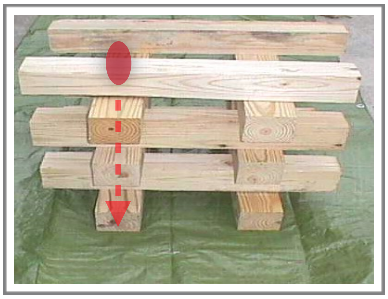
Please note: These test results are not scientific as the testing was limited to only a few pieces of cribbing. These results should not over-ride any current guidelines. Further individual testing is recommended before making any response changes.

Background: During discussions involving heavy truck and semi extrication cribbing, several questions were raised regarding points of contact and 'bridged' pieces of cribbing. The crux of the discussion became: 'can you bridge two points of contact to capture in the middle of a piece of cribbing?' This is particularly a challenge when capturing rear frame members and also van style trailer rails. It can also be a factor occasionally in light vehicle stabilization as well.

Stability verses Capacity: We know from FEMA and USACE testing that the full capacity of a box crib is achieved only at the points of contact. To capture the maximum weight we must be in a straight line from the contact point, through the crib box to the ground. In doing so, we capture 6000 lbs per point of contact. This is an average derived from the crush capacity of many samples of Douglas Fir and Southern Pine resulting in a 500psi crush average. When we take the 3.5" x 3.5" cross section of the 4x4 cribbing, we get 6000lbs. (3.5 x 3.5 x 500). Thus, a four point crib box should hold 24,000 pounds of weight ***IF*** all four points are holding that weight. When we 'bridge' the top row, we degrade that entire box to the capacity of the bridged piece of cribbing.

When we look at stability, we are still concerned with points of contact, but not in the same respect. For total height of the box we can apply the following rules based on the height to base ratio. Assuming we are using the standard 24" stick of cribbing our base is 16". This is allowing for a 4" overhang on each side to allow for crush capture.



- 4 points of contact, in a stable load (stationary) we can go 3:1 (48" high)
- 4 points of contact, unstable (lift and crib) we can go 2:1 (30" high)
- 2 points of contact must be reduce to 1.5:1 (24" high) but caution must be applied
- Any angle or single point should be reduced to 1:1 and monitored as the stack is inherently unstable. At least two points should always be captured.

So, in terms of stability, we know that there are times we have to build a 4 point box up to the frame and then bridge that box with one or two pieces. When we do this, we are improving our stability as opposed to a single stack of 4x4s (which would almost certainly fall over if loaded). However, just because the box is 4 points, the capture is only two (at the bridge). While the true weakness (in terms of stability) is at the connection from the frame to the bridged piece, meaning the box itself is within normal parameters, we must still use caution as the rule and degrade the rating. By backing the height down to 1.5:1 (two points of contact) we are giving ourselves a safer window for stability.

Bridge Capacity: Going back to the discussion of weight capacity, we must now consider the bridged piece itself. Since we already know what the box will hold (24,000 lbs), we need to discover if the 4x4x24 will hold the same amount horizontally (as opposed to the traditional vertical loading in collapse rescue). If not, we must be reduce the assumed capacity of our box crib to that break average, minus a safety factor (typically 2:1 as with collapse).

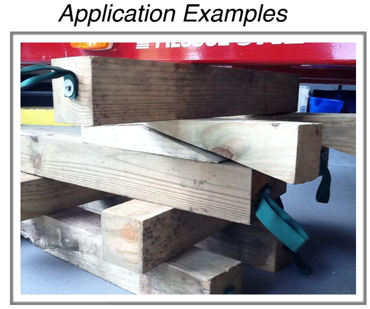
Testing: A local concrete company, Builders Concrete, was gracious enough to lend us their time and facility for the testing we performed. Through their support we were able to place test pieces of cribbing and wedges in a compression test machine used to check cores of concrete for crush strength. The size of the machine did limit some of our testing but we were able to draw many conclusions.

Our testing included three pieces of 4x4, 2 wedge packs and 1 piece of 2x4. The 4x4 and 2x4 testing was run as shown in the picture to the left. Each piece was place on two pieces of 4x4 and compressed in the center with a metal bar that approximated the width of a frame rail (approx 3" wide). The wedge packs were tested once time each in two different configurations. The first was with the wedges running parallel to both a top and bottom 4x4 (fig 6). The weight of the crush was distributed by the top piece, contacting only the ends of each wedge due to the length. This gave a wider gap under the top 4x4. The second wedge test changed the top piece to run perpendicular to the wedge pack. To do this we cut a short section of crib to fit within the machine. This avoided direct crush from the metal bar and was still wider than the wedges (fig 7). The gap here was much smaller, resulting in almost direct contact in the stack.

Fig 6

Fig 7

Application Examples



Results: Below is an example of each test application and the total force it withstood. The compression was increased until there was an audible 'pop' or visual deflection of the crib piece. In some cases, the test machine reached it's maximum capacity prior to either failures occurring.

Bridged 4x4 **3,700 psi / 16,000 lbs maximum machine compression**

Bridged 2x4 **9,200 lbs break**

Wedges under parallel **9,300 lbs break**

Wedges perpendicular **13,000 lbs crush**

Summary: If we take into consideration a safety factor of 2:1, we need to essentially cut these values in half. Knowing that our cribbing is never holding the full weight of the vehicle (as it is shared with multiple crib stacks or other components on larger vehicles) we feel the results allow for bridging in most applications. The use of a 2x4 as a primary load bearing point should be avoided. Place the 2x4 under the top row instead, putting it in direct contact with all points of the row above and below. As for the wedges, we can see that the more gap there is under the top 4x4, the lower the value will be. If the wedge can be placed directly in-line with the points of contact, there will be little, if any loss in strength.

Again, these results were taken from *very limited* testing, but they do help us in our cribbing considerations for all extrication scenarios. Using an average passenger car weight of 5000 lbs we can comfortable use a bridged piece all the way up to the larger heavy dump truck at 20,000 lbs. As for semi extrication, depending on the number of crib stacks or stabilization points, a bridged box should have little impact in the overall stability. Particularly if we are following 'Street Smart' cribbing @ 20,000 lbs per axle.