Building a Home Track

by curt young
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Introduction

I started my track in 1996 because someone loaned me a bulldozer to build a pond. When I finished that project I thought I would just rough out a railroad track right-of-way. Over the next 10 years I worked weekly on the track, and now have 2000 feet of mainline, a 100 foot long trestle and a 100 foot long tunnel, and I still have a ways to go (see photo below). I have done a few things right and a few things wrong. The intent of this article is to let others gain from this experience so if they build their own track it will be a more efficient project. I have included a lot of things I wish I knew, and things people have asked me about track construction. I present specific figures, but take them as guidelines rather than absolutes.

Aerial View of My Track Layout

If you are considering building a home track the first thing to consider is your own personality. Anyway you slice it there is a lot of hand labor involved, with much on your hands and knees. So your personality should be slanted towards a person that is able to finish long-term projects and enjoying working alone with hands-on projects. If you have a life partner make sure they will not object to being a “railroad widow”. Expect to do 95% of the work yourself. Work parties are great for some
aspects (laying ballast and track), but most of the work can be done by one person. My experience is that volunteers quickly tire of the task if they are not stakeholders. Expect to spend about 75% to 90% of your time on getting the grade prepared to lay track. Cost in time is substantial, but there is also cost of materials, tools, and equipment. A front loader on a tractor is almost a necessity unless your lot is small and very flat.

To see what works for you get a 100-foot tape, a transit and a bunch of stakes. Hopefully, you will not have a lot of trees and shrubs in the way. If you do, it is a lot more difficult, and then it is definitely a 2-person survey job. (If you have objects you can’t survey through, like your house, read the article “Curves by Offset” in the March 1992 issue of Modeltec magazine.) The first thing to do is to swing a few rough arcs to see what maximum radius you can hold. The smallest radius and steepest grade sets the limits of your track. Also, beware of bio-slime from overhanging trees, which can seriously reduce traction.

Slope and Radius

The major factors in designing a track are degree of slope and radius of curve. At 1% slope (1 foot rise over 100 foot length) the engine has only 26% of the traction compared to level ground. At 2% you are at 13% traction. So keep the grade at less than 1.2% for most of the track, with a few spots at 2+% for a little challenge. At most a 2.7% for a short period. A grade over 3% will require sanding for traction when the track is wet, even with only the engineer on board, especially with aluminum track. With wet rail even 2.7% can be a challenge. If you have a grade on a curve it is even worse, as you have added flange friction that also reduces tractive effort. Option - get a geared locomotive.

The radius of the curve is another limiting factor, especially for steam engines with longer wheelbase. Depending on wheel configuration, and other factors, each engine has a minimum radius it will handle. Except for the smallest steam engines anything less than 40 feet will be a problem. For a home track, with space problems, I recommend 55 foot as minimum radius, and if that is not possible, no less than 47 feet. Remember the smallest radius curve determines the limitation of the track. A diesel engine will handle much smaller radii, but below 35 feet radius you may have trouble with coupler travel, unless you have an extra wide coupler pocket. For public tracks I recommend a minimum of 70 foot radius, with 65 foot being at the low end of acceptable. For the radius I stake out the inside rail. It is much easier to lay the inside rail against the stake than have stake in center of track.

If you use scale rail most build straight and curved sections of 10' panels in the shop. I prefer an 18” overlap of the rail. Make a gauge for this so each section is exactly 18” so you do not have to trim ends. The curved sections of rail should be pre-bent to your radius. Otherwise the rail will want to assume the natural shape of a straight rail over time. Pre-bending is not needed with strap iron rail. Also, if you want a smooth track you should have a transition curve between the straight and curved sections on anything less than 90 foot radius. This can be “eye balled” when laid. Also, when going from a right hand curve to a left hand curve always put at least a 10' straight section between them to minimize the whiplash effect. Also, switch radius may be larger than your track radius. Since these three factors increase the effective radius it is best if you add at a foot to your minimum radius when surveying. If you don't, you will probably have to compensate with a tight curve to make up for these factors. And of course this reduces the effective radius of the track.
Track Layout

When designing the track there is a lot of surveying work required, plan on this. You will need a transit that is reasonably accurate, say 1/4 inch in 100 feet. Here is an easy way to check the accuracy of the instrument. Find a nice smooth paved parking lot or something similar. Mark two spots about a 100 feet apart. Set up over one point and measure carefully the distance from the ground to the center of your eyepiece. Record that reading. Have someone hold a rod or tape on the other spot and take a shot on it. Record the difference in elevation between the two spots. Now pick up the level and reset it over the second spot and do the same procedure looking back at the first spot. If they record the same difference in elevation, your level is correctly adjusted. If there is a difference between the two readings (say 1 inch), then adjust the level screw on your level until you adjust for one-half the error (1/2") while still looking at the rod. Your instrument should now be properly adjusted. This is assuming the bubble stays level when you rotate the head.

Since you will be doing a LOT of surveying I recommend you put in control points. Select areas that are central to your layout and out of the way of future construction. Keep them within the accuracy of your survey equipment. You may have to reference several control points to each other to cover the whole area. Drive a steel stake and call the top zero. Then when you survey your points along the radius they will be plus or minus X inches from this control point. Whether you come back tomorrow or a year later to re-survey, all data points will be referenced to the same elevation. This is important, especially when you are doing the cut and fill.

I found that a homemade Stadia rod worked best. I took a 1 x 2 board 7 feet long, drilled staggered holes 1 inch apart, painted it white, and marked it like a giant tape measure. The holes were drilled to fit a 16 penny nail. Take 6 nails and paint half of them yellow and the other half green, we will use them later to set grades. Paint one nail black. If working by yourself use a camera tripod to steady the Stadia rod. Shoot the reference point and put the black nail in the hole at the cross hairs and call this “zero”. An adjustable foot on the Stadia rod makes this easier. Then shoot elevations every 25 feet and mark the difference from “zero” on your hand made map, drive in a stake and write the elevation on flagging attached to the stake. Once done you can figure out grades and how much cut and fill will be needed. For a 25 foot interval a 6” change in elevation is a 2 % grade, a maximum number to shoot for. Ideally you will not have trees and shrubs on the land, so a non-stretchable cord can be used to swing the arc for the curves. Two people here is highly recommended.

I would encourage you to survey in your entire “ultimate” track plan and commit it to paper before breaking ground. If possible put in a reversing loop for each direction (see track layout photo at beginning of article). When you change direction it looks like a whole new track, as you are seeing everything from the opposite direction. So it is kind of like a track doubler. A Wye will work smoothly in only one direction, but is an good option if space is a problem. Some sections may not get done for years, but it is a real downer to take up old track and move it, when the new proposed track addition will not fit. Matching the old grade to the new grade can be a major problem if it has to connect in more than one location, which is another reason to get it all on paper first. I had to build a spreadsheet, with formulas, to figure out variables for a long tunnel and overpass I added years latter. Fortunately I had allowed enough room, just did not take the time to survey the elevation points to compute the cut and fill operation to keep the grade under 2.7%.

As mentioned above allow for transition curves, straight sections when changing curve direction, and recognize that the switch radius is usually larger than the track radius. Survey in desired radius plus 1 foot to make it easier to make it fit.
You should also plan on a loading/unloading area and steaming bays. With this you should have water, electricity, and compressed air. Steaming bay height should be around 30 inches. Some type of storage shed for your equipment is also necessary. Think about ground moisture in shed and lay down heavy plastic under cement, or for us cheapies, gravel. An elevated track works well also as you can put down drip pans and lights underneath for heat if desired. Below is a 1200 pound capacity hydraulic lift I use.

I like the roll around lift best as vehicle does not have to be so precise in backing up, as lift can move to vehicle and all tracks in the vehicle. The lift range is also a concern. A trailer can be 16 inches, and my have multiple heights of storage. A pickup can be 40 inches. If lift does not have enough spread one might be able to build a two level loading area if there is enough space.

Rail

You have three options, aluminum scale rail, steel scale rail, or strap iron. Aluminum rail is relatively easy to buy, but not locally. It has the disadvantage of having highest expansion coefficient, and the lowest coefficient of friction, and it is, well aluminum colored. It is also a more flexible than steel so any track imperfections or mole holes show up as dips and bumps. Steel scale rail is about twice as expensive as aluminum and harder to order as it is not made in U.S. Scale rail of both varieties come in 10' lengths so it is easy to build panels in shop and transport to track for laying down, but you have a lot of joints. If you use slip joints beware that there is no limitation to joint expansion. Can be a problem, especially on the curves. The more positive bolt on rail joiners are better, but does require a lot more effort to drill rail and attach. Strap iron is the third option and can be bought at any local steel vendor. Get the hot rolled version as it is cheaper. It you get stuff that is only run through the die once it will have a rounder top, which is good. The normal stuff you get has a pretty sharp edge. I do recommend that you grind a radius on the inside of the rail to minimize the potential for wheel wear. You can buy material in 20 lengths of various dimensions. One inch by 3/8 inch is the cheapest, and works perfectly well. Some want more rail clearance and get 1 1/4 by 3/8. You can even go whole hog and buy 1/2 inch wide material. I butt welded the 20 foot sections into 60 to 80 foot long sections to make a smoother track with less joints. But keep a joint close to any cement crossings, just in case it needs replacement. Strap iron rail construction is done on the track. Lay the rail on top of 4x4 blocks every 15 feet and adjust to proper curve. Then with a home made tool press on the notched ties. Tap the end of a tie in one direction to adjust radius and fix warbles. When done, lower track to grade, fine tune and ballast. The current standard is 7 5/8 inch rail spacing. If you use about 2.5 inch tie spacing you can get the tie snapper tool between the ties to seat a tie. A large channel grip pliers works well to re-seat ties also. The head of the tie snapper is show below. Make the angle iron head 6.5 inches, the support bar 9 inches and the handle 4 feet. Don't make it too flimsy as a lot of force is needed.
sometimes.

Building the grade and laying track

The amount of work required to build the railroad depends on the amount of cut and fill required, tunnels, trestles, bridges, etc. Figure that laying the track is like putting icing on the cake. Ninety percent of the work will be in site preparation. Above I said I put down survey markers every 25 feet. For the final grade I put a grade stake every 12.5 feet. Add fill to the correct grade around the stakes, fill in between stakes, then use a 14 foot board to check for dips. I then hand tamp the sub-ballast so it is flat. I tried to keep the grade to at least 1/4 inch variation from survey elevation. If you have less patience than this you can rough in the grade, pack it down, then prop the track up to needed height and put down the ballast. This works best if you then use a hose and put nozzle between each tie to wash ballast under them. Let it sit and settle in before running on it. It is easier to use a board to get the grade flat than to put a board or string on the constructed track, especially with curves.

I feel a radius gauge is needed to lay your track properly. Make it at least 10' long, and 14' is good, but awkward to carry around. I have a separate writeup on how to make one.

Based on my experience I recommend at least 8 inches, and preferably 12 inches of sub-ballast base beyond the end of each tie. Remember you will loose about 2 inches on each end when ballast is filled to top of tie. I cut a landscaping rake to 40 inches to measure and smooth out final base before laying tack. While this wide of a base is not prototypical, it gives you a place to stand for track maintenance. Also, over time the slope will erode and if top is too narrow it will leave the end of the tie unsupported by ballast, which is not good. When tamping ballast do it just under the tie ends. Tamping in center can cause tie to rock if ballast pushed slightly higher or firmer. Hydro packing is ideal, either from heavy rain or use of a hose. Near the head of landscape rake I installed a torpedo level so I could tell when grade is flat side to side.

For your slopes think about maintenance needs in 3 years when grass is mature, unless you plan to keep
them entirely in weed free ballast. If so use heavy fabric underneath for sure. This will not keep it weed free as they will grow in ballast, but it helps and weeds easy to pull. Lesson learned - plant lawn grass or clover along track, not pasture mix as this grows too fast and tall. When the side slope is raw dirt it looks great at 45 degrees. But when knee high in grass it looses a lot of appeal. Many of my berms are 3 to 4 feet high, so after one year of manual grass cutting I went back and added several hundred cubic yards of dirt to make them less than 30 degrees, so I could mow them with a tractor. If you make them prototypical at 45 degrees, you have to cut grass and evergreen blackberry by hand, your choice.

For the layout I feel straight sections are boring, well planned curves add character to the track, but avoid curves on grades greater than 1.7 percent if possible. Landscaping should be designed so shrubs are planted at curves, and in other strategic spots, so you can visually shield the upcoming track, adding mystery to the track, and the ride will seem longer. When planting shrubs and trees figure out what the mature width will be. Then plant so you will have a 5 foot space between the track and the limb tip. It seems odd to plant a 18 inch fir tree 25 feet away from the track, but that is what it takes unless you want the tree limbs to grow over the track. Also, if possible plant the tree to give afternoon shade on the track.

If you have wet spots on the right-of-way it is advisable to run drainage tile. Otherwise soft ground will result in track maintenance problems as the weight and vibration of train will soften base by pumping water up from below. A good base will provide almost zero track maintenance over time. About the only track maintenance I do is fix the superelevation on the curves every couple of years, and replace a few broken ties. Weed control and trimming shrubs will be the biggest problems, unless you live in the desert. Grass, weeds, and blackberries will grow in the ballast and along edges causing a constant fight, at least in Western WA.

I prefer a nicely packed base by compacting dirt with machines and water, no sod. Done properly a 4 foot high fill will settle less than 1 inch over the next year from my experience. Once your base is firm put down 2” of 5/8 minus gravel, preferably with a minimum of “dirt” as filler. Some quarry sites are better than others. If you have spongy ground, you may need larger base rock, and perhaps you will need to lay down landscape cloth first. I have not noticed any difference in weeds whether I used landscape cloth or not.

Next lay the track and ballast. Some espouse the use of more prototypical 3/8 or 5/8 clean ballast, but if you use this type of ballast the ties should be 3 1/2 inches deep, otherwise the track will just slide around like it is on ball bearings. Plastic ties are great as they are already made, last forever, but are expensive. I used wooden ties soaked for 2 months in motor oil, wood preservative, and diesel. A 55 gallon drum will hold 200 ties. If you keep the moss and leaf matter off of them the ties will last for about 12-25 years. If you go this route make the rounds of construction sites and see if you can take any 2 x material over 16 inches long. Then rip, cut to 16 inches, notch (if you use strap iron), and treat. It takes about 3 ties per foot, so start this process early. Switches of course take longer tie material. For this I cut to length, notch the straight section, and treat.

Crossings

For temporary crossings I made two 2x8 wood structures. They have to span the track and the ties, so make them 22 X 18 inches. With the 22 inch dimension nail a 2x6 with a 2” overlap. On top of that nail a 2x10. This provides 3” of lift and a built in ramp for the tires.
Permanent crossings should be cement. They should be built with strap iron at least 1 x 3/8 inch. If you have an active crossing 1.5 x 3/8 is even better. If using scale rail, and you want tops to match, use 1/2 in. wide strap iron. Make concrete at least 12 feet wide to minimize people driving over track. Some 6-8 inches of concrete beyond the rail and 3.5 inches deep is sufficient, unless base is soft and heavy gravel trucks are expected. Use rebar in the cement. Unless the crossing is perfectly straight I laid the rail to the shape I wanted then pressed slotted ties every foot along the top to keep gauge and radius. Then lifted it up with front loader and carried to shop to weld straps on bottom of rails about every foot. Then knocked off wooden ties. This method minimized potential welding distortions.

The prototypical crossing has two narrow slots to allow room for the flanges. I have found this to be difficult to keep rocks and debris out of. I find it far superior to screed the cement so there is a 3/8 inch depression between the rails. Make a wooden scraper that will follow on top of the rails, and stick down 3/8 of an inch between the two rails. This gives room for wheel flanges and is easy to sweep off rocks, dirt, debris, and snow. The cement on outside of rail can be just below top of rail.

Happy Rails To You!