Galvanizing Plate Girders

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The American Galvanizers Association (AGA) offers a few tips to keep in mind when designing plate girders that will be hot-dip galvanized.

Until recently, girders were generally made of rolled structural sections, came in specific sizes, were delivered in certain strengths, were produced by several suppliers and were routinely galvanized. These hot-rolled sections with a flange-to-web thickness ratio of approximately 1.5 to 1.0, were massive and had only slight induced stress that was infrequently relieved by the 815° F (435 C) molten zinc used in the galvanizing process. If there was minor resultant camber or sweep in the web, normal field welding of the diaphragms would easily pull the girder into alignment.

As bridge designers more frequently use cold-formed plate girders with their infinitely variable size, shape and strength, engineers, fabricators and galvanizers (design teams) must proactively collaborate to deliver the highest quality product. The unique web and flange steel thickness, coupled with welding along sometimes 75 to 100-foot (23 to 31 meter) lengths, create specific challenges associated with the galvanizing. Ideally, the design team should know:

1. The flange-to-web thickness ratio should be no more than 3 to 1. If the ratio is greater than 3:1, the flanges take much longer to come up to temperature in the molten zinc bath (which allows the metallurgical reaction between the zinc and iron to completely take place) than the web. The girder can distort because of the temperature changes and the expansion and contraction differences between the web and the flange. In other words, the thinner sections are going to expand at a faster rate than the thicker sections and distortion is the result.

2. The finished galvanized girder should NEVER be water quenched. Gradual air-cooling minimizes the induced stress from the cooling cycle.

3. Continuous welding should always be used because the stress relieving in the kettle can generate large forces that may fracture spot welds. Continuous welds also prevent any of the cleaning solutions used to prepare steel for immersion into the molten zinc from being trapped behind the welded areas. Trapped solutions may flash steam in the molten zinc, preventing areas around the spot weld from galvanizing, or they may build up pressure (up to 3600 psi [25 MPa]) behind the weld

and cause explosive forces that either fracture the weld or destroy the girder in the localized area.

4. The girder may have some intentional camber or sweep in its design. The galvanizing may accentuate it or remove it. This is not usually problematic as the diaphragm members attached during construction can be used to draw the girder in to place. This is done by welding or fastening (with hot-dip galvanized connections) the diaphragm steel members to the girder, starting at one end of the girder and working to the other end.

5. Stiffeners should be used and they should be liberally cropped (1” [2.5 cm]or greater) to allow for the free flow of cleaning solutions and molten zinc within the web space.

6. The steel should not be left in the molten zinc bath too long. Doing so simply applies more than the necessary heat to the thinner steel of the girder and relieves more stresses that may be manifested as warpage or distortion.

7. Any lifting (material handling) of the girder before, during and after galvanizing should be at the quarter points. This is critical to maintaining a straight girder.

8. To completely support a positive or negative camber, the newly galvanized girder should be placed on as many blocks as possible, always laying it on the strong axis. This prevents any gravity forces from being applied to the flat surface of the web that may result in distortion.

SUMMARY

The various plate steel thickness and welding that may be utilized to fabricate bridge plate girders introduces new design, fabrication and galvanizing issues that must be considered by the design team in order for the highest quality galvanized girder to be delivered to the job site. There are successful applications of galvanized plate girders in a variety of bridge designs located throughout North America.

Philip G. Rahrig is Executive Director of the American Galvanizers Association. For more information about hot-dip galvanized steel, contact the American Galvanizers Association at 720.554.0900 or visit their web site at www.galvanizeit.org.