Handbook to BC1: 2023

Design Guide for the Use of Alternative Structural Steel to Eurocode 3

Building and Construction Authority

Handbook to BC1: 2023

Design Guide for the Use of Alternative Structural Steel to Eurocode 3

© 2023 BCA

Amendments issued since publication

Amd. No.	Date	Comments
1	21/08/2024	Clarity has been provided regarding FPC certificates or MTCs with CE Marking

Building and Construction Authority

NOTE

1. Whilst every effort has been made to ensure accuracy of the information contained in this design guide, the Building and Construction Authority ("BCA") makes no representations or warranty as to the completeness or accuracy thereof. Information in this design guide is supplied on the condition that the user of this publication will make their own determination as to the suitability for his or her purpose(s) prior to its use. The user of this publication must review and modify as necessary the information prior to using or incorporating the information into any project or endeavour. Any risk associated with using or relying on the information contained in the design guide shall be borne by the user. The information in the design guide is provided on an "as is" basis without any warranty of any kind whatsoever or accompanying services or support.

2. Nothing contained in this design guide is to be construed as a recommendation or requirement to use any policy, material, product, process, system or application and BCA makes no representation or warranty express or implied. NO REPRESENTATION OR WARRANTY, EITHER EXPRESSED OR IMPLIED OF FITNESS FOR A PARTICULAR PURPOSE IS MADE HEREUNDER WITH RESPECT TO INCLUDING BUT NOT LIMITED, WARRANTIES AS TO ACCURACY, TIMELINES, COMPLETENESS, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR COMPLIANCE WITH A PARTICULAR DESCRIPTION OR ANY IMPLIED WARRANTY ARISING FROM THE COURSE OF PERFORMANCE, COURSE OF DEALING, USAGE OF TRADE OR OTHERWISE, TO THE FULLEST EXTENT PERMITTED BY LAW. In particular, BCA makes no warranty that the information contained in the design guide will meet the user's requirements or is error-free or that all errors in the drawings can be corrected or that the drawings will be in a form or format required by the user.

3. In no event will BCA be responsible or liable for damages of any kind resulting from the use or reliance upon information or the policies, materials, products, systems or applications to which the information refers. In addition to and notwithstanding the foregoing, in no event shall BCA be liable for any consequential or special damages or for any loss of profits incurred by the user or any third party in connection with or arising out of use or reliance of this design guide.

Copyright @ 2023 Building and Construction Authority, Singapore.

All rights reserved. This document or any part thereof may not be reproduced for any reason whatsoever in any form or means whatsoever and howsoever without the prior written consent and approval of the Building and Construction Authority.

Whilst every effort has been made to ensure the accuracy of the information contained in this publication, the Building and Construction Authority, its employees or agents shall not be responsible for any mistake or inaccuracy that may be contained herein, and all such liability and responsibility are expressly disclaimed by these said parties.

CONTENTS

Contents ii

List of Tables v

List of Figures viii

Preface ix

Acknowledgement ix

1. Introduction 1

2. Design procedures 2
- 2.1 Adequacy assessment 3
  - 2.1.1 Certification 3
  - 2.1.2 Material testing 3
- 2.2 Reliability assessment 5
  - 2.2.1 Factory production control certification 5
  - 2.2.2 Manufacturer test certification 6
- 2.3 Summary of design procedure 7
- 2.4 Alternative procedure 8

3. Design parameters for Class 1 steel materials 9
- 3.1 British/European (BS EN) steel materials 9
- 3.2 American (ASTM and API) steel materials 10
- 3.3 Japanese (JIS) steel materials 11
- 3.4 Australian/New Zealand (AS/NZS) steel materials 12
- 3.5 Chinese (GB) steel materials 13
- 3.6 Korean (KS) steel materials 14

4. Design parameters for Class 2 steel materials 16
- 4.1 Structural steels 16
- 4.2 Non-preloaded bolts 16
- 4.3 Preloaded bolts 16
- 4.4 Fillet welds 16
- 4.5 Profiled steel sheets 16
- 4.6 Stud shear connectors 16

5. Design parameters for Class 3 steel materials 17

6. Certified steel materials 18
- 6.1 Criteria for acceptance as certified steel 18
  - 6.1.1 Mechanical properties 18
    - 6.1.1.1 Strength 18
    - 6.1.1.2 Ductility 19
    - 6.1.1.3 Impact toughness 19
    - 6.1.1.4 Hardness 19

6.1.2 Chemical composition 20
6.1.3 Dimensional and mass tolerances 21
6.2 Certified British/European steel materials 21
6.2.1 Certified British/European steel plates 21
6.2.2 Certified British/European hot rolled sections 22
6.2.3 Certified British/European hollow sections 22
6.2.4 Certified British/European steel for cold forming 23
6.2.5 Certified British/European non-preloaded bolting assemblies 23
6.2.6 Certified British/European preloaded bolting assemblies 23
6.2.7 Certified British/European welding consumables 24
6.2.8 Certified British/European profiled steel sheets 24
6.2.9 Certified British/European stud shear connectors 24
6.2.10 Certified British/European hot rolled steel bars 24
6.2.11 Certified British/European sheet piling 24
6.3 Certified American steel materials 25
6.3.1 Certified American steel plates 25
6.3.2 Certified American hot rolled sections 25
6.3.3 Certified American hollow sections 25
6.3.4 Certified American steel for cold forming 25
6.3.5 Certified American non-preloaded bolting assemblies 26
6.3.6 Certified American preloaded bolting assemblies 26
6.3.7 Certified American welding consumables 26
6.3.8 Certified American profiled steel sheets 26
6.3.9 Certified American stud shear connectors 27
6.3.10 Certified American hot rolled steel bars 27
6.3.11 Certified American sheet piling 27
6.4 Certified Japanese steel materials 27
6.4.1 Certified Japanese steel plates 27
6.4.2 Certified Japanese hot rolled sections 27
6.4.3 Certified Japanese hollow sections 28
6.4.4 Certified Japanese steel for cold forming 28
6.4.5 Certified Japanese non-preloaded bolting assemblies 28
6.4.6 Certified Japanese preloaded bolting assemblies 28
6.4.7 Certified Japanese welding consumables 28
6.4.8 Certified Japanese profiled steel sheets 29
6.4.9 Certified Japanese stud shear connectors 29
6.4.10 Certified Japanese hot rolled steel bars 29
6.4.11 Certified Japanese sheet piling 29
6.5 Certified Australian/New Zealand steel materials 29
6.5.1 Certified Australian/New Zealand steel plates 29
6.5.2 Certified Australian/New Zealand hot rolled sections 30
6.5.3 Certified Australian/New Zealand hollow sections 30
6.5.4 Certified Australian/New Zealand steel for cold forming 30
6.5.5 Certified Australian/New Zealand non-preloaded bolting assemblies 31
6.5.6 Certified Australian/New Zealand preloaded bolting assemblies 31
6.5.7 Certified Australian/New Zealand welding consumables 31

6.5.8 Certified Australian/New Zealand profiled steel sheets 31
6.5.9 Certified Australian/New Zealand stud shear connectors 32
6.5.10 Certified Australian/New Zealand hot rolled steel bars 32
6.5.11 Certified Australian/New Zealand sheet piling 32
6.6 Certified Chinese steel materials 32
6.6.1 Certified Chinese steel plates 32
6.6.2 Certified Chinese hot rolled sections 33
6.6.3 Certified Chinese hollow sections 33
6.6.4 Certified Chinese steel for cold forming 33
6.6.5 Certified Chinese non-preloaded bolting assemblies 34
6.6.6 Certified Chinese preloaded bolting assemblies 34
6.6.7 Certified Chinese welding consumables 34
6.6.8 Certified Chinese profiled steel sheets 34
6.6.9 Certified Chinese stud shear connectors 34
6.6.10 Certified Chinese hot rolled steel bars 34
6.6.11 Certified Chinese sheet piling 35
6.7 Certified Korean steel materials 35
6.7.1 Certified Korean steel plates 35
6.7.2 Certified Korean hot rolled sections 35
6.7.3 Certified Korean hollow sections 36
6.7.4 Certified Korean steel for cold forming 36
6.7.5 Certified Korean non-preloaded bolting assemblies 36
6.7.6 Certified Korean preloaded bolting assemblies 36
6.7.7 Certified Korean welding consumables 36
6.7.8 Certified Korean profiled steel sheets 37
6.7.9 Certified Korean stud shear connectors 37
6.7.10 Certified Korean hot rolled steel bars 37
6.7.11 Certified Korean sheet piling 37

7. Non-Certified steel materials 38
7.1 Non-Certified British/European steel materials 38
7.2 Non-Certified American steel materials 38
7.3 Non-Certified Japanese steel materials 39
7.4 Non-Certified Australian/New Zealand steel materials 40
7.5 Non-Certified Chinese steel materials 40
7.6 Non-Certified Korean steel materials 40

8. Reusability of steel materials 42
8.1 Quality assessment 43
8.1.1 Manufacturer test certificate and factory production control certificate 43
8.1.2 Certification 43
8.1.3 Material testing 43
8.2 Reusability assessment 44
8.3 In-House quality assurance system 44
8.4 Summary of design procedure for re-used steel 44

LIST OF TABLES

Table 2.1	Summary of adequacy assessment and reliability assessment	2
Table 2.2	Implementation of certification and material testing	4
Table 2.3	Mandatory test results to be indicated on manufacturer test certificate	5
Table 2.4	Implementation of factory production control certification and manufacturer test certification	6
Table 2.5	Actions to be taken by QPs for Class 1 steel materials	7
Table 2.6	Actions to be taken by QPs for Class 2 steel materials	8
Table 3.1a	Design parameters of British/European (BS EN) structural steels	9
Table 3.1b	Design parameters of British/European (BS EN) non-preloaded bolts	9
Table 3.1c	Design parameters of British/European (BS EN) preloaded bolts	9
Table 3.1d	Design strengths of fillet weld made of British/European (BS EN) welding consumables	9
Table 3.1e	Design parameters of British/European (BS EN) profiled steel sheets	9
Table 3.1f	Tensile strengths of British/European (BS EN) stud shear connectors	10
Table 3.2a	Design parameters of American (ASTM and API) structural steels	10
Table 3.2b	Design parameters of American (ASTM) non-preloaded bolts	10
Table 3.2c	Design parameters of American (ASTM) preloaded bolts	10
Table 3.2d	Design strengths of fillet weld made of American (AWS) welding consumables	10
Table 3.2e	Design parameters of American (ASTM) profiled steel sheets	11
Table 3.2f	Tensile strengths of American (AWS) stud shear connectors	11
Table 3.3a	Design parameters of Japanese (JIS) structural steels	11
Table 3.3b	Design parameters of Japanese (JIS) non-preloaded bolts	11
Table 3.3c	Design parameters of Japanese (JIS) preloaded bolts	11
Table 3.3d	Design strengths of fillet weld made of Japanese (JIS) welding consumables	11
Table 3.3e	Design parameters of Japanese (JIS) profiled steel sheets	12
Table 3.3f	Tensile strengths of Japanese (JIS) stud shear connectors	12
Table 3.4a	Design parameters of Australian/New Zealand (AS/NZS) structural steels	12

Table 3.4b Design parameters of Australian/New Zealand (AS/NZS) non-preloaded bolts 12

Table 3.4c Design parameters of Australian/New Zealand (AS/NZS) preloaded bolts 12

Table 3.4d Design strengths of fillet weld made of Australian/New Zealand (AS/NZS) welding consumables 12

Table 3.4e Design parameters of Australian/New Zealand (AS/NZS) profiled steel sheets 13

Table 3.4f Tensile strengths of Australian/New Zealand (AS/NZS) stud shear connectors 13

Table 3.5a Design parameters of Chinese (GB) structural steels 13

Table 3.5b Design parameters of Chinese (GB) non-preloaded bolts 13

Table 3.5c Design parameters of Chinese (GB) preloaded bolts 13

Table 3.5d Design strengths of fillet weld made of Chinese (GB) welding consumables 13

Table 3.5e Design parameters of Chinese (GB) profiled steel sheets 14

Table 3.5f Tensile strengths of Chinese (GB) stud shear connectors 14

Table 3.6a Design parameters of Korean (KS) structural steels 14

Table 3.6b Design parameters of Korean (KS) non-preloaded bolts 14

Table 3.6c Design parameters of Korean (KS) preloaded bolts 14

Table 3.6d Design strengths of fillet weld made of Korean (KS) welding consumables 14

Table 3.6e Design parameters of Korean (KS) profiled steel sheets 15

Table 3.6f Tensile strengths of Korean (KS) stud shear connectors 15

Table 4.1 Design parameters of Class 2 structural steels 16

Table 4.2 Design parameters of Class 2 non-preloaded bolts 16

Table 4.3 Design parameters of Class 2 preloaded bolts 16

Table 5.1 Design parameters of Class 3 structural steels 17

Table 6.1 Yield and tensile strength requirements for certified steel materials 18

Table 6.2 Ductility requirements for certified steel materials 19

Table 6.3 Hardness requirements for bolts and nuts for certified steel materials 19

Table 6.4 Chemical composition requirements based on ladle analysis for certified steel materials 21

Table 6.5 Dimensional and mass tolerances requirements for certified steel materials 21

Table 8.1 Summary of quality assessment and reusability assessment 43

Table 8.2 Implementation of quality assessment 44

Table 8.3 Actions to be taken by steel suppliers and QPs for re-used steel materials 45

LIST OF FIGURES

Figure 2.1 Classification of steel materials 2

Figure 8.1 Verification on reusability of steel materials 42

PREFACE

This handbook is a companion publication to the design guide BC1: 2023 which has been updated to remove reference to BS 5950 and its associated standards, expanded to cover additional new steel and updated with the latest standards in use.

The main objective of this handbook is to provide clearer explanations on how to interpret and use the design guide BC1: 2023, i.e. how to classify the steel into the different classes, and the criteria to qualify for certified, non-certified and re-used steel materials.

Where appropriate, Eurocode's symbols are used in this handbook.

As a handbook, it only provides guidance and recommendations for material usage and it should not be construed as mandatory requirements from the Building and Construction Authority. The Qualified Persons should ensure that the ensuing design and execution of his/her projects are in accordance with the Authority's requirements.

Additional references should be made to the appropriate chapters in SS EN 1993.

ACKNOWLEDGEMENT

The Building and Construction Authority of Singapore (BCA) acknowledges the contribution of Prof Chiew Sing Ping of the Singapore Institute of Technology for technical materials and edits made to this design guide for BCA. In addition, BCA also acknowledges the assistance of Prof Pang Sze Dai et al, representing the Singapore Structural Steel Society for reviewing this guide.

1.0 Introduction

In Singapore, the current approved design code for structural steel design is SS EN 1993. These design codes will specify clearly the steel materials which can be used to design to these codes.

This is a critical consideration as design codes are formulated taking into account the type of materials manufactured to specific material production standards, in this case, it will be those materials manufactured to British/European (BS EN) production standards. The implication of this is that builders should only procure such steel materials to comply fully with the design adopted by the Qualified Person (QP) and the building regulations. Strictly speaking, other steel materials manufactured to non-BS EN production standards cannot be used as they will be in conflict with the design requirements.

The Building and Construction Authority has taken steps to allow a wider choice of steel materials to achieve greater economy and sustainability, and to promote greater usage of structural steel in the building and construction industry. In the ensuing process, it will be necessary to ensure product conformity, quality and traceability in materials coming from various sources, and only adequate and reliable alternative materials are used to ensure public safety.

In this connection, the design guide BC1: 2023 was written specifically for this purpose and a list of certified materials manufactured to BS ENs as well as non-BS EN materials such as ASTM, JIS, AS/NZS, GB and KS are compiled for design to SS EN 1993 design codes. The design guide also gives guidance on how to optimize the usage of such alternative materials, i.e. to use the full design strength for more competitive design if the certified materials can demonstrate adequately that they meet all the reliability requirements and qualify as Class 1 steel materials.

This handbook serves as a complimentary publication to the design guide BC1: 2023 and the primary intention is to provide some background information and explain how to classify steel into the different classes in BC1: 2023. In addition, it provides the design parameters to be adopted for BS EN, ASTM, JIS, AS/NZS, GB and KS steel materials as well as a list of certified and non-certified steel materials.

2.0 Design procedure

BC1: 2023 classified the certified steel material into Class 1, 2 and 3. The design approaches are different based on this classification. This section explain in details the various design procedures which can be adopted during the design stage and the design implications based on the recommendations given in BC1: 2023.

The design procedure is first based on classifying the steel materials by means of adequacy assessment and reliability assessment into the appropriate classes. The classified steel materials shall then be designed to SS EN 1993 based on the design requirements for that material class. The design flow chart is shown in Figure 2.1. A brief summary of the adequacy assessment and reliability assessment are given in Table 2.1.

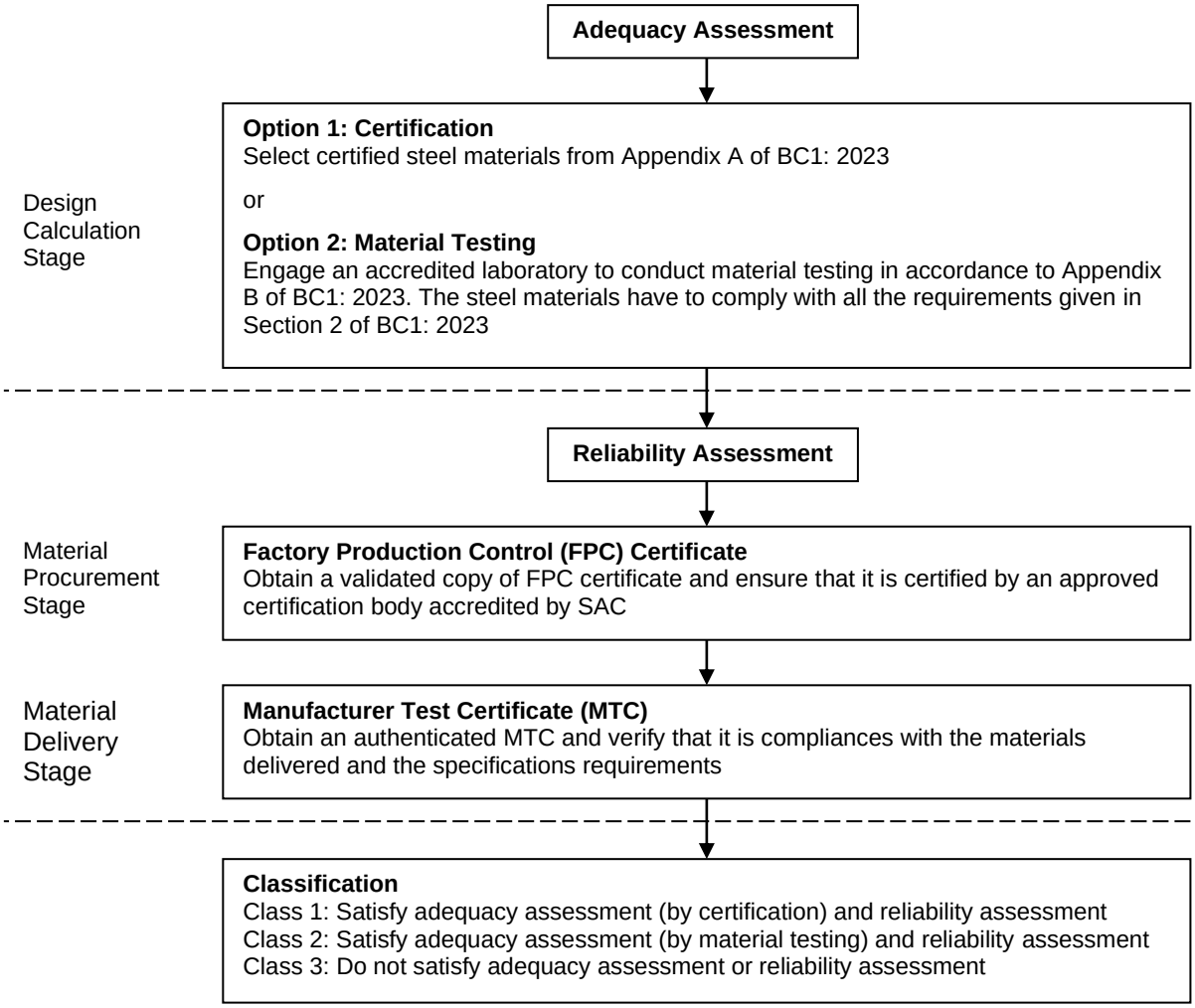

Figure 2.1: Classification of steel materials

	Adequacy Assessment	Reliability Assessment
Requirements to satisfy	Material performance requirements (Section 2 of BC1: 2023)	Quality assurance requirements (Section 3 of BC1: 2023)
Objective of assessment	Steel materials properties	Steel materials manufacturers
Mode of assessment	Certification or material testing	Factory production control (FPC) certificate and Material test certificate (MTC)

Table 2.1: Summary of adequacy assessment and reliability assessment

2.1 Adequacy assessment

The first step in the classification approach involves the verification of the steel material properties against the material performance requirements given in Section 2 of BC1: 2023. Failure in the adequacy assessment shall result in the downgrade of the material class to Class 3. Two modes of adequacy assessment are possible, either by certification or material testing. The differences in the implementation these two modes of assessment and the respective results are given in Table 2.2.

2.1.1 Certification

Certification is the process of evaluating the material properties against the material performance requirements in Section 2 of BC1: 2023 for British/European, American, Japanese, Australian/New Zealand, Chinese and Korean material standards. Materials which meet these requirements are classified as certified steel, whereas those which do not meet the requirements are classified as non-certified steel.

A list of certified steel materials in which their material properties comply with the relevant material performance requirements is listed in Appendix A of BC1: 2023. The use of any steel material from this list of certified materials shall be considered as meeting the material performance requirements given in Section 2 of BC1: 2023 and satisfying the adequacy assessment.

During the design stage, QPs shall select the steel material from the list of certified steel materials. The QPs shall then carry out the design and calculation using the design parameters recommended in Section 5.1 of BC1: 2023 for the steel material selected. It is assumed that the materials will be sourced from manufacturers who can meet the quality assurance requirements and this will have to be verified during material procurement and delivery stage.

2.1.2 Material testing

Basically, Material testing is the process to demonstrate the adequacy of alternative steel other than those already considered in Section 2.1.1 through appropriate sample testing and test method given in Appendix B of BC1: 2023.

Material testing carried out for the purpose of adequacy assessment during the design stage shall not exempt the end purchasers from performing the obligatory inspection and testing in accordance with appropriate regulations during procurement and execution stage.

Test reports from accredited laboratories under the Singapore Laboratory Accreditation Scheme (SAC-SINGLAS) or other laboratories accredited under a mutual recognition agreement with SAC-SINGLAS are required to prove that such materials are able to comply with all the material performance requirements given in Section 2 of BC1: 2023.

When the limiting values are not given in Section 2 of BC1: 2023, linear interpolation shall be allowed to determine the limiting value for the test parameters.

During the design stage, if the QPs decided to select a non-certified steel material, the QPs shall engage an accredited laboratory to conduct material sample testing in accordance to Appendix B of BC1: 2023 and submit a test report containing the necessary information (see Table 2.3) to show that the materials complies with all the material performance requirements given in Section 2 of BC1: 2023.

For non-certified steel which meet the test requirements, the QPs shall carry out the design and calculation using the design parameters recommended in Section 5.2 of BC1: 2023. It is also assumed at this stage that the materials will be sourced from manufacturers who can meet the quality assurance requirements.

	Certification	Material Testing
Initiation	Based on Section 2 of BC1: 2023	QPs to initiate testing
Steel materials coverage	Certified steel materials, as given in Appendix A of BC1: 2023	Any material not listed in Appendix A of BC1: 2023 manufactured to material standards which are current and confirmed, regardless of the country or region of origin
Condition to pass the assessment	QPs to select steel materials from the list of certified steel materials given in Appendix A of BC1: 2023	QPs to engage an accredited laboratory to conduct material testing in accordance to Appendix B of BC1: 2023 and show that the steel materials are in compliance with all the relevant requirements given in Section 2 of BC1: 2023
Class of material, if pass the assessment	Class 1, if also pass the reliability assessment	Class 2, if also pass the reliability assessment
Class of material, if fail the assessment	Class 3, and review design	Class 3, and review design

Table 2.2: Implementation of certification and material testing

Type of steel materials	Mandatory test results
• Steel plates • Hot rolled sections • Hollow sections	• Yield strength • Tensile strength • Elongation after fracture • Impact energy • Chemical content based on ladle or product analysis, of carbon, sulphur, phosphorous, silicon, manganese, copper, chromium, molybdenum, nickel, aluminum, niobium, titanium, vanadium, nitrogen and any other element intentionally added • Carbon equivalent value computed based on equation: $\mathrm{CEV}(\%) = \%\mathrm{C} + \frac{\%\mathrm{Mn}}{6} + \frac{\%\mathrm{Cr} + \%\mathrm{Mo} + \%\mathrm{V}}{5} + \frac{\%\mathrm{Cu} + \%\mathrm{Ni}}{15}$
• Non-preloaded bolting assemblies • Preloaded bolting assemblies	• Yield strength (bolts) • Tensile strength (bolts) • Elongation after fracture (bolts) • Hardness (bolts, nuts and washers) • Proof load stress (nuts) • Chemical content, based on product analysis, of carbon, sulphur and phosphorous (bolts and nuts)
• Welding consumables	• Yield strength • Tensile strength • Elongation after fracture • Impact energy

• Steel for cold forming • Profiled steel sheets • Hot rolled bars • Sheet piles	• Yield strength • Tensile strength • Elongation after fracture • Chemical content based on ladle or product analysis, of carbon, sulphur, phosphorous, silicon, manganese, copper, chromium, molybdenum, nickel, aluminum, niobium, titanium, vanadium, nitrogen and any other element intentionally added • Carbon equivalent value computed based on equation: $\mathrm{CEV}(\%) = \%\mathrm{C} + \frac{\%\mathrm{Mn}}{6} + \frac{\%\mathrm{Cr} + \%\mathrm{Mo} + \%\mathrm{V}}{5} + \frac{\%\mathrm{Cu} + \%\mathrm{Ni}}{15}$
• Stud shear connectors	• Yield strength • Tensile strength • Elongation after fracture

Table 2.3: Mandatory test results to be indicated on manufacturer test certificate

2.2 Reliability assessment

The second step in the classification involves the verification of the material reliability against the quality assurance requirements given in Section 3 of BC1: 2023. The reliability assessment is to ensure that the steel materials are manufactured under stringent quality assurance system and that it shall meet the quality assurance requirements given in Section 3 of BC1: 2023. Failure in the reliability assessment shall result in the immediate downgrade of the material to Class 3.

The implementation of reliability assessment shall involve the submission of valid factory production control certificates and manufacturer test certificates. The differences in the implementation of the reliability assessment are summarized in Table 2.4.

2.2.1 Factory production control certification

The manufacturers shall have a factory production control (FPC) system attested by a certification body accredited by SAC for this task for it to carry out the duty of auditing the production control system of a manufacturer through necessary inspection, assessment and surveillance.

Certificates of factory production control system, issued by the accredited certification body, shall form the acceptable indicator for an attested factory production control system.

General requirements on FPC are given in Section 3.1 of BC1: 2023. However, the following shall be noted:

- ISO 9001 certificate for quality management system is complimentary. Having an ISO 9001 certificate alone is regarded as insufficient to demonstrate reliability of the FPC system for manufacturers in a production environment.
- FPC certificates shall form the only acceptable indicator for an attested production control system in manufacturing a particular type of steel materials.
- FPC certificates for BC1's certified steel materials should clearly indicate the validity period of 3 years in the certificates.
- FPC certificates for BS EN steel materials issued under the European Union Construction Directives, which are already widely recognised in the European market, shall be considered 'acceptable in lieu' of an FPC certificate to BC1 if their FPC or Manufacturer Test Certificate (MTC) bears the CE Marking. Similarly, hollow sections specified in Annex A.2.3 shall have the API Monogram to be considered 'acceptable in lieu' of an FPC certificate to BC1. The FPC system of such manufacturers in producing the particular type of steel materials shall be considered already attested.

Upon confirmation of the source of the steel materials, QPs shall evaluate the validated copy of the FPC certificate, obtained either directly from the manufacturer or through the stockist or trader. The FPC certificate shall also be made available for subsequent inspection by BCA, if required.

	Factory production control (FPC) certification	**Manufacturer test certification (MTC)**
Requirements to meet	Factory production control, as given in 3.1 of BC1: 2023	Manufacturer test certificates, as given in 3.2 of BC1: 2023
Objective of assessment	The manufacturer of steel materials	The steel materials
Certificate to be produced by the manufacturers	A valid factory production control (FPC) certificate issued by a certification body accredited by SAC for this task	• A sample test certificate • An authenticated test certificate containing complete information for every batch of steel materials delivered
Valid coverage of the certificate	The production control and quality assurance provided by the manufacturer in producing the particular type of steel materials	Quality assurance on the particular batch of steel materials delivered
Condition to pass assessment	QPs are to evaluate the certificate upon confirmation of source of materials	• QPs are to evaluate the sample certificate upon confirmation of source of materials • QPs are to evaluate the actual certificate which shall also specify the actual quantity of steel materials delivered
Class of material, if pass both assessment	• Class 1, if pass the adequacy assessment by certification • Class 2, if pass the adequacy assessment by material testing	
Class of material, if fail one of the assessment	Class 3	

Table 2.4: Implementation of factory production control certification and manufacturer test certification

2.2.2 Manufacturer test certification

The manufacturer shall issue an authenticated test certificate for every batch of steel materials as a form of quality assurance on the steel materials delivered to site.

Mandatory information on test results corresponding to different type of steel materials is summarized in Table 2.3.

It shall be noted that the use of the test results of feedstock materials, if any, shall be clearly indicated. Actual quantity of steel materials purchased from the stockist or trader shall be clearly indicated and the validated copy of the authenticated test certificate corresponding to the steel materials delivered shall be given to the purchaser.

Upon confirmation of the source of steel materials, QPs shall evaluate sample copy of manufacturer test certificate, obtained directly from the manufacturer or through the stockist or trader.

Upon delivery of the steel materials to the site, QPs shall inspect and confirm that all the mandatory information is indicated on the actual manufacturer test certificate. The document shall also be made available for inspection by BCA, if required.

2.3 Summary of design procedure

The necessary actions to be taken by QPs during the various stages in the overall design procedure are summarized in Tables 2.5 and 2.6 for Class 1 and 2 steel materials respectively.

Stage	QPs
Design calculation	• Select certified steel materials from Appendix A of BC1: 2023 • Assume* materials to be Class 1 and adopt design parameters from Section 5.1 of BC1: 2023 • Submit the necessary design calculation as per authority requirements
Material procurement	• Confirm the source of steel materials • Obtain a validated copy of the valid FPC certificate • Obtain a sample of manufacturer test certificate to ensure all mandatory information can be provided • Keep copy of the above document for inspection
Material delivery	• Obtain an authenticated manufacturer test certificate (or its validated copy) and verify the compliance of the steel materials delivered to the specifications • Keep copy of above documents for inspection
* It shall be noted that QPs can only assume that the materials will be Class 1 during the design calculation stage. The QPs need to perform the necessary follow-up checks during the material procurement and delivery stages to confirm the materials to be Class 1.	

Table 2.5: Actions to be taken by QPs for Class 1 steel materials

Stage	QPs
Design calculation	• Engage an accredited laboratory to conduct sample material testing in accordance to Appendix B of BC1: 2023 and show that the steel materials are in compliance with all the relevant requirements given in Section 2 • Assume* materials to be Class 2 and adopt design parameters from 5.2 of BC1: 2023 • Submit a copy of the test report and the necessary design calculation as per authority requirements
Material procurement	• Confirm the source of steel materials • Obtain a validated copy of the valid FPC certificate** • Obtain a sample of manufacturer test certificate to ensure all mandatory information can be provided • Keep copy of above document for inspection
Material delivery	• Obtain an authenticated manufacturer test certificate (or its validated copy) and verify the compliance of the steel materials delivered to the specifications • Keep copy of above documents for inspection
* It shall be noted that QPs can only assume that the materials will be Class 2 during the design calculation stage. The QPs need to perform the necessary follow-up checks during the material procurement and delivery stages to confirm the materials to be Class 2. ** The FPC certificate certified to the material standards of the selected material.	

Table 2.6: Actions to be taken by QPs for Class 2 steel materials

2.4 Alternative procedure

In lieu of the adequacy and reliability assessments recommended in Sections 4.1 and 4.2 of BC1: 2023, a material performance-based assessment based on rigorous material testing and control might be appropriate, subject to a case-by-case approval from BCA, as stated under Section 4.4 Special Case of BC1: 2023.

If approved, the steel materials concerned may be treated as Class 2 materials if their adequacy and reliability can be guaranteed through rigorous control and testing plans of the materials delivery to site.

The assessment shall include but not limited to:

- 100% material visual inspection and non-destructive testing to confirm manufacturing tolerances and surface delivery conditions;
- A set of destructive material testing for each batch/lot (see Table 2.3 for tests required);
- Test reports from SAC-SINGLAS accredited laboratory or other laboratory accredited under a mutual recognition agreement with SAC-SINGLAS; and
- A material assessment report from an independent expert consultant.

3.0 Design parameters for Class 1 steel materials

This section list the steel design strengths and parameters to be adopted for the design of steel materials classified as Class 1.

3.1 British/European (BS EN) steel materials

Grade	f_y (N/mm^2), for thickness (mm) less than or equal to					
	16	**40**	**63**	**80**	**100**	**150**
S235	235	225	215	215	215	195
S275	275	265	255	245	235	225
S355	355	345	335	325	315	295
S420	420	400	390	370	360	340
S460	460	440	430	410	400	380
S500	500	500	480	480	480	440
S550	550	550	530	530	530	490
S620	620	620	580	580	580	560
S690	690	690	650	650	650	630

Table 3.1a: Design parameters of British/European (BS EN) structural steels

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
4.6	240	400
8.8	640	800
10.9	900	1000

Table 3.1b: Design parameters of British/European (BS EN) non-preloaded bolts

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
8.8	640	800
10.9	900	1000

Table 3.1c: Design parameters of British/European (BS EN) preloaded bolts

Grade	Tensile strength U_e (N/mm^2)	Design strength p_w (N/mm^2)
35	440	$0.50U_e \leq 0.55U_s$ U_s = Tensile strength of parent metal
38	470	
42	500	
46	530	
50	560	

Table 3.1d: Design strengths of fillet weld made of British/European (BS EN) welding consumables

Grade	Basic yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_u (N/mm^2)
S220GD	220	300
S250GD	250	330
S280GD	280	360
S320GD	320	390
S350GD	350	420
S550GD	550	560

Table 3.1e: Design parameters of British/European (BS EN) profiled steel sheets

Material standards	Tensile strength f_u (N/mm^2)
BS EN ISO 13918	450

Table 3.1f: Tensile strengths of British/European (BS EN) stud shear connectors

3.2 American (ASTM and API) steel materials

Grade	f_y (N/mm^2), for thickness (mm) less than or equal to				
	32	**50**	**65**	**80**	**100**
ASTM structural steels					
36 [250]	250	240	230	220	210
42 [290]	290	280	270	260	250
50 [345]	345	335	325	315	305
55 [380]	380	370	360	350	340
60 [415]	415	405	395	385	375
65 [450]	450	440	430	420	410
70 [485]	485	475	465	455	445
100 [690]	690	680	670	660	650
API line pipes					
B [L245]	245	235	-	-	-
X42 [L290]	290	280	-	-	-
X46 [L320]	320	310	-	-	-
X52 [L360]	360	350	-	-	-
X56 [L390]	390	380	-	-	-
X60 [L415]	415	405	-	-	-
X65 [L450]	450	440	-	-	-

Table 3.2a: Design parameters of American (ASTM and API) structural steels

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
307B	240	400
A325	660	830
A449	640	800
A490	900	1000

Table 3.2b: Design parameters of American (ASTM) non-preloaded bolts

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
A325	660	830
A354 BC	680	790
A354 BD	790	960
A490	900	1000

Table 3.2c: Design parameters of American (ASTM) preloaded bolts

Grade	Tensile strength U_e (N/mm^2)	Design strength p_w (N/mm^2)
E49xx	490	245

Table 3.2d: Design strengths of fillet weld made of American (AWS) welding consumables

Grade	Basic yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_u (N/mm^2)
230	230	310
255	255	360
275	275	380
340	340	410
380	380	480
410	410	480
480	480	550
550	550	570

Table 3.2e: Design parameters of American (ASTM) profiled steel sheets

Material standards	Tensile strength f_u (N/mm^2)
AWS D1.1 (Type B)	450

Table 3.2f: Tensile strengths of American (AWS) stud shear connectors

3.3 Japanese (JIS) steel materials

Grade	f_y (N/mm^2), for thickness (mm) less than or equal to					
	16	40	75	100	160	200
400	245	235	215	215	205	195
490	325	315	295	295	285	275
490Y	365	355	335	325	-	-
520	365	355	335	325	-	-
570	460	450	430	420	-	-

Table 3.3a: Design parameters of Japanese (JIS) structural steels

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
4.6	240	400
8.8	640	800
10.9	900	1000

Table 3.3b: Design parameters of Japanese (JIS) non-preloaded bolts

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
F8T	640	800
F10T	900	1000
F11T	950	1100
S10T	900	1000

Table 3.3c: Design parameters of Japanese (JIS) preloaded bolts

Grade	Tensile strength U_e (N/mm^2)	Design strength p_w (N/mm^2)
D43xx	450	225
D50xx	510	255
D53xx	600	300

Table 3.3d: Design strengths of fillet weld made of Japanese (JIS) welding consumables

Grade	Basic yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_u (N/mm^2)
340	245	340
400	295	400
440	335	440
490	365	490
540	400	540

Table 3.3e: Design parameters of Japanese (JIS) profiled steel sheets

Material standards	Tensile strength f_u (N/mm^2)
JIS B 1198	400

Table 3.3f: Tensile strengths of Japanese (JIS) stud shear connectors

3.4 Australian/New Zealand (AS/NZS) steel materials

Grade	f_y (N/mm^2), for thickness (mm) less than or equal to					
	12	**20**	**32**	**50**	**80**	**150**
250	250	250	250	250	240	230
300	300	300	280	280	270	260
350	350	350	340	340	340	330
400	400	380	360	360	360	-
450	450	450	420	400	-	-
CA220	210	-	-	-	-	-
CA260	250	-	-	-	-	-
CA350	350	-	-	-	-	-
PT430	300	280	280	270	270	250
PT460	305	295	295	275	275	265
PT490	360	340	340	330	330	320
PT540	450	450	420	400	-	-

Table 3.4a: Design parameters of Australian/New Zealand (AS/NZS) structural steels

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
4.6	240	400
8.8	640	800
10.9	900	1000

Table 3.4b: Design parameters of Australian/New Zealand (AS/NZS) non-preloaded bolts

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
8.8	640	800
10.9	900	1000
12.9	1080	1200

Table 3.4c: Design parameters of Australian/New Zealand (AS/NZS) preloaded bolts

Grade	Tensile strength U_e (N/mm^2)	Design strength p_w (N/mm^2)
E43xx	430	215
E49xx	490	245
E55xx	550	275
E57xx	570	285

Table 3.4d: Design strengths of fillet weld made of Australian/New Zealand (AS/NZS) welding consumables

Grade	Basic yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_u (N/mm^2)
250	250	320
300	300	340
350	350	420
450	450	480
500	500	520
550	550	550

Table 3.4e: Design parameters of Australian/New Zealand (AS/NZS) profiled steel sheets

Material standards	Tensile strength f_u (N/mm^2)
AS 1554.2	410

Table 3.4f: Tensile strengths of Australian/New Zealand (AS/NZS) stud shear connectors

3.5 Chinese (GB) steel materials

Grade	f_y (N/mm^2), for thickness (mm) less than or equal to				
	16	35	50	100	150
Q235	235	225	215	215	195
Q275	275	265	255	245	225
Q295	295	275	255	235	-
Q345	345	325	295	275	-
Q355	355	345	335	325	-
Q390	390	370	350	330	-
Q420	420	400	380	360	-
Q460	460	440	420	400	-

Table 3.5a: Design parameters of Chinese (GB) structural steels

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
4.6	190	320
8.8	450	560
10.9	630	700

Table 3.5b: Design parameters of Chinese (GB) non-preloaded bolts

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
8.8	450	560
10.9	630	700

Table 3.5c: Design parameters of Chinese (GB) preloaded bolts

Grade	Tensile strength U_e (N/mm^2)	Design strength p_w (N/mm^2)
43	420	210
50	490	245
55	540	270

Table 3.5d: Design strengths of fillet weld made of Chinese (GB) welding consumables

Grade	Basic yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_u (N/mm^2)
220	220	300
250	250	330
280	280	360
320	320	390
350	350	420
400	400	470
500	500	530
550	550	560

Table 3.5e: Design parameters of Chinese (GB) profiled steel sheets

Material standards	Tensile strength f_u (N/mm^2)
GB/T 10433	400

Table 3.5f: Tensile strengths of Chinese (GB) stud shear connectors

3.6 Korean (KS) steel materials

Grade	f_y (N/mm^2), for thickness (mm) less than or equal to				
	16	40	75	100	150
275	275	265	255	235	225
355	355	345	335	315	295
380	380	370	360	340	320
420	420	400	380	360	340
460	460	440	420	400	380

Table 3.6a: Design parameters of Korean (KS) structural steels

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
4.6	240	400
4.8	320	400
8.8	640	800
10.9	900	1000

Table 3.6b: Design parameters of Korean (KS) non-preloaded bolts

Grade (Bolt marking)	Yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_{ub} (N/mm^2)
F8T	640	800
F10T	900	1000
S10T	900	1000

Table 3.6c: Design parameters of Korean (KS) preloaded bolts

Grade	Tensile strength U_e (N/mm^2)	Design strength p_w (N/mm^2)
E50xx	490	245
E53xx	520	260
E58xx	570	285

Table 3.6d: Design strengths of fillet weld made of Korean (KS) welding consumables

Grade	Basic yield strength f_{yb} (N/mm^2)	Ultimate tensile strength f_u (N/mm^2)
245	245	340
295	295	400
335	335	440
365	365	490

Table 3.6e: Design parameters of Korean (KS) profiled steel sheets

Material standards	Tensile strength f_u (N/mm^2)
KS B 1062	400

Table 3.6f: Tensile strengths of Korean (KS) stud shear connectors

4.0 Design parameters for Class 2 steel materials

This section list the steel design strengths and parameters to be adopted for design purposes for steel materials classified as Class 2. Generally, the design strengths of Class 2 materials are reduced by at least 10% from that of Class 1.

4.1 Structural steels

Design parameters f_y (N/mm^2), for thickness[a] (mm) less than or equal to					
16	**40**	**63**	**80**	**100**	**150**
$f_{yo} = R_{eh}/1.1 \leq R_m/1.3$ or 460 N/mm^2	$0.95f_{yo}$	$0.92f_{yo}$	$0.90f_{yo}$	$0.85f_{yo}$	$0.80f_{yo}$
a) For rolled sections, used the specific thickness of the thickest element of the cross-section.					

Table 4.1: Design parameters of Class 2 structural steels

4.2 Non-preloaded bolts

Tensile strength	Yield strength	Yield strength f_{yb}	Ultimate tensile strength f_{ub}
$U_b \leq 1000$ N/mm^2	Y_b	$0.7Y_b$	$0.7U_b$

Table 4.2: Design parameters of Class 2 non-preloaded bolts

4.3 Preloaded bolts

Tensile strength	Yield strength	Yield strength f_{yb}	Ultimate tensile strength f_{ub}
$U_b \leq 1000$ N/mm^2	Y_b	$0.7Y_b$	$0.7U_b$

Table 4.3: Design parameters of Class 2 preloaded bolts

4.4 Fillet welds

For design to SS EN 1993, the specified strengths of the welding consumables shall be at least equivalent to 1.2 times of that specified for the parent metal, and the specified ductility and impact toughness of the welding consumables shall be at least equivalent to that specified for the parent metal.

4.5 Profiled steel sheets

Basic yield strength (SS EN 1993): $f_{yb} = 0.9Y_s$
Ultimate tensile strength (SS EN 1993): $f_u = 0.9U_s$

4.6 Stud shear connectors

Design shear resistance (SS EN 1993):

$$P_{Rd} = \frac{0.6 f_u \pi d^2/4}{\gamma_V} \quad \text{or} \quad \frac{0.25\alpha d^2\sqrt{f_{ck}E_{cm}}}{\gamma_V}$$

where $\alpha = 0.2\left(\frac{h_{sc}}{d}+1\right) \leq 1$ for $\frac{h_{sc}}{d} \geq 3$

5.0 Design parameters for Class 3 steel materials

This section summarises the steel material properties to be adopted for design purposes for steel materials classified as Class 3. Only structural steels can be of Class 3 materials. All other sections (i.e. bolts, fillet welds, etc…) shall not be of Class 3 materials. Class 3 structural steel which meet the requirements in Table 5.1 shall only be restricted to non-structural purposes.

Design parameters f_y (N/mm^2), for thickness[a] (mm) less than or equal to					
16	**40**	**63**	**80**	**100**	**150**
170	160	155	150	145	135
a) For rolled sections, used the specific thickness of the thickest element of the cross-section.					

Table 5.1: Design parameters of Class 3 structural steels

6.0 Certified steel materials

The design guide only covers certified steel materials manufactured to certain British/European standards (BS EN), American standards (API, ASTM and AWS), Japanese standards (JIS), Australian/New Zealand standards (AS/NZS and AS), Chinese standards (GB) and Korean standards (KS).

6.1 Criteria for acceptance as certified steel

The criteria can be broadly classified based on mechanical properties, chemical composition and dimensional and mass tolerances. The material has to satisfy ALL the relevant criteria below before it can be classified as a certified steel material. A list of certified steels manufactured to the different standards is presented in Sections 6.2 to 6.6 for ease of usage.

6.1.1 Mechanical properties

6.1.1.1 Strength

Material	Nominal yield strength (N/mm^2)	Nominal tensile strength (N/mm^2)
Steel Plates (t ≥ 3 mm)	235 to 690	300 to 1000
Hot Rolled Sections	235 to 460	300 to 750
Hollow Sections	235 to 460	300 to 750
Steel for Cold Forming	200 to 550	250 to 750
Non-Preloaded Bolts	-	300 to 1200
Grade 4.6	≥ 240	≥ 400
Grade 8.8	≥ 640	≥ 800
Grade 10.9	≥ 900	≥ 1000
Non-Preloaded Nuts	400 to 1200	-
Grade 4	≥ 400	-
Grade 8	≥ 800	-
Grade 10	≥ 1000	-
Preloaded Bolts	-	800 to 1200
Grade 8.8	≥ 640	≥ 800
Grade 10.9	≥ 900	≥ 1000
Preloaded Nuts	800 to 1200	-
Grade 8	≥ 800	-
Grade 10	≥ 1000	-
All-Weld Metal	355 to 690	-
Profiled Steel Sheets	220 to 550	275 to 600
Stud Shear Connectors	-	≥ 400
Hot Rolled Steel Bars	235 to 690	300 to 1000
Sheet Piles	235 to 460	300 to 750

Table 6.1: Yield and tensile strength requirements for certified steel materials

6.1.1.2 Ductility

Material	Elongation after Fracture (%)	Tensile / Yield Strength Ratio, Nominal (Actual)
Steel Plate (Yield strength ≤ 460 N/mm^2)	≥ 15	≥ 1.2 (1.1)
Steel Plate (Yield strength > 460 N/mm^2)	≥ 10	≥ 1.2 (1.1)
Hot Rolled Sections	≥ 15	≥ 1.2 (1.1)
Hollow Sections	≥ 15	-
Steel for Cold Forming (Yield strength ≤ 460 N/mm^2)	≥ 15	-
Steel for Cold Forming (Yield strength > 460 N/mm^2)	≥ 10	-
Non-Preloaded Bolts	≥ 8	-
Preloaded Bolts	≥ 8	-
All-Weld Metal	≥ 15	-
Stud Shear Connectors	≥ 14	-
Hot Rolled Steel Bars (Yield strength ≤ 460 N/mm^2)	≥ 15	≥ 1.2 (1.1)
Hot Rolled Steel Bars (Yield strength > 460 N/mm^2)	≥ 10	≥ 1.2 (1.1)
Sheet Piles	≥ 15	≥ 1.2 (1.1)

Table 6.2: Ductility requirements for certified steel materials

6.1.1.3 Impact toughness

The material shall be able to absorb at least 27J of impact energy at 20°C.

6.1.1.4 Hardness

Grade of Bolts / Nuts	Range of Hardness		
	Vickers Hardness (HV)	Brinell Hardness (HB)	Rockwell Hardness (HRB or HRC)
Non-Preloaded Bolts			
4.6	120 to 220	114 to 209	67 to 95 (HRB)
8.8	250 to 335	238 to 318	22 to 34 (HRC)
10.9	320 to 380	304 to 361	32 to 39 (HRC)
Non-Preloaded Nuts			
≤ 8	≤ 310	≤ 302	≤ 30 (HRC)
10	≤ 370	≤ 353	≤ 36 (HRC)
12	≤ 395	≤ 375	≤ 39 (HRC)
Preloaded Bolts			
8.8	250 to 335	238 to 318	22 to 34 (HRC)
10.9	320 to 380	304 to 361	32 to 39 (HRC)
Preloaded Nuts			
8	175 to 310	166 to 302	88 (HRB) to 30 (HRC)
10	258 to 370	248 to 353	24 (HRC) to 36 (HRC)
12	≤ 395	≤ 375	≤ 39 (HRC)

Table 6.3: Hardness requirements for bolts and nuts for certified steel materials

6.1.2 Chemical composition

Material	Maximum Content (% by mass)			
	CEV	P[a]	S	C
Steel Plates (t ≤ 16 mm) p_y (N/mm^2)				
235	0.40	0.045	0.050	-
275	0.44	0.045	0.050	-
355	0.49	0.045	0.050	-
420	0.52	0.040	0.050	-
460	0.55	0.040	0.050	-
460[b]	0.50	0.040	0.040	-
550[b]	0.83	0.030	0.020	-
690[b]	0.83	0.030	0.020	-
Hot Rolled Sections (t ≤ 16 mm) p_y (N/mm^2)				
235	0.40	0.045	0.045	-
275	0.44	0.045	0.045	-
355	0.49	0.045	0.045	-
420	0.52	0.040	0.040	-
460	0.55	0.040	0.040	-
Hot Finished Hollow Sections (t ≤ 16 mm) p_y (N/mm^2)				
235	0.41	0.040	0.040	-
275	0.45	0.040	0.040	-
355	0.50	0.035	0.035	-
420	0.52	0.035	0.035	-
460	0.55	0.035	0.035	-
Cold-Formed Hollow Sections (t ≤ 16 mm) p_y (N/mm^2)				
235	0.37	0.040	0.040	-
275	0.40	0.040	0.040	-
355	0.48	0.035	0.035	-
420	0.50	0.035	0.035	-
460	0.53	0.035	0.035	-
Steel for Cold Forming				
All Grades	0.48	0.050	0.050	0.25
Non-Preloaded Bolts (Grade)				
≤ 6.8	-	0.050	0.060	0.55
≥ 8.8	-	0.050	0.060	0.55
Non-Preloaded Nuts (Grade)				
≤ 6	-	0.110	0.150	0.50
8	-	0.060	0.150	0.58
10 and 12	-	0.048	0.058	0.58
Preloaded Bolts				
All Grades	-	0.060	0.060	0.55
Preloaded Nuts (Grade)				
8	-	0.060	0.150	0.58
10 and 12	-	0.050	0.060	0.58
Profiled Steel Sheets				
All Grades	-	0.120	0.050	0.25
Hot Rolled Steel Bars				
235	0.40	0.045	0.050	-
275	0.44	0.045	0.050	-
355	0.49	0.045	0.050	-
420	0.52	0.040	0.050	-
460	0.55	0.040	0.050	-
460[b]	0.50	0.040	0.040	-
550[b]	0.83	0.030	0.020	-

690[b]	0.83	0.030	0.020	-
Sheet Piles				
All Grades	0.48	0.050	0.050	0.25
a) For certain weathering steel, maximum phosphorous content shall be allowed up to 0.15% b) For quenched and tempered steel only				

Table 6.4: Chemical composition requirements based on ladle analysis for certified steel materials

6.1.3 Dimensional and mass tolerances

Material	Dimensional Tolerances Deviation in Actual Thickness from Nominal Plate Thickness	Mass Tolerances Deviation in Actual Mass from Mass Computed
Steel Plates	≤ Smaller of ± 2 mm and ± 15%	Density of 7850 kg/m^3 and limited by Dimensional Tolerances
Hot Rolled Sections	Overall Dimensions ≤ Larger of ± 4 mm and ± 3% Thickness of Components ≤ Smaller of ± 2 mm and ± 15%	Density of 7850 kg/m^3 All Sections (except T) ≤ ± 6% T-Sections ≤ ± 8%
Hollow Sections	Overall Dimensions ≤ ± 2% Wall Thickness ≤ Smaller of ± 2 mm and ± 15%	Density of 7850 kg/m^3 All Sections ≤ ± 6%
Steel for Cold Forming	≤ Smaller of ± 0.3 mm and ± 15%	Density of 7850 kg/m^3 and limited by Dimensional Tolerances
Profiled Steel Sheets	≤ Smaller of ± 0.2 mm and ± 15%	Density of 7850 kg/m^3 and limited by Dimensional Tolerances
Hot Rolled Steel Bars	≤ Smaller of ± 0.5 mm and ± 10%	Density of 7850 kg/m^3 and limited by Dimensional Tolerances
Sheet Piles	Thickness ≤ 5mm ≤ ± 0.5 mm Thickness > 5mm ≤ ± 10%	Density of 7850 kg/m^3 and limited by Dimensional Tolerances

Table 6.5: Dimensional and mass tolerances requirements for certified steel materials

6.2 Certified British/European steel materials

6.2.1 Certified British/European steel plates

Any combination of steel grades manufactured to:

BS EN 10025-2:2019
- S235JR
- S235J0
- S235J2
- S275JR
- S275J0
- S275J2
- S355JR
- S355J0
- S355J2
- S355K2
- S460JR
- S460J0
- S460J2
- S460K2

or

BS EN 10025-3:2019
- S275N
- S275NL
- S355N
- S355NL
- S420N
- S420NL
- S460N
- S460NL

or

BS EN 10025-4:2019
- S275M
- S275ML
- S355M
- S355ML
- S420M
- S420ML
- S460M
- S460ML

or

BS EN 10025-5:2019
- S235J0W
- S235J2W
- S355J0WP
- S355J2WP
- S355J0W
- S355J2W
- S355K2W

or

BS EN 10025-6:2019
- S460Q
- S460QL
- S460QL1
- S500Q
- S500QL
- S500QL1
- S550Q
- S550QL
- S550QL1
- S620Q
- S620QL
- S620QL1
- S690Q
- S690QL
- S690QL1

With dimensional and/or mass tolerances in accordance with:

BS EN 10029:2010
- Class A
- Class B
- Class C
- Class D

BS EN 10051:2010
- Category A
- Category B

or

6.2.2 Certified British/European hot rolled sections

Any combination of steel grades manufactured to:

BS EN 10025-2:2019
- S235JR
- S235J0
- S235J2
- S275JR
- S275J0
- S275J2
- S355JR
- S355J0
- S355J2
- S355K2
- S460JR
- S460J0
- S460J2
- S460K2

or

BS EN 10025-3:2019
- S275N
- S275NL
- S355N
- S355NL
- S420N
- S420NL
- S460N
- S460NL

or

BS EN 10025-4:2019
- S275M
- S275ML
- S355M
- S355ML
- S420M
- S420ML
- S460M
- S460ML

or

BS EN 10025-5:2019
- S235J0W
- S235J2W
- S355J0WP
- S355J2WP
- S355J0W
- S355J2W
- S355K2W

or

BS EN 10025-6:2019
- S460Q
- S460QL
- S460QL1

or

With dimensional and/or mass tolerances in accordance with:
BS EN 10024:1995, BS EN 10034:1993, BS EN 10055:1996, BS EN 10056-2:1993, BS EN 10279:2000

6.2.3 Certified British/European hollow sections

Either any combination of steel grades manufactured to:
BS EN 10210-1:2006
- S235JRH
- S275J0H
- S275J2H
- S275NH
- S275NLH
- S355J0H
- S355J2H
- S355K2H
- S355NH
- S355NLH
- S420NH
- S420NLH
- S460NH
- S460NLH

With dimensional and/or mass tolerances in accordance with BS EN 10210-2:2019

Or any combination of steel grades manufactured to:
BS EN 10219-1:2006
- S235JRH
- S275J0H
- S275J2H
- S275MH
- S275MLH
- S275NH
- S275NLH
- S355J0H
- S355J2H
- S355K2H
- S355MH
- S355MLH
- S355NH
- S355NLH
- S420MH
- S420MLH
- S460MH
- S460MLH
- S460NH
- S460NLH

With dimensional and/or mass tolerances in accordance with BS EN 10219-2:2019

6.2.4 Certified British/European steel for cold forming

Either any combination of steel grades manufactured to:

BS EN 10025-2:2019
- S235JR
- S235J0
- S235J2
- S275JR
- S275J0
- S275J2
- S355JR
- S355J0
- S355J2
- S355K2
- S460JR
- S460J0
- S460J2
- S460K2

or

BS EN 10149-2:2013
- S315MC
- S355MC
- S420MC
- S460MC
- S500MC
- S550MC

or

BS EN 10149-3:2013
- S260NC
- S315NC
- S355NC
- S420NC

With dimensional and/or mass tolerances in accordance with BS EN 10051:2010

Or any combination of steel grades manufactured to:

BS EN 10346:2015
- S220GD
- S250GD
- S280GD
- S320GD
- S350GD

With dimensional and/or mass tolerances in accordance with BS EN 10143:2006

6.2.5 Certified British/European non-preloaded bolting assemblies

Bolts manufactured to:
- BS 4190:2014
- BS 7419:2012
- BS EN ISO 4014:2022
- BS EN ISO 4016:2022
- BS EN ISO 4017:2022
- BS EN ISO 4018:2022

Nuts manufactured to:
- BS 4190: 2014
- BS EN ISO 4032:2012
- BS EN ISO 4033:2012
- BE EN ISO 4034:2012

Washers manufactured to:
- BS EN ISO 898-3:2018+A1:2021
- BS EN ISO 7091:2000

6.2.6 Certified British/European preloaded bolting assemblies

Bolts manufactured to:
- BS EN 14399-3:2015
- BS EN 14399-4:2015

Nuts manufactured to:
- BS EN 14399-3:2015
- BS EN 14399-4:2015

Washers manufactured to:
- BS EN 14399-5:2015
- BS EN 14399-6:2015

6.2.7 Certified British/European welding consumables

Welding consumables, which result in all-weld metals meeting the requirements in Section 6.1, and manufactured to:

- BS EN ISO 14174:2019
- BS EN ISO 636:2017
- BS EN ISO 2560:2020
- BS EN ISO 14171:2016
- BS EN ISO 14341:2020
- BS EN ISO 14343:2017
- BS EN ISO 16834:2012
- BS EN ISO 17632:2015
- BS EN ISO 17633:2018+A1:2021
- BS EN ISO 17634:2015
- BS EN ISO 18274:2010
- BS EN ISO 21952:2012
- BS EN ISO 24373:2018
- BS EN ISO 24598:2019
- BS EN ISO 26304:2018

6.2.8 Certified British/European profiled steel sheets

Any combination of steel grades manufactured to BS EN 10346:2015:

- S220GD
- S250GD
- S280GD
- S320GD
- S350GD
- S550GD

With dimensional and/or mass tolerances in accordance with BS EN 10143:2006

6.2.9 Certified British/European stud shear connectors

Stud shear connectors manufactured to BS EN ISO 13918:2018+A1:2021

6.2.10 Certified British/European hot rolled steel bars

Any combination of steel grades manufactured to:

BS EN 10025-2:2019

- S235JR
- S235J0
- S235J2
- S275JR
- S275J0
- S275J2
- S355JR
- S355J0
- S355J2
- S355K2
- S460JR
- S460J0
- S460J2
- S460K2

or

BS EN 10025-3:2019

- S275N
- S275NL
- S355N
- S355NL
- S420N
- S420NL
- S460N
- S460NL

or

BS EN 10025-4:2019

- S275M
- S275ML
- S355M
- S355ML
- S420M
- S420ML
- S460M
- S460ML

or

BS EN 10025-5:2019

- S235J0W
- S235J2W
- S355J0WP
- S355J2WP
- S355J0W
- S355J2W
- S355K2W

or

BS EN 10025-6:2019

- S460Q
- S460QL
- S460QL1
- S500Q
- S500QL
- S500QL1
- S550Q
- S550QL
- S550QL1
- S620Q
- S620QL
- S620QL1
- S690Q
- S690QL
- S690QL1

With dimensional and/or mass tolerances in accordance with:
BS EN 10058:2018, BS EN 10059:2003, BS EN 10060:2003

6.2.11 Certified British/European sheet piling

Either any combination of steel grades manufactured to BS EN 10248-1:1996, with dimensional and/or mass tolerances in accordance with BS EN 10248-2:1996

Or any combination of steel grades manufactured to BS EN 10249-1:1996, with dimensional and/or mass tolerances in accordance with BS EN 10249-2:1996

Or any certified steel for cold forming in Section 6.2.4

6.3 Certified American steel materials

6.3.1 Certified American steel plates

Any combination of steel grades manufactured to:

ASTM A 36-2019
- Grade 250

or

ASTM A 242-2013
- Grade 345

or

ASTM A 572-2021e1
- Grade 290
- Grade 345
- Grade 380
- Grade 415
- Grade 450

or

ASTM A 588-2019
- Grade 345

or

ASTM A 709-2021
- Grade 250
- Grade 345
- Grade 485
- Grade 690

or

ASTM A 945-2016
- Grade 345
- Grade 450

ASTM A 1066-2022
- Grade 345
- Grade 415
- Grade 450
- Grade 485
- Grade 550

With dimensional and/or mass tolerances in accordance with ASTM A 6-2022

6.3.2 Certified American hot rolled sections

Any combination of steel grades manufactured to:

ASTM A 36-2019
- Grade 250

or

ASTM A 588-2019
- Grade 345

ASTM A 572-2021e1
- Grade 290
- Grade 345
- Grade 380
- Grade 415
- Grade 450

or

ASTM A 709-2021
- Grade 250
- Grade 345

or

ASTM A 992-2020
- Grade 345

or

ASTM A 913-2019
- Grade 345
- Grade 415
- Grade 450

With dimensional and/or mass tolerances in accordance with ASTM A 6-2022

6.3.3 Certified American hollow sections

Steel grades manufactured to ASTM A 501-2021:
- Grade 345

Or steel grades manufactured to API 5L-2018:
- Grade B-PSL 2
- Grade X42-PSL 2
- Grade X46-PSL 2
- Grade X52-PSL 2
- Grade X56-PSL 2
- Grade X60-PSL 2
- Grade X65-PSL 2

6.3.4 Certified American steel for cold forming

Any combination of steel grades manufactured to:

ASTM A 1011-2018a
- Grade SS 205
- Grade SS 230
- Grade SS 250
- Grade SS 275
- Grade SS 310
- Grade SS 340
- Grade SS 380
- Grade SS 410
- Grade SS 480
- Grade SS 550

or

ASTM A 1008-2021a
- Grade SS 205
- Grade SS 230
- Grade SS 275
- Grade SS 310
- Grade SS 340
- Grade SS 410
- Grade SS 480
- Grade SS 550

or

ASTM A 792-2022
- Grade SS 230
- Grade SS 255
- Grade SS 275
- Grade SS 340
- Grade SS 410
- Grade SS 480
- Grade SS 550

or

ASTM A 875-2022
- Grade SS 230
- Grade SS 255
- Grade SS 340
- Grade SS 550

or

With dimensional and/or mass tolerances in accordance with:
ASTM A 568-2019a or ASTM A 924-2022a

6.3.5 Certified American non-preloaded bolting assemblies

Bolts manufactured to:
- ASTM A 193-2023
- ASTM A 307-2021 (Grade B)
- ASTM F 3125-2022 (Limited to ASTM A 325-2014 and ASTM A 490-2014a)
- ASTM A 449-2014 (2020)

Nuts manufactured to:
- ASTM A 563-2021ae1
- ASTM A 194-2022a

Washers manufactured to:
- ASTM F 436-2019

6.3.6 Certified American preloaded bolting assemblies

Bolts manufactured to:
- ASTM F 3125-2022 (Limited to ASTM A 325-2014 and ASTM A 490-2014a)
- ASTM A 354-2017e2 (Grade BC and Grade BD)

Nuts manufactured to:
- ASTM F 3125-2022 (Limited to ASTM F 1852-2014)
- ASTM A 563-2021ae1

Washers manufactured to:
- ASTM F 959-2017a
- ASTM F 436-2019

6.3.7 Certified American welding consumables

Welding consumables, which result in all-weld metals meeting requirements in Section 6.1 and manufactured to AWS A 5.1-2012 and AWS A 5.9: 2022

6.3.8 Certified American profiled steel sheets

Any combination of steel grades manufactured to:

ASTM A 653-2022
- Grade SS 230
- Grade SS 255
- Grade SS 275
- Grade SS 340
- Grade SS 380
- Grade SS 410
- Grade SS 480
- Grade SS 550

ASTM A 1046-2022
- Grade SS 230
- Grade SS 255
- Grade SS 275
- Grade SS 340
- Grade SS 550

or

With dimensional and/or mass tolerances in accordance with ASTM A 924-2022a

6.3.9 Certified American stud shear connectors

Stud shear connectors manufactured to:
AWS D1.1-2020
- Type B

6.3.10 Certified American hot rolled steel bars

Any combination of steel grades manufactured to ASTM A 709-2021, with dimensional and/or mass tolerances in accordance with ASTM A 6-2022

6.3.11 Certified American sheet piling

Either any combination of steel grades manufactured to ASTM A 328-2013a (2018) or ASTM A 857-2019, with dimensional and/or mass tolerances in accordance with ASTM A 6-2022

Or any certified steel for cold forming in Section 6.3.4

6.4 Certified Japanese steel materials

6.4.1 Certified Japanese steel plates

Any combination of steel grades manufactured to:

JIS G 3106:2020 +A1:2022
- SM400B
- SM400C
- SM490B
- SM490C
- SM490YB
- SM520B
- SM520C
- SM570

or

JIS G 3114:2022
- SMA400BP
- SMA400BW
- SMA400CP
- SMA400CW
- SMA490BP
- SMA490BW
- SMA490CP
- SMA490CW
- SMA570P
- SMA570W

or

JIS G 3136:2022
- SN400B
- SN400C
- SN490B
- SN490C

With dimensional and/or mass tolerances in accordance with JIS G 3193:2019

6.4.2 Certified Japanese hot rolled sections

Any combination of steel grades manufactured to:

JIS G 3106:2020 +A1:2022
- SM400B
- SM400C
- SM490B
- SM490C
- SM490YB
- SM520B
- SM520C
- SM570

or

JIS G 3114:2022
- SMA400BP
- SMA400BW
- SMA400CP
- SMA400CW
- SMA490BP
- SMA490BW
- SMA490CP
- SMA490CW
- SMA570P
- SMA570W

or

JIS G 3136:2022
- SN400B
- SN400C
- SN490B
- SN490C

With dimensional and/or mass tolerances in accordance with JIS G 3192:2021

6.4.3 Certified Japanese hollow sections

Steel grades manufactured to JIS G 3475:2021:
- STKN400B
- STKN400W
- STKN490B

6.4.4 Certified Japanese steel for cold forming

Either any combination of steel grades manufactured to:

JIS G 3106:2020 +A1:2022
- SM400B
- SM400C
- SM490B
- SM490C
- SM490YB
- SM520B
- SM520C
- SM570

or

JIS G 3114:2022
- SMA400BP
- SMA400BW
- SMA400CP
- SMA400CW
- SMA490BP
- SMA490BW
- SMA490CP
- SMA490CW
- SMA570P
- SMA570W

or

JIS G 3136:2022
- SN400B
- SN400C
- SN490B
- SN490C

With dimensional and/or mass tolerances in accordance with JIS G 3193:2019

Or steel grade manufactured to JIS G 3350:2021
- SSC400

6.4.5 Certified Japanese non-preloaded bolting assemblies

Bolts manufactured to:
- JIS B 1051:2014
- JIS B 1180:2014

Nuts manufactured to:
- JIS B 1052-2:2014
- JIS B 1181:2014

Washers manufactured to:
- JIS B 1256:2008

6.4.6 Certified Japanese preloaded bolting assemblies

Bolts manufactured to:
- JIS B 1186:2013
- JSS II-09:2015

Nuts manufactured to:
- JIS B 1186:2013

Washers manufactured to:
- JIS B 1186:2013

6.4.7 Certified Japanese welding consumables

Welding consumables, which result in all-weld metals meeting requirements in Section 6.1, and manufactured to JIS Z 3211:2008 and JIS Z 3313:2009

6.4.8 Certified Japanese profiled steel sheets

Any combination of steel grades manufactured to:

JIS G 3302:2022
- SGH340
- SGH400
- SGH440
- SGH490
- SGH540
- SGC340
- SGC400
- SGC440
- SGC490

or

JIS G 3317:2019
- SZAH340
- SZAH400
- SZAH440
- SZAH490
- SZAH540
- SZAC340
- SZAC400
- SZAC440
- SZAC490

or

JIS G 3321:2022
- SGLH400
- SGLH440
- SGLH490
- SGLH540
- SGL400
- SGL440
- SGL490

6.4.9 Certified Japanese stud shear connectors

Stud shear connectors manufactured to JIS B 1198:2011

6.4.10 Certified Japanese hot rolled steel bars

Any combination of steel grades manufactured to:

JIS G 3106:2020 +A1:2022
- SM400B
- SM400C
- SM490B
- SM490C
- SM490YB
- SM520B
- SM520C
- SM570

or

JIS G 3114:2022
- SMA400BP
- SMA400BW
- SMA400CP
- SMA400CW
- SMA490BP
- SMA490BW
- SMA490CP
- SMA490CW
- SMA570P
- SMA570W

or

JIS G 3136:2022
- SN400B
- SN400C
- SN490B
- SN490C

With dimensional and/or mass tolerances in accordance with JIS G 3191:2022

6.4.11 Certified Japanese sheet piling

Steel grades manufactured to JIS A 5523:2021 and JIS A 5530:2019 with dimensional and/or mass tolerances in accordance with JIS A 5528:2021

Or any certified steel for cold forming in Section 6.4.4

6.5 CERTIFIED AUSTRALIAN / NEW ZEALAND STEEL MATERIALS

6.5.1 Certified Australian / New Zealand steel plates

Either any combination of steel grades manufactured to AS/NZS 3678-2016+A1:2017

- Grade 250
- Grade 300
- Grade 350
- Grade 400
- Grade 450

With dimensional and/or mass tolerances in accordance with AS/NZS 1365-1996+A1:2014, with plates rolled on continuous mills. If plates are rolling on reversing mills, width of plate should be less than 2.7m

Or steel grades manufactured to AS 1548-2008:

- PT430NL0
- PT430NL20
- PT430NL40
- PT430NRL0
- PT430NRL20
- PT430NRL40
- PT430TRL0
- PT430TRL20
- PT430TRL40
- PT460NL0
- PT460NL20
- PT460NL40
- PT460NL50
- PT460NRL0
- PT460NRL20
- PT460NRL40
- PT460NRL50
- PT460TRL0
- PT460TRL20
- PT460TRL40
- PT460TRL50
- PT490N
- PT490NL20
- PT490NL40
- PT490NL50
- PT490NR
- PT490NRL20
- PT490NRL40
- PT490NRL50
- PT490T
- PT490TRL20
- PT490TRL40
- PT490TRL50
- PT540T
- PT540TL20
- PT540TL40
- PT540TL50

6.5.2 Certified Australian / New Zealand hot rolled sections

Steel grades manufactured to AS/NZS 3679.1-2016:

- Grade 300L0
- Grade 300L15
- Grade 300S0
- Grade 350L0
- Grade 350S0

6.5.3 Certified Australian / New Zealand hollow sections

Steel grades manufactured to AS/NZS 1163-2016+A1:2017:

- Grade C250L0
- Grade C350L0
- Grade C450L0

6.5.4 Certified Australian / New Zealand Steel for cold forming

Any combination of steel grades manufactured to AS/NZS 1595-1998+A1:2014:
- CA 220
- CA 260
- CA 350

With dimensional and/or mass tolerances in accordance with AS/NZS 1365-1996+A1:2014

Or any combination of steel grades manufactured to AS 1397-2021:
- Grade 250
- Grade 300
- Grade 350
- Grade 400
- Grade 450

With dimensional and/or mass tolerances in accordance with AS/NZS 1365-1996+A1:2014

6.5.5 Certified Australian / New Zealand non-preloaded bolting assemblies

Bolts manufactured to:
- AS/NZS 1252.1-2016+A1:2018
- AS/NZS 1252.2-2016
- AS 4291.1-2015*
- AS 1559-2018

Note: *Grade 12.9 is non-certified

Nuts manufactured to:
- AS/NZS 1252.1-2016+A1:2018
- AS/NZS 1252.2-2016
- AS/NZS 4291.2-2016

Washers manufactured to:
- AS/NZS 1252.1-2016+A1:2018
- AS/NZS 1252.2-2016

6.5.6 Certified Australian / New Zealand preloaded bolting assemblies

Bolts manufactured to:
- AS/NZS 1252.1-2016+A1:2018
- AS/NZS 1252.2-2016
- AS 4291.1-2015

Nuts manufactured to:
- AS/NZS 1252.1-2016+A1:2018
- AS/NZS 1252.2-2016
- AS/NZS 4291.2-2016

Washers manufactured to:
- AS/NZS 1252.1-2016+A1:2018
- AS/NZS 1252.2-2016

6.5.7 Certified Australian / New Zealand welding consumables

Welding consumables, which result in all-weld metals meeting material performance requirements in Section 6.1, and manufactured to:

- AS/NZS 1554.1-2014+A2:2017
- AS/NZS 4855-2022
- AS/NZS 4857-2022*
- AS/NZS ISO 14171-2013
- AS/NZS ISO 14174-2013
- AS/NZS 14341-2012
- AS/NZS 16834-2013
- AS/NZS 21952-2012
- Note: *Only grades 55, 62 and 69 are certified
  **Z is non-certified
  ***Only grades W5xxx to W6xxx are certified; grade W5ZXH is non-certified

6.5.8 Certified Australian / New Zealand steel for profiled steel sheets

Any combination of steel grades manufactured to AS 1397-2021:

- Grade 250
- Grade 300
- Grade 350
- Grade 400
- Grade 450
- Grade 500
- Grade 550

With dimensional and/or mass tolerances in accordance with AS/NZS 1365-1996+A1:2014

6.5.9 Certified Australian / New Zealand stud shear connectors

Stud shear connectors manufactured to AS 1554.2-2021 with stud diameter at least 15.9mm

6.5.10 Certified Australian / New Zealand hot rolled steel bars

Steel grades manufactured to AS/NZS 3679.1-2016

6.5.11 Certified Australian / New Zealand sheet piling

Any certified steel for cold forming in Section 6.5.4

6.6 Certified Chinese steel materials

6.6.1 Certified Chinese steel plates

Any combination of steel grades manufactured to:

GB/T 700-2006*

- Q235BZ
- Q235CZ
- Q235DTZ
- Q275BZ
- Q275CZ
- Q275DTZ

or

GB/T 1591-2018*

- Q345B
- Q345C
- Q345D
- Q345E
- Q355B(AR)
- Q355C(AR)
- Q355D(AR)
- Q355ND
- Q355NE
- Q355MD
- Q355ME
- Q390B
- Q390C
- Q390D
- Q390E
- Q420B
- Q420C
- Q420D
- Q420E
- Q460C
- Q460D
- Q460E
- Q500C
- Q500D
- Q500E
- Q550C
- Q550D
- Q550E
- Q620C
- Q620D
- Q620E
- Q690C
- Q690D
- Q690E

or

GB/T 4171-2008

- Q265GNH
- Q295GNH
- Q310GNH
- Q355GNH
- Q235NH
- Q295NH
- Q355NH
- Q415NH
- Q460NH
- Q500NH
- Q550NH

or

GB/T 19879-2015

- Q235GJC
- Q235GJD
- Q235GJE
- Q345GJC
- Q345GJD
- Q345GJE
- Q390GJC
- Q390GJD
- Q390GJE
- Q420GJC
- Q420GJD
- Q420GJE
- Q460GJC
- Q460GJD
- Q460GJE

With dimensional and/or mass tolerances in accordance with GB/T 709-2019*:

- Class A
- Class B
- Class C
- Class N
- PT.A
- PT.B

Note: *Steel plates manufactured to GB/T 3274-2017, which make reference to GB/T 700-2006, GB/T 1591-2018 and GB/T 709-2019, shall be considered certified

6.6.2 Certified Chinese hot rolled sections

Any combination of steel grades manufactured to:

GB/T 700-2006

- Q235BZ
- Q235CZ
- Q235DTZ
- Q275BZ
- Q275CZ
- Q275DTZ

or

GB/T 1591-2018

- Q345B
- Q345C
- Q345D
- Q345E
- Q355B(AR)
- Q355C(AR)
- Q355D(AR)
- Q355ND
- Q355NE
- Q355MD
- Q355ME
- Q390B
- Q390C
- Q390D
- Q390E
- Q420B
- Q420C
- Q420D
- Q420E
- Q460C
- Q460D
- Q460E

or

GB/T 4171-2008

- Q265GNH
- Q295GNH
- Q310GNH
- Q355GNH
- Q235NH
- Q295NH
- Q355NH
- Q415NH
- Q460NH

With dimensional and/or mass tolerances in accordance with GB/T 706-2016 and GB/T 11263-2017

6.6.3 Certified Chinese hollow sections

Either any combination of steel grades manufactured to:

GB/T 700-2006

- Q235CZ
- Q235DTZ
- Q275CZ
- Q275DTZ

or

GB/T 1591-2018

- Q345B
- Q345C
- Q345D
- Q345E
- Q355B(AR)
- Q355C(AR)
- Q355D(AR)
- Q355ND
- Q355NE
- Q355MD
- Q355ME
- Q390B
- Q390C
- Q390D
- Q390E
- Q420B
- Q420C
- Q420D
- Q420E
- Q460C
- Q460D
- Q460E

or

GB/T 4171-2008

- Q265GNH
- Q295GNH
- Q310GNH
- Q355GNH
- Q235NH
- Q295NH
- Q355NH
- Q415NH
- Q460NH

With dimensional and/or mass tolerances in accordance with GB/T 6728-2017

Or any combination of steel grades manufactured to GB/T 8162-2018:

- Q235B
- Q235C
- Q235D
- Q275B
- Q275C
- Q275D
- Q295B
- Q345B
- Q345C
- Q345D
- Q345E
- Q390B
- Q390C
- Q390D
- Q390E
- Q420B
- Q420C
- Q420D
- Q420E
- Q460C
- Q460D
- Q460E

With dimensional and/or mass tolerances in accordance with GB/T 8162-2018 and GB/T 17395-2008

6.6.4 Certified Chinese steel for cold forming

Any combination of steel grades manufactured to:

GB/T 700-2006

- Q215AZ
- Q215BZ
- Q235AZ
- Q235BZ
- Q235CZ
- Q235DTZ
- Q275AZ
- Q275BZ
- Q275CZ
- Q275DTZ

or

GB/T 1591-2018

- Q345A
- Q345B
- Q345C
- Q345D
- Q345E
- Q355B(AR)
- Q355C(AR)
- Q355D(AR)
- Q355ND
- Q355NE
- Q355MD
- Q355ME
- Q390A
- Q390B
- Q390C
- Q390D
- Q390E
- Q420A
- Q420B
- Q420C
- Q420D
- Q420E

With dimensional and/or mass tolerances in accordance with GB/T 709-2019

6.6.5 Certified Chinese non-preloaded bolting assemblies

Bolts manufactured to:
- GB/T 5780-2016
- GB/T 5781-2016
- GB/T 5782-2016
- GB/T 5783-2016

Nuts manufactured to:
- GB/T 41-2016
- GB/T 6170-2015
- GB/T 6175-2016

Washers manufactured to:
- GB/T 95-2002

6.6.6 Certified Chinese preloaded bolting assemblies

Bolts manufactured to:
- GB/T 1228-2006
- GB/T 3632-2008

Nuts manufactured to:
- GB/T 1229-2006
- GB/T 3632-2008

Washers manufactured to:
- GB/T 1230-2006
- GB/T 3632-2008

6.6.7 Certified Chinese welding consumables

Welding consumables, which result in all-weld metals meeting requirements in Section 6.1, and manufactured to:
- GB/T 5117-2012
- GB/T 5118-2012
- GB/T 5293-2018
- GB/T 8110-2020
- GB/T 10045-2018
- GB/T 12470-2018
- GB/T 17493-2018

6.6.8 Certified Chinese steel for profiled steel sheets

Any combination of steel grades manufactured to GB/T 2518-2019:
- S220GD
- S250GD
- S280GD
- S320GD
- S350GD
- S550GD

6.6.9 Certified Chinese stud shear connectors

Stud shear connectors manufactured to GB/T 10433-2002

6.6.10 Certified Chinese hot rolled steel bars

Any combination of steel grades manufactured to:

GB/T 700-2006
- Q235BZ
- Q235CZ
- Q235DTZ
- Q275BZ
- Q275CZ
- Q275DTZ

or

GB/T 1591-2018
- Q345B
- Q345C
- Q345D
- Q345E
- Q355B(AR)
- Q355C(AR)
- Q355D(AR)
- Q355ND
- Q355NE
- Q355MD
- Q355ME
- Q390B
- Q390C
- Q390D
- Q390E
- Q420B
- Q420C
- Q420D
- Q420E
- Q460C
- Q460D
- Q460E
- Q500C
- Q500D
- Q500E
- Q550C
- Q550D
- Q550E
- Q620C
- Q620D
- Q620E
- Q690C
- Q690D
- Q690E

or

GB/T 4171-2008
- Q265GNH
- Q295GNH
- Q310GNH
- Q355GNH
- Q235NH
- Q295NH
- Q355NH
- Q415NH
- Q460NH
- Q500NH
- Q550NH

With dimensional and/or mass tolerances in accordance with GB/T 702-2017

6.6.11 Certified Chinese sheet piling

Steel grades manufactured to GB/T 20933-2021

Or any certified steel for cold forming in Section 6.6.4.

6.7 Certified Korean steel materials

6.7.1 Certified Korean steel plates

Any combination of steel grades manufactured to:

KS D 3515:2018*
- SM275A
- SM275B
- SM275C
- SM275D
- SM355A
- SM355B
- SM355C
- SM355D
- SM420A
- SM420B
- SM420C
- SM420D
- SM460B
- SM460C

or

KS D 3529:2018
- SMA275BW
- SMA275BP
- SMA275CW
- SMA275CP
- SMA355BW
- SMA355BP
- SMA355CW
- SMA355CP
- SMA460W
- SMA460P

or

KS D 3861:2018
- SN275B
- SN275C
- SN355B
- SN355C
- SN460B
- SN460C

NOTE: *SM460B and SM460C are certified with a thickness not exceeding 100 mm.

With dimensional and/or mass tolerances in accordance with:
KS D 3051:2002, KS D 3052:2002, KS D 3500:2019 and KS D 3502:2019

6.7.2 Certified Korean hot rolled sections

Steel grades manufactured to:

KS D 3866:2019*

- SHN275
- SHN355
- SHN420
- SHN460

or

KS D 3868:2018**

- HSB380
- HSB380L
- HSB380W
- HSB460
- HSB460L
- HSB460W

NOTE: *Steel section with a thickness not exceeding 75mm.
NOTE: **The steels that exceed 100 mm shall be specified by agreement between the purchaser and the manufacturer.
NOTE: SHN grade in KS D 3866 is recommended to building structure applicant. HSB grade in KS D 3868 is recommended to bridge structure applicant.

With dimensional and/or mass tolerances in accordance with:
KS D 3502:2002

6.7.3 Certified Korean hollow sections

Any combination of steel grades manufactured to:

KS D 3632:2019

- SNT355A
- SNT355E
- SNT460A
- SNT460E

KS D 3864:2019

- SNRT395E
- SNRT360E
- SNRT275A
- SNRT355A

or

With dimensions in accordance with:
KS D 3502:2002

6.7.4 Certified Korean steel for cold forming

Either any combination of steel grades manufactured to:

KS D 3530:2018

- SSC275

or

KS D 3558:2018

- SWH275
- SWH275L
- SWH355
- SWH355L
- SWH420
- SWH420L
- SWH460
- SWH460L

or

KS D 3512:2007

- SPCD
- SPCE
- SPCF

With dimensional and/or mass tolerances in accordance with:
KS D 3530:2018, KS D 3558:2018, KS D 3512:2007 and KS D 3770:2018

6.7.5 Certified Korean non-preloaded bolting assemblies

Bolts manufactured to:

- KS B 1002:2016
- KS B 1016:2015

Nuts manufactured to:

- KS B 1012:2017

Washers manufactured to:

- KS B 1326:2009

6.7.6 Certified Korean preloaded bolting assemblies

Bolts manufactured to:

- KS B 1010:2009
- KS B 2819:2016

Nuts manufactured to:

- KS B 1010:2009
- KS B 2819:2016

Washers manufactured to:

- KS B 1324:2017

6.7.7 Certified Korean welding consumables

Welding consumables, which result in all-weld metals meeting the requirements in Section 6.1, and manufactured to:

- KS B 7006:2018
- KS D 7025:2005
- KS D 7101:2002

6.7.8 Certified Korean profiled steel sheets

Any combination of steel grades manufactured to:
KS D 3506:2018

- SGH245Y
- SGH295Y
- SGH335Y
- SGH365Y

With dimensional and/or mass tolerances in accordance with:
KS D 3506:2018

6.7.9 Certified Korean stud shear connectors

Stud shear connectors manufactured to:
KS B 1062:2014

6.7.10 Certified Korean hot rolled steel bars

Steel grades manufactured to:
KS D 3857:2018

- SNR275A
- SNR275B
- SNR355B

With dimensional and/or mass tolerances in accordance with:
KS D 3051:2017

6.7.11 Certified Korean sheet piling

Either steel grades manufactured to:

KS D 3858:2018

- SPY345W
- SPY450
- SPY345M
- SPY380M

or

- KS D 4602:2016
- STP275
- STP355
- STP380
- STP450
-
- or

- KS D 4603:2016
- SHP275W
- SHP355W
- SHP450W

With dimensional and/or mass tolerances in accordance with:
KS D 3858:2018, KS D 4602:2016 and KS D 3052:2017

Or any certified steel for cold forming in Section 6.7.4.

7.0 Non-Certified steel materials

Any steel materials which do not satisfy the criteria in Section 6.1 in this handbook (Section 2 in BC1: 2023) shall be classified as non-certified steel materials. This chapter only covers non-certified steel materials manufactured to certain British/European standards (BS EN), American standards (API, ASTM and AWS), Japanese standards (JIS), Australian/New Zealand standards (AS/NZS and AS), Chinese standards (GB) and Korean standards (KS), and shall be updated in accordance with the latest version of the respective standards.

These materials are non-certified because one or more of the following parameters were not controlled or specified in the respective codes.

- Strength: Not within the required strength range
- Ductility: Did not elongation beyond the required ductility
- Impact Toughness: Not able to absorb the minimum required energy
- Hardness: Beyond the required hardness
- Dimensional Tolerance: Beyond the required dimension
- Mass Tolerance: Beyond the required mass
- Usage: Not intended for usage for structural purpose

7.1 Non-Certified British/European steel materials

Material Standard	Steel Grades
Steel Plates	
BS EN 10025-2: 2019	E295, E335, E360, S185, S450J0
BS EN 10025-6: 2019	S890Q, S890QL, S890QL1, S960Q, S960QL
Hot Rolled Sections	
BS EN 10025-2: 2019	E295, E335, E360, S185, S450J0
BS EN 10025-6: 2019	S890Q, S890QL, S890QL1, S960Q, S960QL
Steel for Cold Forming	
BS EN 10025-2: 2019	E295, E335, E360, S185, S450J0
BS EN 10149-2: 2013	S600MC, S650MC, S700MC
BS EN 10326: 2004	S550GD

7.2 Non-Certified American steel materials

Material Standard	Steel Grades
Steel Plates	
ASTM A 283-2018	A, B, C, D
ASTM A 514-2022	All Grades
ASTM A 529-2019	50, 55
ASTM A 573-2020	440, 460
ASTM A 871-2020	60, 65
Hot Rolled Sections	
ASTM A 529-2019	50, 55
Hollow Sections	
API 5L-2018	PSL1
ASTM A 53-2022	A, B
ASTM A 268-2022	All Grades
ASTM A 333-2018	All Grades
ASTM A 423-2019	All Grades
ASTM A 500-2021a	A, B, C, D
ASTM A 501-2021	A

ASTM A 595-2022	All Grades
ASTM A 618-2021	Ia, 1b, II, III
ASTM A 847-2021	All Grades
Steel for Cold Forming	
ASTM A 109-2016 (2018)	All Grades
ASTM A 308-2010	SS30, SS33, SS40
ASTM A 653-2022	All Grades
ASTM A 606-2018	All Grades
ASTM A 875-2022	SS330
ASTM A 1003-2015	ST230H, ST230L, ST255H, ST255L, ST275H, ST275L, ST340H, ST340L
ASTM A 1011-2018a	HSLA480, HSLA-F480, HSLA-F550, HSLAS310, HSLAS340, HSLAS380, HSLAS410, HSLAS450, HSLAS-F410
Non-Preloaded Bolting Assemblies	
ASTM A 194-2022a	1, 2, 3, 6, 8
ASTM A 307-2021	A
ASTM A 563-2021ae1	8S3-B
Preloaded Bolting Assemblies	
ASTM A 193-2023	All Grades

7.3 Non-Certified Japanese steel materials

Material Standard	Steel Grades
Steel Plates	
JIS G 3101: 2020+A1:2022	SS330, SS400, SS490, SS540
JIS G 3106: 2020+A1:2022	SM400A, SM490A, (All type A material)
JIS G 3114: 2022	SMA400AW, SMA400AP, SMA490AW, SMA490AP
JIS G 3128: 2021	SHY685, SHY685N, SHY685NS
JIS G 3131: 2018	SPHC, SPHD, SPHE
JIS G 3132: 2018	SPHT1, SPHT2, SPHT3, SPHT4
JIS G 3136: 2022	SN400A, SN490A
Hot Rolled Sections	
JIS G 3101: 2020+A1:2022	SS330, SS400, SS490, SS540
JIS G 3106: 2020+A1:2022	SM400A, SM490A, (All type A material)
JIS G 3114: 2022	SMA400AW, SMA400AP, SMA490AW, SMA490AP
JIS G 3136: 2022	SN400A, SN490A
Hollow Sections	
JIS G 3444: 2021	STK290, STK400, STK500, STK490, STK540
JIS G 3466: 2021	STKR400, STKR490
Steel for Cold Forming	
JIS G 3101: 2020+A1:2022	SS330, SS400, SS490, SS540
JIS G 3106: 2020+A1:2022	SM400A, SM490A, (All type A material)
JIS G 3114: 2022	SMA400AW, SMA400AP, SMA490AW, SMA490AP
JIS G 3136: 2022	SN400A, SN490A
JIS G 3302: 2022	SGHC, SGH340, SGH400, SGH440, SGH490, SGH540, SGCC, SGCH, SGCD1, SGCD2, SGCD3, SGC340, SGC400, SGC440, SGC490, SGC570
JIS G 3312: 2019	CGCC, CGCH, CGCD1, CGC340, CGC400, CGC440, CGC490, CGC570
JIS G 3321: 2022	SGLHC, SGLH400, SGLH440, SGLH490, SGLH540, SGLCC, SGLCD, SGLC400, SGLC440, SGLC490, SGLC570
JIS G 3322: 2019	CGLCC, CGLCD, CGLC400, CGLC440, CGLC490, CGLC570
JIS G 3352: 2014	SDP1, SDP2, SDP3

Profiled Steel Sheets	
JIS G 3302: 2022	SGHC, SGCC, SGCH, SGCD1, SGCD2, SGCD3, SGC570
JIS G 3321: 2022	SGLHC, SGLH400, SGLH440, SGLH490, SGLH540, SGLCC, SGLCD, SGLC400, SGLC440, SGLC490, SGLC570

7.4 Non-Certified Australian / New Zealand steel materials

Material Standard	Steel Grades
Steel Plates	
AS/NZS 1594-2002	All Grades
Hot Rolled Sections	
AS/NZS 3679.1-2016	250, 400
Steel for Cold Forming	
AS 1397-2021	G500, G550
AS 1548-2008	5-490N or A, 7-430 N, R, T or A, 7-460 N, R, T or A, 7-490 N, R, T or A
AS/NZS 1594-2002	All Grades
AS/NZS 1595-1998+A1:2014	CW300

7.5 Non-Certified Chinese steel materials

Material Standard	Steel Grades
Steel Plates	
GB/T 700-2006	Q195F, Q195Z, Q215AF, Q215AZ, Q215BF, Q215BZ, Q235AF, Q235AZ, Q235BF, Q275AF, Q275AZ
GB/T 1591-2018	Q295A, Q345A, Q390A, Q420A
Hot Rolled Sections	
GB/T 700-2006	Q195F, Q195Z, Q215AF, Q215AZ, Q215BF, Q215BZ, Q235AF, Q235AZ, Q235BF, Q275AF, Q275AZ
GB/T 1591-2018	Q295A, Q345A, Q390A, Q420A
Hollow Sections	
GB/T 700-2006	Q195F, Q195Z, Q215AF, Q215AZ, Q215BF, Q215BZ, Q235AF, Q235AZ, Q235BF, Q235BZ, Q275AF, Q275AZ, Q275BZ
GB/T 1591-2018	Q295A, Q345A, Q345B, Q390A, Q390B, Q420A, Q420B
Steel for Cold Forming	
GB/T 700-2006	Q195F, Q195Z, Q215AF, Q215BF, Q235AF, Q235BF, Q275AF

7.6 Non-Certified Korean steel materials

Material Standard	Steel Grades
Steel Plates	
KS D 3503:2018	All Grades
KS D 3529:2018	SMA275AW, SMA275AP, SMA355AW, SMA355AP
Hot Rolled Sections	
KS D 3868:2018	HSB690, HSB690L, HSB690W
Hollow Sections	
KS D 3566:2018	All Grades
KS D 3568:2018	All Grades
KS D 3632:2019	SNT275A, SNT275E
Steel for Cold Forming	
KS D 3512:2007	SPCC, SPCG
KS D 3770:2018	All Grades

Preloaded Bolting Assemblies	
KS B 1010:2009	F11T, F13T, F13
Profiled Steel Sheets	
KS D 3506:2016	SGCC, SGCH, SGCD1, SGCD2, SGCD3, SGC560Y

8.0 Reusability of steel materials

The procedure for verifying the quality of re-used steel is similar to the classification of new steel material mentioned previously in Section 2 in which the re-used steel is also classified based on the traced certificates together with the material testing results. This section explain in details the procedures which can be adopted for verifying the quality of the ex-stock steel materials and to determine if it can be reused, based on the recommendations given in BC1: 2023.

The verification procedure is first based on tracing the manufacturer test certificate (MTC) and factory production control (FPC) certificate. This is followed by material testing following the relevant tests. The steel materials are then classified by means of quality assessment into the appropriate classes. The classified steel materials are only considered reusable if it also satisfied the reusability requirements.

Currently, the usage of re-used steel shall only be restricted to sheet piles and structural steel materials used in steel strutting system for earth retaining and supporting structures (ERSS). The overall verification flow chart is summarized in Figure 8.1. A brief description of the quality assessment and reusability assessment are given in Table 8.1.

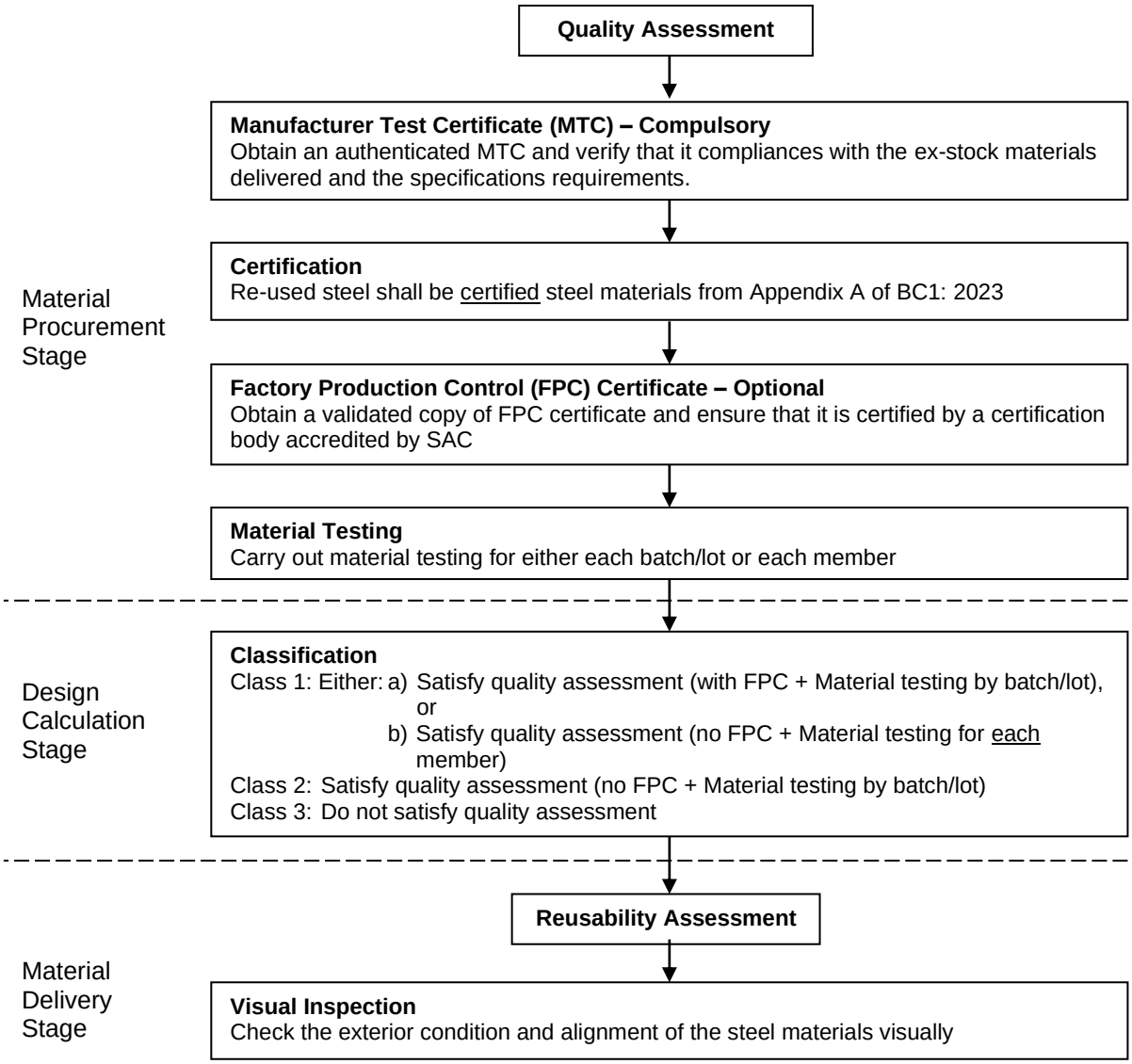

Figure 8.1: Verification on reusability of steel materials

	Quality Assessment	Reusability Assessment
Requirements to satisfy	Quality assurance and Material performance requirements (Section 6 of BC1: 2023)	Material condition requirements (Section 6 of BC1: 2023)
Objective of assessment	Steel material manufacturers and properties	Steel material exterior condition
Mode of assessment	FPC, MTC certification and Material testing	Visual inspection

Table 8.1: Summary of quality assessment and reusability assessment

8.1 Quality assessment

The first step in the classification approach involves the verification of the steel material quality by tracing the MTC and FPC certificates of the ex-stock materials. The steel material chosen must already be in the list of certified steel material in Section 6. The ability to trace the MTC and FPC will determine whether the steel material is classified as a Class 1 or Class 2 material. After tracing and verifying the certifications, material testing is to be carried out to verify the adequacy of the material properties of the steel material based on its existing condition. Failure of the material in either destructive or non-destructive testing will result in the immediate downgrade of the steel material to Class 3. A summary of the quality assessment and the respective results are given in Table 8.2.

8.1.1 Manufacturer test certificate and factory production control certificate

The steel supplier must be able to produce the manufacturer test certificate (MTC) for all the re-used steel. The MTC shall meet the requirements stated in Section 2.2.2. Failure to produce valid MTC or if the MTC does not satisfy the requirements in Section 2.2.2 shall result in the downgrade of the re-used steel to Class 3.

Factory production control certificate (FPC) is an optional certificate to be submitted. The FPC shall meet the requirements stated in Section 2.2.1. The FPC shall affect the amount of material testing to be carried out and the classification of the re-used steel. Therefore, it would be preferable that supplier produce the FPC if the manufacturer of the steel material is known. Class 1 re-used steel shall either have a valid FPC and satisfactory material testing by batch/lot, or no FPC but satisfactory material testing (NDT) for every steel member. Class 2 re-used steel shall have no FPC and satisfactory material testing by batch/lot.

8.1.2 Certification

Certification is the process of evaluating the material properties of the re-used steel against the material performance requirements in Section 6 for British/European, American, Japanese, Australian/New Zealand, Chinese and Korean material standards. The comparison shall be based on the MTC submitted and material testing results. Materials which meet these requirements are classified as certified steel, whereas those which do not meet the requirements are classified as non-certified steel. The re-used steel must be certified steel before it can be classified as Class 1 or 2. Non-certified steel shall only be Class 3.

8.1.3 Material testing

Material testing is the process of demonstrating the adequacy of the re-used steel materials in its current condition through appropriate sample testing and test method given in Appendix B of BC1: 2023. The requirements are similar to that stated in Section 2.1.2.

	MTC, FPC, Certification	Material Testing
Initiation	Steel material supplier	QPs to initiate testing
Steel materials coverage	Certified steel materials, as given in Section 6	All re-used steel materials
Condition to pass the assessment	Steel material supplier to submit valid MTC (compulsory) and FPC (optional) certifications	QPs to engage an accredited laboratory to conduct material testing in accordance to Appendix B of BC1: 2023 and show that the steel materials are in compliance with all the relevant requirements given in Section 6
Class of material	Class 1 (Valid FPC + Testing by batch) Class 1 (No valid FPC + Testing for every member) Class 2 (No valid FPC + Testing by batch) Class 3 (Do not meet requirements)	

Table 8.2: Implementation of quality assessment

8.2 Reusability assessment

The second step in the classification involves the verification of the reusability of the steel material based on the recommendations given in Section 6.2 of BC1: 2023 by visually inspecting the exterior condition of the steel members and to check for any unique identification markings.

8.3 In-House quality assurance system

Steel supplier or fabricators with the intention to re-used steel materials shall have an established in-house quality assurance (QA) system. The primarily purpose of this QA system is to ensure the traceability of the materials.

The QA system shall address (but not limited to) the following:

- How the re-used materials are identified from the other materials.
- How the re-used materials will be stored.
- Detailed flow chart / steps on how the materials will be traced from the moment it entered the yard till it is delivered to site.
- Documentation (MTC, FPC, material test reports, history of usage) of the re-used materials
- Personnel involved in ensuring that the QA system is strictly adhered to.
- Independent certification body accredited by SAC which has attested the QA system

8.4 Summary of design procedure for re-used steel

The necessary actions to be taken by the steel suppliers and QPs during the various stages in the overall design procedure for re-used steel are summarized in Table 8.3.

Stage	Steel Supplier	QPs
Material procurement	• Submit valid copies of MTC certificate • Submit valid copies of FPC certificate	• Confirm the source of steel materials and ensure that the re-used steel is in the certified steel list in Section 6 • Obtain valid copies of MTC and FPC certificates and ensure that the material properties requirements are satisfied • Keep copies of MTC and FPC for inspection

Design calculation	• Prepare material for testing based on the steel material classification requirements	• Design to Class 1 or 2 depending on whether a valid FPC is available. Assume that material testing is satisfied.* • Submit the necessary design calculation as per authority requirements
Material testing	• Submit the steel material for testing in accordance to Appendix B of BC1: 2023	• Ensure that the material test results satisfy the requirements in Section 6
Visual inspection	• Re-conditioned the steel materials for minor defects found during visual inspection	• Visually inspect the exterior condition of the re-used steel materials
* It shall be noted that QPs can only assume that the materials will be certified steel during the design calculation stage. The QPs need to ensure that the material testing results are satisfactory to confirm that the steel materials are certified.		

Table 8.3: Actions to be taken by steel suppliers and QPs for re-used steel materials

Building and Construction Authority

BuildSG

Transforming the way we Build Singapore