# ANNEX D NOTES ON TESTING TO ESTABLISH STEEL CLASS AND ESSENTIALS OF SOME PRODUCT STANDARDS

## D1 TESTING TO ESTABLISH STEEL CLASS

### Class 1 steel and Class 1H steel:

No additional testing is needed as these steels comply with one of the reference material standards in Annex A1.1 and the basic requirements given in clause 3.1.2, and the steels are produced from a manufacturer with an acceptable Quality Assurance system.

## Class 2 steel:

Where steels are not supplied in accordance with one of the recognized reference material standards in Annex A1.1 but are produced from a manufacturer with an acceptable Quality Assurance system, such steels shall be tested to show that they comply with one of the reference material standards in Annex A1.1.

Tests shall include tensile strength and ductility, notch toughness and chemical compositions.

At a minimum one test in each category shall be made for every 20 tonnes of steels or part thereof the same product form, of the same range of sizes and thicknesses, and of the same cast.

The results of each test and the characteristic value obtained by statistical analysis shall not be less than the value required by the standard.

#### Class 3 steel:

Uncertified steels shall be tested for tensile strength and ductility to demonstrate that they have a yield strength of at least 170N/mm<sup>2</sup>, an elongation of at least 15% and a tensile strength of at least 300N/mm<sup>2</sup>. One test in each category shall be made for every 20 tonnes of steels or part thereof the same product form, of the same range of sizes and thicknesses. If the steels are to be welded, the Responsible Engineer may additionally require tests for weldability as described in Annex D1.1.

#### Quality control of testing

The testing shall be carried out to meet the reference material standards listed in Annex A1.1 by a HOKLAS accredited laboratory or by other laboratory accreditation bodies which have reached mutual recognition agreements/arrangements with HOKLAS.

## D1.1 Essential requirements

The basic requirements for structural steels are:

- Strength
  - Resistance to brittle fracture
  - Ductility
  - Weldability

Table D1a lists the essential performance requirements for typical hot rolled sections and plates, and hot finished and cold formed structural hollow sections, and Table D1b lists the essential performance requirements for typical cold formed thin gauge steel.

Performance requirement	Specified by	Additional requirements for steel in structures designed by the plastic theory		
Minimum yield strength	Smaller of yield strength ( $R_{eH}$ ), 0.2% proof strength ( $R_{p 0.2}$ ) and stress at 0.5% total elongation ( $R_{t 0.5}$ )	$R_m/R_{eH} \ge 1.2$ (1.2 is a minimum and a higher value may be required)		
Minimum tensile strength	Tensile strength (R <sub>m</sub> )			
Notch toughness	Minimum average Charpy V-notch impact test energy at specified temperature	None		
Ductility	Elongation in a specified gauge length Bend test	Stress-strain diagram to have a plateau at yield stress extending for at least six times the yield strain. The elongation refers to Clause 3.1.2		
Weldability	Maximum carbon equivalent value, Carbon content, Sulphur and Phosphorus contents	None		
Through thickness properties (only for certain situations, see 3.1.5 and 14.3.3.4)	Elongation to failure in the through thickness direction	None		

# Table D1a - Essential performance requirements for hot rolled and hot finished structural steel and cold formed steel

## Table D1b - Essential performance requirements for cold formed thin gauge steel

Performance requirement	Specified by	Specific requirements
Minimum yield strength	Smaller of yield strength ( $R_{eH}$ ), 0.2% proof strength ( $R_{p 0.2}$ ) and stress at 0.5% total elongation ( $R_{t 0.5}$ )	R <sub>m</sub> / R <sub>eH</sub> ≥ 1.08 (min) ~ 1.2 (max)
Minimum tensile strength	Tensile strength (R <sub>m</sub> )	
Notch toughness	None	None
Ductility	Elongation in a specified gauge length	The total elongation should not be less than:
		10% for a 50mm gauge length, or
		7% for a 200mm gauge length.
Weldability	None	None
Quality on external/ internal surface	See the relevant standards in Annex A1.8	None
Through thickness property	None	None

# D1.2 Quality control of testing

The testing shall be carried out to meet the reference material standards as contained in Annex A1.1 by a HOKLAS accredited laboratory or by other accredited laboratories which have reached mutual recognition agreements/arrangements with HOKLAS.

Stee	1	Source	Yield Strength	Ultimate Strength	Elongation
			Y <sub>S</sub> N/mm <sup>2</sup>	U <sub>S</sub> N/mm <sup>2</sup>	
Bisplate	60	Australia	500	590-730	20%
	70		600	690-830	20%
	80		690	790-930	18%
HT690	70	Japan	590	690	(Min 20% reqd.)
HT780	80		685	780	(Min 20% reqd.)
RQT	601	UK	620	690-850	(Min 20% reqd.)
RQT	701		690	790-930	(Min 20% reqd.)
HPS	485W	USA	485	-	(Min 20% reqd.)
ASTM A913	70		485	620	16%
ASTM A514	100		690	760 – 895	18%
S500Q		Europe	440 - 500	540 – 590	Refers to
S550Q			490 - 550	590 - 640	Clause 3.1.2
S620Q			560 - 620	650 - 700	
S690Q			630 - 690	710 - 770	

Table D2 - Minimum material property requirements for various high strength steels

# D2 ABSTRACT OF ESSENTIAL REQUIREMENTS FOR BOLTS

Abstract of essential requirements for bolts:

- (a) In a matched assembly of a nut and bolt, the nut must be sufficiently strong enough such that the bolt shank fails in tension prior to the nut or bolt threads stripping.
- (b) When bolts and nuts are galvanized, it is usual that the manufacturer will tap the nut threads oversize in order to fit the galvanized bolt threads. Therefore the nut is required to be stronger than for the case when it is not galvanized in order to comply with (a). Typically the manufacturer should supply a higher grade of nut, e.g. an ISO grade 10 nut for an ISO grade 8.8 bolt.
- (c) Bolts should only be used in the range of strengths given in Table D4 below unless test results demonstrate their acceptability in a particular design application.
- (d) Friction grip bolts may be tightened using the torque control method, part-turn method, or direct tension to BS 7644 or other acceptable standard and the manufacturer's recommendations. Torque spanners and other devices shall be recalibrated in accordance with BS 4604 or other acceptable standard.

Performance requirement	Specified by
Minimum tensile strength	Tensile testing
Minimum yield strength	Tensile testing
Elongation	Tensile testing
Hardness	Brinell Hardness Testing

#### Table D3 - Essential performance requirements for bolts

Table D4 - Various normal	ly used bolt strength
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Bolt source and grade	Design shear strength <i>p</i> <sub>q</sub> (N/mm <sup>2</sup> )	Design bearing strength p <sub>b</sub> (N/mm <sup>2</sup> )	Design yield strength <i>p</i> y (N/mm <sup>2</sup> )	Minimum tensile strength (N/mm <sup>2</sup> )
ISO 4.6	160	460	240	400
ISO 6.8	240	900	440	600
ISO 8.8	375	1000	560	800
ISO 10.9	400	1300	700	1000
ISO 12.9	480	1600	840	1200
General grade HSFG ≤ 24	400	1000	590	840
General grade HSFG ≥ 27	350	900	515	735
High strength HSFG	400	1300	700	1000
ASTM A307	165	460	310	425
ASTM A325	330	900	620	855
ASTM A490	415	1300	780	1070
AS/NZS 1111 4.6/S	160	460	280	400
AS/NZS 1252 8.8/S, TB, TF	330	900	580	830
GB50017 Grade 3	130	170	225	325
JGJ 82-91 Grade 8.8	250	750	500	625
JGJ 82-91 Grade 10.9	310	850	630	775
JIS B 1051 Grade 4.6	160	460	240	400
JIS B 1051 Grade 6.8	240	750	480	600

Figures in normal test are from published data and figures in bold are calculated from formulae in Section 9.

Both hardness and toughness of bolts and washers should apply to relevant standard

Precision bolts to BS 3692 or other equivalent

Friction grip bolts to BS 4604: Part 1 or 2 or other equivalent

Bolt tightening to BS4604: Part 1 or other equivalent

Torque control method, part-turn method, or direct tension to BS 7644 or other equivalent and the manufacturer's recommendations

Torque spanners and other devices shall be re-calibrated in accordance with BS 4604 or other equivalent