TCR Advanced Engineering P. Ltd

Experts in Metallography, Failure Investigation and RLA

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Detecting embrittlement in Hot dip galvanized structural steel products.

An insight of test method.

Complete or partial loss of ductility when a steel product characteristically fails by fracture without appreciable deformation is called embrittlement. Galvanized structural steel products are often susceptible to embrittlement due to aging phenomena, cold working, and absorption of hydrogen.

Factors in Embrittlement

Embrittlement due to strain-aging: Strain-aging refers to the delayed increase in hardness and strength, and loss of ductility and impact resistance which occur in susceptible steels as a result of the strain induced by cold working. The aging proceeds slowly at room temperature, but proceeds at an accelerated rate at the galvanizing temperature which is approximately 455°C.

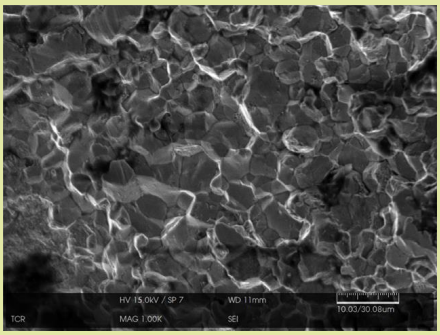
Hydrogen embrittlement may also occur due to the possibility of atomic hydrogen being absorbed by the steel. The susceptibility to hydrogen embrittlement is influenced by the type of steel, its previous heat treatment, and degree of previous cold work. In case of galvanized steel, acid pickling reaction prior to galvanizing presents a potential source of hydrogen. However, the heat of the galvanizing bath partially expels hydrogen that may have been absorbed. In practice, hydrogen embrittlement of galvanized steel is usually of concern only if the steel exceeds approximately 1100 MPa in ultimate tensile strength, or if it has been severely cold worked prior to pickling.

cold-working often associated with embrittlement is dependent on many factors including the type of steel, thickness of steel, and degree of cold work, and accentuated by source of stress concentration caused by notches, holes, fillets of small radii, sharp bends, etc.

Low temperatures increase the risk of brittle failure of all plain carbon steels including one that has been galvanized.

Testing for Embrittlement: Embrittlement in structural products can be tested by various methods for Steel Shapes, Steel Castings,

Microstructure of the Month



Magnification: *1000X*

MOC: BS 970 Grade EN 8D

Component: D bolt

Observation:

Highlights intergranular nature of brittle fracture surface with propensity for intergranular cracking

Useful hints:

Studs are to be used in hardened and tempered condition. If tempering is not done adequately then they are susceptible to inter granular cracking.

Threaded Articles, and Hardware Items. ASTM A143 specification lists various methods of identifying embrittlement in galvanized products.

Method 1: A simple bend test is performed for testing embrittlement of galvanized steel products such as bolts, braces, rods, reinforcing bars, etc. It consists of bending the article and comparing the degree of bending to that which is obtained on a similar un-galvanized article. The article, before and after galvanizing, may be bent until cracking of the base steel occurs, or to 90°. The galvanized article should withstand a degree of bending substantially same as that of un-galvanized article. Flaking or spalling of the galvanized coating is not to be considered as an embrittlement failure.

Method 2: Small steel castings and steel hardware of the shape and size that do not permit bending may be struck with a hammer. If an article withstands a blow in the un-galvanized condition, but after galvanizing cracks under the blow, it shall be considered embrittled.

Method 3: This method is employed for galvanized angle sections. A test specimen with a suitable length as shown in Fig. 1 shall be cut from the steel section. A hole shall be pierced into the test specimen in the centre, using same method employed in its fabrication. The specimen shall then be galvanized.

A 2 inch gage length is prick-punched in the middle edge of the vertical leg of the galvanized angle along a line parallel to its length and centered directly under the hole.

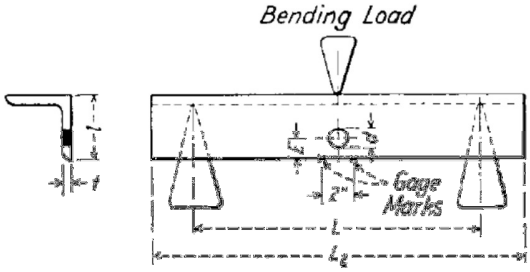


Fig -1

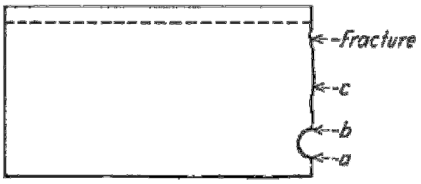


Fig -2

The test is conducted by applying the load gradually, until fracture of the galvanized test specimen occurs. After the test, the distance along the punch marks to the corresponding edge of the fracture shall be measured and the percentage of elongation calculated.

For determining the percentage reduction of thickness after fracture, the reduction shall be measured at the three locations indicated in Fig. 2. Outer side of hole (a), inner side of hole (b) and middle of leg(c). The percentage reduction of thickness shall be the average % reduction at locations a, b and c with respect to original thickness of the angle.

The material is said to be embrittled if the elongation measured shall be less than 5 % or the sum of the percentage of elongation plus the average percentage reduction of thickness shall is less than 10 %

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