How-To: Design, Estimate, and Conceptually Build Custom Metals Fabrications

Objective: By mastering this lesson, you will be able to design, estimate and conceptually build custom metals fabrications. You will learn:

1. What common terminology and specifics to the custom metals fabrication industry should I be aware of?
2. What should I use for top rail?
3. What should I use for pickets?
4. What should I use for posts?
5. What should I use for bottom rails?
6. What should I use for weld tabs?
7. What code requirements should I be aware of when designing my railing?
8. What types of materials are available and common for metals fabrication?
9. What are the available coating options?

What common terminology and specifics to the custom metals fabrication industry should I be aware of?

> **ASTM International.** When it comes to reading up on technical standards for materials, products, systems, and services, you often come across documentation published by the American Society of Testing and Measurements, a nonprofit organization that's published approximately 12,000 technical standards, specifications, guides, and practices to date.
>
> **I.D. vs. O.D. (Inside Diameter vs. Outside Diameter).** The custom steel fabrication industry is synonymous with the structural and mechanical industries. When it comes to pipe sizing, profiles are referred to according to plans in the I.D. So, when you see a pipe product referred to as 1 ½" pipe, the architect was not being sloppy in referring to 1 5/8" O.D. pipe. He is actually referring to 1.98" O.D. pipe.

When looking at "I"-beam measurements, the first dimension is the width of the webbing. (This is the outside distance between the flanges.) The second dimension is the weight per foot.

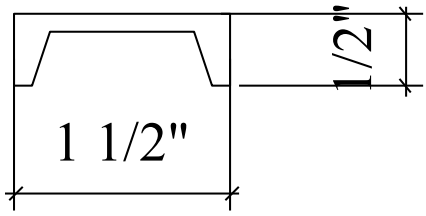
> Note: Flange width can be determined by your steel provider.

When looking at channel measurements, the first dimension is the width of the webbing. The second dimension will be either the weight per foot or flange width. This will be obvious.

What should I use for top rail?

Without question, your choice of top rail should reflect the needs and wants of your customer. However, in many cases, it is your responsibility to make a judgment according to design, application, and price and then educate the customer on what the best choice is.

1½" x ½" x 3/16" channel

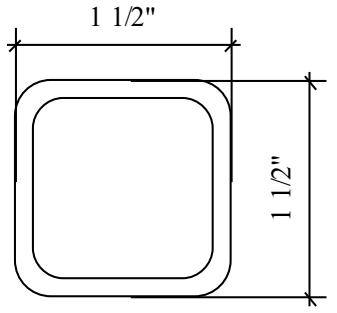


Pros: Inexpensive, and you only have to weld two sides of the picket and/or the welds can be unfinished in consideration that the sides of the channel hide the point of attachment. Also, you can punch through the material with Iron Worker.

Cons: In consideration that this is a single-profile material, when you weld the picket to the rail, you heat the entire width of the profile, causing it to bow. Also, welding the picket to the underside of the channel may leave weld burns on top of the channel. Not a good choice if the end goal is a smooth railing.

Available lengths: 20'

1 ½" x 3/16" tube

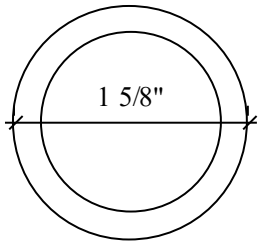


Pros: This being a double profile, when you weld the pickets to the underside of the tube, it does not heat the entire width and sides of the tube, resulting in very little bowing. This tube is an excellent choice for providing a continuous and smooth railing to run your hand along.

Cons: Because the railing is tubular, you have to vent for galvanizing. Also, this is more expensive than channel. Welds have to be complete because these show from the sides.

Available lengths: 20' & 24'

1 ¼" (1.625 tube) x Sch 40

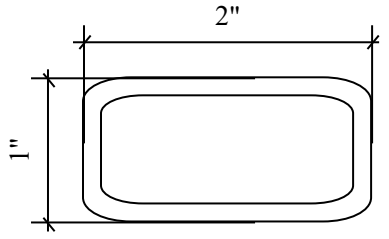


Pros: This being a double profile, when you weld pickets to the underside of the tube, it does not heat the entire width and sides of the tube, resulting in little bowing. This tube is an excellent choice for providing a continuous and smooth railing to run your hand along.

Cons: Because the railing is tubular, you have to vent for galvanizing. Also, this is more expensive than channel. Welds have to be complete because these show from the sides. Also, because of the round profile, the pickets do not sit entirely flush against the rail or posts. For this reason, the posts may have to be coped in order to fit.

Available lengths: 21’

2” x 1” x 3/16” rectangular tube

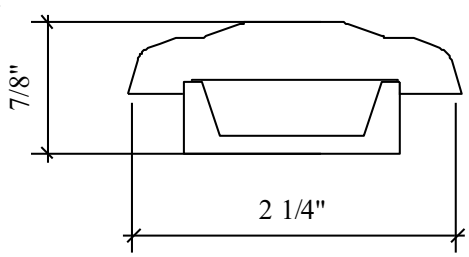


Pros: This being a double profile, when you weld the pickets to the underside of the tube, it does not heat the entire width and sides of the tube, resulting in little bowing. This tube is an excellent choice for providing a continuous and smooth railing to run your hand along.

Cons: Because the railing is tubular, you have to vent for galvanizing. Also, this is more expensive than channel, pipe and square tube. Welds have to be complete because they will show from sides. Due to its size, this product may not be acceptable for continuous top rail.

Available lengths: 20’

2 ¼” cap rail with 1 ½” x ½” channel underneath

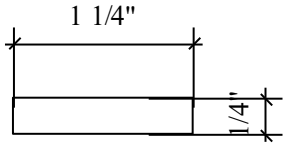


Pros: This product is very attractive and provides your railing with a higher-end look.

Cons: This product is expensive, requiring two profiles to complete installation, special order materials, and additional fabrication for attaching the channel to the cap rail.

Available lengths: 8’ for UPS, 10’ and 20’

1 ¼” or 1 ½” x ¼” flat bar:



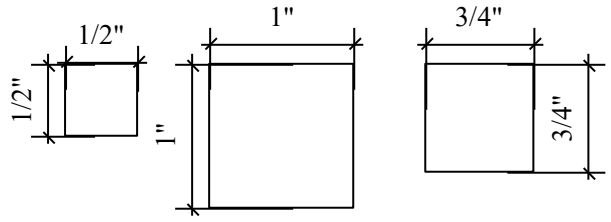
This flat bar would be primarily used when mounting a wood cap rail to the top of the top rail. For this application, drill holes in the flat bar (alternating from side to side over the length of the rail). Attach the wood cap rail to the flat bar using wood screws underneath the bar.

Available Lengths: 20’

What should I use for pickets?

Without question, your choice of pickets should reflect the needs and wants of your customer. However, in many cases, you will want to make a judgment according to design, application, and price and then educate the customer as to what is the best choice.

½”, ¾” & 1” solid square pickets:

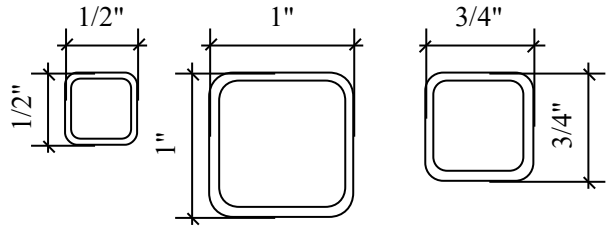


Pros: Solid steel pickets provide that true wrought iron look.

Cons: Solid steel pickets are more expensive, more time-consuming to cut, and do not fit with all railing adornments because there is no radius in the corners. Painting may chip at corners due to the lack of a radius.

Available lengths: 20’

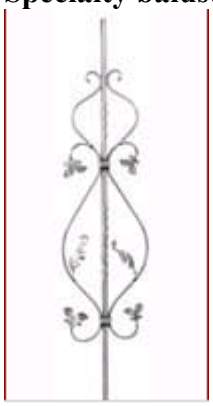
½”, ¾” & 1” x 16 ga. tubular pickets:



Pros: Less expensive than solid. Provides a nice finished look with the radius corners. Requires less time to cut.

Cons: None.

Specialty balusters and pickets:



Pros: With some additional costs, you can make an ordinary railing look extraordinary. The pickets come prefabricated with scrolls, twists, bends, adornments, etc., reducing your overall fabrication and required expertise.

Cons: Expensive, difficulty ordering correct materials, specialty ordering, calculation to fit into railings.

What should I use for posts?

Generally, your posts are the same size and composed of the same material type as your top rail—with the exception of channel. When fabricating railings, ensure that your post is not larger than your top railing—as is the case with fencing.

Posts Profiles: 1 ½” square tube, 1’ square tube, 1” solid bar, and 1 ¼” (1.625” O.D.) pipe are all typical selections.

What should I use for the bottom rails?
If the pickets are to extend through the bottom rail, select a channel so that you can punch the rail. You can not punch tubing and you can not drill a square hole. If the pickets do not extend through the bottom rail, you may still consider channel in addition to square tube, pipe, and flat bar. The rail cannot be wider than your posts.

Bottom Rail Profiles: 1 ½" x ½" channel, 1 ¼" x ¼" flat bar, 1 ½" square tube and 1 ¼" (1.625" O.D.) pipe are all typical selections.

What should I use for weld tabs?
Steel fabrication product providers such as King Architectural provide an endless array of weld tabs, plates, castings, etc. for your use. The key to selecting the right tab is determined by: a) how you plan to attach the railing to the surface, b) where are you going to attach the railing, and c) how often. (A common weld tab for post attachments is shown below.)

Placed perpendicular to the railing, the weld tab allows two points of attachment per post, better stabilizing the lateral movement of the rail.

What code requirements should I be aware of when designing my railing?
Code requirements only apply to railings and items used as guard rails to: prevent people from falling off ledges or decks with drops greater than 30," or to assist people down/up steps and ramps exceeding a 1:12 slope or more than one tread respectively. Railing codes are different for residential and commercial applications. Residential is considered single family. Commercial is considered multi-family, apartments, retail, commercial, industrial, etc.

1. **Height.** On residential applications the requirements is 36" minimum. On commercial applications the requirement is 42".
2. **Opening.** Openings in the guard rail cannot exceed 4". (In other words, if you can pass a 4" diameter sphere through the railing, it will not meet code.) Please be advised that testing may involve some slight pressure on the materials; so a good rule of thumb is to use a 3 ½" opening as a standard.
3. **Load Requirements:** The railing should not deflect more than an inch from its stagnate position when a 200 lbs. load is applied horizontally and vertically.
4. On stairs and ramps, the grab rail is typically required to be 34" above the stairs. This measurement is taken from the center of the rail to the nose of the tread.
5. On commercial stairs and ramps, you are required to extend the end of the grab rail 12" horizontally beyond the end of the ramp/stairs. The only exception would be when you have a set of stairs that double back. In this situation, you're required to continue the grab rail around continuously to the next set of stairs.

6. On commercial stairs and ramps, if the stairs/ramp are considered handicap accessible, you are required to place a second grab rail 12" o.c. below the top rail. This rail shall run continuously and parallel to the grab rail above.
7. On commercial stairs and ramps, if the stairs/ramp are considered handicap accessible, you are required to place a 12" bull nose on each end of the grab rail, creating a blunt end. See handicap stair railing illustration.

What types of materials are available and common for metals fabrication?
Metals refers to all types of products including mild steel, hardened steel, cold rolled steel, hot rolled steel, malleable iron, stainless steel, aluminum, copper, bronze, etc. Within each type of metal product listed, there are numerous grades. With each variation in grade is associated a different price and specification. When estimating a project, pay attention to the plans and specifications for specific ASTMs and grades. In an effort to keep it simple, listed below are the most common metal products used in steel fabrication.

1. **Plate, channel, flat, and angle:** The most common is mild steel in accordance with ASTM A-36. However, there are various grades that may be specified such as ASTM A-36 Grade B. This particular grade is tested and considerably more expensive.
2. **Tubing:** The most common is ASTM A500 Grade B. This grade is a structural specification. Again, various grades with various prices such as ASTM A513 are used for mechanical purposes.
3. **Pipe:** The most common is ASTM A-53 Grade B. This product is not tested and is commonly used for steel fabrication. ASTM A-53 Grade F is used for mechanical purposes and is tested. More expensive.
4. **Aluminum plate, channel, flat and angle:** The most common is 6061 – T6.
5. **Aluminum tube:** The most common is 6063 – T52.
6. **Stainless steel:** Type 304 is most common. With stainless steel, this is a very expensive product with various grades and finishes. The common finish is mill finish, but polished finishes are not unheard of or difficult to find. This product will cost almost double that of a mill finish product.

What are the available coating options?
Shop Painting: This can be an enamel or oil-applied paint applied by puff-can, brush, roller or commercial sprayer. Also, detail work may be done with small brush and roller.

Pros: If painting only a few rails for an interior application, shop painting can be inexpensive and effective. It also provides several specialty options using patinas and a variety of colors on one rail.

Cons: If you don't have someone with experience painting, the end result can generate runs, peeling, and poor quality product. Also, in large quantities, this is not a cost-effective method. This process is not good for exterior quality.

Electrostatic Paint: This is an enamel-based paint that is applied wet by charging the paint with a negative charge and the steel item with a positive charge. When the paint is applied, it gravitates to the steel. The product will then require 24 hours to dry.

Pros: This process can be very inexpensive and effective for interior use.

Cons: This process may result in eventual rusting of uncoated detailed areas of materials as a result of inconsistent application. Not very good for exterior applications involving railings and detailed items.

Hot-Dipped Galvanizing: This process of coating involves dipping the item in a liquid bath of zinc-rich materials at extreme temperatures. The end result is a shiny silver coating designed to protect the steel from rust and corrosion. It is the accepted method of exterior metal coatings by architects and engineers.

Pros: This is an exceptional long-term method of coating steel to prevent future rust and corrosion.

Cons: The materials must be prepped for this process; preparations include venting all tubular railings so that the zinc flows in and the air flows out simultaneously. This requires a considerable amount of shop time in drilling and blowing holes in the materials. Materials may warp because of the extreme temperatures of the zinc. Hot-dipped galvanizing does not allow for good paint adhesion. Finally, this process can be very expensive yet still leaves your product to be painted.

Powder-Coating: This process involves cleaning the steel item by means of dipping it in a chemical bath under extreme temperatures. Once the material is free from all oils and debris, the product is electrically charged with a negative charge. In a sealed booth, the product is sprayed with positively charged powder paint, causing the paint to stick to the steel. While still charged, the product is placed into an oven where the powder is baked (melted) onto the steel. The end result is a consistent coating that has a candy-apple finish. This is the most widely used paint process in the exterior product market.

Pros: Because of the even application and melting of the product, the finish is exceptional. Generally speaking, the finish tends to be shiny, consistent, and very attractive. Because the product is melted on, the end result provides an excellent exterior weather application.

Cons: This process can be expensive. Also, in the case of very detailed work, the powder may not consistently stick to the steel, particularly in tight corners.