Tolerance

Title: U.S. Tolerances for Sawing and Core Drilling
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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')