

Bulletin on ASTM F1136/F1136M Zinc/Aluminum Coatings for use with ASTM A490/A490M Structural Fasteners.

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Background-

There has been a need among designers, engineers, owners and end users of high strength (150 ksi min. tensile) structural fasteners for a reliable coating which can safely and cost effectively provide long term corrosion protection. Traditional metallic coatings used in the structural fastener industry have not been permitted for use with A490/A490M grade fasteners due to concerns over potential hydrogen embrittlement.

The ASTM F16.02 committee approved a coating for use with A490/A490M grade fasteners. This coating is ASTM F1136/F1136M Zinc Aluminum Coating, known to many within the industry as Dacromet[®]. Testing performed by IBECA Technologies Corp. concluded that A490 fasteners coated with F1136 coating do not suffer from the effects of hydrogen embrittlement.

Since this is the first coating to be approved by ASTM for A490 fasteners, there are a number of issues that should be addressed and understood by the designer, engineer, owner and end user regarding the effective use of F1136 coatings. Understanding potential issues can aid in the successful implementation of this newly approved coating. Eventually, practical experience, specification updates and modifications, as well as additional research will provide more standards-based guidance for the use of F1136 coatings. Until then, this document has been reviewed jointly by the ASTM F16.93 coating committee and the Research Council on Structural Connections.

Nut Over-tap

F1136 coatings are relatively thin and uniform compared to traditional coatings used on structural fasteners. Many factors can influence the need for over-sizing the nut thread to allow for the thickness of the coating. These include material dimensional limits, dimensional deviation, coating thickness, coating variation, accumulation of tolerances, coating application method, coating grade, and the coating applicator.

The F1136/F1136M specification mentions the potential need for thread over-sizing, but provides no guidance on oversized threads. Component material conditions and dimensional tolerances may permit the use of non-oversized threads with thinner deposits of F1136. Practically speaking, thread over-sizing the pitch diameter between .008" and .018" may be required.

Over-sizing threads for use with high strength fasteners should be done with caution, as the loss of functional engagement may reduce stripping strength of the fastener assembly, and in some cases change the failure mode of an assembly from bolt tensile failure to bolt thread failure. Tensile failure is always the preferred method of failure.

Studies performed on inch and metric structural fasteners indicate that A563 DH nuts manufactured to .024" or greater over-size have the potential for bolt thread failure during installation or service when used with A490 grade fasteners. A small study of large diameter metric A490 fasteners indicated that

over sizing up to 0.018” still allowed for the full development of the tensile strength of the bolt. This study was limited in sizes and only performed on product from one bolt and one nut manufacturer, using standard tolerances. Proper allowance to permit free assembly in the field and interference free fit should be discussed with suppliers prior to ordering.

Proof Load Testing

Most structural fastener assemblies include an ASTM A563 DH nut. Specification requirements for this grade of nut reduce the proof load testing requirement of over-sized heavy hex nuts to 150,000 psi. Non-oversized DH nuts are required to be proof load tested to 175,000 psi, which appropriately exceeds the permitted maximum tensile of A490 bolts.

The purchaser and supplier should specify and ensure that when over-sized DH nuts are required, that the manufacturer performs nut proof load testing to a level exceeding the permitted maximum tensile strength of the bolt it will be mated with. This is to help ensure that bolt tensile failure will most likely remain the mode of failure. The customer should also consider full size axial pull tests until additional research or rotational capacity requirements are specified through additional research.

Coating Thickness

While thinner than traditional metallic coatings, F1136 has some variability in coating thickness. Deposits are often significantly thicker than specified minimum values, with high spots often near 4 times the specified minimum value. The effect of the accumulation of these tolerances and the impact on product thread gauging should be understood.

Coating thickness for ASTM fasteners is frequently measured using cost effective means such as magnetic induction. A potential issue with F1136 coatings and A490 grade fasteners is the effect of magnetic particle testing on the results of magnetic induction coating thickness testing. When performed on A490 fasteners, magnetic particle testing can leave residual magnetic fields which interfere with the results of magnetic induction testing. A490 fasteners for use with F1136 coating should be demagnetized after testing, or another method of coating thickness evaluation should be agreed upon between the supplier, the applicator and the user.

Rotational Capacity

Coated A325 structural fasteners have a requirement for rotation capacity testing. With the approval of coatings for A490 fasteners there is also a need to provide guidance on rotational capacity testing for these fasteners. Currently, the A490 and A490M specifications do not have provisions for rotational capacity testing. Research will need to be done to determine the proper degrees of rotation for A490 fasteners. If required, rotational capacity testing should be as agreed upon between the supplier and user. Generally speaking, A490 grade fasteners lack the ductility to routinely pass RC testing using degrees of rotation established for A325 fasteners.

Reactivity with Concrete

The effects or possible reaction of aluminum components of F1136/F1136M coatings with wet concrete have not been researched. When specifying F1136 for use where coated fasteners may be in direct contact with wet concrete the user should exercise caution.

Paint Adhesion

A study has been performed which indicated that paint adheres well to F1136 coatings. Users should understand that these results were determined using F1136 Grade 3 coating, not F1136 Grade 5 coating, which has a lubricated sealer. Future research will need to be performed to determine paint adhesion on Grade 5 coatings. Grade 5 is the recommended coating grade for A563 nuts.

F1136 Grade

For the best performance, F1136 coatings should be specified as Grade 3 for bolts (sprayed or dip-spin depending on fastener size), Grade 3 dip-spin for washers, and Grade 5 dip-spin for nuts. Application variables will depend on the product weight /dimensions, the processor, and any special customer requirements.

Summary

Having coatings available for ASTM A490/A490M fasteners will solve many application problems associated with the specification and use of high strength structural bolts and will no doubt benefit the steel construction industry. This advisory is to help the manufacturer, supplier, and end user understand the limitations of currently available product specifications. Until additional research and standards-based guidance can be provided, understanding and addressing these points prior to ordering will be beneficial to all parties.