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BUREAU OF INDIAN STANDARDS

(Metallurgical Engineering Department)

Draft Minutes

No. of meeting	Name of the Committee	Day	Date	Time	Venue
44th	Wrought Steel Products Sectional committee **MTD 4**	Friday	22 Sep 2023	1000h onwards	Lal C Verman Hall Manak Bhawan, BIS, New Delhi-110002

Chairman:Shri Nirvik Banerjee **Member Secretary:** Mr Arun Pucchakayala

Members and Invitees Present: Details given at **Annex – I (Pg 4)**

Item 0 GENERAL

0.1 Members were warmly welcomed for the meeting by Shri Sanjiv Maini, Scientist- F/Senior Director & Head MTD. In addition, Head MTD informed the members about recent process reforms considered by BIS for efficient functioning of the committee not exhaustive but comprising of attending 50% meetings in a year, singing declaration and mandatorily going through draft documents in preliminary stage.

0.2 Objectives by the Chairman

0.2 Shri Nirvik Banerjee commended the reforms and stressed for effective participation from the members which would in turn result in making the standards more relevant for the user industry.

Item 1 CONFIRMATION OF MINUTES OF LAST MEETING

1.1 As no comments were received, the committee formally approved the minutes of last meeting held on 28 April 2023.

Item 2 ACTION TAKEN REPORT

2.1 The committee reviewed the status of decisions taken during last meeting as given in Annex I of the Agenda and decided during the meeting to take actions as mentioned at Annex **II (Pg 5 to 172).**

Item 3 COMPOSITION OF SECTIONAL COMMITTEE

3.1 The Committee noted the information given at **3.1 to 3.3** of the agenda.

3.2 The committee recommended to withdraw membership of Powergrid corporation of India, AIIFA,DMRL, INSDAG, IMTA, BHEL, Central boilers board and RDSO on account of lack of participation in last three meetings and DGOFB as it was no longer existing.

3.2.1 The Committee decided to induct M/s American Pre-coat to Panel-11 and M/s Caterpillar to MTD 4:3. Also, it agreed to induct Shri Sushil Kumar (in-personal capacity) into mailing list for assessing his contribution for taking a decision on his interest at a later stage accordingly. Further, it requested Member Secretary to follow up with ISA for seeking nominations.

3.2.2 The Committee noted the information given at 3.4.2 and 3.4.3 to the agenda**.**

Item 4 REVIEW OF INDIAN STANDARDS

4.1 The committee noted the information on standards due for review and requested the members to share their views by 30 Nov 2023 on the standards by following the URL:

https://docs.google.com/document/d/1uHfiPjiQUx2VlkLrUKS127lh8z6WkbJ2WkcNGCEZeU/edit?usp=sharing

4.2 The committee noted the information given at item 4.3 of the agenda.

Item 5 NEW PROPOSALS FOR STANDARDIZATION

5.1 The subcommittee noted the information given at item 5.1, 5.2 of the agenda.

5.2 The Committee agreed to formulate standards on the following new subjects:

SL No	Subject
1	Carbon and Low Alloy Steels for Submerged Arc and Gas Shielded Arc Welding Electrodes
2	Zn-Al Coated Steel Wires
3	Hot-rolled medium and high carbon steel sheets, plates and strip

It requested members to come forward for forming panels to take up the matter further on the drafts received as part of the reports submitted by interns.

Item 6 Comments on Indian Standards

6.1 The committee deliberated on the comments from M/s JSW on IS 513 Pt .2 :2016 and suggested JSW to submit a R&D proposal through Panel 11 for taking up the matter further as the grades recommended by them were new and not existing in any other relevant standard.

Item 7 IMPLEMENTATION OF INDIAN STANDARDS

7.1 The subcommittee noted the information given at item 7.1 of the agenda.

Item 8 INTERNATIONAL ACTIVITY

8.1 The committee noted the information given item 8.1 and 8.2 of the agenda.

8.2 The committee agreed with recommendation of the subcommittee to send A-1 to ISO 404:2013 for WC for 30 days, for adoption.

8.3 SARSO Standards: The Committee noted the information given at 8.5 of the agenda. Further, on the Comments received from Srilanka on SARS 0028-1, SARS 0028-2 and SARS 0028-3 , Member Secretary was given time till 10 December 2023 to complete the associated task.

Item 9 R&D PROJECTS FOR ESTABLISHMENT/REVISION OF INDIAN STANDARDS

9.1 The current guidelines for R&D projects for establishments /revision of Indian Standards is given at **Annex III** (Pg 173-191).

Indian Standard due for review and identified for R&D was IS 1387:1993 *General requirements for the supply of metallurgical materials*.

Template for the terms of Reference for the R&D Projects is enclosed **at Annex IV(**Pg 192 **).**

Members are requested to examine the same and provide inputs for developing Terms of reference for standard mentioned above.

Item 10 DATE AND PLACE FOR THE NEXT MEETING

The committee decided to hold its next meeting at BIS, New Delhi on **15 Dec 2023**.

Item 11 ANY OTHER BUSINESS

The Committee showered words of praise on Shri Rajesh Maheswari (Tata Bluescope Pvt ltd) on his superannuation, reminiscing his significant contribution towards MTD 04 in formulation of coated steel products and for revising standards on terminology. Also, BIS felicitated Shri Rajesh Maheswari with a letter of appreciation duly endorsed by DDG stdzn-II and presented to him by Shri Sanjiv Head MTD and Shri Parmjeet Singh(Addl Industrial Adviser to Ministry of Steel).

Further, the members also expressed their gratitude towards Shri Arunava Dasgupta (SAIL-ISP) on his imminent superannuation on 31 oct 2023, reminiscing his significant contribution towards MTD 04 in formulation of standards on hot-rolled steels both as a member and panel convenor.

Also, it was advised to the newly inducted members of various organizations by the Chairperson Shri Nirvik Banerjee to emulate the efforts made by Shri Rajesh Maheswari and Shri Arunava Dasgupta over the years, for making the standard formulation on steels a robust activity.

The meeting ended with hearty vote of thanks to the Chair.

Sl No.	Organisation	Name of Representative	Phone No.	Email Id
1.	CORSMA	Shivajee Pathak	9416982550	shivajee.pathak@gmail.com
		N. K. Sood	9810129226	steelcorsma@gmail.com
2.	CQA (Metals) Ichapur, DGQA, West Bengal	Arindam Mitra	9836251645	arindam.mitra15@gov.in
3.	Tata Bluescope Pvt. Limited	Ved Prakash	7276444847	ved.prakash@tatabluescope.com
		Rajesh Maheshwari	7766916913	rajesh.maheshwari@tatabluescope.com
4.	JSW Salem/Vasind	B. M. Hasan	9894677120	bm.hasan@jsw.in
5.	JSW Steel Limited Bellary/Dolvi	G. V. Ramana	9480693503	gv.ramana@jsw.in
6.	Tata Steel	Avtar Singh Saini	9234511480	avtar@tatasteel.com
7.	Ministry of Ports, Shipping, Waterways	Shubham Asrani	8827074955	shubham.asrani@gov.in
8.	AMNS Limited	Mohd. Basha Tappa	9510865637	mohammad.basha@amns.in
		Deepak Gupta	9879100356	Deepak.guppta@amna.in
9.	Ministry of Steel	Parmjeet Singh		
10.	Society of Indian Automobile Manufacturers (SIAM), Delhi	Kanishka Chana	9899756734	kanishka@siam.in
11	Steel Authority Of India Limited (SAIL), Research & Development Centre for Iron & Steel, Ranchi	S. Srikanth	8986880375	srikanth@sail.in
12	Steel Authority Of India Limited, IISCO Steel Plant, Barddhaman Industry	Saikat De	9434777250	saikat6028@gmail.com
		Arunava Dasgupta	7543891115	arunava.dasgupta@sail.in
13.	Steel Authority of India Limited, Bokaro Steel Plant, Bokaro Steel City	Biswasi Sunita Minz	9434777250	b.sunitaminz@sail.in
14.	Thyssenkrupp Electrical Steel India Private Limited, Nashik	Kapil Kapoor	7030915117	kapil.kapoor@thyssenkrupp.com
15.	Rashtriya Ispat Nigam Limited, Visakhapatnam	Ruchira Gupta	9989888245	ruchira_gupta@vizagsteel.com

Sl. No	Subject	Decision taken in past meetings	Action taken on the decision of the committee/ subcommittee during last meeting	Decision taken by the committee during the meeting
(1)	(2)	(3)	(5)	(5)
1	Comments from JFE on IS 18386:2023 *Hot Rolled And Cold Rolled Steel Strips Intended For Processing Of Semifully Processed Non-Grain Oriented Electrical Steel Or Fully Processed Grain Oriented Electrical Steel*	Comments received from JFE, post WC period were shared with Panel 2 for examining and obtaining views. Comments received from JFE, post WC period were shared with Panel 2 for examining and obtaining views.	Subcommittee during its meeting held on 28 July 2023, requested the panel convenor Sh Kapil Kapoor to expedite action and submit their recommendation within a month from the date of finalization of the minutes. In addition, we were in receipt of comments from Convenor of Panel, given at **Appendix-1(Pg 34-36)** to the agenda.	On the contents of the standard, the following were informed to the Committee by the panel convenor Shri Kapil Kapoor: i) expressed concerns that it may not cater to the user desirous of producing the CRGO steel using the input material conforming to this standard. ii) User may end up getting inefficient material. As a result, it was put forward by Shri Kapil Kapoor that the scope of present standard may be restricted to CRNO steels and if desired by the Committee a new standard may be formulated for unprocessed electrical steels which could be used for producing CRGO steels. In this regard, the following were observed by the Committee vis-à-vis contents of the standard and concerns expressed by Shri Kapil Kapoor: i) standard in its present content was generic without specifying electrical/magnetic properties as the material is un-processed and it was difficult to mention the same given that the manufacture of electrical steels varies from manufacturer to manufacturer ii) Manufacturers of electrical steels would be

				well aware of the requirements desired from input unprocessed electrical steel capable of suiting their manufacturing practice given that such practices were still classified involving diversity. Thereafter, Member secretary reiterated the purpose of having the standard on the request from Ministry of Steel, which may not be for benefitting the users producing electrical steels from the unprocessed electrical steel but to keep a track on unprocessed electrical steels which was imported without any warranty for chemical composition or electrical/magnetic properties and could be construed used as a leeway for unscrupulous importers. However, having a standard would facilitate tracking the production of electrical steels through effective implementation of QCO as electrical steels were regulated both through QCO under scheme-IV for IS 3024/ IS 648 and under Scheme-V for Laminations for transformer cores, thereby ensuring suitable steel was used for electrical applications which could be constructive in measures for meeting energy related challenges. iv) A need was felt to regulate such an instance and as a result it culminated in the publication of this generic standard involving specifying chemical composition as per definition of silicon steels given in relevant part of IEC 60404 and dimensional tolerances. iv) Standard during its document stage was shared with licences under FMCS and no objections with regard to scope of standard

				except for silicon range from M/s JFE, Japan. iv) Nevertheless, now it was felt that for enhancing the quality of the standard, we may provide additional information on unprocessed electrical steel which could cater to electrical steels classified on basis of technology used for obtaining superior magnetic properties. On account of the above, the Committee suggested the following to the Panel: a) to obviate any difficulty on account of restricted chemical composition, which could possibly be inhibiting scope of the standard and as such changes may be recommended for chemical composition. b) any additional information on unprocessed electrical steels correlating it to the various types of electrical steels may be suggested for the guidance of users.

2	New Standard on thin magnetic steel strip for use at medium frequencies - Both for CRNO and CRGO	It was suggested by Mr Kapil Kapoor to adopt IEC standard 60404-8-8 , standard for thin magnetic steel strip for use at medium frequencies - Both for CRNO and CRGO The committee after deliberation agreed that new standard on thin magnetic steel strip for use at medium frequencies needs to be formulated. Mr Kapil Kapoor of Thyssen Krupp was requested to fill the form provided at Annex IV of agenda for proposing new subjects. During the last meeting committee after discussion requested Mr Kapil Kapoor to forward Annex IV for proposing new subject. Since Tata Cogent representatives were also present in the meeting, they were requested to assist Mr Kapil Kapoor with details required for filling up Annex IV. After receipt of this, the same was to be forwarded to committee members, and if agreed by committee members and approved by Chairman, the recommendation for formulating new standard on thin magnetic steel strip for use at medium frequencies , was to be forwarded to MTDC for approval of new subject. The committee was informed that Annex IV was still awaited. The committee noted the information. Shri Kapil Kapoor informed the committee that he will submit the requisite document by 15 January 2019.	Subcommittee noted the information that an amendment to IS 649 was in process for enhancing the test frequency beyond 400 Hz, for making the standard amenable to cover test methods for thin magnetic steel strip for use at medium frequencies. **In this regard, panel convenor Sh Kapil Kapoor was requested to expedite action and submit their recommendation along with draft amendment within a month from the date of finalization of the minutes.** Further, the members of subcommittee were informed by the member secretary that the desired amendment would only facilitate giving an added advantage for testing as per IS 649 but do not substitute the referred IEC standards in the product Standard. In other words, the foreword of the product standard would be providing a degree of comparison between IEC standards on test methods and IS 649, which would be mentioned as not equivalent against the corresponding IEC standard. Accordingly, it was put forward that the desired amendment should not be construed as deterrent for going ahead with the adoption of IEC 60404-8-8:2017 and suitable changes to the foreword could be considered at a later stage after publishing the desired amendment for IS 649. Also, it was apprised that the product	**Considering the recommendation of the subcommittee, the committee agreed to send the document intended for adoption of IEC 60404-8-8:2017 for wide circulation for 60 days.**

		The duly filled template proposing new standard for use at medium frequencies was received on 12th June 2019 from Sh. Kapil Kapoor. Convener of Panel-18, Sh Kapil Kapoor emphasized on the need to have standard on thin magnetic steel strip for use at medium frequencies - both for CRNO and CRGO and imparted the features of the new work item proposal **(Appendix-2)** to the members and vouched for adoption o The Committee agreed to the proposal in-principle and advised the sub-committee to take further actions for adoption of the IEC standard expeditiously. Also, the Sub-Committee was advised to ensure that the draft document would be circulated among ITMA and IEEMA during wide circulation. Also, the Committee advised the Sub-Committee to examine the adequacy of test methods covered in IS 649 for product covered under IEC 60404-8-8:2017 and decide on the matter. The Subcommittee during its meeting held on 18 April 2022 requested Panel 2 to submit report by 30 June 2022 on adequacy of IS 649 for the proposed adoption of the product standard. Panel 2 held its meeting on 24 May 2022. Report is awaited. The Committee was informed by the Panel Convenor Sh Kapil Kapoor that IS 649 in its present was inadequate to test the products covered under IEC 60404-8- 8:2017, proposed to be adopted as an Indian Standard. The Committee requested the panel convenor either to modify IS 649 suitably for making it amenable for testing of the product as per IEC	standard needs to be expedited on account of ensuring the quality of imports , which was substantiated through data received from Ministry of Steel and shared with Members during April/May 2023. As a result, the subcommittee during its meeting held on 28 July 2023 recommended to send the document intended for adoption of IEC 60404-8-8:2017 for wide circulation for 30 days with prior approval of TC.	

		60404-8- 8:2017. Also, the Committee requested the panel convenor to provide WC draft as this would be an adoption of modified version of IEC 60404-8- 8:2017. The Panel Convenor Sh Kapil Kapoor was requested to submit the desired draft amendment to IS 649 and the modified version of IEC standard within 15 days from the date of finalization of the minutes. Also, it requested Member Secretary to circulate the draft amendment on receipt of it from Panel Convenor, to members of both MTD 4 and MTD 4:3, giving a time period of 21 days for inviting comments. The member secretary was also requested to send the modified version of IEC on receipt from from Panel Convenor Sh Kapil Kapoor for WC for a period of 1 month. Report is awaited from convenor of Panel 2. Panel Convenor Sh Kapil Kapoor briefed the status to the subcommittee. Accordingly, Subcommittee requested Panel Convenor to submit the report within 15 days from the date of finalization of the minutes. Committee noted the status and requested the Panel Convenor Sh Kapil Kapoor to submit the report by 31 Dec 2022. Panel 2 held its meeting on 02 Jan 2023 and agreed to consider an amendment to IS 649 to suit the needs for adoption of IEC 60404-8-8. Draft amendment is awaited.		

		Draft amendment No.6 to IS 649 was awaited from the panel 2, for ensuring adequacy of IS 649 for adoption of IEC 60404-8-8. During the meeting of subcommittee held on 11 April 2023, Convenor of Panel 2, ShriKapil Kapoor was requested to submit the draft amendment within 14 days. Committee was briefed by the member secretary that adequacy of IS 649, with or without awaited modification, only helps manufacturers and testing labs in complying with the standard but it does not obstruct adoption of the IEC 60404-8-8 as an Indian Standard, as the comparison of other referred standards in IEC were only captured in national foreword, which would be comprising IS 649 as not identical with various IEC test method standards. On the above grounds, Member secretary requested the committee to agree with the proposal for sending the document for wide circulation. Consequently, the Committee advised the Member Secretary to obtain consent from the subcommittee MTD 4:3 on the above proposal for wide circulation and apprise the same with them in due course for further action.		

3	New standard on Wear & Abrasion resistant steel plates **MTD 4 13289**	During the last meeting comments received from Volvo steel were discussed and after deliberation the committee did not agree to the comments. The committee after deliberation decided to send the document for wide circulation for two month. The document placed at **Appendix 16** is being prepared for wide circulation. The committee noted the information. Before sending the draft for wide circulation, the draft was examined and observations were shared with the panel by MTD. Also, MTD had informed the panel convener that the composition of the panel was not balanced as there was no representation from User Industry. Subsequently, Panel meeting was held on 30 June 2020 to discuss on comments of MTD. Modified draft was received by MTDfrom the panel convener on 07 July 2020. During the meeting, Member Secretary had informed the committee that the comments of MTD on the draft document were not addressed by the panel even in the modified draft submitted on 07 July 2020. The Committee noted the information and requested the Panel Convener to submit the modified working draft along with work plan for validation of the grades to the sub-committee within 2 months. Also, the Committee took note of the concerns raised by the Member Secretary on composition	During the subcommittee held on 28 July 2023, the summary of the test results were apprised to the members by the Panel Convenor Shri Deepak Gupta (AM/NS). Further, the modified draft on account of the satisfactory results validating the survey of MTCs of importers, involving stipulation of limits for tensile strength instead of a range in the earlier draft, is given at **Appendix-2(Pg 37-42).** The Subcommittee recommended to send the document for wide circulation for 30 days with prior approval of TC.	The Committee noted the changes considered to the draft involving stipulation of limits for tensile strength instead of a range and agreed with the recommendation of the subcommittee to send the document given **at Appendix-1 (Pg 41-46) for wide circulation for 60 days with prior approval of TC.**

		of the panel and advised sub-committee to reconstitute the panel by also having representation from the organizations JCB, Volvo, Caterpillar, Tata Hitachi and BEML. Further, the Committee requested, Addl Industrial Advisor to Ministry of Steel to arrange for requisite samples in due course in consultation with importers, necessitated for validation of properties in the draft standard. Subcommittee during its meeting held on 18 April 2022, requested the convenor to P-Draft by 30th June 2022. The Committee noted the status shared by Panel convenor Sh Deepak Gupta. Also, the Committee discussed on possibilities of some of the varieties to be tested for validation of steel grades using steel produced domestically. It requested AM/NS to provide samples to panel for grades of lower hardness and requested Sh Parmjeet Singh (M/o Steel) to help the panel for getting grades of higher hardness from importers. Further, Head MTD clarified to the Panel convenor that the panel report should be inclusive of grades of steel along with corresponding properties and acceptance criteria for validation of grades i.e number of samples to be tested and also to specify coordination required both for collection of samples and getting them tested. Also, it was suggested by the committee that the samples for validation be got tested in any NABL/BIS approved Lab for steels.		

		The Panel Convenor was requested to submit the panel report within 15 days from the date of finalization of the minutes. The report of the panel would be presented during the meeting by convenor of Panel 27 Sh Deepak Gupta, AM/NS. Draft Standard is placed at Appendix-1(Pg 50-56). Panel convenor, Sh Deepak Gupta, apprised the members of the contents of the report. Subsequently, Head MTD raised concerns on chemical composition, as there was no difference amongst the grades except for maximum allowable limit of carbon. Accordingly, Panel Convenor informed the Subcommittee that the panel would revisit the TCs and share the report by 30 Nov 2022. Panel Convenor Sh Deepak Gupta, briefed the committee about the contents of the report and draft standard. The Committee agreed to start the proceedings by initiating the process of testing and validation for grades covered in draft standard as mentioned below: 1) As-prepared samples for grades 400,450 to be send to MTD, BIS by AMNS. 2) Cut -pieces of other grades from importers to be arranged by Ministry of Steel and to send the same to MTD, BIS. 3) Testing of samples at CL, BIS subsequent to receipt of as-prepared samples from AMNS for all the grades. Further, the Committee agreed to send the draft standard, Appendix-2(Pg 102-109),		

		among members for P-circulation giving time for a period of 21 days from the date of finalization of the minutes. No comments received during P- circulation. Samples of grades ISAR 400,450 and 500 were sent for testing at BIS lab for alltests barring impact test at -40Deg C. Testing would be carried out for free of cost at CL, Sahibabad (BIS, lab) with exception of impact test at -40 Deg C which would be carried out M/s Spectro analytical lab for which AMNS agreed to bear the costs. Committee noted the status and requested the Panel Convenor to examine the test reports and share their recommendation so that further action could be taken in due course. Also, the Committee agreed to send the document for wide circulation, which was previously P-circulated among committee members, in case the desired panel recommendation states that the results of test report were substantiating the requirements as indicated in the P-circulated draft.		

4	Revision of IS 15911:2010 *Structural Steel(Ordinary Quality)*	IS 15911 was revised and agreed by the committee for printing. However, following observations were made on draft approved for printing. 1. Title of standard is not in line with scope of thestandard and not in line with IS 2062. 2. Definition of low tensile is not incorporated in thestandard. 3. The word 'sheets' to be included in Sr No iii of table 4. 4. Permissible variation of % silicon in product analysisnot indicated. 5. Variation allowed on which specified value is not clear .Hence definition of product analysis to be reviewed . 6. Review clause 17.2 as there is no clarity in thesentences. During the last meeting Mr Jayanta Saha, convenor of thepanel responsible for revision of IS 15911 mentioned that he will study the observation and if required the revised draft shall be put up after discussion with the panel members in one month time. As report was awaited, the committee noted the information and again requested Shri Jayant Saha to submit its recommendations by 15 May 2019. Convener of Panel-26, Dr Jayanta Saha, briefed thecommittee about the status of the revision. The Committee noted the status and requested Panel Convener to submit the modified draft to the Sub Committee within two weeks. Also, the Committee took note of change in	Subcommittee during the meeting held on 28 July 2023 requested the Member Secretary for follow-up and ensure that the desired report is made available at the earliest. Report is awaited.	For focusing more on the matters related to exigency cited by Ministry of Steel for formulation of standards on electrical steels for medium and high frequency, abrasion resistant steels, Zn-Ni coated steels, medium carbon cold-rolled steels etc for ensuring quality of imports**, the committee decided to set the revision of IS 15911 aside till the time it is due for periodical review.**

		place of posting and/or superannuation from service against some of the members representing the panel and suggested to the Sub-Committee to reconstitute the panel by inducting Sh S Srikanth(RDCIS), Sh Arunava Dasgupta (DSP) andSh G V Ramana (JSW) into the panel. Subcommittee requested the panel convenor to submit the P-draft by 30th June 2022. Panel held its meeting on 09 June 2022. The Committee noted the status briefed by member secretary and requested the panel convenor Sh Moreshwar Borkar (JSPL) to submit their report along with P-draft within 15 days from the date of finalization of the minutes. Also, it requested Member Secretary to circulate the P- draft on receipt of it from Panel Convenor, to members of both MTD 4 and MTD 4:3, giving a time period of 21 days for inviting comments. Subcommittee requested the Panel Convenor to submit its report within 15 days from the date of finalization of the minutes. Committee noted the status and requested the Panel Convenor Sh Moreshwar Borkar to submit the reportwithin 30 days from the date of finalization of the minutes. Report is awaited from the panel. Committee requested the Panel Convenor to submit its report within 30 days from the date of finalization of the minutes.		

5	Revision of IS 11587:1986 *Structural weather resistant steels*	A Panel 19 consisting of following members was formed for revision of IS 11587:1986 Structural weather resistant steels 1. Mr Jayanta K Saha - INSDAG – Convenor 2. Mr Deepak Gupta – Essar Steel 3. Mr A Dagupta – SAIL, RSP 4. Mr Avtar Singh – Tata Steel 5. Mr Devasish Mishra, JSW, Bellary 6. Mr M Borkar – JSPL 7. Representative from RDSO During the last meeting committee requested the panel to provide the revised draft based on comments received and agreed by committee by incorporating above proposed changes to BIS. The revised draft was then to be sent for wide circulation for one month. The draft placed at **Appendix 12** is being prepared for wide circulation. Committee noted the information. Comments on the working draft was shared with panel convener on 25th June 2021 and placed at Appendix-9. Revised draft was awaited. Convener of Panel-19, Dr Jayanta Saha, briefed the committee about the status of the revision (Appendix-9). The Committee noted the status and requested Panel Convener to submit the modified draft to the Sub Committee within One Month. Subcommittee requested the Panel Convenor to submit the P-Draft by 20th June 2022.	As desired by the committee, Panel held its meeting on 09 June 2023. The report received from the panel on account of its meeting held on 09 June 2023, is given at **Appendix-3(Pg 43-55).** Subcommittee during the meeting held on 28 July 2023, requested the Convenor of Panel 7 to expedite action and submit the desired draft , as mentioned in the report, within 45 days from the date of finalization of the minutes.	The Committee examined the desired draft for revision of IS 11587:1986, which was circulated as addendum to the agenda and agreed with the changes as suggested by the panel. Accordingly, the committee decided to send the draft given at **Appendix-2(Pg 47-70)**, for wide circulation for a period of 30 days.

		The committee noted the status briefed by Sh G V Ramana (representing Panel Convenor Sh Devashish Mishra, JSW) and informed that comments of MTD were duly addressed in the final draft, which were observed to be in review mode capturing the comments of MTD and reply of panel convenor. However, the draft was devoid of desired panel draft and consolidated comments from panel members which were duly addressed in shaping the final draft for revision. Head MTD clarified to the Panel convenor that it was desirous of having a report from panel convenor incorporating references of national/ international standards for the changes suggested for revision of the standard and should also be including the decision of the panel along with the changes therein against all the comments received from members of panel. The committee requested the convenor of panel 7 to submit the report within **07 days** from the date of finalization of the minutes. Also, it requested Member Secretary to circulate the P-draft on receipt of it from Panel Convenor, to members of both MTD 4 and MTD 4:3, giving a time period of 21 days for inviting comments. Amendment No. 1 to IS 11587:1986 was issued in August 2022, on account of 41st meeting of MTD 4 held on 28 July 2022, for catering the need of container manufacturers. The grade SPA-H and SPA-C(JIS G 3125) were incorporated in the standard through the amendment.		

		Report is awaited from Panel 7. Subcommittee requested the Panel Convenor to submit its report by 30 Nov 2022. Committee noted the status and requested the Panel Convenor Sh Devasish Mishra to submit the report within 30 days from the date of finalization of the minutes. Report is awaited from Panel 7. Also,nominations to be obtained from IR classand RDSO. During the meeting of subcommittee held on 11 April 2023, on behalf on Panel convenor of Panel 7, Shri G V Ramana Sought 45 days time to submit the report. Committee noted the status that convenor of Panel 7 Sought 45 days time from 30 April 2023 to submit the report. Further, the Committee advised the Panel Convenor to hold a physical meeting in the Month of May 2023 and finalize the pending action(s) on priority.		

6	Revision of IS 2507:1975 *Cold-rolled steel strips for springs*	Comments received from Bhushan Steel Ltd, Maharashtra During the previous meetings the committee discussed the draft revision and after deliberation some of the committee members requested for some more time to go through the revised standard and give comments on same. The committee agreed to give 21 days to the committee members to give their comments on the draft. In case no comments are received in this period, the draft shall be sent for wide circulation for one month after taking approval of Chairman MTD 4. Vide email dated 3/4/2018 following clarification has been sought from Mr Murlidhar of Bhushan Steel for which reply is awaited. "In the covering letter attached you have informed that for revising this standard you have taken help of ISO 4960. You are requested to kindly inform whether the ISO 4960 can be adopted in total replacing the current standard or only a few clauses need to be taken from ISO 4960. Also as understood the changes made by you are highlighted by red colour. You are requested to inform whether the changes made are as mentioned in ISO standard particularly for chemical composition, physical properties, heat treatment temperature . During the last meeting Committee decided that the Bhushan Steel should send their comments with justification in the comment format. Mr Murlidhar agreed that he shall send the same to BIS in one week's time. The same shall then be forwarded to committee member for 21 days for comments and in case no comments are received the revised document may be sent for wide circulation for one month. The committee noted the information and after deliberation decided that as no reply has been	As desired by the committee, Panel held its meeting on 08 June 2023. Report is awaited from Shri Ravindra Gujar (M/s Tata Steel Ltd) and requested Member Secretary to ensure follow up action and obtain the report within 45 days.	For focusing more on the matters related to exigency cited by Ministry of Steel for formulation of standards on electrical steels for medium and high frequency, abrasion resistant steels, Zn-Ni coated steels, medium carbon cold-rolled steels etc for ensuring quality of imports**, the committee decided to merge IS 7226 and IS 2507.** **Accordingly, it requested Sh Mohammed Basha(AM/NS) to formulate a draft merging both IS 7226, IS 2507 , further deriving assistance from other national/international standards on the subject and on account of import related data from Ministry of Steel. Sh Basha was also requested to submit the draft within 30 days from the date of finalization of the minutes.** **Members including subcommittee were requested to examine the resultant draft and share their views within 07 days from the date of its circulation and it also decided that in case of no comments the document would be sent for wide circulation for 30 days.**

		received from Bhushan Steel the draft document placed at Appendix 14 may be sent for wide circulation for one month. Observations made by Member Secretary, while preparing the draft for wide circulation, were shared with Panel for disposal (see Appendix-11 pg 147-156). Reply is awaited from the Panel Convener. The Committee took note of the comments of MTD (Appendix-11) and advised the Sub-Committee to take decision on the matter. Subcommittee referred the matter to panel 11 to examine the working draft received from Tata-BSL Ltd earlier and submit the P-Draft by 20th June 2022. The committee requested the convenor of panel 11 to submit the report within 15 days from the date of finalization of the minutes. Report is awaited from **Panel 11**. Subcommittee requested the Panel Convenor to submit its report by 30 Nov 2022. Committee noted the status and requested the Panel Convenor Sh Avtar Singh Saini to submit the report within 30 days from the date of finalization of the minutes. Report is awaited from Panel 11. Subcommittee during its meeting heldon 11 April 2023 had advised the panel to expedite action. Also, panel was also advised for considering adoptionof ISO 4960. Committee noted the status and requested Panel 11 to hold a physical meeting in the Month of May 2023 and finalize the pending actions on priority.		

7	IS 2062:2011 *Hot Rolled Medium and High Tensile Structural Steel*	In the 32nd meeting, comments received from Mr P.K.Patra, JSW Steel limited were considered and after deliberation the committee decided that some more study is required before permitting higher level of nitrogen in IS 2062:2011. The committee requested Mr P.K.Patra to undertake the study and get the high nitrogen level steel samples tested in WRI,BHEL, Trichy and welding laboratory of Tata Steel and present the findings in the next meeting. Comments received from JSW and TATA Steel were discussed and after deliberatioin the committee decided not to increase the permissible nitrogen content without testing as decided in last meeting. The comments of JSW wereagreed. The amendment was discussed and after deliberation and as pointed by Power Grid, the committee did not find any justification for increasing the chemical composition limits and decreasing the elongation values of existing grades. The committee thus decided to remove this from the proposed amendment. JSW informed that they shall provide justificaition for the same. During the last meeting justification received from JSW for amendment was discussed and after deliberation the committee agreed to the justification provided. The committee also discussed the comments received from DSP and the following decision was taken for the comments made Point 1 & 2 was not agreed by the committee since there is no change in carbon equivalent. Point 3 was agreed by the committee and it was decided that in the amendment it will be mentioned that the elongation was for transverse/longitudinal direction. It was decided to circulate the revised amendment among the committee members for 21 days and	Subcommittee noted that the report was provided by the panel on account of its meeting held on 09 June 2023 and was given at Appendix-2. Further, the Subcommittee during its meeting held on 28 July 2023 requested the Convenor of Panel 7 to expedite action and submit the desired draft, as mentioned in the report, within 30 days from the date of finalization of the minutes. Draft standard for Q&T structural received from the panel convenor is given at **Appendix-4 (Pg 56-74)**	As the desired draft for formulation of Q&T structural steel was circulated as addendum to the agenda , making it now feasible to revise IS 2062:2011 as IS 2062 Part 1 for non-alloy structural steels and IS 2062 Part 2 for Q&T structural steels, **the Committee decided the following:** **a) to send the draft finalized earlier during Dec 2022 for wide circulation for 30 days for the purpose of revising IS 2062:2011 as IS 2062 Part 1.** **b) to send the draft given at Appendix-3 for wide circulation for a period of 60 days for the purpose of formulation of IS 2062 Part 2, Appendix-3 (Pg 71-89).**

		incase no comments are received the same was to be sent for wide circulation for one month. The draft amendment was revised as per the comments received and agreed to by the committee and sent for circulation among the members of the committee on 14/10/2018. Following comments were received from Tata steel:  Draft Amendment to IS 2062 tata steel.do The comment received was discussed and committee after deliberation and reviewing the draft amendment decided to modify the amendment. The committee requested the member secretary to circulate the modified amendment placed at **Appendix 8** among members for 14 days. In case no comments are received the modified amendment will be sent for wide circulation for one month. The committee also deliberated and decided to include Quenched and Tempered grades for higher strength material for structural use. It requested the panel revising IS 2062 to consider incorporating quenched and tempered grades in the existing standard or consider a new standard on the same. The committee noted the information and after deliberation decided to refer the matter again to the panel and requested them to submit the draft revision of document within the period of two months. The Draft revision then received will be send in wide circulation for the period of one month in consultation with the Chairman. The comments of MTD for want of justification for		

		the proposed changes seeking details of reference in national/International standards was awaited from the Panel (Appendix-17). The Committee took a note of the comments of MTD (Appendix-17) and requested convener of Panel-17 to submit the modified draft to the sub-committee within three weeks. Subcommittee reconstituted panel 7 and requested them to submit the P- Draft by 30th June 2022. The committee noted the status briefed by Sh G V Ramana on behalf of convenor Sh Devashish Mishra. The committee requested the l convenor of panel 7 to submit the report, indicating references of national/ international standardsfor the changes suggested for revision of the standard and also including the decision of the panel along with the changes therein against all the comments received from panel members, within 15 days from the date of finalization of the minutes. Also, it requested Member Secretary to circulate the P-draft on receipt of it from Panel Convenor, to members of both MTD 4 and MTD 4:3, giving a time period of 21 days for inviting comments Meeting of panel 7 was held on 26 July 2022. Minutes of the meeting , Annex-1 to the minutes and draft standard for revision of IS 2062:2011 is placed at **Appendices- 3,4 & 5**(Pg 79, 80-84, 85-100). Member Secretary was advised to circulate the		

		working draft along with the minutes inviting comments from members of both MTD 4:3 and MTD 4, giving them a time period of 15 days. The Committee was informed by the member secretary that no comments were received from subcommittee on the draft document during P-circulation culminated on 09 Dec 2022. Accordingly, the Committee agreed to send the draft standard, placed at Appendix-10(Pg 102-109), for wide circulation for a period of 30 days. Draft for revision of IS 2062 is being sentfor wide circulation. Further, during subcommittee meetingheld on 11 April 2023, Shri G V Ramana was requested to submitproposal for coming up with Q&T structural steel, which is intended to be covered under a new standard IS 2062 Part 2. Committee noted the status and requested the Member Secretary to send the document for WC for 30 days within 15 days from the date of finalization of the minutes. Further, the Committee advised the Convenor of Panel 7 to hold a physical meeting in the Month of May 2023 and finalize the pending action(s) on priority.		

8	Amendment to IS 10748: 2004 *Hot Rolled Steel Strip for Welded Tubes And Pipes*	Modifications are proposed in Section 3 (Clause 3.1), Section 7 - Table 1 (clause 7.1), Sections 8 & 9 - Table 3 (Clauses 8.3 and 9.2.4) Presently, the hot rolled steel composition does not have any provision for addressing fire resistant properties. Inherent fire resistant properties in steel structures can be attained by adding micro-alloying element like Mo and Cr in combination with other elements like Ti, V, Nb. The last three elements are already mentioned in Clause 3.1. Therefore the following modifications are being proposed: 3.1 Micro-Alloying Elements (Page No. 1) Elements, such as niobium, vanadium, titanium, molybdenum and chromium added singly or in combination to obtain higher strength levels combined with better formbility, weldability, toughness and fire resistant property as compared with non-alloyed steel produced to equivalent strength levels.Table 1 Inclusion of point No 6 in the notes against Table 1: "For fire resistant property requirement, Mo in combination with other micro alloying element Ti, Nb, V, Cr, B, Cu, W may be added up to 0.25 %" During the last meeting of the committee comments received from JSW were discussed and after deliberation the committee requested Tata Steel to submit the following clarifications 1. The reason for inclusion of this grade in IS 10748 when there is a separate standard IS 15103 for fire resistant steel . 2.As per JSW comment the validation data submitted now and submitted during previous meeting held in Jan 2018 of MTD 4.36 S.No 25 in Annex2 in which attachment AnnexII have	Clarification is awaited from the proposer.	**As no interest was exhibited by the proposer, the Committee decided to do away with the proposal and not to take up the matter further for the time being.**

		some differences in chemical composition (Mn, Si, Mo & Cr for Trial1 & Trial2) needs to be understood. 1. The data submits very narrow range of validation. 2. Whether the grade proposed is fire resistant or it can be termed as heat resistant. 3. In case the grade is included in the standard, how will Tata Steel handle its patent. Tata steel was requested to send their reply on above issues to BIS. Following reply was received from Tata steel: '1. The chemistry against Trial heat (V44627/55600642) sent to BIS on Sep 13 2017 was a mistake from our side. It was for another trial heat (V27351/Coil ID 37530401), which was not up to our full satisfaction. The document sent on Jan 11 2018 along with chemistry, mechanical properties and fire resistance properties are correct and validated by an independent accredited NABL lab. 2.Regarding patent, Dr Sanjay Chandra, Chief R&D and Scientific Services Tata Steel, has already sent you an email communication on April 27 2018.' The letter mentioned above is attached below:  BIS.pdf The committee noted the information and after detailed deliberation decided that 'Fire Resistance' term is already covered in IS 15103 so including a grade with similar terminology in IS		

		10748 would be misleading. Also, the grade for which inclusion is being proposed by Tata steel do not meet the requirements specified in scope of IS 15103 and so the proposed cannot be termed as fire resistant grade or cannot be included in IS 15103. Tata steel submitted a changed nomenclature for the grade as 'Elevated temperature application'. The committee agreed to form a new standard for elevated temperature application once requisite approvals are received from BIS as it a patented grade. Member Secretary apprised the committee about procedures involving reference to the patented items in developing a standard, as mentioned below: *a) BIS cannot give authoritative or comprehensive information about evidence,* *validity and scope of patent and like rights but it is desirable that the fullest available information be disclosed. Therefore the originator of a proposal of such a kind shall draw the technical committee's attention to any known patent and like rights on a worldwide basis or any known pending applications, although BIS is not in a position to guarantee the authority of any such information.* *b) If the proposal is accepted on technical grounds, the originator shall ask any known* *patent holder for a statement that he would be willing to negotiate licences under patent and like rights with applicants throughout the world on reasonable terms and conditions. A record of patent holder's statement shall be placed in the relevant technical file and shall be referred to in the standard. If the patent holder does not provide such a statement, the technical committee shall not proceed with the inclusion. of the patented item unless the respective division council gives permission.* *c) Should it be revealed after publication of the standard that licences under a patent and like rights*		

		cannot be obtained under reasonable terms and conditions, the standard shall be referred back to the technical committee for further consideration As the current template of BIS for submitting new proposal, captures all provisions including reference to patents, the Committee suggested the Proposer (M/s Tata Steel Ltd) to submit the proposal for developing new standard on ***Steel for Elevated temperature application*** through BIS portal. Further, the sub-committee was advised to examine the proposal subsequently and send its recommendation to the Committee in due course. Subcommittee Chairman Sh. Avatar Singh volunteered to help member secretary in referring the matter to concerned department/unit of M/s TATA steel ltd. The committee noted the status shared by Member Secretary. Committee noted the status and requested the Member Secretary to expedite action on obtaining the clarification. Clarification is awaited from the proposer. Committee noted the status and requested Member secretary to obtain the desired clarification from the proposer.		

9	IS 10748: 2004- Hot Rolled Steel Strip For Welded Tubes And Pipes	During the last meeting comments received from JSW on the proposal fpr amendment in IS 10748 received from Mr B B Prasad of Tata steel were discussed and after deliberation the committee agreed to the comments made. It was decided that Mr B B Prasad shall draft an amendment to IS 10748 based on the agreed comments. The draft amendment shall then be circulated within MTD4 and MTD 19 committee member for 21 days and incase no comments are received , the same shall be sent for wide circulation for one month. Draft amendment received from Mr B B Prasad is given below Amendment to IS10748.2017-R2.do The committee discussed the draft amendment and after deliberation decided to circulate the amendment among committee members of MTD 4 and MTD 19 for 21 days and if no comments are received send the draft amendment for wide circulation for one month. The committee took note of the status and requested Member Secretary to take action. Subcommittee examined the matter and requested Panel 7 to submit their report by 20 June 2022 The Committee noted the status and requested Convenor of Panel 7 to submit their report within 15 days from the date of finalization of the minutes. Comments were received from AM/NS. Panel 11 is requested to dispose them off and submit the modified amendment. Panel Convenor was requested to submit the	Report provided by the panel on account of its meeting held on 09 June 2023 is given at **Appendix-3**. During the meeting held on 28 July 2023, Subcommittee requested the Convenor of Panel 7 to expedite action and submit the desired draft standard, as mentioned in the report, within 60 days from the date of finalization of the minutes.	**The Committee requested the panel convenor Sh Devasish Mishra(JSW) to submit the desired draft within 30 days from the date of finalization of the minutes.**

		report by 30 Nov 2022. Report is awaited from Panel 7. Panel Convenor was requested to submit the report within 15 days from the date of finalization of the minutes. Committee noted the status and requested the panel convenor to expedite action on submitting the report. Report is awaited from Panel 7. Committee noted the status that convenor of Panel 7 Sought 45 days time from 30 April 2023 to submit the report. Further, the Committee advised the Panel Convenor to hold a physical meeting in the Month of May 2023 and finalize the pending action(s) on priority.		

10	Harmonization of Indian Standard with ISO standards	The Committee noted the status and advised Sub-Committee reconstitute the Panel -17 by substituting the retired or moved away personnel by the existing personnel representing the same organization in MTD 4. Further, the Sub-Committee to submit its recommendation to the Committee in due course. The matter has been referred to panel 7 with a request submit report to the subcommittee by 30th June 2022. The Committee noted the status and requested Convenor of Panel 7 to submit their report within 15 days from the date of finalization of the minutes. Report is awaited. Panel Convenor was requested to submit the report by 30 Nov 2022. Committee noted the status and requested the panel convenor to expedite action on submitting the report. Report is awaited from Panel 7.	Report provided by the panel on account of its meeting held on 09 June 2023 is given at **Appendix-3** to the agenda.	**Committee examined the report and requested member secretary to take it up with SARSO accordingly during its next meeting.**
11	Documents published and sent for printing		Following documents were sent for printing: **MTD 4 22895** **MTD 4 22896**	**Committee noted the information.**
12	Documents sent for wide circulation		**New:** **MTD 4 23033** *Hot-Dip Zinc- Aluminium-Magnesium Alloy Coated Steel Sheets Plates and Strips* **Revisions:** **MTD 4 23040** *Steel Plates And Strips For Pressure Vessels Used At Moderate And Low Temperature* **MTD 4 22804** *Hot Dip Aluminium-Zinc Alloy Metallic Coated Steel Strip And*	On basis of recommendation of the panel and as briefed by the Member Secretary, the committee decided as follows: **New** a) To send the document MTD 4 23033, given at **Appendix-4(pg 90-119)**, for printing. **Revision** b) To send the documents MTD 4 23040 and MTD 4 23086 for

			Sheet **MTD 4 23086** *Steel Plate For Pressure Vessel For Intermediate And High Temperature Service Including Boilers* **MTD 4 22863** *Continiously Prepainted Galvanized Steel Sheets& Strips* **MTD 4 22826** *Pre-Painted Aluminium Zinc Alloy Metallic Coated Steel Strip And Sheet* Comments were received from for all the above documents. Report is awaited for all the documents with exception for MTD 4 23086, MTD 4 23040. **Committee may please note and may decide on report on comments received for** MTD **4 23086, MTD 4 23040, given at Appendix-5(Pg 75-76).** **<u>Amendment:</u>** **MTD 4 11513** *Cold Reduced Carbon Steel Sheet and Strip Part 2 High Tensile and Multi-phase Steel Amendment* **MTD 4 13189** *Cold Reduced Carbon Steel Sheet and Strip Part 1 Cold Forming and Drawing Purposes* As no comments received, it is proposed that we may send the documents for printing.	printing, incorporating the changes as given at Appendix-5 to the agenda. c) To send the document MTD 4 22863 for printing on basis of recommendation of panel as given at **Appendix-5(Pg 120-141)**. d) Requested the panel to submit their recommendation for MTD 4 22804, MTD 4 22826 on priority. **Amendment:** e) To send the document MTD 4 11513 and MTD 4 13189 for printing.
13	Comments on IS 1993	subcommittee noted that comments in IS 1993 were collated and shared with ISO TC 17 SC 9 for further action. Committee noted that comments in IS 1993 were collated and shared with ISO TC 17 SC 9 for further action	Comments were taken up with ISO TC 17 SC 9 during its 28th meeting held on 06-07 Sep 2023. Report was shared with members through email on11 Sep 2023	**Committee noted the information.**

14	Comments on IS 648:2022	M/s Posco Maharashtra Ltd was requested to submit draft amendment for IS 648:20222 for inclusion of the grade 35PN440. Committee noted the status during its meeting held 0n 28.04.2023.	Draft amendment received from Panel 2 is being examined.	**Committee noted the information and requested the panel convenor to expedite the matter.**
15	Comments on IS 3024	Request was received from ITMA for inclusion of 0.20mm thickness. Matter was referred to Panel 2	Draft amendment received from Panel 2 is being examined.	**Committee noted the information and requested the panel convenor to expedite the matter.**
16	Revision of IS 1875:1992 *Carbon SteelBillets, Blooms, Slabs and Bars forForgings*	The following panel was formed for revision of IS 1875 1. Mr D. Karmarkar SAIL – Convenor 2. Mr Sanjay Roy, RINL - Member 3. Mr Devashish Mishra, JSW – Member 4. Mr P.K. Biswal, Kalyani Carpenter Special SteelLtd, Pune – Member 5. Mr Dinesh Singh, Vardhman Steel – Member 6. Dr M Krishnamurthy, CQA(metals) –Member 7. Member from DSP During the last meeting the comments received from Vardhman steel were discussed and agreed. Based on the comments and the discussion held in the meeting,it was decided to revise draft of IS 1875 and Mr Karmarkar was requested to send the revised draft to BIS. The revised draft thus received was to be sent for wide circulation for one month. The committee noted the information and requested the panel again to send the revised draft to BIS by 30 April 2019 and the document thus received shall be sent for wide circulation for one month. Comments on the draft were circulated to Panel Convener on 25 June 2021. Modified draft was awaited. Member Secretary informed the	The draft was shared with members of MTD 16 during its 25th meeting held on 11 May 2023. It is informed that no comments were received from members. However, Panel Convenor Sh Saikat De, who was also a member of MTD 16,informed the members that the draft presently was devoid of the grades mentioned in the standards IS 5517(Q&T), IS 4432 (case hardening) and IS 3930(Flame and Induction hardening). Accordingly, the Subcommittee agreed to incorporate them and requested Sh Saikat De to provide the draft within two days so that the same could be circulated as Addendum to the minutes. Draft received from Sh Saikat De is being examined.	**Committee agreed to send the draft given at Appendix-6 (Pg 142-158) for wide circulation for a period of 30 days. However, it advised member Secretary to seek consent from MTD 16 for the same.**

		committee about co - existence of the grades of IS 1875 in IS 13352, an IndianStandard covering steel produced through continuous casting route. The Committee noted the observations andadvised Panel -4 to submit the modified draft to the Sub -Committee within one month.Also, the Sub - Committee was advised by the Committee to reconstitute the panel by getting revised nominations from SAIL - RDCIS and by also inducting SAIL –ISP (Sh SK De). The subcommittee during its meeting held on 28 June 2022 deliberated on the need for having IS 1875 and agreed that the standard should continue to serve steel stock for forging quality produced through ingot route. Accordingly, it reconstituted the panel 4 and requestedthem to share P-draft within **three months** for reviewing both IS 1875 and IS 13352.Composition of reconstituted panel 4 was mentioned below: 1. SAIL RDCIS, Sh S K Jha, convenor 2. Saarloha Steels Ltd, 3. JSW, Salem 4. Tata Steel Long products, DrT Bhaskar 5. Bharat forge 6. CHW forge 7.Forging Manufacturers association 8. L&T 9.Mukand Sumi Steels Ltd The Committee noted the status and recommended tohave Sh S K De (SAIL-ISP) as convenor of Panel 4 replacing Sh S K Jha SAIL-RDCIS.		

		Also, it requested the panel on reviewing the proposal of having individual standards on Steels for forging stock both for continuous casting and ingot route respectively. Report awaited from Panel 4. Convenor of Panel 4 was requested to expedite actionand share the report within 45 days from the date of finalization of the minutes. Nominations were obtained from AIFI. Nominations were still awaited from saarloha, CHW forge and L&T. Further, meeting of Panel 4 was held on 02 March 2023. On the basis of panel report (**Appendix-1, pg 48**) and the draft (**Appendix-2, pg 49-66**), subcommittee recommended for sending the draft document for wide circulation. Committee agreed to send the document for wide circulation. However, it advised Member Secretary to obtain consent from members of MTD 16 on the proposal for wide circulation.		
17	Amendment No.2 to IS 280:2006 *Mild SteelWire for General Engineering Purposes*	The committee after deliberation decided that MTD 24 may be requested to consider revision of IS 4826 based on ISO 7989 on priority , since IS 280 is proposed to come under Mandatory certification . The committee also decided the following two members may also be allowed to participate in MTD 24 meeting when revisionof IS 4826 is discussed . Mr Nirmal Saraf - SWMAI Mr Shishir Desai – Tata steel Wires division. The committee noted the information. Revised draft forrevision of IS 280 was tabled by Shri Shishir Desai andis placed at Appendix 15. The committee deliberated over the document	Draft document is being sent for wide circulation for 30 days.	**The Committee requested the Member secretary to send the document for WC for 30 days within 15 days from the date of finalization of the minutes.**

		and decided to send the document for wide circulation for one month. This issue was discussed in the meeting of MTD 24 andthe committee after deliberation decided that since IS 4826 is cross referred in 18 Indian Standards it would not be appropriate to make any changes in the same. The committee suggested that the changes may be incorporated in the product standard i.e, IS 280 if agreed by MTD 4 committee. The committee noted the status and requested membersecretary to circulate the P-draft to its members as wellalongside members of MTD 4:2. As only one clause was being modified through the proposed revision, it was put forward by Shri Shishir Desai to consider amendment instead of revision. Draft amendment has been prepared considering the above and comments received from CMD-II raising concern on coating requirements for galvanized wire of sizes under 0.2 mm and over 10mm. Draft amendment received from Shri Shishir Desai on 3rd April 2020 is placed at **Appendix-12(Pg 157158)**. Further, the Committee advised Sub-Committee to decide on the matter. The subcommittee examined the comments of MTD and agreed that there was need to specify coating requirements for electrogalvanized wires as well. Further, the members were informed about technological developments in production of EG wires upto 300gsm, at par with HDG wires. Accordingly, the members agreed to modify cl		

		11 of draftamendment so that requirements reproduced from IS 4826 holds applicable to zinc coating wires regardless of them being HDG or EG. Member secretary was requested to modify the amendment and do P-circulation among member within 21 days from the date of finalization of the minutes. Draft amendment was shared as addendum to the agenda. During the meeting, Sh Shishir Desai expressed that the draft amendment circulated as an addendum to theagenda comprised of requirements as per IS 4826, which were obsolete, instead of the desired requirements prevalent in the industry, which were as per ISO 7989-2. Also, it was informed to the members that the draft amendment circulated during Dec 2020 was comprising of requirements as per ISO 7989-2. The subcommittee examined the requirements and recommended to send the modified draft amendment for wide circulation with prior approval of MTD4. Subcommittee was informed that the Draft amendment was being sent for wide circulation. Committee noted the status and requested the member secretary to send the document for wide circulation for 30 days within 30 days from the date of finalization of the minutes.		
18	Revision of IS 9550 :2001 *Bright Bars*	The subcommittee examined the comments received on IS 9550 from various organizations. It decided to refer the matter to panel constituted at Item 4.3 above with a request to	Panel 28 held its meeting on 07 July 2023. Report of the panel was shared with	**Committee agreed to send the draft given at Appendix-7(Pg 159-172), for wide circulation for a period of 30 days.**

		dispose of the comments within 3 months. Report awaited. Subcommittee noted the status and requested the panel convenor to submit the report within 45 days from the date of finalization of the minutes. Committee noted the status and requested the panel convenor to expedite action.	subcommittee during its meeting held on 14 July 2023. Subcommittee deliberated on the draft standard. The resultant draft incorporating the change is given at **Appendix-6(Pg 77-90).**	
19	Revision of IS 7283	Report of panel on Action research report received for IS 7283:1992 along with draft standard**, Annex-II**(Pg 36-57) , was discussed by the subcommittee along with the proposal put forward by Member Secretary to withdraw IS 7283 for avoiding duplicity of grades, stating that the grades of bars were covered under various standards such as IS 2062, IS 4432, IS 5517 etc. Subcommittee agreed to review the draft standard and above proposal and to send their views in due course of time. Committee noted the status during its meeting held on 28.04.2023.	Subcommittee during its meeting held on 14 July 2023, agreed to set this task aside till such a time as the basis would be dependent on outcome on revision of IS 5517, IS 4431 and IS 4432.	**Committee agreed to set aside the review of IS 7283 till the time decision on revision of IS 5517, IS 4431 and IS 4432 was considered by MTD 16.**

BUREAU OF INDIAN STANDARDS

Indian Standard

SPECIFICATION FOR WEAR AND ABRASION RESISTANT STEEL SHEETS AND PLATES

ICS 77.140.50

Last date for receipt of comments is 28 12 2018

FOREWORD

(*Formal clauses will be added later*)

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

This standard covers the requirements for wear and abrasion resistant steel and plates in Quenched (Q) or Quenched and Tempered (Q&T) condition.

2. REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of standard indicated below:

IS No.	*Title*
IS 228 (in various parts)	Methods for chemical analysis of Steel
IS 1599 : 2012	Metallic materials- Bend test (third revision)
IS 1956 (Part I)	Glossary of terms relating to iron and steel (General metallurgy, heat treatment and testing)
IS 1956 (Part IV)	Glossary of terms relating to iron and steel (Steel sheet and strip)
IS 1608 (Part 1) : 2018/ ISO 6892-1 : 2016	Metallic Materials – Tensile Testing Part 1 Method of Test at Room Temperature (fourth revision)
IS 1730 : 1989	Steel plates, sheets, strips and flats for structural and general engineering Purposes - Dimensions (second edition)
IS 1852 : 1985	Specification for Rolling and cutting tolerances for hot-rolled steel products (fourth edition)
IS 1757 (Part 1) :2014/ ISO 148-1 :2009	Metallic materials – Charpy Pendulum Impact Test Part 1 Test Method (third revision)
IS 4225:2004	Recommended practice for straight beam ultrasonic testing of steel plates
IS 8910 : 2010/ ISO 404 :1992	General technical delivery requirements for steel and steel products (first revision)
IS 1500 (Part 1) :2013/ IS0 6506-1 : 2005	Metallic Materials - Brinell hardness test Part 1 Test method

3. SUPPLY OF MATERIAL

3.1 General requirements for the supply of material shall be as laid down in IS 8910.

3.2 Steel shall be supplied in the form of sheets or plates in mill edge or cut / trimmed edge condition.

3.3 The products shall be supplied in Quenched (Q) or Quenched and Tempered (Q&T) conditions.

4 TERMINOLOGY

4.1 Quenching

The process of quenching or quench hardening involves heating the steel above the upper critical temperature, soaking for sufficient time so as to attain a uniform temperature through the thickness and then rapidly cooling the steel in water / oil / forced air / other media (Quenching) to increase the hardness of steel significantly.

4.2 Tempering

Heating to elevated temperature but below transformation zone, of hardened steel and holding for specified time at temperature followed by cooling at desired rate to develop desired mechanical properties in these steel.

4.3

Wear and Abrasion Resistant Steels

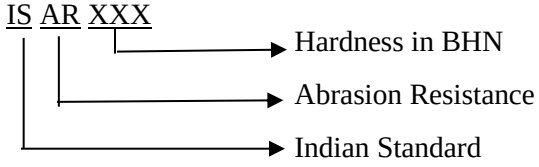
These are steels with higher hardness than conventional steels such that the sheets and plates of this steel resist surface wear and abrasion due to rubbing or friction during use.

5 DESIGNATION AND GRADES

There are five different grades of steel based on hardness levels as given below in Table 1.

Table 1 Designation and Grades

S. No.	Grade	Hardness in BHN	Designation (Quality)
1	ISAR 400	360-430	The number in front of the grade gives the indication of hardness level of steel plates in Brinell Hardness Number (BHN)
2	ISAR 450	410-490	
3	ISAR 500	450-550	
4	ISAR 550	500-580	
5	ISAR 600	550-650	



6 MANUFACTURE

6.1 The steel shall be manufactured by any process of steel making with secondary refining at the discretion of the manufacturer. The steel may be processed through vacuum degassing if agreed between the manufacturer and purchaser at the time of order.

6.2 Steel sheets and plates may be supplied in following heat treated conditions:

a) Quenched (Q)
b) Quenched and Tempered condition (Q&T)

The supply condition may be agreed between the manufacturer and purchaser at the time of order.

7 CHEMICAL COMPOSITION

7.1 Ladle Analysis

Ladle analysis of the material when carried out either by the method specified in the relevant part of IS 228 or any other established instrumental/ chemical method shall be as given in Table 2. In case of dispute, the procedure given in the relevant part of IS 228 shall be the referee method.
The Heat shall be certified based on ladle analysis. Table 3 gives the recommended values for carbon equivalent for each grade of steel.

Table 2 Chemical Composition

Steel Grade	Constituent, *Percent , Max*								
	C	Mn	Si	P	S	Cr	Mo	Ni	B
ISAR 400	0.30	1.60	0.70	0.025	0.010	1.80	0.50	1.20	0.0050
ISAR 450	0.32	1.60	0.70	0.025	0.010	1.80	0.50	1.20	0.0050
ISAR 500	0.35	1.80	0.80	0.025	0.010	2.00	0.60	1.50	0.0050
ISAR 550	0.37	1.80	0.80	0.025	0.010	2.00	0.60	1.50	0.0050
ISAR 600	0.47	1.80	0.80	0.025	0.010	2.00	0.60	1.50	0.0050

Table 3: Recommended Carbon Equivalent Limits for Different Grades

Steel Grade	Carbon Equivalent (in wt% max) Corresponding to Plate Thickness in mm Range							
	>3.00-<8.00	≥8.00-<20.00	≥20.00-<40.00	≥40.00-<50.00	≥50.00-<60.00	≥60.00-<80.00	≥80.00-<100.00	≥100.00-≤130.00
ISAR 400	0.41	0.55	0.55	0.60	0.65	0.70	0.80	0.85
ISAR 450	0.47	0.55	0.60	0.65	0.70	0.75	0.85	0.90
ISAR 500	0.50	0.65	0.70	0.75	0.80	0.85	0.85	-
ISAR 550	-	0.70	0.75	0.80	0.85	0.90	-	-
ISAR 600	-	0.70	0.75	0.85	0.85	0.90	-	-

NOTES

1 Grain refining elements such as Al, Nb, V and Ti may be added singly or in combination. Total grain refining elements shall not be more than 0.25 percent.
2. Elements other than those given in the above table may be added if agreed between the manufacturer and supplier
2. Restricted chemical composition may be mutually agreed between the purchaser and the supplier
3. Nitrogen content of steel shall not exceed 0.012 percent.
4. Carbon Equivalent (CE) based on ladle analysis = C+Mn/6+(Cr+V+Mo)/5+(Cu+Ni)/15
5. Thickness above 130 mm may be supplied if mutually agreed between the manufacturer and purchaser.
6. Carbon Equivalent (CE) for thickness above 130 mm may be mutually agreed between the manufacturer and purchaser

8 MECHANICAL PROPERTIES

Except Hardness Test, Mechanical testing like Tensile, Bend and Impact tests for Wear and Abrasion Resistance Steels are not mandatory for this standard. However, if required, these tests and their values may be mutually agreed between the manufacturer and purchaser at the time of order.

For reference, the representative values for tensile, Bend and Impact test for 20 mm thickness are given in table 5, 6 and 7 respectively.

8.1 Hardness Test

1. Surface hardness test to be conducted on sample drawn from the heat treated sheet / plate. The ranges of hardness values for different grades are mentioned in Table 4 given below:
2. For plates from plate mill, one test sample shall be taken from corner of each plate as rolled. For Sheets/plates produced from coil, three samples from each coil (Head end, Middle and Tail end) shall be taken.

Table 4. Hardness in BHN

Steel Grade	Hardness (BHN)
ISAR 400	360-430
ISAR 450	410-490
ISAR 500	450-550
ISAR 550	500-580
ISAR 600	550-650

NOTES

1 Surface Hardness testing shall be carried out as per IS 1500 Part 1 (2013)
2 Hardness testing to be done after removing a surface layer by milling or grinding as per given in below table

Sheet/ plate Thickness range (mm)	Depth of Grinding (mm)
Up to 10.0	0.50
>10.0 - 25.0	1.00
>25.0 - 50.0	1.50
>50.0 - 80.0	2.00
>80.0	3.00

3 Minimum core hardness shall be 90% of the guaranteed minimum surface hardness.

8.2 Tensile Test

Table 5 gives the indicative tensile test values for 20mm thickness plate for specified grades.

Table 5. Indicative Tensile Strength for 20mm Thickness Plate

Steel Grade	Yield Strength (in MPa)	Tensile Strength (in MPa)	%Elongation (GL: $5.65\sqrt{So}$)
ISAR 400	~~900-1100~~ 900 min	~~1250~~ 1150 min	8.0 min
ISAR 450	~~1000-1200~~ 1000 min	~~1400~~ 1300 min	8.0 min
ISAR 500	~~1250-1400~~ 1200 min	~~1550~~ 1400 min	6.0 min
ISAR 550	~~1400-1650~~ -------	~~1700 min~~ -------	~~6.0 min~~ -------
ISAR 600	~~1600-1800~~ -------	~~1750 min~~ -------	- ---------

NOTE

1. Tensile test should be conducted as per IS 1608 (Part 1).

8.3 Bend Test

Table 6 gives the indicative bend test radii for 20mm thickness plate for specified grades.

Table 6. Bend Angle and Internal Bend Radius for 20 mm Thick Plate

Steel Grade	Bend Radius (Bend angle: 90º)	
	Sample Orientation Transverse to Rolling Direction	Sample Orientation Longitudinal to Rolling Direction
ISAR 400	3.0 x thickness	4.0 x thickness
ISAR 450	4.0 x thickness	5.0 x thickness
ISAR 500	5.0 x thickness	6.0 x thickness
ISAR 550	-	-
ISAR 600	-	-

NOTES

1. Bend test shall be carried out in accordance with IS 1599.
2. The test piece shall be bend at ambient room temperature through 90º.

8.4 Charpy V-notch Impact Test

Table 7 gives the indicative charpy impact values for 20mm thickness plate for specified grades.

Table 7. Indicative Charpy Impact Values for 20mm Plate Thickness

Steel Grade	Average Charpy Impact energy (Joules)	
	Test Temperature -20ºC	Test Temperature -40ºC
ISAR 400	27 min	20 min
ISAR 450	27 min	15 min
ISAR 500	27 min	15 min
ISAR 550	-	-
ISAR 600	-	-

NOTES

1. Impact test shall be carried out in accordance with IS 1757 (Part 1).
2. The sample orientation is longitudinal to rolling direction.

9 NON DESTRICTIVE TEST

The material may be subjected to non-destructive testing to determine the internal soundness of material subject to mutual agreement between the manufacturer/supplier and purchaser at the time of order.

10 RETEST:

10.1 If a test does not give the specified results, two additional tests shall be carried out from same plate as rolled / sheets-plates from coil. Both the retests shall conform to the requirements of the standard

10.2 If any of the retest fails to meet the mechanical requirements specified, the supplier may re-heat treat the material and in that case, all the mechanical properties shall be re-evaluated.

11 FREEDOM FROM DEFECTS

11.1 Sheets and Plates shall be well and cleanly rolled to the dimensions specified. The finished material shall be reasonably free from surface flaws, laminations, rough/jagged and imperfect edges and other harmful defects.

11.2 Minor surface defects may be removed by the manufacturer by grinding provided that the thickness of the sheet /plate shall not go below the thickness tolerance specified at the spot where dressing is done. The grinding shall be even and smooth and shall be widened enough to remove sharp ridges.

11.3 Repair welding of defective spots shall not be permitted.

12 DIMENSIONS AND TOLERANCES

Unless otherwise agreed to between the purchaser and the manufacturer, the rolling and cutting tolerances for steel products conforming to this standard shall be as per IS 1852.

13 MARKING

Each plate as rolled shall to be marked with manufacturer's name, designation of steel and details like plate no., cast/ heat number and nominal dimensions.

Sheets/plates produced from strip or coil form shall be supplied in bundles. Each bundle shall carry a metal tag or adhesive label/sticker bearing the cast/heat number or identification mark or lot number traceable to the cast/heat number and the manufacturer's name or trade mark. Alternatively, top sheet/plate shall be legibly marked with cast/heat number or identification mark or lot number traceable to the cast/heat number, name of the manufacturer or trade-mark.

14 DELIVERY

The plates may be supplied in as heat treated condition or shot blasted and primer coated condition. The technical requirement of the surface coating shall be mutually agreed between manufacture and purchaser at time of order.

15 BIS CERTIFICATION MARKING

15.1 BIS Certification Marking

The material may also be marked with the Standard Mark.

15.1.1 The products(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the BIS Act, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

16. ORDERING INFORMATION

While placing the order, the following are the minimum information to be specified by the purchaser:

a) Grade;
b) Size;
c) Mass of the material;
d) Total order quantity;
e) Marking instruction other than specified, if any;
f) Restricted chemistry and/or properties, if used for special purpose;
g) Dimension tolerance, if any special agreements to be made; and
h) Supply condition (edge condition, delivery condition and type of surface coating if any, etc.)

Draft Indian Standard

SPECIFICATION FOR STRUCTURAL WEATHER RESISTANT STEELS

(First Revision)

ICS 77.140.20

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Wrought Steel Products Sectional Committee, MTD 4

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1986. While reviewing the standard, in the light of experience gained during these years, the Committee decided to revise it to bring in line with that present practices being followed by the Indian industry.

The atmospheric corrosion resistance of these steels is approximately four times to that of carbon structural steel. Welding is of fundamental importance, and it is pre-supposed that suitable welding procedures will be adopted for welding the steels. These steels are intended for applications where weight saving along with improved atmospheric corrosion resistance is important.

The Indian Standards referred in this standard are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards

In this revision the following changes have been made:

a) Chemical and mechanical properties have been modified; Permissible Variation for Product Analysis also modified;
b) New grade designation system has been adopted; simultaneously old designations have also been given in Annex A;
c) New grades have been added;
d) Some of the Clauses are rearranged and modified.
e) Amendment No. 1 has been incorporated.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO Standard may also be followed as an alternate method.

In the formulation of this standard, due consideration has been given to the trade practices followed in the country in this field. Due consideration has also been given to international co-ordination among the standards prevailing in different countries:

ISO 630-5: 2014 ‘Structural steels with improved atmospheric corrosion resistance’,
ISO 5952: 2019 ‘Hot Rolled Structural quality with improved atmospheric corrosion resistance’,
DIN EN 10025-5: 2019 ‘Structural steels with improved atmospheric corrosion resistance’,
ASTM A606: 2018 ‘Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance’
ASTM A709: 2021 ‘Standard Specification for Structural Steel for Bridges’
ASTM A871:2020 ‘High-Strength Low-Alloy Structural Steel Plate with Atmospheric Corrosion Resistance’,
JIS G 3125: 2021 ‘Superior atmospheric corrosion resisting rolled steels’

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2: 1960 ‘Rules for rounding off numerical values (revised). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard
SPECIFICATION FOR STRUCTURAL WEATHER RESISTANT STEELS
(First Revision)

1 SCOPE

1.1 This standard covers the requirements for hot-rolled and cold-rolled structural weather resistant steels (flat and long products) in the form of plates, sheets, strips, sections, flats, bars and rods for welded, riveted or bolted construction requiring atmospheric corrosion resistance.

1.2 The grades in this standard except ISH310WR contain additional alloying elements and provide a level of corrosion resistance substantially better than that of carbon steels with or without copper addition. When properly exposed to the atmosphere, steel can be used bare (unpainted) for many applications.

1.3 ISH 340WP available in 2 grades: Grade1 for sheets and plates (in flat or coil form): Intended for structural purposes where guaranteed mechanical properties, weldability and suitability for forming simple cold pressed parts are required. Grade2 for sheets, plates (in flat or coil form) and sections: Intended for general engineering purposes with guaranteed mechanical properties and weldability.

1.4 The guidelines for thicknesses in which products of the steel grades and qualities specified in this document can be supplied are given in Table A below. However, max thickness grade wise as per table 3A will be applicable.

Table A — Product forms for the different steel grades with improved atmospheric corrosion resistance depending on their thickness

Designation	Flat products Nominal thickness, mm			Long products Nominal thickness or diameter, mm		
				Sections	Bars	Rods
	≤ 16	≤ 100	≤ 200	≤ 63	≤ 150	≤ 60
ISH235WR, ISH245WR, ISH310WR, ISH345WR, ISH355WR, ISH365WR1, ISH365WR2			Yes	Yes	Yes	Yes
ISH245WP, ISH340WP, ISH355WP, ISH360WP	Yes			Yes		
ISH400WR, ISH415WR, ISH450WR, ISH460WR1, ISH460WR2, ISH500WR, ISH600WR, ISH700WR		Yes		Yes		

2 REFERENCES

The following standards contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
228(in various parts)	Methods of chemical analysis of steels
808: 2021	Dimensions for hot rolled steel beam, channel and angle sections (*fourth revision*)
1173: 1978	Specification for hot rolled and slit steel tee bars (*second revision*)
1252:1991	Hot rolled steel bulb angles –Dimensions (*first revision*)
1599: 2019/ ISO 7438: 2016	Metallic materials – Bend test (*fourth revision*)
1608(Part 1): 2022/ ISO 6892-1: 2019	Metallic materials – Tensile testing - Part 1 Method of test at room temperature (*fifth revision*)
1730: 1989	Steel plates, sheets, strips and flats for structural and general engineering purposes – Dimensions (*second revision*)
1732:1989	Steel bars, round and square for structural and general engineering purposes – Dimensions *(second revision)*
1757(Part 1): 2020/ ISO 148-1: 2016	Metallic materials – Charpy pendulum impact test Part 1 Test method (*fourth revision*)
1852:1985	Specification for rolling and cutting tolerances for hot rolled steel Products (*fourth revision*)
1863:1979	Specification for rolled steel bulb flats (*first revision*)
1956 (various parts)	Glossary of terms relating to iron and steel (*second revision*)
2314:1986	Specification for steel sheet piling sections (*first revision*)
3803 (Part 1): 1989	Steel – Conversion of elongation values: Part 1 Carbon and low alloy steels (*second revision*)
3954:1991	Hot rolled steel channel sections for general engineering purposes – Dimensions (*first revision*)
4923:2017	Hollow steel sections for structural use – Specification (*third revision*)
8910: 2022/ ISO 404: 2013	General technical delivery requirements for steel and steel products (*second revision*)
12779: 1989	Rolling and cutting tolerances for hot rolled parallel flange beam and column sections
10842 (Part 2): 2019	Destructive Tests on Welds in Metallic Materials - Cold Cracking Tests for Weldments — Arc Welding Processes part 2 self-Restraint Tests (*first revision*)
IS 4225:2022/ ISO 17557:2016	Steel — Ultrasonic Testing of Steel Flat Products of Thickness Equal to or Greater than 6 mm
IS/ISO 16160: 2012	Hot-rolled steel sheet products — Dimensional and shape tolerances (*first revision*)
IS/ISO 16162: 2012	Cold-rolled steel sheet products — Dimensional and shape tolerances (*first revision*)
IS 4748:2021/ ISO 643:2019	Steels - Micrographic determination of the apparent grain size

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 1956 and the following definitions shall apply.

3.1 As-rolled - Delivery condition without any special rolling i.e. Conventional hot rolling without any normalized rolling or thermos-mechanical rolling and/or heat treatment like normalizing or quenching.

3.2 Normalizing Rolling – A hot rolling process in which the final deformation is carried out within a certain temperature range equivalent to normalizing temperature, leading to a material condition equivalent to that obtained after normalizing, such that the specified mechanical properties would still be met in the event of any subsequent normalizing.

NOTE In international publications for both the normalizing rolling, as well as the thermo-mechanical rolling, the expression "controlled rolling" may be found. However, in view of the different applicability of the products a distinction of the terms is necessary.

3.3 Normalized– Produced by heating to a suitable temperature above the transformation range (austenitizing) followed by air cooling.

3.4 Thermo-Mechanical Rolling –A hot rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition with certain properties that cannot be achieved or repeated by heat treatment alone.

Note: The term "Thermo-Mechanical Control Process" can also be used.
NOTE 1 Subsequent heating above 580 °C may lower the strength values.
NOTE 2 Thermo-mechanical rolling can include processes with an increasing cooling rate with or without tempering including self-tempering but excluding direct quenching and quenching and tempering.
NOTE 3 In some publications the word TMCP (Thermo-mechanical Control Process) is also used.

3.5 Steel with improved atmospheric corrosion resistance (Weather resistance steels) –
Steel in which a certain number of alloying elements, such as P, Cu, Cr, Ni, etc., have intentionally been added in order to increase its resistance to atmospheric corrosion, by forming an auto-protective oxide layer on the base metal under the influence of weather conditions; these steels are commonly known as "weathering steels"

4 SUPPLY OF MATERIALS

General requirements relating to the supply of material shall conform to IS 8910.

5 DESIGNATION AND GRADES

5.1 Weathering Steels covered by this standard shall be designated by their yield strength.
This standard specifies
- 19 steel grades are covered in Table 1A, 3A, 4 and 5 for hot rolled steel (designated by ISH) and
- 2 steel grades are covered in Table 1B, 3B and 4 for cold rolled steel (designated by ISC).

Grades are subdivided into classes WR and WP which differ primarily in their phosphorus contents; grades ISH365 and ISH460 are subdivided into classes WR1 and WR2 which differ primarily in alloying element requirements for Si, Cr, Cu, and Ni (see Table 1A).
Class WR denotes weathering steel has an improved atmospheric corrosion resistance; class WP denotes weathering steel with higher levels of phosphorus.

Each grade is available in up to four (4) qualities. These grades and qualities differ in their specified mechanical properties and impact energy requirements. The qualities on basis of impact energy requirements are as follows:

— Quality A: no impact testing
— Quality BR: impact testing at +20 °C
— Quality B0: impact testing at 0 °C
— Quality C and C1: impact testing at –20 °C

NOTE Quality C1 specifies a higher minimum impact energy than C.

5.2 Application

Class A steels satisfy only moderate loading conditions (Applicable to ISH355WP).

Class B steels are intended for use in welded structures or structural parts, subjected to normal loading conditions (Applicable to ISH235WR, ISH245WR and ISH365WR1).

Class C steels are to be used in cases where, owing to loading conditions and the general design of the structure, some resistance to brittle fracture is necessary (Applicable to ISH355WR).

Class D steels are to be used for structures or structural parts where, owing to loading conditions and the general design of the structure, a high resistance to brittle fracture is necessary (Applicable to ISH235WR, ISH245WR, ISH355WR, ISH355WP and ISH365WR1).

5.3 Basis for order

While placing an order for the purchase of material covered by this standard, the purchaser should specify the following:

a) Designation (Grade and Quality for Hot rolled steel. Grade for Cold rolled steel);
b) Product Form (plate, section, bar, sheet or strip);
c) Quantity (mass or number);
d) Nominal dimensions - thickness, width and length (for cut lengths);
e) Condition;
f) Quality (A, BR, B0 and C or C1)

6 MANUFACTURE

6.1 The manufacturing process of the steel is left to the discretion of the manufacturer or as per agreement between manufacturer and purchaser. If required, secondary refining in the form of ladle refining, vacuum degassing may follow steel making.

6.2 The method of deoxidation are designated as follows:
— FN - Rimming steel not permitted. This Option is applicable to Qualities A, BR and B0;
— FF - Fully killed steel containing nitrogen binding elements in amounts sufficient to bind the available nitrogen (for example, minimum 0.020% total aluminium). The usual guideline is minimum aluminium to nitrogen ratio of 2:1, when no other nitrogen binding elements are present. This Option shall be applicable to Qualities C & C1. On mutual agreement Qualities A, BR and B0 can be used this option.

6.3 The products may be rolled and supplied in as-rolled or normalized or normalizing rolling or controlled rolling or thermo-mechanical rolling and accelerated cooling conditions as per the agreement between the purchaser and the manufacturer/supplier.

6.4 The manufacturer can supply sheets, plates and sections either in hot rolled and if required in as skin passed or cold rolled and annealed condition only or hot rolled followed by cold finishing or cold rolled and annealed. In case of cold rolled finished supply, there shall, however, be no adverse effects on the properties of the product. The manufacturing process adopted for cold rolling/finishing shall be furnished by the supplier.

6.5 Hot rolled sheets and strips shall be descaled if so requested by the purchaser, using either acid pickling or shot blasting. Hot rolled and cold rolled Steel sheets and strips which have been descaled by acid pickling or shot blasting shall be oiled, if so requested by the purchaser.

6.6 Surface condition

Oxide or scale in hot-rolled steel sheet is subject to variations in thickness, adherence and colour. Removal of the oxide or scale by pickling or blast cleaning may disclose surface imperfections not readily visible prior to this operation.

6.7 Oiling

As a deterrent to rusting, a coating of oil is usually applied to hot-rolled, descaled steel sheet, but sheet may be furnished unoiled, if required. The oil is not intended as a forming lubricant and shall be easily removable with degreasing chemicals. When requested, the manufacturer shall advise the purchaser which type of oil has been used.

6.8 Corrosion resistance

The resistance of these steels to atmospheric corrosion is due to the formation of a protective oxide layer. The formation of this protective layer depends not only on chemical composition, such as the distinctive differences between the analyses of the various grades, but also on a number of factors such as surrounding atmosphere, design, etc., over which the steel producer has no control. See Annexes B and C for information on estimating the corrosion resistance and cautions concerning the use of these steels.

7 CHEMICAL COMPOSITION

7.1 Ladle Analysis

The ladle analysis or heat analysis of the steel, when carried out by the method specified in the relevant parts of IS 228 or any other established instrumental/chemical method, shall conform to the requirements as given in Table 1A and Table 1B. This analysis shall be made from a test sample, preferably taken during casting/teeming of the heat. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the purchaser and the manufacturer/supplier. The ladle analysis shall be reported in the test certificate.

The ladle analysis shall be determined once per cast.

7.2 Product Analysis

The permissible variation in the case of product analysis from the limits specified in Table 1A and Table 1B shall be as given in Table 2.

7.2.1 If a product analysis has been agreed upon at the time of enquiry and order, the purchaser shall specify the frequency if not once per cast. The product analysis shall be carried out on the finished product from the standard position.

7.3 Carbon equivalent value (CEV)

Steel grades specified are of weldable quality. If agreed to between the manufacturer/supplier and the purchaser, the weather resistant steel up to and including 50 mm thick plates,

- for steel grade ISH235WR, a maximum carbon equivalent value of 0.44 %, and
- for steel grade ISH355WR, a maximum carbon equivalent value of 0.54 % based on heat analysis shall apply.

For other grades CEV may be mutually agreed between purchaser and supplier. The carbon equivalent value can be calculated using the formula:

$$\text{Carbon equivalent value (CEV)} = C + \frac{Mn}{6} + \frac{(Cr+Mo+V)}{5} + \frac{(Ni+Cu)}{15}$$

7.3.1 If the weather resistant steels are to be used unpainted, it is advisable to select the welding electrodes with matching weathering characteristics.

7.3.2 Lower limits for carbon equivalent values may be agreed to between the contracting parties.

7.3.3 Weldability

The steels specified in this document do not have unlimited suitability for the various welding processes, since the behavior of a steel during and after welding depends not only on the material but also on the dimensions and shape and on the manufacturing and service conditions of the components.

If filler metal without improved atmospheric corrosion resistance is used ensure that the weld itself is weather resistant.
Before welding, any surface layer which has already been formed should be removed to a distance of 10 mm to 20 mm from the joint edges.

General requirements for arc welding of the steels specified in this document shall be as given in IS 10842 part2.

For Grade ISH340WP and ISC300WP - The Plates and sections shall be suitable for gas and metal arc welding. The Sheets shall be suitable for gas and metal arc welding as well as suitable for spot and seam welding processes. Special precautions should be taken when welding steel grades of class WP with a high phosphorus content.

NOTE
1) With increasing product thickness and strength level cold cracking can occur. Cold cracking is caused by the following factors in combination:
— The amount of diffusible hydrogen in the weld metal;
— A brittle structure of the heat affected zone;
— Significant tensile stress concentrations in the welded joint.
2) Special precaution should be taken when welding grades ISH245WP, ISH340WP, ISH355WP, ISH360WP, ISC300WP and ISC315WP with a high phosphorous content.
3) In case of assembling by riveting and bolting, precautions should be taken with regard to the choice of rivets and bolts to be used for assemblies in order to prevent the start of the corrosion process.

Table 1A Chemical Composition for Hot Rolled Steel

(*Clauses 5.1, 7.1 and 7.2*)

Designation		Ladle Analysis, Percent, Max											
Grade	Quality	C	Si	Mn	P [b]	S [b]	N	Addition of "N" binding elements [c]	Cr	Cu	Ni	V	Others
ISH235WR	B0 C	0.13	0.40	0.20-0.60	0.035	0.035 0.030	0.009 [d, e] -	- Yes	0.40-0.80	0.25-0.55	0.65	-	
ISH245WR	A, BR, B0	0.18	0.15-0.65	1.25	0.035	0.035	-	Yes	0.45-0.75	0.30-0.50	0.05-0.30	-	
ISH245WP	A	0.15	0.10 min	0.55	0.06-0.16	0.040	-	-	0.24-1.31	0.20-0.60	0.20-0.70	-	
ISH310WR	A	0.22	-	1.25	-	0.040	-	-	-	0.20 min	0.65	-	
ISH340WP [h]	A	0.10	0.28-0.72	0.25-0.45	0.075-0.14	0.030	-	-	0.35-0.60	0.30-0.60	0.20-0.47	0.05	Mo-0.05, Nb-0.04, Al-0.08
ISH345WR	BR	0.23	0.40	0.50-1.60	0.035	0.045	-	-	0.35	0.60	0.45	0.15	Mo-0.15, Nb-0.05
ISH355WR [g]	A, BR, B0 C, C1	0.19 0.16	0.15-0.50	0.50-1.50	0.035 0.030	0.035 0.030	0.009 [d, e] -	- Yes	0.40-0.80	0.25-0.55	0.65	0.10	Mo-0.30, Zr-0.15
ISH355WP [g]	B0 C	0.12	0.20-0.75	0.60 [f]	0.070-0.15	0.035 0.030	0.009 [e]	- Yes	0.30-1.25	0.25-0.55	0.65	-	
ISH360WP [g]	C	0.17	0.40	1.0	0.07-0.10	0.050	-	-	0.70-1.0	0.25-0.55	0.65	0.10	
ISH365WR1	A, BR, B0	0.18	0.15-0.65	1.40	0.035	0.035	-	Yes	0.45-0.75	0.30-0.50	0.05-0.30	-	
ISH365WR2	A, BR, B0	0.18	0.55	1.40	0.035	0.035	-	Yes	0.30-0.55	0.20-0.35	-	-	
ISH400WR	BR	0.15	0.15-0.55	2.00	0.020	0.006	0.006	Yes	0.45-0.75	0.30-0.50	0.05-0.30		
ISH415WR	B0, C, C1	0.20	0.15-0.50	0.50-1.35	0.040	0.050	-	Yes	0.30-0.70	0.20-0.50	0.50	0.01-0.10	Mo-0.10, Nb-0.05
ISH450WR	B0, C, C1	0.20	0.15-0.50	0.50-1.35	0.040	0.050	-	Yes	0.30-0.70	0.20-0.50	0.50	0.01-0.10	Mo-0.10, Nb-0.05
ISH460WR1	B0	0.18	0.15-0.65	1.40	0.035	0.035	-	Yes	0.45-0.75	0.30-0.50	0.05-0.30	-	
ISH460WR2	B0	0.18	0.55	1.40	0.035	0.035	-	Yes	0.30-0.55	0.20-0.35	-	-	
ISH500WR	B0	0.11	0.15-0.55	2.0	0.020	0.006	0.006	Yes	0.45-0.75	0.30-0.50	0.05-0.30	-	
ISH600WR	BR, B0	0.11	0.15-0.55	2.0	0.020	0.006	0.006	Yes	0.45-0.75	0.30-0.50	0.05-0.30	0.05	Mo-0.30, Nb-0.05
ISH700WR	C	0.11	0.15-0.55	2.0	0.015	0.006	0.006	Yes	0.45-1.20	0.30-1.50	0.05-2.0	0.05	Mo-0.60, B-0.005

Notes

a) When the steel is killed by aluminium the total aluminium content should not be less than 0.02 percent. When steel is silicon killed the silicon content shall not be less than 0.1 percent. When the steel is aluminium silicon killed the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent. (see 6.2 for killing options).

b) For long products, the P and S content can be 0,005% higher.

c) The steel shall contain at least one of the following elements: At total ≥0.020 %, Nb: 0.015 % to 0.060 %, V: 0.02 % to 0.15%, Ti: 0.02 % to 0.10 %. If these elements are used in combination, at least one of them shall be present with the minimum content indicated.

d) It is permissible to exceed the specified values provided that for each increase of 0,001 % N, the maximum P content shall be reduced by 0,005 %; the N content of the ladle analysis, however, shall not be more than 0,012 %.
e) The maximum value for nitrogen does not apply if the chemical composition shows a minimum total A1 content of 0,020 %, or if sufficient, other N binding elements are present. The N binding elements shall be mentioned in the inspection document.
f) The upper limit of Mn may be 1.0% *Max* by agreement between the purchaser and the supplier.
g) Chemical composition for thicknesses over 16 mm is subject to agreement between the manufacturer and the purchaser.
h) Total incidental elements shall be 0.15 max
i) Any element other than those listed in this table, which is added intentionally, shall be indicated to the purchaser.
j) Restricted chemistry can be agreed mutually between purchaser and supplier.

Table 1B Chemical Composition for Cold Rolled Steel

(*Clauses 5.1, 7.1 and 7.2*)

Designation	Ladle Analysis, Percent, Max										
Grade	C	Si	Mn	P	S	N	Cr	Cu	Ni	V	Others
ISC300WP	0.10	0.28-0.72	0.25-0.45	0.075-0.14	0.030	-	0.35-0.60	0.30-0.60	0.20-0.47	0.05	Mo-0.05, Nb-0.04, Al-0.08
ISC315WP	0.12	0.20-0.75	0.60	0.070-0.15	0.035	0.009	0.30-1.25	0.25-0.55	0.65	-	

Table 2 Permissible Variation for Product Analysis

(*Clause 7.2*)

Element	Range of specified element, %	Permissible Variation Over/Under the Specified Limit, % max
Carbon	≤0.15	0.03 [b]
	>0.15≤0.22	0.04
Silicon	≤0.80	0.06 [b]
Manganese	≤ 2.00	0.10 [b]
Phosphorus	≤ 0.04	0.01 [b]
	Over 0.04 to 0.15	[a]
Sulfur	≤ 0.05	0.01 [b]
Vanadium	≤0.10	0.01
	>0.10≤0.25	0.02
Niobium	≤ 0.06	0.01
Titanium	≤ 0.15	0.01
Copper	≤ 1.00	0.03
	Over 1.00 to 1.20	0.05
Nickel	≤ 1.00	0.03
	>1.00≤1.50	0.05
Chromium	≤0.90	0.04
	>0.90≤ 2.00	0.06
Molybdenum	≤0.20	0.01
	>0.20≤0.40	0.03
	>0.40≤0.65	0.04
Nitrogen	≤ 0,030	0,005
Boron	≤ 0.006	0.001

a) Product analysis not applicable.
b) For ISH340WP - Carbon: Permissible Variation Over the Specified Limit, 0.02 % max.
- Manganese: Permissible Variation Over/Under the Specified Limit, 0.05 % max.
- Silicon: Permissible Variation Over/Under the Specified Limit, 0.03 % max.
- Sulfur: Permissible Variation Over/Under the Specified Limit, 0.005 % max.
- Phosphorus: Permissible Variation Over/Under the Specified Limit, 0.005 % max.

8. SELECTION AND PREPARATION OF TEST SAMPLES

8.1 The position from which test samples are taken shall be so located in the product as to yield the clearest possible information regarding properties in the cross-sectional and longitudinal planes. The recommended locations for taking test samples for plates, sheets, strips, sections, flats, bars and rods are indicated in Fig. 1. Selection of location of test pieces may also be mutually agreed to between the purchaser and the manufacturer/supplier.
The sampling position of test piece shall be at a quarter-width from the edge of the sheet, strip and plate. If this is infeasible, the sampling should be made as close to the aforementioned position as possible. Tensile and bend test piece direction shall be as per below table.

Class of Steel Product	***Direction of Test Piece***
Plates, Sheets and Strips	Crosswise (Transverse)
Sections	Lengthwise for each type
Flats, bars (round hexagonal, etc) and rods	Lengthwise

Alternative test piece direction may also be mutually agreed to between the purchaser and the manufacturer/supplier.

8.2 Wherever practicable, the rolled surface of the steel shall be retained on the two opposite sides of the test samples.

8.3 In case of flat test samples for tensile test, both surfaces are normally to be left on the test specimen for sheets, strips, and plate up to 32 mm thick. At least one rolled surface shall be left on rectangular test samples taken from plate more than 32 mm thick. Round test samples are permitted, but should only be adopted for thickness exceeding 20 mm.

8.4 In case of flats up to 16 mm thick, the test sample shall undergo, if possible, no machining whatsoever prior to use as a test piece. If this is not possible, the test sample shall undergo the minimum amount of machining.

8.5 Bars below 28mm and rods shall be tested without machining. In case of bars having diameters or thicknesses between 28 and 71 mm, the bars may be symmetrically reduced by machining. For bars having diameters or thicknesses exceeding 71 mm, the test sample may be taken from the position shown in Fig. 1.

8.6 In the case of plates, sheets, strips, sections, flats, and bars, bend tests are to be carried out on rectangular test samples which, as far as possible, should be of the full thickness of the product. In the case of sections, flats and plates exceeding 28 mm in thickness, it is permissible to remove metal from one side of the test sample before using it as a test piece. The rolled surface of the test piece shall be on the outer side of the bend during the test.

8.7 Test samples shall be cut in such a manner that deformation is avoided as far as possible. If shearing or flame-cutting is employed, an adequate allowance shall be left for removal by machining.

8.8 Test samples taken from rolled steel which have undergone deformation through bending or twisting-shall in all cases be straightened cold. If the deformation is too severe to allow cold straightening, it is permissible in the case of materials to be delivered in the annealed or normalized condition, to carry out straightening under the application of heat, provided the temperature does not exceed 650°C. While straightening test samples, care shall be taken to avoid any cold-working or temperature rise which will alter the properties of the samples as compared with the finished product which they represent.

8.9 Test samples shall not be subjected to heat treatment unless the material from which they are cut is similarly and simultaneously treated with the material before testing. Any slight straightening of test samples which may be required shall be done cold.

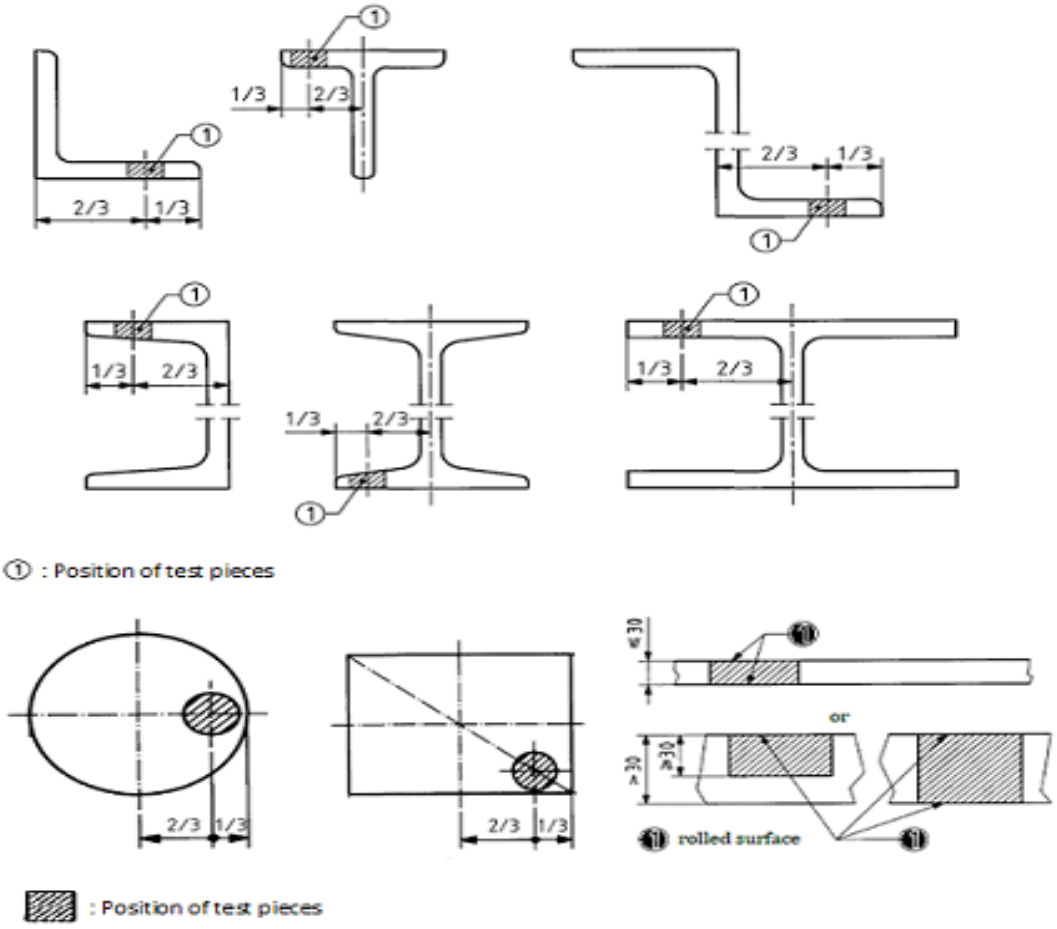


FIG. 1 STRUCTURAL STEEL SECTIONS, POSITION AND ORIENTATION OF SAMPLE

9 MECHANICAL PROPERTIES

9.1 Tensile Test

Yield strength, tensile strength and percentage elongation, when determined in accordance with IS 1608 (Part 1), shall conform to the requirements as given in Table 3A and Table 3B.

For the specified yield strength, the upper yield strength (*R*eH) shall be determined.
If a yield phenomenon is not present, the 0.2% proof strength (*R*p 0.2) shall be determined.

9.1.1 In case of sections, the thickness of which is not uniform throughout the profile, the limits of sizes given in Table 3A shall be applied according to the actual maximum thickness of the piece adopted for testing.

9.1.2 Should a tensile test piece break outside the middle half of the gauge length (*see* IS 1608 (Part 1)) and the percentage elongation obtained is less than that specified, the test may be discarded at the manufacturer/supplier's option and another test made from the sample sheet, plate, strip, section, flat, bar or rod.

9.1.3 Number of Tensile Tests

Hot rolled steel - Number of test samples shall be 2 from each cast/heat and same form, grade, quality and delivery condition irrespective of cast/heat size.

Cold-rolled steel - Take one tensile from each lot of steel sheets/strips of the same heat, the same thickness, the same rolling condition. If the lot exceeds 50 t in mass, take additional tensile test pieces for every 50t.

9.1.4 Tensile Test Pieces

The tensile strength, yield strength and percentage elongation of steel shall be determined from standard test pieces. The test shall be carried out as on the standard test pieces prepared in accordance with IS 1608 (Part 1).

9.1.4.1 Test pieces with a non-proportional gauge length, other than $5.65\sqrt{S_o}$ may be used in which case the elongation values shall be converted to $5.65\sqrt{S_o}$ in accordance with IS 3803 (Part 1).

9.2 BENDTEST

Bend test shall be conducted in accordance with IS 1599.

For bend test, the test piece at room temperature shall withstand bend through 180° to an internal diameter not greater than that given in Table 4 without cracking.

For grade ISC315WP, bend test is optional and shall be performed only when specified by the purchaser. For this the bend test piece shall be 15 mm to 50 mm in width, and have an appropriate length which is about twice the width. The test piece shall be bent manually with a vise through 180° along the length direction of the test piece as shown in Fig. 2 with an internal spacing of 1*t*. If bending with a vise is not possible, other suitable means of bending may be used.

9.2.1 Number of Bend Test

Hot rolled steel - Number of test samples shall be 2 from each cast/heat and same form, grade, quality and delivery condition irrespective of cast/heat size.

Cold-rolled steel - Take one sample from each lot of steel sheets/strips of the same heat, the same thickness, the same rolling condition. If the lot exceeds 50 t in mass, take additional tensile test pieces for every 50t.

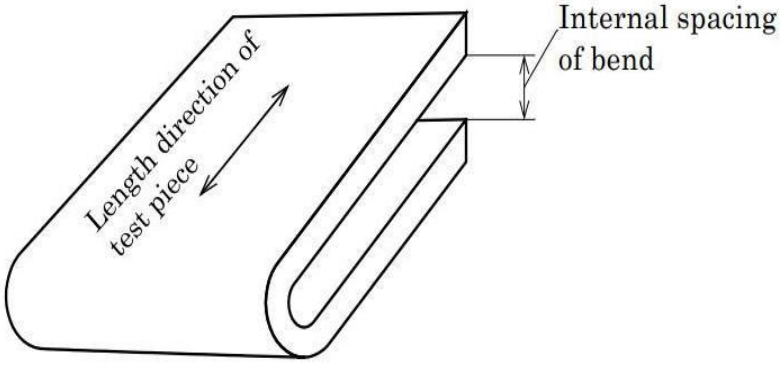


FIG. 2 DIRECTION OF BEND TEST

9.2.2 Bend Test Pieces

When sections permit, these shall be not less than 40 mm wide. If the manufacturer/supplier so desires, round, square, hexagonal and flat bars and structural sections shall be bent in the full section as rolled.

9.2.2.1 In all bend test pieces, the rough edges arising as a result of shearing may be removed by filing or grinding or machining, but the test pieces shall receive no other preparation.

9.2.2.2 The test pieces shall not be annealed or otherwise subjected to heat treatment unless the material from which they are cut is similarly treated, in which case the test pieces shall be similarly treated with the material, before testing.

9.3 IMPACT TEST

9.3.1 The impact test on V notched test pieces shall be carried out in accordance with IS 1757-1. The impact properties of Charpy V-notch test pieces shall comply with the values specified in Table 5. The orientation of the specimens shall be longitudinal unless transverse orientation is agreed between purchaser and manufacturer.
The impact properties of steel grade ISH class WP are verified only when specified at the time of the order.
For grades with quality C and C1 contained in Table 5 with nominal thickness <6 mm, the ferritic grain size shall be ≥ 6, verified by the method as described in IS 4748, if specified at the time of the order.

9.3.2 Impact test shall normally be carried out on products having thickness/diameter greater than or equal to 12 mm. For nominal thicknesses $12 < t < 40$ mm, standard 10 mm x 10 mm test pieces shall be machined in such a way that one side is not further away than 2 mm from a rolled surface, for nominal thicknesses ≥ 40 mm impact test pieces shall be taken from 1/4*t* position. The notch axis shall be perpendicular to the rolled surface.

9.3.3 In the case of nominal product thickness 6 mm ≤ t ≤ 12 mm, sub-sized test pieces shall be machined. The largest possible standard sub-sized test piece (7.5 mm or 5.0 mm) shall be used. The notch shall be perpendicular to the surface of the product. Where sub-sized test pieces are used, the minimum impact energy values given in Table 5 shall be reduced in proportion to the cross-sectional area of the test piece.

9.3.4 Impact tests shall not be required for nominal thickness t < 6 mm.

9.3.5 The test sample shall be taken from the thickest product. One test sample shall be taken from thickest product per cast/heat. If the test sample taken from the thickest product rolled from a cast meets the requirements, the whole cast shall be deemed to meet the requirements of the test, if not, the test shall be performed on a product of next lower thickness rolled from same cast, if it meets the requirements specified, this particular thickness as also other sections of lower thickness shall be deemed to satisfy this specification. If this thickness also does not meet the requirements, the test shall be carried out on the next lower thickness and so on, because the toughness of the product will be dependent on the rolling direction as well as on the product size.

9.3.6 The minimum impact values given in Table-5 apply for the mean of three test pieces. One individual value may be lower than the specified value, provided that it is not less than 70 % of the specified value.

Three additional test pieces shall be taken from the same sample in accordance with 9.3.5 and tested in any one of the following cases:

— if the average of three impact values is lower than the minimum average value specified;

— if the average value meets the specified requirement, but two individual values are lower than the minimum average value specified;

— if any one value is lower than 70 % of the minimum average value specified.

The average value of the six tests shall be not less than the minimum average value specified. Not more than two of the individual values may be lower than the minimum average value specified and not more than one may be lower than 70 % of this value.

9.3.7 Impact test at different temperatures and grades other than specified in Table 5 may be mutually agreed between the purchaser and the manufacturer/supplier accordingly the impact test values may be mutually agreed between the purchaser and the manufacturer/supplier.

10 FLATTENING TEST

10.1 Flattening test shall be carried out for circular hollow section if specified at the time of enquiry or order. If agreed upon between the manufacturer/supplier and the purchaser, this test may also be carried out on rectangular hollow sections.

10.2 A ring not less than 40 mm in length shall be cut for every 40 tonnes or part thereof and the inner and outer edges of the ring shall be rounded off.

10.3 The ring shall be flattened cold between the parallel plates with the weld, if any, at 45° in accordance with IS 2328. No opening shall occur by fracture in the weld until the distance between the plates is less than 75 percent of the original outside diameter. The test shall continue until the weld, if any, opens and the weld shall show no sign of incomplete fusion. No crack or breakage in the metal elsewhere than the weld shall occur until the distance between the plates is 2/3 of the original outside diameter.

Table 3A – Tensile properties at room temperature for hot rolled steel

(*Clauses 5.1, 9.1 and 9.1.1*)

Grade	Quality	**Minimum yield strength, R_{eH}[a]** MPa						**Minimum Tensile strength, R_m[a] MPa**			**Position of test pieces [a]**	**Minimum percentage elongation after fracture [a, b], %** Nominal thickness [d], mm								
		Nominal thickness [d], mm						Nominal thickness [d], mm				L_0 = 50mm	L_0 = 200mm	L_o = 80 mm			L_o = 5.65 $\sqrt{S_o}$			
		≤16	> 16 ≤ 40	> 40 ≤ 63	> 63 ≤ 100	> 100 ≤ 150	> 150 ≤ 200	< 3	≥ 3 ≤ 100	>100 ≤150				>1.5 ≤ 2.0	> 2.0 ≤ 2.5	> 2.5 < 3.0	≥ 3 ≤ 40	> 40 ≤ 63	> 63 ≤ 100	> 100 ≤150
ISH235WR	B0, C	235	225	215	215	195	-	360-510	360-510	350-500	l t	-	-	19 17	20 18	21 19	26 24	25 23	24 22	22 22
ISH245WR	A, BR,B0	245	235	215	215	205 t>125 : 195	195	410-540	410-540	410-540[h]	t	23	17	-	-	-	18[i]	18	18	18
ISH245WP	A	245	235	-	-	-	-	410	410	-	t	25	-	-	-	-	-	-	-	-
ISH310WR	A	310	300	-	-	-	-	450	450	-	l	22	-	-	-	-	-	-	-	-
ISH340WP	A	t≤12.5 : 340	-	-	-	-	-	480 min	t≤12.5: 480 min	-	t	-	-	-	-	-	t≤12.5: 22 [i]	-	-	-
ISH345WR	A, BR	345	345	345	345	-	-	450	450	-	t	21	18	-	-	-	-	-	-	-
ISH355WR	B0, C, C1	355	345	335	325 t>80: 315	295	-	510-680	470-630	450-600	l t	-	-	16 14	17 15	18 16	22 20	21 19	20 18	18 18
ISH355WP	B0, C	355	345	-	-	-	-	490[e]	t≤16: 490 t>16: 470-630[f]	-	l t	- t≤6: 22	- 6<t≤16: 15	16 14	17 15	18 16	22[f] 20[g]	- -	- -	- -
ISH360WP	C	t≤12: 355	-	-	-	-	-	500	t≤12: 500	-	t	-	-	-	-	-	t ≤12:20 [i]	-	-	-
ISH365WR 1	A, BR, B0	365	355	335	325	305 t>125 : 295	295	490-610	490-610	490-610 [h]	t	21	15	-	-	-	17 [i]	17	17	17
ISH365WR 2	A, BR, B0	365	355	335	325	305 t>125 : 295	295	490-610	490-610	490-610 [h]	t	21	15	-	-	-	17 [i]	17	17	17
ISH400WR	BR	400	400	400	400	-	-	490-640	490-640	-	t	21	15	-	-	-	17 [i]	17	17	-
ISH415WR	B0, C, C1	415	415	390	-	-	-	520	t≤40: 520	-	l t	- 15	- 13	15 13	15 13	15 13	19 17	18 16	- -	- -
ISH450WR	B0, C, C1	450	450	430	-	-	-	550	t≤40: 550	-	l t	- 14	- 12	14 12	14 12	14 12	17 15	16 14	- -	- -

ISH460WR 1	B0	460	450	430	420	-	-	570-720	570-720	-	t	20	-	-	-	-	16 [i]	16	16	-
ISH460WR 2	B0	460	450	430	420	-	-	570-720	570-720	-	t	20	-	-	-	-	16 [i]	16	16	-
ISH500WR	B0	500	500	500	500	-	-	570-720	570-720	-	t	20	-	-	-	-	16 [i]	16	16	-
ISH600WR	BR, B0	600	600	600	600	-	-	700	690	-	t	16	-	-	-	-	14 [i]	14	14	-
ISH700WR	C	700	700	700	-	-	-	780-930	t≤63: 780-930	-	t	16	-	-	-	-	14 [i]	14	-	-

Notes

1 MPa = 1 N/mm2.

a) For plate and wide flats with widths ≥ 600 mm, the direction transverse (t) to the rolling direction applies. For all other products, the values apply for the direction parallel (l) to the rolling direction.

b) For thicknesses up to 3 mm, use either L_o = 50 mm or L_o = 80 mm. For thicknesses of 3 mm inclusive to 6 mm inclusive, use $L_o = 5.65\sqrt{S_o}$, or L_o = 50 mm. For thickness over 6 mm, use $L_o = 5.65\sqrt{S_o}$ or L_o = 200 mm. In case of dispute, however, only the results obtained on a proportional test piece will be valid for material 3 mm and over in thickness. Unless specified on the order, the manufacturer may use either a proportional or fixed gage length specimen. When the test value is reported, the specimen used shall be reported.

c) For plate, applicable up to 12 mm; for wide flats, bars, and sections, applicable up to 40 mm.

d) Manufacturer should be contacted for possible thickness limits (*see clause 1.4*).

e) For ISH355WP steel sheet and strip of under 3 mm in thickness, the tensile strength of 510 N/mm2 or over is applicable by agreement between the purchaser and the manufacturer.

f) For plate, applicable up to 12 mm; for wide flats, bars, and sections, applicable up to 40 mm.

g) For ISH355WP grade, minimum Elongation 21% agreement between the purchaser and the manufacturer. In this case Yield Strength shall be 345Mpa minimum for t≤12mm, 325Mpa minimum for t 12-40mm and Tensile strength shall be 480Mpa minimum for t≤40mm.

h) The given tensile strength values shall be applicable up to 200mm thickness also.

i) The given elongation values shall be applicable for thickness <3mm also.

Table 3B – Tensile properties at room temperature for cold rolled steel
(*Clauses 5.1 and 9.1*)

Grade	**Yield Strength**, R_{eH}, Min MPa[5)]	**Tensile Strength** R_m, Min MPa[5)]	**Percentage Elongation** At Gauge Length 5.65√So, Min	**Percentage Elongation** At Gauge Length 50mm, Min
ISC300WP	300	440	26	-
ISC315WP*	315	450	-	26[a]

Notes

1 MPa = 1 N/mm2.
* Applicable thickness 0.6 to 2.3mm
a) Other values may also be applied subject to mutual agreement between manufacturer and purchaser.

Table 4 – Bend test
(*Clauses 5.1 and 9.2*)

Grade	**Internal Bend Diameter**, Max Nominal thickness, mm	**Inside Radius**, Max Nominal thickness, mm	
	t≤25	t≤6	t>6-16
ISC300WP	1t	-	-
ISC315WP	1t	-	-
ISH310WR	-	2.5t [c]	-
ISH340WP	t≤12.7: 1t	-	-
ISH355WR	3t [a]	-	-
ISH355WP	3t [a]	0.5t [b]	1.5t
ISH360WP	3t [a]	-	-

Notes
't' is the thickness/diameter of the test piece
a) Round bars 25 mm and under internal bend diameter shall be 2t. Round bars >25 mm internal bend diameter shall be 3t.
b) For ISH355WP steel sheet and strip of 6.0 mm or under in thickness, the inside radius of 1.0 times the thickness is applicable by agreement between the purchaser and the manufacturer.
c) On agreement the suggested radii should be used as minimums for 90° bends in actual shop practice

11 INTERNAL SOUNDNESS

Ultrasonic testing may be agreed upon at the time of the order. If specified at the time of the order, ultrasonic testing shall be carried out for flat products in nominal thicknesses ≥ 6 mm, except for hot rolled strip and plate cut from strip in accordance with IS 4225.
For sections and bars, test methods and acceptance criteria may be mutually agreed between the purchaser and the manufacturer/supplier.

12 RETEST

12.1 If a test does not give the specified results, two additional tests shall be carried out at random on the same lot. Both retests shall conform to the requirements of this standard; otherwise, the lot shall be rejected.

12.2 Re-heat Treatment

If any heat treated material fails to meet the mechanical requirements specified, the supplier may re-heat treat the material and in that case, all mechanical properties shall be re-evaluated.

Table 5—Longitudinal Charpy V-notch properties [a]
(*Clauses 5.1, 9.3.1, 9.3.3, 9.3.6 and 9.3.7*)

Designation		Minimum impact energy, J, at test temperature, °C			
Grade	**Quality**	**RT [b]**	**0**	**- 20**	**-30**
ISH235WR	B0	-	27	-	-
	C	-	-	27	-
ISH245WR	BR	27	-	-	-
	B0	-	27	-	-
	C	-	-	27	-
ISH345WR	BR	27	-	-	-
ISH355WR	B0	-	27	-	-
	C	-	-	27	-
	C1	-	-	40	27
ISH355WP	B0	-	27	-	-
	C	-	-	27	-
ISH360WP	C	-	-	27	-
ISH365WR1 ISH365WR2	BR	27	-	-	-
	B0	-	27	-	-
ISH400WR	BR	27	-	-	-
ISH415WR ISH450WR	B0	-	27	-	-
	C	-	-	20[c]	-
	C1	-	-	-	20[d]
ISH460WR1 ISH460WR2 ISH500WR	B0	-	27	-	-
ISH600WR	BR	27	-	-	-
	B0	-	27	-	-
ISH700WR	C	-	-	27	-

a) For nominal thicknesses ≤12mm, Where sub-sized test pieces are used (see 9.3.3), the minimum impact energy values given shall be reduced in proportion to the cross-sectional area of the test piece.
b) RT = Room Temperature
c) Thickness ≤12mm and 27J min can be agreed
d) Thickness >12mm and 27J min can be agreed

13 FREEDOM FROM DEFECTS

13.1 All finished steel shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/jagged and imperfect edges and all other harmful defects.

13.2 Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent but not exceeding 7 percent may be made subject to mutual agreement between the purchaser and the manufacturer/supplier.

13.2.1 Subject to agreement with the purchaser, surface defects which cannot be dealt with as in **13.2** may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that,

a) after complete removal of the defects and before welding, the thickness of the item is in no place reduced by more than 20 percent;

b) welding is carried out by approved procedure by competent operators with approved electrodes and that the welding is ground smooth to the correct nominal thickness; and

c) subsequent to the finish grinding, the item maybe required to be normalized or otherwise heat-treated at the purchaser's discretion.

14 DIMENSIONS AND TOLERANCES

14.1 Unless otherwise agreed to between the purchaser and the manufacturer, the nominal dimensions of rolled steel products conforming to this specification shall be in accordance with the relevant Indian Standards. Currently available Indian Standards are listed in Table 6.

Table 6 Indian Standards which give nominal dimensions of rolled steel products
(*Clause* 14.1)

Sl No	PRODUCT	RELEVANT INDIAN STANDARD
i)	Beam, column, channel and angle sections including parallel beam and column sections	IS 808
ii)	Tee bars	IS1173
iii)	Bulb angles	IS 1252
iv)	Plates, sheet and strip	IS 1730
v)	Flats	IS 1731
vi)	Round and square bars	IS 1732
vii)	Bulb flats	IS 1863
viii)	Sheet, piling sections	IS 2314
ix)	Channel sections	IS 3954
x)	Hollow sections	IS 4923

14.2 Unless otherwise agreed to between the purchaser and the manufacturer/supplier, the rolling and cutting tolerances for steel products conforming to this standard shall be those specified in IS 1852 or IS/ISO 16160 for hot rolled steel sheet, strip and sections, IS 12779 for Parallel beam and column section and IS/ISO 16162 for cold rolled sheet and strip. Other tolerances may be followed within the total tolerance range as specified in IS 1852, IS/ISO 16162 and IS 12779 as applicable.

15 CALCULATION OF MASS

Material shall be supplied on the basis of actual weight. If weighing is not possible, the mass of the steel shall be calculated on the basis of steel density 7.85 g/cm^3.

16 DELIVERY

Subject to prior agreement between the manufacturer and the purchaser, a suitable protective treatment may be given to the material after rolling.

16.1 Conditions of Delivery

The products covered by this specification are delivered in the as-rolled, normalized-rolled,

normalized and thermo-mechanical processed condition. Delivery condition shall be mutually agreed between the purchaser and the manufacturer/supplier.

17 MARKING AND PACKING

17.1 Plates, sheets, sections, bars and flats may be supplied in bundles, and strips and rods either in bundles or coils. Each bundle/coil shall carry a tag or label/sticker bearing the cast number or identification mark or lot number traceable to the cast number and the manufacturer‘s name or trade mark. Alternatively, top sheet/plate or strips in each bundle shall be legibly marked with the cast number or identification mark or lot number traceable to the cast number, name of the manufacturer or trade mark.

17.2 Unless otherwise agreed the packing shall be adequate to ship the material safely and in good condition.

17.3 BIS Certification Marking

The material may also be marked with Standard Mark.

17.3.1 The product (s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed there under, and the products may be marked with the Standard Mark.

ANNEX A
(Informative)
(Foreword)

Mapping of old Grade and new grade designation system is as follows:

S. No.	New Grade	Old Grade
1	ISH355WP	WR-Fe 480A and WR-Fe 490H
2	ISH355WR	WR-Fe 480B
3	ISH360WP	WR-Fe 500
4	ISC315WP	WR-Fe 490C

Mapping of Grades with possible other specifications for reference

BIS Grade	BIS 11587	IRSM 41/97	JIS 3125	ISO 630-5	ISO 5952	EN 10025-5	ASTM	
	Grade	Grade	Grade	Grade	Grade	Grade	Specification	Grade
ISH 235WR				S235W	HSA235W	S235J0W S235J2W		
ISH 245WR				SG245W1	HSA245W			
ISH 245WP							ASTM A423	Gr1
ISH310WR							ASTM A606	Type 2 & Type 4
ISH345 WR							ASTM A709	Gr50(345) & Gr50S
ISH 340WP		Grade1 & Grade2						
ISH355WR	WR-Fe480B			S355W	HSA355W2	S355J0W S355J2W S355K2W		
ISH355WP	WR-Fe480A WR-Fe490H		SPA-H	S355WP	HSA355W1			
ISH 360WP	WR-Fe500							
ISH 365WR1				SG365W1	HSA365W			
ISH 365WR2				SG365W2				
ISH400WR				SG400W				
ISH 415WR						S420J0W S420J2W	ASTM A871	Gr60
ISH 450WR						S460J0W S460J2W	ASTM A871	Gr65
ISH 460WR1				SG460W1				
ISH 460WR2				SG460W2				
ISH 500WR				SG500W				
ISH 600WR							ASTM A709	
ISH 700WR				SG700W				
ISC 300WP		Grade1						
ISC 315WP	WR-Fe490C		SPA-C				ASTM A606	Type 2

Annex B
(informative)
Guidelines for estimating the atmospheric corrosion resistance of low-alloy steels

B.1 General

This annex presents a method for estimating the atmospheric corrosion resistance of low-alloy weather-resistant steels from chemical composition data.

The method utilizes predictive formulae based on the steel composition to calculate indices of atmospheric corrosion resistance.

As many indices have been used around the world, it is necessary to consider the different environments and the chemical composition of the steel when choosing an index. As any index may be inappropriate based on the above, it is necessary for the purchaser and supplier to decide on the type of index to use and the requirement levels of that index for the expected environment.

B.2 Terminology

Low-alloy steels mean iron-carbon alloys containing greater than 1 % but less than 5 %, by mass, of total alloying elements.

NOTE Most “low-alloy weather-resistant steels” contain additions of both chromium and copper, and can also contain additions of silicon, nickel, phosphorus, or other alloying elements which enhance atmospheric corrosion resistance.

B.3 Procedure

B.3.1 Formulae for predicting the corrosion penetration of low-alloy steels after 15.5 years of exposure to various atmospheres, based on the chemical composition of the steel, were published by Legault and Leckie. The formulae are based on extensive data published by Larrabee and Coburn.

B.3.2 For use with these guidelines, the Legault-Leckie formula for an industrial atmosphere (Kearny, N.J., USA) was modified to allow calculation of an atmospheric corrosion resistance index based on chemical composition. The modification consisted of deletion of the constant and changing the signs of all the terms in the formula. The modified formula for calculation of the atmospheric corrosion resistance index (I) is given below. The higher the index, the more corrosion resistant is the steel.

$$I = 26.01\,(\%\,Cu) + 3.88\,(\%\,Ni) + 1.20\,(\%\,Cr) + 1.49\,(\%\,Si) + 17.28\,(\%\,P) - 7.29\,(\%\,Cu)\,(\%\,Ni) - 9.10\,(\%\,Ni)\,(\%\,P) - 33.39\,(\%\,Cu)^2$$

B.3.3 The predictive formula should be used only for steel compositions within the range of the original test materials in the Larrabee-Coburn data set. These limits are as follows:

— $0.012 \leq Cu \leq 0.51$
— $0.05 \leq Ni \leq 1.1$
— $0.10 \leq Cr \leq 1.3$
— $0.10 \leq Si \leq 0.64$
— $0.01 \leq P \leq 0.12$

B.3.4 The minimum acceptable atmospheric corrosion index should be a matter of negotiation between the manufacturer/supplier and the purchaser.

Annex C
(informative)
Additional information for the use of steel with improved atmospheric corrosion resistance

The corrosion-inhibiting effect of the auto-protective oxide layer relates to the nature of its constituents and to the particular distribution and concentration of alloying elements in it. The resistance to atmospheric corrosion resistance depends on weather conditions giving a succession of dry and wet periods for the forming of the auto-protective oxide layer of the base metal. The protection afforded depends on the environmental and other conditions prevailing at the site of the structure.

Provisions should be made in the design and fabrication of the structure, for the auto-protective oxide layer on the surface to form and regenerate itself unimpeded. It is the responsibility of the designer to include corrosion of unprotected steels in his or her calculation and, as far as is necessary, to compensate for this by increasing the thickness of the product.

Conventional surface protection is recommended when the content of particular chemical substances in the air is significant. It is absolutely necessary where the structure is in contact with water for long periods, is permanently exposed to moisture, or is to be used in a marine atmosphere. Before painting, the products should be descaled. Under comparable conditions, the susceptibility to corrosion of steel with improved atmospheric corrosion resistance under painting is less than that for conventional structural steels.

The surface of structures which are not exposed to the elements, but may be subject to the build-up of condensation, should be appropriately ventilated. Otherwise, a suitable surface protection is necessary. Generally valid statements on the corrosion process cannot be made, due to the extent to which the process depends on the prevailing climatic conditions and the details of the structure.

Indian Standard

HOT ROLLED QUENCHED AND TEMPERED STRUCTURAL STEEL PLATES AND WIDE FLATS –SPECIFICATION

ICS 77.140.01

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Wrought Steel Products Sectional Committee, MTD 4

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO Standard may also be followed as an alternate method.

While preparing the standard, assistance has been derived from the following international specifications:
ISO 630-4:2021 “High yield strength quenched and tempered structural steel plates”
EN 10025-6:2019 “High yield strength structural steels in the quenched and tempered condition”

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (revised). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

HOT ROLLED QUENCHED AND TEMPERED STRUCTURAL STEEL PLATES AND WIDE FLATS – SPECIFICATION

1 SCOPE

1.1 This document specifies qualities for high-yield strength quenched and tempered structural steels. It applies to steel plates and wide flats rolled on reversing mills which are used in the quenched and tempered condition and normally intended for welded or bolted structures.

1.2 This document covers 10 grades and 5 qualities. Grades ISH S460Q, ISH S500Q, ISH S550Q, ISH S620Q, ISH S690Q, ISH S890Q and ISH S960Q are covered in Table A.1, A.2, A.3, and A.4. Grades ISH SG460Q, ISH SG500Q, and ISH SG700Q are covered in Table B.1, B.2, B.3, and B.4. Not all grades are available in all qualities, and some qualities have Charpy V-notch requirements.

1.3 The steels specified in this document are applicable to hot-rolled flat products with a minimum nominal thickness of 3 mm and a maximum nominal thickness of 200 mm for grades ISH S460Q, ISH S500Q, ISH S550Q, ISH S620Q and ISH S690Q, a maximum nominal thickness of 125 mm for grades ISH S890Q and ISH S960Q, a maximum nominal thickness of 100mm for grades ISH SG460Q and ISH SG500Q and a maximum nominal thickness of 150 mm for grade ISH SG700Q.

2 NORMATIVE REFERENCES

The standards listed below contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
228(in various parts)	Methods of chemical analysis of steels
1599: 2019/ ISO 7438: 2016	Metallic materials – Bend test (*fourth revision*)
1608(Part 1): 2022/ ISO 6892-1: 2019	Metallic materials – Tensile testing - Part 1 Method of test at room temperature (*fifth revision*)
1730: 1989	Steel plates, sheets, strips and flats for structural and general engineering purposes – Dimensions (*second revision*)
1757(Part 1): 2020/ ISO 148-1: 2016	Metallic materials – Charpy pendulum impact test Part 1 Test method (*fourth revision*)
1852:1985	Specification for rolling and cutting tolerances for hot rolled steel Products (*fourth revision*)
1956 (in various parts)	Glossary of terms relating to iron and steel (*second revision*)
3803 (Part 1): 1989	Steel – Conversion of elongation values: Part 1 Carbon and low alloy steels (*second revision*)
8910: 2022/ ISO 404 : 2013	General technical delivery requirements for steel and steel products (*second revision*)

IS 9595:1996	Metal arc welding of carbon and carbon manganese steels – Recommendations (*first revision*)
10842 (Part 2): 2019	Destructive Tests on Welds in Metallic Materials - Cold Cracking Tests for Weldments — Arc Welding Processes - part 2 self-Restraint Tests (*first revision*)
ISO 1461: 2022	Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods
ISO 14713-2: 2019	Zinc coatings — Guidelines and recommendations for the protection against corrosion of iron and steel in structures — Part 2: Hot dip galvanizing
ISO 17577: 2016	Steel — Ultrasonic testing of steel flat products of thickness equal to or greater than 6 mm

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 1956 and the following definitions shall apply.

3.1 Quenching: Operation which consists of cooling a ferrous product more rapidly than in still air

3.2 Tempering: Heat treatment applied to a ferrous product generally after quench hardening or other heat treatment to bring the properties to the required level

Note: Tempering consists of heating to specific temperatures (<Ac1) and soaking one or more times followed by cooling at an appropriate rate.

3.3 Fine-grain steel: Steel with fine-grain structure with an equivalent index of grain size ≥ 6 determined in accordance with IS 4748/ ISO 643.

4 SUPPLY OF MATERIALS

General requirements relating to the supply of material shall conform to IS 8910.

5 DESIGNATION (GRADES AND QUALITIES)

There shall be 10 grades of steel. Grades ISH S460Q, ISH S500Q, ISH S550Q, ISH S620Q, ISH S690Q, ISH S890Q and ISH S960Q are covered in Table A.1 to table A.6. Grades ISH SG460Q, ISH SG500Q, and ISH SG700Q are covered in Table B.1 to table B.5. They differ in their minimum yield strength at room temperature.

Each grade is available in up to 5 qualities. These grades and qualities differ in their specified mechanical properties and impact energy requirements:

- Quality A: Impact test not required;
- Quality B: Impact testing at 0°C;
- Quality C: Impact testing at –20°C;
- Quality D: Impact testing at –40°C;
- Quality E: Impact testing at –60°C;

While placing the order, the steel should be designated by ‘Grade’ and ‘Quality’.

The requirements of table A.1 to table A.5 or Table B.1 to table B.5 are to be regarded separately. Each Table A or Table B is independent of the other without combining in any way.

5.1 Options

The following options may apply to products according to this document. If the purchaser does not indicate a wish to implement any of these options at the time of the order, the products shall be supplied in accordance with the basic specification.

1) Testing of tensile and impact properties at a frequency per each plate and wide flat as heat-treated.

2) On special request of the purchaser, the manufacturer shall inform the purchaser at the time of the order which of the alloying elements appropriate to the steel grade required will be deliberately added to the material to be delivered and reported in the heat analysis.

3) On special request of the purchaser, the manufacturer shall inform the purchaser at the time of the order which of the alloying elements appropriate to the steel grade required will be deliberately added to the material to be delivered and reported in the product analysis. The product analysis shall be carried out at an agreed frequency when specified at the time of the order.

4) The steel making process shall be indicated (see clause 6.2).

5) The product shall have a chemical composition required for hot-dip zinc-coating (see clause 10.3)

6) Sheet, plate, strip and wide flats with a nominal thickness ≤ 16 mm shall be suitable for flanging without cracking (see clause 10.2.3).

7) For flat products in nominal thickness ≥ 6 mm, except for hot rolled strip and plate cut from strip, the freedom from internal defects shall be verified in accordance with ISO 17577 (see clause 11).

8) For each heat treatment unit, the impact properties only or the impact properties and the tensile properties shall be verified (see clause 9.5).

9) Testing of impact properties in the transverse direction (see clause 9).

10) For plates and wide flats, the permissible surface discontinuities and for the repair of surface defects by grinding and/or welding (see clause 13.3).

11) Die stamping is not allowed or the position for die stamping shall be as indicated by the purchaser (see Clause 18.1).

6 MANUFACTURE

6.1 Steel shall be supplied in fully killed condition. The steels shall contain sufficient amount of nitrogen-binding elements and have a fine-grain structure.

6.2 The processes used in the steel making, casting and further hot rolling are left to the discretion of the manufacturer/supplier. If required, secondary refining in the form of ladle refining, vacuum degassing may follow steel making.

6.3 The products shall be supplied in the quenched and tempered condition.
Note: Direct quenching after hot-rolling followed by tempering is considered equivalent to conventional quenching and tempering.

7 CHEMICAL COMPOSITION

7.1 Ladle Analysis (Heat Analysis)

The ladle analysis or heat analysis of the steel, when carried out by the method specified in the relevant parts of IS 228 or any other established instrumental/chemical method, shall conform to the requirements as given in Table A.1 & Table B.1. This analysis shall be made from a test sample, preferably taken during casting/teeming of the heat. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the purchaser and the manufacturer/supplier. The ladle analysis shall be reported in the test certificate.

7.2 The ladle analysis shall be determined once per cast.

Table A.1 — Chemical composition of the Ladle analysis
(*Clauses 5, 7*.1)

Designation		Ladle Analysis, Percent, Max														
Grade	Quality	C	Mn	S	P	Si	Cr	Ni	Mo	N	B	Cu	Nb (b,c)	Ti (b,c)	V (b,c)	Zr (b,c)
All Grades	A to C D, E	0.20	1.70	0.015 0.010	0.025 0.020	0.80	1.50	4.0	0.70	0.015	0.0050	0.50	0.06	0.05	0.12	0.15

Notes:

a. Depending on the thickness of the product and the manufacturing conditions, the manufacturer may add to the steel one or several alloying elements up to the maximum values given in order to obtain the specified properties.

b. There shall be at least 0.015% of a grain-refining element present. Aluminium is also one of these elements. The minimum content of 0.015% applies to soluble aluminium, this value is regarded as attained if the total aluminium content is at least 0.018%; in case of dispute, the soluble aluminium content shall be determined.

c. Nitrogen binding elements shall be in amounts sufficient to bind the nitrogen (for example min. 0.020% total aluminium). The usual guideline is a minimum aluminium to nitrogen ratio of 2:1, when no other nitrogen binding elements are present.

d. For killed steel, when the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.020%. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10%. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03% and total aluminium content shall not be less than 0.010%.

Table B.1 — Chemical composition of the Ladle analysis
(*Clauses 5, 7*.1)

Designation		Ladle Analysis, Percent, Max													
Grade	Quality	C	Mn	S	P	Si	Cu	Ni	Cr	Mo	V	Nb	Ti	B	Zr
ISH SG460Q	A, B, C	0.18	1.70	0.035	0.035	0.55	a	a	a		a	a	a	a	b
ISH SG500Q	A, B, C	0.22	2.00	0.040	0.035	0.55	a	a	a	0.05	0.11	0.05	a	a	b
ISH SG700Q	A, C, D	0.21	2.00	0.035	0.035	0.80	0.50	1.50	2.0	0.60	0.10	0.06	0.10	0.006	0.15

Notes:

a. There is no requirement, but the amount of these elements shall be determined for each heat and shall be reported in the inspection document. However, depending on the thickness of the product and the manufacturing conditions, the manufacturer may add to the steel one or several alloying elements to obtain the specified

properties up to the maximum limits specified in table A.1.

b. There is no requirement.

c. For killed steel, when the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.020%. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10%. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03% and total aluminium content shall not be less than 0.010%.

7.2 Product Analysis

The product analysis shall be carried out when specified at the time of the order. The product analysis shall be carried out on the finished product from the standard position.
The product analysis of grades ISH S460Q, ISH S500Q, ISH S550Q, ISH S620Q, ISH S690Q, ISH S890Q and ISH S960Q shall comply with the values given in Table A.2.
The permitted deviations on analysis of grades ISH SG460Q, ISH SG500Q, and ISH SG700Q, relative to the values for heat analysis, are given in Table B.2.

7.2.1 If a product analysis has been agreed upon at the time of enquiry and order, the purchaser shall specify the frequency if not once per cast.

Table A.2 — Chemical composition of the Product analysis based on Table A.1
(*Clauses 5, 7.2*)

Designation		Ladle Analysis, Percent (%), Max														
Grade	Quality	C	Mn	S	P	Si	Cr	Ni	Mo	N	B	Cu	Nb (b,c)	Ti (b,c)	V (b,c)	Zr (b,c)
All Grades	A to C D, E	0.22	1.80	0.017 0.012	0.030 0.025	0.86	1.60	4.1	0.74	0.016	0.0060	0.55	0.07	0.07	0.14	0.17

Notes:

a. Depending on the thickness of the product and the manufacturing conditions, the manufacturer may add to the steel one or several alloying elements up to the maximum values given in order to obtain the specified properties.

b. There shall be atleast 0.010% of a grain-refining element present. Aluminium is also one of these elements. The minimum content of 0.010% applies to soluble aluminium, this value is regarded as attained if the total aluminium content is atleast 0.013%; in case of dispute, the soluble aluminium content shall be determined.

c. Nitrogen binding elements shall be in amounts sufficient to bind the nitrogen (for example min. 0.015 % total aluminium). The usual guideline is a minimum aluminium to nitrogen ratio of 2:1, when no other nitrogen binding elements are present.

Table B.2 — Permissible Variation for Product Analysis vs Ladle analysis of Table B.1
(*Clauses 5, 7.2*)

Element	Range of specified element, %	Permissible Variation Over/Under the Specified Limit, % max
Carbon	≤0.15	0.03
	>0.15≤0.22	0.04
Silicon	≤0.80	0.06
Manganese	≤2.00	0.10
Phosphorus	≤0.035	0.01
Sulfur	≤ 0.04	0.01

Vanadium	≤0.10	0.01
	>0.10≤0.25	0.02
Niobium	≤ 0.06	0.01
Boron	≤ 0.006	0.001
Titanium	≤0.10	0.01
Copper	≤0.50	0.03
Nickel	≤ 1.00	0.03
	>1.00≤1.50	0.05
Chromium	≤0.90	0.04
	>0.90≤ 2.00	0.06
Molybdenum	≤0.20	0.01
	>0.20≤0.40	0.03
	>0.40≤0.60	0.04
Zirconium	≤0.15	0.03

7.3 Carbon equivalent value

The maximum carbon equivalent value (CEV) requirements for Table A.1 grades are given in Table A.3 and for Table B.1 grades are given in Table B.3.

Carbon equivalent value (CEV) would be calculated based on ladle analysis, only.

$$CEV = \mathbf{C} + \frac{\mathbf{Mn}}{\mathbf{6}} + \frac{(\mathbf{Cr+Mo+V})}{\mathbf{5}} + \frac{(\mathbf{Ni+Cu})}{\mathbf{15}}$$

Table A.3—Maximum CEV based on the ladle analysis for table A.1
(*Clauses 7*.3)

Designation		**Maximum CEV in % for nominal product thickness in mm**			
Grade	**Quality**	**≤50**	**>50 ≤100**	**>100 ≤125**	**>125 ≤200**
ISH S460Q	C, D, E	0.47	0.48	0.50	0.50
ISH S500Q	C, D, E	0.47	0.70	0.70	0.70
ISH S550Q	C, D, E	0.65	0.77	0.83	0.83
ISH S620Q	C, D, E	0.65	0.77	0.83	0.83
ISH S690Q	C, D, E	0.65	0.77	0.83	0.83
ISH S890Q	C, D, E	0.72	0.82	0.83	-
ISH S960Q	C, D	0.82	0.85	0.85	-

Note: Max. CEV is increased for ***Option 5*** (Clause 5.1), see 7.4.

Table B.3 — Maximum CEV[a] based on the heat analysis for table B.1
(*Clauses 7*.3)

Designation		Maximum CEV in % for nominal product thickness in mm	
Grade	**Quality**	≤50	>50≤100
ISH SG460Q	A, B, C	0.44	0.47
ISH SG500Q	A, B, C	0.47	0.50
ISH SG700Q	A, C, D	0.60	0.63
a By agreement for ISH SG700Q.			

Note: Max. CEV is increased for ***Option 5*** (Clause 5.1), see 7.4.

7.4 When products are supplied with a control on Si e.g. for hot-dip zinc-coating so that there could be a need to increase the content of other elements like C and Mn to achieve the required tensile properties, the maximum carbon equivalent values of Table A.3 and table B.3 shall be increased as follows:
— for Si ≤ 0,04 %, increase the value of the CEV by 0,02;
— for Si ≤ 0,25 %, increase the value of the CEV by 0,01.

8 TENSILE TEST

The tensile properties at room temperature shall comply with the values specified in Table A.4 or Table B.4

8.1 Number of Tensile Tests

Number of test samples shall be 2 from each cast/heat and same form, grade, quality and delivery condition for thickness range as specified in table A.4 & table B.4 for the yield strength. On Mutual agreement the test unit shall be taken on each plate and wide flat as heat treated for grades mentioned in table B.4.

8.2 Location of samples and orientation of test pieces

The samples shall be taken from any product of the test unit, from the location in the product as shown in fig 1.

Additionally, for plates, sheet, wide strip and wide flats the samples shall be taken so that the axes of the test pieces are approximately midway between the edge and center line of the products.

For wide strip the sample shall be taken at an adequate distance from the end of the product.
For narrow strip (<600 mm wide) the sample shall be taken at an adequate distance from the end of the coil and at one third of the width.

Type of test	Nominal thickness of product	Direction of the longitudinal axis of the test piece in relation to the principal direction of rolling for product nominal widths of		Distance of the test piece from the rolled surface
		< 600	≥ 600	
Tensile [a]	≤ 30	longitudinal	transverse	≤ 30, 1, 1 rolled surface
	> 30			or, t, t/2, 1
Impact [b d]	> 12 [c]	longitudinal	longitudinal	≤ 2, ≥ 12

Fig 1: Sample location

a In case of dispute, for products of nominal thickness greater than or equal to 3 mm use proportional test pieces of gauge length $L_o = 5.65\sqrt{S_o}$, see 8.3.1 and 8.3.2

b The axis of the notch shall be perpendicular to the surface of the product.

c For nominal thicknesses $t \leq 12$ mm see 9.1.

d For products nominal thickness $t \geq 40$ mm impact test pieces shall be taken from ¼ t position.

8.3 Tensile Test Pieces

The tensile strength, yield strength and percentage elongation of steel shall be determined from standard test pieces.

8.3.1 For flat products of nominal thickness > 30 mm a round test piece may be used with the longitudinal axis at 1/4 thickness, if a testing machine with an adequate capacity is not available. In cases of dispute, the total thickness of the plate shall be subdivided in equal thick flat test pieces. The average of the individual results of the mechanical tests shall be valid.

8.3.2 As a rule, test pieces with a proportional gauge length complying with the requirements $L_o = 5.65\sqrt{S_o}$ should be used for the tensile test, where L_o is the gauge length and S_o is the cross-sectional area of the test piece.

8.3.3 Test pieces with a non-proportional gauge length, other than $5.65\sqrt{S_o}$ may be used in which case the elongation values shall be converted to $5.65\sqrt{S_o}$ in accordance with IS 3803 (Part 1).

8.4 Tensile Test

Yield strength, tensile strength and percentage elongation, when determined in accordance with IS 1608 (Part 1), shall conform to the requirements as given in Table A.4 and table B.4.

For the specified yield strength, the upper yield strength (*R*eH) shall be determined.
If a yield phenomenon is not present, the 0.2% proof strength (*R*p 0.2) shall be determined.

8.4.1 Should a tensile test piece break outside the middle half of the gauge length (*see* IS 1608 (Part 1)) and the percentage elongation obtained is less than that specified, the test may be discarded at the manufacturer/supplier's option and another test made from the sample plate, strip, or flat.

8.5 The maximum stress-relief temperature should be at least 30 °C below the tempering temperature and not be held for more than 1 hour. As this temperature is normally not known in advance it is recommended that the purchaser if he intends to perform a stress relief treatment to contact the steel producer. If the purchaser intends to stress relief the products at higher temperatures or for longer times than mentioned above the minimum values of the mechanical properties after such a treatment should be agreed upon at the time of the order.

Table A.4 Tensile Properties at room temperature
(*Clause 5 and 8.4*)

Designation		**Minimum Yield Strength** R_{eH}, MPa[2)] **Nominal Thickness, mm**				**Tensile Strength** Rm, MPa[2)] **Nominal Thickness, mm**				**Elongation A**, % *Min* **at Gauge Length,** $L_0=5.65\sqrt{So}$
Grade	**Quality**	≥3 ≤50	>50 ≤100	>100 ≤125	>125 ≤200	≥3 ≤50	>50 ≤100	>100 ≤125	>125 ≤200	≥3 ≤200
ISH S460Q	C, D, E	460	440	400	400	550-720		500-670		17
ISH S500Q	C, D, E	500	480	440	440	590-770		540-720		17
ISH S550Q	C, D, E	550	530	490	490	640-820		590-770		16
ISH S620Q	C, D, E	620	580	560	560	700-890		650-830		15
ISH S690Q	C, D, E	690	650	630	630	770-940	760-930	710-900		14
ISH S890Q	C, D, E	890	830	830	-	940-1100	880-1100	880-1100	-	11
ISH S960Q	C, D, E	960	850	850	-	980-1150	900-1100	900-1100	-	10

NOTES:

1. For plates and wide flats with widths ≥600 mm, the direction transverse to the rolling direction applies.
2. 1MPa = $1N/mm^2$ = $1MN/m^2$ = 0.102 kgf/mm^2 = 144.4 psi.
3. If R_{eH} is not pronounced, refer to 8.4.

Table B.4 Tensile Properties at room temperature
(*Clause* 5, *and 8.4*)

Designation		Minimum Yield Strength Min R_{eH}, MPa[a)] Nominal Thickness, mm				Tensile Strength Rm, MPa [a)] Nominal Thickness, mm	Elongation [b)] **A**, % *Min* Nominal Thickness (≤150), mm		
Grade	**Quality**	≤16	>16 ≤40	>40 ≤100	>100 ≤150	≤ 150	L_0=5.65 √So	Gauge Length=50 mm [d]	Gauge Length=200 mm
ISH SG460Q	A, B, C	460	450	420	e	570-720	15	20	15
ISH SG500Q	A, B, C	500	500	500	e	600-760	17	19	17
ISH SG700Q	A, C, D	690	690	620	620	760-930	14	16	14

NOTES:

a 1 MPa = 1 N/mm2.

b Only one of the three requirements is required. Unless specified in the order, the manufacturer may use either a proportional or fixed gauge length specimen. When the test value is reported, the specimen used shall be reported.

c The producer should be contacted for possible thickness limits.

d If measured using a 40 mm wide tension test specimen, the elongation is determined in a 50 mm gauge length that includes the fracture and shows the greatest elongation.

e Not available.

9 IMPACT TEST

The verification of the impact energy value shall be carried out, unless otherwise agreed upon.
The impact properties of Charpy V-notch test pieces shall comply with the values specified in Table A.5 or Table B.5. The orientation of the specimens shall be longitudinal, unless a transverse orientation is agreed between the purchaser and manufacturer (see ***option 9*** clause 5.1 and the values are in Table A.6).

9.1 Preparation of impact test pieces

V-notch test pieces shall be machined and prepared in accordance with IS 1757(Part 1)/ ISO 148-1. In addition, the following requirements apply for flat products:

— for nominal thicknesses 12 < *t* < 40 mm, standard 10 mm x 10 mm test pieces shall be machined in such a way that one side is not further away than 2 mm from a rolled surface, for nominal thicknesses ≥ 40 mm impact test pieces shall be taken from 1/4*t* position for plates;

— for nominal thicknesses ≤ 12 mm, when test pieces with reduced widths are used, the largest width possible has to be chosen; If agreed upon at the time of enquiry and order, sub-sized test pieces shall be used in the case of nominal thicknesses of 6 mm ≤ *t* ≤ 12 mm. The largest possible standard sub-sized test piece (7,5 mm or 5,0 mm) shall be used.

— for nominal thickness < 6 mm no impact tests are required.

9.2 Impact test

The impact test shall be carried out in accordance with IS 1757(Part 1)/ ISO 148-1 on V-notch specimen using 2 mm striker.

The average value of the three test results shall meet the specified requirement. One individual value may be below the minimum average value specified, provided that it is not less than 70 % of that value.

Three additional test pieces shall be taken from the same sample in accordance with 9.3 and tested in any one of the following cases:

— if the average of three impact values is lower than the minimum average value specified;
— if the average value meets the specified requirement, but two individual values are lower than the minimum average value specified;
— if any one value is lower than 70 % of the minimum average value specified.

The average value of the six tests shall be not less than the minimum average value specified. Not more than two of the individual values may be lower than the minimum average value specified and not more than one may be lower than 70 % of this value.

9.3 The test sample shall be taken from the thickest product. One test sample shall be taken from thickest product per cast/heat. If the test sample taken from the thickest product rolled from a cast meets the requirements, the whole cast shall be deemed to meet the requirements of the test, if not, the test shall be performed on a product of next lower thickness rolled from same cast, if it meets the requirements specified, this particular thickness as also other sections of lower thickness shall be deemed to satisfy this specification. If this thickness also does not meet the requirements, the test shall be carried out on the next lower thickness and so on, because the toughness of the product will be dependent on the rolling direction as well as on the product size.

9.4 Impact test at different temperatures other than specified in table A.5, table A.6 and table B.5 may be mutually agreed between the purchaser and the manufacturer/supplier accordingly the impact test values may be mutually agreed between the purchaser and the manufacturer/supplier.

9.5 If specified at the time of the order on each heat treatment unit the impact properties only or the impact properties and the tensile properties shall be verified.

Table A.5 — Longitudinal Charpy V-notch properties [a]
(*Clauses 5, 9*)

Designation		Minimum energy, J at test temperature [b], °C			
Grade	**Quality**	0	−20	−40	−60
ISH S460Q ISH S500Q ISH S550Q ISH S620Q ISH S690Q ISH S890Q ISH S960Q	C	40	30	—	—
ISH S460Q ISH S500Q ISH S550Q ISH S620Q ISH S690Q ISH S890Q ISH S960Q	D	50	40	30	—
ISH S460Q ISH S500Q ISH S550Q ISH S620Q ISH S690Q ISH S890Q ISH S960Q	E	60	50	40	30

[a] For nominal thicknesses ≤12mm, Where sub-sized test pieces are used (see 9.1), the minimum impact energy values given shall be reduced in proportion to the cross-sectional area of the test piece.

[b] Unless otherwise specified, the testing temperature for each quality is the lowest available with a specified energy value.

Table A.6—Transverse Charpy V-notch properties [a,c]
(*Clauses 5, 9*)

Designation		Minimum energy, J at test temperature [b], °C			
Grade	**Quality**	0	−20	−40	−60
ISH S460Q ISH S500Q ISH S550Q ISH S620Q ISH S690Q ISH S890Q ISH S960Q	C	30	27	—	—
ISH S460Q ISH S500Q ISH S550Q ISH S620Q ISH S690Q ISH S890Q ISH S960Q	D	35	30	27	—
ISH S460Q ISH S500Q ISH S550Q ISH S620Q ISH S690Q ISH S890Q ISH S960Q	E	40	35	30	27

a For nominal thicknesses ≤12mm, Where sub-sized test pieces are used (see 9.1), the minimum impact energy values given shall be reduced in proportion to the cross-sectional area of the test piece.

b Unless otherwise specified, the testing temperature for each quality is the lowest available with a specified energy value.

c See ***option 9*** clause 5.1.

Table B.5—Longitudinal Charpy V-notch properties [a]
(*Clauses 5, 9*)

Designation		Minimum impact energy, J, at test temperature, °C			Maximum thickness, mm
Grade	Quality	0	-20	- 40	
ISH SG460Q	A	—	—	—	100
	B	27	—	—	100
	C	—	27	—	100
ISH SG500Q	A	—	—	—	100
	B	27	—	—	100
	C	—	27	—	100
ISH SG700Q	A	—	—	—	150
	C	—	27	—	150
	D	—	—	27	150

a For nominal thicknesses ≤12mm, Where sub-sized test pieces are used (see 9.1), the minimum impact energy values given shall be reduced in proportion to the cross-sectional area of the test piece.

10.0 TECHNOLOGICAL PROPERTIES

10.1 Weldability

The steels specified in this document do not have unlimited suitability for the various welding processes, since the behavior of a steel during and after welding depends not only on the material but also on the dimensions and shape and on the manufacturing and service conditions of the components.

General requirements for arc welding of the steels specified in this document shall be as given in IS 10842 part 2 or ISO 17642 part 2.

NOTE With increasing product thickness and strength level cold cracking can occur. Cold cracking is caused by the following factors in combination:

— the amount of diffusible hydrogen in the weld metal;
— a brittle structure of the heat affected zone;
— significant tensile stress concentrations in the welded joint.

10.2 Formability and flame straightening

10.2.1 Hot-forming

Hot forming is not recommended for quenched and tempered steels as the necessary heat treatment after hot forming is very difficult to reproduce.

10.2.2 Cold formability

Cold forming leads to reduction in the ductility. Furthermore, it is important to draw the attention to the risk of brittle fracture in connection with hot-dip zinc coating.

10.2.3 Flangeability

If specified at the time of the order and mutually agreement between the purchaser and the manufacturer, plates and wide flats with a nominal thickness ≤ 16 mm are suitable for flanging without cracking with the indicative values for the inside minimum bend radii for cold forming as given in table A.7. (See ***Option 6***, Clause 5.1 for Flangeability without cracking).

Table A.7— Minimum recommended inside bend radii for flanging
(Informative for clause 10.2.3)

Designation		Minimum recommended inside bend radii for nominal thicknesses (t) $3 \leq t \leq 16$ mm [a]	
Grade	**Quality**	**Axis of bend in transverse direction**	**Axis of bend in longitudinal direction**
ISH S460Q ISH S500Q ISH S550Q ISH S620Q ISH S690Q	C, D, E	3.0t	4.0t
ISH S890Q ISH S960Q	C, D, E	4.0t	5.0t

a The values are applicable for bend angles ≤ 90°.

10.3 Hot-dip zinc-coating

ISO 1461 should be used to specify coating requirements. ISO 14713-2 provides further guidance, including information on the influence of various factors, including steel chemical composition, on the coating formation.

Option 5, Clause 5.1 can be used to order steels with a chemical composition required for hot-dip zinc coating. When option 5 is implemented, the purchaser and manufacturer shall agree to a steel composition (heat analysis) of silicon and phosphorous according to either Category A (or steels satisfying the formula Si ≤ 0,03 % and Si+2,5P ≤ 0,09 %) or Category B (limited to 0,14 % ≤ Si ≤ 0,25 %) or Category D (limited to 0,25 % < Si ≤ 0,35 %)

NOTE 1 ISO 14713-2:2019, Table 1, gives guidance on typical coating characteristics associated with certain steel compositions on the basis of the surface composition of silicon and phosphorous.

The maximum carbon equivalent shall be increased by 0,02 or by 0,01 (see 7.4).

NOTE 2 Products quenched in water can be susceptible to stress corrosion cracking after hot-dip zinc-coating.

In some cases, steels above S460 may be sensitive to cracking during galvanizing and therefore special care should be taken.

11 INTERNAL SOUNDNESS

Ultrasonic testing may be agreed upon at the time of the order. If specified at the time of the order, ultrasonic testing shall be carried out for flat products in nominal thicknesses ≥ 6 mm, except for hot rolled strip and plate cut from strip in accordance with ISO 17577 or with test methods and acceptance criteria agreed upon.

See ***Option 7***, Clause 5.1 (Ultrasonic testing for flat products).

12 RE-TESTS

12.1 If a test does not give the specified results, two additional tests shall be carried out at random on the same lot. Both retests shall conform to the requirements of this standard; otherwise, the lot shall be rejected.

In the case of strip, retests on a rejected coil shall be carried out after the cutting of an additional longitudinal section of sufficient length to remove the coil end effect with a maximum of 20 m.

12.2 Re-heat Treatment

If any heat treated material fails to meet the mechanical requirements specified, the supplier may re-heat treat the material and in that case, all mechanical properties shall be re-evaluated.

13 FREEDOM FROM DEFECTS

13.1 All finished steel shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/jagged and imperfect edges and all other harmful defects.

13.2 Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent but not exceeding 7 percent may be made subject to mutual agreement between the purchaser and the manufacturer/supplier.

13.2.1 Subject to agreement with the purchaser, surface defects which cannot be dealt with as in 13**.2** may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that,

a) after complete removal of the defects and before welding, the thickness of the item is in no place reduced by more than 20 percent;
b) welding is carried out by approved procedure by competent operators with approved electrodes and that the welding is ground smooth to the correct nominal thickness; and
c) subsequent to the finish grinding, the item maybe required to be normalized or otherwise heat-treated at the purchaser’s discretion.

13.3 Alternatively, the requirements for surface condition can be agreed at the time of enquiry and order in accordance with ISO 7788 for plates and wide flats
See ***Option 10***, Clause 5.1 (surface condition).

14 DIMENSIONS

Unless otherwise agreed to between the purchaser and the manufacturer /supplier, the nominal dimensions of rolled products conforming to this standard shall be in accordance with the relevant Indian Standard.

15 TOLERANCES

Unless otherwise agreed to between the purchaser and the manufacturer/supplier, the rolling and cutting tolerances for steel products conforming to this standard shall be those specified in IS 1852.

16 CALCULATION OF MASS

The mass of the steel shall be calculated on the basis that steel weighs7.85 g/cm^3.

17 DELIVERY

The products shall be supplied in the quenched and tempered condition (Q) as defined in Clause 3 and 6.3.

NOTE Direct quenching after hot-rolling followed by tempering is considered equivalent to conventional quenching and tempering.

18 MARKINGAND PACKING

18.1 The products shall be legibly marked using methods such as painting, stamping, laser marking, bar coding, durable adhesive labels or attached tags with the following:

— the grade, the quality and if applicable the delivery condition indicated by its abridged designation;
— heat number or cast number;
— the manufacturer’s name or trademark.

The type of marking may be specified at the time of the order.

NOTE 1 Where the option for hot dip galvanizing is chosen (see ***option 5*** Clause 5.1) the marking methods and materials used can be agreed upon in order to avoid interference with preparation for hot dip galvanizing (see ISO 14713-2).

In addition, if specified at the time of the order there shall be either no die stamping or only die stamping in positions indicated by the purchaser.
See ***Option 11***, Clause 5.1 (Die stamping not allowed or at special position).

18.2 Marking shall be at a position close to one end of each product or on the end cut face at the manufacturer's discretion.

18.3 Where products are supplied in securely tied bundles the marking shall be on a label attached to the bundle or on the top product of the bundle.

18.4 BIS Certification Marking

The material may also be marked with Standard Mark.

18.4.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations made there under. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

भारतीय मानक ब्यूरो

भारतीय मानक प्रारूप

तप्त-निमज्जी जिंक-एल्यूमीनियम-मैग्नीशियम मिश्रधातु लेपित इस्पात पत्तियां प्लेटें एवं चादरें - विशिष्टि

Draft Indian Standard

Hot-Dip Zinc- Aluminium-Magnesium Alloy Coated Steel Sheets, Plates and Strips - Specification

ICS 77.140.50

FOREWORD

(*Formal clauses will be added later*)

Galvanizing is a process in which a layer of zinc through hot-dip coating is bonded to steel in order to protect it against corrosion. In recent years, to improve the corrosion resistance of hot-dip galvanized steel sheets, Zn-based alloy coatings such as Zn–Al coatings with higher aluminium contents than the alloy used in the conventional galvanising process (IS 277) and Galvalume (IS 15961) were developed. Besides, combination of aluminium magnesium was found to have a positive effect on the corrosion resistance of zinc based steel coatings, which led to the development of several Zn–Al–Mg coatings across the world.

With the constant requirement of greater, stringent, and varied requirements for steel sheets and strips having superior corrosion resistance and enthusiasm to identify, summarize and create a new standard on such products culminated in development of standard on Zn–Al–Mg coated steels.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO standard may also be followed as an alternate method.

The composition of the Committee responsible for formulation of this standard is given in Annex E.

For the purpose of whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

HOT-DIP ZINC- ALUMINIUM-MAGNESIUM ALLOY COATED STEEL SHEETS, PLATES AND STRIPS - SPECIFICATION

1 SCOPE

This document applies to the requirements for steel sheets, in coils and cut lengths, metallic-coated by the continuous hot-dip process, with Zinc-Aluminium-Magnesium alloy coating.

The product is intended for applications requiring high corrosion resistance, formability and Paintability.

The steel sheet is produced in several quality designations and grades, coating mass, surface treatments and coating finish conditions designed to be compatible with differing application requirements.

2 REFERENCES

The Indian Standards are listed in Annex A, and contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For this standard, the definitions given in IS 1956 (Part 4), IS 3531, IS 513 (Part 1) , IS 513 Part 2, IS 1079, IS 5986, IS 277, and the following definitions shall apply.

3.1Thickness of Sheet- The thickness of a Zinc-Aluminium-Magnesium alloy-coated steel sheet shall be specified as a combination of the base metal and metallic coating, or as the base metal alone. The purchaser shall indicate on the order which method of specifying thickness is required. If the purchaser does not indicate any preference, the thickness as a combination of the base metal and coating will be provided. Annex B describes the requirements for specifying the thickness as base metal alone.

3.2 Coating Mass — The amount of coating expressed in grams per unit surface area of the sheet (g/m^2).

3.3 Product — Hot-dip Zinc-Aluminium-Magnesium alloy coated hot rolled and cold reduced carbon steel sheet, plate and strip.

3.4 Blackening/ Presence of Black spots—The surface of the coating may appear blackened, especially the coating composition containing magnesium, during storage or in high temperature and high humidity environments. There may be presence of random black spots on the surface of the material coated with Zinc-Aluminium-Magnesium. This is due to formation of phase of Zinc-Aluminium-Magnesium during solidification of coating.

3.5 Flow lines / Air blowing pattern— There may be a presence of visible air blow patterns on coating surface especially for thicker and / or high GSM coating.

3.6 Differential coating — Coating is deliberately produced to have a different coating mass on each surface.

3.7 Breakage allowance — Agreed upon level of acceptable die breakage not subject to a claim.

3.8 Structural — Base metal quality intended for parts needing guaranteed mechanical properties and where simple forming may be involved.

3.9 Equivalent Coating Thickness — Total thickness of the coating mass applied on both surfaces.

4 SUPPLY OF MATERIAL

4.1 The general requirements relating to the supply of Zinc-Aluminium-Magnesium coated steel sheets and strips shall conform to IS 8910.

4.2 Product is manufactured in thicknesses from 0.20 mm to 9 mm inclusive after coating, and in widths of 600 mm and over in coils and cut lengths.

4.3 Product less than 600 mm wide, is slit from a wide coil and further cut into required lengths.

5 DESIGNATIONS

5.1 Base Metal Grade— Product covered by this standard shall be designated by the type of base metal used for coating. The grades, therefore, are classified as given in Table **1** for coated steels with cold substrate and Table **2** for coated steels with hot-rolled substrate.

5.2 Coating Class— Expressed as ZMXXX, Where ZM stands for Zinc-Aluminium-Magnesium alloy coated and XXX Stands for coating mass expressed in g/m^2. The coating class shall be as given in Table **3**.

5.3 Coating Type— The coating bath metal used to produce Zinc-Aluminium-Magnesium coated steel sheet and strip shall contain 0.2 to 20% Aluminium, 0.2 to 6 % Magnesium, up to 1 % total additional alloying elements (except iron) and the balance zinc.

5.4 Surface Finish— The surface finish of the product shall be as given in Table **4**

5.5 Surface Treatment— The surface treatment for the product shall be as given in Table **5**

5.6 The designation for the product shall comprise Base Metal Steel grade (Table 1 or Table 2) and Coating class (Table 3) separated by hyphen.
Example : 'IZMC480S - ZM080'.

6 MANUFACTURE

6.1 Processes used in steel making, rolling, and manufacturing process of hot dip of Zinc-Aluminium-Magnesium coating shall be left to the discretion of the manufacturer unless there is a restriction on the steel grades or as per mutual agreement between the purchaser and the manufacturer.

6.2 For the hot-dip coating process, hot-rolled or cold-rolled substrates shall be used. The hot rolled strip shall be pickled first before the hot-dip coating process.

6.3 The strip is dipped in a suitable bath of molten metal alloys of Zinc-Aluminium-Magnesium at a temperature suitable to produce a complete and uniform adherent coating.

6.4 The ingots of zinc and zinc alloys, Aluminium and Magnesium used for the molten bath for dipping shall conform to any of the grades specified in IS 13229 / IS 209 , IS 2590, IS 6694 respectively. In case

of Zn-Mg-Al alloyed ingot, its properties and chemical composition can be as per mutual agreement between the purchaser and the manufacturer.

7 CHEMICAL COMPOSITION

7.1 Ladle Analysis— The ladle analysis of the base metal of steel sheet and strip shall be as per the requirements given in Table **6A** and Table **6B** for cold rolled substrate and hot rolled substrate respectively when carried out either by the method specified in the relevant parts of IS 228 or any other national/international standard for instrumental/chemical method. In case of dispute, the procedure given in the relevant part of IS 228 shall be the referee method.

7.2 Product Analysis— Permissible variation in the case of product analysis, after stripping of coating, from the limits specified in Table **6A**, Table **6B** shall be as given in Table **7**.

8 COATING PROPERTIES

8.1 Coating Mass— The coating mass expressed in grams per square metre given for both surfaces shall conform to the requirements specified in Table **3**. The maximum coating mass may be agreed upon between the purchaser and the manufacturer. Differentially coated products can be mutually agreed upon between the purchaser and manufacturer.

8.2 Coating Mass Test

8.2.1 The coating mass of the product is to be tested by taking a sample piece from each coil approximately 300 mm in length by the as-coated width, and cutting three test specimens, one from the mid-width position and one from each side, not closer than 50 mm to the side edge. The minimum area of each of the three specimens shall be 1200 mm^2.

8.2.2 The coating mass is the triple spot test result which shall be the average coating mass found on the three specimens taken in accordance with **8.2.1**. However, the minimum of three coating values should comply with the single spot test requirements of the coating designation. For narrow strips, which have been slit from a wide hot dip Zinc-Aluminium-Magnesium alloy-coated coil, only a single spot test is applicable and should comply with the minimum requirement of the coating designation.

8.2.3 The coating mass shall be determined by the X-ray fluorescence method (*see* IS 12860) or by weight loss (Gravimetric) method (*see* IS 6745). For measuring coating on a single surface, a suitable method (see IS 6745) by employing any suitable method of masking the second surface as agreed to between the manufacturer and the purchaser or by X-ray fluorescence method. In case of dispute, the procedure agreed to between the manufacturer and the purchaser shall be the referee method.

8.2.4 The equivalent coating thickness can be calculated based on the mutual agreement between the purchaser and manufacturer or as per information provided in Annex B.

8.3 Adherence Test

8.3.1 Zinc-aluminium-magnesium alloy-coated steel sheet shall be capable of being bent in any direction, in accordance with the mandrel diameter requirements of Table 8, without flaking of the coating on the outside of the bend. The test piece shall be taken in parallel to the rolling direction of the base metal unless otherwise specified. Flaking of the coating within 7 mm from the edge shall not be a cause for rejection. Subject to mutual agreement between purchaser and manufacturer, stricter conditions can be applied.

8.3.2 One sample is to be drawn from each mother coil or a lot of 50T or less processed under the identical conditions of a single ladle, hot & cold rolling conditions, thickness, width, coating and process conditions at a hot dip galvanizing line.

8.3.3 Corrosion resistance for coating— On request of the purchaser, corrosion resistance of the product may be tested. The test conditions for the corrosion resistance test and evaluation criteria shall be in accordance with the agreement between the purchaser and the manufacturer or as per the established national or international standards.

9 SURFACE TREATMENT & FINISH

9.1 Mill Passivation— When Specified, A chemical treatment is normally applied to Zinc-Aluminium-Magnesium alloy-coated steel sheets to minimize the hazard of wet storage staining (white rust) and blackening during shipment and storage. However, the inhibiting characteristics of the treatment are limited and, if a shipment is received wet, the material shall be used immediately or dried.

NOTES
1 Blackening occurs only on the surface of the coating and does not affect the corrosion resistance of the coating.
2 Chromate-free treatment is available for use.

9.2 Mill Phosphating — When specified and based on mutual agreement between the purchaser and the manufacturer, the manufacturer shall apply phosphate treatments to Zinc-Aluminium-Magnesium alloy-coated steel sheets to prepare the surface for painting without further treatment except normal cleaning.

9.3 Oiling — When specified, the Zinc-Aluminium-Magnesium alloy-coated steel strip as produced shall be oiled to prevent marring and scratching of the soft surface during handling or shipping and to minimize wet storage stains.

NOTE: When a Zinc-Aluminium-Magnesium alloy-coated steel sheet has received a passivating treatment, oiling will further minimize the hazard of wet storage stain.

9.4 Thin Organic Film (or Sealing)— When specified, the Zinc-Aluminium-Magnesium alloy-coated steel sheet as produced shall be coated with a thin organic film coating to offer additional corrosion protection and, depending on its nature, increase the protection against fingerprints. It may improve the sliding characteristics during forming operations and may be used as a priming coat for subsequent painting based on the mutual agreement between the purchaser and manufacturer.

9.5 As agreed between the purchaser and the manufacturer, other applicable and suitable kinds of surface treatments can be applied.

9.6 The surface finish can be presented as, as Coated surface finish without a skin pass and a coated surface with a Skin pass finish. Based on end-use requirements, the purchaser and manufacturer decide upon and mutually agree on the kind of surface finish requirements.

10 MECHANICAL PROPERTIES:

10.1 Test Frequency— Specimen for mechanical properties shall be drawn from each mother coil or a lot of 50T or less processed under the identical conditions of a single ladle, hot & cold rolling conditions, thickness, width, coating, and process conditions at a hot dip galvanizing line.

10.2 For hot rolled substrate one tensile test shall be taken from each cast. Where Strips of more than one thickness are rolled from the same cast, one additional tensile test shall be made from the material: In the case of strips (for thickness less than 5mm) — One sample shall be tested for thickness less than 2.00 mm,

One sample shall be tested for thickness greater than 2.00 mm and less than 3.20 mm and one sample shall be tested for thickness greater than 3.20mm.

10.3 Tensile Test

10.3.1 Tensile Test Specimen— Tensile test values apply to the direction and type of specimen mentioned in Table **9A** & Table **9B**. Strips having a width of 250 mm and below shall be tested longitudinally.

10.3.2 Testing— Tensile test to be conducted as per IS 1608 (Part 1) at room temperature and Tensile properties i.e. Yield Strength, Tensile Strength &% Elongation shall meet the requirements specified in Tables **9A** & **9B**. The yield strength value applies to 0.2% of proof stress and if Yield stress is not clearly defined, the value applies to lower yield stress or upper yield stress based on mutual agreement between purchaser and manufacturer. When there is no specific agreement, lower yield stress values will be applied.

10.4 Plastic Strain Ratio (r bar/r-td)

10.4.1 The plastic strain ratio, an index of draw ability (r bar/r-td), shall apply to a thickness between 0.50 mm to 2.00 mm. For thicknesses more than 1.00 mm, the r- bar/r-td value is reduced by 0.10 and if required, for the thickness more than 2.0mm, the r- bar/r-td value is reduced by 0.20.

10.4.2 The plastic strain ratio shall be checked in accordance with IS 11999 and results shall conform to as given in Table **9A.**

10.4.3 When specified by the purchaser, the plastic strain ratio requirement can be omitted.

10.5 Tensile Strain Hardening Exponent (n value/n-td)

10.5.1 The tensile strain hardening is an index of the stretchability (n-value/n-td), which shall be applicable to a thickness between 0.50 mm and 2.00 mm. If required, for a thickness of more than 2.00 mm, the n-value/n-td is reduced by 0.02.

10.5.2 The tensile strain hardening component shall be checked in accordance with IS 15756 and results shall conform to as given in Table **9A**.

10.5.3 When specified by the purchaser, the tensile strain hardening exponent test can be omitted.

10.6 Bake Hardening Index (BH)

10.6.1 Bake hardening index shall be as given in Table **9A** when tested as per Annex C**.**

10.7 Bend Test

10.7.1 Bend test shall be carried out in accordance with IS 1599 for the cold rolled substrate.
10.7.2 The angle of bend and the internal diameter for the different grades of material shall be as given in Table **10.**
10.7.3 The axis of the bend shall be in the direction of rolling. The test pieces shall be deemed to have passed the test if the outer convex surface is free from cracks.
10.7.4 When specified by the purchaser, the bend test can be omitted.
10.7.5 The bend test is applicable to fully annealed steel products only.

10.8 Hardness Test

If specified by the purchaser, the hardness test shall be carried out in accordance with IS 1586 Part 1 for Rockwell Hardness and as per IS 1501 Part 1 for Vickers Hardness. The evaluation criteria shall be subject to mutual agreement between the purchaser and the manufacturer.

10.9 Ageing period The values mentioned against the requirements for different mechanical properties are applicable for the periods mentioned in Table **11** from the date , product is available for the shipment at manufacturer's end.

10.10 Thickness for calculating tensile properties and bake hardening properties shall be either one of the following

a) Actual measured thickness after removing the coating layer.
b) Result after subtracting the coating thickness on each side specified in Table **3** from the actual measured thickness including the coating layers.
c) Results after subtracting the equivalent coating thickness of the actual measured coating mass from the measured thickness including the coating layers.
d) Refer to Annex **B** for calculating coating thickness based on coating mass.

11 DIMENSIONS, SHAPE &TOLERANCES

11.1 Coil Inner Diameter— Unless otherwise agreed, the internal diameter of coils shall be 508 mm (±10 mm)

11.2 Tolerances— Tolerances on dimensions (Thickness, width, Length), shape (Flatness, Waviness), camber, and out-of-squareness shall be as per IS/ISO 16163.

11.3 Sheets and strips may be supplied either with mill or trimmed edges. For untrimmed/hot rolled mill edges, width tolerances shall be +20/-0 mm and for edges that are trimmed before cold rolling, width tolerances shall be +7/-0 mm. For edges trimmed after cold rolling, annealing & coating, width tolerances shall be as per IS/ISO 16163.

11.4 For Hot rolled substrate — coated steel sheet and strip with Untrimmed or mill edges, thickness shall be measured at any point not less than 40 mm from a side edge.

12 RETEST

12.1 When a part of the test results fails to comply with the requirement specified, a re-test (two more sets of test samples shall be taken for specific test requirements from the same lot) on the relevant items may be carried out to determine whether it is acceptable or not.

12.2 If any of the re-test samples fail to meet the test requirements of this standard, the lot represented by the sample shall be deemed as not conforming to this standard.

12.3 On any tensile test, if any part of the fracture is outside the middle half of the gauge length as scribed before the test, the test shall be discarded, and a retest carried out.

13 STRAIN AGEING

13.1 Zinc-Aluminium-Magnesium alloy-coated steel sheets and strips tend to strain age, and this may lead to following:

a) Surface marking from stretcher strains or fluting when the steel is formed; and
b) Deterioration in ductility.

13.2 Freedom from stretcher strain for a period of 6 months from the date of manufacture can be achieved by the supply of skin-passed non-ageing steel.

13.3 The details given above are for information and the manufacturer may adopt the same at their discretion.

14 SURFACE APPEARANCE

14.1 The steel sheet in cut lengths shall be free from laminations, surface flaws and other imperfections that are detrimental to the final product's practical application or subsequent appropriate processing.

14.2 However, it is difficult to inspect the overall coils for defects and removing defects in strips is not as easy as the removal of defects in sheets. There can be a mutual agreement between the purchaser and the manufacturer for treating such cases.

14.3 Unless otherwise specified, criteria for acceptability of surface defects shall be applicable to one side. For sheets, it generally refers to the top side of the packing and for strips, the outer side is referred to as the applicable side.

14.4 For Zinc-Aluminium-Magnesium alloy-coated steel sheets and strips, defects that are inherent like dull surface, random black spots, presence of visible airflow patterns, surface darkening, orange peel, Flow marks etc. should not be a reason for rejection if it meets the end application and requirements. The acceptance level of these defects will be as per mutual agreements between the purchaser and the manufacturer.

14.5 The required Surface Quality of the Zinc-Aluminium-Magnesium alloy-coated steel sheets and strips shall be as follows and to be fixed during placing of the order.

14.5.1 As Coated Surface (AC)

Imperfections such as pimples, marks, scratches, pits, variation in surface appearance, dark spots, strip marks, and slight passivation marks are permissible. Stretch levelling marks may appear.

14.5.2 Improved Surface (B)

With this surface quality, small imperfections such as stretch levelling marks, skin pass marks, run-off marks, slight passivation stains are permissible.

14.5.3 Best Quality Surface (I)

The controlled surface shall make it possible to apply a uniform high class paint finish. The other surface shall at least have the characteristics of surface quality of the improved surface.

15 PACKING

Zinc-Aluminium-Magnesium alloy-coated steel sheets and strips should be suitably packed to avoid transit/handling/storage damage and as per the agreement between the purchaser and the manufacturer.

16 MARKING

16.1 The following shall be legibly and indelibly marked on the top of each coil or package of sheets or shown on a tag attached to each coil or packet:

a) IS No. of this standard.
b) Manufacturer's name or trademark.
c) Material identification/coil number/packet number/batch number, etc.
d) Product dimensions.
e) Number of sheets or mass.
f) Designation of Zinc-Aluminium-Magnesium alloy-coated hot rolled and cold reduced carbon steel sheet/strip; and,
g) Date of manufacture.

16.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations framed there under, and the products may be marked with the Standard Mark.

17 STORAGE AND TRANSPORTATION

17.1 Moisture, in particular condensation between the sheets, laps of the coil or other adjacent parts made of hot dip-coated flat products, can lead to the formation of corrosion products. The possible types of temporary surface protection are given in **9**. As a precaution, the products should be transported and stored dry and protected from moisture.

17.2 During transportation, dark spots may appear on the surfaces as a result of friction. Generally, they only impair the appearance. Friction is reduced by oiling the products. Additionally, secure packing, transporting the coils laid flat and avoiding local pressure points, reduce the risk of dark spots.

Table 1 - Type and Designation for Cold Rolled Substrate

(*Clause* 5.1)

Type and Designation		**Thickness** mm
(1)	(2)	(3)
Mild Steel	IZMCCR0	0.20-3.00
	IZMCCR1	0.20-3.00
	IZMCCR2	0.40-3.00
	IZMCCR3	0.40-3.00
	IZMCCR4	0.40-3.00
	IZMCCR5	0.40-3.00
Structural Quality Steel	IZMC300S	0.40-3.00
	IZMC310S	0.40-3.00
	IZMC330S	0.40-3.00
	IZMC360S	0.40-3.00
	IZMC380S	0.40-3.00
	IZMC410S	0.40-3.00
	IZMC420S	0.40-3.00
	IZMC440S	0.40-3.00
	IZMC460S	0.40-3.00
	IZMC480S	0.40-3.00
	IZMC510S	0.40-3.00
	IZMC560S	0.40-3.00
	IZMC570S	0.40-3.00
Bake-hardening steel	IZMC270B	0.40-2.30
	IZMC290B	0.40-2.30
	IZMC320B	0.40-2.30
	IZMC340B	0.40-2.30
	IZMC360B	0.40-2.30
	IZMC400B	0.40-2.30
	IZMC440B	0.40-2.30
Interstitial Free - High Strength	IZMC300P	0.40-2.30
	IZMC330P	0.40-2.30
	IZMC340P	0.40-2.30
	IZMC360P	0.40-2.30
	IZMC370P	0.40-2.30
	IZMC390P	0.40-2.30
	IZMC440P	0.40-2.30
C-Mn Steel (Solid Solution strengthening)	IZMC340W	0.40-3.00
	IZMC370W	0.40-3.00
	IZMC390W	0.40-3.00
	IZMC440W	0.40-3.00
	IZMC490W	0.60-3.00
	IZMC540W	0.60-3.00
	IZMC590W	0.60-3.00
High Strength Low Alloy	IZMC310LA	0.40-3.00
	IZMC320LA	0.40-3.00
	IZMC340LA	0.40-3.00

	IZMC370LA	0.40-3.00
	IZMC410LA	0.40-3.00
	IZMC440LA	0.60-3.00
	IZMC470LA	0.60-3.00
	IZMC500LA	0.60-3.00
	IZMC530LA	0.60-3.00
	IZMC620LA	0.60-3.00
Dual Phase Steel	IZMC450Y	0.40-3.00
	IZMC490Y	0.40-3.00
	IZMC540Y	0.40-3.00
	IZMC590Y	0.40-3.00
	IZMC780Y	0.60-3.00
	IZMC980Y	0.80-3.00
	IZMC980YH	0.80-3.00
	IZMC1180Y	0.80-3.00
TRIP Steel	IZMC590T	0.40-3.00
	IZMC690T	0.60-3.00
	IZMC780T	0.70-3.00
Complex Phase Steel	IZMC600N	0.40-3.00
	IZMC780N	0.70-3.00
	IZMC980N	0.80-3.00

NOTES

1 For any thickness greater than or less than the mentioned range, the same can be produced as mutually agreed to between the manufacturer and the purchaser. Acceptance criteria for the range out of the available product range shall be as agreed to between the purchaser and the manufacturer.

2 Nomenclature of the grade is explained in Annex D.

Table 2 - Type and Designation for Hot Rolled Substrate

(*Clause* 5.1)

Type and Designation		**Thickness** mm
(1)	(2)	(3)
Commercial Quality Steel	IZMHHR1	1.60 -9.00
Drawing Quality Steel	IZMHHR2	1.60 -9.00
	IZMHHR3	1.60 -9.00
	IZMHHR4	1.60 -9.00
Structural Quality Steel	IZMH290S	1.60 -9.00
	IZMH330S	1.60 -9.00
	IZMH360S	1.60 -9.00
	IZMH410S	1.60 -9.00
	IZMH430S	1.60 -9.00
	IZMH450S	1.60 -9.00
	IZMH490S	1.60 -9.00
	IZMH540S	1.60 -9.00
	IZMH570S	1.60 -9.00
High Strength Low Alloy High yield ratio steel	IZMH320LA	1.60 – 9.00
	IZMH360LA	1.60 – 9.00
	IZMH390LA	1.60 – 9.00
	IZMH410LA	1.60 – 9.00
	IZMH430LA	1.60 – 9.00
	IZMH450LA	1.60 – 9.00
	IZMH480LA	1.60 – 9.00
	IZMH500LA	1.60 – 9.00
	IZMH550LA	2.00 - 9.00
	IZMH600LA	2.00 - 9.00
	IZMH650LA	2.00 - 9.00
	IZMH700LA	2.00 - 9.00
	IZMH750LA	2.00 - 9.00
High Strength Structural Steel	IZMH440R	1.60 – 9.00
	IZMH490R	1.60 – 9.00
	IZMH540R	2.00 - 9.00
	IZMH590R	2.00 - 9.00
	IZMH780R	2.00 - 9.00
High hole expansion ratio steel	IZMH440FB	1.60 – 9.00

NOTES

1 For any thickness greater than or less than the mentioned range, the same can be produced as mutually agreed to between the manufacturer and the purchaser. Acceptance criteria for the range out of the available product range shall be as agreed to between the purchaser and the manufacturer.

2 Designation of grade is explained in Annex D

Table 3 - Coating Mass Requirement

(*Clauses* 5.2 and 10.10)

Minimum Requirement for Both Sides		
Coating Class	**Triple Spot Test** g/m^2	**Single Spot Test[a]** g/m^2
(1)	(2)	(3)
ZM060	60	50
ZM070	70	60
ZM080	80	70
ZM090	90	80
ZM100	100	85
ZM120	120	100
ZM130	130	110
ZM140	140	120
ZM150	150	130
ZM160	160	130
ZM175	175	145
ZM180	180	155
ZM190	190	160
ZM200	200	170
ZM220	220	190
ZM250	250	210
ZM275	275	235
ZM300	300	255
ZM310	310	265
ZM350	350	300
ZM430	430	365
ZM450	450	385
ZM500	500	425
ZM600	600	510
ZM650	650	555

NOTES

1 Because of the many variables and changing conditions that are characteristic of continuous Zinc-Aluminium-Magnesium coating, the coating mass is not always evenly divided between the two surfaces of a sheet, neither is the coating evenly distributed from edge to edge.

2 Other coating masses will be produced by agreement between the manufacturer and the purchaser.

a → Single-spot test≅0.85×Triple-spot test

Table 4 - Surface Finish Requirement

(*Clause* 5.4)

Surface Finish Designation	
Type	**Description**
N	As coated Finish. No Skin pass finish
S	Smooth finish with Skin pass
NOTE — For a smooth finish with skin pass, different kinds of surface finishes with varied ranges of roughness values can be mutually agreed upon between the purchaser and the manufacturer. Roughness check shall be carried out in accordance with the IS 15262	

Table 5 - Surface Treatment & Oiling Requirement

(*Clause* 5.5)

Surface Treatment Designation	
C	Mill Passivation
P	Mill Phosphating
O	Oiling
CO	Mill Passivation and Oiling
S	Thin Organic Film (or Sealing)
U	Un-Treated
NOTES — Based on the mutual agreement between the purchaser and the manufacturer, in addition to the above-mentioned treatment or stand-alone, other surface treatments can also be applied.	

Table 6A – Chemical Composition Requirements for Cold Rolled Substrate

(*Clause* 7.1 &7.2)

Type and Designation		**Constituent,** Percent *Max*			
		C	**Mn**	**P**	**S**
(1)	(2)	(3)	(4)	(5)	(6)
Mild Steel	IZMCCR0	0.20	2.00	0.12	0.035
	IZMCCR1	0.18	1.20	0.12	0.035
	IZMCCR2	0.10	0.50	0.04	0.030
	IZMCCR3	0.08	0.45	0.03	0.030
	IZMCCR4	0.06	0.45	0.03	0.030
	IZMCCR5	0.02	0.25	0.03	0.020
Structural Quality Steel	IZMC300S	0.25	1.60	0.10	0.040
	IZMC310S	0.25	1.60	0.10	0.040
	IZMC330S	0.25	1.60	0.10	0.040
	IZMC360S	0.25	1.60	0.10	0.040
	IZMC380S	0.25	1.60	0.10	0.040
	IZMC410S	0.25	1.60	0.10	0.040
	IZMC420S	0.25	1.60	0.10	0.040
	IZMC440S	0.25	1.60	0.10	0.040
	IZMC460S	0.25	1.60	0.10	0.040
	IZMC480S	0.25	1.60	0.10	0.040
	IZMC510S	0.25	1.60	0.10	0.040
	IZMC560S	0.25	1.60	0.10	0.040
	IZMC570S	0.25	1.60	0.10	0.040
Bake-hardening steel	IZMC270B	0.01	0.80	0.10	0.020
	IZMC290B	0.01	0.80	0.10	0.020
	IZMC320B	0.01	0.80	0.10	0.020
	IZMC340B	0.01	1.20	0.10	0.020
	IZMC360B	0.01	1.40	0.10	0.020
	IZMC400B	0.01	1.60	0.10	0.020
	IZMC440B	0.01	1.60	0.10	0.020
Interstitial Free - High Strength	IZMC300P	0.01	0.80	0.10	0.020
	IZMC330P	0.01	0.80	0.10	0.020
	IZMC340P	0.01	0.80	0.10	0.020
	IZMC360P	0.01	1.00	0.10	0.020
	IZMC370P	0.01	1.20	0.10	0.020
	IZMC390P	0.01	1.40	0.10	0.020
	IZMC440P	0.01	1.60	0.10	0.020
C-Mn Steel (Solid Solution strengthening)	IZMC340W	0.12	0.90	0.03	0.030
	IZMC370W	0.15	1.30	0.03	0.030
	IZMC390W	0.20	1.50	0.03	0.030
	IZMC440W	0.20	1.70	0.03	0.030
	IZMC490W	0.20	2.00	0.03	0.030
	IZMC540W	0.20	2.50	0.03	0.030
	IZMC590W	0.25	2.50	0.03	0.030
High Strength Low Alloy	IZMC310LA	0.10	1.00	0.07	0.025

	IZMC320LA	0.10	1.00	0.07	0.025
	IZMC340LA	0.10	1.20	0.07	0.025
	IZMC370LA	0.12	1.40	0.07	0.025
	IZMC410LA	0.12	1.50	0.07	0.025
	IZMC440LA	0.12	1.60	0.07	0.025
	IZMC470LA	0.14	1.60	0.07	0.025
	IZMC500LA	0.14	1.80	0.07	0.025
	IZMC530LA	0.14	1.80	0.07	0.025
	IZMC620LA	0.16	2.50	0.07	0.025
Dual Phase Steel	IZMC450Y	0.15	2.00	0.10	0.020
	IZMC490Y	0.15	2.00	0.10	0.020
	IZMC540Y	0.15	2.20	0.10	0.020
	IZMC590Y	0.15	2.50	0.10	0.020
	IZMC780Y	0.18	2.50	0.10	0.020
	IZMC980Y	0.25	3.50	0.10	0.020
	IZMC980YH	0.25	3.50	0.10	0.020
	IZMC1180Y	0.30	3.50	0.10	0.020
TRIP Steel	IZMC590T	0.30	2.20	0.10	0.015
	IZMC690T	0.35	2.50	0.10	0.015
	IZMC780T	0.35	2.50	0.10	0.015
Complex Phase Steel	IZMC600N	0.18	2.20	0.10	0.015
	IZMC780N	0.18	3.00	0.10	0.015
	IZMC980N	0.20	3.50	0.10	0.015

Notes

1 Steels of these grades can be supplied with the addition of micro-alloying elements like Boron, Titanium, Niobium and Vanadium either singly or in combination shall not exceed 0.2% or as per the above table. However, Boron addition will be restricted to 0.006 per cent max.

2 The nitrogen content of the steel shall not be more than 0.009 per cent. For aluminium killed or aluminium silicon killed the nitrogen content shall not exceed 0.012 per cent. This shall be ensured by occasional checking.

3 The elements (for example Cr, Mo, Ni, etc) not mentioned in the above table can be added up to 1 per cent max either singly or in combination.

4 Restricted chemical composition may be mutually agreed to between the purchaser and the supplier.

5 When the steel is Aluminium killed, the total Aluminium content shall not be less than 0.02 percent. However, aluminium less than 0.02 per cent can be mutually agreed upon between the purchaser and the supplier for Aluminium killed steel.

Table 6B – Chemical Composition Requirements for Hot Rolled Substrate

(*Clauses* 7.1 *and* 7.2)

Type and Designation		**Constituent,** Percent**,** *Max*					
		C	**Mn**	**P**	**S**	**Si**	**Micro Alloying**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Commercial Quality Steel[1]	IZMHHR1	0.15	0.60	0.05	0.035	-	-
Drawing Quality Steel[1]	IZMHHR2	0.10	0.45	0.04	0.035	-	-
	IZMHHR3	0.08	0.40	0.35	0.030	-	-
	IZMHHR4	0.08	0.35	0.30	0.030	-	-
Structural Quality Steel	IZMH290S	0.12	0.60	0.04	0.040	0.50	0.15
	IZMH330S	0.15	0.80	0.04	0.040	0.50	0.15
	IZMH360S	0.17	1.20	0.04	0.040	0.50	0.15
	IZMH410S	0.20	1.40	0.04	0.040	0.50	0.15
	IZMH430S	0.25	1.70	0.05	0.035	0.50	0.15
	IZMH450S	0.25	1.70	0.05	0.035	0.50	0.15
	IZMH490S	0.25	1.70	0.05	0.035	0.50	0.15
	IZMH540S	0.25	1.70	0.05	0.035	0.50	0.15
	IZMH570S	0.25	1.70	0.05	0.035	0.50	0.15
High Strength Low Alloy High yield ratio steel	IZMH320LA	0.12	1.20	0.02	0.025	-	0.22
	IZMH360LA	0.12	1.20	0.02	0.025	-	0.22
	IZMH390LA	0.12	1.30	0.02	0.025	-	0.22
	IZMH410LA	0.12	1.40	0.02	0.025	-	0.22
	IZMH430LA	0.12	1.50	0.02	0.025	-	0.22
	IZMH450LA	0.12	1.50	0.02	0.025	-	0.22
	IZMH480LA	0.12	1.50	0.015	0.025	-	0.22
	IZMH500LA	0.12	1.60	0.015	0.025	-	0.22
	IZMH550LA	0.12	1.70	0.015	0.025	-	0.22
	IZMH600LA	0.12	1.80	0.015	0.025	-	0.22
	IZMH650LA	0.12	1.90	0.015	0.025	-	0.22
	IZMH700LA	0.12	2.00	0.015	0.025	-	0.22
	IZMH750LA	0.12	2.10	0.015	0.025	-	0.22
High Strength Structural Steel	IZMH440R	0.20	1.50	0.02	0.030	-	0.20
	IZMH490R	0.20	1.60	0.02	0.030	-	0.20
	IZMH540R	0.20	1.70	0.02	0.030	-	0.20
	IZMH590R	0.20	1.80	0.02	0.030	-	0.20
	IZMH780R	0.20	2.00	0.02	0.030	-	0.25
High hole expansion ratio steel	IZMH440FB	0.16	1.60	-	-	-	0.20

Notes

1 Steel of these grades can be supplied with the addition of micro-alloying elements like Boron, Titanium, Niobium and Vanadium either singly or in combination shall not exceed 0.2% or as per the above table. However, Boron addition will be restricted to 0.006 per cent max.

2 The nitrogen content of the steel shall not be more than 0.009 per cent. For aluminium killed or aluminium silicon killed the nitrogen content shall not exceed 0.012 per cent. This shall be ensured by occasional checking.

3The elements (for example Cr, Mo, Ni, etc) not mentioned in the above table can be added up to 1 per cent max either singly or in combination.

4 Restricted chemical composition may be mutually agreed to between the purchaser and the supplier.

5 When the steel is Aluminium killed, the total Aluminium content shall not be less than 0.02 percent. However, aluminium less than 0.02 percent can be mutually agreed between the purchaser and the supplier for Aluminium killed steel.

Table 7– Tolerances on Product Requirements

(*Clause* 7.2)

Element	**Specified Chemical Composition Limit,** Percent, *Max*	**Permissible Variation Over the specified Limit,** Percent, *Max*
(1)	(2)	(3)
Carbon	≤0.150	0.02
	> 0.150	0.03
Manganese	≤0.6	0.03
	>0.60, ≤1.150	0.04
	>1.150	0.05
Sulphur	≤ 0.050	0.005
Phosphorus	≤0.050	0.005
	> 0.050	0.01
Silicon	≤0.600	0.03
	> 0.600	0.06
Micro Alloy	-	Subject to negotiation
Note — Sufficient care should be taken while carrying out product analysis on thin samples.		

Table 8 – Coating Adherence Test

(*Clause* 8.3)

Type	**Grade Designation/Strength**	**Bending Angle**	**Diameter of Mandrel for Bending** mm					
			t **< 1.6 mm for Cold-rolled substrate 1.60 mm≤** ***t*** **< 3.00 mm for Hot-rolled substrate**			***t*** **≥ 1.6 mm for Cold-rolled substrate** ***t*** **≥ 3.00 mm**		
			up to ZM275	**ZM300-ZM350**	**ZM450 & Above**	**up to ZM275**	**ZM300-ZM350**	**ZM450 & Above**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mild Steel	IZMCCR1	180^0	1*t*	--	--	1*t*	--	--
	IZMCCR2, IZMCCR3,IZMCCR4,IZMCCR5	180^0	Close	--	--	Close	--	--
Structural Quality Steel (Cold-rolled substrate)	Tensile Strength ≤310 MPa	180^0	1*t*	1*t*	2*t*	1*t*	2*t*	2*t*
	310 MPa < Tensile Strength ≤ 400 MPa	180^0	2*t*	2*t*	2*t*	2*t*	2*t*	2*t*
	400 MPa < Tensile Strength ≤ 500 MPa	180^0	3*t*	3*t*	3*t*	3*t*	3*t*	3*t*
	Tensile Strength >500 MPa	180^0	*	*	*	*	*	*
High Strength Low Alloy (Cold-rolled substrate)	Tensile Strength ≤500 MPa	180^0	1*t*	1*t*	1*t*	1*t*	1*t*	1*t*
	Tensile Strength >500 MPa	180^0	2*t*	2*t*	2*t*	2*t*	2*t*	2*t*
Commercial Quality Steel	IZMHHR1	180^0	1*t*	2*t*	2*t*	2*t*	2*t*	2*t*
Drawing Quality Steel	IZMHHR2	180^0	1*t*	2*t*	2*t*	2*t*	2*t*	2*t*
	IZMHHR3	180^0	1*t*	2*t*	2*t*	2*t*	2*t*	2*t*
	IZMHHR4	180^0	1*t*	2*t*	2*t*	2*t*	2*t*	2*t*
Structural Quality Steel	IZMH290S	180^0	1*t*	2*t*	2*t*	2*t*	2*t*	2*t*
	IZMH330S	180^0	1*t*	2*t*	2*t*	2*t*	2*t*	2*t*
	IZMH360S	180^0	1*t*	1*t*	2*t*	2*t*	2*t*	3*t*
	IZMH410S	180^0	2*t*	2*t*	2*t*	3*t*	3*t*	3*t*
	IZMH430S	180^0	2*t*	2*t*	2*t*	3*t*	3*t*	3*t*
	IZMH450S	180^0	3*t*	3*t*	3*t*	3*t*	3*t*	3*t*
	IZMH490S	180^0	3*t*	3*t*	3*t*	3*t*	3*t*	3*t*
	IZMH540S	180^0	3*t*	3*t*	3*t*	3*t*	3*t*	3*t*
	IZMH570S	180^0	3*t*	3*t*	3*t*	3*t*	3*t*	3*t*

Notes

1 (--) → Can be applied based on the mutual agreement between the purchaser and manufacturer.

2 Stricter Conditions and adherence tests on other designations & grades can be applied based on mutual agreement between purchaser and manufacturer.

3 (*) → These are generally not subjected to coating adherence test. Subject to mutual agreement between purchaser and manufacturer.

4 *t* Nominal thickness of the product.

5 For the remaining grades of hot rolled substrate, coating adherence test to be carried out as per the mutual agreement between purchaser and manufacturer and acceptance criteria shall be as per the mutual agreement between purchaser and manufacturer.

Table 9A – Mechanical Property Requirement
(For Cold Rolled Substrate)

(*Clauses* 10.3.1, 10.3.2, 10.4.2, 10.5.2 *and* 10.6.1)

Type and Designation		**Tensile Strength** N/mm^2 *Min*	**Yield point or proof stress** N/mm^2			**%Elongation**, *Min* (Test Piece Type 2 of IS 1608 Part 1)			**Testing Direction**	**Bake Hardening Index (BH)** N/mm^2, *Min*	**Plastic strain Ratio**		**Strain Hardening Exponent**	
			Thickness, *t* mm			Thickness, *t* mm								
			≤ 0.5	0.5 <*t*≤ 0.7	*t*> 0.70	≤ 0.5	0.5 <*t*≤ 0.7	*t*> 0.70			r-td, *Min*	r bar, *Min*	n-td , *Min*	n Value, *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Mild Steel[9]	IZMCCR0	--	--	--	--	--	--	--	--	--	--	--	--	--
	IZMCCR1[9]	270	--	--	--	--	--	22	--	--	--	--	--	--
	IZMCCR2	270	140-300	140-280	140-260	26	28	30	Transverse	--	--	--	--	--
	IZMCCR3	270	120-260	120-240	120-220	30	32	34	Transverse	--	1.6[a]	1.4[a]	0.18[a]	0.16[a]
	IZMCCR4	260	120-220	120-200	120-180	33	35	37	Transverse	--	1.7[a]	1.4[a]	0.2[a]	0.18[a]
	IZMCCR5	260	120-210	120-190	120-170	35	37	39	Transverse	--	1.9[a]	1.6[a]	0.21[a]	0.2[a]
Structural Quality Steel	IZMC300S	300	220 Min			16	18	20	Longitudinal	--	--	--	--	--
	IZMC310S	310	230 Min			16	18	20	Longitudinal	--	--	--	--	--
	IZMC330S	330	250 Min			15	17	19	Longitudinal	--	--	--	--	--
	IZMC360S	360	280 Min			14	16	18	Longitudinal	--	--	--	--	--
	IZMC380S	380	280 Min			13	15	17	Longitudinal	--	--	--	--	--
	IZMC410S	410	335 Min			12	14	16	Longitudinal	--	--	--	--	--
	IZMC420S	420	350 Min			12	14	16	Longitudinal	--	--	--	--	--
	IZMC440S	440	365 Min			11	13	15	Longitudinal	--	--	--	--	--
	IZMC460S	460	390 Min			11	13	15	Longitudinal	--	--	--	--	--
	IZMC480S	480	420 Min			10	12	14	Longitudinal	--	--	--	--	--
	IZMC510S	510	450 Min			10	12	14	Longitudinal	--	--	--	--	--
	IZMC560S	560	550 Min			--	--	--	Longitudinal	--	--	--	--	--
	IZMC570S	570	550 Min			--	--	--	Longitudinal	--	--	--	--	--
Bake-hardening steel	IZMC270B	270	160-260	160-240	160-220	34	36	38	Longitudinal	30	--	1.3	--	0.18
	IZMC290B	290	180-280	180-260	180-240	30	32	34	Transverse	30	1.7	--	0.16	--
	IZMC320B	320	220-320	220-300	220-280	28	30	32	Transverse	30	1.2	--	0.15	--
	IZMC340B	340	220-330	220-310	220-290	28	30	32	Transverse	30		1	--	0.15

	IZMC360B	360	260-370	260-350	260-330	24	26	28	Transverse	30	--	--	--	--
	IZMC400B	400	300-400	300-380	300-360	22	24	26	Transverse	30	--	--	--	--
	IZMC440B	440	340-440	340-420	340-400	20	22	24	Transverse	30	--	--	--	--
Interstitial Free – High Strength	IZMC300P	300	160-260	160-240	160-220	33	35	37	Transverse	--	1.9	--	0.2	--
	IZMC330P	330	180-280	180-260	180-240	30	32	34	Transverse	--	1.7	--	0.18	--
	IZMC340P	340	180-290	180-270	180-250	28	30	32	Transverse	--	--	1.3	--	0.2
	IZMC360P	360	220-330	220-310	220-290	28	30	32	Transverse	--	1.5	--	0.17	--
	IZMC370P	370	260-370	260-350	260-330	26	28	30	Transverse	--	1.2	--	0.15	--
	IZMC390P	390	280-400	280-380	280-360	23	25	27	Transverse	--	1.3	--	0.15	--
	IZMC440P	440	280-420	280-400	280-380	22	24	26	Transverse	--	--	1.1	--	0.15
C-Mn Steel (Solid Solution strengthening)	IZMC340W	340	220-340	220-320	220-300	29	31	33	Transverse	--	--	--	--	--
	IZMC370W	370	240-360	240-340	240-320	26	28	30	Transverse	--	--	--	--	--
	IZMC390W	390	260-390	260-370	260-350	25	27	29	Transverse	--	--	--	--	--
	IZMC440W	440	280-410	280-390	280-370	22	24	26	Transverse	--	--	--	--	--
	IZMC490W	490	--	310-420	310-400	--	20	22	Transverse	--	--	--	--	--
	IZMC540W	540	--	330-460	330-440	--	17	19	Transverse	--	--	--	--	--
	IZMC590W	590	--	350-470	350-460	--	14	16	Transverse	--	--	--	--	--
High Strength Low Alloy	IZMC310LA	310	210-330	210-310	210-290	22	24	26	Transverse	--	--	--	--	--
	IZMC320LA	320	240-360	240-340	240-320	20	22	24	Transverse	--	--	--	--	--
	IZMC340LA	340	260-380	260-360	260-340	20	22	24	Transverse	--	--	--	--	--
	IZMC370LA	370	300-420	300-400	300-380	19	21	23	Transverse	--	--	--	--	--
	IZMC410LA	410	340-460	340-440	340-420	16	18	20	Transverse	--	--	--	--	--
	IZMC440LA	440	--	380-460	380-440	--	15	17	Transverse	--	--	--	--	--
	IZMC470LA	470	--	420-540	420-520	--	14	16	Transverse	--	--	--	--	--
	IZMC500LA	500	--	460-600	460-580	--	10	12	Transverse	--	--	--	--	--
	IZMC530LA	530	--	500-640	500-620	--	8	10	Transverse	--	--	--	--	--
	IZMC620LA	620	--	550 *Min*	550 *Min*	--	7	9	Transverse	--	--	--	--	--
Dual Phase Steel	IZMC450Y	450	260-380	260-360	260-340	23	25	27	Transverse	--	--	--	--	--
	IZMC490Y	490	290-420	290-400	290-380	20	22	24	Transverse	--	--	--	--	--
	IZMC540Y	540	310-450	310-430	310-410	18	20	22	Transverse	--	--	--	--	--
	IZMC590Y	590	330-470	330-450	330-430	16	18	20	Transverse	--	--	--	--	--
	IZMC780Y	780	--	440-570	440-550	--	12	14	Transverse	--	--	--	--	--
	IZMC980Y	980	--	--	590-740	--	--	10	Transverse	--	--	--	--	--
	IZMC980YH	980	--	--	700-850	--	--	8	Transverse	--	--	--	--	--
	IZMC1180Y	1180	--	--	740-1000	--	--	7	Transverse	--	--	--	--	--
TRIP Steel	IZMC590T	590	360-550	360-530	360-510	22	24	26	Transverse	--	--	--	--	--
	IZMC690T	690	--	380-550	380-530	--	19	21	Transverse	--	--	--	--	--
	IZMC780T	780	--	--	410-560	--	--	16	Transverse	--	--	--	--	--
	IZMC600N	600	350-570	350-550	350-530	10	12	14	Transverse	--	--	--	--	--

Complex Phase Steel	IZMC780N	780	--	--	500-710	--	--	9	Transverse	--	--	--	--	--
	IZMC980N	980	--	--	690-910	--	--	6	Transverse	--	--	--	--	--

NOTES for Table 9A

1 $1N/mm^2 = 1$ MPa.

2 Stricter mechanical properties requirements may be agreed to between the manufacturer and the purchaser, before placing the order.

3 Mechanical properties apply only to annealed followed by skin-passed products.

4 The values of yield stress are the 0.2 per cent proof stress for products that do not represent a marked yield point and the lower yield stress for the others.

5 (--) → Not required. Where deemed required, the purchaser and the manufacturer can agree up on testing with mutually agreed criteria for evaluation.

6 a → It is required to report only one value against the plastic strain ratio (either r-bar or r-td) and strain hardening exponent (n-value or n-td).

7 Based on the mutual agreement between purchaser and manufacturer, different testing directions & test specimen types can be applied while conducting tensile tests. For such cases, mechanical properties requirements will be based on the mutual agreement and those agreed values should be reasonably close to the values mentioned in Table 9A.

8 IZMCCR0 is a cold rolled full hard grade. Based on mutual agreement, a hardness check can be applied.

9 Tensile requirements are not required, if desired by the purchaser.

10 td – Tensile test direction

Table 9B – Mechanical Property Requirement (For Hot Rolled Substrate)

(*Clauses* 10.3.1 *and* 10.3.2)

Type and Designation		**Tensile Strength** N/mm^2	**Yield point or proof stress** N/mm^2 *Min*	**Elongation**, Percent, *Min*				**Testing Direction**
				$t \leq 3.0$ mm		$t > 3.0$ mm		
				Type 2 Specimen as Per IS 1608 (Part 1)	Type 3 Specimen as Per IS 1608 (Part 1)	Gauge Length $L_0=5.65\sqrt{S_0}$	Gauge Length $L_0=50$ mm	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Commercial Quality Steel	IZMHHR1	440 *Max*	--	23	24	28	29	Transverse
Drawing Quality Steel	IZMHHR2	420 *Max*	--	25	26	30	31	Transverse
	IZMHHR3	400 *Max*	--	28	29	33	34	Transverse
	IZMHHR4	380 *Max*	--	31	32	36	37	Transverse
Structural Quality Steel	IZMH290S	290 *Min*	165 *Min*	22	--	30	--	Transverse
	IZMH330S	330 *Min*	205 *Min*	20	--	28	--	Transverse
	IZMH360S	360 *Min*	235 *Min*	19	--	26	--	Transverse
	IZMH410S	410 *Min*	255 *Min*	17	--	23	--	Transverse
	IZMH430S	430 *Min*	320 *Min*	12	--	21	14	Transverse
	IZMH450S	450 *Min*	350 *Min*	10	--	20	12	Transverse
	IZMH490S	490 *Min*	355 *Min*	10	--	20	--	Transverse
	IZMH540S	540 *Min*	380 *Min*	10	--	17	12	Transverse
	IZMH570S	570 *Min*	450 *Min*	--	--	--	--	Transverse
High Strength Low Alloy High yield ratio steel	IZMH320LA	320-420	255 Min	25	--	27	--	Transverse
	IZMH360LA	360-460	300 Min	23	--	25	--	Transverse
	IZMH390LA	390-510	315 Min	20	--	24	--	Transverse
	IZMH410LA	410-520	340 Min	20	--	23	--	Transverse
	IZMH430LA	430-550	355 Min	19	--	23	--	Transverse
	IZMH450LA	450-570	380 Min	18	--	21	--	Transverse
	IZMH480LA	480-620	420 Min	16	--	19	--	Transverse
	IZMH500LA	500-670	450 Min	14	--	18	--	Transverse
	IZMH550LA	550-700	500 Min	12	--	14	--	Transverse

	IZMH600LA	600-760	550 Min	12	--	14	--	Transverse
	IZMH650LA	650-820	600 Min	11	--	13	--	Transverse
	IZMH700LA	700-880	650 Min	10	--	12	--	Transverse
	IZMH750LA	750-950	700 Min	10	--	11	--	Transverse
High Strength Structural Steel	IZMH440R	440	305 Min	--	26	--	28	Transverse
	IZMH490R	490	355 Min	--	22	--	24	Transverse
	IZMH540R	540	410 Min	--	19	--	21	Transverse
	IZMH590R	590	450 Min	--	17	--	19	Transverse
	IZMH780R	780	675 Min	--	14	--	15	Transverse
High hole expansion ratio steel	IZMH440FB	440	265 Min	--	28	--	33	Longitudinal

NOTES for Table 9B

1 1N/mm2 = 1 MPa.

2 Stricter mechanical properties requirements may be agreed to between the manufacturer and the purchaser, before placing the order.

3 Mechanical properties apply only to annealed followed by skin-passed products.

4 The values of yield stress are the 0.2 per cent proof stress for products that do not represent a marked yield point and the lower yield stress for the others.

5 (--) → Not required. Where deemed required, the purchaser and the manufacturer can agree up on testing with mutually agreed criteria for evaluation.

6 Minimum tensile strength for IZMHHR1, IZMHHR2, IZMHHR3 and IZMHHR4 would normally be expected to be 270 MPa. Where minimum tensile strength is required, the value of 270 MPa may be specified. All tensile strength values are determined to the nearest 10MPa.

7 Based on the mutual agreement between the purchaser and manufacturer, different testing directions can be applied while conducting tensile tests. For such cases, mechanical properties requirement will be based on the mutual agreement and those agreed values should be reasonably close to the values mentioned in Table 9B.

8. For Grade IZMH440FB, Minimum Hole expansion (HER) required shall be 70 %. The test shall be conducted in accordance with IS 17414.

Table 10 – Requirements for Bend Test for Cold Rolled Substrate

(*Clause* 10.7.2)

Minimum Tensile Strength MPa	**Bend Angle**	**Bend Radius (t= thickness of sheet)**
(1)	(2)	(3)
340	180^0	Close
370	180^0	Close
390	180^0	Close
440	180^0	Close
490	180^0	Close
540	180^0	0.5*t*
590	180^0	1*t*
780	180^0	3*t*
900	180^0	4*t*
980	180^0	4*t*
1100	180^0	4*t*

NOTES

1 For grades, where a minimum tensile requirement is not mentioned in the above table, the nearest minimum tensile strength value can be applied.

2 Based on mutual agreement, stricter test conditions can be applied

Table 11 – Ageing Period Requirement for Cold Rolled Substrate

(*Clause* 10.9)

Type and Designation		**Applicable Non-Ageing Period**
(1)	(2)	(3)
Mild Steel	IZMCCR2	8 Days
	IZMCCR3	1 Month
	IZMCCR4	6 Months
	IZMCCR5	6 Months
Bake-hardening steel	IZMC270B	3 Months
	IZMC290B	3 Months
	IZMC320B	3 Months
	IZMC340B	3 Months
	IZMC360B	3 Months
	IZMC400B	3 Months
	IZMC440B	3 Months
Interstitial Free - High Strength	IZMC300P	6 Months
	IZMC330P	6 Months
	IZMC340P	6 Months
	IZMC360P	6 Months
	IZMC370P	6 Months
	IZMC390P	6 Months
	IZMC440P	6 Months

NOTES

1 Applicable non ageing period is applicable only for the Type and designation mentioned in Table 11. For the remaining Type and designations, based on mutual agreement, non-ageing period can be applied.

2 Based on mutual agreement, stricter test conditions can be applied

ANNEX A
(*Clause* 2)
LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 228(Various parts)	Method for chemical analysis of steel
IS 513 (Part 1) : 2016	Cold reduced carbon steel sheet and strip: Part 1 Cold forming and drawing purpose (*sixth revision*)
IS 513 (Part 2) : 2016	Cold reduced carbon steel sheet and strip : Part 2 High tensile and multi-phase steel (*sixth revision*)
IS 1079 : 2017	Hot rolled carbon steel sheet, plate and strip — specification (*seventh revision*)
IS 1501 Part 1:2020/ ISO 6507-1:2018	Metallic materials — Vickers hardness test Part 1 test method (*fifth revision*)
IS 1586 Part 1:2018/ ISO 6508-1:2016	Metallic materials — Rockwell hardness test : Part 1 test method (*fifth revision*)
IS 1608 (Part 1) : 2022/ ISO 6892-1 : 2019	Metallic materials — Tensile testing : Part 1 Method of test at room temperature (*fifth revision*)
IS 1956 (Part 4) : 2013	Glossary of terms relating to iron and steel : Part 4 Flat products (*second revision*)
IS 2590:1987	Specification For Primary Aluminium Ingots For Remelting For General Engineering Purposes (*Second Revision*)
IS 2629:1985	Recommended practice for hot- dip galvanizing of iron and steel (*first revision*)
IS 3531:1997	Glossary Of Terms Relating To Corrosion Of Metals (*Second Revision*)
IS 6694: 1999	Magnesium Ingots - Specification (*Second Revision*)
IS 6745 : 1972	Methods for determination of mass of zinc coating on zinc coated iron and steel articles
IS 8910 : 2022 / ISO 404:2013	Steel and Steel Products — General Technical Delivery Requirements (*second revision*)
IS 11999:2022/ ISO 10113:2020	Metallic Materials — Sheet and Strip — Determination of Plastic Strain Ratio (*second revision*)
IS 12860 : 1989	Metallic coating thickness by X-Ray fluorescence technique method — Determination
IS 15262:2002/ ISO 4287 : 1997	Geometrical product specifications (GPS) — surface texture: Profile method — terms, definitions, and surface texture parameters
IS 15756: 2022/ ISO 10275:2020	Metallic materials - Sheet and strip - Determination of tensile strain hardening exponent (*first revision*)
IS/ISO 16163: 2012	Continuously hot - dipped coated steel sheet products - Dimensional and shape tolerances (*first revision*)
IS 5986: 2017	Hot Rolled Steel Sheet, Plate and Strip for Forming and Flanging Purposes — Specification
IS 18385: 2023	Hot-Dip Galvanized/Galvannealed Steel sheet, Plate and Strip for Automotive Applications — Specification
IS 17414:2020/ ISO 16630:2017	Metallic Materials — Sheet and Strip — Hole Expanding Test

Annex B

(*Clauses* 3.1 *and* 10.10)

ORDERS REQUIRING BASE-METAL THICKNESS

B.1 THE AVERAGE THICKNESS OF THE COATING CALCULATION

When specified by the purchaser, the ordered thickness shall be the base-metal thickness. In these cases, the product thickness shall be calculated as the base-metal thickness + the equivalent coating thickness for each surface, as indicated in FIG.1.
Thickness tolerance tables apply to the product thickness.

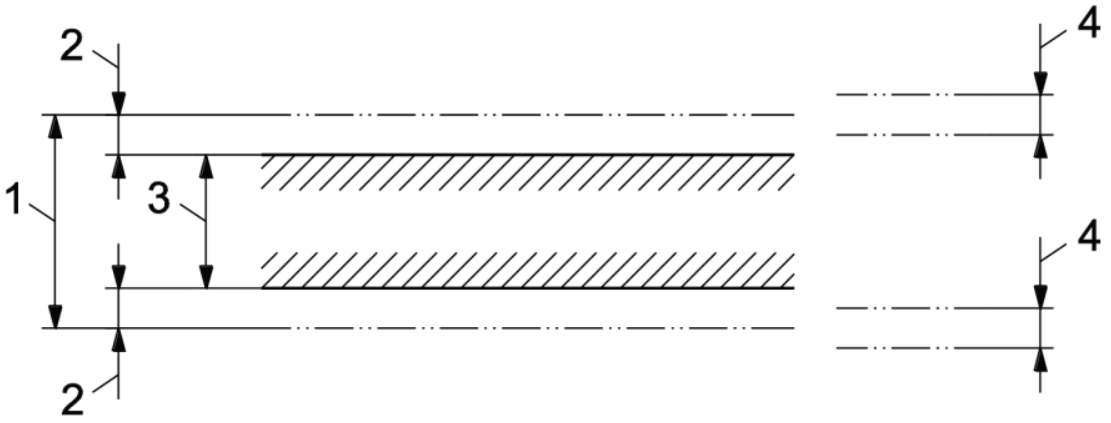


FIG.1 — CALCULATIONOF THE PRODUCT THICKNESS

Key
1 product thickness
2 equivalent coating thickness
3 base-metal thickness
4 thickness tolerance
The equivalent coating thickness may be calculated from coating mass, e.g. as follows:

$$t_z = m_z / 2d$$

Where
t_z— equivalent coating thickness(μm)
m_z— coating mass on both surfaces (g/m^2)
d — coating density (g/cm^3)

CALCULATION OF THE COATING DENSITY

The coating density calculation of the Zinc-Aluminium-Magnesium alloy coating may be calculated as follows:

$$d = 7.14 \cdot X_{Zn} + 2.70 \cdot X_{Al} + 1.74 \cdot X_{Mg}$$

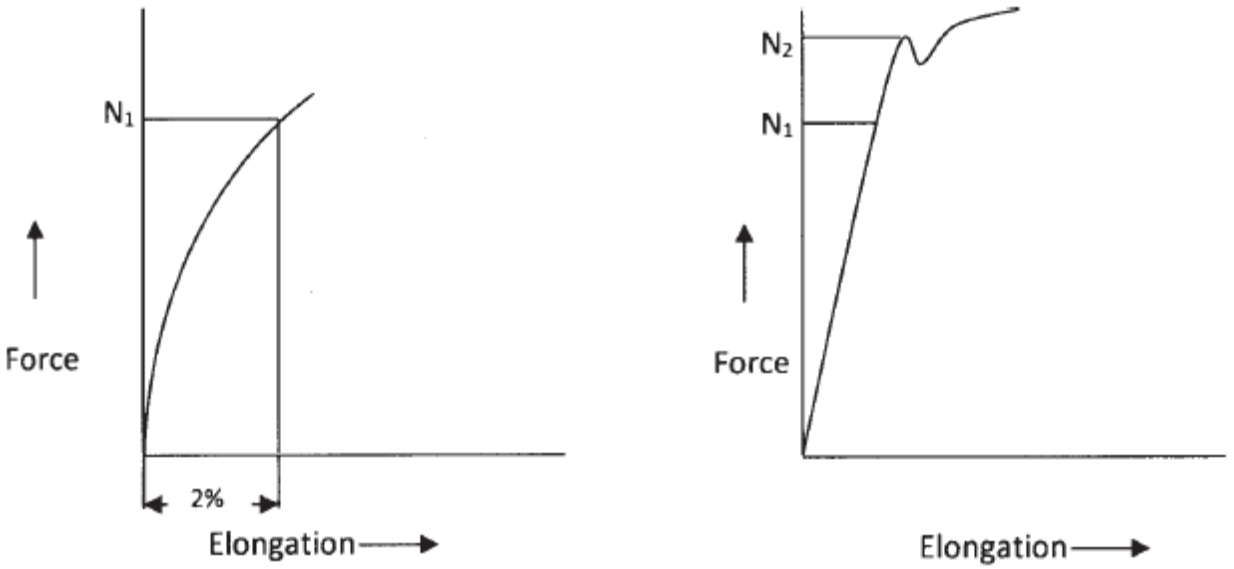
Where
d — coating density (g/cm^3)
X_{Zn}— mole fraction of zinc in the Zinc-Aluminium-Magnesium alloy
X_{Al}— mole fraction of aluminium in the Zinc-Aluminium-Magnesium alloy
X_{Mg}— mole fraction of magnesium in the Zinc-Aluminium-Magnesium alloy

ANNEX C
(*Clause* 10.6.1)

BAKE HARDENING TEST

The bake hardening index (BH) is the increase in the yield point that is found in the bake hardening test carried out. Bake hardening of steel is achieved during the paint baking treatment. The test procedure for the determination of bake hardening index is as follows:

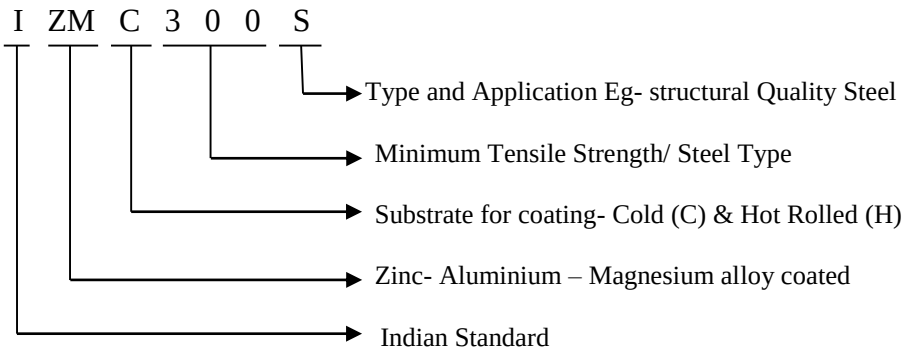
a) Test specimens shall be collected from annealed skin-passed material in the direction mentioned as per Table 9A. Tensile specimen to be prepared as per IS 1608 Part 1
b) The parallel portion area of the test piece shall be noted be as A_0.
c) The test specimen shall be strained to 2 per cent tensile elongation. The corresponding force shall be noted as N_1.
d) The specimen shall be unloaded from the tensile tester and heat treated for 20 min at a temperature of 170^0C
e) After the heat treatment, the test specimen shall be subjected to tensile testing again. The sharp yield point is expected to appear along with the yield drop phenomenon. The force corresponding to the upper yield point shall be noted as N_2.
f) The BH value calculation shall be obtained as $BH = (N_2 – N_1)/A_0$
g) BH Value calculation is schematically represented in below FIG 2.



Preliminary Strain Loading — After Baking Process – Heat Treatment

FIG 2. -Schematic Representation of BH values.

Annex D
(*Table 1 and Table 2*)
NOMENCLATURE



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भारतीय मानक ब्यूरो

भारतीय मानक प्रारूप

सतत् पूर्व-रोगनीत जस्तिकृत इस्पात की चादरें एवं पत्तीयां – विशिष्टि

(IS 14246 *का दूसरा पुनरीक्षण)*

Draft Indian Standard

CONTINUOUSLY PRE-PAINTED GALVANIZED STEEL SHEETS AND STRIPS - SPECIFICATION

(*Second revision of* IS 14246)

ICS 47.020.05

Wrought Steel Products Sectional Committee, MTD 4

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1995 and revised in 2013. While reviewing this standard, in the light of experience gained during these years, the Committee decided to revise it to bring it in line with the present practices being followed by the Indian industry.

Pre-painted galvanized steel sheets and strips produced by coating synthetic resin / organic coating such as alkyd, epoxy, polyester, acrylic, etc., on continuous paint line (CPL) covered by this standard are intended to be used for roofing, architectural siding, home appliances and other general article purposes.

In this revision the following changes have been made:

a) Scope has been modified;
b) Solvent Resistance Test has been added;
c) Assessment of degree of blistering has been added;
d) Requirements for Salt Spray Resistance has been modified;
e) Clauses 4.1, 4.2, 4.3, 6.1, 6.2.3, 9.4.1, 9.4.2, 10.1 and 10.2 have been modified;
f) Clauses 1.3, 4.4, 4.5, 6.4.3, 6.6 , 8.1 and 8.2 have been added.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO standard may also be followed as an alternate method.

The Committee responsible for the formulation of this standard has reviewed the provisions of following International Standards referred in this standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 2808 : 2019	Paints and varnishes — Determination of film thickness
ISO 4628-2 : 2016	Paints and varnishes — Part 2: Assessment of degree of blistering

The composition of the Committee responsible for formulation of this standard is given in Annex D

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision)'. The number of significant places retained in the rounded off value should be* the same as that of the specified value in this standard.

CONTINUOUSLY PRE-PAINTED GALVANIZED STEEL SHEETS AND STRIPS - SPECIFICATION

(*Second Revision*)

1 SCOPE

1.1 This standard covers the requirement of continuously pre-painted hot-dip galvanized steel sheets and strips.

1.2 Sheets and strips produced by uniformly coating and baking durable organic coating, for example, alkyd, epoxy, polyester, acrylic, etc., over one or both surfaces of galvanized steel sheets and strips using cold rolled steel sheets and strips as base.

1.3 This standard covers requirements for different classes of durability of paint coatings in accordance with the severity of the application.

2 REFERENCES

The standards listed below contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS 101 (Part 4/Sec 4):2020/ISO 2813:2014	Methods of Sampling and Test for Paints, Varnishes and Related Products Part 4 Optical Test Section 4 Gloss — Determination of gloss value at 20°, 60° and 85° (*fourth revision*)
IS 101 (Part 5/Sec 1):1988	Methods of sampling and test for paints, varnishes and related products: Part 5 mechanical test on paint films: Sec 1 hardness tests (*third revision*)
IS 101 (Part 5/Sec 2):1988	Methods of sampling and test for Paints, varnishes and related products. Mechanical Tests: Sec 2 flexibility and adhesion (*third revision*)
IS 101 (Part 6/Sec 1):1988	Methods of sampling and test for Paints, varnishes and related products. Durability Tests: Sec 1 Resistance to Humidity under conditions of condensation (*third revision*)

IS 277:2018	Galvanized steel strips and sheets (plain and corrugated) — specification (*seventh revision*)
IS 8910:2022/ ISO 404:2013	Steel and Steel Products — General technical delivery requirements (*second revision*)
IS 9844: 1981	Method of testing corrosion resistance of electroplated and anodized aluminium coating by neutral salt spray test
IS/ISO 16163:2012	Continuously hot-dipped coated steel sheet products — Dimensional and shape tolerances (*first revision*)
ISO 2808: 2019	Paints and varnishes — Determination of film thickness
ISO 4628-2: 2016	Paints and varnishes — Part 2: Assessment of degree of blistering

3 SUPPLY OF MATERIAL

General requirement relating to the supply of pre-painted galvanized steel sheets and strips shall be as laid down in IS 8910.

4 MANUFACTURE

4.1 Steel Base

The base steel and its grade for pre-painted galvanized sheet and strip shall conform to IS 277.

4.2 Metallic Coating

The recommended grade of zinc coating shall be as per IS 277.

4.3 Organic coating

Pre-painting shall be done on a continuous paint line by applying a conversion coating, primer, backer coat and finish coat on substrate that is galvanized steel. Curing of paint coatings shall be at a temperature suitable to produce an aesthetic and durable painted surface. While referring to Table 1, for Class 1 and Class 2, primer coat may not be there. For Class 2, 3 & Class 4, minimum primer coating for each surface shall not be less than 4 μm with specified top side coating thickness shall not be less than be 15 μm and the bottom side (backer coat) coating shall not be less than 4 μm . For Class 1, the top side coating shall not be less than 10 μm and the bottom side (backer coat) coating shall not be less than 4 μm . The triple spot organic coating thickness, i.e. the average of three tests, shall not be less than 80% of the coating thickness specified. The single spot thickness, i.e. the lowest value of the three determinations, shall not be less than 90% of the triple spot thickness. The double sided product shall have same organic coating system for both surfaces. Product with organic coating on one surface only is also possible and which is classified as “Class 0”.

For guidance, type and thickness of coating and applications are given in Annex A. Other coating thicknesses can be supplied as per mutual agreement between the manufacturer and the supplier.

4.4 Dry Film Thickness

This refers to the paint film thickness of the finish coat or topcoat. When measured by method as mentioned in **5B** of ISO 2808, the supplied dry film thickness of paint coating (Finish coat or topcoat) shall comply with the requirements of the **4.3** of this specification or the agreement between the manufacturer and the purchaser.

4.5 The pre-painted galvanized steel sheets of this standard may also be supplied in profiles based on mutual agreement between the purchaser and the supplier for structural applications subject to fulfillment of required condition for imposed load on roofs as per **4.2** of IS 875 (Part 2).

5 CLASSIFICATION OF DURABILITY OF ORGANIC COATING

It shall be as given in Table 1.

Table 1 Classification of Durability of Paint Coating
(*Clauses* 4.3, 5 *and* 8)

Sl. No.	Classification	Duration of Salt Spray Test in Hours, *Min*		Humidity Resistance (IS 101 Part 6/Sec 1)	
		Top Side	Bottom Side	Top Side	Bottom Side
(1)	(2)	(3)	(4)	(5)	(6)
i)	Class 1	350	200	350	200
ii)	Class 2	500	200	500	350
iii)	Class 3	1000	500	1000	500
iv)	Class 4	2000	750	1000	500

NOTES
1 Other durations may also be specified and agreed between the supplier and the purchaser
2 Durability tests are for manufacturer's information only and are not necessarily mandatory at the time of production/coating.

6 TESTS FOR PHYSICAL PROPERTIES OF ORGANIC COATING

6.1 Sampling of Test Specimen

One sample for bend test, pencil hardness test, reverse impact resistance test, cross hatch adhesion and solvent resistance tests shall be taken from every 10 t of sheets/strips or part

thereof of the same quality, dimensions, grade of zinc coating and colour. Unless otherwise specified, only one test piece shall be cut out of one sheet/strip in parallel to the rolling direction of the base metal.

6.2 Bend Test

6.2.1 Bend test shall be carried out for annealed and skin passed material.

6.2.2 The test piece shall have a width of 75 mm to 125 mm and length of 230 mm.

6.2.3 The test specimen shall be bent through an angle of 180 degree around a mandrel having diameter (times nominal thickness) specified in Table 2 with a hand vice or any other suitable means. A bench vice approximately 150 mm wide or alternative bending apparatus can also be used. The axis of the bend shall be in the direction of rolling. Bending shall be done such that top side surface is outside.

6.2.4 There shall be no peeling or cracking of paint film at the bent portion.

6.3 Pencil Hardness Test

6.3.1 Standard pencils of hardness as given in Table 2 should be used for pencil hardness test as per IS 101 (Part 5/ Sec 1).

Table 2 Physical Properties of Paint Coating
(*Clauses* 6.2.3 *and* 6.3.1)

Sl. No.	Test	Requirement
(1)	(2)	(3)
i)	Bend Test	
	a) For roofing, cladding and accessories	4*t*
	b) For appliances and other internal applications	2*t*
ii)	Pencil Hardness Test	
	a) For roofing and cladding	2*H*
	b) For appliances and other internal applications	*H*

NOTE — *t* = nominal thickness of sample
H= hardness of pencil

6.3.2 The pencil shall be sharpened so as to expose about 3 mm of lead. Holding the pencil at an angle of 90^0 to the abrasive paper grit No. 400, rub the lead against the paper maintaining an angle of 90^0 to the abrasive paper until a flat, smooth and circular cross section is obtained. The tip of the lead shall be ground flat before use for each test.

6.3.3 Place the coated panels on a level, firm horizontal surface. Holding the pencil against the panel surface at 45 degree angle, push the pencil away from the operator with moderate pressure (*see* Fig. 1).

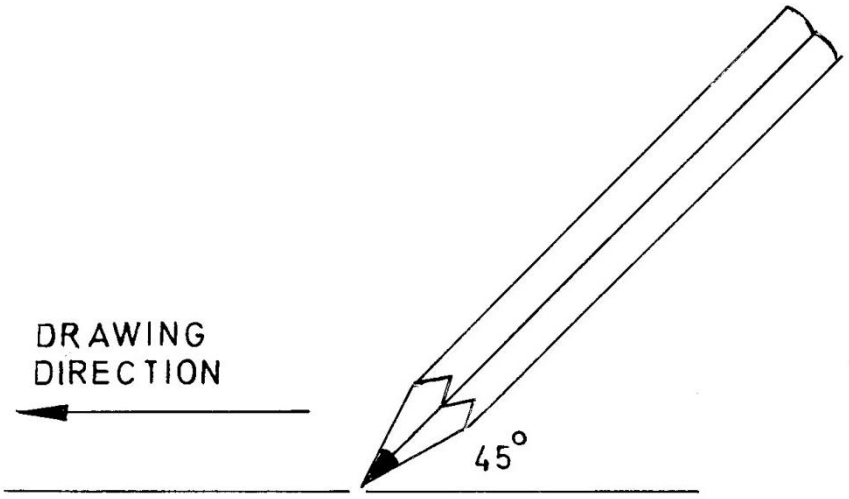


FIG. 1 PENCIL HARDNESS TEST

6.3.4 On visual inspection, there shall not be scratch on the tested portion.

6.4 Impact Resistance Test

6.4.1 Place the test panel on the impact tester with the bottom side up unless specified or agreed upon. Drop a 500 g mass of weight from 600 mm height on the test panel.

6.4.2 On visual inspection there shall not be any crack or peeling of the paint film.

6.4.3 The test is applicable for minimum base cold rolled steel thickness of 0.40 mm.

6.5 Cross Hatch Test

6.5.1 Select an area free from blemishes and other surface imperfections. Make 11 parallel straight lines at intervals of 1 mm on the test panel with a cutting tool or cutting guide so as to reach the substrate through the paint film. Eleven such straight lines shall also be made crosswise (at right angle) at an interval of 1 mm.

6.5.2 After making the required cuts, brush the film lightly with a soft brush or tissue to remove any detached flakes or nubbins of coating. Cut a piece about 75 mm long from a standard ~25 mm wide semi-transparent pressure sensitive tape. Place the centre of the tape over the grid of cut lines. To ensure good contact with the paint film, rub the tape firmly with finger.

6.5.3 Remove the tape by holding the free end steadily (without jerk) pulling it off as close as possible to 180 degree angle. Inspect the grid area for removal of paint film from the substrate.

6.5.4 There should not be any lifting of paint by the tape (*see* Fig. 2).

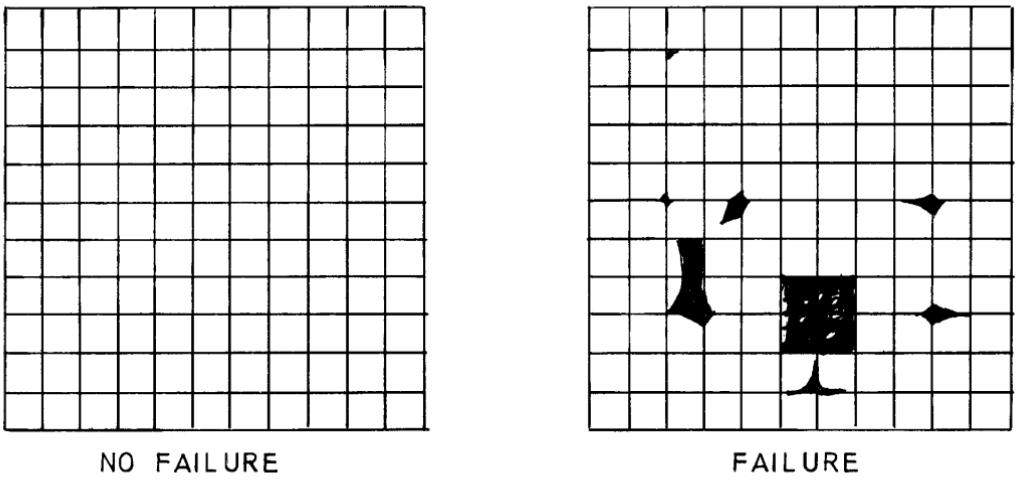


FIG. 2 CROSS HATCH TEST

6.6 Solvent Resistance Test

Solvent (Methyl Ethyl Ketone-MEK) double rub test shall be conducted on a test piece in accordance with Annex B. This is one of the measures for determination of oven paint curing process completion.

6.7 Other Tests

Any test other than those described in **6.1** may be carried out if agreed to between the manufacturer and the purchaser.

7 APPEARANCE

7.1 Pre-painted steel sheets and strips shall be reasonably flat and free from holes, tears, distinct colour differences and other defects detrimental to practical use.

7.2 Strips, however, may contain some abnormal imperfections which render a portion of the strip unusable since the imperfections in the strip cannot be removed as in case of cut lengths.

7.3 Gloss and colour of sheets and strips shall be as agreed to between the purchaser and supplier.

7.3.1 *Gloss*

Gloss of pre-painted steel product shall comply with the requirement as agreed between the supplier and the purchaser, when tested as per IS 101 (Part4/Sec 4). Gloss unit normally do not apply to textured finishes. Gloss is dependent on the paint system. However, 10-40 percent gloss with 60° head is a typical range for typical pre-painted steel.

7.3.2 *Colour*

The colour shall match to standard colour specified. The degree of color match as determined by unaided visual inspection is described in Table 3. When tested in a Light booth having a daylight simulator and incandescent light source, the visual color match shall achieve a rating of 2 or lower.

A more accurate instrumental measurement of color, with spectrophotometer adopting the Hunter Color Measurement System, is also allowed for better batch-to-batch color consistency.

Table 3 Degree of Color Match
(*Clause* 7.3.2)

Sl No	Rating	Degree of match	Explanatory Note
(1)	(2)	(3)	(4)
i)	0	Exact match	Color of test sample indistinguishable from that of reference or standard sample.
ii)	1	Critical match	A small, just perceptible colour difference can be seen when the samples are held in contact but it cannot be detected when separated by 5 mm.
iii)	2	Close match	When separated by 5 mm a small color difference can be seen, but it is undetectable when increased to 25 mm.
iv)	3	Approximate match	When separated by 20 mm a small color difference can be seen, but it is undetectable when increased to 100 mm.
v)	4	Crude match (Poor match)	Difference is readily detectable even when separated by more than 100 mm

NOTE — A standard light booth shall be used for the above qualitative measurement. These qualitative comparison measurements shall preferably be backed by color measurements with a standard spectrophotometer for high repeatability and reproducibility of colour.

8 SALT SPRAY TEST (CORROSION RESISTANCE)

8.1 When suitably prepared test specimens (scribed or un-scribed, as appropriate) are exposed to the salt spray test specified in IS 9844 and Table 1 and assessed in accordance with Annex C, the pre-finished product shall comply with the requirements of Table 4.

Table 4 Requirements for Salt Spray Resistance

(*Clause* 8.1)

Sl. No.	Type of deterioration	Method of Test, Ref. to	Requirement
(1)	(2)	(3)	(4)
i)	Undercut at scribed lines	C-1	Rating of 2 or less with no corrosion of base metal, no red dust formation
ii)	Corrosion of the base metal	C-2	Rating 0
iii)	Blistering	C-3	Not worse than rating 2(S3) [1)]

[1)]Face of panel.

NOTE — Other requirement / acceptance level may be specified and agreed between the customer and the supplier.

8.2 When suitably prepared test specimens (scribed or un-scribed, as appropriate) are tested in accordance with IS 101 (Part 6/Sec 1) and Table 1 and assessed in accordance with Annex C, the pre-finished product shall comply with the requirements of Table 5.

TABLE 5 Requirements for Humidity Resistance

(*Clause* 8.2)

Sl No	Type of deterioration	Method of Test, Ref to	Requirement
(1)	(2)	(3)	(4)
i)	Undercut at scribed lines	C-1	Rating of 2 or less with no corrosion of base metal, no red rust formation
ii)	Blistering	C-3	Not worse than rating 3 (S2) [1)]

[1)]Face of panel.

NOTE -Other requirement / acceptance level may be specified and agreed between the customer and the supplier.

9 DIMENSIONS AND TOLERANCES

9.1 The nominal thickness of sheets shall be as per IS 277 or as agreed between supplier and purchaser. Width and length (in case of sheet) shall be as agreed between the supplier and the purchaser.

9.2 In the case of strips, the internal diameter of coils shall be 450 mm or 510 mm or 610 mm as agreed between supplier and purchaser.

9.3 The mass of each pack shall not exceed 10 tonne.

9.4 Tolerances

9.4.1 *Thickness*

The tolerances on thickness sheets and strips shall be as given in IS 277.

9.4.2 *Width*

Width of the sheet or strip shall not be smaller than specified. The positive tolerance on width shall be 10 mm. The total unilateral width tolerance range may be allowed bilaterally as agreed between purchaser and supplier on mutual agreement basis.

9.4.3 *Length*

No sheet shall be smaller in length than that specified. Tolerance on length on plus side shall be 15 mm or 0.5 percent of length whichever is greater.

9.4.4 *Mass*

The tolerance on mass of individual sheets shall be within ±10 percent and tolerance on mass of each bundle of sheets/strips shall be ± 5 percent.

9.5 Sizes and tolerances other than those specified in **9.1, 9.2, 9.3** and **9.4** may be supplied, if agreed to between the purchaser and the supplier.

10 SHAPE

10.1 Camber

Maximum camber values for strips and sheets shall be as per IS/ISO 16163.

10.2 Deviation from Squareness (Out-of Square)

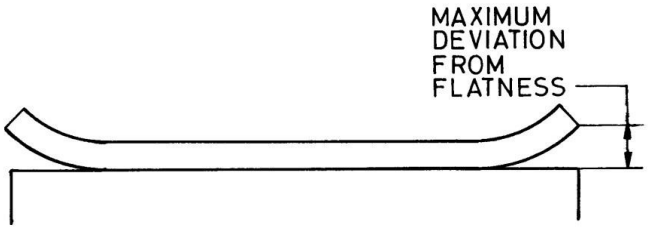
Deviation form squareness for flat sheets shall be as per IS/ISO 16163.

10.3 Deviation from Flatness

Maximum deviation from flatness (*see* Fig. 3) for cut sheets shall be as given in Table 6.

Table 6 Deviations from Flatness
(*Clause* 10.3)
All dimensions in millimeters

Sl. No.	Thickness mm	Tolerances on Specified Width mm	
		Up to 1200	Above 1200
(1)	(2)	(3)	(4)
i)	Up to and including 0.7	15	18
ii)	Above 0.7 up to 1.6	12	15



NOTE — Maximum deviation from flatness is the maximum distance between the lower surface of the sheet and flat horizontal surface on which the sheet is made to rest with its own weight.

FIG. 3 DEVIATION FROM FLATNESS

11 RETEST

When a part of the test results for physical properties fails to comply with the requirement, a retest (two more sets of test samples shall be taken for specific test requirements from the same lot) on the relevant items may be carried out to determine whether it is acceptable or not. If any of the retest samples fail to meet the test requirements of this standard, the entire batch of sheets represented by the sample shall be deemed as not conforming to this standard.

12 PACKING AND TRANSPORTATION

12.1 Strips and sheets should be suitably packed so as to avoid damage during transit, handling and storage.

12.2 During transportation, strip and sheet packs should be secure properly so as to avoid inter surface abrasion and damage to coating during transit.

13 STORAGE AND HANDLING

It is essential that pre-painted products be kept dry in transit and stored under cover clear of the ground. Sheet packs or strips of the product become wet, layers should be separated, wiped dry with a clean cloth and positioned so that air circulation will

complete the drying process. The use of these procedures should prevent deterioration of the coating, which otherwise can lead to reduced life expectancy or poor appearance of the product.

Pre-painted products should be lifted directly and not dragged over rough surfaces or over each other. Care should also be taken to avoid dragging, cutting and forming tools over the surfaces of the pre-painted products.

Stocks of pre-painted products should be used in rotation as some mechanical properties of the coating may change slightly during prolonged storage, for example duration greater than six months. These changes are typically small and in most fabrication processes are not significant. However, it is possible that they could cause fabrication problems during severe forming operations.

14 MARKING

14.1 The following shall be legibly and indelibly marked on the top of each coil or package of sheets or shown on a tag attached to each coil:

a) Manufacturer's name or trade-mark;
b) Material identification/ coil number/ packet number/ batch number etc;
c) Product dimension;
d) Number of sheets or mass;
e) Zinc coating grade;
f) Color name of top-coat; and
g) Date of packing.

14.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

ANNEX A

(*Foreword and Clause* 4.3)

GUIDANCE FOR THE PAINT/RESIN TYPE, COATING THICKNESS AND APPLICATIONS FOR PRE-PAINTED GALVANISED STEEL

Sl. No.	*Coat*	*Paint/Resin Coat Type*	*Coating Thickness* (micrometer)	*Remarks*
(1)	(2)	(3)	(4)	(5)
i)	Topcoat	a) Epoxy	15-30	for external and internal applications
		b) Polyester polyurethane	15-30	for external and internal applications and appliances
		c) Silicon modified polyester/ high durable polyester	15-30	for external applications requiring very good paint durability
		d) PVDF/PVF2	15-30	For external applications requiring excellent paint durability
		e) Plastisol	70-200	For bus body, railway coaches and panels. Better flexibility and corrosion resistant
		f) PVC	100-200	For internal applications and interior decoration
		g) Zinc Rich Primer coated CRCA	14-16(one side) and oiling (other side)	Automobiles and railway coaches primer coated side and oiling subjected to corrosion CRCA (other side)
ii)	Back Coat	Alkyd/Epoxy or Polyester	4-10	All pre-painted steel. One coat system for two coat system with primer

ANNEX B

(*Clause* 6.6)

SOLVENT RESISTANCE TEST

B-1 This procedure is to be used to determine the degree of cure of a baked film by the paint films resistance to a specified solvent. This procedure is applicable whenever the resistance to Methyl Ethyl Ketone (MEK) or Methyl Iso-Butyl Ketone (MIBK) has to be determined.

B-2 PRINCIPLE

The determination of solvent resistance is carried out by using a Double rub Machine. This machine rubs the test piece/panel with cotton doused in MEK or MIBK.

B-3 APPARATUS

a) Fume cupboard;
b) Protective gloves;
c) Cotton pad (~50 mm square);
d) Solvent (MEK or MIBK); and
e) Solvent double rub machine.

B-4 PREPARATION OF TEST PIECE

A panel of minimum size 60 mm × 200 mm is prepared from the production test sample to be tested face up in the solvent rub machine.

B-5 PROCEDURE

B-5.1 Clamp the panel of minimum size 60 mm × 200 mm in the solvent rub machine.

B-5.2 Place a 50 mm square cotton pad between the magnetic holders on the bottom of the solvent rub machine head.

B-5.3 Fill the reservoir with recommended solvent - MEK for topcoats and bottom coats or MIBK for primer evaluations.

B-5.4 Start the machine with minimum 1Kg load and stop it based on observations mentioned in following item 6.

B-6 EVALUATIONS

B-6.1 Observe the operation of the solvent rub machine and stop the machine when failure has occurred. Failure shall consist of removal of the film to expose the primer or substrate at any spot along the centre-line of the double-rub stroke. The first and the last 25 mm of the stroke shall not be considered.

B-6.2 The solvent resistance of the organic coating is classified as the number of strokes the machine has made prior to failure of the organic coating.

B-6.3 The number of rubs required is dependent on the paint system. However, completion of 50 double rubs is sufficient for the test of standard paint system (for

durability class 2, 3 & 4). Failure of the paint film at less than 50 double rubs is an indication of a "problem".

ANNEX C

(*Clause* 8 *a*nd *Table* 4)

METHODS OF ASSESSMENT OF SALT SPRAY AND HUMIDITY TEST RESULT

C-1 UNDERCUT AT SCRIBED LINES

C-1.1 This method describes the assessment of the degree of deterioration for a metal substrate that has been coated by a paint system.

C-1.2 Principle

Coated test panels are exposed to an accelerated corrosive (Salt Spray Test) or humid (Humidity Test) environment. The corrosion on the surface of the paint film and on the metal surface beneath the paint film is assessed by comparison with photographic reference standards and rating table.

C-1.3 Procedure

a. Remove loose corrosion products and any coating that has lost adhesion from the vicinity of the scribed line by scraping with a metal spatula or dull knife.

b. Rate the mean creepage of undercut corrosion or loss of paint extending from the scribed line, as prescribed in Table 7.

TABLE 7 Rating for Failure at scribe and panel edge

Rating Scale (1)	Representative mean creepage of under film corrosion from scribed line mm (2)		
0	0		
1	> 0	≤	1.0
2	> 1.0	≤	3.0
3	> 3.0	≤	7.0
4	> 7.0	≤	13.0

1

5	> 13

C-2 CORROSION OF THE BASE METAL

C-2.1 This method describes the assessment of the degree of deterioration for a metal substrate that has been coated by a paint system.

C-2.2 Principle

Coated test panels are exposed to an accelerated corrosive environment. The corrosion on the metal surface beneath the paint film is assessed by comparison with photographic reference standards.

C-2.3 Procedure

a. Carefully remove a portion or whole of the paint film using a suitable solvent-based paint remover.
b. Determine the severity of corrosion by referring to the pictorial standards in the following Figure 4.

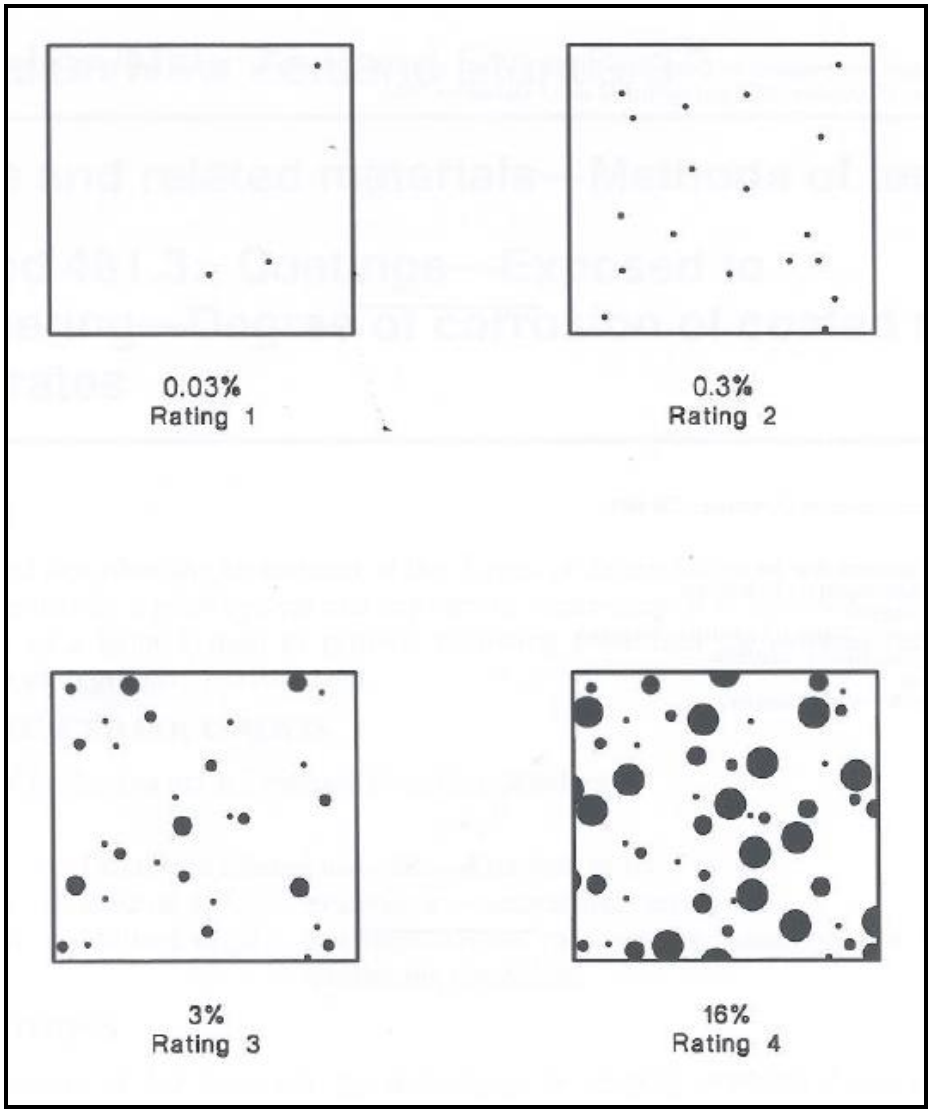


FIG. 4 TYPICAL CORROSION ON THE STRIPPED METAL SUBSTRATE

C-3 BLISTERING

C-3.1 This Annex sets out a method for determining the degree of blistering in a paint film exposed to accelerated weathering conditions.

C-3.2 Principle

The test is visually evaluated for the degree of blistering by comparing with diagram reference standards, which shows rated stages of blistering.

NOTE - The diagram reference standards have been adopted from ISO 4628-2.

C-3.3 Apparatus Diagram standards (*see* Fig. 5, 6 & 7) - required for comparison with the test film.

C-3.4 Viewing Environment Examination of the films should be carried out under lighting conditions of at least 500 lux or lumen per sq. meter.

C-3.5 Procedure

a) Visually examine the test film by comparing the surface finish with the reference diagram standards (*see* **C-3.2**) that shows a similar amount of blistering.

b) Using Table 8 determine the rating for density of blistering and Table 9 for the size of blistering.

c) Record the rating as for e.g. 2(S 3) where 2 stands for density and S 3 stands for size of blister.

TABLE 8 Rating for Density of Blistering

(*Clause* C-3.5)

Rating Scale [1)] (1)	**Density of blistering** (2)
0	None
1	Less than few
2	Few
3	Medium
4	Medium-dense
5	Dense

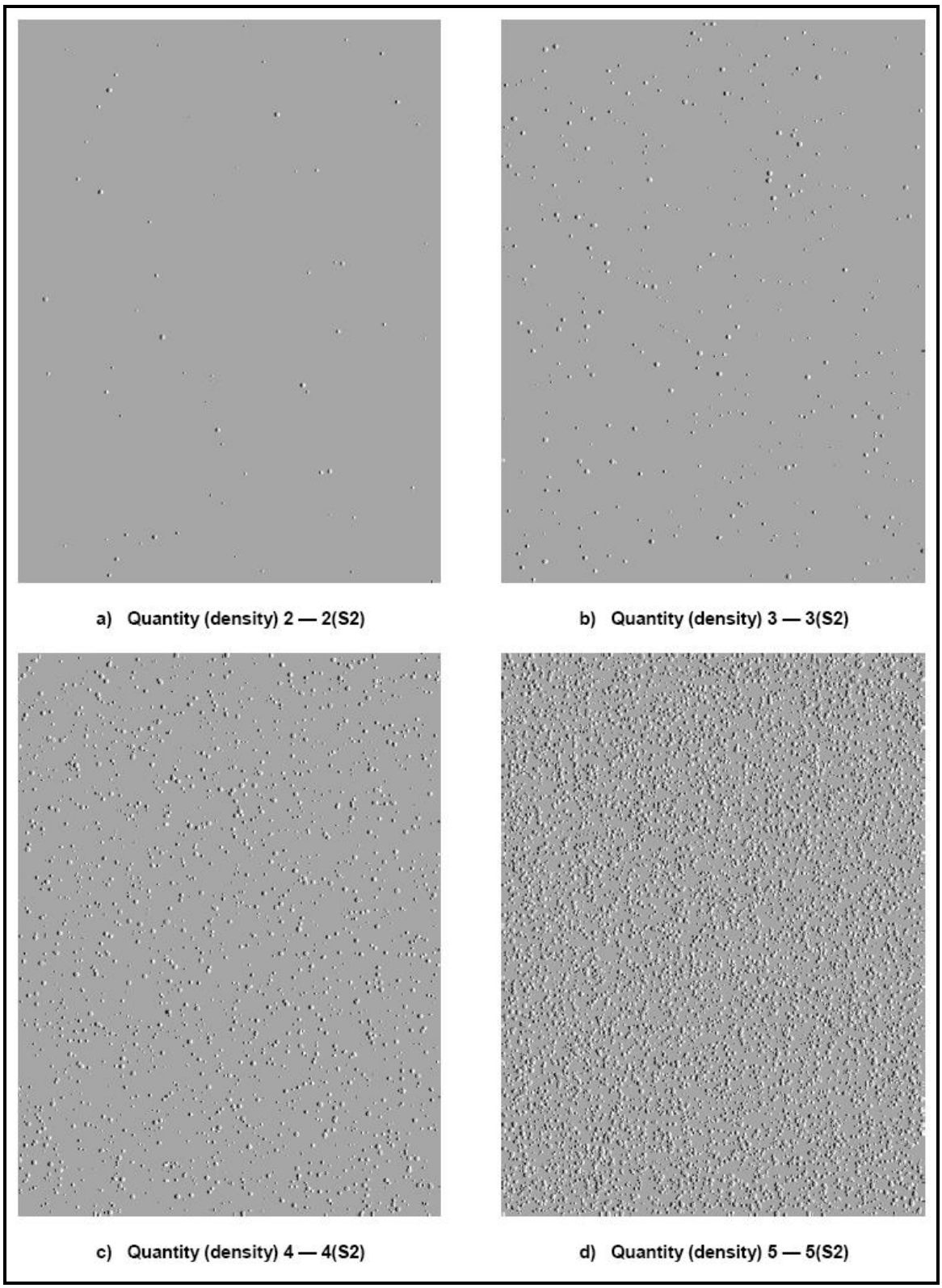
Note — [1)] The rating scale conforms to current ISO practice.

TABLE 9 Rating for Size of Blisters

(*Clause* C-3.5)

Rating Scale [1)] (1)	**Size of blistering** (2)
1	Finer than in Fig. 5
2	See Figure 5
3	See Figure 6
4	See Figure 7

Note — [1)] The rating scale conforms to current ISO practice.



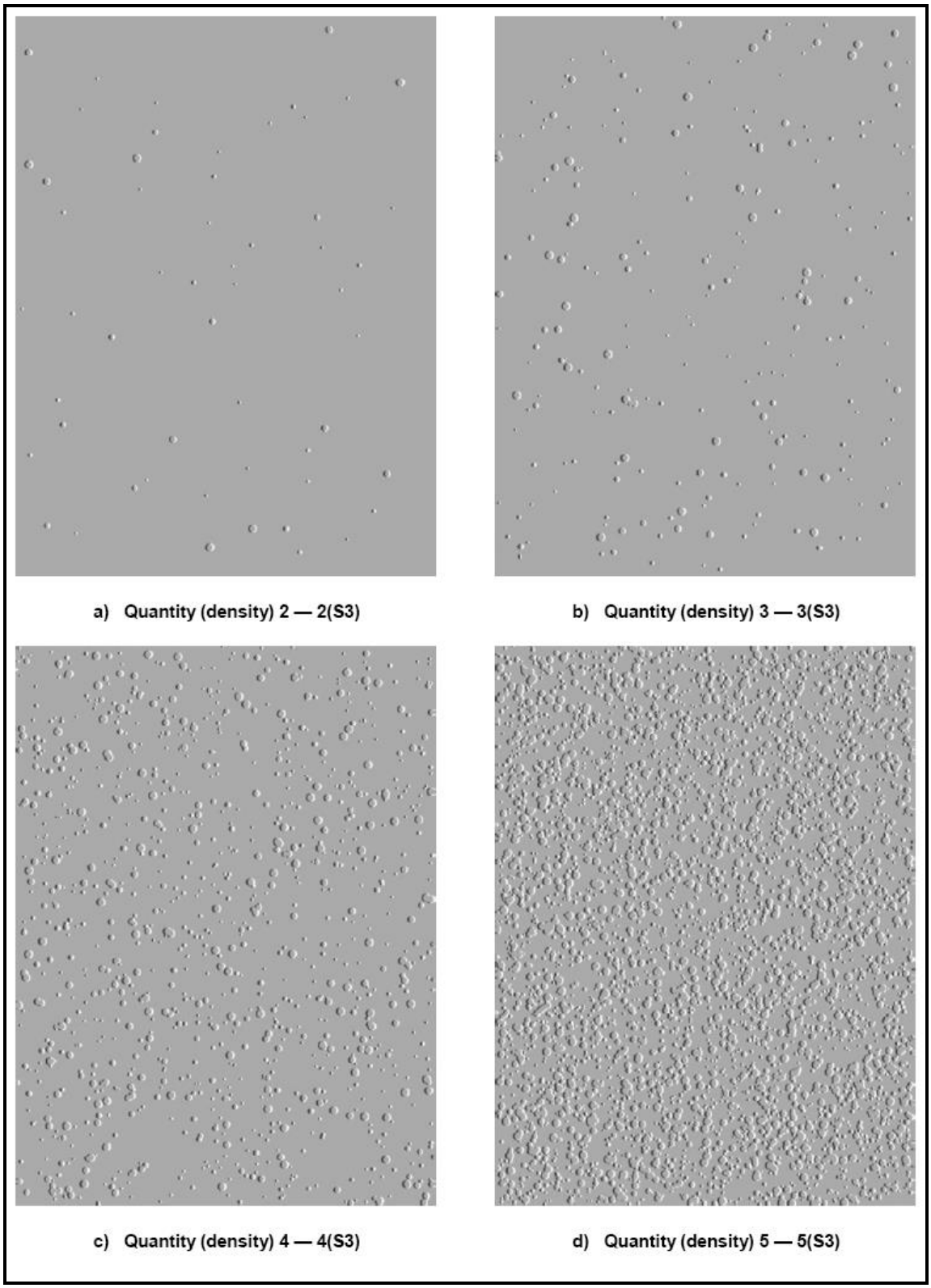
a) Quantity (density) 2 — 2(S2)

b) Quantity (density) 3 — 3(S2)

c) Quantity (density) 4 — 4(S2)

d) Quantity (density) 5 — 5(S2)

FIG. 5 BLISTERS OF SIZE 2



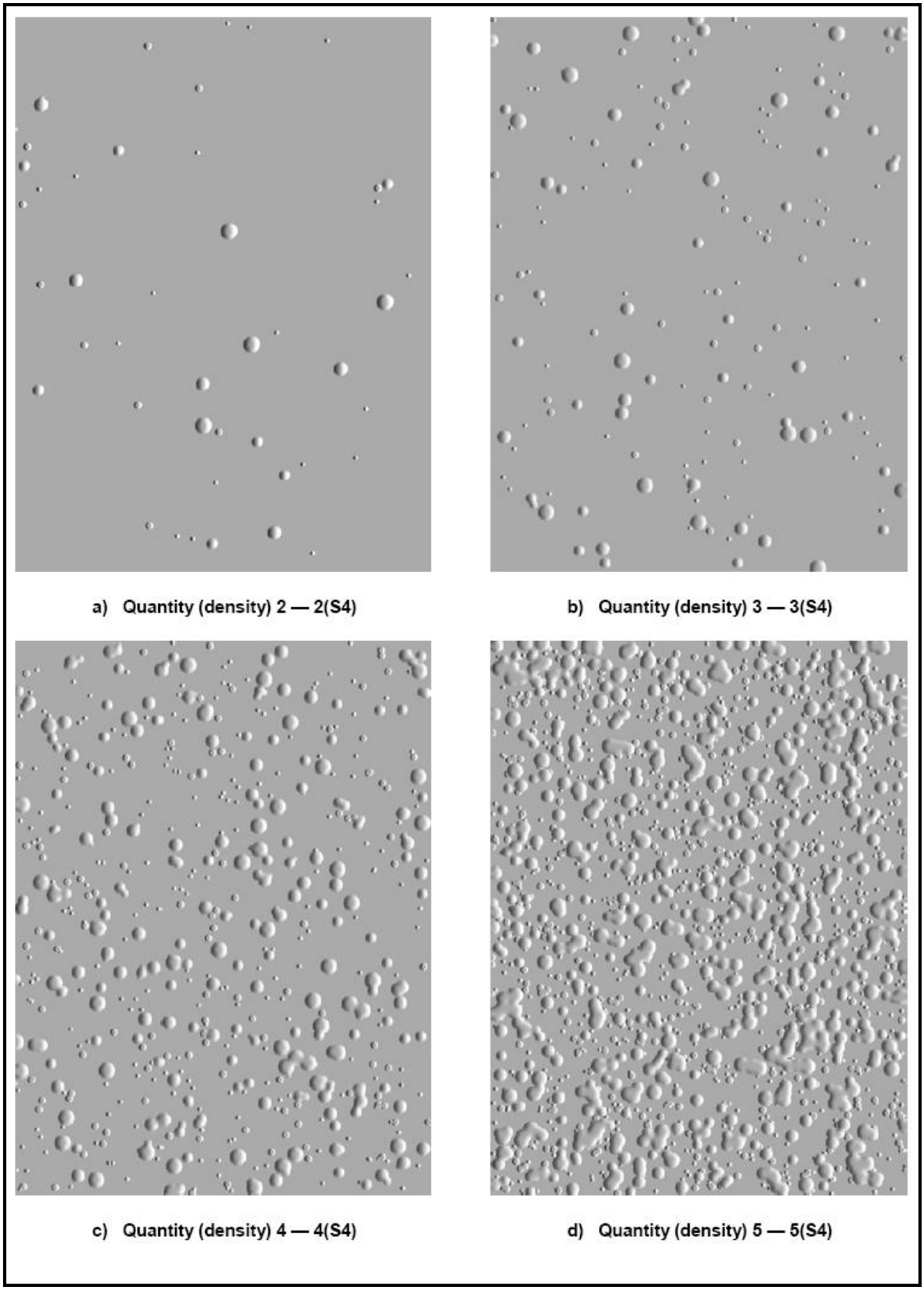
a) Quantity (density) 2 — 2(S3)

b) Quantity (density) 3 — 3(S3)

c) Quantity (density) 4 — 4(S3)

d) Quantity (density) 5 — 5(S3)

FIG. 6 BLISTERS OF SIZE 3



a) Quantity (density) 2 — 2(S4)

b) Quantity (density) 3 — 3(S4)

c) Quantity (density) 4 — 4(S4)

d) Quantity (density) 5 — 5(S4)

FIG. 7 BLISTERS OF SIZE 4

STEEL INGOTS, BILLETS, BLOOMS, SLABS AND BARS FOR FORGING - SPECIFICATION

1 SCOPE

This standard covers the requirements for unalloyed and low & medium alloyed steel ingots, rolled or forged or continuously cast billets, blooms, slabs and bars for forgings for general engineering purposes.

2 REFERENCES

The following Indian Standard contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subjects to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	***Title***
228 (Various Parts)	Methods for chemical analysis of steel
1500 (Part 1) : 2019 / ISO 6506-1 : 2014	Metallic Materials - Brinell Hardness Test Part 1 Test Method (*fifth revision*)
1599 : 2019 / ISO 7438 : 2016	Metallic Materials - Bend Test (*Fourth Revision*)
1608 (Part 1) : 2022 / ISO 6892-1 : 2019	Metallic materials -Tensile Testing Part 1 Method of test at room temperature (*sixth revision*)
1852 : 1985	Rolling and cutting tolerances for hot rolled steel products (*fourth revision*)
1956 (Various Parts)	Glossary of terms relating to iron and steel
3848 : 1981	Method for end quench test for hardenability of steel
4075 : 1985	Method for macrostreak flaw test for steel
4163 : 2021 / ISO 4967 : 2013	Steel - Determination of Content of Nonmetallic Inclusions - Micrographic Method Using Standard Diagrams (*third revision*)
4748 : 2021 / ISO 643 : 2019	Steels - Micrographic Determination of the Apparent Grain Size (*second revision*)
6396 : 2000	Methods of measuring decarburized depth of steel (*second revision*)
8811 : 1998	Method for Emission Spectrometric Analysis of Plain Carbon and low alloy Steels Point to Plane Technique
8910 : 2022 / ISO 404 : 2013	General technical delivery requirements for steel and steel products (*second revision*)
9684 : 1980	Technical conditions for the supply of hot rolled billets blooms, slabs and bars for closed die forgings
10138 : 2010	Macroscopic Methods for Determination Of Non-Metallic Inclusion Content In Wrought Steels (*second revision*)
11371 : 2022	Method for macroetch test for wrought steel products
12037 : 1987	Macrographic examination by Sulphur print (Baumann method)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1956 shall apply.

4 SUPPLY OF MATERIAL

4.1 General requirements relating to the supply of steel shall conform to IS 8910.

5 MANUFACTURE

5.1 Unless otherwise agreed to between the purchaser and the manufacturer, the processes used for making steel shall be left to the discretion of the manufacturer. The steel shall be fully killed.

5.2 When so desired, the purchaser and manufacturer may agree to a particular secondary steel making / refining technology including degassing etc.

5.3 Ingot, continuously cast billet, bloom or slab shall be reasonably free from pipe, marked segregation and other harmful internal and surface defects. Sufficient discard shall be made to ensure freedom from defects as stipulated in **6**. The method o evaluating the internal and surface defects and their acceptance for such material may be mutually agreed to at the time of enquiry and order between the purchaser and the manufacturer.

5.4 Stocks made from ingot, continuously cast billet, bloom or slab shall have total reduction of at least 6:1 (measured by cross section of the initial cast product to the final forging stock). The stock may be manufactured by hot rolling or forging.

5.5 Higher reduction ratios for specific applications can be mutually agreed to between the purchaser and the manufacturer. However, lower reduction ratios can be agreed to between the purchaser and the manufacturer at the time of enquiry and order subject to a minimum of 2:1 and without impairing the end use of the steel.

5.6 Ingot, continuously cast billet, bloom or slab without any reduction shall not be directly used as stock for forging except at the risk of the purchaser.

6 FREEDOM FROM DEFECTS

6.1 Surface and Sub-Surface Defects

6.1.1 The forging stock shall be free from harmful surface and sub-surface defects, which may impair the forgeability and or the end use of the steel.

6.1.2 If necessary, the billet or bloom (including continuously cast) before rolling/forging and bars shall be suitably conditioned to ensure the quality of the forging stock.

6.1.3 Unless otherwise specified, the manufacture shall be at liberty to choose the method of conditioning subject to the following conditions:

a) It shall not have any injurious effects on the product
b) The conditioning shall be allowed only in the longitudinal direction. Conditioning in the transverse direction shall not be allowed, except for surface inspection purposes.
c) The depth of conditioning shall not exceed 1 mm for every 15 mm of dimensions concerned, up to a maximum depth of 20 mm.
d) The width of the conditioning shall be at least four times its greatest depth
e) In the case of slabs, the depth of conditioning on the wide surface shall not exceed 1 mm for every 10 mm of dimensions concerned, up to a maximum depth of 20 mm. The maximum depth of conditioning on two parallel sides at opposite locations shall not exceed one and a half times the maximum allowed for one side
f) While conditioning the material, the dimensions of the product shall not go below the minimum dimensions permitted according to the tolerances specified until and unless otherwise agreed to between the manufacturer and the purchaser
g) The transition between conditioned and non-conditioned areas shall be gradual. All heavy swarf or slag shall be removed

6.1.4 In special cases, particularly where it is necessary on large material and is not injurious, greater depth of conditioning may be permitted by special agreement between the manufacturer and the purchaser.

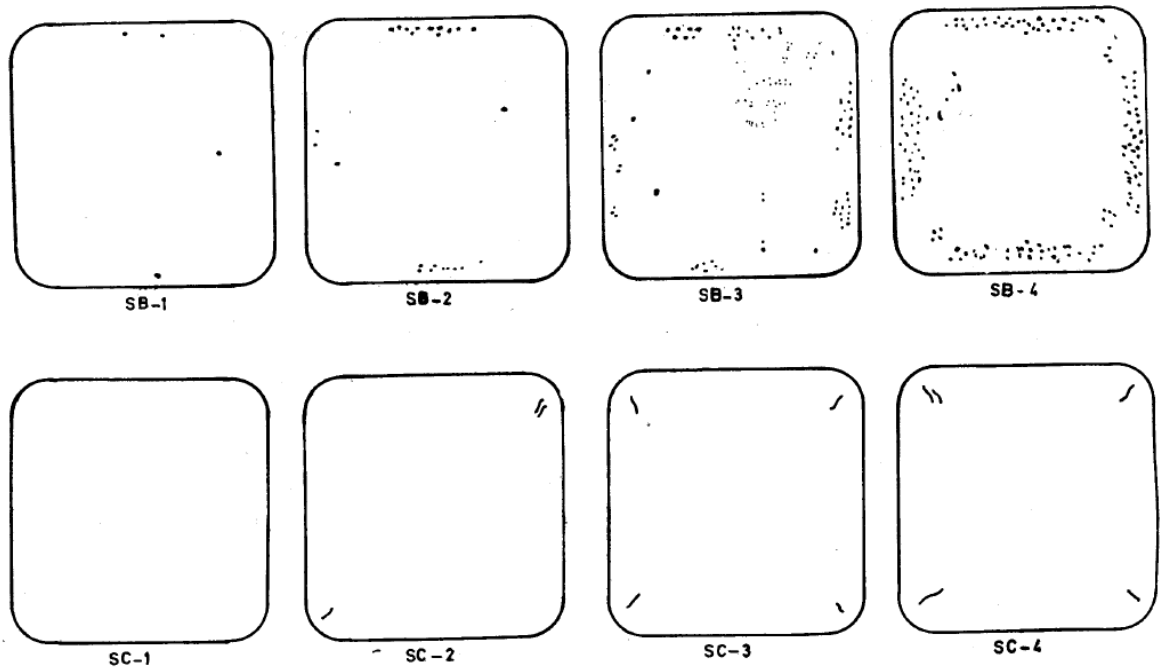
6.2 Internal Defects

6.2.1 The forging stock shall also be free from harmful internal defects like centre looseness, corner crack, half way cracks, concentrated pin holes, voids, flakes, etc which may impair the forgeability and or the end use of the steel.

6.2.2 The transverse section of the forging stock shall be suitably inspected by sulphur print/ macro etching as per IS 12037 / IS 11371. For acceptance criteria of the stock produced from concast steel, reference can be made to Plate 1 and Plate 2 of Fig. 1 to arrive at mutually acceptable limits of a certain type of defects present either singularly or in combination depending upon the subsequent manufacturing operation and the end use of the product. However, the acceptance norms shall be as agreed to between the manufacturer and the purchaser.

6.2.3 The forging stock shall be free from coarse dendrities, if so desired by the purchaser.

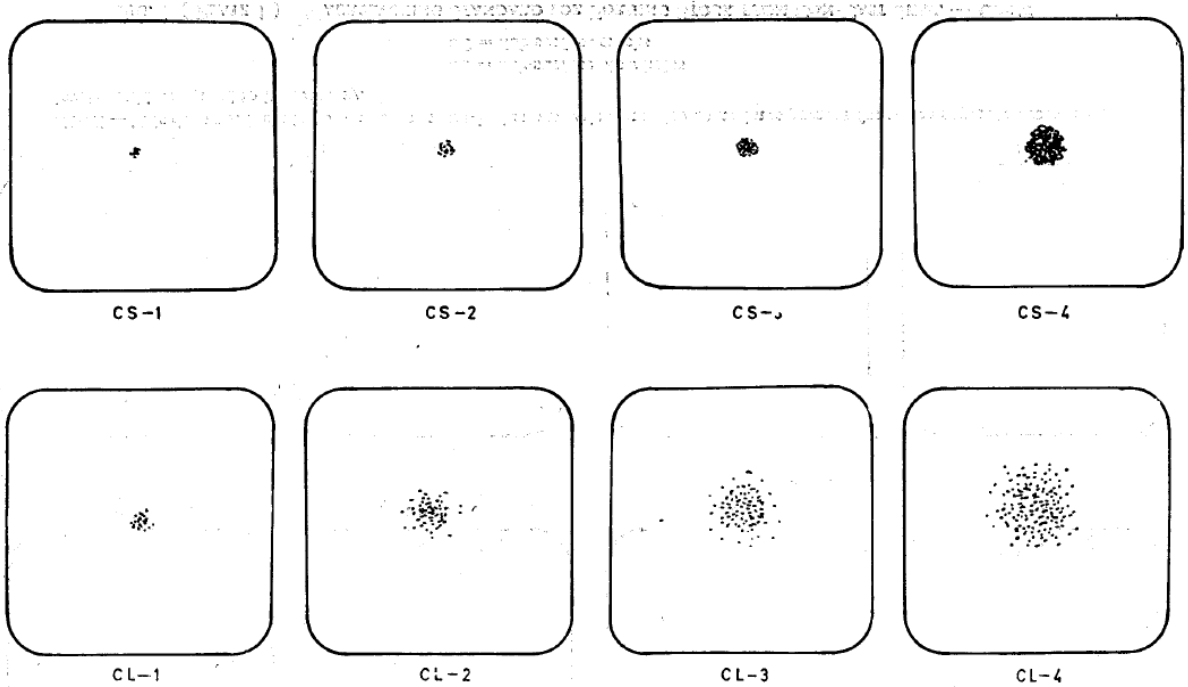
6.2.4 The forging stock shall be by and large homogenous and free from large, segregated inclusions and macrostreaks when examined by macroetching the longitudinal section.



NOTE — This does not include non-metallic macro-inclusions which are also sometimes present for which separate acceptance level should be agreed to it necessary.

SB = Sub-surface blow holes
SC = Sub-surface cracks

FIG. 1 (PLATE 1) MACROETCHING STANDARD FOR FORGING STOCK FROM CON-CAST STEEL — *Contd*



NOTE — Centre piping and centre cracking are not permissible in any degree.

CS = Centre segregation
CL = Centre looseness

FIG. 1 (PLATE 2) MACROETCHING STANDARD FOR FORGING STOCK FROM CON-CAST STEEL

7 CHEMICAL COMPOSITION

7.1 The ladle analysis of the steel, when carried out by the method specified in the relevant parts of IS 228 or IS 8811 or any other established instrumental/chemical method, shall be as given in Table A.1. In case of dispute the procedure given in relevant parts of IS 228 shall be referee method. However, where method is not given in IS 228 and its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

7.2 Elements wherever not specified in Table A.1 shall not be added other than for the purpose of finishing the heat, and shall not exceed the following limits:

Constituent	Percent, Max
Chromium	0.25
Nickel	0.25
Molybdenum	0.05
Copper	0.25
Vanadium	0.05
Boron	0.0003
Tin	0.05

NOTES

1. All reasonable precautions shall be taken to prevent the addition of such elements, which affect the hardenability, mechanical properties and applicability.
2. Trace elements (Cr+Ni+Mo) when added together shall not exceed 0.50 percent.
3. % Copper + 10 x (% Tin) shall not exceed 0.50 percent.

7.3 Where necessary, more restricted ranges of chemical composition may be specified subject to mutual agreement between the manufacturer and the purchaser.

7.4 Check Analysis

Check analysis shall be carried out on the finished product if specified by the purchaser. Permissible variations in the case of check analysis from the limits of ladle analysis specified in Table A.1 shall be as given in Table 1. Variation shall not be applicable both over and under the specified limits in several determinations in one heat.

8 DIMENSIONAL TOLERANCES

8.1 Unless otherwise agreed to between the purchaser and the manufacturer/supplier, the tolerances as given in 8.2 to 8.9 shall apply.

8.2 In case of billets, blooms and slabs (including continuously cast), the tolerances shall be as given in Table 2.

8.3 The length of billets, blooms and slabs shall be agreed to at the time of enquiry and order. A tolerance of -0 +150 mm shall be permitted on the specified length.

8.4 In the case of slabs, the bend and camber shall not exceed 8 mm/m of slab length subject to a maximum of 40 mm. In the case of billets and blooms, the bend shall not exceed 5 mm/m.

8.5 For rolled square billets, corner radius shall be about 15 percent of the nominal size or as agreed.

8.6 Rolled steel bars shall be true to the prescribed dimensions within the tolerances specified in IS 1852. The length of bars shal1 be agreed to at the time of enquiry and order. The cutting tolerance for all lengths of hot rolled bars shall be -0, + 100 mm.

8.7 The tolerance on straightness shall be 3 mm for every meter length of machine straightened bars. For as rolled bars, the straightness tolerance shall be as agreed to between the purchaser and supplier.

8.8 If agreed at the time of enquiry and order, for supply of hot rolled billets, blooms, slabs and bars for closed die forging, the tolerances shall be in accordance with IS 9684.

8.9 Subject to mutual agreement between the purchaser and the manufacturer, the material may be supplied to closer tolerances also.

Table 1 VARIATION FOR CHECK ANALYSIS

(*Clause* 7.4)

Element	Limiting values of the ladle (heat) analysis	Permissible deviation (±) for the product analysis for nominal size, mm		
		Up to 250	Over 250 up to 500	Over 500
	% mass fraction	% mass fraction	% mass fraction	To be mutually agreed
Carbon	up to 0.45	0.02	0.04	
	Over 0.45 to 0.90	0.03	0.05	
Silicon	up to 0.40	0.03	0.04	
	Over 0.40 to 2.00	0.05	0.06	
	Over 2.00	To be mutually agreed		
Manganese	up to 1.20	0.04	0.06	
	Over 1.20 to 2.00	0.05	0.07	
Nickel	up to 1.00	0.03	0.03	
	Over 1.00 to 2.20	0.05	0.05	
	Over 2.00 to 5.00	0.07	0.07	
Chromium	up to 0.80	0.03	0.04	
	Over 0.80 to 2.20	0.05	0.06	
	Over 2.20 to 5.50	0.11	0.13	
	Over 5.50	To be mutually agreed		
Molybdenum	up to 0.40	0.03	0.04	
	Over 0.40 to 1.20	0.04	0.05	
Vanadium	up to 0.15	0.02	0.02	
	Over 0.15 to 0.30	0.03	0.03	
Aluminium	≤ 0.060	0.005	To be mutually agreed	
	Over 0.060	To be mutually agreed		
Sulphur		0.005	0.010	
Phosphorus		0.005	0.010	

Note

1) The deviation of the product analysis in one heat for a given element may occur over the upper value or under the lower value of the specified range of the ladle analysis, but not both at the same time.
2) For sulphur controlled steels, the permitted variation in the product analysis of sulphur is ± 0.005%. However, for steels with a minimum sulphur range of 0.020% according to ladle analysis, sulphur in the product should not have less than 0.017%, unless otherwise agreed.

Table 2 Tolerances in billets, blooms and slabs
(*Clause* 8.2)

Product	Width Across Flat mm	Thickness mm	Tolerances on Width/Thickness mm
(1)	(2)	(3)	(4)
Billets	Up to and including 75	—	± 1.5
	> 75 to 125	—	± 3.0
	> 125 to 150	—	+4.0 -3.0
	Over 150	—	+6.0 -3.0
Blooms	Up to and including 150	—	+4.0 -3.0
	Over 150	—	+6.0 -3.0
Slabs	—	Up to and including 150	+ 3.0 -4.0
		Over 150	+3.0 -6.0
	Up to and including 300	—	+3.0 -6.0
	Over 300	—	+5.0 -10.0

9 CONDITIONS OF DELIVERY

9.1 Steels covered by this standard shall be ordered and delivered on any one or a combination of the following basis:

a) Chemical Composition
b) As rolled or forged, normalized or annealed
c) Maximum Hardness
d) Hardenability (Jominy)
e) Mechanical Properties and
f) Grain Size

10 TEST

10.1 Tensile Test - For steels ordered on the basis of mechanical properties, the tensile tests shall be carried out in accordance with IS 1608 (Part 1). The test pieces shall be taken in the longitudinal direction as shown in Fig. 2. The required tensile properties shall be as mutually agreed or else as given in Table A.2.

10.2 Hardness Test - For steels ordered on the basis of hardness, the hardness test shall be carried out in accordance with IS 1500 (Part 1). The hardness requirements of the test pieces shall be mutually agreed.

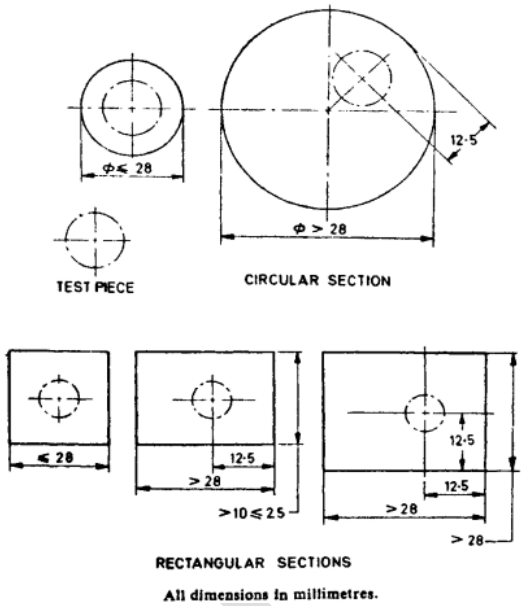


Fig 2 LOCATION OF THE TENSILE TEST PIECES IN THE PRODUCTS

10.3 Hardenability Test - For steels ordered on the basis of hardenability, the complete end-quench hardenability band and hardness, at fixed distance shall be as agreed to between the manufacturer and the purchaser or else as given in Table A.3. The minimum and maximum limits of a specified hardness range shall be consistent with the hardness obtainable in the full range of the specified chemical limits. The method of testing hardenability steel shall be in accordance with IS 3848.

10.4 Grain Size - Unless otherwise agreed, the steel when tested for grain size in accordance with IS 4748 shall show grain size of 5 to 8 for inherently fine-grained steel. Grain size outside the range of 5 to 8 may be supplied on mutual agreement. The grain size shall be considered satisfactory if 75 percent of grains are within the specified limit, and the remaining 25 percent of the grains falling either one size below or above the range but not spread at both ends of the range.

11 SAMPLING

11.1 If check analysis is required, at least one sample shall be taken from each cast. Samples for check analysis shall be taken midway between the centre and outside of the material.

11.2 For bars supplied on the basis of mechanical properties, in the case of bars up to 100 mm size, the test samples shall be selected from finished parts at the rate of one sample from each lot, provided the quantity from one cast does not exceed 25 metric tonnes. Where the quantity from each cast exceeds 25 metric tonnes, one more test sample shall be selected. When more than one diameter or thickness of bar is rolled from the same cast, one additional test sample shall be selected from each diameter or thickness of bar. For other sections the sampling rate shall be as per mutual agreement.

11.3 For material supplied on the basis of maximum hardness, at least one sample shall be taken from each cast from each size of each heat treatment batch. If the material is continuously heat-treated, one sample shall be taken from each 10 tonnes or part thereof, but at least one sample from each cast shall be taken.

11.4 For material supplied to other conditions of delivery, at least one sample shall be taken from each cast for testing.

11.5 Higher sampling rate may be agreed to at the time of enquiry and order.

12 RETESTS

12.1 Retest for check Analysis

If the results of the product analysis do not meet the composition requirements given in Table A.1 and 1, unless otherwise agreed to between the purchaser and the manufacturer, two new samples shall be taken on different pieces from the same cast. Should the two analyses satisfy the requirements, the lot represented shall be accepted. Should either of the tests fail, the material shall be taken as not complying with this standard.

12.2 Retest for Hardness Test in the Normalized / Annealed Condition

Should any of the test pieces fail to pass the tests specified, two further test samples shall be selected from the same heat treatment batch for testing in respect of each failure. The consignment shall be considered to conform to the requirements if both the additional tests are satisfactory. Should either of the samples fail, the manufacturer shall have the right, if he so desires, to reheat-treat the product in any suitable manner before two fresh samples are taken for testing. Should the two tests satisfy the requirements of this standard, the lot represented shall be accepted. Should either of the samples fail, the material shall be taken as not complying with this standard.

12.3 Retest for Mechanical Tests on Test Pieces

Should any of the test pieces fail to pass the tests specified, two further samples shall be selected from the same size grouping for testing in respect of each failure. The fresh test bars shall be treated under the same conditions and tested. The consignment shall be considered to conform to the requirements if both the additional tests are satisfactory. Should either of the test pieces fail, the material shall be taken as not complying with this standard.

13 ADDITIONAL REQUIREMENTS

13.1 If agreed to between the purchaser and the manufacturer at the time of enquiry and order, any or a combination of the following tests may also be carried out as additional requirements to ensure that the steels meet the quality requirements of the purchaser. The sampling frequency and acceptable level for each or any of these additional tests shall be mutually agreed to at the time of enquiry and order.

13.2 HOT UPSET TEST

13.2.1 The forging stock surface shall be able to withstand Hot Upset Test as described below:

Upset test from every heat is to be carried out in the following manner:

a) A sample of height equal to 2 times the diameter/thickness is to be taken.

b) The sample is hot upset to 50 percent of the original height.

The outside surface should not indicate any crack or lap after upsetting.

13.2.2 For general forging purposes, the permissible depth of seam shall be 1 percent of the forging stock diameter / thickness or 0.5 mm whichever is less.

13.3 INCLUSION RATING

13.3.1 Nonmetallic inclusions in rolled or forged steel products having a reduction ratio of at least 3 shall be determined in accordance with IS 4163 (Method A). The worst field of each inclusion from each sample shall be recorded as a rating for the sample. The inclusion rating for the samples shall not exceed the following limits:

a) For air melted quality:

Inclusion Type	Thin	Thick
A	3	2
B	3	2
C	3	2
D	3	2
DS	-	2

b) For vacuum, ESR or secondary refined quality requirements shall be Subject to mutual agreement between the manufacturer and the purchaser.

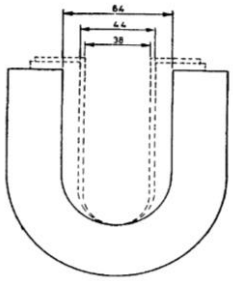
13.4 Decarburized depth: Decarburization depth shall be assessed as per IS 6396.

13.5 BEND TEST

13.5.1 Bend test shall be carried as per IS 1599 for grades 14C6, 15C8, 20C8, 25C8, 30C8, 35C8 and 45C8. Where the dimensions permit, test pieces 230 mm long and 32 mm square with edges rounded off shall be machined lengthwise from each sample and bent cold by direct pressure round a former of diameter appropriate to the grade of steel as shown in Fig. 3 until the sides of the test piece are parallel.

13.5.2 Smaller sizes shall be bent in full section by a former having a diameter proportional to that specified for a 32 mm square test piece. Each bend test shall comply with the requirements without a fracture.

13.5.3 Subsequently, the ends of the test pieces for grades 14C6, 15C8, 20C8, 25C8, 30C8 and 35C8 shall be brought together by direct pressure and the test piece shall not fracture.



64 for 45C8
44 for 30C8 & 35C8
38 for 14C6, 15C8, 20C8 & 25C8

Fig 3 BEND TEST

All dimensions in millimeters

13.6 Cleanliness of the steel can also be assessed by any or a combination of the fo

a) Blue Fracture test as per IS 10138
b) Step Machined test as per IS 10138
c) Magnetic Particle inspection as per IS 10138
d) Macrostreak Flaw test as per IS 4075

However, this is not applicable for re-sulphurized steel grades according to Table A.1.

13.7 Other Tests:

a) Ultrasonic Test
b) Blank hardening test for core strength guarantee
c) Microstructure for machinability including banding

The method of testing and requirements shall be as mutually agreed.

14 MARKING

14.1 All bars of above 40 mm diameter or equivalent section and shall be stamped or suitably marked at the end with material designation, heat number and manufacturer's name or trademark. Bars of smaller sections shall be tied in suitable bundles which will carry tags giving the information. Each ingot, billet, bloom and slab shall be legibly stamped or painted with the cast number. The ends of ingots, billets, blooms, slabs and bars may be suitably colour coded to mark the grade of the material as per agreement between the purchaser and the manufacturer.

14.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

15 ORDERING INFORMATION

While placing an order for the product(s) covered by this standard, the purchaser should specify clearly the following:

a) Grade designation;
b) Description regarding product form, size, length, etc;
c) Condition of delivery;
d) Tests required;
e) Method for manufacture;

f) Additional requirements as per Clause 13; and
f) Any special requirements;

ANNEX A

TABLE A. 1 LADLE ANALYSIS
(Clauses 7.1)

Designation	CONSTITUENT, PERCENT										
	C	Si	Mn	Ni	Cr	Mo	V	Al[a]	Cu	S[b]	P
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
UNALLOYED STEEL											
10C4[e]	0.15 max	0.15-0.35	0.30-0.60	-	-	-	-	-	-	0.045 max	0.045 max
14C6	0.10-0.18	0.15-0.35	0.40-0.70	-	-	-	-	-	-	0.040 max	0.040 max
15C4	0.12-0.18	0.15-0.40	0.30-0.60	0.40 max	0.40 max	0.10 max	-	-	0.30 max	0.035 max	0.025 max
15C8[e]	0.10-0.20	0.15-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
20C8	0.15-0.25	0.15-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
25C8	0.20-0.30	0.15-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
30C8	0.25-0.35	0.10-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
35C8	0.30-0.40	0.10-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
40C8	0.35-0.45	0.10-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
45C8	0.40-0.50	0.10-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
50C8	0.45-0.55	0.10-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
55C6	0.50-0.57	0.10-0.35	0.40-0.70	-	-	-	-	-	-	0.035 max	0.035 max
55C8	0.50-0.60	0.10-0.35	0.60-0.90	-	-	-	-	-	-	0.035 max	0.035 max
65C6	0.60-0.70	0.15-0.35	0.50-0.80	-	-	-	-	-	-	0.035 max	0.035 max
20C14	0.17-0.23	0.15-0.35	1.20-1.50	-	-	-	-	-	-	0.030 max	0.030 max
22C6	0.18-0.25	0.10-0.40	1.30-1.65	0.40 max	0.40 max	0.10 max	-	-	0.30 max	0.035 max	0.025 max
33C14	0.30-0.36	0.15-0.35	1.20-1.50	-	-	-	-	-	-	0.030 max	0.030 max
20C15	0.16-0.24	0.10-0.35	1.30-1.70	-	-	-	-	-	-	0.035 max	0.035 max
27C15	0.22-0.32	0.10-0.35	1.30-1.70	-	-	-	-	-	-	0.035 max	0.035 max
37C15	0.32-0.42	0.10-0.35	1.30-1.70	-	-	-	-	-	-	0.035 max	0.035 max
38C15	0.35-0.41	0.15-0.35	1.35-1.65	-	-	-	-	-	-	0.030 max	0.030 max
43C15	0.40-0.46	0.15-0.35	1.35-1.65	-	-	-	-	-	-	0.030 max	0.030 max
47C15	0.42-0.50	0.10-0.35	1.30-1.70	-	-	-	-	-	-	0.035 max	0.035 max
RESULPHURIZED STEEL											
10C8S10	0.15 max	0.15-0.35	0.60-0.90	-	-	-	-	-	-	0.08-0.13	0.035 max

11C10S25	0.08-0.18	0.10-0.35	0.80-1.20	-	-	-	-	-	-	0.20-0.30	0.045 max
14C14S14	0.10-0.18	0.10-0.35	1.20-1.50	-	-	-	-	-	-	0.10-0.18	0.045 max
40C10S18	0.35-0.45	0.25 Max	0.80-1.20	-	-	-	-	-	-	0.14-0.22	0.060 max
40C15S12	0.35-0.45	0.25 Max	1.30-1.70	-	-	-	-	-	-	0.08-0.15	0.035 max
46V1S3	0.42-0.50	0.60 Max	0.60-1.00	-	-	-	0.08-0.13		-	0.045-0.065	0.035 max
SILICON ALLOYED STEEL											
36Si7	0.33-0.40	1.50-2.00	0.80-1.00	-	-	-	-	-	-	0.035 max	0.035 max
55Si7	0.50-0.60	1.50-2.00	0.80-1.00	-	-	-	-	-	-	0.035 max	0.035 max
NICKEL STEEL											
40Ni14	0.35-0.45	0.10-0.35	0.50-0.80	3.20-3.60	0.30 max	-	-	-	-	0.035 max	0.035 max
CHROMIUM STEEL											
15Cr3	0.12-0.18	0.10-0.35	0.40-0.60	-	0.50-0.80	-	-	-	-	0.035 max	0.035 max
16Cr4	0.13-0.18	0.15-0.35	0.60-0.90	-	0.90-1.20	-	-	-	-	0.030 max	0.030 max
17Cr3	0.14-0.20	0.15-0.40	0.60-0.90	-	0.70-1.00	-	-	-	0.40 max	0.035 max	0.025 max
20Cr4[d]	0.17-0.23	0.15-0.40	0.60-0.90	-	0.90-1.20	-	-	-	-	0.035 max	0.030 max
28Cr4	0.24-0.31	0.40 max	0.60-0.90	-	0.90-1.20	-	-	-	0.40 max	0.035 max	0.025 max
30Cr4	0.28-0.33	0.15-0.35	0.60-0.90	-	0.90-1.20	-	-	-	-	0.030 max	0.030 max
34Cr4	0.30-0.37	0.10-0.40	0.60-0.90	-	0.90-1.20	-	-	-	0.40 max	0.035 max	0.025 max
35Cr4	0.33-0.38	0.15-0.35	0.60-0.90	-	0.90-1.20	-	-	-	-	0.030 max	0.030 max
37Cr4	0.34-0.41	0.10-0.40	0.60-0.90	-	0.90-1.20	-	-	-	0.40 max	0.035 max	0.025 max
40Cr4	0.35-0.45	0.10-0.35	0.60-0.90	-	0.90-1.20	-	-	-	-	0.035 max	0.035 max
41Cr4	0.38-0.45	0.10-0.40	0.60-0.90	-	0.90-1.20	-	-	-	0.40 max	0.035 max	0.025 max
45Cr4	0.43-0.48	0.15-0.35	0.60-0.90	-	0.90-1.20	-	-	-	-	0.030 max	0.030 max
50Cr4	0.45-0.55	0.10-0.35	0.60-0.90	-	0.90-1.20	-	-	-	-	0.035 max	0.035 max
55Cr3	0.50-0.60	0.10-0.35	0.60-0.80	-	0.60-0.80	-	-	-	-	0.035 max	0.035 max
SILICON MANGANESE STEEL											
37Mn5Si5	0.33-0.41	1.10-1.40	1.10-1.40	-	-	-	-	-	-	0.035 max	0.035 max
MANGANESE CHROMIUM STEEL											
16Mn5Cr4[d]	0.14-0.19	0.10-0.40	1.00-1.30	-	0.80-1.10	-	-	-	-	0.035 max	0.035 max
20Mn5Cr2	0.17-0.23	0.15-0.35	1.20-1.50	-	0.35-0.70	-	-	-	-	0.030 max	0.030 max
20Mn5Cr5[d]	0.17-0.22	0.10-0.40	1.00-1.40	-	1.00-1.30	-	-	-	-	0.035 max	0.035 max
43Mn6Cr2	0.40-0.46	0.15-0.35	1.35-1.65	-	0.35-0.70	-	-	-	-	0.030 max	0.030 max
SILICON CHROMIUM STEEL											

45Cr36Si12	0.40-0.50	2.75-3.25	0.30-0.60	-	8.50-9.50	-	-	-	-	0.035 max	0.035 max
55Si6Cr3	0.50-0.60	1.20-1.60	0.50-0.80	-	0.50-0.80	-	-	-	-	0.035 max	0.035 max
NICKEL MOLYBDENUM STEEL											
20Ni7Mo2	0.17-0.22	0.15-0.35	0.45-0.65	1.65-2.00	-	0.20-0.30	-	-	-	0.035 max	0.035 max
MANGANESE MOLYBDENUM STEEL											
35Mn6Mo3	0.30-0.40	0.10-0.35	1.30-1.80	-	-	0.20-0.35	-	-	-	0.035 max	0.035 max
35Mn6Mo4	0.30-0.40	0.10-0.35	1.30-1.80	-	-	0.35-0.55	-	-	-	0.035 max	0.035 max
NICKEL CHROMIUM STEEL											
13Ni13Cr3	0.10-0.15	0.15-0.35	0.40-0.70	3.00-3.50	0.60-1.00	-	-	-	-	0.035 max	0.035 max
14Cr6Ni6	0.12-0.17	0.15-0.40	0.40-0.60	1.40-1.70	1.40-1.70	-	-	-	-	0.035 max	0.035 max
15Ni9Cr1	0.12-0.18	0.15-0.35	0.35-0.65	2.00-2.50	0.20-0.50	-	-	-	-	0.030 max	0.030 max
15Ni13Cr3[d]	0.12-0.18	0.15-0.40	0.35-0.65	3.00-3.50	0.60-1.00	-	-	-	-	0.035 max	0.030 max
15Ni16Cr5	0.12-0.18	0.10-0.35	0.40-0.70	3.80-4.30	1.00-1.40	-	-	-	-	0.035 max	0.035 max
16Ni3Cr2	0.12-0.20	0.15-0.35	0.60-1.00	0.60-1.00	0.40-0.80	-	-	-	-	0.035 max	0.035 max
16Ni4Cr3	0.13-0.19	0.15-0.40	0.70-1.00	0.80-1.10	0.60-1.00	-	-	-	0.40 max	0.035 max	0.025 max
17Ni6Cr6	0.14-0.20	0.15-0.40	0.50-0.90	1.40-1.70	1.40-1.70	-	-	-	0.40 max	0.035 max	0.025 max
18Ni5Cr4	0.16-0.21	0.15-0.40	0.60-0.90	1.20-1.50	0.90-1.20	-	-	-	0.40 max	0.035 max	0.025 max
30Ni16Cr5	0.26-0.34	0.10-0.35	0.40-0.70	3.90-4.30	1.10-1.40	-	-	-	-	0.035 max	0.035 max
31Ni11Cr3	0.27-0.35	0.15-0.35	0.35-0.65	2.50-3.00	0.60-1.00	-	-	-	-	0.030 max	0.030 max
35Ni5Cr2	0.30-0.40	0.10-0.35	0.60-0.90	1.00-1.50	0.45-0.75	-	-	-	-	0.035 max	0.035 max
36Ni5Cr3	0.32-0.40	0.15-0.35	0.50-0.80	1.00-1.50	0.50-0.90	-	-	-	-	0.030 max	0.030 max
36Ni13Cr3	0.32-0.40	0.15-0.35	0.35-0.65	3.00-3.50	0.60-1.00	-	-	-	-	0.030 max	0.030 max
CHROMIUM MOLYBDENUM STEEL											
7Cr4Mo6	0.12 Max	0.15-0.60	0.40-0.70	-	0.70-1.10	0.45-0.65	-	-	-	0.035 max	0.035 max
10Cr9Mo10	0.15 Max	0.50 Max	0.40-0.70	-	2.00-2.50	0.90-1.10	-	-	-	0.035 max	0.035 max
15Cr4Mo2	0.13-0.18	0.15-0.35	0.60-0.90	-	0.90-1.20	0.15-0.25	-	-	-	0.030 max	0.030 max
15Cr13Mo6	0.10-0.20	0.15-0.35	0.40-0.70	-	2.90-3.40	0.45-0.65	-	-	-	0.035 max	0.035 max
18Cr4Mo2[d]	0.15-0.21	0.15-0.40	0.60-0.90	-	0.90-1.20	0.15-0.25	-	-	-	0.035 max	0.030 max
20Cr4Mo2	0.17-0.23	0.15-0.35	0.60-1.00	-	0.90-1.20	0.15-0.25	-	-	-	0.030 max	0.030 max
20Cr2Mo5	0.17-0.23	0.10-0.40	0.70-1.00	-	0.30-0.60	0.40-0.50	-	-	0.40 max	0.035 max	0.025 max
21Cr4Mo2	0.26 Max	0.10-0.35	0.50-0.80	-	0.90-1.20	0.15-0.30	-	-	-	0.035 max	0.035 max
22Cr3Mo5S	0.19-0.24	0.10-0.40	0.70-1.00	-	0.70-1.00	0.40-0.50	-	-	0.40 max	0.020-0.040	0.025 max
22Cr4Mo4	0.20-0.25	0.15-0.35	0.60-0.90	-	0.90-1.20	0.35-0.45	-	-	-	0.030 max	0.030 max

24Cr4Mo2	0.20-0.27	0.10-0.40	0.60-0.90	-	0.90-1.20	0.15-0.30	-	-	0.40 max	0.035 max	0.025 max
25Cr4Mo2[d]	0.22-0.29	0.10-0.40	0.60-0.90	-	0.90-1.20	0.15-0.30	-	-	-	0.035 max	0.030 max
25Cr13Mo6	0.20-0.30	0.10-0.35	0.40-0.70	-	2.90-3.40	0.45-0.65	-	-	-	0.035 max	0.035 max
30Cr4Mo2	0.28-0.33	0.15-0.35	0.60-0.90	-	0.90-1.20	0.15-0.30	-	-	-	0.030 max	0.030 max
32Cr6Mo2	0.27-0.37	0.15-0.35	0.30-0.60	-	1.00-1.50	0.15-0.30	-	-	-	0.030 max	0.030 max
34Cr4Mo4	0.30-0.37	0.10-0.40	0.60-0.90	-	0.90-1.20	0.15-0.30	-	-	0.40 max	0.035 max	0.025 max
35Cr4Mo2	0.33-0.38	0.15-0.35	0.60-0.90	-	0.90-1.20	0.15-0.30	-	-	-	0.030 max	0.030 max
40Cr4Mo2[d]	0.38-0.45	0.10-0.40	0.60-0.90	-	0.90-1.20	0.15-0.30	-	-	-	0.035 max	0.035 max
40Cr4Mo3	0.35-0.45	0.10-0.35	0.50-0.80	-	0.90-1.20	0.20-0.35	-	-	-	0.035 max	0.035 max
45Cr4Mo2	0.43-0.48	0.15-0.35	0.60-0.90	-	0.90-1.20	0.15-0.30	-	-	-	0.030 max	0.030 max
50Cr4Mo2	0.46-0.54	0.10-0.40	0.50-0.80	-	0.90-1.20	0.15-0.30	-	-	0.40 max	0.035 max	0.025 max
CHROMIUM VANADIUM STEEL											
42Cr6V1	0.37-0.47	0.10-0.35	0.50-0.80	-	1.40-1.70	-	0.07-0.12	-		0.035 max	0.035 max
50Cr4V1	0.45-0.55	0.15-0.40	0.70-1.10	-	0.90-1.20	-	0.10-0.20	-		0.035 max	0.035 max
50Cr4V2	0.45-0.55	0.10-0.35	0.50-0.80	-	0.90-1.20	-	0.15-0.30	-		0.035 max	0.035 max
51Cr4V4	0.47-0.55	0.10-0.40	0.60-1.00	-	0.80-1.10	-	0.10-0.25	-	0.40 max	0.025 max	0.025 max
58Cr4V1	0.53-0.63	0.15-0.35	0.80-1.10	-	0.90-1.20	-	0.07-0.12	-		0.035 max	0.035 max
NICKEL CHROMIUM MOLYBDENUM STEEL											
15Ni5Cr4Mo1	0.12-0.18	0.10-0.35	0.60-1.00	1.00-1.50	0.75-1.25	0.08-0.15	-	-	-	0.035 max	0.035 max
15Ni7Cr2Mo2	0.12-0.18	0.15-0.35	0.40-0.70	1.60-2.00	0.40-0.60	0.15-0.30	-	-	-	0.030 max	0.030 max
15Ni7Cr4Mo2	0.12-0.18	0.10-0.35	0.60-1.00	1.50-2.00	0.75-1.25	0.10-0.20	-	-	-	0.035 max	0.035 max
15Ni17Cr3Mo2	0.12-0.18	0.15-0.35	0.30-0.60	4.00-4.50	0.70-1.00	0.15-0.30	-	-	-	0.030 max	0.030 max
16Ni8Cr6Mo2	0.12-0.20	0.10-0.35	0.40-0.70	1.80-2.20	1.40-1.70	0.15-0.25	-	-	-	0.035 max	0.035 max
16Ni12Cr6Mo5	0.13-0.20	0.15-0.35	0.80-1.20	2.80-3.20	1.40-1.80	0.40-0.60	-	-	-	0.030 max	0.030 max
17Ni6Cr4Mo2	0.14-0.20	0.15-0.40	0.60-0.90	1.20-1.60	0.80-1.10	0.15-0.25	-	-	0.40 max	0.035 max	0.025 max
18Ni6Cr7Mo3	0.15-0.21	0.15-0.40	0.50-0.90	1.40-1.70	1.50-1.80	0.25-0.35	-	-	0.40 max	0.035 max	0.025 max
20Ni2Cr2Mo2[d]	0.17-0.23	0.15-0.40	0.60-0.95	0.40-0.70	0.35-0.70	0.15-0.25	-	-	-	0.035 max	0.035 max
20Ni7Cr2Mo2	0.17-0.23	0.15-0.35	0.40-0.70	1.60-2.00	0.40-0.60	0.15-0.30	-	-	-	0.035 max	0.035 max
25Ni13Cr5Mo2	0.20-0.30	0.15-0.35	0.35-0.60	3.00-3.50	1.00-1.50	0.15-0.30	-	-	-	0.030 max	0.030 max
30Ni12Cr12Mo6	0.25-0.35	0.15-0.35	0.35-0.60	2.50-3.50	2.50-3.50	0.50[c]-0.70	-	-	-	0.030 max	0.030 max
30Ni8Cr8Mo4	0.26-0.34	0.10-0.40	0.50-0.80	1.80-2.20	1.80-2.20	0.30-0.50	-	-	0.40 max	0.035 max	0.025 max
31Ni7Cr3Mo2	0.27-0.35	0.15-0.35	0.60-0.90	1.60-2.00	0.60-1.00	0.15-0.30	-	-	-	0.030 max	0.030 max
31Ni10Cr3Mo6	0.27-0.35	0.10-0.35	0.40-0.70	2.25-2.75	0.50-0.80	0.40-0.70	-	-	-	0.035 max	0.035 max

34Ni6Cr6Mo2	0.30-0.38	0.10-0.40	0.50-0.80	1.30-1.70	1.30-1.70	0.15-0.30	-	-	0.40 max	0.035 max	0.025 max
36Ni4Cr4Mo2	0.32-0.40	0.10-0.40	0.50-0.80	0.90-1.20	0.90-1.20	0.15-0.30	-	-	0.40 max	0.035 max	0.025 max
39Ni7Cr3Mo2	0.36-0.43	0.15-0.35	0.60-0.90	1.60-2.00	0.60-1.00	0.15-0.30	-	-	-	0.030 max	0.030 max
40Ni2Cr2Mo2	0.37-0.44	0.10-0.40	0.70-1.00	0.40-0.70	0.40-0.60	0.15-0.30	-	-	-	0.035 max	0.030 max
40Ni6Cr4Mo2[d]	0.35-0.45	0.10-0.35	0.40-0.70	1.20-1.60	0.90-1.30	0.10-0.20	-	-	-	0.035 max	0.035 max
40Ni6Cr4Mo3	0.35-0.45	0.10-0.35	0.40-0.70	1.25-1.75	0.90-1.30	0.20-0.35	-	-	-	0.035 max	0.035 max
40Ni10Cr3Mo6	0.36-0.44	0.10-0.35	0.40-0.70	2.25-2.75	0.50-0.80	0.40-0.70	-	-	-	0.035 max	0.035 max
47Ni7Cr3Mo2	0.44-0.50	0.15-0.35	0.60-0.90	1.60-2.00	0.60-1.00	0.15-0.30	-	-	-	0.030 max	0.030 max
CHROMIUM MOLYBDENUM VANADIUM STEEL											
40Cr13Mo10V2	0.35-0.45	0.10-0.35	0.40-0.70	-	3.00-3.50	0.90-1.10	0.15-0.25	-	-	0.035 max	0.035 max
CHROMIUM MOLYBDENUM ALUMINIUM STEEL											
40Cr7Al10Mo2	0.35-0.45	0.10-0.35	0.40-0.70	-	1.50-1.80	0.10-0.25	-	0.90-1.30	-	0.035 max	0.035 max
45Cr6Al10Mo2	0.40-0.50	0.15-0.50	0.60 Max	-	1.30-1.70	0.15-0.30	-	0.70-1.20	-	0.030 max	0.030 max
STEELS WITH BORON											
20C13BT	0.17-0.23	0.40 max	1.10-1.40	-	-	B: 0.0008-0.0050			0.40 max	0.035 max	0.025 max
30C13BT	0.27-0.33	0.40 max	1.15-1.45	-	-	B: 0.0008-0.0050			0.40 max	0.035 max	0.025 max
39C13BT	0.36-0.42	0.40 max	1.15-1.45	-	-	B: 0.0008-0.0050			0.40 max	0.035 max	0.025 max
16Mn5Cr5BT	0.14-0.19	0.15-0.40	1.00-1.30	-	0.80-1.10	B: 0.0008-0.0050			0.40 max	0.035 max	0.025 max
27Mn5Cr2BT	0.24-0.30	0.40 max	1.10-1.40	-	0.30-0.60	B: 0.0008-0.0050			0.40 max	0.035 max	0.025 max
33Mn5Cr2BT	0.30-0.36	0.40 max	1.20-1.50	-	0.30-0.60	B: 0.0008-0.0050			0.40 max	0.035 max	0.025 max
39Mn6Cr2BT	0.36-0.42	0.40 max	1.40-1.70	-	0.30-0.60	B: 0.0008-0.0050			0.40 max	0.035 max	0.025 max

Note:

a) When required, the steels shall be supplied in fully Aluminium killed condition and the total Aluminium content shall be within 0.020-0.050%. When the steel is aluminium killed or killed with both Aluminium and Silicon, the requirements of minimum Silicon content shall not apply except for grades alloyed with Silicon (≥0.50%).

b) For grades specifying maximum Sulphur, Sulphur in the range of 0.020-0.035% or any other range may be agreed to between the manufacturer and purchaser. For such grades specifying sulphur range, a letter 'S' shall be added at the end of grade designation.

c) The lower limit of Mo may be 0.30% upon agreement between the purchaser and the manufacturer.

d) Cu may be 0.40% max upon agreement between the purchaser and the manufacturer.

e) Si may be 0.40% max, Cu may be 0.30% max, Cr may be 0.40% max, Mo may be 0.10% max and Ni may be 0.40% max upon agreement between the purchaser and the manufacturer.

- In the case of steels with hardenability requirements, minor deviations from the specified limits are permitted (with the exception of sulphur and phosphorus), provided that they do not exceed 0.01% for carbon and the values indicated in Table 1 for the other elements.
- In special cases, it may be desirable that the range of carbon or other elements content should be more closely controlled than in the range specified above. When this is necessary, restricted ranges of carbon or other elements may be agreed to between the manufacturer and the purchaser.

TABLE A. 2 TENSILE PROPERTIES

(Clauses 10.1)

Grade	Tensile Strength *Min* (MPa)	Yield Strength *Min* (MPa)	Elongation ($GL = 5{\cdot}65\sqrt{S_o}$), *Min*, Percent	Normalizing Temperature (°C) (For information only)
(1)	(2)	(3)	(4)	(6)
14C6	370	200	26	880—910
15C8	410	220	25	880—910
20C8	430	230	24	880—910
25C8	460	250	22	880—910
30C8	490	270	21	860—890
35C8	540	280	20	850—880
45C8	620	320	15	830—860
55C8	710	350	13	810—840
65C6	740	370	10	800—830

Note:

1) The properties given in the table refer to ruling section upto 100 mm in the as rolled or as forged and normalized condition and are applicable to test samples taken along the direction of grain flow. For higher section as well as for the supply in the hardened and tempered condition, the properties shall be as agreed to between the purchaser and the manufacturer.
2) The properties are applicable to test piece taken on rounds. For rectangular sections the ranges for equivalent section shall be as given in Fig. A.1

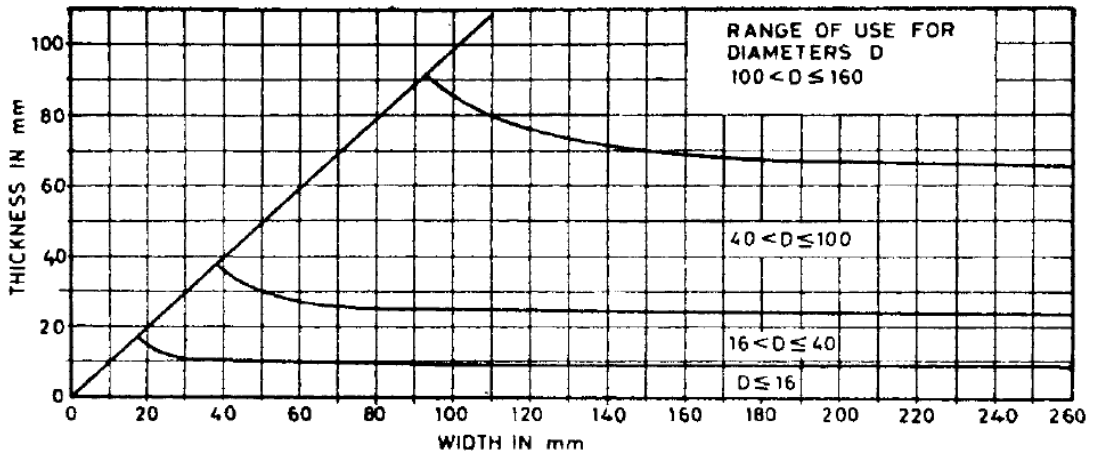


Fig A.1 APPLICABILITY OF THE VALUES, GIVEN IN TABLE A.2 FOR ROUND SECTION, TO RECTANGULAR SECTION

TABLE A.3 Provisional Limiting Rockwell Hardness for End Quench Test
(Clause 10.3)

Steel Grade	Limits of Spread	Hardness HRC at a Distance from End Quench Face in mm														
		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
27C15	Maximum	55	54	51	48	45	42	39	37	33	31	29	28	27	27	26
	Minimum	46	43	37	31	27	23	20	-	-	-	-	-	-	-	-
16Mn5Cr4	Maximum	47	46	44	41	37	35	34	33	31	30	29	28	27	-	-
	Minimum	39	35	31	28	24	22	20	-	-	-	-	-	-	-	-
20Mn5Cr5	Maximum	49	49	48	46	44	42	41	40	37	35	34	33	31	-	-
	Minimum	41	39	36	33	31	29	27	25	23	21	-	-	-	-	-
40Cr4	Maximum	61	61	60	59	58	56	54	52	46	42	40	38	37	36	35
	Minimum	53	52	50	47	44	40	37	35	30	27	25	23	22	21	20
14Cr6Ni6	Maximum	47	47	46	45	43	42	41	39	37	35	3$	34	33	-	-
	Minimum	39	38	36	35	32	30	28	26	24	22	20	20	-	-	-
40Cr4Mo3	Maximum	61	61	61	60	60	59	59	58	56	53	51	48	47	46	45
	Minimum	53	53	52	51	50	48	45	43	38	35	34	33	32	32	32
42Cr4Mo2	Maximum	61	61	61	60	60	59	59	58	56	53	51	48	47	46	45
	Minimum	53	53	52	51	50	48	45	43	38	35	34	33	32	32	32
50Cr4V2	Maximum	65	65	64	64	63	63	62	61	60	58	56	55	54	53	53
	Minimum	57	56	56	55	53	52	50	48	44	41	40	39	38	37	37

Draft Indian Standard

BRIGHT STEEL BARS — SPECIFICATION

(*Second Revision of IS 9550*)

1 SCOPE

1.1 This standard covers cold drawn, turned, turned and reeled, or ground steel bars of grades and cross sections regarded as generally suitable for heat treatment, for machining into component or for use in 'as finished' condition in constructional applications or other similar purposes, such as for the manufacture of threaded and machined components for general engineering purposes.

1.2 This document does not apply to the following steel qualities:

— Steel for Cold Heading/Cold Extrusion Applications – Wrought Carbon and Low Alloy Steels as per IS 11169 Part 1;
— Steel for Cold Heading/Cold Extrusion Applications – Stainless Steels as per IS 11169 Part 2;
— Tool steels as per IS 3748;
— Stainless steel semi-finished products, bars, wire rods and bright bars as per IS 6603.

2 REFERENCES

The Indian Standards are listed in Annex A, contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

3.1 For the purpose of this standard the definitions given in IS 1956 (Part 3) and the following shall apply.

3.1 Bright Bars : Bright bars are drawn or peeled/turned bars with smoother surface quality and better dimensional accuracy in comparison to hot-rolled bars.

3.2 Drawn Products

Products of various cross section shapes obtained, after descaling, by drawing of hot rolled bars or rods on a draw bench (cold deformation without removing material). This operation gives the product special features with respect to shape, dimensional accuracy, surface finish and mechanical properties. In addition, the process causes cold working of the product, which can be eliminated by subsequent heat treatment. Products in lengths are delivered straightened regardless of size.

3.3 Peeled/ Turned Products

Peeled/turned products round bars produced by peeling or turning where the product can be further processed by straightening and polishing. This operation gives the bar special features with respect to shape, dimensional accuracy and surface finish. The removal of metal is carried out in such a way that the bright product is generally free from rolling defects and surface decarburization.

3.4 Ground Products

Drawn or turned round bars given an improved surface quality and dimensional accuracy by grinding and polishing.

3.5 Thickness

nominal dimension of the product

Which means:

a) the diameter in the case of rounds;

b) the lateral length in the case of squares;

c) the width over flats in the case of hexagons;

d) the shorter lateral length in the case of flats (rectangular bars) and wide-flats

3.6 Out-Of Round

Difference between the smallest and largest dimension measured across the pairs of opposing points at a common cross-section

4 SUPPLY OF MATERIAL and PRODUCT DESIGNATION

4.1 General requirements relating to the supply of material shall be as laid down in IS 8910.

4.2 The treatment condition of the bars shall be as follows

Sl No.	Treatment condition at delivery	Symbol
1	As-rolled and peeled/ turned[a]	+SH
2	Cold drawn	+C
3	Soft annealed and peeled/turned	+A+SH
4	Soft annealed and cold drawn	+A+C
5	Treated to ferrite-pearlite structure and hardness range and peeled/turned	+FP+SH
6	Treated to ferrite-pearlite structure and hardness range and cold drawn	+FP+C
7	Quenched and tempered and peeled or cold drawn and quenched and tempered	+QT+SH+C+QT
8	Quenched + tempered and cold drawn	+QT+C
9	Other heat-treated conditions, for example stress relieved (+SR), normalized (+N), cold drawn and annealed or normalized (+C+A, +C+N)	

a Peeling is in general possible for diameters of 16 mm and over.

4.3 The Bright bars shall be delivered in or a combination of the following surface conditions:

a) Cold Drawn, +C
b) Cold Drawn, Heat treated, +C+QT, +C+N, +C+SR, +C+A
c) Peeled/Turned, +SH
d) Ground, + G, and
e) Polished , +PL.

4.3 Unless otherwise agreed, bars up to 45 mm in dimensions are normally delivered with sheared ends. The ends of the product shall be as specified by the purchaser at the time of enquiry and order, for example, chamfering, facing, etc

4.4 Basis for order

While placing an order for the steels covered by this standard, the purchaser should specify clearly the following:

a) Chemical composition;(*see* 6)
b) Mechanical properties;(*see* 7)
c) Dimensions ;(*see* 8.1)
d) Dimensional tolerance;(*see* 8.2)
e) Treatment condition of bars (*see* 4.2)
f) Supply surface conditions (*see 4.3*)
g) Surface quality class : (*see* table 8)
h) Decarburization depth (*see* 9.1)
i) Optional test if required (see 11)

4.5 Product Designation

4.5.1 The product designation shall follow the sequence below:

(a) Number of this Indian Standard with prefix IS.
(b) Corresponding product standard (CPS) as applicable
(c) Number of corresponding Indian Standard on bars, if any
(d) Grade/Designation of the bars as per (c) above , if any

Example 1 IS 9550 CPS 2062/ E250 BR
Example 2 IS 9550 XXXX (in case of grade without any CPS, where XXXX is a grade supplied on mutual agreement between the manufacturer and the purchaser)

5 MANUFACTURE

5.1 The processes used in making the steel and in manufacturing bright steel products are left to the discretion of the manufacturer.

5.2 Unless specified otherwise, the steel shall be supplied in the rimmed, semi-killed or killed condition, as per mutual agreement between the purchaser and the manufacturer.

6 CHEMICAL COMPOSITION

6.1 The chemical composition of bright bars shall be as per relevant product Indian standard or it may be as agreed between purchaser and supplier. The material specification and heat treatment, if any, shall be so selected that the rolled bars used for the manufacture of bright bars will ensure the desired mechanical properties as per the requirements of the purchaser.

6.2 The analysis of steel shall be carried either by the method specified in the relevant parts of IS 228 or any other established instrumental/chemical method. In case of dispute, the procedure given in the relevant part of IS 228 shall be referee method. However, where the method is not given in IS 228 or its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer

6.3

7 MECHANICAL PROPERTIES

7.1 The mechanical properties of bright bars shall be as agreed to between the purchaser and the manufacturer. The test method standard shall be the relevant standards depending on the mechanical properties such as IS 1608 (various parts) for tensile test, IS 1500 for brinell hardness, etc

8 DIMENSIONS AND TOLERANCES

8.1 Dimensions

Bars~~, sections and flats~~ shall be supplied as per the dimensions specified in the orders.

8.2 Tolerances

8.2.1 *Diameter, Thickness and Width*

Tolerances on dimensions shall be as specified by the purchaser and shall be in accordance with 1S 919 (Part 2) as given in Table 1

Table 1 Tolerance Class According to Finished Conditions

Sl No.	Surface condition at delivery	Symbol	Tolerance class to IS 919 Part 2[a]			
			Rounds	Squares	Hexagons	Drawn flats Special sections
(1)	(2)	(3)	(4)	(5)		(6)
i)	Cold drawn or heat-treated and cold drawn	+C	h10 (h9 to h12) *see* Table 3	h11 for $d \leq 80$ mm, h12 for $d > 80$ mm (h11 or h12); *see* Table 3		h11, h12 *see* Table 4
ii)	Cold drawn, heat treated	+C+QT (+C+N) (+C+SR) (+C+A)	h11 *see* Table 3	– b	– b	–
iii)	Peeled/turned	+SH	h10 (h9 to h12) *see* Table 3	–	–	–
iv)	Ground	+G	h9 (h6 to h12) *see* Table 3	–	–	–
v)	Polished	+PL	h9 (h6 to h12) *see* Table 3	–	–	–

NOTES
a Standard tolerance classes unless otherwise specified. In brackets: other possible tolerance classes according to IS 919 Part 2 if required at the time of enquiry and order.
b To be agreed at the time of enquiry and order.
c stress relieved (+SR), normalized (+N), annealed (+A), Quenched and tempered (+QT).

8.2.1.1 Unless specified otherwise, tolerances on dimensions shall be as follows:

a) For drawn round bars other than those under (e), or turned bars: h10 to Table 3.
b) For hexagonal and square drawn bars: h11 for dimensions up to and including 80 mm, h12 for dimensions over 80 mm according to Table 1 and 3.
c) For drawn flats: in accordance with Table 4 and 5;
d) For ground products: in accordance with Table 1 and 2
e) For drawn round bars in the heat treated condition: h 11.

8.2.2 *Length*

Unless otherwise agreed at the time of enquiry and order, the length and the tolerance on length shall be as specified in Table 2.

Table 2 TYPES OF LENGTH AND LENGTH TOLERANCES

Sl No.	Type of length	Length mm	Length tolerances mm	To be stated in order
(1)	(2)	(3)	(4)	(5)
i)	Manufacturing length[a]	3000 to 9000	±500	Length
ii)	Stock length[a]	3000 or 6000	0, +200 0, +200	e.g. stock 6000
iii)	Cut to length	Up to 9000	Corresponding to specifications with ±5 minimum	Length and tolerance

[a] Short bars: each bundle may contain a percentage of short bars.

NOTES
1 Dimensions ≤ 25 mm: the percentage is 5 % maximum, the length of these short bars being at the minimum two thirds the nominal length ordered.
2 Dimensions > 25 mm: the percentage is 10 % maximum, with the same restriction on the minimum length
3 If agreed at the time of enquiry and order bright products are delivered without any short bars.

8.2.2.1 The ends of the bars shall be cut square without disturbing the dimensional tolerances.

Table 3 – Tolerance Classes for rounds, squares and hexagons

Nominal Thickness mm	Tolerances Class to IS 919 Part 2[a]						
	h6	h7	h8	h9	h10	h11	h12
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$1 < t \leq 3$	0.006	0.010	0.014	0.025	0.040	0.060	0.100
$3 < t \leq 6$	0.008	0.012	0.018	0.030	0.048	0.075	0.120
$6 < t \leq 10$	0.009	0.015	0.022	0.036	0.058	0.090	0.150
$10 < t \leq 18$	0.011	0.018	0.027	0.043	0.070	0.110	0.180
$18 < t \leq 30$	0.013	0.021	0.033	0.052	0.084	0.130	0.210
$30 < t \leq 50$	0.016	0.025	0.039	0.062	0.100	0.160	0.250
$50 < t \leq 80$	0.019	0.030	0.046	0.074	0.120	0.190	0.300
$80 < t \leq 120$	0.022	0.035	0.054	0.087	0.140	0.220	0.350
$120 < t \leq 180$	0.025	0.040	0.063	0.100	0.160	0.225	0.400
$180 < t \leq 250$	0.029	0.045	0.072	0.115	0.185	0.290	0.460

[a] The above deviation values are negatively disposed about the nominal dimension. For example, a 20 mm nominal diameter having a tolerance class h9 has 20 mm – 0.052/+ 0 mm or 19.948/20.000 mm.

Table 4 Width Tolerances for Drawn Flats
(*Clauses 8.2.1.1*)

Sl No.	Width	Deviation		IS 919-2
	mm	mm	mm	Class
(1)	(2)	(3)	(4)	(5)
i.	$w \leq 18$	-	-	h 11
ii.	$18 < w \leq 30$	+0	-0.13	h 11
iii.	$30 < w \leq 50$	+0	-0.16	h 11
iv.	$50 < w \leq 80$	+0	-0.19	h 11
v.	$80 < w \leq 100$	+0	-0.22	h 11
vi.	$100 < w \leq 150$	+0.50	-0.50	
vii.	$150 < w \leq 200$	+1.00	-1.00	
viii.	$200 < w \leq 300$	+2.00	-2.00	
ix.	$300 < w \leq 400$	+2.50	-2.50	
x.	$400 < w \leq 500$	+1%	-1%	

Table 5 Thickness Tolerances for Drawn Flats
(*Clauses 8.2.1.1*)

Sr. No.	Thickness[b] mm	Deviation[a]		
		mm	mm	
(1)	(2)	(3)	(4)	(5)
i.	$3 < t \leq 6$	+0	-0.075	h 11
ii.	$6 < t \leq 10$	+0	-0.090	h 11
iii.	$10 < t \leq 18$	+0	-0.11	h 11
iv.	$18 < t \leq 30$	+0	-0.13	h 11
v.	$30 < t \leq 50$	+0	-0.16	h 11
vi.	$50 < t \leq 60$	+0	-0.19	h 11
vii.	$60 < t \leq 80$	+0	-0.30	h 12
viii.	$80 < t \leq 120$	+0	-0.35	h 12
ix.	$120 < t \leq 140$	+0	-0.40	h 12

NOTES
a The tolerances in this table apply to low carbon ($C \leq 0.20$ %) and low carbon free-cutting steels only. For all other steels, deviation may increase to 150 % of the mentioned tolerance class.
b For $w > 150$ mm and $t \leq 18$ mm the tolerance of the thickness is h12.

8.2.3 *Straightness Tolerance*

8.2.3.1 Unless otherwise agreed, the permissible deviations for straightness given in Table **6** and Table **7** shall apply**.** The methods for evaluating straightness are given in Annex B.

Table 6 — Deviation from straightness for rounds, squares and hexagons [a]

Product form	Steel group[b]	Nominal dimension	Deviation *Max* mm
(1)	(2)	(3)	(4)
Rounds	Non-alloy steels < 0.25 % C		1.0
	Non-alloy steels ≥ 0.25% C, alloy steels, quenched and tempered steels		1.5
Squares and hexagons	Non-alloy steels < 0.25 % C	t≤ 75mm	1.0
	Non-alloy steels ≥ 0.25% C, alloy steels, quenched and tempered steels	t≤ 75mm	2.0
	Non-alloy steels < 0.25 % C	t >75 mm	1.5
	Non-alloy steels ≥ 0.25% C, alloy steels, quenched and tempered steels	t >75 mm	2.5

[a] For the method of evaluating straightness *see* Annex B.
[b] *see* IS 7598

Table 7 — Deviation from straightness for flats

Product form	Steel group	Nominal dimension	Deviation *Max* mm	
			for w/t≥ 10:1	for w/t < 10:1
(1)	(2)	(3)	(4)	(5)
Flats	Non-alloy steels < 0.25 % C	*w* < 120	2	1.5
		w ≥ 120	2.5	2
	Non-alloy steels ≥ 0.25% C, alloy steels, quenched and tempered steels	*w* < 120	2.5	2
		w ≥ 120	3	2.5

[a] For the method of evaluating straightness *see* Annex B.

8.2.3.2 Any other details regarding measuring and sampling method for straightness tolerance of bright bars shall be agreed upon at the time of inquiry and order

8.2.4 *Out of Shape*

Maximum deviation from ‘out of shape’ shall be not more than half the specified tolerance.

8.2.5 *Edges of Non-round Bars*

Non-round bars, that is, square, hexagon and flat in widths up to and including 150 mm shall have sharp corners without radius. For widths over 150 mm the corner profile may be undefined within a distance of 0.5 ‘mm of the hypothetical edge, unless sharp corners have specifically been ordered.

9 SURFACE CONDITION

The surface quality of the steel product shall be one of the classes according to Table 8 ~~5~~. Drawn products shall have a smooth, scale free surface. Products in the final heat treated condition shall be free from loose surface scale, but may have surface discoloration or darkening.

NOTES
1 Drawn products may have minor surface imperfections, for example, pores, pits, scoring.
2 Non-circular sections will not have the same quality of surface finish as round sections.
3 Products in drawn and turned condition are not supplied with a specified surface finish.
4 Longitudinal surface cracks cannot be entirely eliminated from surfaces of drawn products without removal of material.
5 Products in the ‘technically crack free by testing’ condition are only available in the turned or turned and ground condition.
6 Bars shall be reasonably free from harmful internal defects.

9.1 Decarburization

9.1.1 No surface decarburization shall be permitted for turned and ground bars.

9.1.2 In cold drawn bars, total decarburization shall not be permitted. The maximum extent of partial decarburization that can be permitted for cold drawn bars will be guided by the maximum depth of defects ~~for Class 2~~ bars as given in Table 8. It however, a lower depth of decarburization is required, it shall be mutually agreed to between the purchaser and the manufacturer.

9.1.3 The depth of decarburization shall be checked as per the method specified in IS 6396.

TABLE 8 Surface Quality Classes

Condition	Class			
	1	2	3	4
(1)	(2)	(3)	(4)	(5)
Permissible depth of discontinuities	0.3 mm *Max* for $t \leq 15$ mm; 0.02*t Max* for $15 < t \leq 100$ mm	0.3 mm *Max* for $t \leq 15$mm; 0.02*t Max* for $15 < t \leq 75$ mm 1.5mm *Max* for t > 75mm	0.2 mm *Max* for $t \leq 20$ mm; 0.01*t Max* for $20 < t \leq 75$mm; 0.75mm *Max* for t > 75mm	Technically crack free by manufacture [e]
Maximum percentage of delivered weight with discontinuities in excess of specified level	4%	1%	1%	0.2%
Product form[a]				
Rounds	+	+	+	+
Squares	+	+(for $t \leq 20$ mm)[c]	-	-
Hexagons	+	+(for $t \leq 50$ mm)[c]	-	-
Flats	+[b]	-	-	-
Special Sections	+[d]	-	-	-
t = nominal thickness that means diameter of bars and distance across flats of squares and hexagons.				
NOTES a + indicates available in these classes, - indicates not commonly available in these classes. b Maximum depth of discontinuities refers to respective section (Width or thickness) c Crack detection with eddy current device not possible for $t > 20$ mm or $t > 50$ mm as indicated. d Reference dimensions to be agreed at the time of enquiry and order e The surface quality class shall be better than class 3 . The requirements and the kind of verification are to be agreed at the time of enquiry and order.				

10 SAMPLING

10.1 Sampling for Chemical Analysis

If the product analysis is required by the purchaser, at least one sample product shall be taken from each cast/lot.

10.1.1 For product analysis, the selection of sample shall be carried as per mutual agreement between the purchaser and the supplier. Product analysis shall not be applicable for rimming steel.

10.2 Sampling for Mechanical Tests:
For the purpose of Mechanical tests, samples shall be selected on the following basis:

Condition	*Number of Samples*
Peeled /Turned, Polished or Ground	One of every 20 tonnes or part thereof with a minimum one per cast
Cold Drawn	One of every cast
Cold Drawn, Heat-treated	One of every batch (not over 20 tonnes) with a minimum of one per cast

10.2.1 Test pieces for mechanical properties shall be taken in the direction of the fibre , the rolling direction.

10.3 Selection and preparation of samples and test pieces shall be done in accordance with IS 3711.

11 OTHER TESTS

11.1 If required and mutually agreed to between the purchaser and the manufacturer, the following tests may be carried out and test certificates furnished by the manufacturer:

a) Hardenability (*see* IS 3848);
b) Inclusion content (*see* IS 4163)
c) Grain size (*see* IS 4748);
d) Microstructure [*see* IS 7739(Part 1), IS 7739 (Part 2) and IS 7739 (Part 5)]
e**)** Crack testing (*see* IS 2595, IS 3658, IS 3664 and IS 3703);
~~f) Decarburization (*see* IS 6396);~~
f) Microscopic examination for depth of defects; and
g) Any other tests (that is, surface roughness in micron), etc.

11.1.1 Acceptance values and details of tests in absence of any Indian Standard shall be as agreed to between the purchaser and the manufacturer

12 RETEST

Should any one of the test pieces first selected fail to pass any of the tests specified in this standard, two further samples shall be selected from the same lot for testing in respect of each failure. Should the test pieces from both these additional samples pass, the material represented by the test samples shall be deemed to comply with the requirement of that particular test. Should the test pieces from either of these additional samples fail, the material represented by the test samples shall be deemed as not conforming to this standard.

13 SURFACE PROTECTION AND PACKING

A suitable clear temporary rust preventive shall be applied on all the bars to avoid rust during transit (see IS 1153 and IS 1154). The material shall be suitably packed in bundles- hessian wrapped to prevent sagging, corrosion and damage during transit.

14 MARKING

14.1 Each bar over 50 mm in diameter or of equivalent cross sectional area shall be stamped at one end with the cast identification and supplier's identification mark/ code. Bars of 50 mm in diameter or of equivalent cross sectional area and below shall be bundled together and tied with suitable steel strappings at 3-4 places along the length 'of the bars. The metal tag shall be securely attached to each bundle and shall bear the information such as supplier's name, cast heat number, size and mass, order No., etc.

14.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed there under, and the product(s) may be marked with the Standard Mark.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 919 (Part2) : 1993/ ISO 286-2 :2010	Geometrical Product Specifications (GPS) — ISO Code System for Tolerances on Linear Sizes Part 2 Tables of Standard Tolerance Classes and Limit Deviation for Holes and Shafts (*second revision*)
IS 1153:2021	Temporary Corrosion Preventives, Hard Film, Solvent Deposited — Specification (*third revision*)
IS 1154:2022	Temporary Corrosion Preventive Fluid, Soft Film, Solvent Deposited, Water Displacing – Specification (*second revision*)
IS 1956 (Part 3):2019	Glossary of Terms Relating to Iron and Steel Part 3 Long Products (Including Bars, Rods, Sections and Wires) (*second revision*)
IS 2595:2008	Industrial Radiographic Testing — Code of Practice (*second revision*)
IS 3658:1999	Code Of Practice for Liquid Penetrant Flaw Detection (*second revision*)
IS 3664:1981	Code Of Practice for Ultrasonic Pulse Echo Testing By Contact and Immersion Methods (*first revision*)
IS 3703:2023	Recommended practice for magnetic particle flaw detection (*third revision*)
IS 3711 : 2020/ ISO 377:2017	Steel and Steel Products — Location and Preparation of Samples and Test Pieces for Mechanical Testing (*third revision*)
IS 3848:1981	Method for end quench test for hardenability of steel (*first revision*)
IS 4163:2021/ ISO 4967: 2013	Steel — Determination of Content of Non-metallic Inclusions — Micrographic Method Using Standard Diagrams (*fourth revision*)
IS 4748 : 2021/ ISO 643 : 2019	Steel — Micrographic Determination of the Apparent Grain Size (*third revision*)
IS 6396: 2000	Methods of measuring decarburized depth of steel (*second revision*)
IS 7598:1990	Classification of steels (*first revision*)
IS 7739 (Part l):1975	Code of practice for preparation of metallographic specimens -general feature
IS 7739 (Part 2):1975	Code of practice for preparation of metallurgical specimens-Electrolytic polishing
IS 7739 (Part 5):1976	Code of practice for preparation of metallurgical specimens-Iron and steel and their examination
IS 8910:2022 /ISO 404:2013	Steel and Steel Products — General Technical Delivery Requirements (*second revision*)

ANNEX B

(*Clause* 8.2.3.1)

METHODS FOR EVALUATING STRAIGHTNESS

B-1 This annex specifies two methods for the evaluation of the straightness of the bright steel bars as provided for in 8.2.3. The method specified in B-2 is the preferred method and B-3 is an alternative method. The choice of method shall be as agreed at the time of enquiry and order.

B-2 PREFERRED METHOD

B-2.1 The bar shall be supported on a suitably so as to eliminate or minimize sagging.

B-2.2 A 1-m long straight edge shall be placed on the surface of the bar at any position along its length. No part of the straight edge shall be within 150 mm of the ends of the bar.

B-2.3 Straightness shall be determined by measuring the maximum gap between the bar and the straight edge by suitable means, for example, feeler gauge. The bar shall be deemed straight where the maximum gap does not exceed the values specified in **8.2.3.1.**

B-3 ALTERNATIVE METHOD FOR ROUND BARS

B-3.1 The round bar shall be supported on centres placed 1 m apart and capable of being rotated.

B-3.2 Straightness shall be measured by means of a suitable dial or indicator gauge placed at any position between the supporting centres.

B-3.3 The bar shall be deemed straight when rotating the bar through 360° the indicated reading is not greater than twice the deviation specified in **8.2.3.1.**

Doc no. SCMD/R&D Guidelines/20230909

GUIDELINES FOR RESEARCH & DEVELOPMENT PROJECTS FOR FORMULATION AND REVIEW OF STANDARDS

1 INTRODUCTION

Bureau of Indian Standards (BIS), as the National Standards Body of India is responsible for formulating Indian Standards for products, processes and services. In the pursuit of this endeavour, it has so far developed more than 22000 Indian Standards. Action Research and Research & Development Projects have always been part of the standardization process. However, there has been a growing realisation in the context of the increasing diversification, innovation and complexities in the manufacturing sector and evolution of services and also due to the fast pace of changes in the manufacturing and services landscapes, research & development projects have to be made an integral part of the standardization process. The idea is that in principle no standard should be developed without intensive and insightful research work, which is not confined only to the review of the existing literature and focus group discussions on the subject chosen for standardization, but also covers the detailed field level study of the existing processes and practices in product manufacturing and service delivery. This requires a large network of domain area experts to carry out the research & development work. The existing network encompasses only a small segment of experts, who are either associated with technical committees as members or belong to some R&D organizations. The Memorandum of Understanding with the premier educational institutions imparting technical and professional education opens the window to the opportunities to expand this network substantially by utilizing the intellectual capital that resides with the faculty and the research scholars in these institutions. This association is conceived not only as a way to promote research & development work necessary for standards formulation but also to enrich the research ecosystem in these educational institutions.

2 OBJECTIVES

Objectives of this Scheme are to:

2.1 support and commission research & development projects to generate knowledge, empirical data and insights that would help in formulating new standards and updating & upgrading the existing Indian standards;

2.2 expand the network of domain area experts to carryout research & development projects in the areas related to standardization and conformity assessment; and

2.3 enrich the research ecosystem in the educational institutions imparting technical and professional education.

3 RESEARCH & DEVELOPMENT PROJECTS

3.1 Research & development projects under these guidelines are described as follows:

A project aimed at comprehensive, in depth and incisive study of a product, process or service or all taken together in respect of a subject under standardization, encompassing literature review, analysis of the data from secondary sources, collection and analysis of data from primary sources and stakeholder consultations.

3.2 The duration of a project shall not exceed six months counted from the date of the award of the project to acceptance of the final report by the Sectional Committee concerned, provided that the Sectional Committee must not take more than one month to give its decision on the final report. Further provided that the time taken by the Sectional Committee for giving its decision shall not be counted. The Sectional Committee may extend the duration but for not more than 2 months in special circumstances, the reasons for which shall be recorded in the minutes of meeting of the Sectional Committee.

3.3 The upper limit for expenditure for a project shall be Rs 10 lakhs (including taxes) only.

3.4 BIS will publish a list of research & development projects along with Terms of Reference (ToR) on Standardization portal or any other suitable digital platform.

3.5 If any organization or an expert on behalf of an institute wants to propose a research & development project on any new and emerging area in which they have expertise, they can do so through the same platform for the consideration of the Sectional Committee.

4 TERMS OF REFERENCE (ToR)

4.1 The ToR of Research& development project shall be prepared by the Sectional Committee concerned, and shall contain:

a) Title, background and objectives of the study;
b) Expected research methodology (brief information, for example, survey, testing, industry visits, etc.);
c) Scope of study;
d) Outline of the tasks and final deliverables expected from the Proposers;
e) Methods of review, schedule for submitting the 1st draft report and project completion report;
f) Any support or inputs to be provided to the Proposer; and
g) Maximum duration of project and timelines for submission of proposal.

4.2 While preparing the Terms of Reference (ToR) the sectional committee may consider the following points as a research & development project may include one or mix of the following:

a) Secondary research based on internet or published information including authentic data sources;
b) Survey based research (including industry visits) to ascertain prevailing market conditions and practices, standards in use, industry and consumer preferences, availability of infrastructure, technical capabilities, comparative trends, economic trends;
c) Ascertaining compliance to existing and proposed standards through testing, review of past test reports, other validation and verification checks; and
d) Basic and innovative research to establish normative criteria. Criteria may include performance, health, safety, environmental impact.

5 APPROVAL OF COMISSIONING OF THE RESEARCH AND DEVELOPMENT PROJECTS

5.1 There shall be a Review Committee for approving the projects recommended by the Sectional Committee. The composition of Review Committee shall be as follows:

DDG (SCMD)	: Chairperson
DDG (Standardization) concerned	: Member
DDG (Certification)	: Member
DDG (Labs)	: Member
Officer in-charge for research works in SCMD	: Member Secretary

5.2 The Head of Technical Department concerned and Member Secretary of the Sectional Committee shall apprise the review committee about the project and explain the rationale behind the proposed research & development project.

6 ELIGIBILITY CRITERIA

6.1 The following shall be eligible for carrying out research & development projects under the Scheme:

a) Academic institutions & universities having MoU with BIS and faculties and research scholars thereof;
b) Member(s) of Technical Committees of BIS.

6.2 Faculties and research scholars shall submit proposals through their institute. Members of technical committees belonging to any association/organization shall submit the proposals through their association/organization. Members of technical committees in personal capacity can submit their proposals directly to BIS, however if carrying out a research & development project requires collaboration with any institution/organization, concurrence of the same shall also be submitted.

7 PROCEDURE FOR APPLICATION

7.1 Submission of Proposal

7.1.1 Applications for undertaking research & development projects shall be submitted in the manner prescribed by the Bureau and within the prescribed timelines,

7.1.2 Proposer(s) shall submit their proposal in a "single stage - two envelope bid system" consisting of separately sealed "Technical and Financial proposals". The Technical Proposal shall be submitted as per format prescribed in **Annex A** and the Financial Proposal shall be submitted in the format prescribed as per **Annex B**, clearly specifying expected expenditure against each element such as manpower, equipment (shall not include computer hardware and software), travelling, testing, consumables, stationery, overheads, etc.

7.1.3 There shall be maximum one proposal from one institute on a given subject.

7.1.4 No contractual obligation whatsoever shall arise until a formal agreement is signed and executed between the Bureau and the Proposer.

7.2 The proposals shall inter-alia consist of the following:

7.2.1 In respect of the research & development projects put up by the Bureau:

a) Details of the Project team along with the organization/institution associated with;
b) The CV of the Project leader and expert/expert(s) to be associated with the project and a letter from organization authorizing Project Leader and expert/expert(s) to undertake the research as proposed.
c) A write up on the understanding of the scope and objectives of the project.
d) Methodology (sampling size, if applicable) to be adopted for the proposed study with a clear road map and time plan for completion of the project;
e) Stage wise timelines for completion of the project.

7.2.2 In respect of research & development projects proposed by any expert/organization:

a) Details of the Project team along with the organization/institution associated with;
b) The CV of the Project leader and expert/expert(s) to be associated with the projects and a letter from organization authorizing Project Leader and expert/expert(s) to undertake the study as proposed.
c) Objective that will be achieved and scope of the project clearly highlighting the need of such study and what would be the final deliverable;
d) Methodology (sampling size if applicable) to be adopted for the proposed study with a clear road map and time plan for completion of the project;
e) Details of infrastructure facilities available for the project, in the institution and additional facilities required (if any) for carrying out research.

f) Stage wise timelines for the completion of the project

7.3 The Head of the concerned institution while forwarding the application and nominating the project leader shall certify that:

a) the core facilities (land, buildings, laboratory, manpower and other infrastructure etc.) are available and will be provided to the Project Leader to work on the proposed project,
b) the organization will discharge all its obligations, particularly in respect of management of the financial assistance given, and
c) no other funding is being received/sought for the project proposed to be sanctioned by BIS.

8 PROCEDURE FOR APPROVAL WITHIN BIS

8.1 There shall be a Research Evaluation Committee (REC) to evaluate the proposals received, the composition of which shall be as follows:

DDG (PRT) : Chairperson
Head (CMD) concerned : Member
Head (LPPD) : Member
Head of the Technical Department concerned : Member
Director Finance : Member
Two Experts from the Sectional Committee concerned : Members
Head (SCMD) : Member Secretary

*The experts shall be nominated by the Sectional Committee and the nominated members shall give a declaration to the effect that there is no conflict of interest with respect to the project.

8.2 The evaluation and selection will be as per Quality and Cost Based Selection (QCBS) method (Rule 192, GFR 2017) which is explained in **Annex C**.

8.3 The criteria for evaluation of technical proposal shall be as under:

Sl No.	**Criteria**	**Max. Marks**	**Score by REC**
1	Profile of key individual/individuals to be associated with the research project	**10**	
2	Experience of the individual/organisation in conducting research projects in the relevant discipline	**20**	
3	Understanding of Scope, Objectives and deliverables	**15**	
4	Methodology	**30**	
5	Work plan/Execution strategy	**15**	
6	Chapterisation, contents and lay out of the proposed report	**10**	
	TOTAL	**100**	

Note: REC may call for a presentation by the proposers if deemed necessary.

8.4 The minimum qualifying marks shall be 70. All the proposals with marks below 70 shall be considered rejected.

8.5 REC may refer back, advise changes for reconsideration or reject any proposal.

8.6 REC shall open the financial proposals (bids) within 7 days from completion of technical evaluation.

8.7 A final score sheet of all the proposers shall be made as detailed in **Annex C** and the proposer getting the highest combined score shall be selected for awarding the project.

8.8 The member secretary (REC) shall send the selected proposals to DG/DDG Standardization concerned, as per their delegated powers, for consideration and approval for sanction of the project.

8.9 After the approval of project, the member secretary (REC) shall inform the concerned technical department and the proposer regarding the decision.

8.10 After the sanction of fund is approved, the draft agreement (prepared in line with model agreement given at **Annex D**, to be modified on case-to-case basis) shall also be prepared by the Member Secretary (Sectional Committee), clearly highlighting the payment term. The Head (Technical Department) shall sign the agreement on behalf of BIS in all cases.

8.11 In case the proposer to whom the project is awarded declines to take up the project, the Research project shall be awarded to the proposer getting the next highest combined score among the qualified proposers.

9 SIGNING OF AGREEMENT AND ISSUING OF SANCTION LETTER

9.1 After receipt of duly signed agreement from the proposer and after the receipt of the approval of competent authority, a sanction letter shall be issued by the concerned Head (Technical Department) to the organization/individual member. The project would be considered to have commenced from the date the sanction letter is issued.

10 FUNDING

10.1 The mode of payment for Research & development projects shall be as follows:

a) First instalment up to a maximum of 30 percent of the total approved project cost would be released after approval of the project.
b) Second instalment to the extent of 50 percent of the approved estimated cost would be released on the submission of progress report along with the report on utilization of the 75 percent of the fund and acceptance of the same by the Sectional Committee.

c) The balance amount shall be released after submission of the final project report along with utilization certificate for the fund released and its acceptance by the Sectional Committee.

10.2 Release of each instalment is subject to satisfactory progress, required stage - wise deliverables and submission of the Utilization Certificate (UC) as per Form GFR12-A of GFR 2017 along with the statement of expenditure (SoE) issued by the Competent Authority.

11 PROGRESS REPORT AND MONITORING OF PROJECT

11.1 The relevant Sectional Committees of BIS will monitor the progress of project to ensure that the project is progressing as per the planned arrangement. However, member secretary of the concerned Sectional Committee under overall coordination of HoD would be the controlling/link officer for Research & Development projects and would constantly monitor the progress of the project every 30-45 days. Any delay in implementation of project should be duly justified by the Project leader and shall be put up to Research Evaluation Committee (REC) for approval.

11.2 The Sectional Committee shall review and give its acceptance of the progress reports submitted, within 3 weeks.

12 SUBMISSION OF FINAL PROJECT REPORT (FPR)

12.1 The FPR must be detailed and should include information about:

a) the original objective(s) of the project,
b) how far these objective(s) have been achieved, and
c) how the results will benefit the development of the national standard(s) and
d) a copy of final working draft of the concerned standard(s) (wherever applicable)
e) include clear inferences, recommendations regarding their use in the proposed standards,
f) all references used, raw data of surveys, sampling, testing and experiments,
g) undertaking that all the information presented is authentic.

12.2 FPR received in BIS would be put up to the concerned Sectional Committee, which will take necessary action for preparation/revision of standard appropriately. The Project leader shall assist in the disposal of comments received on the research project, draft standard and for the preparation of the finalized draft, as may be desired by the Sectional Committee.

12.3 The proposer shall submit the Project Completion Report (PCR), within one month of completion of project along with the Utilization Certificate of the fund released as per Form GFR 12-A of GFR 2017 and the statement of expenditure (issued by the Competent Authority -in case of Govt. organization / Charted Accountant in case of private organization).

13 RESULTS OF RESEARCH & DEVELOPMENT

13.1 Project Leader(s) would be encouraged to publish the results of research & development. While doing so, acknowledgement to the effect that financial assistance was received from BIS should be made in the research paper(s) published. BIS should be acknowledged in similar type of other published work/press reports.

13.2 One re-print of each research paper(s) published as a result of the work done under the BIS funds shall be sent to BIS as and when published.

14 INTELLECTUAL PROPERTY RIGHTS

14.1 Ownership of any intellectual property, including but not limited to confidential information, know-how, patents, copyrights, design rights, rights relating to computer software, and any other industrial or intellectual property rights, developed solely by Proposer shall be vested with that Party.

14.2 Ownership of any intellectual property, including but not limited to confidential information, know-how, patents, copyrights, design rights, rights relating to computer software, and any other industrial or intellectual property rights, developed solely by the Bureau shall be vested with that Party.

14.3 The Intellectual Property arising out as an outcome of research project undertaken under these guidelines shall be vested with Bureau.

15 OPERATION OF FUNDS

15.1 The utilization certificate of the funds received in previous instalment (if any) to BIS should be annexed with the Statement of all equipment, books, etc purchased out of the funds certified by the Head of the organization. The name, description of the equipment, cost in rupees, date of purchase, and the name of the supplier to be given in the list. The main purpose/function of the equipment may also be mentioned against each item.

15.2 Any unspent balance lying with the organization should be refunded to BIS after the finalization of the draft immediately, by means of demand draft or online transfer.

15.3 The Head of the concerned standardization department of BIS shall ensure that the project leader submits the utilization certificate in the manner prescribed in Form GFR 12-A of GFR 2017.

15.4 Head of the Standardization department shall also ensure that the operation of funds is monitored strictly as specified in **Annex E**. Further the Project Leader is also fully aware and shall adhere to the obligations of his/her as given in this procedure.

16 OTHER REQUIREMENTS

16.1 Organizations receiving financial assistance for research & development projects from BIS would have to maintain separate accounts for each research project.

16.2 In the event of a Project Leader's absence from his normal place of duty for two months at a stretch, the Head of the organization would need to immediately nominate an Alternate Project Leader(s) to supervise the implementation of the project and such a name has to be approved in advance by BIS. In any event, a Project Leader shall give prior notice to BIS of his intention to stay away from the project.

16.3 Items of equipment, etc should be purchased on the basis of the established rules and procedures of the entity/organization.

16.4 Stock register of all equipment, books, etc purchased out of the funds shall be maintained.

16.5 Any capital-intensive equipment/devices purchased using financial assistance from BIS for research & development projects shall be allowed to be retained by the proposer for their research activity etc.

16.6 The organization shall have to ensure that expenditure with respect to TA/DA are made only as per their own norms but under no circumstances the executive/business class air travel or stay in a five-star hotel is made. The overhead expenses should not be more than 20 percent of the cost of the project.

16.7 The Project Leader must ensure that the concerned organization's newsletter would carry information on the activities and accomplishments of the various projects funded by the BIS.

16 TERMINATION OF PROJECT:

The research & development project can be terminated in case of any of the following:

a) the approval of research & development project may be treated as withdrawn, if the sanctioned research & development project does not commence within one month from the date of receipt of the sanction letter, unless otherwise authorized by BIS;
b) A Proposer may request for the withdrawal of a research & development project even after commencement of the project. In such case the entire fund given till that date shall be refunded to the Bureau; and
c) if the Proposer fails to submit Progress report/Completed Project report within the prescribed timelines.

The REC shall take decision on all cases of termination.

18 RESOLUTION OF DISPUTES

Dispute Resolution: In case of any dispute that cannot be resolved amicably, it shall be referred to Sole Arbitrator appointed by the Director General of the Bureau of Indian standards, whose decision shall be final and binding upon both the parties. The provisions of the Arbitration and Conciliation Act, 1996, as amended from time to time, shall be applicable.

ANNEX A

TECHNICAL PROPOSAL

1. Name of the Proposer and Organization	
2. Project title	

3. Project leader

a) Title: Prof/Dr/Mr/Ms b) Name:	Sex M/F
c) Full official address	
Mobile/Telephone Fax E-mail	
d) Designation	
e) Date of birth	
f) Academic qualifications along with year of completion	
g) Experience	

4. Other members of the research team (give name, address, experience and academic qualifications for each member)

1. Name	Designation: Address: Experience: Academic Qualifications:
1. Name	Designation: Address: Experience: Academic Qualifications:

5. Research support availed/being availed/applied for by the Project leader from different sources, including BIS, during the last 5 years:

Funding agency	Title of the project and reference number	Duration (from mm/yyyy to mm/yyyy)	Percentage of time devoted /being devoted/to be devoted, in man months	Amount in lakh Rs.

6. Details of facilities available with the institute/organization w.r.t. the research & development project

Facilities	Relevance to project
1.	

7. Aims and significance of the project
(Include the current status of work in area, both in India and abroad, with appropriate reference list at the end; identify lacunae, define question to be investigated; list briefly specific objectives of investigation. ethical clearance be enclosed where necessary).

8. The CV of the Project leader and expert/expert(s) to be associated with the projects and a letter from organization authorizing Project leader and expert/expert(s) to undertake the study as proposed.

9. Objective that will be achieved and scope of the project clearly highlighting the need of such study and what would be the final deliverable.

10. Methodology (sampling size if applicable) to be adopted for the proposed study.
11. Road map (Stage wise timelines for the completion of the project) and time table for completion of the project
12. Plan of work, methods and techniques to be used.
13. List of awards and honours conferred on the Project leader with dates.
14. Deliverables
15. Declaration and attestation:

I certify that all the details declared here are correct and complete. Signature of Project leader	Date:

12. Certificate of the institution:

This is to certify that a) we have read the terms and conditions of the BIS Research & Development Guidelines necessary for the compliance of the same. b) the necessary institutional facilities are available and will be provided for the implementation of this research proposal being submitted to the BIS for funding. c) Full account of expenditure will be rendered by the institution.
Name of the head: of the institution Signature with date: Seal:

ANNEX B
FINANCIAL PROPOSAL FORMAT
[To be submitted on letterhead wherever applicable]

To:
Bureau of Indian Standards
Manak Bhavan, 9 Bahadur Shah Zafar Marg
New Delhi – 110002, India

Sub: Financial Proposal for Research & development Project on (Title: _____) for Bureau of Indian Standards (Research guidelines document no._____dated: ___-___-2023).

Dear Sir,

We are pleased to submit our Financial Proposal for Research & Development Project on (Title: _____) for Bureau of Indian Standards as per the terms and conditions of the Research & Development guidelines document (Ref No.: _____ dated: ___-___-2023).

1. We hereby declare that our financial proposal is unconditional in all respects.
2. Our financial proposal is as follows:

3. Cost of the Project:

Sl no.	Budget items	Amount
1	Manpower cost	
2	Consumables [Chemicals, samples, testing glassware, stationery, books etc, information search (from databases)]	
3	Equipment	
4	Travel	
5	Any other/Overhead expenses	
	Total project cost	

*Please write NA in case any item is not applicable
a) The prices should be quoted in Indian Rupees above by the proposer.
b) The quoted price should be inclusive of all applicable taxes and charges.
c) Fund shall be released after deducting TDS as per applicable provisions of GST and income tax.
d) Justification of cost (for each item of equipment, consumables and travel. Quotation(s) for equipment should also be enclosed).

Yours faithfully,
Date: (Signature of the Project leader)
Place: (Name and Designation of the proposer)
Name and Signature of the head of the institution
(Rubber seal of the proposer/institution/organization, as applicable)

ANNEX C

Stage 1: Evaluation of Technical Proposal:

a) The proposal will be evaluated against the criteria defined at clause 8 in these Guidelines. The proposer may be required to provide additional details as deemed necessary by the REC.

b) Upon technical evaluation of each proposal, "Technical marks" out of 100 marks will be assigned to every proposal.

c) The proposals with score 70 or more marks in technical evaluation, will qualify for the evaluation of the financial proposal.

d) The proposer with the highest marks in technical proposal will be awarded 100 "Technical Score" and subsequently other proposers will also be awarded "Technical Score" relative to the highest technical marks for the final composite score calculation purpose e.g., if the highest technical marks is 90 then "Technical Score" is (90/90) × 100 = 100, hence the proposer with highest technical marks will score 100"Technical Score". Similarly, another proposer who scored 80 marks, will get (80/90)x 100 = 88.88 "Technical Score". Following formula will be used for the "Technical Score" (TS) calculation:

$$\text{Technical Score (TS)} = \left[\frac{\text{Proposer's Technical Marks}}{\text{Highest Technical Marks}}\right] \times 100$$

e) The details of technical evaluation parameters are provided at clause 9.

Stage-2 Evaluation of Financial Proposal

a) The evaluation will be carried out if financial proposals are complete and computationally correct.

b) Upon financial evaluation of each proposal, the lowest financial proposal will be awarded 100 "Financial score". The "Financial Score" of other proposer(s) will be computed by measuring the financial proposal against the lowest financial proposal. Following formula will be used for calculating "Financial Score":

$$\text{Financial Score (FS)} = \left[\frac{\text{Lowest Financial proposal}}{\text{Proposer's Financial Proposal}}\right] \times 100$$

Stage-3 Computation of Combined Score

The "Combines Score" is a weighted average of the Technical and Financial Scores. The ratio of Technical and Financial Scores is 70:30 respectively. The Combined Score will be derived using the following formula:

$$\text{Combined Score} = [(TS \times 0.70) + (FS \times 0.30)]$$

The responsive proposers(s) will be ranked in descending order according to the Combined Score, which is calculated based on the above formula. The highest-ranking proposer asper the Combined Score will be selected for award of Research Project.

ANNEX D

MODEL AGREEMENT

(To be modified on case-to-case basis)

This Deed of Agreement made this _____ day of _____ (Month & Year) between Bureau of Indian Standards having Head Office at Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi – 110 002 (hereinafter called 'BIS', which expression shall, wherever the context so admits, includes its successors and assigns) on one part and (name of the organization/expert) (hereinafter called _____which expression shall, wherever the context so admits, include their heirs, executors, administrators, legal representative and assigns) of the other part, witness as follows:

1. Whereas (name of the organization/expert) through (name of the Project Leader) has submitted a proposal to BIS pertaining to Research & development project titled _____ for consideration and BIS has accepted the proposal.

2. That duration of the Research & development project shall be ___ months with periodic and final reviews. The total cost of the project shall be Rs_____/- (Rupees in words) for the complete project. No further expenditure shall be borne by BIS on any account of this project including escalation of time.

3. The fund would be utilised for the specific project/assignment as approved by BIS and shall be spent within the specified time. Any portion of the fund which is ultimately not required for expenditure for the approved purpose shall be duly surrendered to BIS.

4. (Name of the organization/expert) shall not entrust the implementation of the project/assignment approved by BIS for which fund has been received to any other institution/expert or to divert the fund received from BIS as assistance to any other institution/expert/proposer.

5. (Name of the organization/expert) indemnifies BIS from any legal and/or financial encumbrance arising out of any infringement of IPR/licensing of IPR/technology transfer/commercialization.

6. (Name of the organization/expert) shall maintain an audited record in the form of a register for permanent, semi-permanent assets acquired solely or mainly out of BIS fund. Once the Research & development project is completed satisfactorily, the organization taking up the Research project may retain the equipment/devices for their Research & development activities, etc. The equipment procured through BIS fund should bear a label "BIS Funded".

7. BIS shall release the funds for the project as follows:

a) First instalment up to a maximum of 30 percent of the total approved project cost would be released after approval of the project.

b) Second instalment to the extent of 50 percent of the approved estimated cost would be released on the submission of progress report along with the report on utilization of the 75 percent of the fund and acceptance of the same by the Sectional Committee.
c) The balance amount shall be released after submission of the final project report along with utilization certificate for the fund released and its acceptance by the Sectional Committee.

8. The completion of the Research & development project shall remain the responsibility of (name of the organization/expert) even if the project leader is not available due to any reason whatsoever. After completion of the project, a Project Completion Report giving details (objective(s) achieved, raw data of surveys, sampling, testing and experiments) of shall be submitted by the Project leader the original objective(s) of the project,

9. (Name of the organization/expert) shall ensure the completion of the project under the guidance and supervision of any other faculty/researcher, if the nominated project leader would not be available due to any reason. Such a faculty member/researcher can only be nominated with the approval of BIS.

10. In case (name of the organization/expert) is unable to complete the project to the satisfaction of BIS in stipulated time or extended time and leads to termination of the research project, BIS shall be entitled to claim the refund of fund so sanctioned with interest @ 10 percent thereon from (name of the organization/expert).

11. The authority to extend the duration of the project shall rest with BIS.

12. BIS shall have the right to formulate monitoring methodology of the Research & development project.

13. Dispute Resolution: In case of any dispute that cannot be resolved amicably, it shall be referred to Sole Arbitrator appointed by the Director General of the Bureau of Indian standards, whose decision shall be final and binding upon both the parties. The provisions of the Arbitration and Conciliation Act, 1996, as amended from time to time, shall be applicable.

14. Undertaking given by project leader, if any, shall be part of the agreement.

15. (Name of the organization/expert) shall be responsible for discharge of all its obligations of the project through the nominated project leader or any other expert/expert(s) in case of necessity particularly in respect of management of financial assistance given to them. (Name of the organization/expert) shall refund any excess/unutilized amount of the fund to BIS.

16. Release of subsequent instalments is subject to satisfactory progress, required stage - wise deliverables and submission of the Utilization Certificate (UC) as per Form GFR12-A of GFR 2017 along with the statement of expenditure (SoE) issued by the Competent Authority.

17. (Name of the organization/expert) shall ensure that Project leader shall give presentation on the progress of project to BIS as and when directed by BIS for continuation of the project,

and shall assist in the disposal of comments received related to the Research & development Project.

18. The project shall be deemed to have been commenced from the date of release of sanction letter.

19. (Name of the organization/expert) shall ensure that while publishing the results of research & development, acknowledgement to the effect that financial assistance so received from BIS be made in the research papers published/ other published work/ press reports.

20. Procedure for screening/evaluation, selecting, monitoring Research & development projects prescribed in "Guidelines for Research & Development Projects for Formulation and Review of Standards' shall be part of the agreement.

ANNEX E

OPERATION OF FUNDS AND PROGRESS REPORT

1. Title of the Project:	Project number:
2. Name & Address of Project leader:	Date of Commencement: dd/mm/yyyy

3. Details of Equipment Purchased (if any):

Name of equipment	Cost	Supplier	Date of purchase/ placing order for each item of equipment
NOTE - The equipment fund once fixed cannot be enhanced. Project leaders are advised to give authenticated estimates of the cost of equipment. Equipment should invariably be purchased within 1 month from the date of receipt of the fund and/or sanction letter.			

4. Fund received_____.
5. Expenditure made in Rupees: (Please provide the details)

Expenditure	Amount	Taxes (as applicable)	Total
Manpower cost			
Consumables			
Equipment			
Travel			
Others			
Grand Total			

6. Amount saved (if any) from the last instalment: Rs_____.

7. Date on which scheme will complete its normal tenure of months _____.

8. Whether extension beyond normal tenure has been requested. Yes /No.

If yes, justification for extension and programme of work to be completed. Also mention as to why the work could not be completed as per the original plan.

{Extension beyond normal tenure should be requested at the Project Monitoring Session before end of tenure (as given in ToR)}.

9. Constraints (if any) faced in the progress of work and suggestions to overcome them.

10. Any deviation from original plan with its nature and cause.

11. List of publication giving full bibliographic details accrued from this project (copies of the paper (s) should be enclosed).

12. Summary of work done (200 words).

13. Proposed programme of work for the next month (1000 words).

14. Detailed Progress Report enlisting the objectives in beginning briefly (up to five pages maximum).

Signature of Project leader
Date:

Note: No column should be left blank; write not applicable (NA), wherever applicable.

TEMPLATE FOR THE TERMS OF REFERENCE FOR THE R&D PROJECTS

(*Refer to the Guidelines on R&D Projects issued vide note SCMD/R&D dated xx-09-23*)

1. **Title of the Project**: Mention the title of the project.

2. **Background:**
   a) Mention the Technical Committee and Division Council the project is related to;
   b) Mention the standard / document no. for the standard under development or review to which the project is related to;
   c) Briefly explain the rationale for the commissioning of the project.

3. **Scope**: Mention the scope of the project.

4. **Expected Deliverables**: Mention the outcome of the project.

5. **Research Methodology**:
   Mention the essential components of the methodology like mid-term review, focus group discussions, visits to the manufacturing units and/or laboratories, collection and testing of samples etc. with the details of the sample size for them as applicable.

6. **Requirement for the CVs:**
   Mention the requirement for the CVs of the persons to be engaged for the project.

7. **Timeline and Method of Progress Review:**
   Suggest the stagewise timelines including that for the submission of the first draft, final draft and the report and the mechanism for the review of the progress.

8. **Support BIS will Provide:**
   Indicate the support BIS may provide in terms of the standards, other publications, information regarding manufacturers and labs etc.