DGC AFRICA
MEMBER OF DICKINSON GROUP OF COMPANIES

# DGC TECHNICAL SUPPORT

## STUD WELDING BASICS - MECHANICAL PROPERTIES GRADE 4.6 vs 8.8

### PURPOSE

The purpose of this document is to provide some comparative data as a guide on the mechanical properties, including torque requirements of Drawn Arc Reduced Base Studs (Grade 4.6), and Class / Grade 8.8 threaded bar (based on bolt data).
(Class and Grade are used interchangeably throughout this document)

### BACKGROUND

The terminology of drawn arc stud welds specified on many drawings, varies from using brand names, such as Nelson Studs, or referring to a material specification as Grade 4.6, with diameter and length listed, which are covered by AS/NZS 1554.2:2003

(WTIA Tech Note: TN11-04). Additionally, Grade 8.8 studs are nominated on drawings and specifications for wear liners.
For this reason, the properties of Class 4.6 and 8.8 are included in the tables provided for comparison purposes.

### MECHANICAL PROPERTIES

The mechanical properties of studs supplied to AS/NZS 1554.2:2003 closely confirm to Class 4.6 bolts.

| CLASS | HEAD MARKING | SIZE RANGE (mm) | PROOF LOAD STRENGTH (MPa) | MINIMUM PROOF STRENGTH (MPa) | MINIMUM TENSILE STRENGTH (MPa) | BRINELL Min. Max. | ROCKWELL Min. Max. | MATERIAL |
|---|---|---|---|---|---|---|---|---|
| STUDS | N.A. | Reduced Based Studs M10 – M24 | | | **380** | | | AS1443 1010 to 1020 |
| 4.6 |  | M5 - M36 | 225 | 240 | 400<br>209 | 114<br>67 | **HRB**<br>95 | Low or medium carbon steel |
| 8.8 |  | M1.6 - M36 | ≤M16<br>580<br>>M16<br>600 | ≤M16<br>640<br>>M16<br>660 | ≤M16<br>800<br>>M16<br>830 | ≤M16<br>219-285<br>>M16<br>242-319 | **HRC**<br>≤M16<br>20-30<br>>M16<br>23-34 | Medium carbon steel<br>Q & T |

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# DGC TECHNICAL SUPPORT STUD WELDING BASICS

# MECHANICAL PROPERTIES GRADE 4.6 vs 8.8

## BREAKING AND PROOF LOADS

The following values for the Class 4.6 and Class 8.8 are taken from The Ajax Fasteners Handbook Issue 99 Tables 10 and 11 respectively for the typical stud sizes installed by **DGC AFRICA.**

| SIZE | TENSILE STRESS AREA OF THREAD | CLASS 4.6 | | CLASS 8.8 | |
|---|---|---|---|---|---|
| | | PROOF LOAD OF BOLT | BREAKING LOAD OF BOLT (MIN.) | PROOF LOAD OF BOLT | BREAKING LOAD OF BOLT (MIN.) |
| | mm2 | kN | kN | kN | kN |
| M10 | 58.0 | **13.0** | **23.2** | 33.7 | 46.4 |
| M12 | 84.3 | **19.0** | **33.7** | 48.9 | 67.4 |
| M16 | 157 | **35.3** | **62.8** | 91.0 | 125 |
| M20 | 245 | **55.1** | **98.0** | 47 | 203 |
| M24 | 353 | **79.4** | **141** | 212 | 293 |

**Note:** These values are based on bolts for Class 8.8 bolts, and may not be representative of welded threaded bar used as studs.

## RECOMMENDED ASSEMBLY TORQUES

The following values for the Class 4.6 and Class 8.8 are taken from The Ajax Fasteners Handbook Issue 99 Tables 21 and 25 respectively for the typical stud sizes installed by **DGC AFRICA.**

AS/NZS 1554.2:2003 Table 3.1 values are also included to show the comparison between the minimum testing torque required on studs relative to the Recommended Assembly Torque.

| SIZE | AS/NZS 1554.2 REQUIRED TORQUE FOR TESTING THREADED STUDS | CLASS 4.6 | | CLASS 8.8 | |
|---|---|---|---|---|---|
| | | BOLT TENSION = 65% OF PROOF LOAD | RECOMMENDED ASSEMBLY TORQUE | BOLT TENSION = 65% OF PROOF LOAD | RECOMMENDED ASSEMBLY TORQUE |
| | Nm | kN | Nm | kN | Nm |
| M10 | 25.1 | **8.45** | **17** | 21.9 | 44 |
| M12 | 43.8 | **12.4** | **30** | 31.8 | 77 |
| M16 | 108.5 | **22.9** | **73** | 59.2 | 190 |
| M20 | 212.0 | **35.8** | **143** | 95.6 | 370 |
| M24 | 366.4 | **51.6** | **248** | 138 | 640 |

**Note:** These values are based on bolts for Class 8.8 bolts, and may not be representative of welded threaded bar use as studs.

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# DGC TECHNICAL SUPPORT STUD WELDING BASICS

## MECHANICAL PROPERTIES GRADE 4.6 vs 8.8

## ALTERNATIVE WELDING PROCESSES

AS/NZS 1554.2:2003 allows for alternative welding processes, such as qualified flux-cored arc welding, gas metal-arc welding or manual metal-arc welding, if the following requirements are met:

I. The surface to which the studs are to be welded shall be free from all contaminants that would prevent proper welding or produce objectionable fumes.

II. The stud base shall be prepared so that the outside circumference of the stud base fits tightly against the base metal. The end of the stud shall also be clean. (Drawn arc studs are manufactured as a complete item ready for installation).

III. The minimum fillet size to be used shall be as shown in Table 5.1, included below for reference. (Table number refers to table from Australian Standard)

IV. Welding shall be carried out in accordance with AS/NZS 1554.1, AS/NZS 1554.4 or AS/NZS 1554.5 as appropriate.

**Table 5.1 Minimum Fillet Weld Size for Studs**

| STUD DIAMETER (mm) | MINIMUM SIZE FILLET (mm) |
|---|---|
| 6.4 TO 11.1 | 5 |
| 12.7 | 6 |
| 15.9 TO 19.0 | 8 |
| 22.2 TO 25.4 | 10 |

**Note:**

- Grade 8.8 studs do not exist for the drawn arc stud welding machines in operation at the time of publication.
- Where required **DGC AFRICA** provide studs to grade 8.8 specification by specialist welding procedures.

The application of a threaded stud is based on the diameter of the shaft, not the thread diameter. The correlation between shaft diameter (Gr 8.8) and thread diameter (Gr 4.6) is tabled below and related to the fillet weld size, and collar size, respectively. Where correct welding parameters are employed for drawn arc stud welding the expelled metal around the base of the stud is designed to form a collar within the ferrule around the base of the stud.

| SHAFT DIAMETER (mm) | GR 8.8 MINIMUM SIZE FILLET (mm) | STUD THREAD DIAMETER | GR 4.6 STUD COLLAR (mm) (FLASH) | |
|---|---|---|---|---|
| | | | LONG SHANK+ | SHORT SHANK* |
| 6.4 TO 11.1 | 5 | M10 & M12 | N.A. | 2.4 – 3.0 |
| 12.7 | 6 | M16 | N.A. | 2.4 – 3.0 |
| 15.9 TO 19.0 | 8 | M20 | 6mm max | 4 - 5 |
| 22.2 TO 25.4 | 10 | M24 | 6mm max | 4 - 5 |

*** - Short Shank -** Collar height is related to burn-off length, values given are approximate.
**+ - Long Shank –** Collar height limited by internal height of ferrule.

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# DGC TECHNICAL SUPPORT STUD WELDING BASICS

## MECHANICAL PROPERTIES GRADE 4.6 vs 8.8

### COMPARISON OF STUDDING METHODS

| | DRAWN ARC STUD WELDING (DASW) | MANUAL WELDING GR 8.8 |
|---|---|---|
| BASE MATERIAL | Stud to final dimensions | Threaded bar cut to size |
| THREAD | Coarse | Coarse |
| WELDING METHOD | Automated welding machine | Manual Metal Welding |
| POSITIONING OF STUD | Contained within stud gun | Manual (Labour intensive) |
| PRE-HEAT TREATMENT | Not typically required | Typically Required |
| POST-HEAT TREATMENT | Not typically required | Typically Required, depending on base plate |
| STUD WELDING TIME, INCLUDING PREPARATION OF STUDS. (RELATIVE) | 1 | 5-7 x DASW |
| OPERATORS | Trained and skilled on Drawn Arc Welder | Specialist Welders for Manual Method |
| WELD PROCEDURES | Pre-qualified | Qualified weld procedures to be developed |
| COST COMPARISON (RELATIVE TO DASW) | 1 | 5-7 x DASW |

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