

LAMINATED CURVED BEAMS

I am Bob Johnston I have been a stair builder for over 40 years. I have built many open stringer spiral stairs and in order to build these I have had to construct several hundred laminated plywood beams for the curved twisted stringers. I have built some with no nails and no metal fasteners, exactly the same as Loretto Chapel staircase in Santa Fe NM (I had several dozen clamps, he had none, he used wood nails and splinters to clamp the wood pieces together with). I was called by a contractor friend of mine to build a staircase in Roswell NM. The general contractor said it was nothing like he had ever seen or had ever built, but he said he knew I could do it. When I got to the sight he explained that it was not only the rail and balusters he wanted me to install, but also build some curved laminated load bearing beams. I agreed to do the job.

Then he said that as long as I wasn't doing anything until the walls were framed we could hire some carpenters and frame the walls and roof, I agreed to this and we went looking for carpenters.

We framed the walls and built the floor, and then we built the circular stair as shown in the picture.

The curved beams had to be 16" high to span the 24' distance.



and support the load they had to carry. Two beams had to be 3." thick x 24' long with an 4' radius curve in them and two had to be 1." thick x 10' long with a 4' radius curve, another had to be 20' long with one end curved. There were 16 carpenters on the job and not one had ever laminated plywood. They learned quickly. Good bunch of men. We ironed out the mechanics of the operation on the first beam and then things went smoothly on the ones thereafter.

Applying the glue is the most important part. We used Titebond (best glue you can buy) yellow glue, which is melt-back glue. I explained to them that a melt-back glue will let you coat the member you are gluing, and if it dries you can re-coat it and have a super strong joint. Titebond II is water resistant and Titebond III is waterproof and will not let you do this. The carpenters applied the glue with a 9" roller, spreading the glue on the pieces to be attached and also spreading the glue on the pieces already attached to the

forms. If you see the glue clearing up and you can see the wood under it, it is almost dry and you need a second (light) coat. You have to work fast doing this, especially in hot weather. A lot of days at Roswell it was well over 110 degrees.



These are the form blocks (braces) we used. We shot them to the concrete with a pan nailer (powder actuated nail gun). The protruding 2x4's at the bottom are there to hold the plywood up so that we could get clamps on the bottom of the beam. As soon as we got good clamp pressure and squeeze out, we stapled the plywood and then we could move the clamps to the next piece. I had 5 carpenters helping and kept them all busy. We stapled the first piece of 3/8" BC plywood to the forms with 3/4" staples (so we could pull it off) then coated it with glue and coated to next piece with glue and shot it on with 3/8" staples and clamped it as shown. One important point here is that you can only bend ripped

plywood very little (A rip is a piece of plywood ripped length ways of the sheet, 16"x8' long.)



The only way you can bend ripped plywood is to plane or grind off the back skin of the plywood. You have to cut it across the grain (4' long) so it will bend. You will understand this the first time you try to bend a rip. I let the carpenters rip a piece to show them the difference, although we used it when we built the 20' beam that had only a curved end. The 3."thick beams were a 10 ply glue up. We cut the starter pieces 16", 32", and 48" so as to have plywood overlapping every joint at least 16". Then used 4' cut pieces for the rest of the beam. We use ripped pieces when we could. We kept changing out the staples (Senco N's for a deck stapler) and using longer ones as we progressed through the laminating process. Stapling the beams almost eliminates any spring back. Spring-back is when you pull a laminated beam from the forms and it tries to go back to its original shape. After we had all

the beams glued up, we ground the edges with a 24 grit grinder disc, filled the voids then sanded the edges.



We sistered on some 16" wood I-beams to the floor joist, as shown, then install our curved 1" rims as shown in the picture below.



After we installed the 1 1/8" flooring onto the I-beams, we had an extremely solid cantilevered floor.

The next procedure was to install the Roseburg lvs (laminated veneer lumber) on the catwalk.

We built all of the load bearing headers out of lvs, and anywhere we were going to

attach an lvs to a header we installed double trimmers. Small detail, but very important.



As shown we installed 3 on one side and two on the other side.

The space in between the lvs was a heating and cooling chase. Each of these lvs will carry a load of 5000# in the center of the 24' span; the sag would be 1/8" (Engineering results we obtained from Roseburg). The catwalk was 5' wide and 24' long, 120 s.f., and could easily have 30-200# people on it at one time. This is absolutely no time to skimp on materials. There is no time in construction to skimp on materials. A staircase should hold a load of one 200# person on every 3' wide step and a catwalk should hold the same for every 4 s.f. of floor area. Look up "stair disasters" on the internet, there are no exceptions to this law of stair building.

We then used recessed carriage bolts to bolt the laminated beams to the lvs.



On the one above we had to use a hillside hole (hole drilled at an angle) for the bolt. All the others we bolted straight though.

It is better to use carriage bolts on these connections instead of using lag bolts, because you can't get the compression with a lag bolt that you can with a carriage bolt. If you don't have all of these members compressed together you are going to have deflection, and when you have deflection the beams are going to sag. I cover this extensively in the Carpenter Book.

Deflection is when you are under a wood floor and someone above jumps on the floor and the bottom of the joists move (vibrate) sideways at the bottom. Nailing a simple 1x4 on the bottom (perpendicular to the floor joist) and in the center of your floor joist will decrease deflection of the joist and make the floor feel more solid. This is the reason we use bridging, blocking and bracing on floor joist, to reduce the spring effect.



The bolts stabilized the cantilevered curve of the laminated beams. We set a pallet of 8x8x16 blocks (3000#) on top of this catwalk; we had no sagging or deflection of the beams. Roseburg was really helpful on this project; they actually called me back on my cell and gave me some advice, usually unheard of with a big company like Roseburg.

The way to measure sag is to cut a 1x2, 1/8" shorter than the beam is off the floor. When loaded this 1/8" should close, but it didn't.



This was not a project that will be repeated very often.

We priced these curved beams and the delivered price was about \$14,000. We bought the material, built and installed them for half of that.

Building engineered (any time you glue two or more pieces of lumber together you have created engineered lumber) beams is not a project for everyone.

If you noticed we installed 5 lvl's that will more than carry the live load (people walking on it) and dead load (the weight of the material used to build it) of the catwalk we built.

The Roswell building inspector on this job, Charlie Purcell, had a lot faith in us to let us do this. We proved our capabilities when we set that 3000# pallet of blocks in the center of the catwalk and had no deflection or sagging.

When you go to do a project like this you want to make sure you have a "carpenter friendly" building inspector like Charlie. He can make you or break you. You absolutely never want to build something that won't more than carry the load to be applied. There is no excuse for it. Building inspectors and manufacturers are more than willing to help you calculate the loads and determine the members to carry these loads. Spending an hour with a building inspector could save you days of repair work and a lot of money.

Building something that you are not sure of and that you may think it will not hold the anticipated load should give you a severe case of insomnia; at least I hope it does.

It makes more sense to build it right the first time.

I have written a book on carpentry and construction procedures available at <http://carpenterbooks.com>. It has over 200 procedures that every carpenter and contractor should know.

If you have any questions about these procedures you can get in touch with me by email that's on our website.

Bob Johnston, carpenter