

**SINGAPORE STANDARD**

**Specification for steel for the  
reinforcement of concrete – Weldable  
reinforcing steel – Bar, coil and decoiled  
product**



Published by

**Enterprise**  
**Singapore**

## **SS 560 : 2016**

(ICS 77.140.15; 91.080.40)

---

SINGAPORE STANDARD

### **Specification for steel for the reinforcement of concrete – Weldable reinforcing steel – Bar, coil and decoiled product**

---

All rights reserved. Unless otherwise specified, no part of this Singapore Standard may be reproduced or utilised in any form or by any means, electronic or mechanical, including photocopying and microfilming, without permission in writing from Enterprise Singapore. Request for permission can be sent to: [standards@enterprisesg.gov.sg](mailto:standards@enterprisesg.gov.sg).

ISBN 978-981-4726-47-4

This Singapore Standard was approved by the Building and Construction Standards Committee on behalf of the Singapore Standards Council on 25 May 2016.

First published, 2010

First revision, 2016

The Building and Construction Standards Committee, appointed by the Standards Council, consists of the following members:

	<b>Name</b>	<b>Capacity</b>
<b>Chairman</b>	: Mr Chan Kok Way	<i>Member, Standards Council</i>
<b>Deputy Chairmen</b>	: Er. Chew Keat Chuan Mr Larry Ng Lye Hock	<i>Building and Construction Authority Urban Redevelopment Authority</i>
<b>Secretary</b>	: Ms Jo Ng	<i>Standards Development Organisation at Institution of Engineers, Singapore</i>
<b>Members</b>	: Mr Bin Chee Kwan Ms Barbara Bok Er. Chan Ewe Jin Er. Chee Kheng Chye Mr Chng Chee Beow  Mr Dominic Choy Er. Paul Fok Mr Goh Ngan Hong  Mr Goh Peng Thong Mr Desmond Hill Er. Lee Chuan Seng Mr Benedict Lee Khee Chong Mr Rodney Lee Assoc Prof Leong Eng Choon Mr Darren Lim Dr Lim Lan Yuan  Er. Lim Peng Hong  Er. Mohd Ismadi Assoc Prof Gary Ong Khim Chye Er. Yvonne Soh Dr Tam Chat Tim Mr Christopher Tan Er. Tang Pei Luen	<i>National Environment Agency SPRING Singapore The Institution of Engineers, Singapore Housing &amp; Development Board Real Estate Developers' Association of Singapore  Singapore Contractors Association Ltd Land Transport Authority Singapore Institute of Surveyors and Valuers  Individual Capacity Individual Capacity National Environment Agency Singapore Institute of Architects Singapore Manufacturing Federation Nanyang Technological University Building and Construction Authority Association of Property and Facility Managers  Association of Consulting Engineers Singapore  Ministry of Manpower National University of Singapore Singapore Green Building Council Individual Capacity Singapore Civil Defence Force JTC Corporation</i>

The Technical Committee on Building Structures and Substructures appointed by the Building and Construction Standards Committee and responsible for the preparation of this standard consists of representatives from the following organisations:

	<b>Name</b>	<b>Capacity</b>
<b>Chairman</b>	: Er. Lim Peng Hong	<i>Member, Building and Construction Standards Committee</i>
<b>Co-Chairman</b>	: Er. Chew Keat Chuan	<i>Building and Construction Authority</i>
<b>Secretary</b>	: Ms Jasmine Bai	<i>Standards Development Organisation at Institution of Engineers, Singapore</i>
<b>Members</b>	: Er. Chan Ewe Jin	<i>Institution of Engineers, Singapore</i>
	Er. Dr Chiew Sing Ping	<i>Individual Capacity</i>
	Er. Lee Tuck Cheong	<i>Association of Consulting Engineers Singapore</i>
	Er. Dr Richard Liew Jat Yuen	<i>Individual Capacity</i>
	Er. Neo Bian Hong	<i>Land Transport Authority</i>
	Mr Ng Yek Meng	<i>Singapore Contractors Association Ltd</i>
	Dr Ng Yiaw Heong	<i>Singapore Structural Steel Society</i>
	Dr Gary Ong Khim Chye	<i>Singapore Concrete Institute</i>
	Er. Poh Puay Yong	<i>Housing &amp; Development Board</i>
	Mr Sze Thiam Siong	<i>Singapore Welding Society</i>
	Dr Tam Chat Tim	<i>Individual Capacity</i>
	Er. Dr Tan Guan	<i>Individual Capacity</i>
	Prof Tan Kiang Hwee	<i>National University of Singapore</i>
	Er. Dr Tan Teng Hooi	<i>Individual Capacity</i>
	Er. Tang Pei Luen	<i>JTC Corporation</i>
	Dr Susanto Teng	<i>Nanyang Technological University</i>

The Working Group appointed by the Technical Committee to assist in the preparation of this standard comprises the following experts who contribute in their *individual capacity*:

	<b>Name</b>
<b>Convenor</b>	: Er. Dr Chiew Sing Ping
<b>Co-Convenor</b>	: Mr Yusooof Aynuddin
<b>Members</b>	: Mr Eric Cheng Theng How
	Dr Cui Wei
	Er. Goh Kok Hwa
	Mr Goh Teck Sin, Eric
	Mr Eddie Kua
	Assoc Prof Gary Ong Khim Chye
	Mr Ong Lian Teck
	Mr Natarajan Saravanan (WG Secretary 1)
	Mr Sze Thiam Siong
	Prof Tan Kiang Hwee
	Er. Tang Pei Luen

**Members** : Mr Teo Soon Tiong  
Er. Thung Sek Kwang (WG Secretary 2)  
Er. Yong Fen Leong

The organisations which the experts are involved in are:

*Angkasa Amsteel Pte Ltd*

*BRC Asia Ltd*

*Building and Construction Authority*

*Housing & Development Board*

*JTC Corporation*

*Land Transport Authority*

*Lee Welded Mesh Singapore Pte Ltd*

*National University of Singapore*

*NatSteel Holdings Pte Ltd*

*SETSCO Services Pte Ltd*

*Shimizu Corporation*

*Singapore Institute of Technology*

*Singapore Welding Society*

*Tiong Seng Contractors Pte Ltd*

*T.Y. Lin International Pte Ltd*

**Contents**

	<b>Page</b>
Foreword _____	7
1 Scope _____	9
2 Normative references _____	9
3 Terms and definitions _____	10
4 Symbols _____	12
5 Designations _____	13
6 Steelmaking and manufacturing processes _____	13
7 Product characteristics _____	13
8 Evaluation of conformity _____	22
9 Test methods _____	27
10 Identification _____	27
11 Verification of properties in the case of dispute _____	29

**Annexes**

A Bond test for ribbed reinforcing steel – Beam test (normative) _____	30
B Material not covered by a third party product certification scheme (normative) _____	40
C Identification requirements (informative) _____	43
D Specification to limit ionising radiation (informative) _____	45

**Tables**

1 List of symbols _____	12
2 Chemical composition (maximum % by mass) _____	14
3 Conditions of testing the mechanical properties _____	14
4 Characteristic tensile properties _____	15
5 Fatigue test conditions _____	15
6 Mandrel diameters for the bend test _____	17
7 Mandrel diameters for rebend test _____	17
8 Nominal cross-sectional area and mass per metre _____	18
9 Ranges for the rib parameters _____	21
10 Characteristic relative rib area _____	21
11 Threaded reinforcement – Ranges for the rib parameters _____	22
12 Absolute minimum and maximum values of tensile properties for 500 MPa characteristic yield strength _____	24

	<b>Page</b>
13 Absolute minimum and maximum values of tensile properties for 600 MPa characteristic yield strength _____	24
14 Coefficient k as a function of the number n of test results (for a reliable failure rate of 5 % [p = 0.95] at a probability of 90 %) _____	26
15 Coefficient k as a function of the number n of test results (for a reliable failure rate of 10 % [p = 0.90] at a probability of 90 %) _____	26
A.1 Series of reinforcing steel diameters for testing of bond _____	33
C.1 Identification of the country of origin _____	44
D.1 Radioactivity – Maximum activity concentration _____	46

**Figures**

1 Ribbed bar – Definitions of geometry _____	19
2 Rib flank inclination, $\alpha$ , and rib height, $a$ – Section A-A from Figure 1 _____	20
3 Example of bar with varying rib inclinations to the longitudinal axis _____	20
4 Example of bar with transverse ribs of uniform height ( $\beta= 90^\circ$ ) _____	20
5 Example of rib pattern for grade B500A _____	27
6 Example of rib pattern for grade B500B _____	27
7 Example of rib pattern for grade B500C _____	28
8 Example of rib pattern for grade B600A _____	28
9 Example of rib pattern for grade B600B _____	28
10 Example of rib pattern for grade B600C _____	28
A.1 Dimensions of the hinge for beam type A ( $d < 16$ mm) _____	31
A.2 Dimensions of the hinge for beam type B ( $d \geq 16$ mm) _____	31
A.3 Beam test type A ( $d < 16$ mm) _____	32
A.4 Beam test type B ( $d \geq 16$ mm) _____	32
A.5 Bond test type A ( $d < 16$ mm) – Reinforcement of beam specimens _____	35
A.6 Bond test type B ( $d \geq 16$ mm) – Reinforcement of beam specimens _____	36
C.1 Example of manufacturer’s identification mark (using widened ribs) _____	43
Bibliography _____	47

## National Foreword

This Singapore Standard was prepared by the Technical Committee on Building Structure and Sub-structure under the purview of the Building and Construction Standards Committee.

SS 560 : 2010 was revised to include Grade B600 steel. This revised standard is an adoption of BS 4449 + A2 : 2009 'Steel for the reinforcement of concrete – Weldable reinforcing steel – Bar, coil and decoiled product – Specification' and is implemented with the permission of the British Standards Limited.

The modifications made to the BS are as follows:

- Grade B600 steel has been added (including examples shown in Figures 3, 4, 8, 9 and 10);
- A new paragraph (7.1) has been inserted to limit the maximum carbon and carbon equivalent for Grade B600 manufactured by micro-alloying only;
- The number of stress cycles in 'Fatigue strength' (7.2.4) has been amended to 2 million stress cycles;
- A 'bend test' (7.2.5.2) has been included;
- A new clause 7.4.3 has been added to cover threaded reinforcement steel bar;
- Factory production control system (8.1) has been included;
- Marking of bundles of bars (10.3) has been included;
- A new Annex D (informative) has been included. This annex is a specification to limit ionising radiation from steel for the reinforcement of concrete, which has been updated based on IAEA Safety Guide Standards Series No. RS-G-1.7 (2004). It is introduced to address concerns of possible radioactive contamination during the manufacturing process and the risk to health through exposure to radioactivity from the finished steel product.

This standard has been written so that it can be used in conjunction with BS EN 10080 : 2005. BS EN 10080 : 2005 does not define steel grades or technical classes, and requires that technical classes should be defined in accordance with BS EN 10080 : 2005, by specified values of  $R_e$ ,  $R_m/R_e$ ,  $A_{gt}$ ,  $R_{e,act}/R_{e,nom}$  (where appropriate), fatigue strength, bend performance, weldability, bond strength, tolerances and dimensions. The six steel grades in this standard conform to all of the requirements of BS EN 10080 : 2005.

The six grades in this standard also conform to the three recommended ductility classes of SS EN 1992-1-1 : 2008. The only exception to this is for grade B500A and B600A in sizes below 8 mm, where the ductility requirements specified are below those of SS EN 1992-1-1 : 2008.

Bond is specified by means of a relative rib area. As an alternative, a beam test is provided in Annex A, which may be used to demonstrate compliance with SS EN 1992-1-1.

It is recommended that purchasers specify reinforcing steel that has been manufactured and supplied to conform with "Evaluation of Conformity" (Clause 8) through a recognised third party product certification scheme. As an alternative, Annex B provides a batch testing method for material which has not been produced under such a scheme.

This SS 560 : 2016 and SS 561 : 2010 – 'Steel fabric for the reinforcement of concrete' are intended for use with SS EN 1992-1-1:2008 – 'Design of concrete structures – Part 1-1: General rules and rules for buildings'.



Acknowledgement is made to BSI for the use of materials from the above publication.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Attention is drawn to the possibility that some of the elements of this Singapore Standard may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

**NOTE**

1. *Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions.*
2. *An SS or TR is voluntary in nature except when it is made mandatory by a regulatory authority. It can also be cited in contracts making its application a business necessity. Users are advised to assess and determine whether the SS or TR is suitable for their intended use or purpose. If required, they should refer to the relevant professionals or experts for advice on the use of the document. Enterprise Singapore shall not be liable for any damages whether directly or indirectly suffered by anyone or any organisation as a result of the use of any SS or TR.*
3. *Compliance with a SS or TR does not exempt users from any legal obligations.*

## **Specification for steel for the reinforcement of concrete – Weldable reinforcing steel – Bar, coil and decoiled product**

### **1 Scope**

This Singapore Standard specifies requirements for ribbed weldable reinforcing steel used for the reinforcement of concrete structures. The standard covers steel delivered in the form of bars, coils and decoiled products. The standard contains provisions for six steel grades, both of 500 MPa and 600 MPa characteristic yield strength, but with different ductility characteristics. The six grades are B500A, B500B, B500C, B600A, B600B and B600C.

The weldability requirements for all grades of steel are specified in terms of the chemical composition, and in particular the carbon equivalent value.

Steel bars produced by re-rolling finished products, or by rolling material of which the metallurgical history is not fully documented or not known, are not covered by this Singapore Standard.

NOTE – Flash welds in lengths of bar are permissible under this standard, provided all the mechanical requirements are met. However, for some purposes, purchasers might specifically require bars without flash welds, and if so this ought to be stated at the time of enquiry and/or order.

### **2 Normative references**

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 1766 : 2000	Products and systems for the protection and repair of concrete structures – Test methods – Reference concretes for testing.
BS EN 10020 : 2000	Definition and classification of grades of steel
BS EN 10025-1	Hot rolled products of structural steels – General technical delivery conditions
BS EN 10079	Definition of steel products.
BS EN 10080:2005	Steel for the reinforcement of concrete – Weldable reinforcing steel – General
BS EN 12390-3	Testing hardened concrete – Part 3: Compressive strength of test specimens
BS EN ISO 15630-1 : 2002	Steel for the reinforcement and prestressing of concrete – Test methods – Part 1: Reinforcing bars, wire rod and wires
SS EN 1992-1-1 : 2008	Eurocode 2 : Design of concrete structures – Part 1-1 : General rules and rules for buildings (together with it's National Annex)