Shay Tender Frame

Nelson Riedel Nelson@NelsonsLocomotive.com

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The tender frame was built before the main frame because it is smaller and much of it is hidden (which means the poor quality work and screw ups are hidden.) One thought was to try out some different methods before doing the main frame. In fact, the tender frame has evolved several times during this process.

Kenneth welded his frame. One of my main concerns was that I'm not a very good welder. Some test welds were made on scrap pieces of channel. The welds were strong but the weld beads weren't uniform and there was splatter everywhere. A small wire welder with the flux in the wire was used. Acetylene might have worked better, but there is no way I could weld up a frame that matches the quality of the completed trucks.

The prototype frame was riveted together. Drive screws can be used like rivets and then everything silver soldered together. Unfortunately, the drive screws don't hold very well before the joints are soldered. It's also nice to be able to take stuff apart and reassemble them during the fabrication process --- drive screws don't permit easy disassembly. Another problem is that my sulfuric acid pickling solution eats the drive screws pretty quickly.

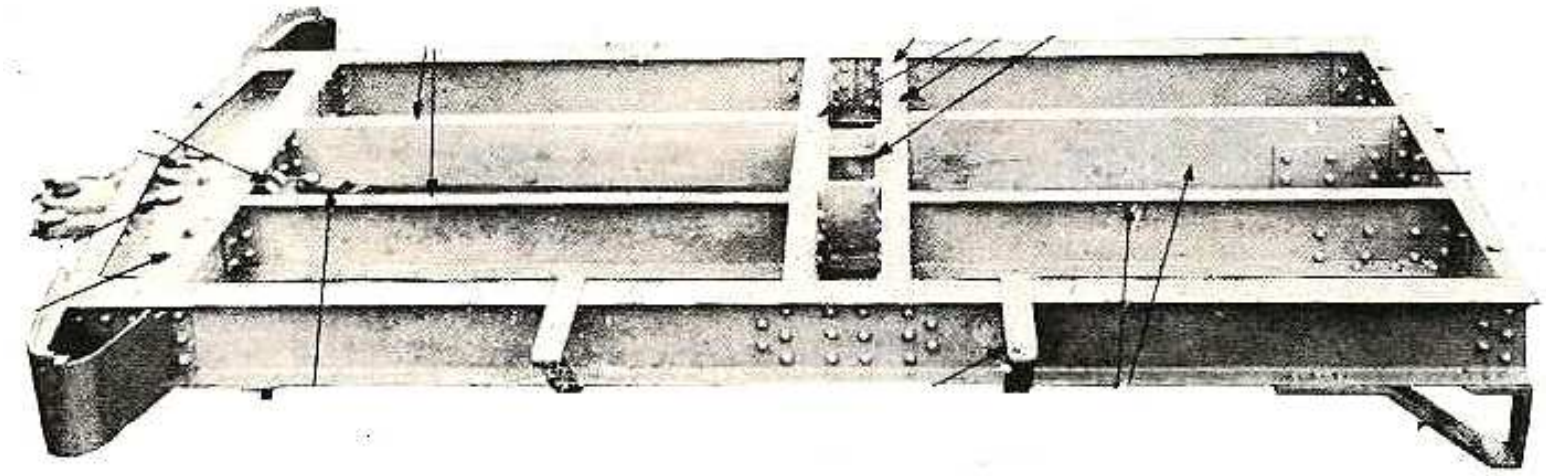
Another concern is to make sure everything is solid ----- don't want the rear coupler and sill to break off when the clutch is popped in low gear!

In response to a question about accessing the pump in the tender tank Kenneth said the rivets in his tank top are decoration and didn't actually hold the top in place. He said every so often he used a ***button head cap screw*** instead of a rivet to hold the top in place. He said these screws are nearly indistinguishable from the rivets, Some of these screws are shown below.

These screws came to mind later when trying to solve the tender frame problem. The 4-40 screw has a 0.112" diameter with a head diameter of 0.213" and 0.59" height. The Lima frame drawing shows all frame rivet holes were drilled 13/16" That scales to 13/128 = 0.102" ---- very close to the 4-40 screw diameter. The head diameter is probably pretty close to the rivet too. The socket is 1/16" hex. The hole will be pretty well covered when the frame is painted. If it is a concern, the holes can be filled auto body putty before painting. These are exactly what was needed and it was decided to use these screws everyplace on the frames where rivet detail is required.

The plan at that point was to screw everything together and silver solder the four corner joints and the joint between the truck bolsters and the frame side channels. However, when everything was screwed together it was rigid. That was before the 1/8" tender floor plate was attached Once the floor is there, it will really be rock solid. As a result, the plan was changed again to just screw the channels together. It is really nice to be able to take everything apart to modify a piece if required. Some smaller parts were silver soldered to the major frame members.

Kenneth's major emphasis is the castings and he furnishes very detailed drawings on how they are to be machined. He also includes drawings for the frame, cab, tanks, etc. for the Shay he constructed. These drawings are an excellent resource. However. I am not at all reluctant to deviate from the cosmetic aspects of his design. I am reluctant to change overall dimensions or to alter structural aspects without considerable thought. Since the plan is to not weld the frame together, it was decided to learn more about how the prototype frame was riveted together.



There was no tender drawing in the collection of Lima drawings obtained from Kenneth . There was a main frame drawing that closely matches the main frame design Kenneth used. The tender frame drawing above is from a reprint of an early Shay Spare Parts Book. This frame has internal channels that run parallel to the side channels. There are no internal channels in Kenneth's design. These internal channels are required on the prototype to support the heavy load of water. The initial plan was to not have the internal channels, but as the design evolved the final plan was to add the internal channels using only screws to hold them in place. This should help keep the ends from being pulled off. It is also reassuring since the tender must support the ~8 gal of water (64 pounds) and the engineer (assume 200 pounds).

Another thing changed from Kenneth's design is the height of the truck bolster. He uses 1 1/4" high channels with the bottom in line with the bottom of the side channels. The top of his bolster is 1/4" below the top of the side channels. This is the standard arrangement for the bolsters on the main frame. It was decided to make the tender bolster the same height as the frame sides matching the drawing above. This will permit a support under the middle of the tank floor plate.

Another difference between the drawing above and Kenneth's design is the curved end on the left that is between the the tender and the main frame. There was a matching curved on the locomotive main frame. Cass No 5, Lima Number 1503, an 80 ton class C build in 1905 has similar curved ends as shown below. (It looks like someone left their lunch on the middle truck. I spent several hours climbing over that thing and never noticed the brown bag.)

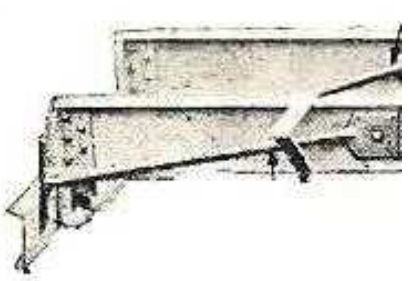
I'm modeling a locomotive of of the 1910-1912 era with Cass No 5 as the primary source for details. However, several areas will be different. The biggest difference is Cass No 5 doesn't have the cast crankcase --- that was introduced a few years later. Note that there are no rivets on the tender tank. The original tank was probably replaced with a welded tank. The under frame supports are very close the Kenneth's drawings as is the rivet detail in the side frame member.

The next two photos are of Cass No 2, Lima Number 3320, a 100 ton Class C built in 1928.

The left photo shows nice rivet detail on the tender and is likely what I'll use. The right photo is a close-up of the front end of the tender frame. The front frame member is straight, not curved and shows nice rivet detail. This closely matches Kenneth's drawings and is what I decided to use..

The final area of design interest is the rear frame member and the rear end sill. The photos below show the the rear end sills of Cass No 5 on left and Cass No 2 on the right. The plan is to use the rectangular end sill specified in Kenneth's drawings that closely matches the Cass No 5 in the left photo.

The frame end members are different between the main frame and the tender frame. The drawing on the right shows the rear of a Class B frame with the rear channel mounted low to line up with the coupler pocket. For the tender, the top of the channel is even with the top of the other frame members as shown on the right side of the first drawing. This is probably to give better support to the water tank. It was decided to mount the rear channel high like the first drawing and install a bracket below the channel to attach the coupler pocket.



The main pieces of the tender frame are the two sides, two ends, the bolster, the four internal channels and the floor plate. The approach was to finish each of these pieces as completely as possible and then fasten the pieces all together. The next photo shows how the frame looked the first time it was assembled.

I was very pleased with the frame at this point. It was square and very rigid with less than 20% of the screws in place.

The only thing I didn't like was the frame brackets. The brackets looked good in terms of matching Kenneth's drawings. My concern was that they seemed out of proportion. They are a close match to the brackets shown on the Lima main frame drawing. I guess the biggest problem is that the bracket material is 1/8" thick which would scale up to 1" on the prototype. Since the brackets are positioned on top of the side channels, the floor plate will not make contact to the frame channels, it ill be 1/8" above the channels.

The prototype tender floor was made of wood planks that rested directly on the channels. The planks are easily identified in some of the Cass photos shown earlier. The brackets don't support the planks but rather support an angle iron finishing piece under the outside edge on the planks. The photos below show some additional views the brackets used on the Cass shays. The left photo shows the brackets on a Shay tender carcass that I assume is being used for spare parts. The brackets on this tender frame are steel triangles with angle iron attached on both sides of the top edge and both sides of the edge next to the

frame. The right photo shows a bracket on the main frame of Cass No 5. This same style bracket is used on at least several of the Cass Shays. It appears that the angles were riveted to the triangles and in many cases the angles were also riveted to the frame channels. My guess is that if the brackets were removed for some reason, the were sometimes reattached using bolts.

The sample triangle bracket shown in the photos below was made to see how it looked. The bracket was made from scrap 0.035" thick (20 gauge?) galvanized steel. The rivets are #2 drive screws. The bracket is temporarily stuck to the frame with putty. The triangle bracket appears much smaller than the original bracket. However, both stick out the same distance from the frame. The right photo shows how it will look when the floor is in position. This look was appealing and it was decided to use the triangle type brackets on both the tender and main frames.

The flat bar brackets and a 1/8" X 1/2" flat bar screwed and silver soldered to the top of the front frame channel were removed. Each triangle bracket was then attached to the side channels with six 2-56 button head cap screws.

The final piece of the tender frame was the rear sill area. The coupler packet was machined per Kenneth's drawings and side brackets were made similar to those on the frame sketch shown at the beginning . Hardwood hasn't been obtained yet for the sills so a temporary sill was made from scrap cedar to see how everything fit together.

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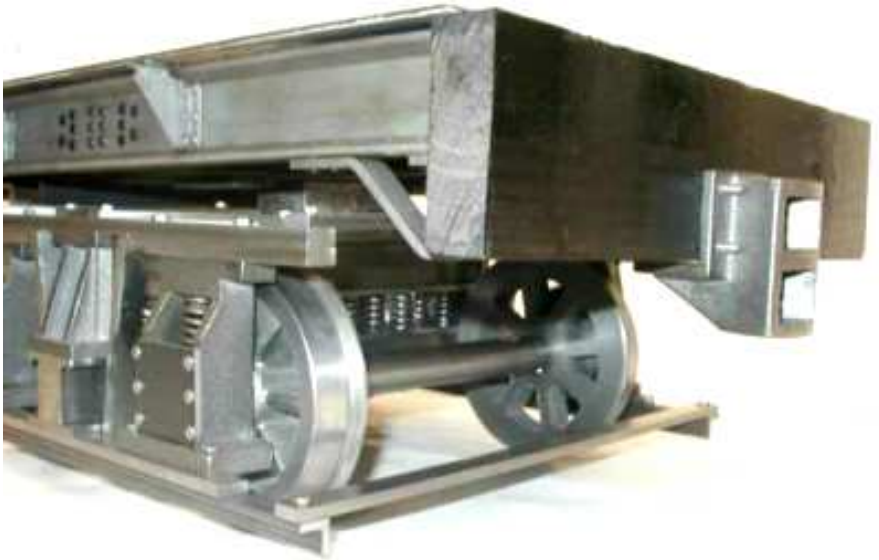
View showing internal channels and bolster.

View showing side detail

Close up of end sill with floor plate setting on frame.



View looking up showing how floor sets on channels and frame brackets.

Rivet detail on the front.

The final sill details such as running board, poling pocket, turn signals, brake lights, etc. were postponed. There needs to be a finishing touch to the side edges of the floor that be done when the water tank is added.

Check out the accompanying Tender Frame Fabrication note for some of the construction details.

On to the main frame ---- which will be assembled using screws!

Shay Home
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