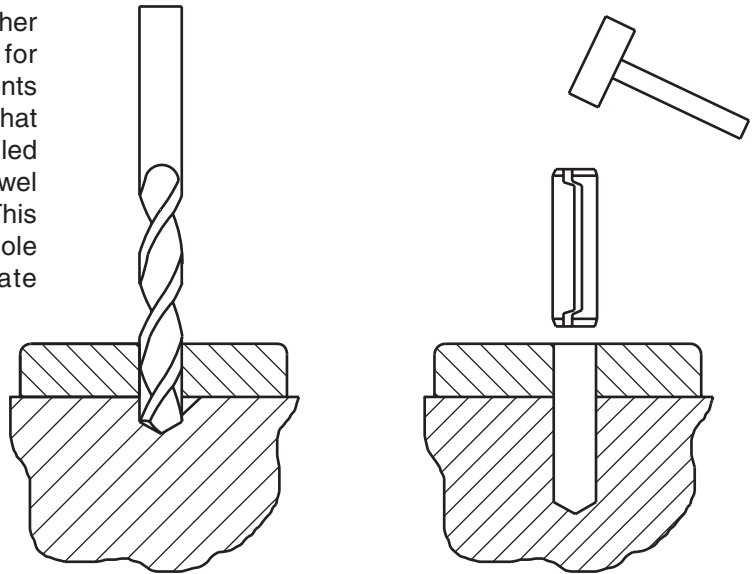


Doweling for Permanent Positioning

If components are located or positioned by methods other than the doweling itself, and the issue is to allow for disassembly and then re-assembly with the components in exactly the same location – then it is recommended that the components be drilled together and the dowel installed in the assembled condition. During disassembly, the dowel may be removed and reinstalled during re-assembly. This method eliminates the need for hole tolerancing and hole centerline concerns. It provides for very accurate permanent locating.



Doweling to Fix Relative Location Of Components

The more common application is to use the dowels to fix the relative location of two or more components. In this situation, the dowels are partially installed in one component, the initial installation, and then holes in the mating component are pushed over the exposed end of the partially installed dowel. The following factors need to be considered for precision location:

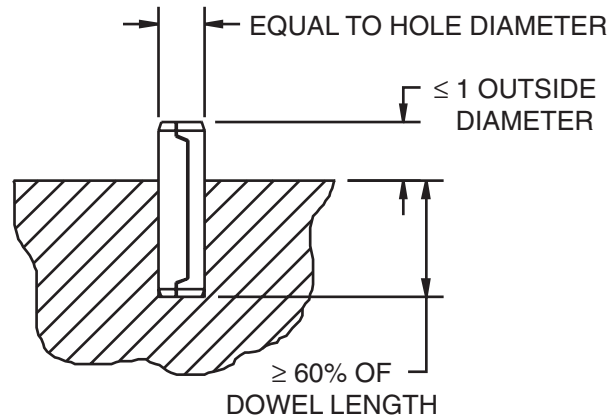
- ⊙ Hole dimension tolerance
- ⊙ Relative depth of initial installation
- ⊙ Total length of the bushing
- ⊙ True position of hole centerlines

These factors are interrelated and need to be considered together. The following general guidelines are helpful in determining the best design in a specific situation.

- ⊙ Precise holes with reduced hole tolerances increase the cost but also increase location accuracy and simplify the design considerations.
- ⊙ Wider hole tolerances require longer dowels to assure a tight, non clearance fit in both components.
- ⊙ Hole tolerance should be minus in the initial installation hole and plus in the mating component hole.
- ⊙ The maximum hole tolerance should not exceed one half (1/2) of the recommended tolerance range to allow for hole tolerancing of both holes within the tolerance range.
- ⊙ Fixing the dowel location in a through hole can be achieved through length of engagement and hole tolerancing, or both. Generally, an engagement of 60% of the total length in the smaller hole is recommended for the fixed location.
- ⊙ If more than one dowel is used, holes in the upper recommended tolerance range allow for a wider tolerance in centerline location.

Precise Holes

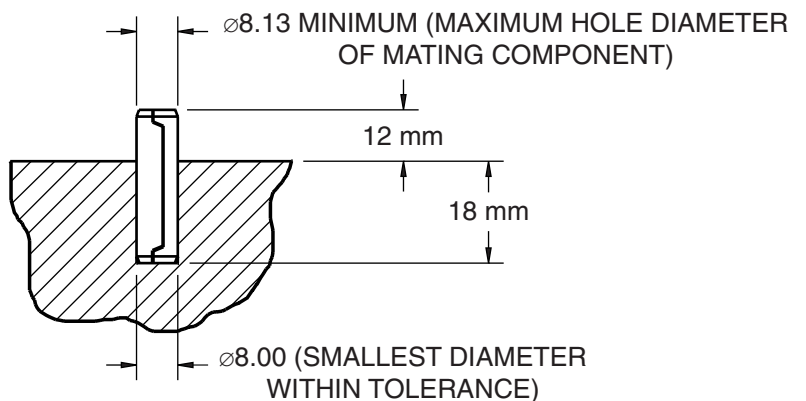
If the holes are precise and the same in both components, such as honed or reamed holes with a tolerance of .0008" or .002 mm, then the length of the bushing need only receive minor consideration for purposes of precise relative location. We recommend using the minimum specified hole in these situations. The bushing will assume the diameter of the initial installation hole and the unsized diameter of the normally exposed end would compensate for the tolerance difference between the holes if any. If no interference whatsoever is acceptable when assembling the mating component over the exposed bushing, then it is recommended to keep the exposed dowel length to a minimum, or if practical, to push the dowel through the initial component to size the exposed end. In any event it is recommended to install at least two thirds of the total dowel length into the initial hole so as to permanently fix the dowel position.

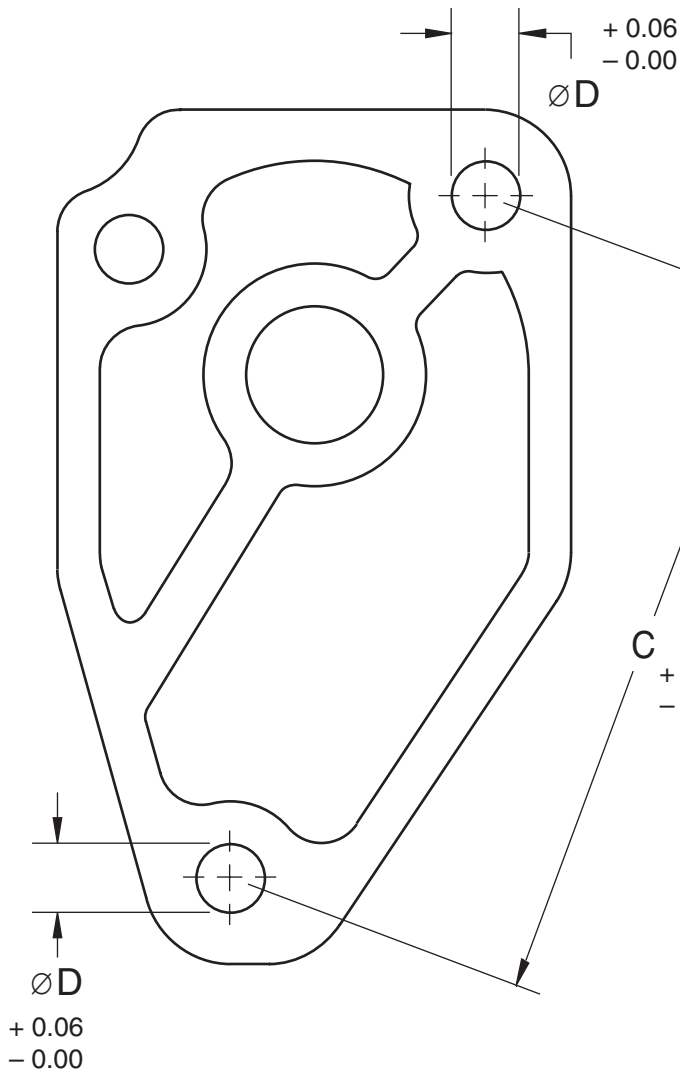


Maximum Tolerance Holes

The maximum allowable tolerance is one-half the total recommended tolerance. This is still within the normal production hole tolerance for drilled or cored holes. The smaller hole, that is the hole with the minus tolerance, should be the hole into which the dowel is initially installed. The larger hole, that is the hole in the mating component, should have a plus tolerance. To illustrate: The total recommended hole tolerance for an 8 mm dowel is 8.00 to 8.13. Take the approximate midpoint and split the tolerance. The smaller hole would be 8.00 to 8.06, the larger 8.06 to 8.13. The smaller hole used for the initial installation will size the dowel but the protruding unsized length of the dowel remains larger, with the diameter increasing as the distance from the hole increases. It normally requires a protruding length equal to 1-1/2 times the dowel diameter for a dowel installed in a minimum hole to have a protruding diameter greater than the maximum hole. For an 8 mm dowel in a 8 mm hole, that would require a protrusion of 12 mm to have a dowel diameter at the protruding end greater than 8.13 mm. The smaller hole in the initial installation helps in fixing the location of the dowel but it is still recommended that the greater length of engagement be in the smaller initial hole. Therefore, in the example used here to illustrate the maximum hole tolerance situation, the dowel would be BUSH 8 x 30 BK SD 200.

TOTAL HOLE TOLERANCE = $\varnothing 8.00$ to 8.13 mm
 HOLE FOR FIXED DOWEL LOCATION = $\varnothing 8.00$ to 8.06 mm
 MATING COMPONENT HOLE = $\varnothing 8.06$ to 8.13 mm





Centerline Tolerancing

If more than one dowel is used, centerline tolerancing for hole positioning becomes an issue. In situations with precision holes requiring precision locating, the centerline tolerancing needs to be accurate and similar to tolerancing used for solid dowels. A tolerance of .0006" or .0015 mm is recommended. When a dowel is installed in a minimum hole, which is recommended in these cases, the dowel gap is butted and further spring action is very limited, if any.

Hole tolerance can be increased to provide for relaxed positioning tolerances with some sacrifice of rigidity. The centerline tolerance can be increased to the tolerance of the holes, or the smallest tolerance if the tolerances of the holes are different. In the 8 mm dowel example used, the centerline tolerance can be .06 mm. The net hole at maximum misalignment cannot be less than the smallest recommended hole; in the example, 8 mm. The misalignment will normally distribute itself between the dowels.

If it is a dowel bushing application with a bolt passing through the dowel into a threaded component, the clearance between the minimum inside diameter of the dowel bushing and maximum bolt diameter needs to be enough to compensate for misalignment. If these guidelines are used, the standard clearance will always be adequate at maximum misalignment.

Blind Holes and Stepped Holes

Blind and stepped holes can be used for dowel location and stepped holes are generally used for dowel bushings used in conjunction with bolts. Since blind and stepped holes only fix the dowel location in one direction, it is still recommended that the dowel be fixed into location by using the smaller hole and greater length of engagement.

Joint Integrity

Loss of joint integrity due to rotational loosening is triggered by vibration. Loads perpendicular to the axis of the bolt, particularly cyclic loading cause slip at the bolt head or the nut which translates into rotational loosening. Dowels, particularly dowel bushings, reduce or even eliminate rotational loosening. In this instance, the use of the smallest hole possible within the tolerance range is recommended to reduce dowel flexibility after insertion. The shear strength also needs review. In static loading or a long cycle time between loads, maximum load should not exceed of 75% of the minimum shear strength. When the loads are in the form of severe vibration, 50% is recommended.

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