04. BOLTING GALVANIZED STRUCTURAL STEEL

INTRODUCTION

Bolting of galvanized steel structures is the most common method of assembly. It is an obvious requirement that the bolts used in these connections are galvanized to the same standard as the structural steel. For reasons related to the galvanizing process, the durability of the galvanized bolts will rarely match that of the galvanized steel to which they are attached.

The Sydney Olympic Shooting Centre is an excellent example of a significant bolted galvanized structure where fast erection and low long-term maintenance were a requirement of the design.

STANDARDS

There are a number of Australian Standards related to the fastening of structural steel and the requirements that need to be satisfied in designing these structures.

AS 4100:1998 Steel structures, details the requirements for joint performance. There are no special requirements where the bolted connections rely on bolt bearing only and galvanized steel can be treated identically to uncoated or painted steel with bearing bolt connections.

Where friction grip connections are required, AS 4100 nominates a slip factor of 0.35 (coefficient of friction) for clean, as rolled surfaces with tightly adherent mill scale. In friction-bolted joints, all loads in the plane of the joint are transferred by friction between the mating surfaces.

Other current standards that are relevant to bolting of galvanized structures include:

1. AS 1214:1983 – Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse series)
2. AS/NZS 1559:1997 – Hot-dip galvanized steel bolts with associated nuts and washers for tower contruction.
3. AS/NZS 1252:1996 – High-strength steel bolts with associated nuts and washers for structural engineering.
4. AS 1111.1:2000 – ISO Metric hexagon bolts and screws – Production grade C – Bolts.
5. AS 1111.2:2000 - ISO Metric hexagon bolts and screws – Production grade C – Screws
6. AS 4100:1998 – Steel structures
7. AS 4100:1998 – Supplement 1 -Steel structures commentary
8. AS 1237.1:2002 – Plain washers for metric bolts, screws and nuts for general purposes. General plan.
9. AS 1237.2 – Plain washers for metric bolts, screws and nuts for general purpose. Tolerances.
10. AS/NZS 1390:1997 – Cup head bolts with ISO metric coarse thread pitches.
11. AS 4291.1:2000 – Mechanical properties of fasteners made of carbon steel and alloy steel – Bolts, screws and studs.

FRICTION-GRIP BOLTED CONNECTIONS

The load in friction-bolted connection is dependent on the clamping force applied by the bolts and the slip factor of the mating surfaces.

Hot-dip galvanized coatings on structural steel require special treatment to ensure that the 0.35 design factor is satisfied. While the hot-dip galvanized coating is largely made up of zinc-iron alloys, the surface of the coating is pure zinc, which is relatively soft and malleable.

Bolted connections on electrical transmission towers have their own standard for bolts in these critical galvanized structures.

As a result, pre-tensioned bolts used in friction grip connections may be subject to relaxation of bolt tension. For this reason, the connecting surfaces of hot-dip galvanized structural elements can satisfy the slip factor requirements using three techniques. These are:

1. Buffing the connecting surfaces during final inspection to roughen the surfaces and remove the thin layer of free zinc.
2. Modifying the cooling of the steel to produce a galvanized coating that is 100% alloy layer, characterised by a matt gray, rather than a shiny surface finish.
3. Brush abrasive blasting the connecting surfaces to remove some of the free zinc layer and profile the surfaces.

TREATMENT OF FRICTION GRIP BOLTED SURFACES

To achieve a coefficient of friction exceeding 0.35 for the friction grip bolted connections on the galvanized structure, the following procedures are recommended.

1. Buffing the connecting surfaces to remove any surface irregularities and to roughen the surface. This should be done using an air grinder of a type equivalent to a Model SP-1222SD 125 mm high-speed grinder (max rpm 15,000). The grinder should be used with a flexible backing pad and 36 grit resin grinding discs. This process should not remove more than 10% of the galvanized coating. This proportion of the coating comprises the free zinc layer. The balance of the coating is made up of much harder zinc-iron alloys, which are not subject to plastic deformation. This ensures that bolt relaxation will not occur after torqueing of the friction grip bolts.
2. Whip blasting the connecting surfaces will roughen the surface to ensure that the design levels for coefficient of friction are satisfied. However, whip blasting will not remove zinc lumps and drainage spikes if they are present on the connecting surfaces. The recommended specification for whip blasting (to prevent damage to the galvanized coating) is as follows:

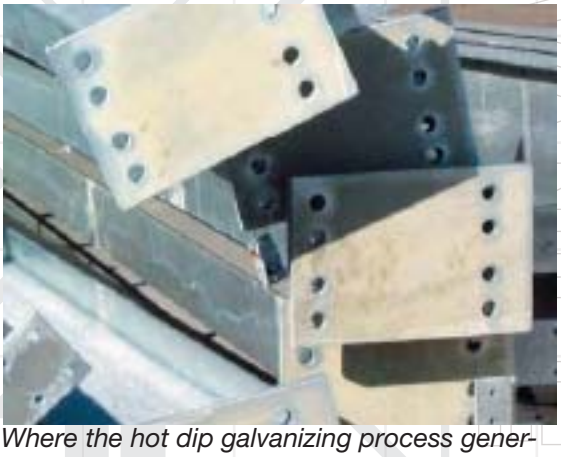
(a) Use fine abrasives of a size which will pass through a test sieve of nominal aperture size 150 pm to 180 pm (80 to 100 mesh), e.g. ilmenite or garnet.

(b) Use a venturi nozzle which has an orifice diameter of 10 mm to 13 mm.

(c) Set the blast pressure at 275 kPa (40 p.s.i) maximum. Keep the venturi nozzle at a distance of 350 mm to 400 mm from the surface of the work piece and at an angle no greater than 45° to the surface.

DURABILITY OF FASTENERS

While structural steel is galvanized by immersing it in a molten zinc bath for periods up to 10 minutes, (depending on the section size) fasteners are hot dip galvanized in small batches in metal baskets using a centrifuge operation. After removal from the molten zinc, the baskets are spun at high revolutions to throw off the excess zinc and produce fasteners with clean threads.



Where the hot dip galvanizing process generates gray coloured coatings, the surfaces are deemed to comply with the 0.35 coefficient of friction minimum requirement for friction grip bolted connections.

For this reason, the minimum specified coating mass for structural bolts exceeding 8 mm in diameter is 390 g/m2 or 55 microns in thickness. The process also allows this thickness to be closely controlled because of the standardised product being galvanized.

The minimum specified coating mass for steel over 6 mm in thickness is 600 g/m2, or 85 microns in thickness. In practice, the hot-dip galvanized coating on hot rolled structural sections

will comfortably exceed this minimum specification and will typically be in the order of 700-900 g/m^2 (100-125 microns in thickness).

As galvanized coating life is a function of the coating thickness, the bolts in any galvanized structure will always be the first to require maintenance. The condition of the galvanized coating on structural bolts will generally provide an indication of the remaining service life of the galvanized coating on the structure. If the galvanized bolts on a structure show signs of early corrosion, the likely remaining life of the coating on the structure should be in the order of an additional 30-50% of that on the bolts.

Galvanized bolts require their nuts to be tapped oversize to allow clearance for the galvanized coating on the thread. Galvanized nuts are not galvanized internally and rely in contact with the coating on the bolt for their corrosion resistance.

INGAL
SPECIFIERS MANUAL

01 - SPECIFIERS MANUAL — THIRD EDITION

Industrial Galvanizers Australian Galvanizing Division (IGAG) operates nine galvanizing plants around Australia, ranging in size from large structural galvanizing facilities to specialised small plants designed to process small parts.

The Australian Galvanizing Division has galvanized in excess of 2 million tonnes of steel products in Australia since its first plant was commissioned in 1965 and is recognized for its ability to handle complex and difficult projects, as well as routine contracts.

This experience has been collated in the Specifiers Design Manual, to assist those involved in the design of steel products and projects to better understanding the galvanizing process and allow the most durable and cost-effective solutions to be delivered to these products and projects. All sections of this Third Edition have been completely updated and additional sections have been included to provide additional technical information related to the use of hot dip galvanized steel.

In addition to its Australian Galvanizing operations, Industrial Galvanizers Corporation has a network of manufacturing operations in Australia, as well as galvanizing and manufacturing businesses throughout Asia and in the USA.

The company's staff in all these locations will be pleased to assist with advice on design and performance of hot dip galvanized coatings and products. Contact details for each of these locations are located elsewhere in this manual.

This edition of the Industrial Galvanizers Specifiers Manual has been produced in both html and .pdf formats for ease of access and distribution and all documents in the Manual are in .pdf format and can be printed if paper documents are required.

The Specifiers Manual is also accessible in its entirety on the company's web site at www.ingal.com.au.

Additional copies of the Specifiers Manual are available on CD on request.

PUBLISHER:
Industrial Galvanizers Australian Galvanizing Division,
PO Box 503, MOOROOKA
QLD 4105
Ph: 07 38597418

EDITOR:
John Robinson,
Mount Townsend Solutions Pty Ltd
PO Box 355, JESMOND NSW 2299
Ph: 0411 886 884
Email: mt.solutions@optusnet.com.au

LAYOUT AND DESIGN:
Adrian Edmunds,
Nodding Dog Design
Ph: 0402 260 734
Email: adrian@noddingdogdesign.com
Web: www.noddingdogdesign.com