# Application Note AN-0130
## *WoodAnchor™ fixturing-slot strength*

## Introduction

To help woodworkers choose appropriate materials for WoodAnchor fixturing slots, ToolQuest conducted ultimate-strength tests of slots milled in a representative sample of wood-based materials. In this application note, the test procedure is described, the test results are presented, and a method for applying the test results to other wood species is suggested. Finally, guidance is offered for estimating the fastener torques applied with typical hand tools.

## Test procedure

Several test specimens of each representative material were cut to dimensions of 6" x 3" x ¾", with natural-wood grain and plywood face grain oriented lengthwise. Natural-wood specimens were straight-grained and free of defects. Fixturing slots were milled lengthwise in the center of each test specimen.

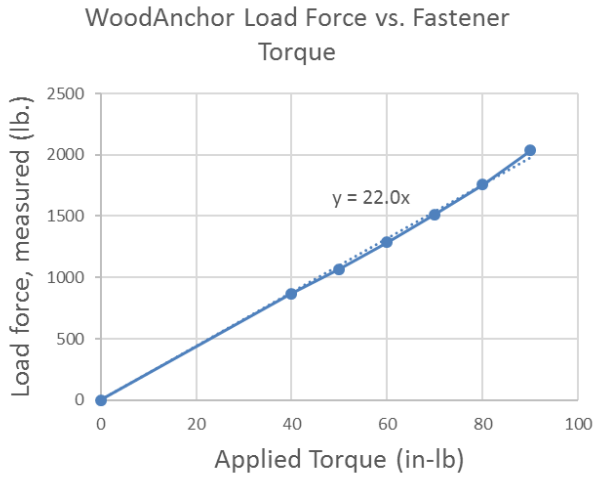
To test both the crushing resistance and the splitting resistance of the specimens under realistic woodworking conditions, a standard hold-down clamp was used to load the WoodAnchor sliding nuts.

**Load testing setup without clamp-base washer**

The sliding nuts were configured as threaded-post assemblies, and tests were conducted both with and without the 2-3/16" diameter WoodAnchor clamp-base washers. For instrumented testing, the female clamp knob shown in the photos was replaced with a hex nut.

**Load testing setup with clamp-base washer**

An Omega LCM901-6-10kN bolt-force sensor, an Omega DP25-S strain gage panel meter, and an ACDelco ARM313-2A digital torque wrench were used to calibrate the ¼"-20 sliding-nut load force vs. applied torque. As the calibration curve below shows, the load force can be determined with acceptable accuracy (+/- 5%) by simply multiplying the applied torque measurement by a gain of 22.0 lb./in-lb.

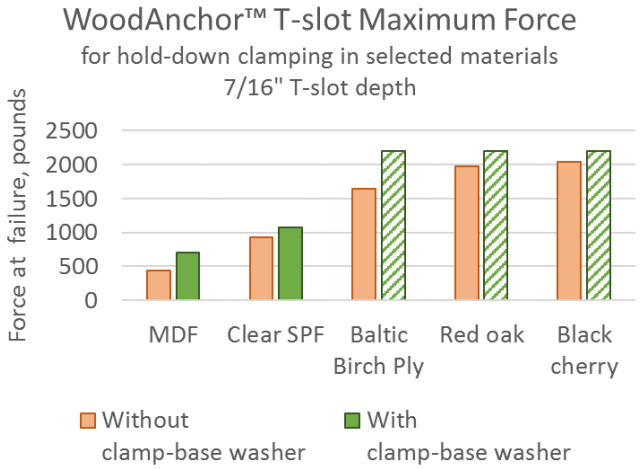


To efficiently determine the applied force during specimen testing, the ACDelco ARM313-2A digital torque wrench was used to both apply and measure the drive torque for each experiment. Sliding-nut load forces were then calculated from the fastener drive torque.


**Applying instrumented drive torque to a test specimen**

For each specimen test, the applied torque was slowly increased from zero to a maximum of 100 in-lb. Tests were terminated upon the splitting or substantial crushing of the fixturing-slot material.

## Test results




The chart above shows the ultimate-strength test results for WoodAnchor fixturing slots milled at the minimum depth of 7/16". Tests represented by green-striped bars were terminated upon reaching the maximum test torque of 100 in-lb. All other tests were terminated when the material specimen failed. The failure mode was consistent for each class of material:

- Natural wood: splitting along grain
- Plywood: crushing
- MDF: splitting (internal bond failure)

The best results were obtained with clamp-base washers installed. These large washers partially support the top of the fixturing slot, distributing the downward force from the heel of the hold-down clamp. This effectively reduces the shear forces on the fixturing-slot top ledges.

All hardwoods tested, including Baltic Birch plywood, performed well at the minimum fixturing-slot depth of 7/16". They had an acceptable safety factor of three or more, as compared with the rated sliding-nut working load of 500 lb.

MDF performed poorly in ultimate-strength testing, with essentially zero safety margin at the rated sliding-nut load. The "internal bond strength" specification of MDF is typically only about 120 psi. This means that pulling on MDF in a direction perpendicular to the sheet surface will separate the internal wood-fiber layers at relatively low forces. Thus MDF is not recommended for WoodAnchor fixturing slots that will be used for hold-down clamping.

Resistance to material-splitting failures can be improved by increasing the depth of the WoodAnchor fixturing slots. Depending on the application requirements, deeper-than-minimum fixturing slots may be desirable in softwoods. In tests of 7/16" deep slots in SPF construction lumber, splitting failures occurred at a 920-pound applied load. But when the same material was tested with a 5/8" deep slot, it survived a 2200-pound test load without splitting. At that load, however, the SPF material did suffer some denting and localized cracking on the underside of the fixturing-slot ledges.

## Strength of other wood species

To help extrapolate these material-strength test results to other solid-wood species, the publication *Mechanical Properties of Wood* by the USDA Forest Products Laboratory is an excellent resource. Referring to tables 4-3A through 4-5B in that publication, fixturing-slot resistance to splitting should be roughly proportional to the pressures given for "Shear Parallel to Grain". Similarly, fixturing-slot resistance to crushing should be roughly

proportional to the pressures given for “Compression Parallel to Grain”.

Resistance to crushing should also be roughly proportional to the wood’s Janka hardness rating, which may be found at wood-database.com.

## Estimating applied forces

Torque wrenches are very useful for controlled tests, but would be impractical to use for routine clamping operations. Fortunately, it’s easy to estimate applied torque for normal woodworking purposes. With a little experience, you’ll quickly develop a feel for appropriate clamping torques.

### T-handle hex wrench

A man with average hand and wrist strength, using maximum effort, can generate roughly 2000 pounds of load force with a 5/32” T-handle wrench. When using this tool, achieving the rated working load of 500 pounds is very easy – just use about a quarter of your hand strength.

### WoodAnchor ergonomic clamp knobs

A man with average hand and wrist strength, using maximum effort, can generate roughly 800 pounds of load force using a WoodAnchor ergonomic clamp knob. If you tighten the knob as much as you can comfortably, without straining, the clamping force should be near the 500-pound rated working load.

### Ordinary clamping knobs

Typical clamping knobs have hard plastic lobes, and have only about one half of the head height of a WoodAnchor ergonomic clamp knob. This generates much higher pressures on the pads of your thumb and fingers. In tests of typical 1-1/2” diameter clamping knobs, finger discomfort prevented users from reaching 500 pounds of clamping force.

Patent Pending