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It was revised on 10/17/02, 12/17/03 and 11/30/04, 12/212/2005 by Victor Tom

How to Build a Structure Tester

Introduction

First, ANYONE can build the Structure Tester. While some teams will elect to build their own Structure Tester, there is no danger of “interference” if the Team Manager (or a helpful parent) builds the Tester. In addition, it is perfectly acceptable to borrow a Structure Tester from somebody else. How the team TESTS their design is not part of their solution. However, since issues like weight placement (and weight order) ARE part of the team’s solution, any help the team gets during testing should be of the “passive lifting” variety.

Tournament officials will provide the Structure Tester and all weights used to test the Structure at the tournament. This means that teams may NOT elect to use their own Structure Tester and weights during the tournament. However, it is still a good idea for the team to get access to a tester (and weights) to test their practice Structures.

It is recommended that weights with a 2” hole in the middle be used at tournaments. While these might be harder for teams to find for testing, it is a good idea to approach testing as much like it will done on tournament day as possible. For tournaments, it will be recommended that an assortment of 5 lb, 10 lb, 25 lb, 35 lb and 45 lb weights be available to total the expected maximum allowed in various combinations (this can change each year). Teams should be aware of the restrictions in this year’s Challenge placed on the use of larger weights by younger teams when they use an “Adult Assistant.”

With that introduction as background, there are 3 elements to a Structure Tester:

1. Presser Board
2. Tester Base
3. Safety Support

This document attempts to provide a step-by-step approach to building each of those elements. There is no one “correct” way to build a Structure Tester – so this document will try to offer a simple approach that will be easier to implement. Finally, the most important Structure Tester for the team to become familiar with is the one that will be used at their tournament.

Building the Presser Board

The Presser Board is 18" x 18", has a 2" diameter hole cut in the center and has a smooth, hard surface on the bottom. The Presser Board must be strong enough that it can transfer the load of the metal weights stacked on it to the Structure (and the Safety Support after the Structure breaks) without significant flexing.

High quality 3/4" thick 5-ply hardwood plywood is probably the best material to use to build the "structural body" of the Presser Board. Hardwood plywood costs ~\$50 per 4 x 8 sheet. Consequently, some teams may elect to use Medium Density Fiberboard (MDF) (which costs less than \$20 per sheet) instead. Particle board or low-grade plywood should NOT be used.

People with limited access to tools might want to buy a whole 4 x 8 sheet of hardwood plywood (or MDF) and have the lumberyard cut it into 18" squares. Cutting uniform 18" squares is VERY challenging without the right tools – and many lumberyards will do it for free (or at least cheaply). A couple of 18" squares of "tileboard" (which is coated 1/8" MDF) or 1/8" High Density Fiberboard (HDF) are needed to provide the "replaceable hard surfaces" of the Structure Tester. Since these "replaceable hard surfaces" have to be replaced occasionally, it might be a good idea to buy a large sheet of this material and have the lumberyard cut that into 18" squares as well. For the current weight limits (no pipe extensions), the possibility of denting is highly reduced.

Figures 1 and 2 provide crude side and top views of the Presser Board. Line two 18" squares of plywood up and clamp them together. Drill countersunk pilot holes through the two boards at various locations (see Figure 2). Unclamp the two boards and apply a "wood glue" liberally between them. Screw the two boards together and allow to dry. Fasten (small screws) an 18" square of "tile board" to the side opposite of the one where the screw heads are showing (see Figure 1). The hardest surface of the tileboard should be showing. Since the "replaceable hard surface" might have to be replaced, it would be a mistake to glue it to the rest of the Presser Board.

The final action is to drill the 2" diameter hole through the center of the Presser Board. Using a pencil, draw lines between opposite corners on the tileboard surface. This makes a big "X" on the square. The center of the "X" is the center of the square. Drill a 2" hole through the middle of the Presser Board (see Figure 1). Drill from the tile board side to avoid damaging the tile board. You now have a completed Presser Board.

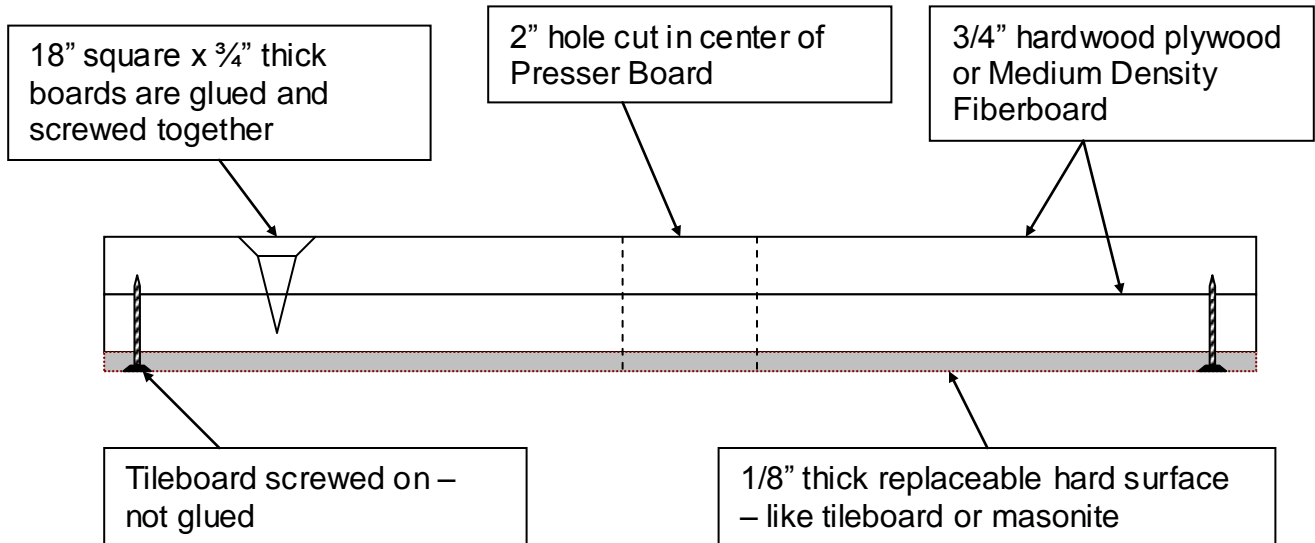


Figure 1 – Side view of Presser board

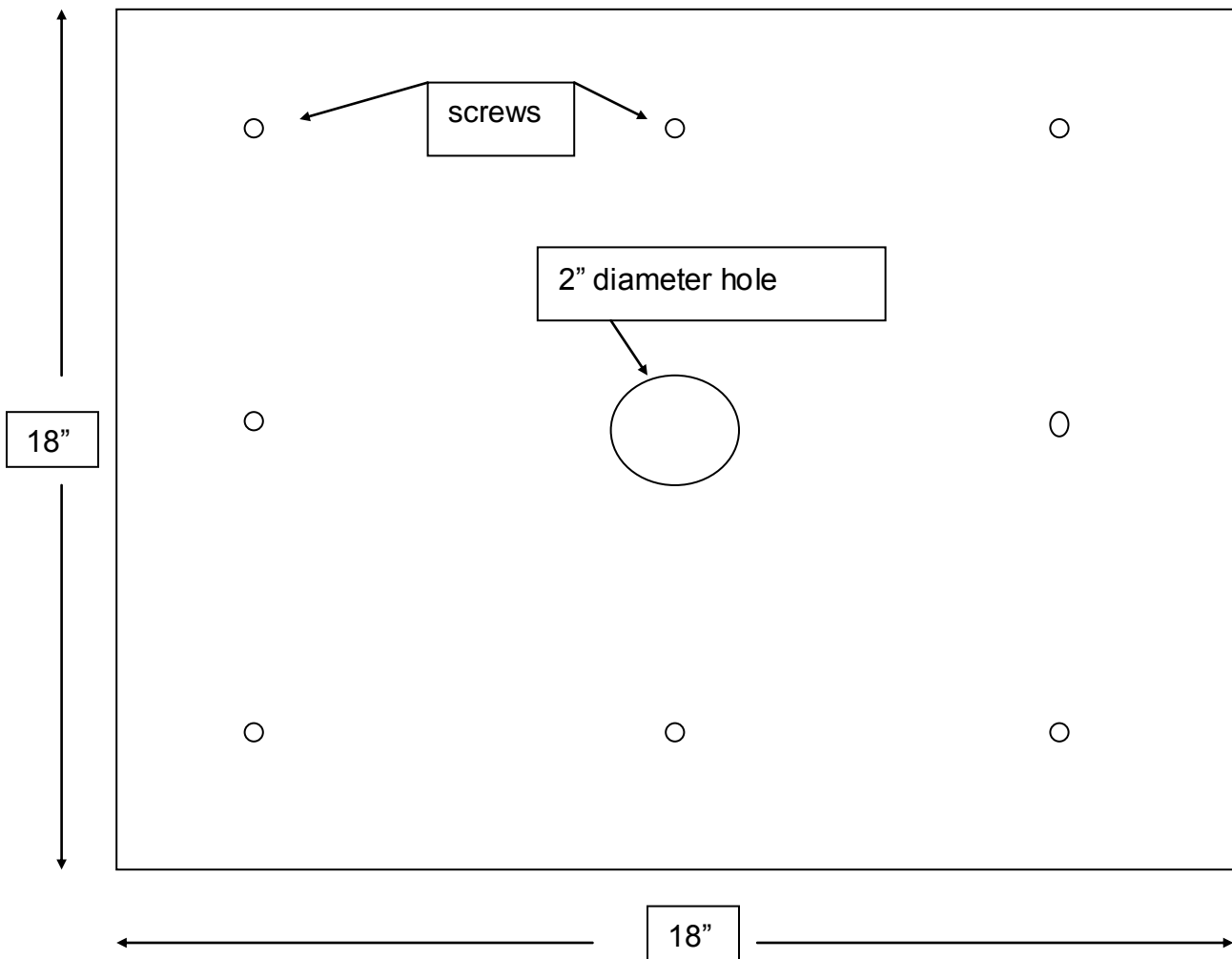


Figure 2 – top view of Presser board

Building the Tester Base

The Tester Base is basically built around a 1" (outer diameter) pipe floor flange. The floor flange is needed to hold the Safety Pole perpendicular to the surface of the Tester Base. The Safety Pole is a 27" long piece of 1" (OD) pipe threaded at one end and screwed into the floor flange. This length is highly dependent on the "HEIGHT OF TESTER POLE" as described in the challenge. There are sometimes two 12" pipe extensions that slide into the main Safety Pole (but not in 2004). Smaller 6" long 3/4" OD pipe sections should be epoxied into the safety pole extensions to allow seamless joints. Like the Presser Board, the Tester Base is 18" x 18". It also has a replaceable hard surface on the side facing the Structure. Figure 3 provides a crude "exploded side view" of the Tester Base.

The loading on the Tester Base isn't as complex as the loading on the Presser Board (or Safety Supports). Consequently, MDF works almost as well as hardwood plywood for use in the Tester Base. To build the Tester Base, begin with a five 18" squares of plywood (MDF). For two boards, draw an "X" between the corners and cut holes slightly larger than the full diameter of the floor flange (2nd and 3rd board from bottom shown in Fig. 3).

On the bottom board, mark a center X and position the floor flange in the middle and rotate the floor flange so the lines of the "X" are visible through the middle of the four attachment holes of the floor flange. Mark these locations and drill 5/16" holes through the MDF. These holes allow the countersunk screw bolts that will hold the floor flange to the bottom board. The floor flanges are rarely perfectly "square" – so some "shimming" of the flange is usually needed to make the Safety Pole perfectly perpendicular to the Tester Base. The 2nd and 3rd board are fastened to this bottom board with deck screws. (see Fig. 3) Do a final tightening of the flange to the bottom board while checking squareness.

For the 4th and 5th board, mark an X in the center and drill out a hole slightly larger than the iron pipe which fits in the flange. Attach these two boards to the rest of the tester base as shown in Fig. 3.

One 18" square piece of "replaceable hard surface" like that used on the Presser Board will be the final testing surface. A hole slightly larger than the pipe needs to be drilled in the center of the "hard surface", but it will not be attached until after the corner posts are fastened because the 2"x2" cutouts in each corner need to be measured and removed.

It will be a good idea to cover anything protruding on the bottom surface with a heavy duty tape such as duct tape to protect floor.

The pieces of the Tester Base don't have to be "tightly bound" together – because gravity will do that as weight is applied. In fact, since it might be necessary to remove the floor flange from time to time, it would be a mistake to do anything that might make it hard to get access to the bolts holding it on. However, it makes sense to at least "loosely tie" all these sheets together (with a few screws) so they don't slip around.

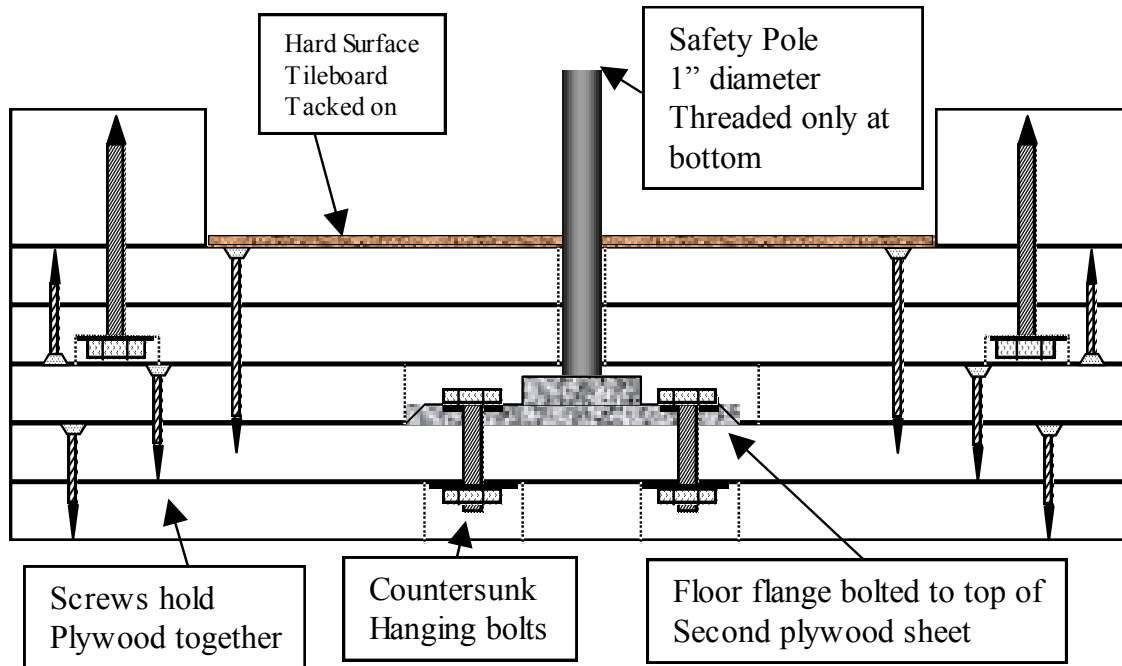


Figure 3 Side view of tester base showing 5 layers and position of flange

It is easier to build from the bottom up (lower three pieces of plywood) with the flange in that assembly. Then screw the upper two sheets together and then bolt the upper two sheets to the Safety Supports (described below) with lag bolts. Then take the upper and lower assemblies and screw those together with 2 1/2 inch screws.

Building the Safety Support

4 x 4 Corner Supports that bolt into Tester Base

The key thing in building a Safety Support is that it must be strong enough to prevent the Presser Board and weights from falling all the way to the Tester Base when the Structure fails. The goal is to construct the Safety Support so it supports the Presser Board about 7" above the Tester Base. This limits the fall to 1 – 3" (which is reasonably safe). The stack of weights can be twisting (or moving laterally) as it falls, so the Safety Support must be robust enough to support these loads as well.

The “simplest” method for providing a “Safety Support” is to use the “old style” 4 x 4 “corner supports” (see Figure 3). The biggest advantage of this approach is simplicity of construction. The construction process is as follows:

1. Cut four 7 1/8 inch long pieces of 4 x 4.
2. Temporarily secure these 4 x 4 corner supports extending upwards from the corners of the tester base (without the masonite or tile board attached).
3. Turn the tester base over so that the upper assembly (two plywood sheets) is resting on the four corner supports. Drill 1/2” diameter holes (the width of the lag bolt shaft) all the way through the base and 2” into the corner supports. Drill a 1” diameter countersink hole halfway into the base so that the lag bolt heads are well countersunk into the base. Use two bolts for each support for extra rigidity.
4. Insert the lag bolts and tighten with a ratchet wrench.
5. After support columns are in place, join the upper and lower assemblies together with long screws (already described above).
6. After the assembly is all together, you can then measure the 4x4 cutouts in each corner for the hard replaceable testing surface.
7. Fasten the hard testing surface to the tester base with small countersunk screws, far from the pole.

Building and attaching the Safety Shields

Four approximately 9” x 18” pieces of 1/16” thick Plexiglas or Lexan should be cut to act as Safety Shields. Depending on the design of the Safety Support, these could actually be quite a bit smaller. Team members involved in weight placement are required to wear Safety goggles this year. This is because the bridges will extend beyond the main tester. For the remaining two sides, safety shields should be used.

The easiest way to attach safety shields is to use self-sticking velcro. Apply 1” square sections in each of the four corners of the plexiglas, remove the other sticky side and press the plexiglass directly to the support posts in the position that is required. Keep the top edge of the plexiglass just below the tops of the support posts. Apply a vinyl tape to the top edge of the shields to protect fingers.

Extension poles are made by gluing 6” long 3/4” OD metal rods (or wooden dowels) into ~12” long pieces of 1” metal pipe. (When you buy the black iron pipe, ask the store to cut a 24” length and two 12” lengths and thread only one end of the 27” length). About 3” of the rod should extend out of the pipe. The inside diameter of the pipe is slightly larger than 3/4” – so some care needs to be exercised to make sure extension pole fits “squarely” into the Safety Pole. Metal tape (used for gutter repairs) can be used to build-up the diameter of the pipe extension so that it fits snugly into the pipe below.

For Designing Bridges two support blocks 18" long made out of the 4x4" posts need to be cut and built up with wood strips to provide a support platform 1" above the surface of the tester base. These blocks provide the bridge base.

When you're all done, spray paint the tester to give it a nice finish (Orville suggests auto enamel to give it that hard finish). Paste a DI logo on for a professional look at tournaments.



Figure 5 Views of completed tester base and presser board with weights

Supplies:



Views of Tester during Construction:

