Marking of steelwork

No. 5.05

Scope

This Guidance Note explains the need for marking and describes the types of marking commonly used in bridge steelwork. Practice at the steel mill and in the fabrication shop is covered. Recommendations of best practice in the fabrication shop are given.

The need for marking

Steel from the mills needs to be marked to ensure identification and traceability of the material. This is important for both the steelmaker and the fabricator.

During erection, a clear and simple marking system for the fabricated components is vital to ensure that all components are correctly located and orientated within the structure.

Over the last 20 years, bridge construction sites have become progressively more constrained by the existence and alignment of other infrastructures. The incidence of varying degrees and combinations of skew, vertical curvature and plan curvature has led to a much greater likelihood that there are components that are apparently identical, but which have small dimensional differences; if wrongly placed, there can be significant effects on structure geometry and possibly on structural adequacy.

Identification marks on components should be capable of being easily found and read, after possibly several weeks of storage on site. Because identification may have to be made in less than ideal conditions of weather and light, the marks must be clear and easily and safely accessible, whether the components are on transport or stored at ground level.

Methods of marking - steel products

The following are examples of marking procedures followed by Tata Steel:

Plate

A dot-matrix stamp mark gives information on mill, cast number, steel grade and plate number that will relate to the test certificate. Additional paint marking gives information on plate dimensions, weight, order number and fabricator requirements.

Sections

Stick-on labels. Each label has a bar code and includes information on section dimensions and length, steel grade and piece weight, plus Tat Steel and customer references.

Strip (coil)

Label tied to the steel binding. Each label gives information on steel grade and coil weight, together with references.

Tubes & pipes

Stencil marks on tubes supplied as individual lengths (RHS over 160 x 160 mm, CHS over 219 mm); labels on each bundle for smaller sizes. The marking includes section size and thickness, steel grade and standard, and cast number.

Where the steel is supplied to a stockholder, the above traceability should be maintained.

Methods of marking - in the fabrication shop

Within the fabrication shop, components are usually identified with white paint or indelible marker pen. Sub-assemblies are then usually identified in the same way.

While perfectly adequate in the confines of the fabrication shop, such marks deteriorate quite quickly outside and can only be regarded as temporary.

In order to add certainty in terms of subsequent material traceability, a permanent mark should be made to each welded assembly or separate component before it leaves the fabrication shop.

Within a shop welded assembly there is seldom a need to add a permanent mark to each component, as the origin of the components forming that item can usually be reconciled via cutting sheets and material inventories.

The normal method of marking by fabricators in bridge construction, and the method that has been used for many years, is hard stamping in appropriate locations.

Types of marking

A hard stamp is a form of punch which, when struck with a hammer, produces an indentation on the surface of the steel in the form of a letter of the alphabet or a number.

Hard stamp sets can be obtained comprising 26 letters and 10 numbers (0 to 9) and are available in various sizes. In bridge construction, 12 mm character height is usually used. Some saw-drill and plate cutting machines incorporate hard stamping devices where the imprint is obtained via hydraulic pressure rather than percussion. This type of equipment is used to mark rolled sections and girder parts, and is gradually replacing manual hard stamping.

Three types of hard stamp are available:

1) The "standard stamp" where the leading edge of the character is sharp and angular.
2) The "low stress stamp" where the leading edge of the character is radiused.
3) The "dot matrix stamps" where the character is formed by a number of pointed tips.

The "low stress stamp" and the "dot matrix" stamp were developed for the aircraft industry who deemed the sharp imprint of the "standard hard stamp" to be a potential source of stress concentration and therefore undesirable in fatigue sensitive areas. The "low stress stamp" with its rounded indentation gave rise to lower stress concentration. The "dot matrix stamp" was considered better again.

The "low stress stamp" has been widely adopted by the offshore industry, and is widely used by steel suppliers and bridge fabricators when stamping by hand.

The "dot matrix stamp" is used by some steel plate suppliers who have CNC (computer numeric controlled) stamps to identify cast numbers and material grades. It is also commonly used in automatic stamping equipment on saw-drill and plate-cutting machines

While the shape of the root of the indentation is important with respect to stress concentration, the location of any such mark is probably more significant.

"Weld writing" can be used to mark girders but it should only be done by robotic welding. Manual "weld writing", although robust and often used in building work, is totally unsuitable for any primary or secondary components in a bridge. The process is substantially uncontrolled in terms of heat input and there is a high risk of introducing serious surface defects.

Location of permanent marks

Few components within a bridge have constant stress distribution throughout their length and, in most cases, it should be possible to find a location of low static and cycling stress where the benefits of hard stamping can be obtained and the risks of impairment of fatigue capability are minimised.

Figure 1 indicates acceptable hard stamp locations for typical bolted construction where the above objectives may be achieved.

Covering of marks by protective coatings

As most components and sub-assemblies in steel bridges receive protective treatment, and as the various coatings tend to fill hard stamp indentations, the depth of the indentation can be important in terms of the clarity of the mark on site. This is more of a problem with the modern thicker epoxy coating than it was with the previously used high solvent coatings which have been abandoned under the Environmental Protection Act.

For equal effort and size of character, the most distinct indentation is that made by the "standard hard stamp", followed by that of the "low stress stamp" and then by the "dot matrix stamp".

The typical indentation for the "standard stamp" applied manually is between 300 and 500 microns. Typically, the combined specified minimum thickness of shop applied protective treatment is in the order of 300 microns. However, it should be remembered that in order to achieve reasonable certainty of a specified minimum thickness, the applicator has to deposit a greater average thickness. Generally, it is held that the necessary average is in the order of 33% higher than the specified minimum.

It is clear, therefore, that for any manually applied hard stamp, *modern* shop coatings as specified for bridge steelwork are likely to substantially obscure the hard stamp. In the case of automated markings, this is less likely because such markings tend to be at least 50% deeper.

The effective way around this potential problem is to mask the hard stamp area after priming or metal spray and sealer. In the majority of cases, the extra paint work on site to reinstate these areas after erection would be insignificant.

Marking weather resistant steel

For weather resistant steel, hard stamping is again the best method of permanent identification. However, for temporary marking in the fabrication shop, care should be taken to avoid the use of wax or oil based markers, because even after blast cleaning some residue remains and such marks locally effect the weathering characteristics; they can be apparent for many years afterwards.

The Risks

The members of the Steel Bridge Group know of no case where hard stamping, either standard or low stress, has been the cause of failure of any part of a bridge structure.

Theoretically, a severe stamp mark that ends up in a particularly fatigue-prone location could lead to problems, but to prohibit hard stamping altogether is not the answer as it remains the most reliable form of long term identification.

Network Rail documents define a ‘hard die stamp’ as a sharp nosed stamp (i.e. the ‘standard stamp’ described above) and they prohibit its use by either steel supplier or fabricator. They do, however, accept the use of ‘low stress’ or ‘dot matrix’ stamping by both supplier and fabricator.

At present, all methods of identification other than hard stamping are insufficiently robust for typical bridge components and are too reliant on individuals to record and transfer markings, particularly during protective treatment. The problem is not so much with large items such as main girders, but with the numerous and smaller bracings and splice plates, which are equally important in terms of correct positioning and orientation in the structure.

Recommendations

1) Use “low stress hard stamps” for the identification of sub-assemblies and components to be sent to site.

2) Identification hard stamp markings should be located in the area of lowest cyclic stress within each component or sub-assembly.

3) Hard stamp marks should be visible after assembly in case there is a need for checking.

4) The contractor/fabricator should provide a written statement of his marking method with locations given for marks on each component or sub-assembly. Consideration must be given within this statement to orientation of component where it is important (i.e. north end, west end, etc.)

5) Identification markings should be kept as brief as possible, although it should be recognized that multi structure projects will inevitably require more characters.

6) Standardize the approach to identifying girders within the bridge. Use a simple matrix, use letters to identify girder lines transversely and numbers to identify girder positions within each line.

7) If there is a risk that the hard stamp indentation may be filled with paint, mask locally during application of the undercoats (marks should in any case not be located in a corrosion-vulnerable area).

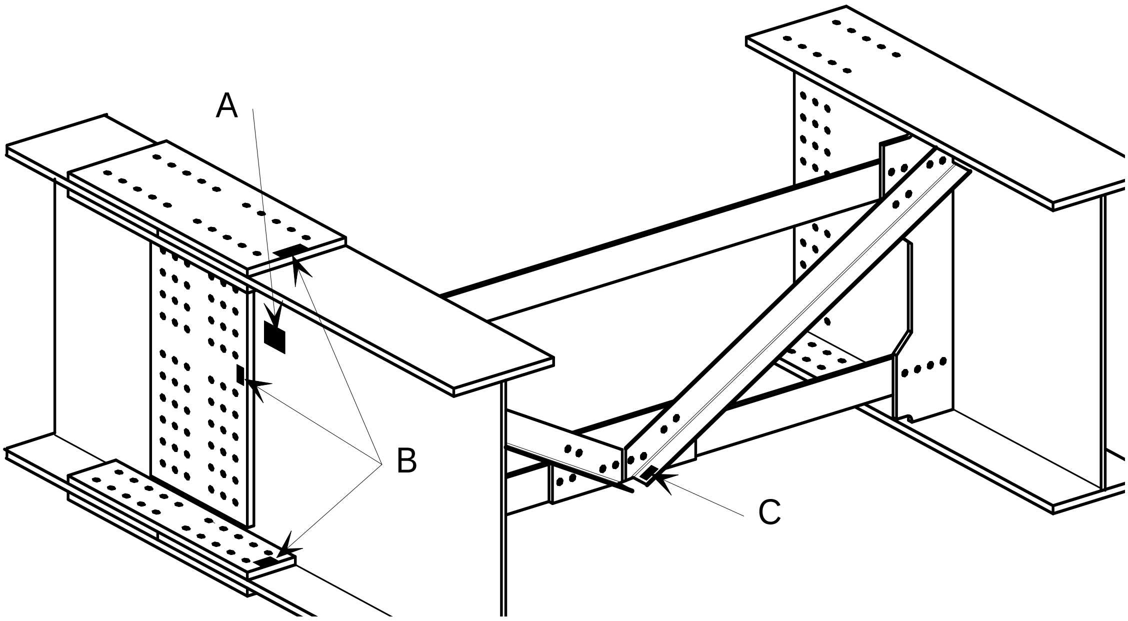

Figure 1 *Locations for hard stamp marks*

Notes: (A) Web plate marked close to neutral axis
(B) Cover plates marked close to unstressed edges
(C) Bracing members marked in lightly stressed region of outstands

