operating efficiently.

Please refer to Appendix A on the following pages for an associated troubleshooting guide.

## Appendix A—Hydraulic Troubleshooting Guide

| Problem | Symptom | Pressure Reading Power Unit | Flow and Pressure on Test Kit | Cause | Solution |
|---|---|---|---|---|---|
| No blade rotation | | 0 or maximum<br><br>Maximum psi | | Hydraulic quick coupler not connected; Wall saw internal damage "locked up" | Inspect, connect as necessary, test Disconnect from hydraulic system-test by hand to locate problem |
| | Pump noise | 0 psi | | Pump shaft failed-pump not rotating | Remove pump to inspect—repair as necessary |
| Blade rotates but with major power loss | Excessive system temp., pump or meter may be noisy | Maximum psi, but slow gauge response under blade stall | Partial to full flow, but psi slow response Maximum flow, maximum psi | Excessive aeration in hydraulic oil or pump cavitation | Refer to pump service manual |
| | Excessive hose vibration | Maximum psi, but slow gauge response under blade stall | Partial to full flow, but psi slow response | Hydraulic meter failure-excess internal slippage—may be noisy<br><br>Pump failure - excess internal slippage shaft failure - | Repair or replace as necessary<br><br>Repair or replace as necessary |
| Blade rotates but with major power loss | Minor heat build-up, no blade | Difficult to maintain 1,250 psi and over stalling blade | Maximum flow Maximum psi | Blade polished can not utilize horsepower output from hydraulic saw | Replace blade or attempt to "open up" |

## Appendix A—Hydraulic Troubleshooting Guide

| Problem | Symptom | Pressure Reading Power Unit | Flow and Pressure on Test Kit | Cause | Solution |
|---|---|---|---|---|---|
| Blade rotates but with major power loss | No heat build-up, no noise Oil to compensator when hose fitting checked* | 300 psi or less | 12 gpm or less 300 psi or less | Stuck flow compensator spool | Remove and clean as necessary Inspect on removal to prove cause |
| | | Maximum psi | Flow less than maximum psi | Worn flow compensator spool or Weak spring on flow compensator spool | Adjust to correct reading or replace |
| | | Maximum psi or less than max | Less than max flow or pressure or less than max on both | Misadjusted compensator spools | Adjust to correct specs |
| | No oil to compensator when hose fitting checked* | 300 psi or less | 12 gpm or less 300 psi or less | Sensing hose obstructed or sensing hose not connected | Repair or replace Inspect and correct |
| | Aerated oil to compensator when hose fitting checked* | 300 psi or less, but erratic | 12 gpm or less 300 psi or less but erratic | Aeration in hyd oil or Air inclusion in sensing line | Refer to pump aeration cause and solution or Bleed sense line |
| | No heat build-up, no noise oil to compensator when hose fitting checked* | 300 psi or less | 12 gpm or less 300 psi or less | Stuck pressure compensator spool | Remove and clean as necessary. Inspect on removal to prove cause |
| | | Less than max., slow response on stall | Full flow, but less than max. psi. Slow response | Weak spring on press. comp spool Worn press. Comp. Spool | Adjust to correct reading or replace comp assy |

* Check oil to comp. at fitting where ¼-inch sensing hose in attached to pump comp.

# Best Practice

**Title:** Ground Penetrating Radar for Concrete Scanning
**No:** CSDA-BP-007
**Effective Date:** Jul 17, 2009
**Revised:** Mar 11, 2014

## Introduction

This document provides an overview and methodology for scanning concrete with Ground Penetrating Radar (GPR), as it applies to the sawing and drilling industry.

GPR is an accepted and routinely used nondestructive method for imaging objects in concrete prior to cutting or coring. It is a safe application of radar regulated by the Federal Communications Commission in the U.S.

Fieldwork typically requires one operator. Imaging results are generated on-site for immediate mark out and analysis of targets in the selected area. The inspection, under normal circumstances, can be performed on one side of the slab, which permits slab-on-grade scanning. Some common applications of GPR include, but are not limited to:

- Locating reinforcing bars
- Locating post-tension cables
- Locating metallic and non-metallic conduits
- Detecting voids beneath slab-on-grade
- Slab thickness and cover depth to targets

This document covers methods of scanning, data interpretation and practical considerations when using GPR on a job site. This document is to be used as a general guide. GPR system operation will vary between manufacturers and models. It is very important that every operator of GPR equipment be trained and certified by the manufacturer of the equipment for the proper use of the equipment. The operator should, as a minimum requirement, have completed manufacturer training. The operator needs to know the limitations of the equipment, and be able to interpret the data from the scans.

## Table of Contents

## 1. Background Theory

GPR works by sending high frequency radio waves into the subsurface (concrete) and measuring the travel time for the returning reflection (Figure 1). Reflections are caused when the GPR wave encounters a material with a different dielectric constant; or to put it simply, a change in material. Rebar, post-tension cables, conduits, bottom of slab and voids all generate reflections that are detected and shown on the GPR display. By continually moving the GPR antenna or antenna array along the concrete, you generate a cross-sectional view of data called a 'line scan'. By systematically collecting several line scans of data in the X and Y directions, a 'grid scan' is performed. Line scan and grid scan are the primary methods for acquiring GPR data, and these methods will be explained in the next section.

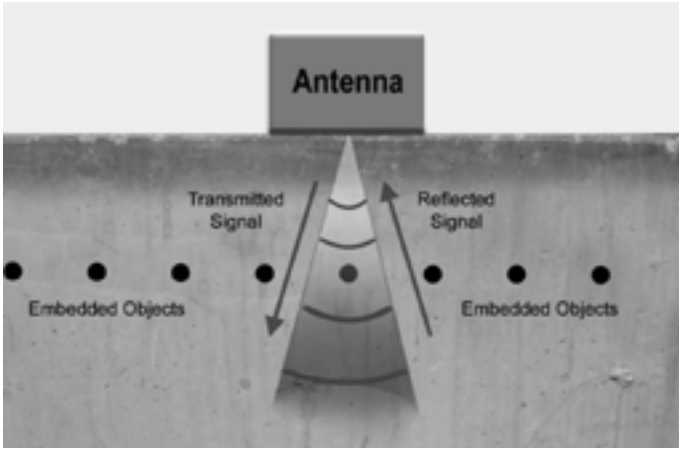



Figure 1: GPR wave reflecting off an embedded object

1.1 Frequency

GPR antennas/transducers come in different frequencies, measured in Megahertz (MHz). This number refers to the center frequency of the antenna or antenna array at which most of the energy is concentrated.

In general, higher frequencies give better resolution but have limited penetration depth. Conversely, a lower frequency allows you to see deeper into the concrete, but with less image resolution.

1.2 Material Properties

The GPR response is governed by the physical properties of the material. Properties of the concrete such as electrical conductivity, aggregate size, air entrainment, water content and admixtures will impact the depth of scan capabilities.

If a material is electrically conductive (such as relatively uncured/green concrete or salt water), the GPR energy is absorbed before it can travel very far into the material. As a rule of thumb, the greater the water content of the concrete, the greater the conductivity and the more difficult it will be to penetrate.

The upper limit for most practical work in concrete is 24 inches (600 millimeters), but quite often the limit will be less than this due to the aforementioned factors.

## 2. Line Scan

Line scans generate a cross-sectional view of data and a plan view, depending on the equipment manufacturer. Most GPR systems create the cross-sectional image in real-time as the GPR antenna or antenna array is pushed across the surface (Figures 2 and 3). In the cross-sectional image, position is displayed along the horizontal axis and depth along the vertical axis.

In relatively simple situations, line scan mode provides a fast method to locate objects. However, the line scan may require more interpretation than the grid scan mode. Line scan mode should be used as a reconnaissance scan when you first arrive at the job site. Even on sites where a grid scan is required, line scan can still provide additional helpful information such as target orientation. It is very important to know the target orientation so the grid scan pad is properly aligned.

2.1 Settings

It is important to make sure that the parameters are set properly when collecting line scan data. Set the depth window or depth scale to ensure that everything in the slab can be seen. It is a good idea to set your depth to be at least 50% deeper than the expected depth of the objects. For example, if your slab is 10 inches in thickness, set your depth window to at least 15 inches.

The 'Gain' setting is used to highlight weaker targets that are usually found deeper in the concrete. It is designed to make deeper targets appear as bright as shallow targets. It is important to select an appropriate gain level without over-gaining (or clipping) the shallow data, and thereby making the image harder to interpret. Start with a low gain setting and then increase as necessary. Some GPR systems can automatically gain this data.

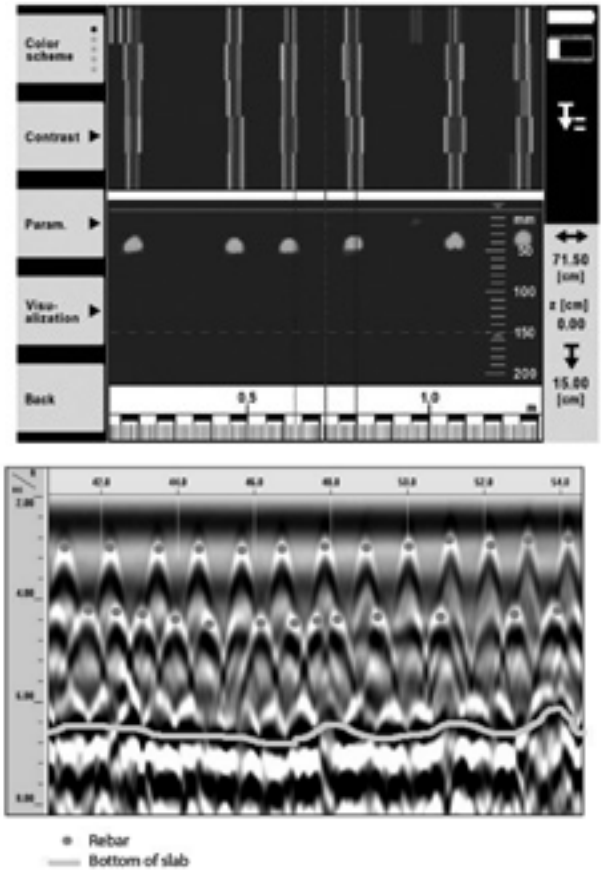



Figure 2: Line Scan Data Examples

2.2 Operation

The GPR antenna or antenna array should be held in contact with the surface to achieve the best coupling and highest data quality. Air gaps between the bottom of the GPR antenna or antenna array and the surface reduces penetration into the concrete.

An example of line scan data is shown in Figure 3. The spikes that resemble inverted U's are called hyperbolas. These are generated when the GPR antenna or antenna array crosses an object in the concrete, preferably at a perpendicular angle. If you cross an object at an oblique angle, the hyperbola widens (Figure 4). This is not desirable, as the clarity of the hyperbola diminishes and can lead to inaccurate depth estimates (more on this below). The solid black line mid-way down the screen corresponds to the bottom of a suspended slab.

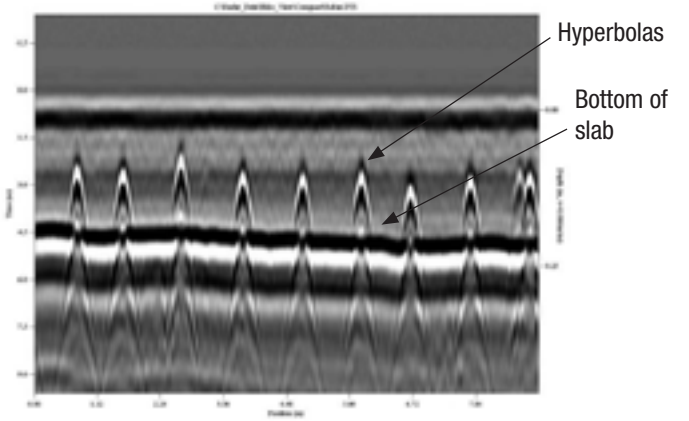



Figure 3: Line Scan data showing rebar (hyperbolas) and bottom of slab

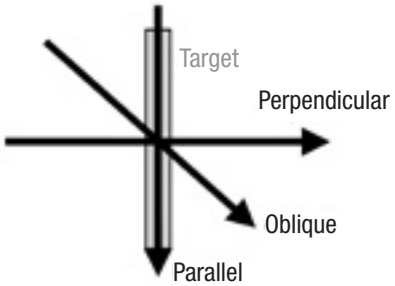



Figure 4: Ways to cross a target (left)

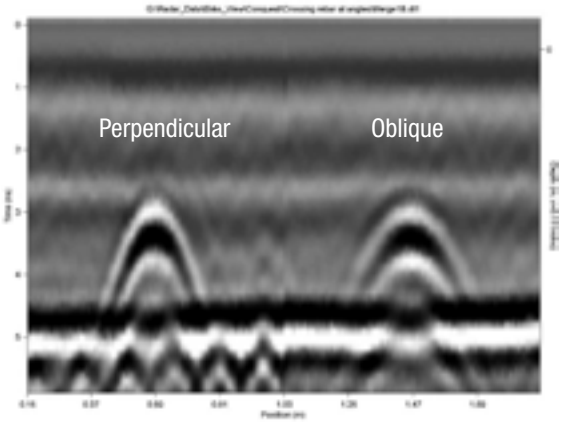



Figure 4a: GPR line scan showing perpendicular and oblique crossing (right)—Notice how the hyperbola on the right is wider

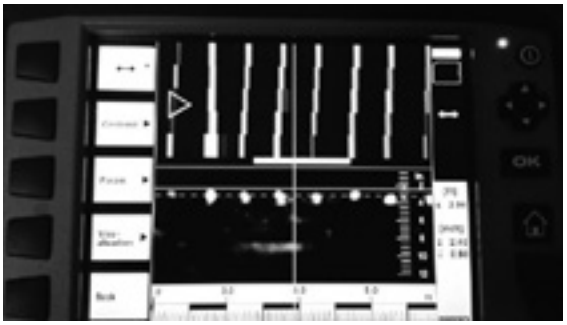


Figure 4b, Data is of an antenna array collected line scan. Normal hyperbolas are shownas processed in the bottom half of the screen. Array data is shown on the top half of the screen detailing perpendicular targets as well as oblique (angled) targets.

All GPR systems contain a distance measuring encoder. Data is displayed in real-time as it is collected. To locate a target, simply pull the GPR system backwards. The distance measuring encoder will detect reverse motion, and an indicator will appear on the screen that shows the antenna position relative to the data (Figure 5).

It is important that the distance measuring encoder be periodically calibrated to ensure accuracy. Calibration involves pushing the GPR antenna or antenna array over a known distance. Follow the GPR manufacturer's calibration procedure.

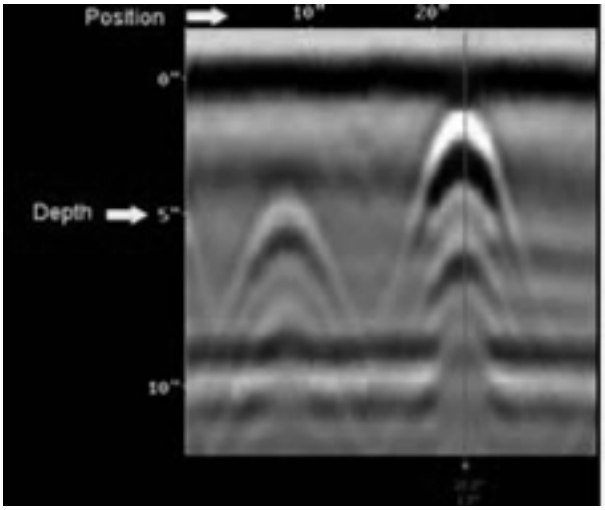



Figure 5: The backup indicator to pinpoint target position

2.3 Determining Object Depth and Concrete Velocity (Dielectric Constant) GPR systems measure the time it takes signals to travel into concrete, reflect from an object and return to the surface. To convert time to depth and measure the depth of an object, an accurate GPR velocity in the concrete must be determined. The velocity of the GPR wave in concrete will vary between different concrete pours, and is a function of the water content, aggregate type, admixtures and air

entrainment. Some GPR systems may work on determining the dielectric constant instead, which is related to GPR wave velocity.

Follow the procedure below:

a. Always determine the depth of an object using line scan data (not from grid scan images).
b. Ensure that the line scan image has crossed the object perpendicularly, not obliquely.
c. Extract the velocity of the GPR wave in the concrete. Once the depth scale is generated based on the GPR velocity, the depth of the object can be read off the depth scale.
d. The best way to ensure the velocity is accurate is by measuring the actual depth of an embedded object, or by measuring the slab thickness. If this is not possible, a computer processing technique called migration or hyperbola calibration can be used (Figure 6).

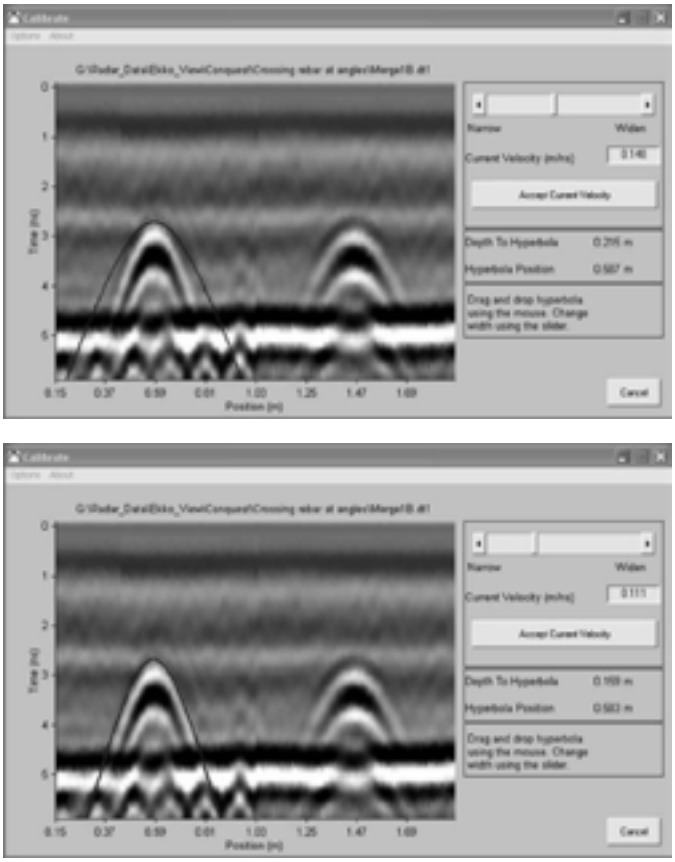


Figure 6: Hyperbola calibration to extract concrete velocity when not matched correctly (left), and when matched correctly (right)

**<u>NOTE:</u> After fitting the hyperbola shape and moving it to the top of the hyperbola, the GPR velocity of the concrete is displayed, as well as the approximate depth of the object. The hyperbola shape is determined by the velocity or dielectric constant. GPR systems incorporate software tools to derive the GPR wave velocity from the hyperbola shape.**

A computer-generated hyperbola (the blue curved line in Figure 6) is first placed over an actual hyperbola. The 'tails' are moved in or out to best approximate the shape of the actual hyperbola. Fitting this hyperbola depends on two main factors: locating the top of the hyperbola and fitting the shape properly. Finding the top of the hyperbola depends on the data quality and target congestion. In complex situations, picking the top can be quite difficult. Fitting the shape of the hyperbola is dependent on how you determine a best fit. There is some interpretation involved, and accuracy is dependent on your consistency and attention to detail.

By matching the shape as accurately as possible, the GPR velocity in the concrete is determined as well as the approximate depth of the object. Velocities are typically between 85 millimeters per nanosecond and 135 millimeters per nanosecond in concrete. If using dielectric constant, values typically fall between 4 and 15 depending on the moisture content of the concrete (less well cured slabs will have a dielectric constant closer to 15 while older, well cured concrete will be closer to 4). The lower the dielectric constant of a material, the higher the GPR velocity.

Generally, absolute depths will have a tolerance of +/- 5–10%, while relative depths (between objects) will have an accuracy of +/- 1%.

Some GPR systems are capable of automatically migrating data. Migrated data should be verified by the user. Check with the manufacturer to determine system capabilities.

## 3. Grid Scan

Grid sizes can vary, but the most common is the 24-inch by 24-inch (or 600 by 600 millimeter) square grid. The grid acts as a template to guide the scanning and reference objects back to the concrete surface. The grid should be centered on the area under consideration and oriented as perpendicular to the target object(s) as possible. Line scan mode (as described in Section 2) can be used to determine the general orientation of the object.

Once the grid is fixed to the concrete, you should set the parameters for the grid collection. Follow the same example from the line scan section (Section 2) and set the maximum depth to deeper than the deepest expected target. The on-board software will guide you to collect the lines on the grid in both directions (Figure 7). For each line, it is very important to ensure the starting position of the antenna or antenna array head is accurate and consistent from line to line. Push the antenna or antenna array straight along the line until it is complete. If there is an obstruction preventing the operator from finishing the line, the line will have to be prematurely ended and you should continue on to the next line.

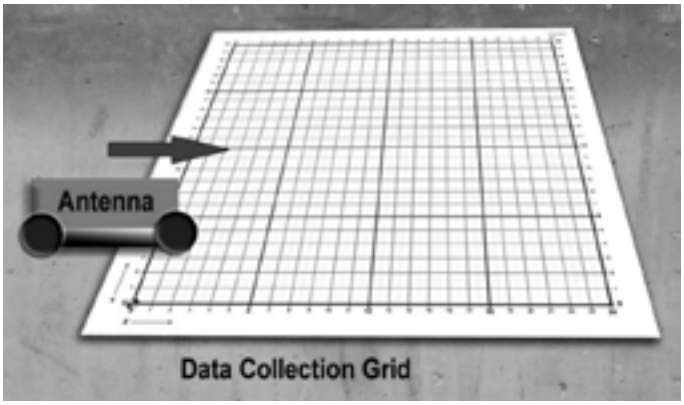



Figure 7: Grid Collection

Upon completion of all grid lines, process the data to generate plan maps. Ensure that the correct velocity is used before proceeding. Once the processing is complete, a series of plan maps will be visible on the GPR system screen. Each plan map shows a specific depth range (e.g. 1 to 2 inches), from which you can cut through and gain an idea of where objects are located (Figure 8).

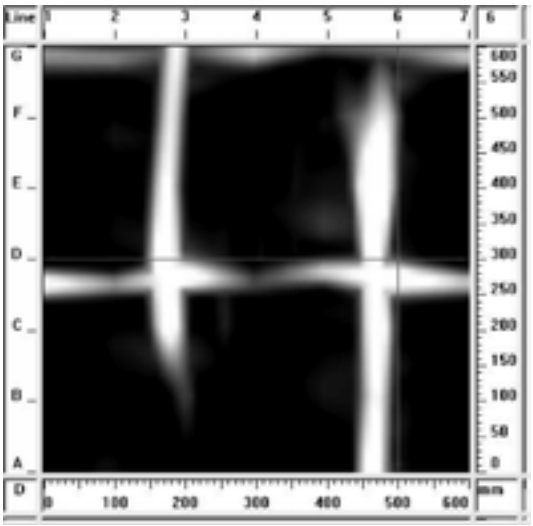


Figure 8: Example of a plan map at 2 to 3 inches deep

If there is any doubt as to the authenticity of an object, it should be checked against the line scan data that composed the grid. If a hyperbola is visible in the line scan data, it should correspond with a target in the plan map. This acts as a 'sanity check', and is a good way to confirm what you are seeing in the plan maps. In Figure 9, the arrows show how the hyperbolas on the horizontal line scan manifest themselves as targets on the plan map view.

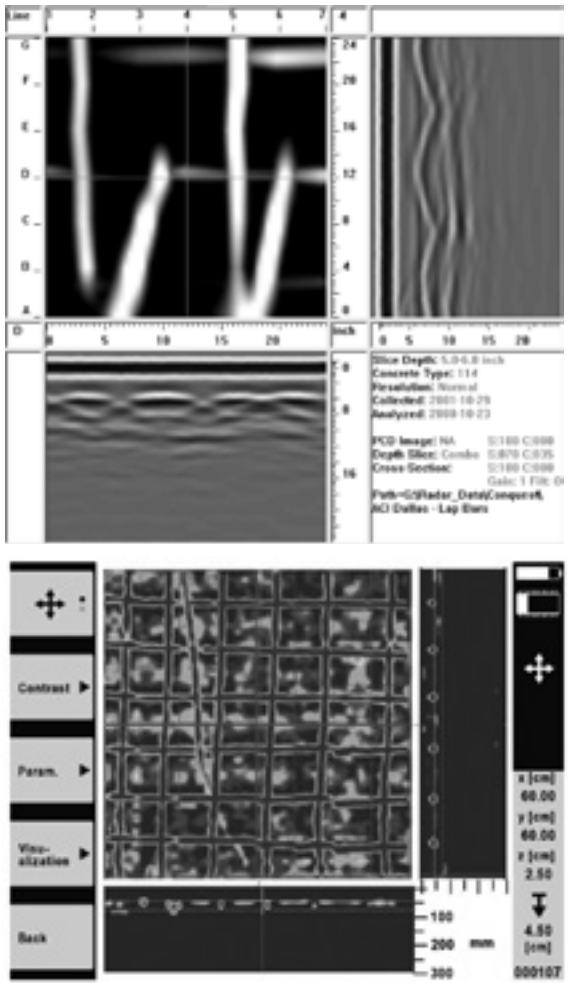



Figure 9: Plan map with line scan data

Some systems allow you to superimpose a drill core over the grid, so you can visualize a safe place to core (Figure 10).

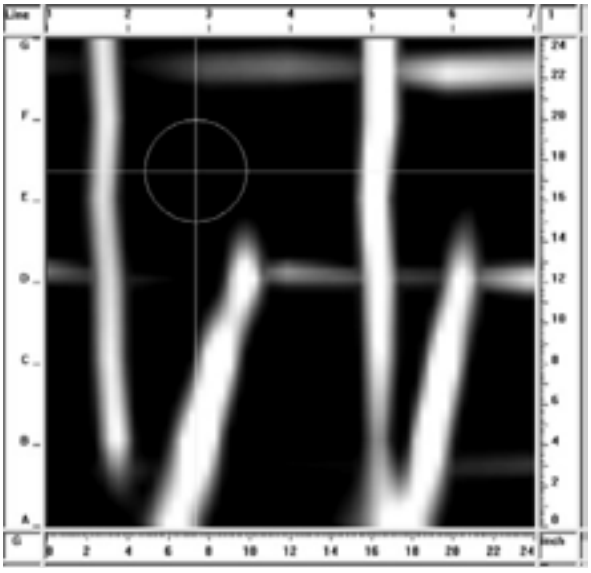


Figure 10: Drill core

**NOTE: Mark all objects on the concrete.**

## 4. Practical Considerations

Understanding how to use GPR is an integral part of successful scanning, but it is as equally important to consider the practical side of being on-site and properly surveying the cutting area. Every site is different, and the following are some guidelines to keep in mind:

4.1 Before arriving at the jobsite, the following are some questions to ask the customer:

- Why does the customer need the area scanned (cutting, coring, or other)?
- How old is the concrete (wet concrete is a GPR limitation)?
- How thick is the concrete?
- Will the area be free of obstructions?
- Are there special safety considerations to be met?
- Is the scan area on a column, wall or ceiling?

4.2 When you first arrive at the site, a walk around should be performed. Useful information regarding the structure to be scanned will prove valuable when reaching conclusions about the targets in the scan area. Below are some good questions to ask once on site:

- Is the area to be scanned a slab on grade or a suspended slab?
- Is the underside of the slab or wall accessible to scan?
- Are there conduits connected to the underside or backside of the slab?
- Do any as-built drawings exist (keeping in mind, these maybe incorrect)?
- Could there be electrical conduits in the slab?
- Could there be radiant floor heating in the slab?
- Has the slab been scanned before (past problems)?
- How was the slab constructed (i.e., pan deck, pre-cast, post-tension, filigree or terrazzo)?
- Is there a support beam under the slab?

4.3 Make sure the floor is clear of any debris that could interfere with scanning and the placement of a grid. Sweep the floor in the area to be scanned. Dusty or gritty surfaces can also cause a problem when taping down the grid and preparing for a grid scan.

4.4 When doing grid scans, align the grid properly, taking into account where the core needs to be located, the orientation of the rebar and any surface obstructions. Align the grid in such a way that you are always running GPR lines into an obstruction, rather than starting close to one.

4.5 Typical grid scans are 24-inch by 24-inch, but larger grid scans may give you the 'bigger picture' of what is located in the slab.

4.6 Use line scan mode to measure depth to targets, and to locate interfaces (bottom of slab).

4.7 Sometimes it is permissible to cut reinforcement. No GPR operator should offer anything more than an estimate when it comes to differentiating between rebar, post-tensioning and electrical conduit. Look for telltale signs of objects that deviate from the rebar pattern. Post-tension cables tend to be draped between columns, starting high near the beam/column line and draping progressively lower towards the center point between beam/column lines (the point of greatest slab deflection). Conduits may curve and take the most direct path from A to B. Non-metallic conduits also return a lower strength signal than metal objects and rebar.

4.8 When you have located all targets, the information should be marked on the floor. One way to do this is to punch holes in the grid and fill them with a marker. When the grid is lifted off you will be left with a series of corner reference points. Refer to CSDA-BP-017 for the proper markings.

4.9 Certified operator training is critical to the success of any concrete scanning project. You must have a firm understanding of the technology, the equipment, its strengths and limitations. Communication of the equipment's capabilities and limitations must be clear to the end client, thus preventing the danger of overselling the technology.

## 5. Limitations

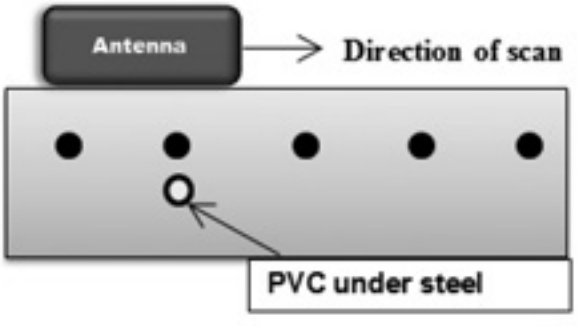
Some common limitations encountered when using GPR:

5.1 GPR does not measure diameter of objects, just their location. When marking information from hyperbolas in line scan mode, allow some margin on each side of the marks. Refer to CSDA- BP-017 for the marking of embedments. When viewing plan map images, remember these are pseudo-images. If the floor is marked as wide as the object width on the screen, this indicates to the coring operator to stay clear of that width when coring.

5.2 Bottom of slab is sometimes not easy to see in slab-on-grade situations. This is due to the interference of the wire mesh and the weak reflection from the concrete-gravel base interface.

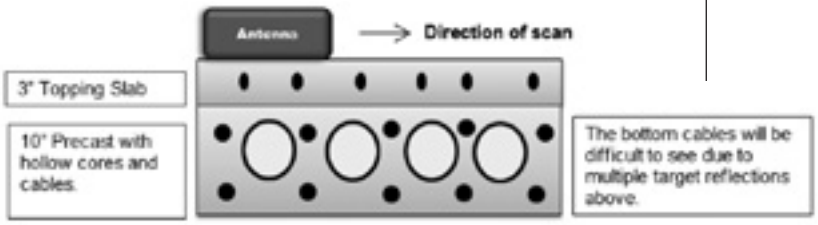
5.3 GPR should not be performed on areas where standing water is present.

5.4 Because GPR is usually performed with one-side access, additional targets may lie in the "shadow" of targets nearer to the surface. Items such as conduits and post-tension cables may be directly underneath rebar and cannot be imaged with GPR.

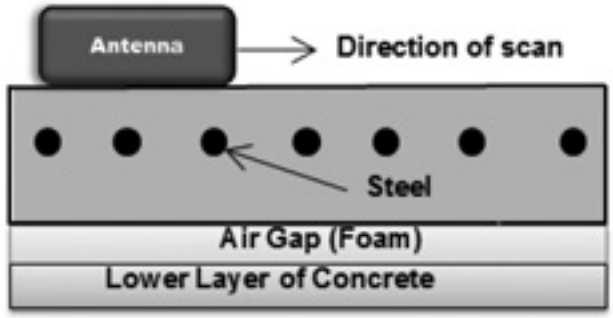



5.5 A limitation distance adjacent to an obstruction (walls, conduits, studs, etc.) is present with GPR devices due to the orientation of the internal transmitter/receiver. Each limitation is unique to the specific devices of individual manufacturers.

5.6 Each GPR antenna or antenna array with a specific frequency cannot image through metal wire mesh/metal fiber with specified spacing (ie, chicken wire mesh). Consult with the manufacturer to determine these limitations specific to each antenna.

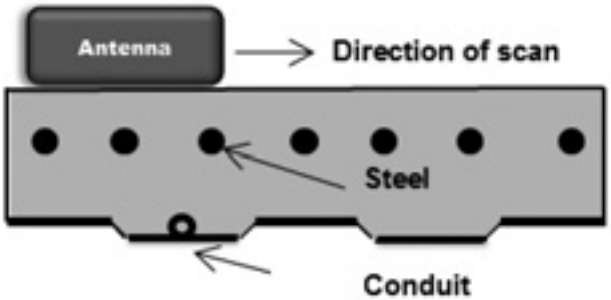



5.7 GPR cannot image through foam used within slabs or on roofs. On roofs, these areas need to be opened up by a qualified individual a minimum of 1 foot larger on all sides than the intended scanned area. For example, a required scan area of 2-foot x 2-foot should be opened to at least a 4-foot x 4-foot area. Foam placed internally in a slab requires scanning from both sides of the deck.

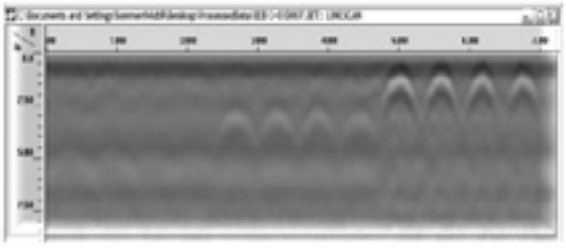



5.8 Ability to image on opposing side of air voids in concrete (i.e., hollow core slabs, CMU block walls) cannot be performed. Access to the opposite side is required to complete the scan.

5.9 Locating metal and PVC conduits in the "valleys" of corrugated steel decks is difficult and in some circumstances impossible. Efforts should be made to avoid drilling into these "valleys".

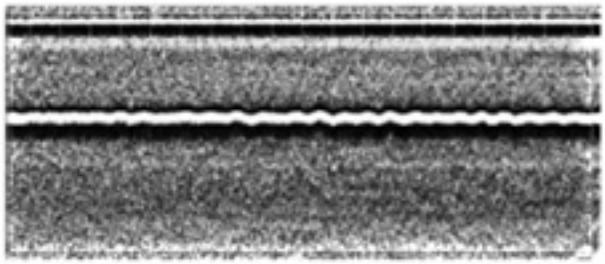



5.10 Relatively uncured concrete is difficult and sometimes impossible to image due to the electrical conductivity of the material. Depending on concrete thicknesses and cure time it is recommended that no scanning occur within a minimum of 30 days after pouring. This time may need to be adjusted on a case-by-case basis.



**Example of data collected from green concrete. Note that targets closer to surface are clearer than deeper targets.**

5.11 Because GPR transmits a radio frequency, use of GPR falls under FCC Title 47 CFR15.5 "that devices may not cause interference and must accept interference from other sources". Jobsite conditions may have radio frequencies from cell phones, two-way radios or other devices that may cause temporary interference.



## 6. Liability

Like any investigative tool, GPR is not perfect. It is subject to your interpretation skills and the physical limitations of the equipment. Regardless of the quality of the equipment, or how skilled you are, there are situations that just cannot be overcome (e.g. freshly-poured concrete). In addition, proper measurements must be taken when translating information from the GPR system to the floor.

It is important for you to understand this limitation and convey this to customers. It is recommended that you have a disclaimer included in the sub-contract or job form.

# Best Practice

**Title:** Polished Concrete Floors
**No:** CSDA-BP-008
**Date Issued:** Mar 22, 2010

## Introduction

This document provides insight on what considerations and decisions should be made when contractors compile a specification for the polishing of a concrete floor.

A number of positive results can be achieved by polishing concrete, not just in terms of aesthetics but also by the practicalities of a polished concrete floor. By polishing concrete, the wear zone—or the top 0.125 inches of the concrete surface—is honed to provide a more durable surface. The result is a smoother surface that is easier to clean and has increased durability and longevity.

The characteristics of polished concrete are:

- Abrasion resistance
- Durability
- Longevity
- Reduced maintenance
- Aesthetics
- Light reflection

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## 1. What to Expect

1.1 Densifiers

There are several types of densifiers on the market, including sodium, potassium, lithium and magnesium. These chemicals all do the same thing, but react at different rates. They react with the calcium hydroxide generated in the hydration of cement. This reaction creates calcium silicate hydrate (CSH). The CSH content represents the hardness of the concrete paste matrix. Calcium hydroxide creation begins when water meets cement and precipitates to the top of the concrete surface throughout the life of the concrete. This process slows with hydration. However, the unreacted calcium hydroxide on the surface, unless densified, reacts with carbon dioxide to form calcium carbonate or "dust." This reaction is accelerated when additional carbon dioxide is introduced through exhaust from gas fired heaters. This calcium hydroxide continues to generate throughout the life of the slab and, though polished or covered with floor coverings, will precipitate to the surface.

1.2 Grinding and Polishing

1.2.1 The process of removing concrete stock from the surface by creating a scratch pattern is also known as grinding. The lower the quantity of diamonds used in a matrix, the deeper the scratches created. Like wood working, scratches are removed by introducing finer diamonds. In order to remove scratches, operators must double the volume of diamonds in the matrix used previously. For instance, 50 to 100 to 200, and so on. When stock removal is completed, operators can move to the Polishing stage but must drop back one level. For example, 100 metals to 50 resins.

1.2.2 Diamond Matrix – Originally there was one type of matrix, but now the industry has progressed to several different types. The basic type used for grinding is a metal matrix and polishing is generally performed using a resin matrix. However, a number of new types have been developed that provide better warring and performance for the varying hardness and softness of concrete surfaces. These include hybrid, coppers and porcelain designs. The contractor should select the most suitable diamonds and matrix to do the job, based on the equipment being used and the finished objective.

1.2.3 The process of grinding usually begins with metal diamonds, hybrids and sometimes resins, but with aggressive diamond levels like 6 metals, 16 metals,

30 metals or 50 metals. Various manufacturers have different opinions on the point where concrete surface stock is being removed and polishing begins. Note: it is necessary to start with grinding to remove material from the surface to expose more calcium hydroxide, which the densifier will react with to harden the surface. The start point for polishing needs to be determined by the contractor when a test area is worked on. A common start point is to use 50 metals.

1.2.4 Polishing is considered to begin when concrete surface stock has been removed and the surface has been honed for durability and gloss. It is not necessary to polish some floor surfaces using high diamond numbers, especially if the floor will not be subjected to heavy abrasion. A high gloss factor can be achieved using protective sealers while working at more reasonable polish levels, thus removing extra cost. Note: the protective sealers will not necessarily replace abrasion resistance, but can improve stain resistance and aid in lowering maintenance costs.

1.3 Concrete Polish Finish

1.3.1 Flatness – It is important to achieve as flat a floor as possible, in order to resist the abrasion it will be subjected. Concrete should be considered as "peaks and valleys." The polishing process reduces the peaks and increases the surface area. This is achieved by polishing with higher diamond pads, i.e., 800, 1,500, 3,000. Gloss and flatness have been used synonymously in the past, but can lead to confusion. It is recommend that these be considered separately.

1.3.2 Gloss – High gloss floors increase maintenance requirements. They can also be misconceived as being slippery, when in actual fact they are not. The key is to match the gloss to the desired objective. A car showroom may desire a high gloss (greater than 55) while a grocery store may want a more manageable gloss (greater than 30 and less than 45). A residential home, even in the kitchen, will not have as much abrasion traffic as a grocery store, and therefore does not need a high flatness level. A manageable gloss is better suited. The abrasion factor and a specified maintenance budget need to be considered before specifying gloss levels.

1.3.3 Aggregate Exposure – The most misunderstood aesthetic in polished concrete. Aggregates that are used in the concrete mix design are normally not durable aggregates. They are placed in the mix design for displacement, reducing shrinkage. Therefore, when these aggregates are exposed, they represent the weakest portion of the floor. Without the concrete matrix to hold them in, aggregate pops occur, leaving voids or divots. In addition, densifiers only react with calcium hydroxide generated in the hydration of cement. They DO NOT REACT WITH AGGREGATE. Therefore the concrete matrix is harder than the aggregate. Temperature changes on the surface caused by exposure to sunlight or cool weather can cause aggregate pops. A "salt and pepper" exposure is recommended to achieve an optimum surface for abrasion resistance and durability.

1.3.4 Color – The color of concrete is not always the same. The addition of "fly ash" can create a darker gray. Remember, fly ash is a pozzolan created by the burning of coal at coal fired generation plants. Slag, a byproduct of steel, is another pozzolan that is lighter in color. It contributes to green points, but is not as cheap. If using integral color or dying, you should consider slag if using a cement replacement.

1.4 Uniformity
This will be greatly dictated by how even the original floor is when grinding is complete.

1.5 Hardness
This is a result of densification and polishing. The degree of hardness should be established as a minimum of 6.5 Mohs Hardness Pencil Test.

1.6 Slip Resistance
This is a calculation of coefficient of friction. In actuality, a higher polished floor has more surface area, thus the coefficient of friction is greater resulting in more slip resistance. This is hard for people to visualize because a gloss finish innately looks more slippery.

1.7 Water Resistance
Densified floors allow for water transmission both ways. Densification and polishing is not a barrier system, thus the problems with peeling and blistering are not an issue. The surface will be breathable in both directions, from the top and the bottom of the slab.

1.8 Stain Resistance
Polished concrete is not a barrier coating as explained above. Because the surface is tighter it does increase stain resistance over trowel finished concrete. However, it will not prevent staining. A protective sealer will increase the resistance, but NOT make the surface "stain resistant." Good maintenance practices are required to minimize staining.

1.9 Maintenance Requirements
Specifying maintenance requirements is an extremely important part of the work. All surfaces need to be maintained. This is NOT a maintenance free system. Proper standards and frequency of maintenance should be based on the projected activity of the surface. Maintenance costs can be reduced over the service life of a concrete polished floor in comparison to other floor covering materials.

## 2. New Concrete Surfaces – 03312 Cast in Place Concrete Slabs

2.1 Concrete Mix Design

Attention to this portion of the specification will affect the desired result of concrete polishing. Failure to achieve an optimum surface ultimately increases job costs and may leave a contractor unable to meet the desired finish.

2.1.1 Cement content – Should be developed for a mix design using Type I Portland cement that will achieve a minimum of 4,000 PSI.

2.1.2 Fly Ash content must be less than 15% - Exceeding 15% conflicts with the chemical reaction of hardening and creates flat spots where minimal reaction with densifier is achieved, thus low gloss from polishing.

2.1.3 Air entrainment admixtures are not needed for interior slabs. The addition of air allows for durability against freeze thaw. Cement naturally entrains air, thus additional air entrainment will not be needed. Excess air entrainment can result in a damaged slab when ground for polishing.

2.1.4 Aggregate exposure – This is controversial when attempted within the normal mix design material. Exposure of fine aggregates is recommended while large aggregates are discouraged. Aggregates used in the mix are inserted as fill, not aesthetics. Large aggregates are usually found deeper in the concrete than the wear layer. Exposure of these tends to compromise the durability of the surface, meaning in most cases that they will NOT be as hard and durable as the concrete paste. Exposure to a lot of large aggregate will minimize the surface hardness by limiting the amount of concrete paste that can be densified and polished. If large aggregate exposure is desired, see section 2.6 regarding "Seeding Floor Surface for Exposure of Large Aggregate."

2.2 Flatness/Levelness

The ability to provide a flat surface impacts the aesthetics of the polished concrete floor. Use of Ff #'s and Fl #'s helps provide tolerances that can be measured by the concrete finisher to insure he or she achieves the desired result. Failure to use high tolerances can result in a wavy floor, which can ultimately lead to uneven exposure of aggregate.

2.2.1 Recommended FF 50 and FL 35 with a tight tolerance for error suggest,+/- 10%

2.2.2 Recommend an outside testing firm confirm numbers with replacement of slab and concrete contractors cost for failure to comply.

2.3 Placement

The method of placement will impact the result for flatness.

2.3.1 Vibrating screeds tend to roll the concrete and help create high and low spots. A laser screed or cutting screed is recommended to help insure a flatter surface.

2.3.2 Smooth and re-straighten surface using an 8- to 10-foot-wide bull float. Apply in two directions at a 45-degree angle to strip.

2.3.3 Wait until the bleed water sheen has disappeared.

2.3.4 Float surface with one or more passes using a power float. First float pass should be across the width of the strip.

2.3.5 Re-straighten surface following paste-generating float passes using 10-foot-wide highway straightedge. Use in two directions at a 45 degree angle to strip. Use supplementary material to fill low spots.

2.3.6 Make multiple passes with a power trowel.

2.3.7 Re-straighten surface after trowel passes using multiple passes with weighted highway straight edge to scrape the high points. No filling of the low spots is done at this stage.

2.4 Finishing

How this affects the aesthetic result:

2.4.1 Multiple directions, four directions to reduce waves. i.e., north/south, east/west, northwest/southeast, northeast/southwest.

2.4.2 Surface does not need to be hard trowel finished, just close surface for curing only.

2.5 Seeding Floor Surface for Exposure of Large Aggregate

If this aesthetic is desired, selection of hard aggregates to complement the surface hardness and density of aggregate on the surface can be achieved by seeding surface. This also enables the polishing contractor to reduce the grind depth, because the large aggregate to be exposed will be at the surface. Densification is minimized, as densifiers only react with calcium hydroxide generated in the concrete paste. By following the correct method, there will be less exposure of this substance on the surface.

2.6 Role of Curing

Curing is needed to complete hydration of the entire slab. The first seven days are critical and, depending on the depth of the slab, an extension of time may be required. Concrete hydration developing calcium hydroxide can continue in excess of 30 or even 90 days, depending on the depth of the slab.

2.6.1 Wet curing is recommended as cures will need to be removed either chemically or mechanically. Blankets are sometime used in conjunction with water. These tend to cause salts to rise to the surface and depending what will be done to the surface may require chemical cleaning before grinding.

2.6.2 Chemical cures are available for interior slabs. These utilize densifiers which help protect the surface and can be easily removed with chemical cleaners. All slabs using some form of chemical cure do require cleaning to insure surface is not compromised for densification.

2.7 Surface Protection

Protection of the slab surface is of extreme importance to achieve a successful aesthetic appearance. This should be the responsibility of the general contractor.

2.7.1 Inform all trades of their responsibility and liability.

a. Prevent oil, hydraulic or acid spillages on the concrete surface

b. Protect the surface from abrasion, gouging or scraping

2.7.2 Utilize breathable material like cardboard or other

protective materials to cover the concrete. It is not recommended to use sheetrock or plywood, as these materials will allow evaporation of moisture at a different rate than the joints, leaving curing lines. In some cases, the moisture causes color bleeding on the floor. DO NOT COVER WITH NON-BREATHABLE FILMS, like visqueen for example.

2.7.3 Daily cleaning before and after polishing is recommended to insure the surface is clean and free from imperfections that may affect the desired result.

## 3. Existing Concrete Surface – 03362 Stained and Polished Concrete

Polishing existing floors is possible whether they are cured for longer than a week, or if they are covered with other floor covering materials. It should be noted that a number of issues can arise with existing floors, especially from those covered with other floor covering materials. First is the fact that the contractor does not know what is underneath the floor covering. The floor could be waved, requiring utilization of leveling materials, or it could have cure marks from VCT like picture framing, checker boarding, cracks or divots. DO NOT ASSUME THE FLOOR IS PRISTINE. Evaluation of the surface is essential before developing a specification. The method of removing previously used floor covering material is crucial to achieving the objective.

3.1 Evaluation

Evaluate the surface before the specification, and re-evaluate the surface before the job starts.

3.1.1 Waves – Waves in the floor can contribute to uneven exposure of aggregate, particularly large aggregate.

- Measure the distance between waves utilizing a straight edge and tape measure. Check north/south and east/west. Map out waves on the floor plan.

3.1.2 Curl at joints and terminations and cold joints – These are areas where uneven curing has occurred. The surface has dried out faster than the mass, thus causing the surface to pull back and create a raised area. Again, the result of grinding will be the same as above in the waves.

- Measure with a straight edge to confirm curl and mark out on floor plan.

3.1.3 Existing coverings – DO NOT ASSUME THE FLOOR IS PRISTINE under the covering.

- It is recommended that before a specification is developed, an area is selected to remove some floor covering to evaluate the surface. If possible, remove in several different areas to get a better idea of the situation. This will help in compiling a correct specification and bid for the work.
  a. Look to determine what type of underlayments were used. i.e., gypsum, cement or synthetic
  b. Check for surface imperfections. i.e., cracks, divots, delamination or aggregate exposure
  c. Evaluate penetrations and supports to determine the extent of edge work, and consider what will be required to create the desired finish
  d. Check for curing marks, i.e., picture framing or checker boarding
- Test the concrete surface for hardness with a Mohs Hardness pencil. The contractor should make sure that the concrete is being tested, not the underlayment
- Resilient floor covering or cure and seal—This can be anything from acrylic sealer, cure and seal, linoleum, urethane, thin film epoxy to trowel down epoxy.
  a. BEAD BLASTING THE SURFACE IS NOT RECOMMENDED, EXCEPT AS A LAST RESORT. Cutting coverings from the surface is a better solution.
  b. The covering material should be removed chemically or mechanically. The surface needs to be chemically cleaned to remove solvents created by mechanical removal driven into the concrete. Failure to remove these materials will result in problems with color and gloss. The solvents in the concrete will provide imitation polish gloss levels that will dissipate over time.

3.2 Evaluating Concrete Prior to Work Commencement

## 4. Quantitative Benchmarks

4.1 Gloss
4.2 Hardness
4.3 Slip Resistance

## 5. Equipment

5.1 Grinder Machines
- Weight and size
- Drive
- Cutting Footprint

5.2 Diamond Tooling
5.3 Burnishers
5.4 Burnishing Pads
5.5 Auto-scrubbers

# Best Practice

**Title:** Green Construction
**No:** CSDA-BP-009
**Date Issued:** Oct 1, 2010
**Revised:** Mar 14, 2013

## Introduction

This document is a guideline that is intentionally structured as an overview to cover topics that may or may not be incorporated into a detailed plan for a sawing and drilling contractor to be more environmentally friendly and take advantage of possible LEED credits when applicable. This plan will be dependent on the specifics of each jobsite, coupled with the considerations of the work environment, the quality of work, the financial impact and safety aspects of that particular jobsite.

Most of the resources available on the subject of "green" construction practices focus primarily on the design and engineering plans of buildings. Limited resources are available on the construction and demolition practices carried out on the actual jobsite during the construction phase, including selective demolition for remodeling. This document is specific to the sawing and drilling industry, and provides insight and guidance in the creation of a site-specific plan for environmentally friendly working practices to be performed by sawing and drilling operators. The adaptive reuse of a building where sawing and drilling is required to accomplish the new configuration is the ultimate in sustainable development.

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## 1. Green Approach

The sawing and drilling contractor interested in a green, more environmentally-friendly operation should approach being green from planning and material procurement management to the final cleanup and waste disposal. Some of the following recommendations can be implemented beyond a single jobsite to involve company policies for day to day operational procedures spanning all of the contractor's jobs. "Green" jobsites are typically noted in the bid documents. Note any additional documentation and procedural requirements which would impact a bid. An example would be documentation for LEED credits for a particular site.

## 2. Sawing and Drilling Operations

Sawing and drilling operations performed by cutting contractors typically involve water and the creation of slurry. In addition, these operations involve the generation of a large volume of concrete debris, expendable diamond/steel tooling (blades, bits and wire) and the use of large engines/motors for generating the power to perform the work (including oil, grease, hydraulic fluid and fuel). The maintenance of the equipment also involves recyclable materials such as batteries and certain types of metals.
The following section highlights just some of the areas where sawing and drilling companies can become green.

2.1 Slurry Recycling

Water/slurry collection, disposal and recycling for concrete sawing and drilling are becoming more of an issue for the industry. Each city, county, state, province and country is developing its own regulations and means to enforce them. Since there is no single standard to deal with water and concrete slurry, it is important for our association to take proactive efforts in dealing with our tools, techniques and procedures as well as with a growing list of regulations and enforcement groups who want to oversee them.

2.2 Concrete Recycling

Concrete debris is highly recyclable and represents a large volume of materials that cutting contractors should avoid disposing of as landfill bulk debris. When concrete is removed from a jobsite, it can be taken to concrete recycling process centers, where millions of tons of concrete are recycled each year. Generally, contractors experienced in green construction typically have separate dumpsters to enhance the recycling of various types of waste. Recycled waste rates can be 75 percent or higher. Consider coordinating concrete and slurry

recycling with the ready- mixed concrete supplier and/or concrete masonry suppliers.

Recycling of concrete pavement is a relatively simple process. It involves breaking, removing and crushing concrete from an existing pavement into a material with a specified size and quality. Crushed concrete may be reused as an aggregate in new Portland cement concrete or any other structural layer. Generally, it is combined with a virgin aggregate when used in new concrete. However, recycled concrete is more often used as aggregate in a sub-base layer. Several advances have made recycling more economical for all types of concrete pavements in recent years. These include:

- Development of equipment for breaking concrete pavements such as unreinforced, mesh- and-dowel or continuously reinforced.
- Development of methods to remove steel that minimizes hand labor.
- Use and application of crushing equipment that can accommodate steel reinforcement.

Successful and economical recycling projects have included jointed plain pavement, jointed reinforced pavement, continuously reinforced pavement and even airport pavement over 17 inches thick.

Arrangements can be made to haul concrete from a demolition site to the recycling plant, or, **in some cases, recyclers are able to move portable recycling machinery to the demolition site. Some limitations apply to size and weight for handling the debris.**

In terms of the overall environment, recycling concrete greatly saves energy compared to mining, processing and transporting new aggregates. And while not considered environmentally damaging, the large volume of concrete waste generated during demolition at times makes it difficult for landfills to accommodate.

Special precautions or restrictions may apply to hazardous or contaminated materials such as radioactive waste or asphalt.

2.3 Recycle Worn Out Blades, Bits and Wire

Recycling core bits, diamond blades and diamond wire helps to create a green jobsite.

Bits – if the barrel is still in good condition it can be re-tipped with new segments from the manufacturers. If the bit is no longer in good condition then the barrel can be tossed into the steel recycling dumpster.

Diamond blades and diamond wire can also be recycled due to their steel content

Any metal debris from a concrete slab, such as rebar can be removed from the concrete and taken to a steel recycler.

2.4 Properly Size Equipment for the Job

- Use appropriate sized generators, saws and drills for the needs of the work being performed.
- Reuse waste motor oil and hydraulic fluid as a fuel source in furnaces.
- Use biofuels like biodiesel or bioethanol to power diesel engines or trucks.
- Use biofuel generators and/or compressors.

2.5 Recycle Used Oil

If not disposed of properly, used oil can pollute land, water and infrastructure. Used oil can be recycled, with some contractors having large tanks on their premises to store it. This can result in thousands of gallons of oil being recycled each year. Companies have been set up to pick up the used oil from the yard, clean it and re-sell it to different industries. Non hazardous used oil can be disposed of through a certified waste disposal company as oil for recycle or disposed of as a fuel source for shop heating.

Used oil or waste oil in most cases can be profiled and manifested as, “oil for recycle” by your local waste disposal company. This oil is typically burned as a secondary fuel source for waste incinerators or kilns.

Used oil can be recycled in waste oil heaters and waste oil boilers. Waste oil can be any oil that is drained from a vehicle or piece of machinery during equipment maintenance, such as transmission oils, hydraulic oils or combustible synthetic oils.

There are several companies that sell multi-oil heating systems. These waste oil heaters and boilers turn a used product into a valuable fuel. The cost of heating with waste oil is very low. The third party cost of waste oil collection is minimized. These heaters offer an economical and environmentally-friendly way to dispose of waste oil and are an ideal solution to heating shops and garages. Portable units are also available for use on jobsites or other well ventilated areas.

Recycling waste oil through on-site heat recovery reduces the risk of spills and contamination, the use of waste oils as a fuel source reduces the pressure on natural gas and fuel oil supplies.

A typical gallon of waste motor oil contains 153,000 to 180,000 BTU—about the same amount of energy as 18 kilowatt hours of electricity. These heating systems, boiler systems and storage tanks typically meet all EPA requirements for waste and oil recycling. The waste oil burners emit little odor and no smoke because the various proprietary components of the burners work together to achieve a clean burn. They are relatively easy to use and maintain.

2.6 Recycle Fuel Filters

Used fuel filters can be stored securely in large drums that accommodate up to 300 filters each. These drums can be retrieved by recycling companies at regular intervals, allowing the contractor to recycle thousands of filters each year.

2.7 Perform Regular Maintenance

- Keep the equipment properly maintained to maximize fuel efficiency.
- Tune up the engines at regular service intervals.
- Have a proactive preventive maintenance program in place.
- Fit air pressure monitors in tires to be certain they are properly inflated.

2.8 Indoor Air Quality

Many construction sites have implemented a no smoking policy within the enclosure of the construction project.

## 3. Office-based Operations

Efforts to recycle waste material and promote a green working environment need not be limited to the jobsite. The office also provides scope for businesses to successfully run a green company, as many

items of office equipment and stationary are recyclable and use of paper can be minimized by using electronic data.

The production of industrialized paper and plastic creates a negative impact on the environment, consuming energy, adding to landfill waste and pollution. Cutting contractors have the opportunity to recycle all paper and plastics consumed or used at their office locations by separating recyclables from non recyclables and loading them into special containers for recycling. Here are some examples of how cutting contractors can make their office-based operations green.

3.1 Recycle Paper
- Have a special trash can for the recycling of waste paper, including letters, notes or large construction drawings.
- Reuse unwanted printouts, where applicable, by printing on the reverse.
- Order recycled printer paper from suppliers.

3.2 Minimize Paper Use
- Cut down on unnecessary printouts where electronic files will suffice.
- Include notes or signatures on emails like, “be kind to the environment, think before printing this email” to encourage others.
- Use projectors and computer data sharing for paperless meetings.

3.3 Recycle Printers and Cartridges
- When equipment is replaced or upgraded, recycle old items such as monitors, keyboards and printers.
- Use the free return packaging supplied with printer cartridges to recycle them.
- Have ink cartridges refilled when empty or buy refilled cartridges from suppliers.
- Use printer cartridges that contain soy-based ink.

3.4 Recycle Packing and Shipping Materials
- Send pallets for recycling or make use of the wood.
- Reuse cardboard boxes or break down to recycle
- Reuse or recycle other packing materials made of paper, card, plastics or metals like aluminum or tin.

In general, green strategies make good economic sense for companies. Replacing incandescent bulbs with compact fluorescent lights when they require replacement can save businesses money through the conservation of energy and the lowering of electricity bills. Transportation for employees can often be as big of an impact as the office operations.

By following just some of the points raised in this document, cutting contractors can become green both on the jobsite and at the shop. Not only this, but employing some of these processes can save the company money too. It is important to observe as many green practices as possible during sawing and drilling operations to protect the environment and, in some cases, abide by state and Federal laws.

# Best Practice

**Title:** Hi-Cycle Concrete Cutting Equipment
**No:** CSDA-BP-010
**Date Issued:** Jul 2, 2010

## Introduction

Hi-cycle/high frequency concrete cutting equipment has become more prevalent in the cutting and drilling industry. With increasing availability and serviceability of hi-cycle/high frequency systems, many contractors are more comfortable making the switch from hydraulic powered equipment. There is increasing pressure from general contractors and government municipalities for cutting contractors to provide alternatives to hydraulic equipment. These parties are looking at ways to prevent incidents or injuries that can result from hydraulic oil leaks in sensitive work areas.

Electric powered equipment has always been an alternative, but a lack of sufficient power from early electrical tools was a problem. For these tools, large and heavy 60-hertz motors were required and were a huge inconvenience for the operators. Hi-cycle/high frequency equipment was, and still is, the answer. This technology allows the tool to be a lighter, more manageable size with plenty of power. During the early days of hi-cycle/high frequency equipment, the tools were limited and difficult to obtain. More recently, however, there is an ever-increasing availability of hi-cycle/high frequency equipment and a large number of manufacturers of cutting equipment have, or are in the process of, developing hi-cycle/high frequency products. Demand from operators, safety personnel and owners for equipment that is lighter and safer to handle is the driving force behind this increase.

This Best Practice Document will discuss the safe operation of hi-cycle/high frequency systems and explain the different terms that may arise in discussions about hi-cycle/high frequency equipment. The document will also cover the difference in systems that utilize power inverters and systems that run directly from a hi-cycle/high frequency generator.

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## 1. Systems Utilizing Power Inverters

Inverter driven systems operate by converting input voltage and frequency from a power source, like 480-volt 60-hertz 3-phase, 220-volt 60-hertz 3-phase and/or 220-volt 60-hertz single phase systems (Input voltage is dependent on manufacturer design). Each design will allow a predetermined input voltage and frequency range that the power inverter will accept.

Output voltage is provided by the power inverter—the hi-cycle/high frequency side of the system. A cable/cord connects the power inverter to the equipment. The voltage and frequency on the output, or hi-cycle/high frequency side of the system, is by design and determined by each manufacturer. Typical voltage and frequency is; 400 volt 400 hertz , 200 volt 400 hertz or 400 volt 1,000 hertz.

The differences with each frequency will be explained further in the following sections. Inverter driven systems have made the availability of hi-cycle/high frequency systems much easier for the end user, due to the fact these systems run from 60-hertz power sources and many end users already own a 60-hertz generator. Today, manufacturers of hi-cycle/high frequency systems have all of the components needed for the complete system.

1.1 System Components

a. Hi-cycle/high frequency motor
b. Power inverter
c. Power cable/cord from tool to power inverter
d. Water hose (connects to water cooled motor and or power inverter)
e. Wall saw, wire saw, core drill or slab saw
f. Remote control (optional on some systems)
g. Power and water source (generator, house power), water pump or house water

## 2. Why is a Hi-Cycle/High Frequency Motor So Much Smaller Than a 60-hertz Motor?

By increasing the motor rpm the frequency/hertz is increased. For example:

- A 60-hertz, 20-horsepower, 3-phase motor operates with an internal rpm about 1,800
- A 400-hertz, 20-horsepower, 3-phase motor operates with an internal rpm about 12,000
- A 1,000-hertz, 20-horsepower, 3-phase motor operates with an internal rpm about 30,000

Horsepower is determined by manufacturer design, with each manufacturer offering its own horsepower for each system. Increasing rpm increases frequency. The higher the frequency the smaller the rotor and stator can be, therefore a lighter weight with motors of a smaller size.

With higher rpm the motor generates more heat, which has to be dealt with in order for the motor to survive. Water cooling is the most effective method to accomplish the job of removing heat. There are water cooling jackets built around the motor stator and rotor, so it is extremely important that the motors are not run without water flowing. Most inverter driven systems will have some method of monitoring internal motor temperature and will try to protect the motor from overheating with warning lights or by shutting the motor down.

## 3. Operating Inverter Driven Systems with Remote Control and Auto Feed

Safety is a big advantage with a remote controlled auto feed system. The operator is at a safe distance away from the cutting. The operator moves a lever or switch on the remote control to feed the blade into the cut and control the direction of the cut. The power inverter software then controls the load and feed rate while the blade is cutting. The operator cannot overload the motor, the software will slow or stop the feed rate when load on the motor changes such as when cutting steel bar or hard aggregate. If the blade jams, the software will sense the sudden change in load and turn the motor off.

3.1 Power Source and Cable/Cords

These cables and cords should be sufficient for the tool in use. Manufacturer recommendations on generator size and cable/cord size must be followed to achieve the best performance from the equipment in use. Voltage and/or frequency fluctuations due to an undersized cable/cord or power source can cause undesirable behavior with the equipment. Never allow higher than the maximum rated voltage to be plugged into the system. Damage to the equipment can, and will, occur.

3.2 Connections

Electrical connections are the single most important item in any system that utilizes electrical power to operate a tool. Make sure connections are tight. Inspect clamping devices or clamping rings for damage and make sure when connected that they remain tight. Inspect cable/cords for cuts in insulation, crushed wires, cord grip damage or fatigue of cable/cord at the cord grip.

3.3 Clean Pins and Sockets

A dirty or worn pin or socket in a connection is a problem waiting to happen. If a pin and socket are full of slurry or worn there is less than 100 percent contact between the two. In order to transfer the power load through the connection efficiently, the pins and sockets need 100 percent of the surface contact area. When the contact area is reduced, heat will be generated, arcing will begin and eventual failure is bound to follow. On some inverter driven systems the loss of a phase in a connection or from the power source can cause a warning light to flash and shut the motor off to protect the machine and the operator.

## 4. Inverter Driven Manual Feed Systems

This system has no auto feed function. The operator manually feeds blade or bit into cut and manually controls feeding rate. Operators must utilize load warning lights or meters in order to stay within the operating range specified by the operator. Ignoring the warnings will cause overloading and damage can occur to motor and other components.

Some systems have overload protection and will shut down when the system reaches a specified overload range. Always follow manufacturer recommended operating procedure.

## 5. Systems Run Directly from a Hi-Cycle/High Frequency Generator

Systems that run directly from a hi-cycle/high frequency power source differ slightly to an inverter driven system. These systems operate by connecting a power source directly to a switch box or control box that is used to turn the power on and off to the hi-cycle/high frequency motor.

The most common voltage and frequency for these systems is 200 volts and 400 hertz. This was the first level of voltage and frequency introduced to the concrete cutting industry for hi-cycle equipment. There are also some 400-volt, 400-hertz systems of this type in circulation.

Connections should be cared for in the same way as with the inverter driven systems and any other system that utilizes electricity.

5.1 System Components

a. Hi-cycle/high frequency motor
b. Hi-cycle/high frequency generator
c. Switch box/control box
d. Power cable/cord from tool to switch box/control box
e. Wall saw, wire saw, core drill and slab saw
f. Power and water source, (Hi-cycle/high frequency generator), water pump or house water.

5.2 Power Source

The power source is very important with this type of system. Voltage drops and frequency variations have a different affect on this type of system. When voltage drops from the generator it also drops at the motor. As voltage drops, amperage rises. More heat is generated and the motor, cords and connections run hotter. If the heat is severe enough, damage can occur to the equipment. Some systems utilize a temperature sensor inside the motor for protection, however, most do not. Operators must utilize volt meters and/or amp meters to properly apply the correct load when sawing or drilling with this type of system. Always follow manufacturer recommended operating procedure.

## 6. Common Terms and Definitions

Here are some commonly-used terms with regards to electric powered equipment, together with a brief definition of each.
The terms are listed in alphabetical order.

**AC (Alternating Current)**
The commonly available electric power, supplied or distributed in single or three-phase forms. AC current changes its direction of flow (cycles).

**Air Gap**
The space between the rotating (rotor) and stationary (stator) part of an electric motor.

**Ampere (Amp)**
The standard unit of electrical current. The current produced by a pressure of one volt in a circuit having a resistance of one ohm.

**Bearings**
These are used to reduce friction and wear while supporting rotating elements. For a motor, it must provide a relatively rigid support for the output shaft. The bearing acts as the connection point between the rotating and stationary elements of a motor. The ball bearing is the most commonly used type of bearing in virtually all types and sizes of electric motors.

**Coil**
The electrical conductors wound into the core slot that are electrically insulated from the iron core. It is these coils that carry and produce the magnetic field when the current passes through them.

**Current**
The time rate flow of an electrical charge. Current is measured in amps (amperes).

**Cycles Per Second (Hertz)**
One complete reverse of flow of alternating current per rate of time, hertz is a measure of frequency. 60 hertz (cycles per second) AC Power is common throughout the USA, while 50 hertz is more common in other parts of the world.

**Fuse**
A piece of metal connected in the circuit to be protected, that melts and interrupts the circuit when excess current flows.

**Hertz (HZ)**
One cycle per second (as in 60 hertz, which is 60 cycles per second).

**Horsepower**
The measure of rate of work. One horsepower is equivalent to lifting 33,000 pounds to a height of one foot in one minute. The horsepower of a motor is expressed as a function of torque and rpm. For motors, the following approximate formula may be used:

$$hp = \frac{t \times rpm}{5{,}252}$$

Where hp = horsepower, t = torque (lb ft.)
rpm = Revolutions per minute

Usually torque is unknown to the end user in the concrete cutting industry. Horsepower is the most commonly known rating. Torque = horsepower x 5,252/rpm. This calculation will provide the rated torque. The common rpms of hi-cycle/high frequency motors in this industry are 60 hertz at 1,800 rpm, 400 hertz at 12,000 rpm and 1,000 hertz at 30,000 rpm.

**Inverter**
An electrical device that converts fixed frequency and fixed voltages to variable frequency and voltage. An inverter enables the operator to electrically vary the speed of an AC motor.

**Kilowatt**
Since the watt is a relatively small unit of power, the kilowatt (kW) is used where larger units of power measurements are desirable. Generators are rated in kW and kVA. If you know the kVA and need to convert to kW, or you know the kW and need to convert to kVA:
kW =kVA x 0.8
**Example:** 25kVA x 0.8 = 20kW
kVA =kW divided by 0.8
**Example:** 20kW divided by 0.8 = 25kVA
The minimum supply of kilowatts needed to run hi-cycle/high frequency systems is determined by each manufacturer. Always follow manufacturer recommendations. A general rule is that 1

kW per rated horsepower of the hi-cycle/high frequency motor should be the absolute bare minimum. At least 1.25 kW or more per rated horsepower is a much better option, and leaves more of a margin for losses in these systems.

**Laminations**
The steel portion of the rotor and stator cores made up of a series of thin laminations (sheets) which are stacked and fastened together by cleats, rivets or welds.

**Losses**
A motor converts electrical energy into a mechanical energy and in so doing, encounters losses. These losses are all the energy that is put into a motor and not transformed to usable power but are converted into heat, causing the temperature of the windings and other motor parts to rise.

**Motor**
A device that takes electrical energy and converts it into mechanical energy to turn a shaft.

**Phase**
The number of individual voltages applied to an AC motor. A single-phase motor has one voltage in the shape of a sine wave applied to it. A three-phase motor has three individual voltages applied to it. The three phases are at 120 degrees with respect to each other so that peaks of voltage occur at even time intervals to balance the power received and delivered by the motor throughout its 360 degrees of rotation.

**Poles**
In an AC motor, poles refer to the number of magnetic poles in the stator winding. The number of poles is a determinant of the motor's speed.

**Resistance**
The degree of obstacle presented by a material to the flow of electric current is known as resistance, and is measured in ohms.

**Rotor**
The rotating member of an induction motor made up of stacked laminations. A shaft running through the center and a squirrel cage made in most cases of aluminum which holds the laminations together and act as a conductor for the induced magnetic field. Hi-cycle/high frequency motors in the concrete cutting industry tend to use copper squirrel cages for better performance and strength.

**RPM (revolutions per minute)**
The number of times per minute the shaft of the motor (machine) rotates. This is a function of design and the power supply.

**Speed**
The speed of the motor refers to the rpms (revolutions per minute) of the shaft. For a three-phase AC motor the synchronous speed is: 120 x frequency measured in hertz or cycles per second, divided by the number of poles. The numbers of poles are a function of design. In the concrete cutting industry common pole counts are: 2 Pole, 4 Pole and 8 Pole. 4 Pole is the most common.

**Stator**
The part of an AC induction motor's magnetic structure which does not rotate. It usually contains the primary winding. The stator is made up of laminations with a large hole in the center in which the rotor can turn; there are slots in the stator in which the windings for the coils are inserted.

**Thermal Protector (inherent)**
An inherent overheating protective device which is responsive to motor temperature and which, when properly applied to a motor, protects the motor against dangerous overheating due to overload or failure to start.

**Thermistor-Thermally Sensitive Resistor**
A semiconductor used to measure temperature. A thermistor can be attached to an alarm or meter to detect motor overheating.

**Torque**
Turning force delivered by a motor or gear motor shaft, usually expressed in pounds. Torque can be derived by completing hp x 5,252/rpm = full load torque.

**Transformer**
A device which converts electrical power (alternating current) to electrical power of a different voltage. In this device both primary and secondary windings are usually stationary, and are wound on a common magnetic core.

**Voltage**
The force that causes a current to flow in an electrical circuit. A device which causes a current to flow in an electrical circuit. Analogous to pressure in hydraulics, voltage is often referred to as electrical pressure. The voltage of a motor is usually determined by the supply to which it is being attached.

**Watt**
The amount of power required to maintain a current of one ampere at a pressure of one volt. Most motors are rated in kilowatts equal to 1,000 watts. One horsepower is equal to 746 watts.

# Best Practice

**Title:** Establishing and Maintaining the Work Area
**No:** CSDA-BP-011
**Date Issued:** Sep 19, 2011

## Introduction

Concrete sawing and drilling work areas are usually extremely busy places. These work areas often contain equipment and contractor personnel, with a consistent and high level of activity. Each person entering into a concrete sawing and drilling work area must exercise care for their own personal safety and that of others. They also must comply with basic safety standards, standards and requirements provided by rule or regulation, or by specific standards and protocols issued for the site. The following provisions are recommended but are not exclusive. None of them are necessarily required; adaptation to the specific site and activities may be appropriate or required by law or other authority. These suggestions are not intended to set a standard of conduct but are offered as guidance. Other authority may require certain equipment or procedures; any such directives will take precedence over these suggestions.

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## 1. Defining the Work Area

The work area should be defined in order to control access for safety and security purposes. This may be accomplished by determining the perimeter of the work area and setting up a barrier. Caution tape or hard barriers can be used to prevent unauthorized persons from entering the work area.

## 2. General Safety and Health

The following elements of safety and health should be considered when establishing a work area:

- Compliance with all applicable local, state and federal traffic and safety rules, regulations, codes and ordinances.
- Pedestrian through traffic is discouraged, but if it is necessary it should be separated.
- The work area should be kept clean and orderly.
- Debris and waste should be stored safely and removed from the work area when not needed.
- If feasible, cutting operations should be kept wet to prevent exposure to airborne silica.
- There should be adequate illumination in the work area.
- Floor openings should be covered or otherwise guarded.
- Smoking areas should be established, where applicable.
- Emergency telephone numbers and procedures should be posted for all employees to see.
- When not in use, equipment should be properly locked out to control hazardous electrical, hydraulic, pneumatic or gravitational energy.

2.1 Means of Egress

It is important for all employees to have a means of exiting the work area. The following should be considered when establishing means of egress from the work area:

- All exits should be clearly marked and include an exit sign illuminated by a reliable back-up light source.
- If a route to an exit is not immediate, directions should be marked with highly visible signs.
- Doors, passageways or stairways that are neither exits nor access to exits, and which could be mistaken for exits, must be appropriately marked. As an example, such points could be marked “NOT AN EXIT,” “TO BASEMENT” or “STOREROOM.”
- All exits should be kept free of obstructions.
- At least two means of egress should be provided.
- Exits should be sufficient to permit prompt escape in case of emergency.
- Exit doors should open with the direction of exit travel and without the use of a key, and without any special knowledge or effort.
- A safe gathering place should be assigned in the event of an evacuation. The location should be communicated to all.
- A headcount should be performed at the assigned gathering place following an evacuation of the work area.

2.2 Walkways

- Aisles and passageways should be kept clear.
- Wet surfaces should be covered with non-slip materials.
- Adequate headroom (or a warning) should be provided for the entire length of any aisle or passageway.
- Guardrails should be provided wherever aisle or walkway surfaces are elevated more than 30 inches above any adjacent floor or the ground.
- Bridges should be provided over conveyors and similar hazards.

## 3. Personal Protective Equipment

Employers should provide personal protective equipment (PPE) to employees and ensure its use. PPE is worn to minimize exposure to a variety of hazards. The following should be provided for sawing and drilling operations in the work area. In most cases, these items should be in place at all times while in the work area.

- A highly visible, reflective safety vest
- Steel-toed safety boots
- Hard hats
- Eye protection
- Hearing protection
- First aid supplies
- Protective gloves
- Respirators, where required

For more information on PPE, refer to CSDA Toolbox Safety Tip (TST) #165.

## 4. Stairways and Ladders

All ladders should be maintained and in good condition. The joints between the rungs and side rails should be tight and all hardware and fittings should be securely attached. Movable parts should operate freely without binding or undue play.

Ladders should always extend at least 3 feet above the elevated surface. Metal ladders should not normally be permitted and may be prohibited by other rules. Ladders should be used only for their intended purpose and inspected before each use. Damaged or modified ladders should be removed from service.

For more information on ladder safety, refer to CSDA TST #142 or OSHA/CSDA Alliance Best Practice CSDA-OBP-1006.

## 5. Elevated Surfaces and Scaffold

Scaffolding forms and temporary structures maybe necessary to support people and material in the renovation or selective demolition of buildings and other structures. Serious injury or death can result if sawing and drilling contractors fail to comply with all applicable safety requirements when erecting, using or dismantling scaffolding.
The following should be considered when using scaffolding in the work area:

- Aerial lifts must be operated and inspected by a competent person.
- Signs must be posted, showing elevated surface load capacity.
- Surfaces elevated more than 30 inches above the floor or ground should be provided with standard guardrails.
- Elevated surfaces (beneath which people or machinery could be exposed to falling objects) must be provided with standard 4-inch toe boards.
- Means of access and exit must be provided to elevated storage and work surfaces.
- Required headroom provided.
- Material on elevated surfaces should be piled, stacked or racked in a manner to prevent it from tipping, falling, collapsing, rolling or spreading.

- Dock boards or bridge plates should be used when transferring materials between docks and trucks or rail cars.

For more information on scaffold safety, refer to CSDA TST #105-A or OSHA/CSDA Alliance Best Practice CSDA-OBP-1005.

## 6. Floor and Wall Openings, Demolition

The following should be considered when creating floor or wall openings in the work area:

- Floor openings should be guarded by a cover, a guardrail or equivalent on all sides except at an entrance to stairways or ladders.
- Toe boards should be installed around the edges of permanent floor opening where persons may pass below the opening.
- Skylight screens should be constructed and mounted so that they will withstand a load of at least 200 pounds.
- Grates or similar type covers over floor openings, such as floor drains, should be designed so that foot traffic or rolling equipment will not be affected by the grate spacing.
- Unused portions of service pits and pits not in use should either be covered or protected by guard rails or equivalent.

## 7. Fall Protection

Guardrails are used to protect people from falling into floor openings or open-sided floors. Guardrails can be found around elevator shafts, pits, duct chases and platforms, and must be capable of withstanding, without failure, a force of at least 200 pounds applied in any outward or downward direction. For further information, refer to OSHA Standard 1926.500, 1926.501, 1926.502 and 1926.503 or visit www.osha.gov.

Personal fall arrest systems should be inspected prior to every use. Damaged or modified components should be removed from service. Personal fall arrest components should be in working condition and free from visible damage. Personal fall arrest systems that have been subject to impact loading should be immediately removed from service and inspected by a qualified personal.

Personal arrest systems consist of:

- Body harnesses
- Deceleration devices
- Lanyards
- Connectors
- Anchorage
- A rescue plan

For more information on fall protection, refer to CSDA TST #111.

## 8. Electrical Safety

Electricity is widely recognized as a potential workplace hazard, exposing sawing and drilling operators to electric shock, burns, fires, and explosions. Working in a work area around electrical conductors and equipment can be particularly dangerous, because electrical energy often cannot be sensed until contact is made. Here are some examples of how electrical hazards can be reduced in the work area:

- Use electrical power drops.
- Provide protection for cable runs to avoid being driven over by vehicular traffic.
- Use GFCI 120V systems.
- Check electrical cords for signs of fraying or broken insulation.
- Electric tools and equipment should be grounded or double insulated.
- Ground connections must be clean and tight.
- Motors should be clean and kept free of excessive grease and oil.
- Portable lights should be equipped with proper guards.

For more information on electrical safety, refer to OSHA/CSDA Alliance Best Practice CSDA-OBP-1004.

## 9. Fire Protection and Prevention

Fire extinguishers for the work area should be available in adequate numbers and be the correct type. Extinguishers should be secured during transport. They should also be inspected monthly for general condition and operability, and inspections should be noted on the inspection tag. Fire extinguishers should be recharged regularly and the safety pin should be in place. Extinguishers should not obstruct walkways or doors.

Other things to be considered:

- Use the type of fire extinguisher that corresponds to the type of material burning.
- Never use an extinguisher that contains water or foam on an electrical fire.
- Know where extinguishers are located and how to use them. Follow the directions printed on the label.
- Keep the area around the fire extinguisher clear for easy access.
- Treat extinguishers like work tools and take care of them.
- Never remove inspection tags from extinguishers.
- Have extinguishers inspected as and when required.
- Report any defective or suspect extinguishers to your supervisor so they can be replaced or repaired immediately.

## 10. Hand and Power Tools

Many sawing and drilling contractors use hand-held tools for cutting concrete and other masonry. Severe injuries can occur when using this type of equipment if not handled correctly. It is important for sawing and drilling operators to observe specific safety requirements for each type of tool used. Operators should consider the following:

- When using electric hand power tools, make sure electrical equipment such as cords and generators are in good operating condition and use ground fault circuit interrupters (GFCI). When using hydraulic tools, make sure all lines and fittings are in good condition and hoses are not leaking.
- Inspect the backside of the work area. Make sure there are no obstructions such as electrical or gas lines. If unable to inspect the area, get assurances there are no hazards before starting work.
- Form a stable base when performing cutting work.
- Do not perform cutting work while on ladders or scaffolding.
- Keep hands clear of all moving parts while the tool is running.
- Where applicable, make sure the tool has an air filter that is in good working order to prevent dust build-up in the motor.
- Switch off the motor and disconnect the plug before carrying out any maintenance or inspections. Any tools that are unfit for use should be removed from site.

## 11. Motor Vehicles and Mechanized Equipment

Sawing and drilling contractors can often operate in large work areas where it is necessary to have vehicles travel through the area where operators are using heavy equipment. Whether an operator is responsible for a vehicle or piece of equipment, or whether they are working around work area traffic or heavy equipment and it is important to be aware of potential hazards.

Equipment should be properly guarded to maintain the safety of operators and other workers nearby. Blade guards should be in place during operation. Compressed gas cylinders should be examined regularly for defects, deep rusting and leaks. Any cylinders that are deemed unfit for use should be removed from the work area.

In most fatal accidents involving forklifts, the operator is the one who is killed. Many of these accidents may be avoided as long as safe driving skills are understood and practiced. There are many safety areas for concrete sawing and drilling contractors to consider when operating forklifts. It is recommended that employers and workers comply with OSHA regulations, maintain equipment, consider the following measures to help prevent injury.

Pedestrian Safety

- Be aware of pedestrians and give them the right-of-way.
- Do not allow anyone to walk, stand or ride on or under the forks.
- Do not allow a person to get between the forklift and a hard surface like a wall, table, bench or any other fixed object.
- Use a horn, mirrors or flash the lights to indicate a presence to others.

Parking

- Do not park on an incline.
- Turn the engine off when the forklift is unattended or refueling and do not smoke around a forklift.

Driving

- Do not operate a forklift unless trained and deemed competent by an employer.
- Maintain awareness at all times.
- Always use a seatbelt and keep arms, legs, head and feet inside the forklift when driving.
- Never drive with the forks up or use the forklift to push other vehicles.
- Do not jump from an overturning, sit-down type forklift. Stay with the truck, holding on firmly and leaning in to the opposite direction of the overturn.
- Use extreme caution on grades or ramps. On grades, tilt the load back and raise it only as far as needed to clear the road surface.
- Do not handle loads that are heavier than the weight capacity of the forklift.
- Operate the forklift at a speed that will permit it to be stopped safely; remember it will take a forklift traveling at 10 mph at least 22 feet to come to a full stop on a dry surface.
- When dismounting from a forklift, set the parking brake, lower the forks or lifting carriage and neutralize the controls.
- A supervisor should be told of any damage or problems that occur to a forklift.

For more information on forklift safety, refer to CSDA TST #195.

## 12. Materials, Occupational Health and Environmental Controls

Material Safety Data Sheets (MSDS) contain important information concerning the nature, composition and safe handling of chemicals, materials and products. By law, these documents must be supplied when requested.

A MSDS is a written document that provides employees, product users and emergency personnel with information and procedures needed for handling and working with chemicals, materials and products. A MSDS outlines the physical and chemical properties of a chemical and/or material, describes potential hazards associated with the substance (health, storage cautions, flammability, radioactivity), prescribes emergency actions and provides spill and clean-up information. The document also includes manufacturer identification, address, MSDA date and emergency telephone numbers. MSDS information must be maintained at each job or in company vehicles so that employees may have access to review them at any time.

Sawing and drilling operators should consider air quality when performing cutting work in confined spaces. The availability of clean, breathable air is required for any operator to complete his or her work safely. Confined spaces that have poor air quality, or are not properly ventilated, can lead to operator illness or death. In this regard and in general, CSDA recommends the use of electric saws when working inside.

- Ensure that the correct length of ducting is in place when using ventilation equipment.
- Ensure there are no kinks in the ducting.
- Consider using multiple blowers with shorter ducting lengths if adequate ventilation cannot be supplied by one unit.
- Perform a site survey to determine how ventilation equipment will be powered.
- Be aware that some confined spaces or work areas may have restrictions on exhaust fumes.
- Appropriate operator training on confined spaces is essential before performing sawing or drilling work. In addition, the person responsible for safety in the work area should also have received formal confined space training.

Hazard communication is the process of inspecting the work area for all possible hazards. Operators must practice hazard communication every day, in every work area to prevent accidents and ensure a safe work environment. When inspecting a work area, operators should ask themselves:

- Where am I working?
- What hazards are present?
- How can they hurt me?
- How can I protect myself?

For more information on hazard communication, refer to CSDA TST #123.

## 13. Excavations

To avoid injuries and citations arising from unsafe trenching and excavations, follow these rules:

- All trenches must be approved by a competent person who knows trenching and excavation standards. A competent person should have the authority to shut down a job that appears to be unsafe.
- A protective system must be used in all excavations that are 5 feet deep or greater, except for excavations in "stable rock."
- Any excavation that is greater than 20 feet deep must include a protective system designed by an engineer.
- Operators working in trenches must be aware of changes in weather and vehicle traffic near the trench.
- Operators working in trenches must have means of access and egress. Egress must extend 3 feet above the trench.
- A ladder must be placed every 25 feet of trench length.
- There are three different types of protective systems. Sloping involves cutting back the trench wall at an angle inclined away from the excavation. Shoring requires installing aluminum, hydraulic, or other types of supports to prevent soil movement and cave-ins. Shielding protects workers by using trench boxes or other types of supports to prevent soil cave-ins.
- OSHA requires that trenches and excavations are inspected by a competent person daily before workers enter, and whenever there is a change in conditions.
- Keep heavy equipment away from trench edges and do not work under raised loads.
- Test for low oxygen, hazardous fumes and toxic gases where necessary.

For more information on trenching and excavation safety, refer to CSDA TST #113-A.

# Best Practice

**Title:** Mechanical Anchors
**No:** CSDA-BP-012
**Date Issued:** Sep 20, 2011

## Introduction

Mechanical anchors of different types are used by concrete sawing and drilling contractors on jobsites. Two of the most common type of anchors in use in the industry are drop-in anchors and wedge type anchors. It is important for operators to understand how to use anchors safely to avoid potential accidents.

Sawing and drilling contractors should always read the manufacturer's installation instructions before using any anchor. Not following these instructions can negatively affect anchor performance—sometimes significantly. Manufacturers typically publish technical literature describing what the anchors are generally suitable for, what their load capacity is and what factors affect performance. If a contractor has any doubt about the anchors suitability, load capacity or has other questions, most manufacturers offer technical assistance.

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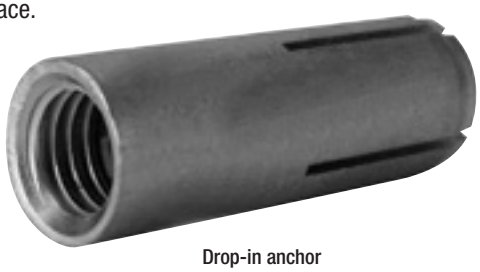
## 1. Drop-in Anchors

Drop-in anchors are internally threaded, female expansion anchors for use in concrete and are either lipped or non-lipped. Lipped drop-ins, when being installed, automatically stop when they are flush with the concrete surface. Non-lipped anchors can be countersunk below the surface.



Drop-in anchor

Drop-in anchor with lip

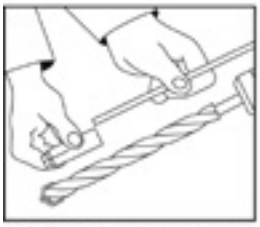
Manual setting tool

Automatic setting tool

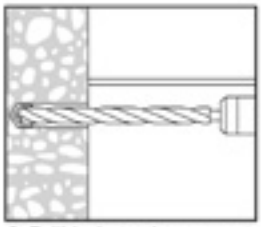
### 1.1 Properly Sized Drop-in Anchors

Calculations need to be performed to determine the loads (forces and moments) and to properly determine the quantity and physical size of anchor needed to safely secure the load. Calculating the load can be complicated—the weight of the machine and bit, offset loads, operator feed pressure and dynamic conditions—so if unsure, it is advised to involve a technical professional.

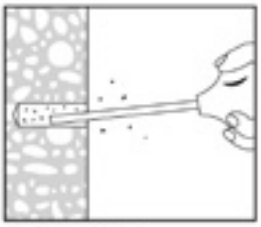
It is easy to underestimate the forces acting on anchors, especially on walls and ceilings. It should be noted that edge distances (the distance from the anchor to the edge of the concrete), spacing between anchors, concrete strength



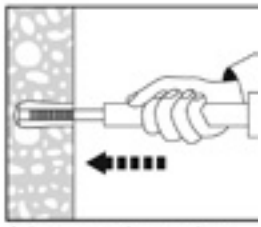
1. Adjust depth gauge to equal overall length of drop-in anchor.



2. Drill hole to the correct depth.



3. Clean hole.



4. Insert anchor and set anchor using proper setting tool. Drive tip into anchor until the the shoulder of the setting tool meets the top of the anchor.

and condition all influence how anchors will perform. If using multiple anchors to handle larger loads, it should be determined how the load is distributed between the anchors to prevent overloading. Using multiple anchors in the same core rig baseplate slot requires special consideration, because the spacing between anchors, as well as unequal load distribution, can decrease anchor performance.

1.2 Properly Installed Drop-in Anchors

For a drop-in anchor to perform correctly, it is critical that it be properly installed per manufacturer instructions. This starts with the correct size hole. In addition, operators should use the correct diameter bit specified by the anchor manufacturer. Note that as a carbide bit wears, the diameter hole it drills becomes smaller and smaller. If the drop-in anchor cannot be easily inserted into the hole, either by hand or with a slight hammer tap, the bit should be replaced. Some bit manufacturers provide an indent or wear mark on the flute of the bit to help operators identify when the bit is worn.

Next, the hole should be drilled to the proper depth. Drop-in anchors are designed to be installed flush with the concrete surface. Never use a drop-in anchor that is not fully installed and sticks up above the concrete surface. Non-lipped drop-in anchors can be set below flush, but operators should make sure the resulting lower shear and bending capacities are considered.

The hole should be cleaned as per manufacturer's instructions. The hole must be clean and free from dust and debris. Any concrete dust or slurry left in the hole can significantly affect the anchor's ability to perform. Depending on the instructions, a blow out bulb, blow out pumps or other forms of compressed air can be effective tools to clean the holes. Operators should make sure to insert the nozzle to the bottom of the hole to remove concrete dust from the entire hole. If water is used, the residual must be removed to avoid leaving slurry in the hole. Water can be flushed into the hole or a vacuum can be used to remove slurry from the hole.

The careful selection and proper use of a setting tool is essential. Setting tools vary between manufacturers and can wear over time, so it is advised to use the specified tool and make sure it is in good condition. Operators should not attempt to repair or grind a deformed or damaged setting tool. The dimensions are critical for proper anchor installation. If the setting tool becomes deformed it should be replaced.

When using a tool to set the anchor, the shoulder of the setting tool should be fully driven in until it meets the top edge of the anchor. This will achieve proper anchor performance.

1.3 Properly Adjusted Drop-in Anchors

Once an anchor is installed correctly, a properly rated threaded rod is screwed into the anchor. The rod should be turned into the anchor all the way, then backed off one turn or 360 degrees. A double-check of the rod should be done to make sure it is in far enough and "in equals out." As an example, this means a rod with a ½-inch outer diameter is threaded into the anchor at least ½-inch or a ⅝-inch rod is in at least ⅝-inch. At this point, the nut or collar can be tightened down.

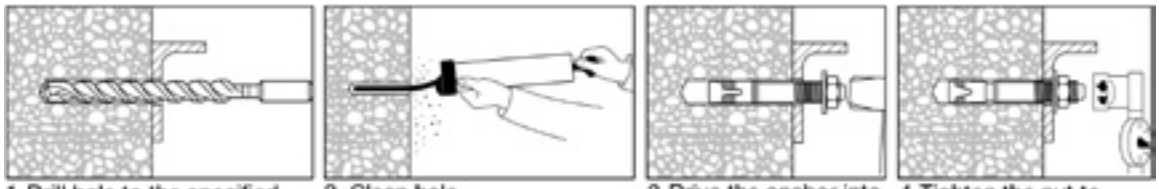
Operators should never over-torque anchors as permanent damage can occur. Torque guidelines should always be followed, as outlined by the anchor manufacturer. Adjusting the leveling screws on the rig base after the nut or collar is torqued can put additional load on the anchor. Leveling screws should always be adjusted first. Pulling wrenches across the body, or using long leverage bars or long wrenches invites over-torquing of the anchor. The maximum torque for these anchors is not large—a ½-inch drop-in anchor typically has a maximum torque of 20-30 ft-lbs. This information can be confirmed with the manufacturer. Lubrication of the threads should be avoided. This can cause overloading during torque-up, which can significantly affect performance.

## 2. Wedge Type Anchors

This type of anchor is a male mechanical anchor commonly used by cutting contractors for a variety of applications.

2.1 Properly Sized Wedge Type Anchors

Calculations must be performed to determine the loads—forces and moments—that will properly determine the quantity and physical size of anchor needed to safely secure the load. Calculating the load can be complicated—the weight of the machine, offset loads, operator feed pressure and dynamic conditions—so if unsure, the operators should involve a technical professional. It is easy to underestimate the forces acting on anchors, especially on walls and ceilings. Operators should remember that edge distances, the distance from the anchor to the edge of the concrete, spacing between anchors, concrete strength and condition all influence how the anchor will perform. If using multiple anchors to handle larger loads, the operator should determine how the load is distributed between the anchors to prevent overloading. Using



1. Drill hole to the specified depth and diameter for the anchor being used.
2. Clean hole.
3. Drive the anchor into the hole. The anchor must be driven until at least six threads are below the surface of the fixture.
4. Tighten the nut to the recommended installation torque.

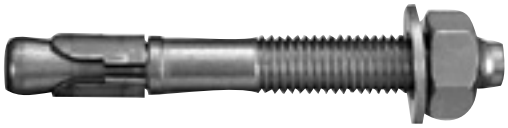
multiple anchors in the same core rig baseplate slot requires special consideration, because the spacing between anchors, as well as unequal load distribution, can decrease anchor performance.

2.2 Properly Installed Wedge Type Anchors

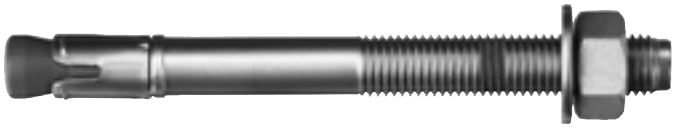
For a wedge-type anchor to perform correctly, it is critical it be properly installed per the manufacturer's instructions. Operators should use the correct diameter bit specified by the anchor manufacturer. It is important to note that as a carbide bit wears, the diameter hole it drills becomes smaller and smaller. The bit should be inspected regularly for excessive wear, especially when the anchor becomes difficult to insert into the hole. For easier identification of wear, some manufacturers provide an indent or wear mark on the flute of the bit. When the indent is no longer visible the bit should be replaced. Never wallow the hole to get the anchors to fit the hole, as difficulty getting the anchor to fit is a certain sign the bit needs to be replaced. The hole depth should be at least ¼-inch deeper than the desired anchor embedment. Operators should know what embedment depth is required for the application, as anchor performance is typically influenced by how deep it is installed. If the anchor cannot be left protruding from the concrete after the job is completed, operators can either cut or grind it off.

The anchor hole should be prepared for anchor insertion in line with manufacturer instructions. This includes making sure the hole is clean and free from dust and debris, as concrete dust or slurry left in the hole can significantly affect the anchor's ability to perform. Depending on the manufacturer's instructions, blow out pumps or other forms of compressed air can be effective tools to clean the hole. The nozzle should be pushed to the bottom of the holes to clean the entire hole. The wedge anchor should be hammered into the hole to the desired embedment, with enough threads driven past the surface of the rig baseplate to allow the anchor to pull up during tightening. A typical rule of thumb is to place the anchor at least six threads below the surface, but this should be verified with the anchor manufacturer.

Wedge anchor with washer and rod coupler



Carbon steel wedge anchor with washer and hex nut



Stainless steel wedge anchor with washer and hex nut

2.3 Properly Adjusted Wedge Type Anchors

Operators should use a washer sufficient in diameter and thickness to make sure it does not bend or pull through. The nut should be tightened to the manufacturer's recommended installation torque. There should be sufficient threads so that the anchor fully extends through the nut. Do not over-torque wedge-type anchors as this can result in permanent damage. The installation torques for these type of ½-inch-diameter anchors is not large—typically 30-50 ft-lbs. This should be confirmed with the manufacturer. It is possible to over-torque. Using long leverage bars or long wrenches invite over-torquing of the anchor. Never lubricate the threads of the anchor, as this can result in overloading during torque-up and can significantly affect performance.

# Best Practice

**Title:** Care of Quick Disconnect Flanges
**No:** CSDA-BP-013
**Date Issued:** Mar 20, 2012

## Introduction

Most concrete saws use quick disconnect flanges that are affixed to the blade shaft via a bolt. The blade shaft is manufactured with internal threads that are subject to wear over time and with prolonged use. The purpose of this Best Practice document is to provide advice and guidance on how to care for blade shaft threads and flanges to maintain safe cutting and prevent premature wearing of these parts.

## Table of Contents



## 1. Blade Shaft Threads (Bolts)

The threads, both the internal in the blade shaft and the external on the bolt, are subject to wear. The threads wear as a result of repeated tightening. Several precautions can be taken to prevent excessive and premature wear of the threads:

- Always use fasteners (bolts and washers) that have the same specification as those provided by the original equipment manufacturer. Using a bolt that is weaker (softer) or stronger (harder) than the original equipment bolt may compromise the performance of the machine. Using a bolt that is longer or shorter than the original equipment bolt could compromise the bolted joint, as could using a different number of washers and washers of different thickness than the original.
- Keep the thread clean. Both internal and external threads should be cleaned with a wire brush. It is important to keep the threads clear of slurry and dust. Water or a water displacing fluid (WD-40) can be used to flush out internal threads.
- Make sure that the internal thread is thoroughly cleaned. If slurry and other contaminants are not cleared from the thread, the bolt may bottom on the contaminants resulting in a bolt that cannot be tightened against the blade fully.
- Keep threads dry. Do not lubricate the threads. Lubrication attracts contaminants resulting in excessive wear. The torque specification for the blade shaft bolt is established with dry, clean threads.
- Tighten the bolt to the proper torque. Over tightening the bolt can lead to premature failure and excessive wear.

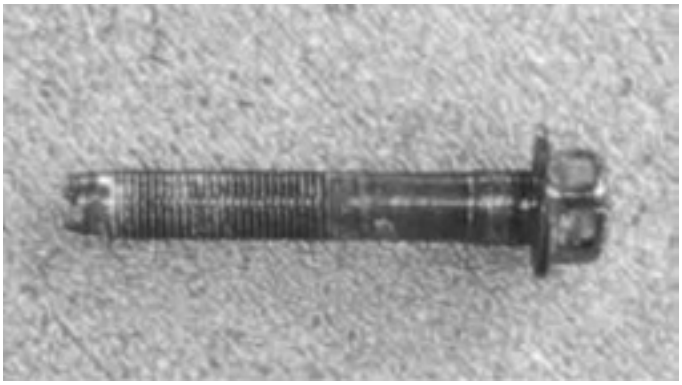


Figure 1 – A Typical Blade Shaft Thread (Bolt)

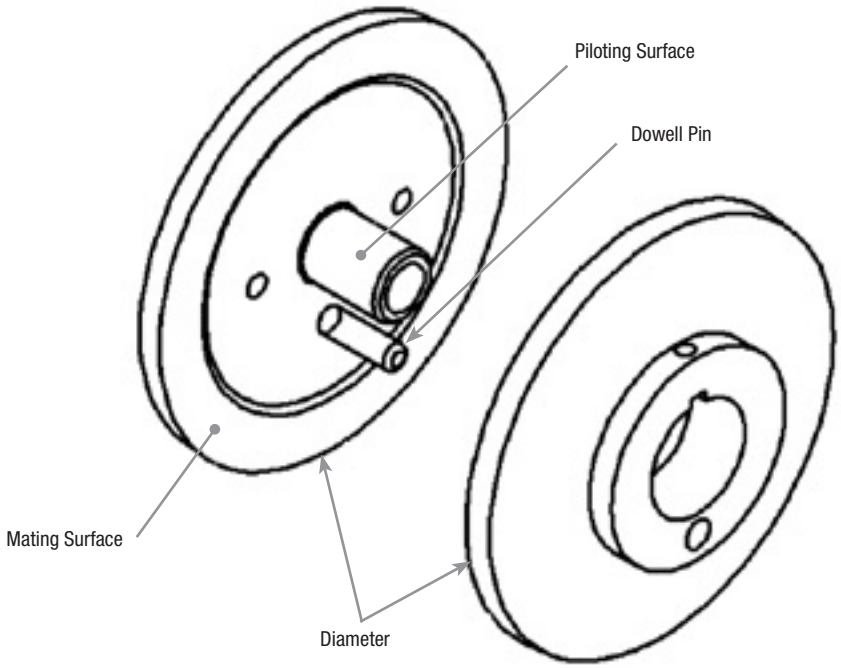



Figure 2 – A Typical Flange Design

Remember, threads are wear items that need to be replaced occasionally. When the threads on the bolt and blade shaft become worn, they cannot maintain the proper torque specifications. If a blade shaft bolt continuously loosens, the threads on the bolt should be inspected.

It is fairly simple to visually inspect the threads of a bolt. If the threads are not sharp and well defined, they are worn and the bolt should be replaced.

Internal threads are not as easy to inspect. A new bolt can be screwed into the internal thread. If the bolt can be moved excessively axially or normal to the blade shaft, then the internal threads may be worn and may also require replacement.

## 2. Flanges

Make sure that the inner and outer flanges are not worn excessively. According to ANSI standards, the flanges must be at least 1/6 of the outside diameter of the blade and should be matched.

2.1 Outer Flange
- Make sure the flange does not have excessive wear to the outside diameter.
- Make sure that the mating surface is clean and free of burrs or high spots.
- Make sure that the pilot diameter (where the blade rests) is not worn.
- Make sure that the outer flange pilots into the blade shaft without excessive slop.

2.2 Inner Flange
- Make sure the flange does not have excessive wear to the outside diameter.
- Make sure that the mating surface is clean and free of burrs or high spots.
- Make sure that the inner flange pilots onto the blade shaft without excessive slop.

2.3 Dowell Pin
- A dowell pin must be present and be used in accordance with manufacturers recommendations.

# Best Practice

**Title:** Images for Publication
**No:** CSDA-BP-014
**Date Issued:** Jan 21, 2013

## Introduction

Photographs of CSDA members at work are often used in magazines, brochures, websites and promotional materials. When a company submits photographs for publication, the recipient has unrestricted rights to use, reproduce and/or alter them. Therefore, it is important that the photographs are of good quality and show safe working practices. In addition, the person responsible for submitting the photographs should be knowledgeable about how to maintain their size and quality when transferring.

To insure the successful publication of company images, and to maintain the reputation of the company, the tips and considerations contained in this document should be followed. By adhering to the information provided in this Best Practice, a library of good quality photographs can be established that shows not only a company's range of skills or products, but also that its employees work to a high standard of safety and professionalism. Such photographs have a greater chance of being used in industry publications and other print and web-based material.

## 1. Photo Tips

- Digital camera: Must be high resolution; dots per inch (dpi) at least 300 or 4 megapixels. Save as high resolution jpeg files.
- Make sure subjects in photos are following all safety precautions (see section 2).
- Show equipment while it is in operation, not while it is idle.
- Take before, during and after shots that show the work as it progresses.
- Show operators when they are working, not standing watching someone else work.
- Take close-up shots of employees and equipment as well as pictures of the work site from a distance.
- Take a combination of portrait and landscape photos, or take one photo in each orientation for a particularly interesting shot.
- Use different positions like crouching, lying at floor level or from above or below the work area where safe to do so. Do not always take photos from a standing position.
- Where lighting is dim, or the job is indoors, turn the flash function of the camera on and off to see which image looks best.
- Where possible, use natural light and position the sun behind the camera
- Focus on workers, not others.
- Take non-job photos that help tell the story. For a job at a shopping center, take a photo of the entrance with center's name prominently displayed. For highway jobs, take a shot of the interstate sign. For a job at a location such as Fenway Park or Disney World, a photo of the main entrance or other distinguishing feature would add interest to your story.
- Do not submit photos unless they meet the safety requirements discussed below.

## 2. Safety Considerations for Photos

2.1 Make sure all persons are wearing appropriate clothing and safety equipment:

- Hard hats on correctly (DO NOT send photos if hard hats are on backwards, even if the lining has been reversed)
- Safety glasses, wrap-around or face shield
- Ear protection – ear plugs, muffs or both (on the ears, not around the head)
- Gloves where applicable
- Boots – leather or rubber, steel-toed; no tennis shoes or sandals
- Respirator where applicable
- Long pants, coveralls and coat if cold weather; preferably not torn
- Short or long-sleeved shirt but no tank tops; t-shirts okay if not torn

2.2 When photographing work on elevated areas or vertical surfaces, show:

- Proper scaffolding with safety railings and tie-off supports
- No ladder work over 8 feet high
- Fall protection harnesses and lanyards (where required); employees working in the proper equipment, not putting it on
- High lifts / scissors lifts with proper cages and fall protection
- Proper safety railing next to open holes or holes covered with proper cover

2.3 For photos showing equipment in action, be sure to include:

- Blade guards of proper size on all saws, installed per manufacturer's specs
- Wire saws with protective shields
- Saw blades for slab saws or wall saws 30 inches in diameter and over:
  - Show blade cut if running
- Proper handling of equipment with oversized blades and bits
  - Saws large enough to handle blade out of cut without lifting front end off the ground to clear the blade
- Shoring or strapping of all live openings
  - Show steel straps anchored into wall and opening to support section
  - No wedges, blocks or temporary shoring not bolted into place
  - Show channel iron or underneath shoring for slab openings unless being supported by crane or lift
- Proper lifting of equipment, slabs or sections with equipment or cranes
  - Make sure supports or strongbacks are in place
  - Cables only; no chains or ropes

- No persons riding on equipment or sections being lifted or removed
- No lifting over operators or others

## 3. Electronic File Information

- 1,000 Kilobytes (Kb) = 1 Megabyte (Mb)
- 1,000Mb = 1 Gigabyte (Gb)
- 1,000Gb = 1 Terabyte (Tb)
- Average email message (without attachments) = 10 to 100Kb
- Average cell phone photo = 20 to 1,500Kb (or 1.5Mb)
- Average digital camera photo = 2 to 5Mb
- A 1Gb memory card can hold around 400 photos (based on 2.5Mb per image)

## 4. Submission or Transfer of Images

Once all photographs have been taken (using the tips from Section 1), the image files need to be saved to a secure location ready for submission. Depending on the size and quantity of the files, images can be sent by email. However, this is also dependant on the allowable size limits for both the sender's and recipient's email accounts. This can lead to splitting the images up into several separate email messages. To send multiple image files at once, there are a few options available.

4.1 CD, DVD and USB Device Transfer – Images can be "burned" to a writeable CD or DVD, or copied to a USB flash drive and sent by mail. A writeable CD can hold 700Mb of information, while a DVD can hold up to 4.7Gb. The storage capacity of USB flash drives can vary from 128Mb to 128Gb.

4.2 Electronic Storage and Transfer Services – Files can be uploaded to an electronic transfer service like Dropbox or Hightail, and a notification sent to the recipient for download. This requires the setting up of a user account for the service, with free and paying versions available. Some web-based email accounts (Microsoft Hotmail/Outlook or Google Gmail, for example) have free file storage and transfer services, where the contents can be viewed or downloaded by others through the sharing of a link.

Regardless of how they are submitted, it is important to maintain the original size and resolution of photos during transfer. Some image uploading software packages, particularly on devices like mobile phones, tend to "compress" files for transfer. This compression means the size and resolution is reduced to allow the photo to be transferred quicker and easier. It is recommended to connect the phone directly to a computer via a USB cable (usually supplied with the phone) and move the files from the device to the hard drive, or take the memory card from the phone and insert into the appropriate slot on the computer (if applicable).

## 5. Use of Camera Phones

The quality and capabilities of cameras integrated into mobile phones is continually improving. Some current models have the ability to capture images up to 8 megapixels in resolution. However, it is still recommended that a "true" digital camera is used to take jobsite photographs instead of camera phones. This is because:

- Higher resolution images can be achieved with products primarily designed for taking photos
- Some camera phone auto-focus features are not as advanced or reliable
- Flash functions for indoor/dark areas are not as good on camera phones; sometimes no flash function is available
- Camera phone software may compress/reduce images when transferring (see Section 4)

Mobile phone cameras are useful for capturing things "in the moment" and sharing a photo with someone quickly, but can often produce an out-of-focus, dark or unflattering image rather than a composed, sharp image that compliments the subject.

# Best Practice

**Title:** Green Polishing and Grinding Practices
**No:** CSDA-BP-015
**Date Issued:** Oct 4, 2013

## Introduction

This document is a guideline that is intentionally structured as an overview to cover topics that may or may not be incorporated into a detailed plan for a grinding and polishing contractor to be more environmentally friendly. This plan will be dependent on the specifics of each grinding and/or polishing jobsite, coupled with the considerations of the work environment, the quality of work, the financial impact and safety aspects of that particular jobsite.

Most of the resources available on the subject of "green" construction practices focus primarily on the design and engineering plans of buildings. Limited resources are available on the renovation and demolition practices carried out on the actual jobsite, including grinding and polishing concrete floors for remodeling projects. This document is specific to the grinding and polishing industry, and provides insight and guidance in the creation of a site-specific plan for environmentally friendly working practices to be performed by operators in this industry. The adaptive re-use of a concrete floor where grinding and polishing is required to accomplish the new configuration is the ultimate in sustainable development.

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## 1. Holistic Approach

It can be beneficial to the contractor to look at the complete jobsite from management to the final cleanup and waste disposal. Some of the following recommendations can be implemented beyond a single jobsite to involve company policies for day to day operational procedures spanning all of the contractor's jobs. "Green" jobsites are typically noted in the bid documents. Note any additional documentation and procedural requirements which would impact a bid.

## 2. Grinding and Polishing Operations

Concrete grinding and polishing operations performed by contractors generate concrete waste (mostly finely ground concrete) and exhaust which must meet applicable air quality standards.

The following section highlights just some of the areas where grinding and polishing companies can become greener.

2.1 Concrete Recycling
Concrete waste from grinding and polishing operations largely consists of concrete dust or slurry and/or substances such as adhesives, mastics and levelers. Concrete dust is recyclable as filler/base for concrete slabs and also can be used as a soil conditioner on clay-based soils. Grinding debris from floors with known hazardous substances such as asbestos engrained in the concrete, or floors that have been exposed to hazardous liquids that penetrate the concrete, should not be used for recycling. This debris should be properly disposed of according to the substance involved.

2.2 Recycle Worn Out Metal Tooling
Recycling metal from worn out tooling helps to create a greener jobsite.

2.3 Properly Size Equipment for the Job
- Use appropriate sized grinders and generators for the needs of the work being performed.
- Use biofuel generators.

2.4 Perform Regular Maintenance
- Properly maintain all equipment to maximize fuel efficiency.
- Have a proactive preventive maintenance program in place.

2.5 Indoor Air Quality
- Regular maintenance of vacuums and filters will keep air filtration systems running at optimum performance and provide the greenest work environment.
- Engine exhaust must meet applicable standards.
- Use of liquid silicate densifiers and guard/sealer products associated with densification of ground and polished floors should contain low amounts of volatile organic compounds (VOC) for a healthier working environment.

## 3. Office-based Operations

Efforts to recycle waste material and promote a green working environment need not be limited to the jobsite. The office also provides opportunities for businesses to successfully run a green company, as many items of office equipment and stationary are recyclable and use of paper can be minimized by using electronic data.

The production of industrialized paper and plastic creates a negative impact on the environment, consuming energy, adding to landfill waste and pollution. Grinding and polishing contractors have the opportunity to recycle all paper and plastics consumed or used at their office locations by separating recyclables from non recyclables and loading them into special containers for recycling. Here are some examples of how cutting contractors can make their office-based operations greener.

3.1 Recycle Paper
- Have a special trash can for the recycling of waste paper, including letters, notes or large construction drawings.
- Reuse unwanted printouts, where applicable, by printing on the reverse.
- Order recycled printer paper from stationary suppliers.

3.2 Minimize Paper Use
- Cut down on unnecessary printouts where electronic files will suffice.
- Include notes or signatures on emails like, “be kind to the environment, think before printing this email” to encourage others.
- Use projectors and computer data sharing for paperless meetings.

3.3 Recycle Printers and Cartridges
- When equipment is replaced or upgraded, recycle old items such as monitors, keyboards and printers.
- Use the free return packaging supplied with printer cartridges to recycle them.
- Have ink cartridges refilled when empty or buy refilled cartridges from suppliers.
- Use printer cartridges that contain soy-based ink.

3.4 Recycle Packing and Shipping Materials
- Send pallets for recycling or make use of the wood.
- Reuse cardboard boxes or break down to recycle.
- Reuse or recycle other packing materials made of paper, card, plastics or metals like aluminum or tin.

In general, green strategies make good economic sense for companies. Replacing incandescent bulbs with compact fluorescent lights when they require replacement can save businesses money through the conservation of energy and the lowering of electricity bills..

By following just some of the points raised in this document, grinding and polishing contractors can become greener both on the jobsite and at the shop. Not only this, but employing some of these processes can save the company money too. It is important to observe as many green practices as possible during grinding and polishing operations to protect the environment and, in some cases, abide by state and Federal laws.

# Best Practice

**Title:** Silica Data Analysis Chart
**No:** CSDA-BP-016
**Date Issued:** Mar 13, 2014

## Introduction

The CSDA Silica Data Analysis Chart is based on extremely thorough data collection from member jobsites and from the National Institute for Occupational Safety and Health (NIOSH). It has been developed for operators to use on jobsites to determine if respiratory protection is needed and, if so, what type of protection is recommended. The aim of the chart is to simplify procedures and help protect workers.

| Task | Tool | Controls | Ventilation | Environment | Results | Sample time HH:MM | NIOSH Recommendations |
|---|---|---|---|---|---|---|---|
| **WALL SAWING** | | | | | | | |
| Indoor Wall Sawing | Hydraulic Wall Saw | saw equipped with water supply/slurry clean up | None | enclosed area | 0.04 | 7:17 | |
| Indoor Wall Sawing | Hydraulic Wall Saw | saw equipped with water supply/slurry clean up | None | enclosed area; 3rd floor of building | 0.068 | 7:24 | |
| Indoor Wall Sawing | Hydraulic Wall Saw | saw equipped with water supply/slurry clean up | None | enclosed area | 0.159 | 6:50 | N100 Disposable respirators |
| Indoor Wall Sawing | Hydraulic Wall Saw | saw equipped with water supply/slurry clean up | None | enclosed area | 0.109 | 7:30 | N100 Disposable respirators |
| Indoor Wall Sawing | Wall Saw | saw equipped with watersupply | None | Indoors | .06-.22 | 4:54 | N100 Disposable respirators |
| Indoor Wall Sawing | Hydraulic Wall Saw | saw equipped with watersupply | None | Indoors | 0.09 | 8:00 | N100 Disposable respirators |
| Indoor Wall Sawing | Hydraulic Wall Saw | saw equipped with water supply | None | Indoors | 0.066 | 1:17 | |
| WallSawing | Hydraulic Wall Saw | saw equipped with water supply / N95 disposable respirator | Natural | Open Air | 0.029 | 8:00 | |
| Wall Sawing | Hydraulic Wall Saw | saw equipped with water supply / remote control | Natural | Open Air | Not Detectable | 8:01 | |

| Task | Tool | Controls | Ventilation | Environment | Results | Sample time HH:MM | NIOSH Recommendations |
|---|---|---|---|---|---|---|---|
| **CORE DRILLING** | | | | | | | |
| Indoor Core Drilling | Core Drill | drill equipped with water supply | None | Indoors | 0.02 | 4:21 | |
| Core Drilling | two-speed coring rig | drill equipped with water supply | None | Indoors | 0.04 | 2:00 | |
| Core Drilling | Core drill | drill equipped with water supply | Natural | Open Air | 0.01 | 8:00 | |
| Core Drilling | Core drill | drill equipped with water supply / N95 disposable respirator | Natural | Open Air | 0.029 | 8:00 | |
| Core Drilling | Core drill | drill equipped with watersupply | Natural | Open Air | 0.015 | 5:52 | |
| **ROCK DRILLING** | | | | | | | |
| Rock Drilling | Air rock drill | N95 disposable respirator | Natural | Open Air | 0.066 | 8:30 | |
| Rock Drilling | Track driven chassis with an attached boom and drilling rig | Rain & drilling rig equipped with water supply | Natural | Open Air | 0.031 | 4:30 | |
| **SLAB SAWING** | | | | | | | |
| Indoor Slab Sawing | Slab Saw | Saw equipped with water supply | None | Indoors | .13-.71 | 4:57 | N100 disposable respirators |
| DRY: Slab Sawing | Slab Saw | None | Natural | Open Air | 6>PEL | No Data | 1/2 face air purifying respirators with P-100 filters |
| Slab Sawing | Slab Saw | Saw equipped with water supply | Natural | Open Air | .05<LOD | 4:00 | |
| Green Sawing | Slab Saw | Saw equipped with water supply | Natural | Open Air | ND | 4:00 | |
| Green Sawing | Slab Saw | Saw equipped with water supply | Natural | Open Air | ND | 4:02 | |
| Green Sawing | Slab Saw | Saw equipped with water supply | Natural | Open Air | ND | 3:58 | |
| Green Sawing | Slab Saw | Saw equipped with water supply | Natural | Open Air | ND | 2:40 | |
| Green Sawing | Slab Saw | Saw equipped with water supply | Natural | Open Air | ND | 2:40 | |
| Green Sawing | Slab Saw | Saw equipped with water supply | Natural | Open Air | ND | 9:00 | |

| Task | Tool | Controls | Ventilation | Environment | Results | Sample time HH:MM | NIOSH Recommendations |
|---|---|---|---|---|---|---|---|
| Green Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | ND | 8:51 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | ND | 2:56 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | ND | 2:54 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | 0.01 | 2:50 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | 0.01 | 4:35 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | ND | 4:31 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | 0.05 | 3:50 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | (.02): result between LOD & LOQ | 3:51 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | 0.03 | 4:21 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | (.02): result between LOD & LOQ | 1:52 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | (.02): result between LOD & LOQ | 6:09 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | 0.01 | 6:23 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | ND | 6:21 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | ND | 2:58 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | ND | 2:54 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | 0.02 | 2:50 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | 0.065 | 5:55 | |
| Slab Sawing | Slab Saw | saw equipped with water supply | Natural | Open Air | 0.04 | 7:40 | |

| Task | Tool | Controls | Ventilation | Environment | Results | Sample time HH:MM | NIOSH Recommendations |
|---|---|---|---|---|---|---|---|
| Slab SawingandConcrete Breaking | Slab Saw & hydra hammer | saw equipped with water supply | Natural | Open Air | <.02 | 8:00 | |
| Slab Sawing and Concrete Breaking | Slab saw and skid steer breaker and loader | saw equipped with water supply | Natural | Open Air | 0.0092 | 8:38 | |
| **HAND SAWING** | | | | | | | |
| Indoor Hand Sawing | Cut off saw | saw equipped with water supply, disposable respirators | None | Indoors | .24-.26 | 2:10 | NIOSH recommends 1/2 face respirators if other operations are present |
| Indoor Hand Sawing-DRY | Handheld concrete saw | A floor stand fan directed toward an open window, disposable respirators | Open window | Indoor restroom | 10.0000 | TWA=8:00 | NIOSH recommends 1/2 face respirators if other operations are present |
| Indoor Hand Sawing-DRY | Handheld concrete saw | A floor stand fan directed toward an open window | Open window | Indoor restroom | 2.3-3.0 | TWA=8:00 | NIOSH recommends 1/2 face respirators if other operations are present |
| Hand Sawing-DRY | Hand saw with a resin blade | particulate respirators | Natural | Open Air | 0.0300 | TWA=8:00 | |
| Hand Sawing-DRY | Hand saw with a diamond blade | particulate respirators | Natural | Open Air | 0.0500 | TWA=8:00 | |
| Hand Sawing-DRY | Hand saw with a resin blade | particulate respirators | Natural | Open Air | 0.1500 | TWA=8:00 | Water to blade and/or a LEV |
| Hand Sawing-DRY | Hand saw with a diamond blade | particulate respirators | Natural | Open Air | 0.0500 | TWA=8:00 | |
| Hand Sawing-DRY | Hand saw with a resin blade | particulate respirators | Natural | Open Air | 0.0300 | TWA=8:00 | |
| Hand Sawing-DRY | Hand saw with a diamond blade | particulate respirators | Natural | Open Air | 0.0100 | TWA=8:00 | |
| Hand Sawing Brick-DRY | Handsawwith-adrycuttingblade | Filtering face piece respirator (3M8210) | Natural | Open Air | 0.0800 | 7:57 | |
| Hand Sawing Brick- | Hand saw with a wet cutting blade | Filtering face piece respirator (3M8210) | Natural | Open Air | 0.0210 | 7:51 | |
| Hand Sawing Brick- | Hand saw with a wet cutting blade | Filtering face piece respirator (3M8210) | Natural | Open Air | ND | 8:09 | |
| Indoor & Outdoor Hand Sawing | Handheld concrete saw | saw equipped with water supply | Natural | Open Air & Indoors | ND | 7:21 | |
| Hand Sawing | Hand saw with a resin blade | saw equipped with a pressuraized water tank system, particulate respirators | Natural | Open Air | <.01 | TWA=8:00 | |
| Hand Sawing | Hand saw with a diamond blade | saw equipped with a pressuraized water tank system, particulate respirators | Natural | Open Air | <.01 | TWA=8:00 | |

| Task | Tool | Controls | Ventilation | Environment | Results | Sample time HH:MM | NIOSH Recommendations |
|---|---|---|---|---|---|---|---|
| Hand Sawing | Hand saw with a resin blade | saw equipped with a mains supply water system, particulate respirators | Natural | Open Air | <.01 | TWA=8:00 | |
| Hand Sawing | Hand saw with a diamond blade | saw equipped with a local exhaust ventilation system, particulate respirators | Natural | Open Air | <.01 | TWA=8:00 | |
| Hand Sawing | Hand saw with a resin blade | saw equipped with a local exhaust ventilation system, particulate respirators | Natural | Open Air | <.01 | TWA=8:00 | |
| Hand Sawing | Hand saw with a diamond blade | saw equipped with a local exhaust ventilation system, particulate respirators | Natural | Open Air | <.01 | TWA=8:00 | |
| **SELECTIVE DEMOLITION** | | | | | | | |
| Demolition: RockQuarry | CAT245 Excavator | Rain | Natural | Open Air | 0.0130 | 8:00 | |
| Demolition: Rock Quarry | CAT245 Excavator | Rain | Natural | Open Air | ND | 8:00 | |
| Demolition: Rock Quarry | CAT245 Excavator | Rain | Natural | Open Air | ND | 8:00 | |
| Demolition: Rock Breaker | Caterpillar Backhoe with a 7-ton attachment | Rain | Natural | Open Air | 0.0140 | 8:00 | |
| Demolition: Rock Breaker | Caterpillar Backhoe with a 7-ton attachment | Rain | Natural | Open Air | ND | 8:00 | |
| Demolition: load and haul of concrete | Backhoe | None | Natural | Open Air | <.02 | 8:00 | |
| BROKK: Demolition: Concrete Breaking | Brokk with hammer attachment | 1/2 facepiece respirator with dual cartridges, water to suppress dust | None | Indoors | 0.6100 | 3:00 | Full face respirator, dust suppression system |
| Demolition: load and haul of concrete | Backhoe with bucket | None | Natural | Open Air | 0.0100 | 10:00 | |
| Demolition: removal of brick | Jack hammers | 3M model 6800 full facepiece airpurifying respirators | Natural | Open Air | (.033)-.12 | 5:00 | N100 disposable respirators |
| DRY Jack hammering: chip away concrete from rebar | Jack hammer | None | Natural | Open Air | 22/25 samples>PEL | No Data | Dust suppression system,1/2 facepiece respirator with p100 cartridges |
| Demolition: Hand tools | hammers, scarpers,spudbars, shovels, brooms, and handtools | N95 filtering facepiece with side shields, tyvek like suits | None | Indoors | (.04)-.05 | 2:02 | |
| **WIRE SAWING** | | | | | | | |
| Wire Sawing & core drilling | Wire Saw & core drill | water, away from sawing operation, remote control | Natural | Open Air | ND | 2:07 | |
| Wire Sawing & core drilling | Wire Saw & core drill | water, away from sawing operation, remote control | Natural | Open Air | 0.0120 | 8:08 | |

| Task | Tool | Controls | Ventilation | Environment | Results | Sample time HH:MM | NIOSH Recommendations |
|---|---|---|---|---|---|---|---|
| Wire Sawing & core drilling | Wire Saw & core drill | water, away from sawing operation, remote control | Natural | Open Air | 0.0500 | 2:06 | |
| Wire Sawing & core drilling | Wire Saw & core drill | water, away from sawing operation, remote control | Natural | Open Air | 0.0200 | 8:05 | |
| **CLEAN UP** | | | | | | | |
| Concrete clean up | Compressed air | None | Natural | Open Air | 2/3>PEL | No Data | N100 disposable respirator |
| Concrete Breaking | Jack hammer | disposable respirator | None | Indoors | 0.2130 | 7:20 | 1/2 face air purifying respirators with P-100filters |
| Clean up from saw operation | broom, squeegee,shovel, vacuum | None | None | enclosed area | 0.18 | 6:15 | 1/2 face air purifying respirators with P-100filters |
| Anchoring wall saw track to wall and clean up activities | rotohammering dry/shovel, broom, squeegee | None | None | enclosed area | 0.275 | 7:21 | 1/2 face air purifying respirators with P-100filters |

# Best Practice

**Title:** Depiction/Marking of Existing Subsurface Embedments
**No:** CSDA-BP-017
**Date Issued:** June 12, 2014

## Introduction

This document provides an overview and methodology for properly marking out embedments found with Ground Penetrating Radar (GPR).

Due to significant and recent advances in GPR, an increasing number of building owners, architects, engineers and contractors are specifying imaging be performed for the correct identification of utilities and structural elements. This increasing demand for imaging is related directly to the specifier's need to avoid unnecessary and/or costly damage to subsurface structures and/or embedments.

This document is intended to supplement CSDA Best Practice CSDA-BP-007 Ground Penetrating Radar for Concrete Imaging by providing GPR technicians with a standardized guide for the proper and accurate marking out of embedments on concrete cutting jobsites.

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## 1. Background

GPR is now the most recognized and useful tool for the investigation of embedded objects within concrete structures. Its accuracy and ability to locate a variety of embedments, with minimal to no disruption, has made it the preferred tool in scanning for subsurface embedments within concrete. The use of GPR also expands into other investigative uses.

The increased number of GPR users has resulted in some jobsites having several GPR contractors present onsite at once. To avoid confusion between imaging contractors regarding the data they have collected, a standardized depiction of subsurface embedments should be agreed upon and implemented.

## 2. Definitions

**Contracting agency:** The contractor hired directly or indirectly by the owner that is sub-letting the imaging requirements to an imaging contractor. Owner of and responsible for the preservation of markings created by the imaging contractor.

**Embedment:** Any signal return interpreted by the imaging technician that is different to the surrounding environment.

**Exclusion Zone:** Markings used to indicate a safe working distance from an embedment or utility. These exclusion zones are marked to help prevent utilities coming into contact or being damaged by cutting tools.

**Locating:** The process of exposing the vertical and horizontal location of an embedment.

**Marking:** The process of leaving a mark on site to identify the location of an embedment or utility. Ownership of marks rests with the owner or contracting agency, not with the imaging contractor.

**Owner:** Legal owner of the structure being imaged and consequently, the owner of the markings created by the imaging contractor.

**Imaging:** The use of Ground Penetrating Radar to search for embedments within a defined area.

**Imaging Contractor:** The contractor hired to perform the imaging operations.

**Utility:** A privately, publicly, or cooperatively owned line, facility or system from producing, transmitting, or distributing communications, cable television, power, electricity, light, heat, gas, oil, crude products, water, steam, waste or any other similar commodity, including any fire or police signal system or street lighting system (CI/ASCE 38-02).

## 3. Concrete Investigation

Investigation of concrete for various embedments is one of the most common applications in the field of GPR as it relates to the construction industry. It is important that proper markings be generated to minimize confusion with other contractors and personnel on site.

3.1 Reinforcement

The marking of embedments interpreted by the imaging contractor to be reinforcement within the deck shall be identified with an appropriate device as job conditions allow. In situations where markings are to be made on exposed concrete that is not the natural exposed surface, a black lumber crayon or black marker shall be preferred. If black markings are not appropriate or are difficult to see, another appropriate color (except red) may be used. Use of another color must be specifically noted to the appropriate contractor in the pre-job and post-job walkthroughs. On finished surfaces, such as polished concrete, tiled floors and carpet, a more temporary mark may be necessary. In these situations, the imaging contractor may use chalk, tape or other appropriate device as job conditions allow. Every effort should be made to avoid the use of temporary markings, as they can easily be moved, altered and/or erased. It is recommended that the GPR contractor take photos of all locations with temporary markings to avoid disputes later.

3.2 Conduits

The marking of embedments interpreted by the imaging contractor to be conduits shall be marked out in red, where appropriate. If red is not appropriate, another color may be used and specifically noted to the appropriate contractor in the pre-job and post-job walkthroughs. The color used to denote conduits must never be the same color used to denote reinforcement. Failure to do so will create confusion and is not in following with this best practice/standard.

3.3 Exclusion Zones

Because GPR cannot initially identify the size/width of an embedment, an appropriate exclusion zone shall be marked on either side of it. This exclusion zone shall be no less than 1 inch on either side of the identified center point of an embedment. This may be larger based on GPR data or other supplied information that may indicate the need for a wider exclusion zone. The area within the exclusion zone markings shall be filled in with an appropriate mark. This may include a separate wavy line, hash marks, text, spray paint or any other appropriate mark (as shown in Figures 1,2 and 3). If a temporary mark is required on a finished surface, such as carpet, tape must be used that has a width of no less than 2 inches.


Figure 1: Samples of proper markings of embedments

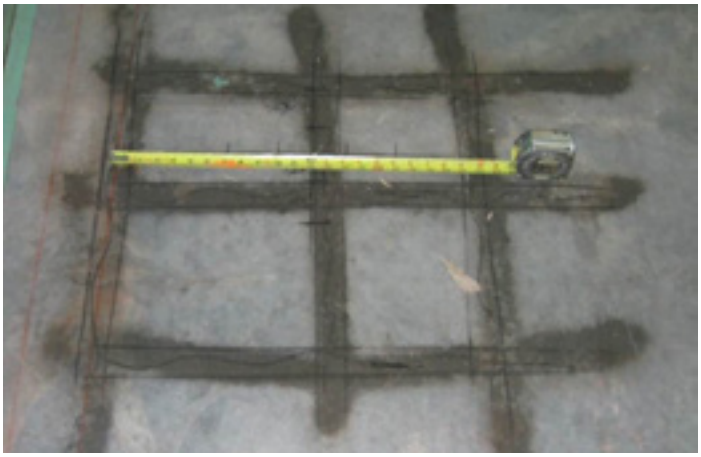

Figure 2: Sample markings identifying embedments in concrete with appropriate exclusion zone

Figure 3: Sample markings identifying electrical utilities in/below concrete with appropriate exclusion zone

In situations where the depths of embedments are necessary, the depth should be written in the same color as the embedment and in a location that will not be confused with another embedment. Refer to CSDA-BP-007 for the proper method of establishing accurate depths.

In order to depict markings for utilities, this CSDA Best Practice shall, where appropriate, remain consistent with the established American Public Works Association (APWA) Uniform Color Code [ANSI Z535.1] (Figure 4). Because GPR does not specifically identify the buried utility, the imaging contractor must use reasonable assessment for the identification of the utility. This may include using as-built drawings, scanning the embedment back to an originating point or using a separate technology to tone or trace a specific utility.

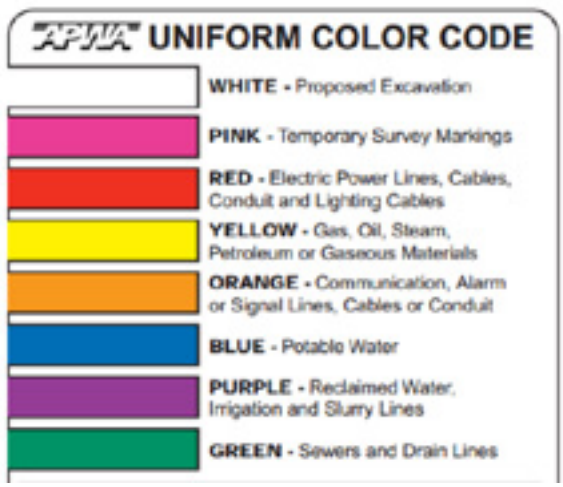


Figure 4: APWA Uniform Color Code for the marking/depiction of subsurface utilities

## 4 Utility Investigation

To mark out utilities underground in non-concrete related investigations, this CSDA Best Practice shall remain consistent with the established Common Ground Alliance Best Practice (CGA BP). This Best Practice is the most widely accepted and used in the depiction of marking underground utilities. The CGA BP also follows the established American Public Works Association (APWA) Uniform Color Code [ANSI Z535.1] (Figure 4).

As mentioned in Section 3, GPR does not specifically identify the buried utility. Because of this, the imaging contractor must use reasonable assessment for the identification of the utility. This may include using as-built drawings, scanning the utility back to an originating point and/or using a separate technology to tone or trace a specific utility. In the event an unknown embedment/utility has been identified from a GPR signal, an agreed upon color shall be used to properly mark the embedment/utility. This color must be agreed upon by both the GPR contractor and the appropriate owner/on-site contractor in the pre-job walkthrough. During the post-job walkthrough, any specific unidentified embedments/utilities must again be identified.

Any depths required for particular embedments/utilities shall be marked using the corresponding color as the embedment/utility. These depths must be marked so as not to be confused with other surrounding marks.

In the event collection of data is required for the imaging of utilities, the collection and depiction of utilities shall remain consistent with the CI/ASCE 38-02: Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data.

## 5. Phase II Environmental Site Assessments (ESAs)

Phase II ESAs are the physical tests performed if a Phase I ESA identifies potential contamination of a site by hazardous materials. Many skilled imaging contractors are asked to perform locates on ESAs for the presence of embedments that may contribute to the contamination of a site. Other locates may be performed to prevent damage to utilities prior to physical test, which typically involves destructive methods such as drilling or boring. Such embedments commonly include underground storage tanks (USTs), waste oil drums and the burial of certain debris. No appropriate color in the APWA Uniform Color Code properly associates with the identification of these types of embedments. In most situations, both private and public utility locates will be, or have been, performed on the site. To avoid confusion with other markings on the site, the preference is to use yellow, as this most closely relates to the use of USTs in the petroleum industry.

## 6. Other Investigation Not Categorized Above

For any investigations using GPR not previously discussed, any markings will be agreed upon with the contracting agency/owner and be specifically noted to the appropriate contractor in the pre-job and post-job walkthroughs. The markings made by the imaging contractor should be documented for other trades subsequently entering the jobsite.

Examples of other investigations include, but are not limited to:

- Cemeteries
- Voids
- Delaminations/deterioration
- Buried debris/waste filled sites
- Forensic investigation
- Archeological (chambers, tunnels)
- Geophysical (sinkholes)

## 7. Scanned Areas Free of Identified Embedments

It is the responsibility of the owner/contracting agency to pre-mark and clearly identify the boundaries of the area to be imaged. In the event that a designated area identified by the contracting agency and/or owner is interpreted by the imaging contractor to be free of embedments, the imaging contractor is to indicate this accordingly. The preferred method of indication is to mark "OK" within the identified area. If no identified boundaries are established by the contracting agency/owner, the imaging contractor should identify the extents of the area scanned.

## 8. Ownership of Markings

Due to changing jobsite conditions and environments, it is impossible for an imaging contractor to leave markings of embedments and have them remain for a guaranteed length of time. Once an imaging contractor leaves a jobsite, that person cannot control the environment to assure the longevity of a marking. Once an imaging contractor has scanned and marked an embedment location, the ownership of those markings shall immediately transfer to the contracting agency and/or owner. It is the responsibility of the contracting agency and/or owner to maintain the condition of the markings as long as they are required. It is recommended that the imaging contractor discusses this with the contracting agency and/or owner in the pre-job and post-job walkthrough.

# Best Practice

**Title:** Drug and Alcohol Testing
**No:** CSDA-BP-018
**Date Issued:** May 20, 2015

## Introduction

Employers who implement drug testing as part of the daily workplace culture, as well as part of the hiring process, set a high standard and send a powerful message about the organization's culture. Current and potential employees understand that the issues of drug use and workplace safety are significant considerations. Drug testing in the workplace benefits the employee, the employer and the customer in the following ways:

- Reduces employer liability
- Allows employees to easily say no to illegal drug use. "No, thanks. They drug test at work"
- Helps employers identify workers with substance abuse issues
- Saves lives and prevents injuries

The following information is provided as an introduction to this subject. State and federal regulations provide specific procedures and information that may apply to your organization. Of course, those rules have precedence over this Best Practice document.

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## 1. Reasons for Testing

Here are examples of instances when drug testing may be appropriate in the workplace.

1.1 Pre-employment
Testing of an applicant before an offer or after beginning work, with employment conditional on the applicant passing the test.

1.2 Reasonable Suspicion
The employer has a specific, contemporaneous and articulable suspicion of drug use based on observations of behavior, appearance, odors, speech, physical symptoms, pattern of abnormal behavior, arrest or convicted of drug offense or corroborated reliable reports.

1.3 Incident Related
Used when an employee is involved in an on-the-job accident, possibly involving human error. It is acceptable to test even if no injury occurred, especially if it appears that the accident could have been avoided or the consequences could have been minimized.

1.4 Random
This type of testing is used in high-risk, safety-sensitive occupations. This involves randomly selecting employees without notice or unscheduled testing of all employees. The Department of Transportation (DOT) Agency that regulates a specific transportation industry sets the random testing rate. The rates are always effective January 1 of the calendar year. To check for the current rate, visit ODAPC's website at: http://www.dot.gov/ost/dapc/rates.html.

1.5 Return to Duty Testing
The DOT's return-to-duty process is explained in Section 2. A positive test is a violation, as is a refusal to be tested and a number of other things that are prohibited by DOT. An employee who has been removed from duty because of a violation must successfully complete this process before he/she can be considered for return to duty or be hired by a different DOT-covered employer. Employers are encouraged to visit **www.dot.gov** and review return-to-duty processes.

## 2. Possible Outcomes

When an employee returns a positive test, refuses to be tested or has one of the DOT's other violations, the DOT requires the employer to immediately remove that employee from safety-sensitive functions. An employer who allows an employee with a violation to continue performing safety-sensitive functions is subject to fines of up to $10,000 per day.

An employee with a violation has two options:

1) He/she can find another job, outside of the transportation industry. **OR**
2) He/she can be considered for returning to safety-sensitive functions in the transportation industry, but only after successfully completing the DOT's return-to-duty process and providing a negative result on a return-to-duty drug and/or alcohol test.

The return-to-duty process requires involvement of a qualified and trained Substance Abuse Professional (SAP). The SAP must conduct a face-to-face clinical evaluation of the employee. DOT's rule then requires the SAP to recommend treatment or education for the employee. The SAP must send a report to the employer, specifying the SAP's recommendation for treatment or education. The SAP must then monitor the employee's progress.

When the SAP determines that the employee has made sufficient progress, the SAP will schedule a follow-up evaluation for the employee. Based on that evaluation, the SAP will report to the employer that the employee has successfully complied with the SAP's recommendation (or that the employee has not complied.) If the SAP reports that the employee has successfully complied with the recommendation, the employer will decide whether to arrange for a return-to-duty test for the employee (the employer is not obligated to take the employee back).

If the SAP reports that the employee has not successfully complied with the recommendation, the employer cannot return the employee to safety-sensitive functions. An employee who has not successfully complied with the SAP's recommendation may not return to safety-sensitive functions for any DOT employer until the SAP's recommendations have been fully met, and the employee is able to provide a negative return-to-duty test.

## 3. Common Questions about Drug Testing

3.1 Who gets tested?
Regardless of job titles—supervisor, part time, apprentice or journeyman—people are chosen for testing based on their job function (known as a safety-sensitive function) and not their occupational title. Only DOT safety-sensitive employees may be part of the DOT random pool or pools. Remember, a DOT testing program must always be separate and distinct from a private company or non-DOT testing program. This applies to random testing pools too. DOT and non-DOT random testing pools must be completely separate.

3.2 How are employees selected for testing?
Everyone in the pool must have an equal chance of being selected and tested in each selection period. Be sure to use a scientifically valid method to select employees for testing, which may include the use of a random-number table or a computer-based random number generator that is traceable to a specific employee.
**Warning:** unacceptable random selection practices include selecting numbers from a hat, rolling dice, throwing darts, picking cards or selecting ping pong balls.

3.3 How often should selections and tests take place?
The element of surprise is essential to an effective program. While employees know they will be tested, they are never quite sure of when. Random selections and testing should be performed at least quarterly but not, for example, only once quarterly. Irregular testing is the key.
Here are smart things you can do to figure out when to test:
- Spread testing dates reasonably throughout the year in a non-predictable pattern.
- Conduct random drug tests anytime employees are on duty and just before, during, or just after the employee performs a safety sensitive job.
- You can enhance the non-predictability of your program by conducting tests at the start, middle or end of each shift. Avoid creating opportunity for such as "Yup, the last Friday of every month the second shift gets tested."

3.4 How are employees notified to report for a test?
Every employee should be discreetly notified according to your company's policy, but random testing must also be conducted in strict confidence with a limited number of people having knowledge of the selection list.
Every employer should have procedures in place to ensure that each employee receives no advanced notice of selection. But, be sure to allow sufficient time for supervisors to schedule for the administration of the test and to ensure that collection sites are available for testing.
Remember, employers must provide appropriate privacy for each employee while he or she is being tested.

3.5 What must employees do when notified of a random test?
When an employee is notified, he or she must proceed immediately to the collection site. Immediately means that after notification, all the employee's actions must lead to an immediate specimen collection. Many employers develop random testing procedures or policies that clearly state what activities are acceptable after notification. It is important that there is no misunderstanding among employees about what is expected.

## 4. Drug Testing Cutoff Levels

DOT Rule 49 CFR Part 40 Section 40.87
Subpart F - **Drug Testing Laboratories**

What are the cutoff concentrations for drug tests?

(a) As a laboratory, you must use the cutoff concentrations displayed in the following table for initial and confirmatory drug tests. All cutoff concentrations are expressed in nanograms per milliliter (ng/mL).

The table follows:

| Initial Test Analyte | Initial Test Cutoff Concentration | Confirmatory Test Analyte | Confirmatory Test Cutoff Concentration |
|---|---|---|---|
| Marijuana metabolites | 50 ng/mL | THCA[1] | 15 ng/mL |
| Cocaine metabolites | 150 ng/mL | Benzoylecgonine | 100 ng/mL |
| Opiate metabolites | | | |
| Codeine/Morphine[2] | 2000 ng/mL | Codeine | 2000 ng/mL |
| | | Morphine | 2000 ng/mL |
| 6-Acetylmorphine | 10 ng/mL | 6-Acetylmorphine | 10 ng/mL |
| Phencyclidine | 25 ng/mL | Phencyclidine | 25 ng/mL |
| Amphetamines[3] | | | |
| AMP/MAMP[4] | 500 ng/mL | Amphetamine | 250 ng/mL |
| | | Methamphetamine[5] | 250 ng/mL |
| MDMA[6] | | | |
| | 500 ng/mL | MDMA | 250 ng/mL |
| | | MDA[7] | 250 ng/mL |
| | | MDEA[8] | 250 ng/mL |

[1]Delta-9-tetrahydrocannabinol-9-carboxylic acid (THCA). [2]Morphine is the target analyte for codeine/morphine testing. [3]Either a single initial test kit or multiple initial test kits may be used provided the single test kit detects each target analyte independently at the specified cutoff. [4]Methamphetamine is the target analyte for amphetamine/methamphetamine testing. [5]To be reported positive for methamphetamine, a specimen must also contain amphetamine at a concentration equal to or greater than 100 ng/mL. [6]Methylenedioxymethamphetamine (MDMA). [7]Methylenedioxyamphetamine (MDA). [8]Methylenedioxyethylamphetamine (MDEA).

(b) On an initial drug test, you must report a result below the cutoff concentration as negative. If the result is at or above the cutoff concentration, you must conduct a confirmation test.
(c) On a confirmation drug test, you must report a result below the cutoff concentration as negative and a result at or above the cutoff concentration as confirmed positive.
(d) You must report quantitative values for morphine or codeine at 15,000 ng/mL or above.

[65 FR 79526, Dec. 19, 2000, as amended at 75 FR 49862, August 16, 2010; 77 FR 26473, May 4, 2012]

Updated: Wednesday, January 16, 2013

NOTE: The above information is provided as a summary of rules and procedures at the time of writing. It must not be taken as authoritative; instead, consult appropriate experts or providers and the relevant rules themselves. Rules change from periodically and this general advice may not be current.

## 5. Drug Test Program Components

A well designed drug testing program should contain the following components:

Employers should provide notice to applicants and employees regarding testing policies. Notice should contain: purpose, type of testing used, circumstances of when it can occur, describe the procedure, disciplinary policies and consequences of a positive test.

If random testing of employees in safety-sensitive positions, those employees should get a separate notice.

Employers should have everyone sign a consent form to acknowledge that they have read the policy and agree to it. Test results should be considered absolutely confidential. Negligent release of test results could result in legal action over issues such as invasion of privacy, intentional infliction of emotional distress and defamation. Due to the laws described in the Americans with Disabilities Act (ADA), it is necessary to maintain such records in a separate, confidential medical file. As a practical matter, the privacy rules in the Health Insurance Portability and Accountability Act (HIPAA) can make it difficult for employers to obtain specific drug test results from the testing lab. For that reason and others, employers should have employees sign a properly-worded consent form allowing the testing lab to release such results to the employer.

Policy should specify the method of confirming positive results and it should allow the person to explain or challenge the results.

Policy should, to the greatest extent possible, protect the confidentiality of the employees and limit the disclosure of the results.

# Best Practice

**Title:** Robotic Demolition
**No:** CSDA-BP-019
**Date Issued:** Dec 3, 2015

## Introduction

Demolition robots are precision specialty demolition machines that are used in conjunction with or in place of cutting and coring demolition work, to surgically remove specific items of interest with minimal impact of surrounding structures.

This Best Practice on Robotic Demolition is intended to be an overview of the Demolition Robots as used in the CSDA type work. This BP does not replace any materials that the specific machine manufacturer provides to properly train the operators in the use of the equipment and safety precautions.

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## 1. Understanding the Equipment

Be certain the Operator has been properly trained on the specific machine they are using. Be certain to read and understand the operator's instruction manual and training materials provided by the manufacturer.

The Six major components of the Robots


1) Arm system
2) Slew Function / Swing Function
3) Drive
4) Outriggers
5) Attachments
6) Operator Controls (Wired or Remote)

Although the operator is controlling the robot by remote control and not physically in or on the machine, they are still in the work zone thus are required to use the proper personal protective equipment (PPE) when operating the robot. At a minimum the operator should use:

- Hardhat
- Eye Protection
- Hearing Protection
- Appropriate footwear (Steel or composite toe)

Other PPE to consider:

- Reflective Safety Vest
- Thick Overalls
- Work Gloves
- Fall Protection Harness
- Dust mask or Respirator (depending on the air quality)
- Face shield

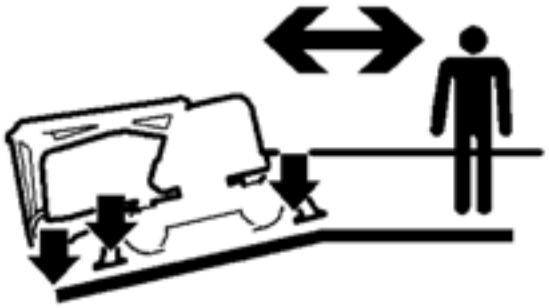
The Robotic Demolition machines are designed to use a variety of hydraulic and mechanical attachments for breaking, crushing, digging, drilling, and making openings. They are great for material handling of heavy debris, working in hazardous and/or dangerous environments (the operator is linked by remote control), and working indoors or outdoors. The robotic Demolition machines are not intended for use in

environments classified as explosive hazards. They are not intended to be used in areas with high water levels that can damage the machine. They are not intended to transport any passengers. Consult the manufacturer of the machine for details on the specific model to fully understand the capabilities and limitations of that specific machine.

## 2. Transporting and Positioning the Robot

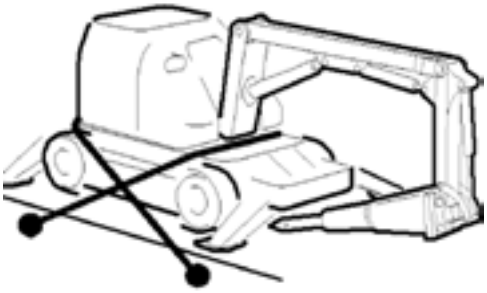
2.1 Loading and Unloading using a ramp

- Be certain the ramp is properly sized/rated for the machine
- Be certain the ramp is properly secured
- Stand in a safe area of the machine, typically uphill of the machine, and keep a safe distance.
- Position the arm system and outriggers as low as possible to lower the center of gravity (cg)



2.2 Transportation

- Be certain not to exceed the Gross Vehicle Weight Rating (GVWR) and/or the Gross Combined Weight Rating (GCWR) if using a trailer.
- Be certain the vehicle bed or trailer is structurally sound for the machines weight loading.
- The control unit must be transported separately from the machine and kept in its carrier box inside the vehicle.
- Position the arm system and outriggers as low as possible.
- Secure the machine with the properly rated and approved straps/chains. Be certain the positioning of the straps will not damage or crush machine components.
- Be certain to secure loose components, tools, and attachments.



2.3 Lifting the Machine

- Never lift overhead, meaning do not lift the machine directly over a person that could be crushed if the machine fell.
- Use the proper rigging equipment and hardware for the size and weight of the machine.
- Inspect proposed rigging prior to use
- The lifting points on the machine are identified and marked. Only lift from the manufacturer approved lifting points.

2.4 Positioning the machine

- For maximum stability, perform work in the direction of the machine travel (forward or straight back) with the outriggers deployed.
- For better results, move machine closer to the work so the arm is not full extended straight to reach the work.

- When the machine's upper section is to be turned to the side, lower the cg by lowering the outriggers and arm as close to the ground as possible.
- Do not brace machine against fixed items to increase the work.

- Let the attachment do the work.

The Hydraulic Fluid in the cylinders cushion and reduce the shock and vibration transferred to the mechanical components of the machine. It is wise to never operate the cylinders at the stroke limits.

2.5 Changing tools and attachments

- Use the appropriate tool for the job. Understand the capabilities and limitations of the tool and/or attachment before it is installed. Consult the Manufacturer for training material
- Ensure that the machine is on a stable surface before changing an attachment or replacing a tool in the hydraulic breaker.
- Be certain the area is properly illuminated to allow for a good visual inspection of the entire machine.
- Follow proper procedures to ensure the machine is not accidentally operated during the tool change.
- Check to be certain the attachment and tool are mounted securely and correctly before using them.

2.6 Service and Inspection

- All service to the machine, especially the hydraulic and electrical system, must be performed by qualified personnel. Be certain that stored energy either mechanical or hydraulic pressure is relieved and at a safe state before any work including inspections are performed on the machine. Follow the manufacturer's requirements for inspection and service instructions and intervals.
- Hydraulic oil must be kept clean and free of dirt or debris to operate properly. Protect connections and fill caps from allowing them to get dirty and if they do,

clean them before exposing the oil to dirt.

- Use the appropriate Hydraulic fluid. Many different Hydraulic fluids cannot be mixed.
- Inspect the machine daily.
- Inspect the machine after transit for any damage caused during transportation to the jobsite.
- Inspect the Control and Electrical cables and the hydraulic hoses and fittings for damage. Never operate the machine with damaged cables and/or hoses.
- Keep the Robotic Demolition machines Clean. Replace any defective, worn or damaged components immediately.
- Regularly Inspect for cracking on the metal or welds of the machine.
- Be certain the machine is positioned horizontally on a flat surface when inspecting the fluid levels. Consult the manufacturers Operation Manual for inspection intervals and inspection points (some are plugs, dipsticks, sight glass or indicator lines). Top off fluid levels to the recommended range before using the machine.
- A clean machine will help identify fluid leaks. Fluid leaks must be identified and repaired immediately. They can lead to more damage of the equipment or sometimes even dangerous situations.

Perform function checks before use:

- Brake functions
- Cylinders
- Slew function
- Telescopic arm function, on applicable machines
- Hydraulic oil cooler
- Radiator/Coolant level
- Electrical cable and connections

Check before use:

- Tool mounting
- Track tension
- Attachment/Breaker function

Be certain the machine is lubricated regularly per manufacturer's recommendations. Keep in mind that the environmental conditions such as Temperatures, Humidity, Water and Dust/Dirt can impact the service intervals.

Ergonomics of the control unit:

- Vary the working position by adjusting the control unit to maximize comfort and control
- Take regular breaks
- Use steady and relaxed movements to operate the controls.

## 3. Defining the Zones. The Work Zone, Risk Zone, Operating Zone and Debris Field.

**The Work Zone** is the area of the overall worksite that this selective demolition is being performed. The zones need to be defined well in advance of the start of work with the Robotic Demolition machine. Review the worksite and details of the area/structure to be demolished. Review the plans to be certain the work can be performed following all applicable regulations governing the worksite.

**The Risk zone** is the dangerous areas surrounding the machine. The risk zone must be limited to essential personnel only, typically only the operator. The risk zone varies greatly depending on the worksite conditions, the working materials and methods, the surrounding structure, the ground surface conditions, other work performed in the work zone, the operating style of the operator, etc.

**The Operating zone** is the immediate area that the machine is operating (usually defined by the limitation of the machine's reach). Typically no one would be in the operating zone except in extreme and carefully planned circumstances.

Plan the work zone for:

- Barriers and signage to identify and restrict access to essential crew members only to the risk zone
- Entrance, operation and exit of the machine
- Stability of the machine during operation. Note that the risk of the machine tipping increases with the arm extended to the maximum reach and/or when using heavy attachments.
- Stability of the ground surface for risk of collapse, especially when working on roofs, on platforms, near shafts, holes or drop-offs.
- Securing of safety harnesses with appropriate tie-off when working on elevated areas near a leading edge.
- Provisions for the operator to stand uphill and behind the machine during operation with a clear visual view of the operating zone.
- Provisions to anchor the machine when work is to be performed near an edge.
- Provisions so the machine does not slip on the ground surface.
- Considerations to reduce risk of tipping/sliding due to height differences and/or inclined surfaces. The risk can be reduced if the machine cg is low and close to the center of the machine.

Define risks within the work zone

- Survey work zone and object of the demolition work for electrical, steam, hydraulic, gas, flammable substances, hot fluids, water, telephone or fiber optic cables, and hidden or buried hazards.
- The ground pressure for the tracks and outriggers. Maximum safe floor loads.
- Load Bearing items are properly secured. Suspended items are secured. Surrounding structures are protected. The structural integrity is maintained.
- Provisions are made for sorting and removing demolition debris.
- Provisions are made for and clearly identified to the operator for emergency evacuation of personnel.

## 4. Defining the Work Methods

Demolition can begin only after the machine is in position and fully set up. Start work at an edge or corner. Work small sections at a time. Work methodically. Keep aware of the surroundings and the next upcoming step at all times.

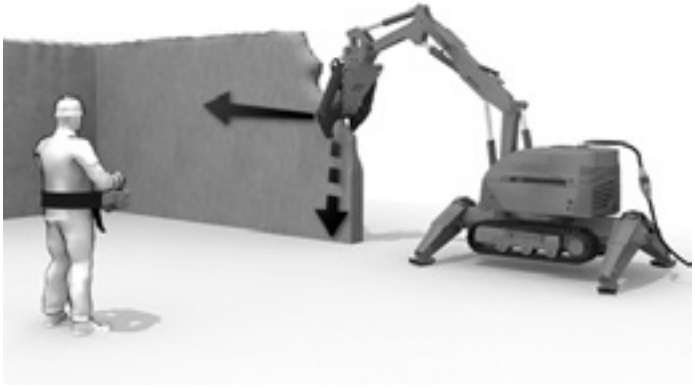
Consideration must be made for electrical supply and cord management as well as handling the debris.

Continual sorting of demolition debris to keep the overall disposal costs down. The materials that have value can be sold to offset the overall costs and the environmentally harmful waste can be minimized and properly disposed of.

Hydraulic Breaker attachments are good universal tools for demolition. They work in a chipping action and are good for breaking up walls. Various tools fit the hydraulic breakers classified by the shape and the length. Longer tools are more easily damaged but have an extended reach. Never use the tool to pry.

The shapes include Moil Point which is used to make holes or general chipping, narrow chisel points for extending cracks, and, wide chisels for breaking materials along a specified directional line.

Concrete crusher/Pulverizer head attachments are good where noise and vibrations are of concern. Good on walls, ceilings, vaults and stairs. Demolition is by crushing and cutting. Do not use for dragging and bending.

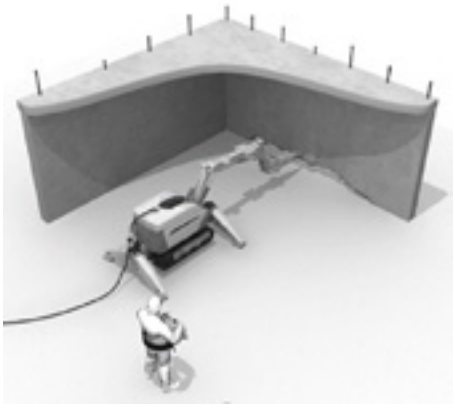


Bucket attachments are good for digging and moving demolition debris. Do not use as a lifting tool. The hydraulic breaker is typically used first to create space. The concrete Crusher is then commonly used when sufficiently large holes have been made. Sometimes the crusher can be a more effective tool.

Think about the optimal position of the machine, arm, tool/accessory and the location of the operator.

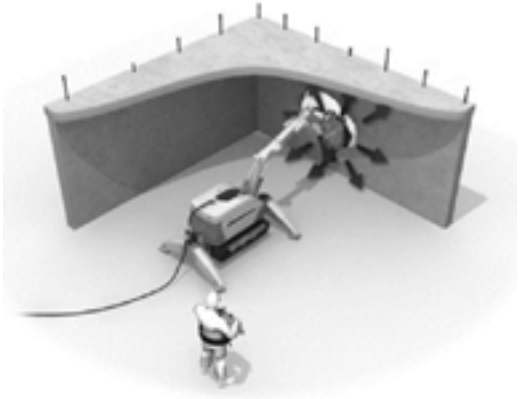
4.1 Short walls with vaults when using breakers

- Start work at the foot in the center point of one of the walls. In confined spaces, start at a corner.
- Demolish outwards along the floor to expose the wall section
- Then demolish upwards.



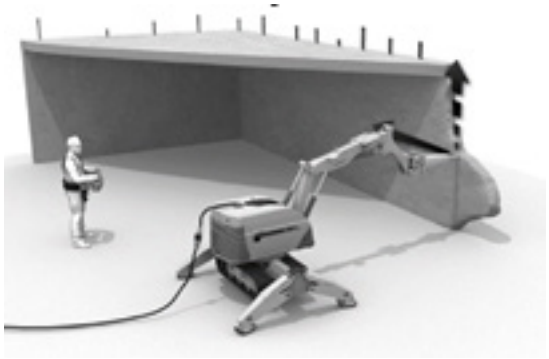
4.2 Short walls with vaults when using crushers

- Make a hole in the center/middle of one wall using the breaker.
- Change to the Crusher tool
- Demolish outwards from the center of the hole.



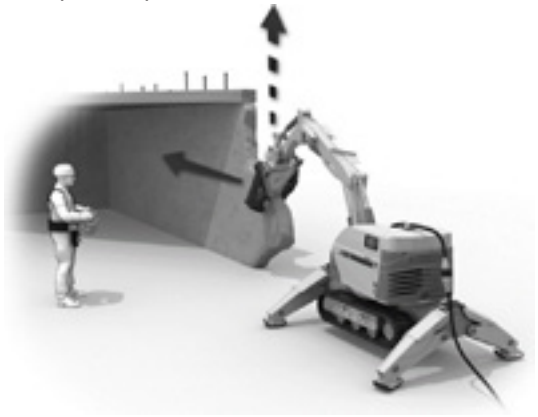
4.3 Long walls with vaults using breakers

- Start at the bottom corner
- Demolish outwards along the floor in one direction
- Demolish upwards
- Demolish in sections. Demolish the entire section within the working zone before moving the machine.
- Orientate the undercarriage along the wall to facilitate moving.



4.4 Long walls with vaults using Crushers

- Make a hole at one end of the wall using the breaker
- Change to the crusher tool
- Demolish outwards from the center of the hole
- Demolish in one direction
- Start demolishing in the center of the wall
- Demolish from the bottom up
- If possible position the machine in the direction of the wall.

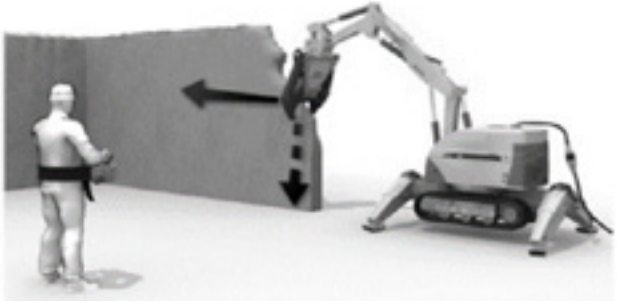


4.5 Free-Standing walls using breakers

- Start at the bottom corner
- Demolish outwards along the floor in one direction
- Demolish upwards
- Demolish in sections. Demolish the entire section within the working zone before moving the machine.
- Caution- walls without supports at the upper edge can be a safety risk
- Orientate the undercarriage along the wall to facilitate moving.

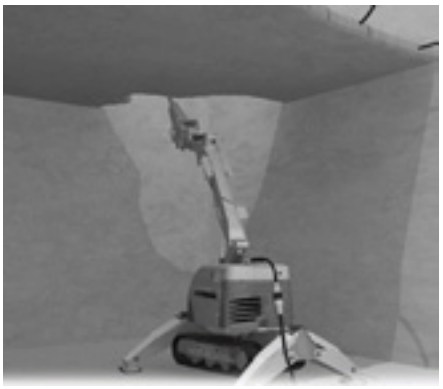
4.6 Free-Standing walls using Crushers

- Start at the top of one end of the wall.
- Demolish in one direction
- Demolish from the top down
- Caution- walls without supports at the upper edge can be a safety risk
- Orientate the undercarriage along the wall to facilitate moving.



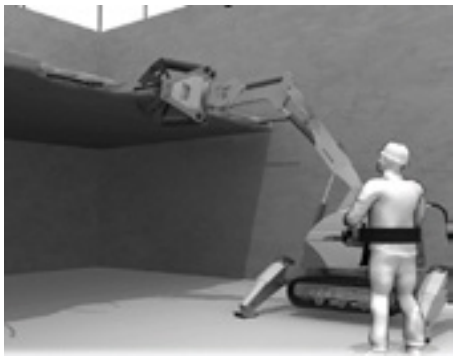
4.7 Demolishing with breaker

- Start at a corner
- Cut section if a fine edge is required
- Demolish in one direction and in sections. Demolish the entire section within the working zone before moving the machine.
- Move backwards
- If possible, position the machine in the direction of the wall.



4.8 Demolishing with a crusher

- Saw sections if fine edges are required
- Make a hole as close to the wall as possible using the breaker
- Change to the crusher accessory
- Demolish outwards from the center of the hole
- Demolish in one direction and in sections. Demolish the entire section within the working zone before moving the machine.
- If possible, position the machine in the direction of the wall.

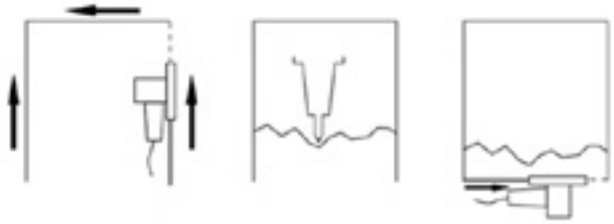


4.9 Demolishing the working floor surface

- The breaker is the most effective tool. The crusher can be used when noise or vibration need to be minimized.
- Position the machine above joists. Do not position the machine to close to an edge. Exercise caution for risks of collapsing.

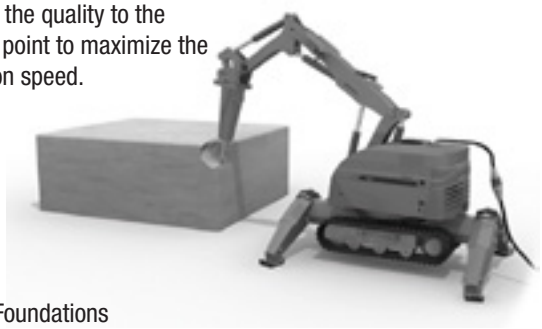
4.10 Demolishing a window or door opening

- Saw cut three sides leaving the bottom uncut.
- Start at the top corner using the breaker and demolish downwards



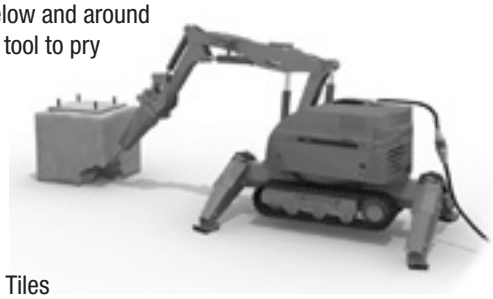
4.11 Large Foundations

- Break from above at the edges
- Consider the quality to the chipping point to maximize the demolition speed.



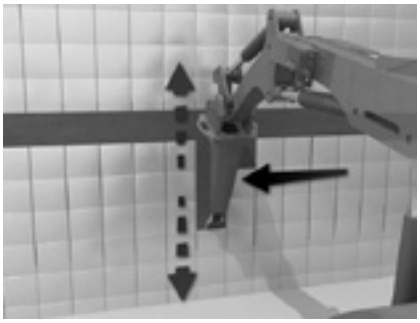
4.12 Small Foundations

- Use a flat chisel and try breaking the foundations at the root
- Break from below and around
- Never use the tool to pry



4.13 Demolishing Tiles

- Start in the center of the wall
- Remove an entire strip of the wall
- Strip the tiles downwards and upwards
- Adjust the impact force and frequency to minimize damage to the substructure and surrounding areas/items.



## 5. Common Terms and Definitions

**Atmospheric Pressure**

**Burst Pressure**–A threshold internal pressure value at which the rated component will burst. Typically 4x Hydraulic working pressure

**Case Drain–**A line to provide a flow path to the reservoir for hydraulic fluid that flows by the piston seals and fluid that flows through the compensator.

**Controlled Demolition**

**Cylinder, Double Acting**–Two parallel cylinders on arm 1 that allows for parallel extension of the boom

**Debris Field**–Area where the operator can come into contract with debris from breaking or crushing

**Deconstruction**

**Down Rigger**

**Earth Ground**

**Excavator**

**Floor Load**

**Footprint**

**Gauge Pressure**

**Ground Pressure Load**

**High-Reach Demolition**

**Implosion-Free Demolition**

**Incline Angle**

**Lift/Tiedown Point–**A Structural Point designated on the machine to support the forces from Lifting and Securing the weight of the machine.

**Micron**–SI Units is 1/1000th of a millimeter. Imperial Units is 0.00003937 inches.

**Micron Rating**–A rating of Hydraulic filters designated as the particle size in Microns that the filter is capable of removing from the Hydraulic oil.

**NEC**–The National Electric Code, NFPA-70, published by the National Fire Protection Association

**Outrigger**

**Point Load vs. Area**

**PSI**–Pounds per square inch

**Reservoir**

**Robotic Demolition**

**Side Load**

**Slewing Speed**

**Static**

**Tracks**

**Transport Speed**

**Wheel**

**Working Pressure**

# Best Practice

**Title:** Highway Work Zone Safety
**No:** CSDA-OBP-1001
**Date Issued:** Jan 24, 2007

**Sawing and cutting adjacent to moving vehicles in a highway work zone is special work. Every job site is different and site-specific safety concerns must be addressed prior to commencement of work. Drivers approaching the work area need to be informed that they are entering a highway work zone and they must see the road rules for that job. When on foot or in a vehicle always try to face the oncoming traffic.**

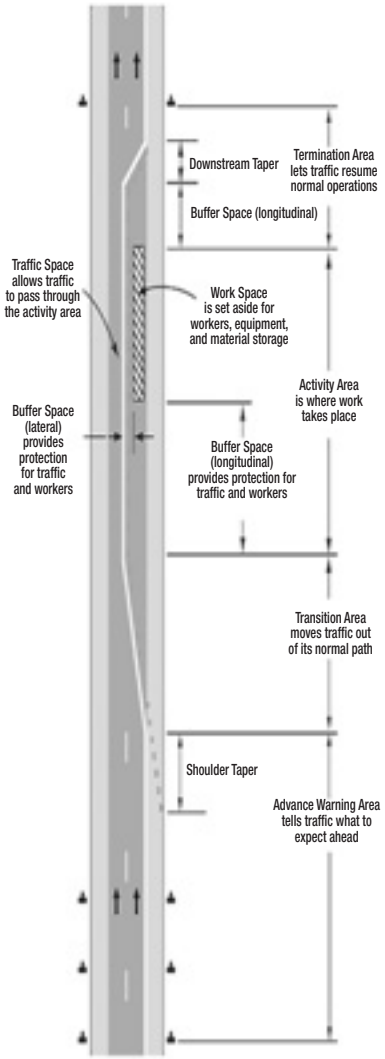
- Prior to the start of work the Temporary Traffic Control plan must be shared with all employees working in the work zone. This plan should match the design for the conditions by following the Manual on Uniform Traffic Control Devices (MUTCD), the State DOT's, or local law enforcement officials. Verify that the sketch of the temporary traffic control zone on the Traffic Control Check-List has been approved by the proper official prior to work.
- Explore the possibility of lane closures and detours to route the traffic away from the project.
- The pattern of signs, signals, message boards, cones, barrels, barriers, and vehicles is designed so that moving traffic will be routed around and away from the work area. Never move the warning and directional signs or the barriers without approval of this new temporary traffic control zone.
- The parts of a temporary traffic control zone are the advance warning area, transition area, buffer zone or zones, work space, and termination area. Buffer zones are the protective spaces in front and after the work zone and on the traffic side of the cones, never place the saw beyond the cones and barrels into the buffer space.
- Consider placing 5 cones, barrels, or barricades across a closed lane at 300-foot intervals or using an intrusion alarm to warn workers that a driver has entered into the work zone.
- When vehicles are used as barriers they should have crash attenuating devices to prevent movement if they are struck. These vehicles should use yellow/orange/white strobe lights to indicate caution and red strobe lights to indicate stop, in accordance with State DOT's and local laws. All vehicles in the roadway or in work zones should be marked with reflectors and lights according to the DOT and State DOT rules.
- Night work and flagger stations are to be illuminated. Lights should be selected so that drivers and workers are not affected by glare. Light towers could be used to give the night crew as much lighting as possible.
- Flaggers need to understand the Traffic Control Plan (see next page). Many State DOT's required a training certificate for flaggers.
- Employees must wear high visibility safety apparel, hard hats, safety glasses/face protection, steel-toed work boots, hearing protection, gloves and respiratory protection as determined in the pre-job hazard analysis.
- Keep all cones and barrels visible by cleaning the slurry from these traffic control devices.
- Never work or stand in the path of moving traffic inside or outside of the work zone. Never allow a saw or pointer to enter a moving lane of traffic.
- Try to direct work trucks and other vehicles in the work zone so movement is always forward. Limit backing up as much as possible.
- Be aware of overhead and underground utilities. Make sure the one call system was used prior to work so that the underground utilities were marked prior to the start of work.
- Encourage DOT or the local jurisdiction to support safety by requiring on-duty policemen to control speeds within the work zone.
- Always hold both handles of a saw. Never straddle the handles of a flat saw. If there is not enough work space, ask for a reconfiguration of the work zone or a flagger to stop traffic during this cut.
- Never operate vehicles or equipment while under the influence of alcohol, illegal drugs or medication that can interfere with your ability to operate safely.
- Work should be suspended if there are unresolved safety concerns, inclement weather and/or vehicle accidents.

## TRAFFIC CONTROL PLAN - CHECKLIST

Superintendent/Foreman: Div/Job#:

Contractor: Supervisor:

Location: Date:

| | Issue / Procedure | OK or NA | Comments | Sketch of the Temporary Control Zone from the MUTCD Part 6, 2003 |
|---|---|---|---|---|
| 1 | Schedule (explained and understood) | | |  |
| 2 | Temporary Traffic Control Plan (explained and understood) | | | |
| 3 | Layout (specific placement of signs, cones, barricades, and barriers) matches the MUTCD and State DOT design | | | |
| 4 | Staging Area Access and Exit | | | |
| 5 | Work Zone Access Plan | | | |
| 6 | Signs, signals, barriers, cones, barrels, or vehicle(s) place properly | | | |
| 7 | Night Work (lighting plan, vehicle beacons, high visibility garments) | | | |
| 8 | Highway Patrol Duties (communicated and understood) | | | |
| 9 | Traffic Control Flagger(s) (confirm training, work location, shift change procedure) | | | |
| 10 | Work Stoppage (safety, inclement weather, and vehicular accidents) | | | |
| 11 | Has there been any recent accidents, closure intrusions, etc. on this job [Near-Misses] and were corrective actions taken? (From state/local agency &/or our customer.) | | | |
| | Other notes: | | | |



Employees Signature: Employees Signature: Employees Signature:

It is the Supervisor's responsibility to ensure that this information is communicated to everyone and that the information is fully understood.

Through the OSHA / CSDA Alliance, CSDA developed this Best Practice for informational purposes only. It does not necessarily reflect the official views of OSHA or the U.S. Department of Labor. 01/07

# Best Practice

**Title:** Reducing Silica Exposure
**No:** CSDA-OBP-1002
**Date:** Jan 21, 2008

**Concrete cutting, coring, drilling, quarrying and brick/block can create an airborne silica exposure and potentially cause silicosis. Cutting wet or using engineering controls such as ventilation are the most effective methods of reducing employee exposure to silica dust. Cutting wet is the preferred method. The following silica fact sheet provides the best practices for employers and employees of concrete cutting companies.**

## Employers

Educate concrete cutting employees:

1. Train workers about the health effects of inhaling silica dust and train them in good work practices.
2. Train workers to recognize when and how silica dust may be generated and provide training on how to eliminate or control the dust at the source.
3. Train workers on how to use and maintain engineering controls to reduce silica dust.
4. Establish a respiratory protection program and train workers on when, where and how to use and take care of respirators.
5. To determine if respirators are necessary, use company task-specific air monitoring data, historical data relevant to the tasks and OSHA/NIOSH data to determine the need and type of respirator required.
6. Respirators are recommended for any dry cutting and also when cutting inside an enclosed or limited work area.

## Employees

Practice preventative measures when cutting:

1. Always use the dust control systems provided with the machinery and keep them in good operating condition.
2. When sawing or drilling concrete, use equipment that provides water to the blade or bit. Use vacuums or wet sweeping to clean up slurry (water and dust debris).
3. Wear washable clothing. Periodically and at the end of the day, vacuum any dust off clothing.
4. Do not eat, drink or use tobacco products while working or smoking outside of the work area.
5. Wash hands and face before eating or drinking.
6. When required, always wear the appropriate respirator.

Note: "With any type of vacuum system, worker protection from respirable dust is only as good as the filter in the vacuum. For the maximum control, use high efficiency particulate air (HEPA) filters, which are 99.97 percent efficient when tested with fine dust (0.3 mm).

## Respirator Training

OSHA standard 1910.34 requires that where respirators are necessary to protect the health of the employee, the employer shall implement a respiratory protection program. This program must include training employees in the proper use of respirators, including instructions for putting them on and removing them as well as providing information about capabilities and limitations.

1. Each respirator shall be selected on the basis of the hazards posed to the worker.
2. No worker is allowed to use a respirator without having been through the company training on respirator protection. This training will be conducted annually, outlining the selection, use and maintenance of each respirator.
3. Only workers who have passed a medical evaluation, a pulmonary function test and a fit test for all respirators used are approved to wear a respirator. These tests and evaluations are required on an annual basis. Changes in body weight, cosmetic surgery or dentistry requires updated fit test to ensure protection.
4. Documentation of each medical evaluation will remain on file in the company's main office.
5. Each respirator shall be selected from those approved by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration, under 30 CFR part 11.
6. Each employee required to wear a respirator will be shown how it should be worn, adjusted and how to determine that it fits properly.
7. All respirators shall be cleaned after each use. Any respirator being shared by more than one worker shall be disinfected prior to use by any other person.
8. After use, respirators should be stored in a dry, clean location.
9. All respirator equipment shall be maintained properly. All respirators should be inspected for any defects prior to use and during cleaning.
10. All damaged or defective respirators shall be returned immediately to the company for repair or replacement.
11. If breathing becomes difficult during the use of a respirator, employees should replace the cartridges or ask for a new respirator. If using disposable respirators, replacement guidelines should be followed.

# Best Practice

**Title:** Defensive Driving
**No:** CSDA-OBP-1003
**Date:** Jan 1, 2009

**Most vehicle accidents can be avoided. To prevent accidents, sawing and drilling operators should make a habit of following the guidelines set forth in this best practice as it applies to employers and employees of concrete cutting companies.**

1. Inspect your vehicle before driving each day. Check that all tools are stored, all doors are properly secured and no loose items are left on trailers. Check that all working lights are functional; check tires for wear and that they are properly inflated; inspect trailer hook-ups and check fluid levels. If a vehicle falls under DOT regulations, fill out and sign your DOT inspection as required.
2. Wear you seat belt at all times, even when driving very short distances.
3. Remember the extra weight you are carrying on the vehicle such as equipment, water or trailers. Stopping distance increases dramatically with increased loads.
4. Allow extra room between vehicles. It is understandable that people will cut into the open space, but slow down and reduce your speed. When stopping behind another vehicle, make sure to leave enough space between your vehicles so that you can see the rear tires of the vehicle in front of you. Rear end collisions are the number one insurance claim in the industry.
5. Drive at or below the posted speed limit. Remember that fines double in construction zones when workers are present.
6. Use your mirrors. Your eyes should continuously scan the mirrors. Be aware of blind spots. Drive professionally, avoid aggressive driving and do not take the actions of other drivers personally.
7. Reduce your multi-tasking by avoiding activities such as eating or talking on the radio or cell phone. Excessive volume on the truck radio and frequently adjusting the radio are also distractions. Excessive volume can also prevent you from hearing emergency vehicles. Most accidents are attributed to excessive speed, driver distraction and driver impairment. Never drive if you are impaired by any drug, alcohol or fatigue.
8. Keep your vehicle clean and neat. Make sure the dashboard is clear of loose items. Make sure there are no cans or bottles on the floor that may interfere with brake or gas pedals.
9. Be aware of changes in the weather. Ice and snow will reduce traction. Heavy rains will cause slick roads as water mixes with oil on the roadways. Bridges will often freeze before roadways freeze, therefore stay focused and be alert.
10. Take extra caution when entering or exiting a highway work zone. Reduce speed, turn on flashers and strobe lights and maneuver in or out of the traffic safely.

Remember to follow company policy in the event of an accident. In some cases, company policy requires that you do not leave the scene until calling your supervisor or the safety director. Also, report all accidents and near misses to your supervisor.

# Best Practice

**Title:** Electrical Safety Fact Sheet
**No:** CSDA-OBP-1004
**Date Issued:** Feb 23, 2010

**Electricity is widely recognized as a potential workplace hazard, exposing employees to electric shock, burns, fires and explosions. Working on or around electrical conductors and equipment can be particularly dangerous, because electrical energy often cannot be sensed until contact is made. The following guidelines should be applied to every workday:**

1. On a daily basis, before starting any task, inspect the work area for possible electrical hazards. Take all necessary precautions to avoid cutting into electrical lines. In work areas where the exact location of the electrical power is unknown, power in the general vicinity of the building should be de-energized.
2. Operators should wear ASTM F 1117 dielectric boots and ASTM D 120 rubber insulating gloves. Leather protector gloves that meet ASTM F 696 should be worn over insulating gloves to prevent damage. Instruct each employee on how to recognize and avoid unsafe conditions that apply to the work areas.
3. Shut off the main power source when working on anything electrical, such as switches and outlets. Follow lockout/tagout procedures. Never overload a circuit by plugging too many items into one outlet.
4. Assure proper grounding of all electrical equipment. In-use proper grounding can be assured by using a Ground Fault Circuit Interrupter (GFCI), in conjunction with an assured equipment grounding conductor program. Use equipment that provides a permanent and continuous path from circuits, equipment, structures, conduit or enclosures to ground.
5. If working near high voltage lines, operators must maintain a safe working distance—a minimum distance of 10 feet (50 kV line or less) between their equipment and the electrical distribution or transmission lines. The higher the voltage line, the greater the distance that is required between the equipment and the line.
6. Inspect electrical tools and equipment daily. Remove defective or suspect equipment from use and tag “Do Not Use.” Make sure equipment is properly maintained.
7. Use only three conductor cords. Do not use worn or frayed electrical cords or any electrical cord with visible wires. Verify the ground plug is present and has not been damaged or modified.
8. Keep all hoses and cords out of the path of travel and away from saw blades, core bits, air tools and keep them from being run over by equipment. Electrical cords in high traffic areas should be protected. Electrical cords should not be secured with staples, coat hangers, nails or wire. Keep all cords, tools and electrical connections dry.
9. Ensure all components, cords, plugs and twist locks are properly sized and not modified from their original specifications. If a cord is warm or hot to the touch, the cord is too small for the equipment being used. Use cords that are rated to carry the maximum current ratings of the motor being used. Larger cords are necessary when using longer stretches of cord.
10. Make sure that the tool is OFF before plugging it in. Shut off power whenever possible when connecting or disconnecting connectors. Verify that once connected, the cord is fully plugged in, secured and cannot be disconnected.
11. Do not pick up or carry a tool by its cord or hose. Do not unplug by pulling on cord. Grasp plug body to remove or insert a cord from an outlet and never use excessive force.
12. Develop and maintain a safety and health program to provide guidance for safe operations. Proper maintenance and records will help ensure that all equipment is safe.

# Best Practice

**Title:** Scaffold Safety Fact Sheet
**No:** CSDA-OBP-1005
**Date Issued:** Nov 15, 2010

**Scaffolding forms temporary structures to support people and material in the renovation or selective demolition of buildings and other structures. Serious injury or death can result if sawing and drilling contractors fail to comply with all applicable safety requirements when erecting, using or dismantling scaffolding.**

**GENERAL SCAFFOLD SETUP REQUIREMENTS:**

1. Scaffolding must be erected by a competent person.
2. Scaffolding must be erected under the direction of a qualified person.
3. Scaffolding should be erected from matching components in good working condition. Damaged or mismatched components must not be used.
4. Scaffolding and its components must support, without failure, its own weight and at least four times the maximum intended load applied or transmitted to it. Additionally, scaffolding must not be loaded in excess of its intended rated capacities.
5. All footings should be sound and rigid. They should not be set on soft, muddy, frozen ground or resting on blocks. The poles, legs, posts, frames and uprights of the supported scaffold must bear on base plates and mud sills or other adequate firm foundations.
6. When positioning scaffolding, sawing and drilling contractors should consider various factors, including traffic, utilities, pedestrian traffic, work height availability and bracing needs.
7. Guardrails and toeboards should be installed on all open sides.
8. Work platforms should be complete, no less than 18 inches wide and not extend over the support by more than 6 inches. They should be fully decked with planks secured to the scaffolding.
9. Supported scaffolds with a height-to-base ratio of more than 4:1 should be restrained from tipping by bracing, tying or a similar method.
10. Scaffolding should have safe, complete access. Sawing and drilling contractors should not climb on cross braces.

**SCAFFOLD USE:**

1. Scaffolding must be inspected by a qualified person for visible defects before use and after any occurrence that could affect the structural integrity of the scaffold.
2. Check scaffolding for inspection tags that identify the status of the scaffold in accordance with OSHA regulation 1910.28, where a green tag = complete; yellow = incomplete; red = unacceptable or hazardous.
3. Personnel working on scaffolding must be trained in all safety procedures to control hazards. Employees must be trained by a qualified person to recognize and control the hazards associated with the type of scaffold being used. The training must include fall hazards, falling object hazards, electrical hazards, proper use of the scaffold and handling of materials.
4. Proper personal protective equipment like hard hats, safety glasses and work boots should be worn while working from scaffolding.
5. Sawing and drilling operators more than 10 feet above a lower level should be protected against falls by guardrails at least 38 inches high or a fall arrest system. Some facilities may require 100% fall protection while working on scaffolding, regardless of height.
6. No work should be done from scaffolding during high winds, rain or snow.
7. Do not ride scaffolding while it is being moved.
8. Before moving scaffolding, remove or secure core bits, saw blades or cutting equipment that may be on the scaffolding.
9. Cutting equipment and materials should be hoisted, not carried up.
10. A qualified person must evaluate the dismantling of scaffolding to determine a safe means of providing access and fall protection in the event of a collapse.

# Best Practice

**Title:** Ladder Safety Fact Sheet
**No:** CSDA-OBP-1006
**Date Issued:** Nov 15, 2010

**Ladders are a convenient tool to reach heights, but they represent a risk to sawing and drilling contractors if not used in accordance with company and specific site safety specifications or requirements. The following are precautions and guidelines for the safe use of step ladders and straight (extension) ladders in the sawing and drilling industry:**

1. Inspect prior to use and remove from service if damaged.
2. When working around energized sources, use non-conductive ladders made of fiberglass or wood.
3. Make sure the ladder meets height and weight restrictions. Remember to include the weight of all sawing and drilling equipment to be used when calculating total load.
4. Ladders must be clean and free of oil and slurry from sawing and drilling operations.
5. The maximum height of a step ladder is 12 feet, but 10 feet is the maximum working height.
6. When working from a ladder, sawing and drilling contractors should not climb higher than the second step from the top.
7. Position the base of a straight ladder one foot away from the wall for every four feet of the ladder's length from the support point to the surface.
8. If a straight ladder extends over a roof or ledge, it must stand at least 3 feet above the highest point of contact.
9. Straight ladders must be tied off prior to use.
10. Maintain a minimum three point contact, meaning at least two hands and a foot or two feet and a hand are in contact with the ladder when ascending or descending. Face the ladder when moving up or down.
11. Sawing and drilling equipment must be transported to or from the work area via rope or hoist. Do not carry objects or loads that could cause loss of balance on a ladder.
12. Ladders cannot be used while placed on scaffolding or sawing and drilling equipment.
13. Never make modifications to a ladder.
14. If possible, restrict access to the area around the ladder to keep people and equipment a safe distance away.
15. Ladders should be positioned safely on a flat surface.
16. Do not use ladders on slippery surfaces unless secured or provided with slip-resistant feet. However, do not use slip-resistant feet as a substitute for using care when placing, lashing or holding a ladder on slippery surfaces.
17. Do not move, shift or extend ladders while in use.

Typical Step Ladder

Straight (Extension) Ladder

Through the OSHA / CSDA Alliance, CSDA developed this Fact Sheet for informational purposes only. It does not necessarily reflect the official views of OSHA or the U.S. Department of Labor. 11/10

# Best Practice

**Title:** Distracted Driving
**No:** CSDA-OBP-1007
**Date Issued:** June 15, 2011

**The risk of a vehicular crash increases when sawing and drilling employees engage in distracted driving. This includes any activity that has the potential to distract employees from their primary task of driving or increase the risk of crashing and decrease the opportunity to avoid the accident altogether. According to the National Highway Traffic Safety Administration, 5,474 people died in 2009 in crashes involving a distracted driver, while an estimated 20% of 1,517,000 injury crashes were reported to have involved distracted driving. Of those drivers reportedly distracted during a fatal crash, the 30 to 39-year-old drivers were the group with the greatest proportion distracted by cell phones. Cell phone distraction was reported for 24 percent of 30 to 39-year-old distracted drivers in fatal crashes.**

Here are some simple steps employers and employees can take to avoid distracted driving.

## EMPLOYERS

1. Prohibit employees from texting while driving and encourage the idea that work vehicles are "text-free zones."
2. Establish procedures and rules that avoid the necessity for employees to text while driving to carry out their duties. This should include safe times and places for employees to contact managers or customers.
3. Set up a distracted driving policy that includes, but is not limited to, answering or making calls, texting and reading or sending emails.
4. Train workers to recognize and avoid the three types of distracted driving:
   - Visual—taking your eyes off the road
   - Manual—taking your hands off the steering wheel or controls
   - Cognitive—taking your mind off driving
5. Train workers to understand that while all distractions can endanger drivers' safety, texting with a mobile device is the most dangerous because it involves all three types of distractions. The University of Utah reports that using a cell phone while driving, whether hand-held or hands-free, delays a driver's reactions as much as having a blood alcohol concentration at the legal limit of .08 percent.
6. The policy should cover vehicles that are company-owned, company-leased, company-rented or are private vehicles being used for company business.

## EMPLOYEES

1. Avoid distracted driving activities, including:
   a. Using a cell phone or other hand-held electronic device to make calls or send texts
   b. Responding to a call or text from a supervisor, customer or co-worker
   c. Eating and drinking
   d. Talking to passengers
   e. Grooming
   f. Reading, including maps or other work or non-work related materials
   g. Using a PDA or navigation system to find jobsites
   h. Watching a video
   i. Changing the radio station, CD or MP3 player
   j. Daydreaming or focusing on surrounding scenery
2. Know your route to and from the jobsite.
3. Do not send or read text messages while driving.
4. Do not use a cell phone or other hand-held electronic device while driving.
5. Hold the steering wheel with both hands and keep adjustments to the radio or other dashboard controls to a minimum.
6. Pull the vehicle over to a location where it is safe to remain stationary to refer to a map or reroute a navigation system.
7. Have a passenger make phone calls, adjust dashboard controls or read a map whenever possible.
8. Try and keep a clear head while driving and focus on the journey ahead.
9. Understand that vehicles driven by concrete cutters are often larger and heavier than standard vehicles and take more time to stop therefore maintain awareness at all times.

Remember to follow the company's policy for distracted driving and applicable state and local laws pertaining to the use of cell phones while driving. For a list of states that restrict cell phone use and texting while driving, visit http://www.iihs.org/laws/maptextingbans.aspx.

# Best Practice

**Title:** Hearing Conservation
**No:** CSDA-OBP-1008
**Date Issued:** Aug 23, 2011

**Noise exposure is widely recognized as a commonplace hazard in sawing and drilling operations. The big issue is that on any given day, the noise level will vary from one jobsite to another. Using a task-based approach is a responsible and realistic solution for hearing conservation. Although noise-induced hearing loss is one of the most common occupational health concerns, it is often ignored because there are no visible effects. The loss of hearing can result in a progressive loss of communication, socialization and responsiveness to the environment.**

**EMPLOYERS:**

OSHA requires employers to implement hearing conservation programs and monitor noise exposure levels in a way that accurately identifies employees exposed to noise at or above 85 decibels (dB) averaged over eight working hours, or an 8-hour time-weighted average. The following points will assist a cutting contractor to implement a hearing conservation program.

1. Training should be provided to each employee who is exposed to noise at or above an 8-hour time weighted average of 85 decibels in accordance with OSHA requirements (29 CFR 1910.95).
2. The employer should institute a training program and ensure employee participation in the program. The training program should be repeated annually for each employee included in the hearing conservation program. Information provided in the training program should be updated to be consistent with changes in protective equipment and work processes.
3. The employer should ensure that each employee is informed of the effects of noise on hearing and the purpose of hearing protectors. Employers should also explain the advantages, disadvantages and attenuation of various types of hearing protection, and provide instruction on the selection, fitting, use and care of this equipment. In addition, the purpose of audiometric testing and an explanation of the test procedures should also be provided.
4. Conduct noise assessments on all sawing and drilling equipment. This information will be the basis for the requirement and selection of hearing protection for employees in the program. Employers shall offer two types of hearing protection to employees: ear plugs and ear muffs. Employers must provide hearing protection PPE at no cost to employees. Historical data from manufacturers or sources may be used.
5. If feasible, use engineering and administrative controls to reduce exposure.

**EMPLOYEES:**

Hearing loss happens over a long period of time and may not even be noticed until the damage is done. Hearing loss can affect a person's ability to understand or discriminate speech. As it progresses, it can affect their ability to hear sounds in general. Noise can also cause harm to a person through stress, muscle tension, ulcers, increased blood pressure and hypertension.

1. Understand the purpose of hearing protectors when sawing and drilling, the advantage of various types and instructions on selection, fit, use and care.
2. Understand the affects of noise on hearing.
3. Know the noise level of the equipment being used. This should be confirmed by the employer.
4. Know the action level for noise exposure for an 8-hour time-weighted average is 85 dBA. This information can be acquired from the employer or safety supervisor.
5. In extremely high noise level areas, dual hearing protection such as ear plugs under an ear muff may be necessary.
6. Personal activities such as, but not limited to, shooting guns, riding motorcycles, loud music, concerts, etc. can be a cause of hearing loss.
7. When necessary, always wear appropriate hearing protection. Hearing protection should be part of your standard PPE while cutting concrete.
8. Know and understand the purpose of audiometric testing and access to information on all test results. This should be explained by an employer or safety supervisor.

# Best Practice

Title: Aggressive Driving and Road Rage
No: CSDA-OBP-1009
Date: June 6, 2012

**The National Highway Traffic Safety Administration (NHTSA) defines aggressive driving as, "The operation of a motor vehicle in a manner that endangers or is likely to endanger persons or property." Aggressive driving includes following too closely, driving at excessive speeds, weaving through traffic or running through stop lights. NHTSA defines road rage as assault with a motor vehicle or other dangerous weapon caused by an incident that occurred on a roadway. Road rage can escalate from aggressive driving to gesturing in anger, yelling at another motorist, confrontation, physical assault and even murder. An important distinction is that aggressive driving is a traffic violation while road rage—yelling and gesturing aside—is a criminal offense. Neither is allowed while driving a company-provided vehicle.**

The following are contributing factors that can lead to aggressive driving and/or road rage. Professionals in the sawing and drilling industry should be aware of these factors and understand how they affect drivers.

1. Traffic Delays – traffic congestion is mentioned frequently as a major contributing factor to aggressive driving. On-the-road delays, highway maintenance and/or accidents and collisions affect all drivers at some point.
2. Running Late – Some people drive aggressively because they have too much to do and not enough time to do it all. Modern life weighs heavily on some individuals and can contribute to a pattern of aggressive driving.
3. Anonymity – Drivers can feel insulated in their vehicles, shielded from the outside world. This detachment can erode inhibitions to antisocial behavior that normally shape interpersonal relations.

**Here are some ways that employers and employees can prevent aggressive driving and road rage while driving.**

**EMPLOYERS:**

Employers should educate employees on how to prevent aggressive driving and road rage, including the following:

1. Knowledge of the type of vehicle being driven, including size, height, length and weight. Knowing this information will help employees control the vehicle and position it correctly on the road.
2. How to read map books and operate GPS systems to choose the best routes. Some routes may not be suitable for large vehicles, and taking them could cause delays for other drivers.
3. Proper care and maintenance of vehicle and/or trailers. Maintaining a vehicle will prevent breakdowns, flat tires or other incidents that may cause delays.
4. Reiteration that aggressive driving and/or road rage is unacceptable and will not be tolerated.
5. What a driver should do if they encounter aggressive driving and/or road rage from another motorist.
6. Maintaining awareness of surroundings and keeping emotions in check while driving.

Employees:

1. Think before you react! Before reacting to a traffic situation that makes you angry, think about the consequences of your actions.
2. Allow adequate time for your trip. Starting out early to account for traffic conditions will lesson stress level and anxiety.
3. Do not make obscene gesture to others, even if they are driving aggressively. This could escalate the situation and lead to road rage.
4. Use the passing lane on the highway for passing; do not drive in the passing lane for long periods of time. Doing so may anger other drivers and could promote tailgating and/or road rage.
5. Keep a safe following distance between your vehicle and the one in front of you.
6. Avoid eye contact with aggressive drivers.
7. Contact local authorities if you observe road rage. Stay away from the offending vehicle and try to obtain the make, model, year and license plate number. This information will be required when making a police report.

Being prepared and giving yourself enough time to get to your job is important to maintaining patience while driving. Remember, aggressive driving and/or road rage is unacceptable. Driver that use their vehicle as a weapon they are committing a criminal offense.

1. You cannot control the actions and behaviors of other drivers. Therefore, maintain awareness of your surroundings and keep your emotions in check while driving. Doing so will avoid conflicts and get you and your passengers to your destination safely.

## CSDA Mission

The CSDA mission is to promote the use of professional cutting, polishing, imaging and selective demolition contractors and their methods. In support of this goal, the CSDA Code of Ethics demands that members pursue the highest standards of safety, quality and integrity. A second objective is to provide a forum in which members can share their ideas, needs and concerns in a constructive framework to further enhance technologies, education and training.

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