1 Purpose

This technical note relates to the supply of bolts, nuts and washers for Transport and Main Roads Projects.

There are two main types of bolts and nuts available.

The first type is a commercial high strength bolt and nut, which can be purchased from a bolt merchant, provided the bolt length falls within the standard lengths specified in the Australian Standards.

The second type is a fabricated bolt, which is manufactured to the required length and conforms to the requirements of the Australian Standard (AS/NZS 1252 or AS/NZS 1111) except in terms of the length of the shank. This technical note does not cover the fabrication of ferrules.

2 Commercial bolts

Commercial bolts are bolts, which can be purchased from a bolt merchant in lengths, complying with the limits set out in the relevant Australian Standard. Commercial bolts and nuts can be supplied in two forms:

- cold or hot forged with or without secondary machining
- machined bolt from bar stock.

3 Fabricated bolts

When standard length bolts are not available then Transport and Main Roads drawings detail forged bolts are to be used. In the past, Contractors have supplied fabricated bolts as an alternative product often without obtaining prior approval from the Design Engineer.

The purpose of this technical note is to indicate how to control the risk associated with the fabrication of bolts and provide clear guidance on the preferred method of supplying bolts for Transport and Main Roads projects.

The two commonly used bolts for Transport and Main Roads projects are Class 4.6 strength bolts and Class 8.8 strength bolts. The notes on the Transport and Main Roads drawings state that Class 8.8 bolts are to be fabricated in accordance with AS/NZS 1252, while Class 4.6 bolts are fabricated in accordance with AS/NZS 1111.

4 Method of supplying bolts

During audits, Transport and Main Roads Structures Group has found that the bolts are being fabricated in a range of ways.

4.1 Acceptable method of supplying manufactured bolts

4.1.1 Method 1: Manufactured double ended stud

Class 8.8 bolts:

- obtain material equivalent to Class 8.8 bolts in terms of chemical and tensile properties (for example Class 4140 bar)
- a conventional thread is placed on one end of the bar and a shorter thread on the other end, refer to Figure 1
- the manufactured bar is then hot dip galvanised
- a galvanised Class 8 nut and washer is placed on the conventional thread
- a galvanised Class 8 nut is placed on the other end of the bar, along with a galvanised Class 8 locking nut, which prevents the head bolt from turning.

Note: Test bolts can be manufactured to a shorter length. Documentation shall be supplied showing the bolt dimensions for the threaded section of both the test bolts and the manufactured bolts are the same.

**Figure 1 – View of the Class 8.8 manufactured double ended stud**

Class 4.6 bolts:
- obtain material equivalent to Class 4.6 bolts in terms of chemical and tensile properties (for example a Grade 250 bar)
- a conventional thread is placed on one end of the bar and a shorter thread on the other end, refer to Figure 2
- the manufactured bar is then hot dip galvanised
- a galvanised Class 5 nut and washer is placed on the conventional thread
- a galvanised Class 5 nut is placed on the other end of the bar, along with a galvanised Class 5 locking nut, which prevents the head bolt from turning.

Note: Test bolts can be manufactured to a shorter length. Documentation shall be supplied showing the bolt dimensions for the threaded section of both the test bolts and the manufactured bolts are the same.

**Figure 2 – View of the Class 4.6 manufactured double ended stud**
4.1.2 Method 2: Threaded rod double ended stud

Class 8.8 bolts:

- purchase a hot dip galvanised Class 8.8 threaded rod
- cut the threaded bar to the correct length
- the exposed end of the bar shall have the original galvanising finish
- a galvanised Class 8 nut and washer is placed on the end of the thread rod which has not been cut, refer to Figure 3
- two galvanised Class 8 nuts are placed on the end of the threaded rod which has been cut. The two nuts are locked together to prevent the head of the fabricated bolt from turning.
- the cut end of the threaded rod is coated with two coat of Jotun Galvanite or approved equivalent
- if long threaded rods are used the centre section cannot be used, as the cut end will not have the original galvanising finish.

Figure 3 – View of the Class 8.8 threaded rod double ended stud

Class 4.6 bolts:

- purchase a hot dip galvanised Class 4.6 threaded rod
- cut the threaded bar to the correct length
- the exposed end of the bar shall have the original galvanising finish
- a galvanised Class 5 nut and washer is placed on the end of the thread rod which has not been cut, refer to Figure 4
- two galvanised Class 5 nuts are placed on the end of the threaded rod which has been cut. The two nuts are locked together to prevent the head of the fabricated bolt from turning
- the cut end of the threaded rod is coated with two coat of Jotun Galvanite or approved equivalent
- if long threaded rods are used the centre section cannot be used, as the cut end will not have the original galvanising finish.
4.2 Banned methods of supplying bolts

4.2.1 Nut threaded on the end and welded in position

The second method involves the placement of conventional thread on one end of a 4140 bar and a shorter thread on the other end. A conventional nut is screwed onto the short thread and the nut welded on to prevent it rotating. The bolt is then hot dip galvanised. This practice is not acceptable to Transport and Main Roads.

4.2.2 Welding nut to the end of a bar

The third method involves removing the thread from a nut, hammering it onto the end of a Grade 4140 steel bar and then placing a weld around the end of the nut. A conventional thread is placed on the other end and then the bolt is hot dip galvanised. Figure 5 is a view of the end of the bolt before and after it was tensioned.

These bolts were supplied as Class 8.8 bolts and were supporting a ring beam framework to prevent the lateral movement of a girder bridge for a bridge bearing replacement. The bolt fabricator claimed that the bolts would be structurally adequate as a Class 8.8 bolt. This practice is not acceptable to Transport and Main Roads.

5 Bolt testing process for all bolts

Each batch of bolts and nuts purchased shall be tested for conformance to the relevant specification and Australian Standard PRIOR to use on a project (Hold Point). The Contractor shall have a procedure to record where each lot of bolts are used.

Two per cent of every batch of bolts shall be tested with a minimum of three bolts tested when less than 50 bolts are supplied. The test certificate shall remain with the batch of bolts as proof that the bolts comply with the Australian Standard and specification.
It is considered that the bolts should be tested in the configuration that they will be used (i.e. assembled bolt and nut). This gives a realistic value of real behaviour of the product in service. The nut shall to be tested in a high strength mandrel. The testing process for Class 8.8 and Class 4.6 fabricated bolts are outlined below.

6 Definition of a “LOT”

A “LOT” generally consists of a number of bolts of the same size and grade manufactured using the same process at the same plant using the same equipment at essentially the same time.

Mixed “LOTS” consisting of bolts differing only in shank length may be included in the one “LOT” provided all the bolts were manufactured in the same plant using the same equipment at essentially the same time.

7 Testing requirements for Class 8.8 bolts

All Class 8.8 manufactured bolts shall be tested in accordance with the requirements of AS/NZS 1252 and MRTS78. Outlined below is a summary of the testing which must be carried out to show conformance.

Manufactured Studs:

- supply the material test certificate for the material used in manufacturing the stud (This certificate is used to access the chemical composition of the stud)
- carry out a mechanical test of the stud in accordance with AS/NZS 1252 at a NATA certified laboratory to verify the stud conforms to the requirements of AS/NZS 1252 (This certificate is used to access the mechanical properties of the stud)
- supply the material test certificate for the nut and washer (This certificate is used to access the chemical composition and mechanical properties of the nut and washer)
- the bolt assembly (assembled stud and nuts) shall be tested as an assembly in accordance with the requirements of MRTS78.

Threaded Rod:

- supply the material test certificate for the threaded rod (This certificate is used to access the chemical composition and mechanical properties of the threaded rod)
- supply the material test certificate for the nut and washer (This certificate is used to access the chemical composition and mechanical properties of the nut and washer)
- the bolt assembly (assembled threaded rod and nuts) shall be tested as an assembly in accordance with the requirements of MRTS78.

Note: The assembly test report shall state the following.

- heat number of the round bar / threaded rod used, and
- heat number of the nuts used for the assembly testing for the particular threaded rod.
8 Testing requirements for Class 4.6 bolts

All Class 4.6 manufactured bolts shall be tested in accordance with the requirements of AS 1111, AS 1112 and MRTS78. Outlined below is a summary of the testing which shall be carried out to show conformance.

Manufactured studs:

- supply the material test certificate for the material used in manufacturing the stud (This certificate is used to access the chemical composition of the stud)
- carry out a mechanical test of the stud in accordance with AS 1111 at a NATA certified laboratory to verify the stud conforms to the requirements of AS 1111 (This certificate is used to access the mechanical properties of the stud)
- carry out a mechanical and chemical analysis of the nut and washer in accordance with AS 1112 at a NATA certified laboratory to verify the nut and washer conforms to the requirements of AS 1112 (This test is used to access the chemical composition and mechanical properties of the nut and washer)
- the bolt assembly (assembled stud and nuts) shall be tested as an assembly in accordance with the requirements of MRTS78.

Threaded rod:

- carry out a mechanical and chemical analysis of the threaded rod in accordance with AS 1111 at a NATA certified laboratory to verify the threaded rod conforms to the requirements of AS 1111 (This test is used to access the chemical composition and mechanical properties of the threaded rod)
- carry out a mechanical and chemical analysis of the nut and washer in accordance with AS 1112 at a NATA certified laboratory to verify the nut and washer conforms to the requirements of AS 1112 (This test is used to access the chemical composition and mechanical properties of the nut and washer)
- the bolt assembly (assembled threaded rod and nuts) shall be tested as an assembly in accordance with the requirements of MRTS78.

Note: The assembly test report shall state the following.

- heat number of the round bar / threaded rod used, and
- heat number of the nuts used for the assembly testing for the particular threaded rod.