BUREAU OF INDIAN STANDARDS
(Ministry of Consumer Affairs, Food & Public distribution, Govt. of India)
Manak Bhavan, 9 Bahadur shah Zafar Marg, New Delhi - 110002
Phone : 011 - 23608253, 23608301 Website: www.bis.gov.in

MINUTES

Reference	Date
CED 5/A- 2.28	09 Feb 2024

SECTIONAL COMMITTEE : Flooring, Wall Finishing & Roofing Sectional Committee, CED 5

ADDRESSED TO:

ALL MEMBERS OF CED 5

Dear Sir(s),

We are glad to send herewith a copy of the Minutes of the **Twenty-Eight Meeting of Flooring, Wall Finishing and Roofing Sectional Committee, CED 05** held on 25 November 2023 in New Delhi (also through video conferencing). The Minutes have been approved by Shri Ashok Khurana, Chairman, CED 05.

Comments if any, confined to the accuracy of recording, may please be mailed to the undersigned preferably within two weeks for comments. If no reply received by this date, we may be permitted to presume your approval of the minutes as recorded.

The members who have been entrusted with some responsibility as recorded in the above minutes are requested to provide their inputs at the earliest so that further necessary action can be taken by BIS on priority.

Thanking you,

Yours faithfully,
sd/-
(Abhishek Pal)
Member Secretary
Sc. D (Civil Engineering)

Encl: as above

BUREAU OF INDIAN STANDARDS

MINUTES

Flooring, Wall Finishing and Roofing Sectional Committee, CED 05 : **Twenty-eighth Meeting**

Monday, 29 November 2023 : **11 00 h**

Venue: Hybrid Meeting Online, Manak Bhavan, Bureau of IndianStandards, 9, Bahadur Shah Zafar Marg, New Delhi - 110 002

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PRESENT:

CHAIRMAN : Shri Ashok Khurana (In-Personal Capacity)

MEMBER SECRETARY : Shri Abhishek Pal, Scientist-D, (BIS)

MEMBERS:

1) Dr Satish Kumar Sharma, Acropolis Institute of Technology and Research, Indore
2) Shri K. P. Paulson, Ardex Endura India Pvt Ltd, Bengaluru
3) Shri Gaurav Srivastav, IIT Gandhinagar
4) Shri R. D. Mathur, In Personal Capacity, Delhi
5) Shri Jerambhai Madhavji Kavar, National Cera Lab, Morbi
6) Shri Nilesh Jetparia, Morbi Ceramic Association, Morbi
7) Shri Amit Sagar, NCCBM, Ballabgarh
8) Dr Somit Neogi, NTH, Kolkata
9) Shri Vijay Kumbhani, Pavers and Blocks Manufacturers Association, Mumbai
10) Shri Harendra Kumar, Premier Polyfilm Limited, Ghaziabad
11) Shri Ashish Mohan, RMG Polyvinyl India Limited, Ghaziabad
12) Shri A. N. Singh, RMG Polyvinyl India Limited, Ghaziabad
13) Shri Kuldeep Singh, RMG Polyvinyl India Limited, Ghaziabad
14) Shri Chirag K Baxi, Steuler Industrial Solution Indian Pvt. Ltd., Gujarat
15) Devesh Kumar, Aludecor Lamination Private Limited, Kolkata
16) Shri Mukesh Garg Shriram Institute for Industrial Research, Delhi
17) Haresh bopaliya Morbi Ceramic Association, Morbi
18) Arvind Goenka, Plastindia Foundation, Mumbai

Item 0 OPENING REMARKS BY CHAIRMAN

The Chairman, Shri Ashok Khurana extended a warm welcome to all members to the Twenty-Eighth meeting of the Flooring, Wall Finishing & Roofing Sectional Committee, CED 05. He requested all members to participate actively in the working groups and sectional committee meetings and give their valuable opinion that would lead to a fruitful outcome of the meetings.

In the last, for active participation in ISO/TC 189, he once again requested all the members to actively participate in the standardization work of ISO/TC189 and provide comments on the ballots circulated by BIS Secretariat.

Item 1 CONFIRMATION OF THE MINUTES OF LAST MEETING

There being no comments, the Committee confirmed the Minutes of the twenty-seventh meeting of the Committee, CED 05.

ITEM 2 COMMITTEE COMPOSITION

2.1 The Committee went through the guidelines for the composition of the sectional Committee and appreciated the holistic view for engaging the concerned stakeholder; in view of that Committee reviewed the present composition of CED 05.

ITEM 3 ROLLING ANNUAL ACTION PLAN

3.1 The Committee agreed with the subject identified for the rolling action Plan. The Committee requested all members to contribute to finalizing these drafts within a year. Committee decided tentative timeline for the finalization of these drafts as given below:

Sl No.	**Topic/ Item Title**	**Decision**
1	Tactile Ground Surface Indicators – Concrete Tiles	The Committee noted the MHD Department of BIS recently adopted the ISO standard. In view of that the Committee decided to hold the above projects.
2	Tactile Ground Surface Indicators – Ceramic Tiles	
3	Precast Paving Flags - Specification	The Committee decided to send this draft Indian Standard for wide circulation considering this product is similar to the paving blocks (IS 15658) except for the few requirements. See **item 6.1**
4	Precast Grasspaving Blocks - Specification	The Committee decided to send this draft Indian Standard for wide circulation considering these products are similar to the paving blocks (IS 15658) except for the few requirements. See **item 6.2**
5	Installation of Aluminium Composite panels	See **item 6.6**

6	Aluminium Honeycomb panels	See **item 6.7**
7	IS 1542 Sand for Plaster	The Committee decided to send this draft Indian Standard for wide circulation. CRRI and NCCBM were requested to submit the concerned research reports to BIS secretariat.

ITEM 4 ANNUAL ACTION PLAN

The Committee decided to take the work mentioned in Item 3 shall be taken as an annual action plan. The Committee requested all the Committee members adhere to the timeline mentioned.

The Committee decided that after receiving the working draft from the working group, it could be circulated as working/Preliminary draft for comments.

ITEM 5 RESEARCH AND DEVELOPMENT TO BE TAKEN UP

5.1 The Committee noted the information.

5.2 The Committee considered the various the draft Terms of Reference (ToR) for R&D projects which were circulated amongst Members, and approved the ToRs of the following subjects:

Sl No.	**IS Number**	**TITLE**
1.	IS 809:1992	Rubber flooring materials for general purposes
2.	IS 1630:1984	Specification for mason's tools for plaster work and pointing work
3.	IS 3462:1986	Specification for unbacked flexible PVC flooring
4.	IS 3464 : 1986	Methods of test for plastic flooring and wall tiles
5.	IS 4860:1968	Specification for acid-resistant bricks
6.	IS 5318:1969	Code of practice for laying of flexible PVC sheet and tile flooring
7.	IS 8374:1977	Specification for bitumen mastic, anti-static and electrically conducting grade
8.	IS 9162:1979	Methods of tests for epoxy resins, hardeners and epoxy resin compositions for floor topping
9.	IS 9197:1979	Specification for epoxy resin, hardeners and epoxy resin compositions for floor topping
10.	New Standard	Acid resistant carbon bricks - Specification
11.	New Standard	PVC flooring for electronics and IT industry

5.3 The Committee opined that IS 653, IS 1661, IS 2394 and IS 2492 are obsolete

standards and require R&D for the same. The BIS secretariat was requested to prepare the draft ToRs on above subjects for the consideration of the members of the Committee.

5.4 The Committee decided that the following Indian Standards do not require any R&D projects as these Indian Standards are Codes of practice and the drafts Indian Standards are prepared considering the latest practices from the industry:

1.	IS 4441:1980	Code of practice for use of silicate type chemical resistant mortars
2.	IS 4442:1980	Code of practice for use of sulphur type chemical resistant mortars
3.	IS 4443:1980	Code of practice for use of resin type chemical resistant mortars
4.	IS 4456 (Part1) :1967	Methods of test for chemical resistant mortars: Part 1 Silicate type and resin type
5.	IS 4456 (Part2) :1967	Methods of test for chemical resistant mortars: Part 2 Sulphur type

However, Dr . P. Paulson and Shri Chirag Baxi were requested to submit the report and suggestive changes on the above subject for Committee's consideration. *(The report and suggestions were received through email and given at Annex 1)*

Considering the above, the Committee requested the concerned WG to expedite the preparation of draft Indian Standards on above subjects and decided to send the above modified drafts for wide circulation for one month to elicit the public comments on the draft Indian standards.

5.4 The Committee was informed about the **internship project** done by B. Tech Student on **PVC Sports flooring – Specification**. The Pre-standardization report of the project is attached herewith. The Committee requested the concerned WG under the convenership of Dr K P Paulson to consider the above report and also the draft received from Shri Ashish Mohan on the above subject for the preparation of the draft Indian Standard.

5.5 The Committee considered the **new subject** as suggested by the BIS secretariat on Glass Mosaic Tiles – Specification. Shri Jeram Bhai, National Cera Lab, Morbi also suggested the few manufacturers of Glass Mosaic Tiles in Morbi. The Committee requested Dr Gaurav Srivastava and BIS secretariat to visit the manufacturing units and concerned labs and prepare the report for the consideration of the Committee. The Committee also opined that this project required an R&D project for which BIS secretariat was requested to prepare the ToR.

5.6 Nomination of Experts for Review Committee

Considering the several R&D projects which would result in receiving several proposals from MoUs institutions, Members organizations, etc, the Committee decided to nominate the following experts in the review Committee for its project:

1) Shri Ashok Khurana, Chairman, CED 05
2) Dr Rakesh Kumar, CSIR- Central Road Research Institute, New Delhi
3) An expert of the subject, as proposed by the Chairman, CED 05.

ITEM 6 DRAFT INDIAN STANDARDS/ AMENDMENTS UNDER PREPERATION

6.1 Precast Concrete Paving Grids and Grass Pavers – Specification

The Committee considered the draft Indian Standard on above subject and opined that this product is similar to Paver blocks (IS 15658) which is already existing standard with more than 2000 BIS operative licensees in India and the draft is prepared after taking the due cognizance of various International Standards and data from various manufacturers in India. The Committee also noted that Shri R, P. Mathur and Dr Somit Neogi also visited lab in Surat to test these products. In view of that, the Committee deliberated that no further R&D is required on the above subject and the draft may be expedited towards publication. However, Shri Vijay Kumbhani, PBMA was requested to submit the report to BIS secretariat for record purpose.

Considering the above, the Committee decided to send the modified draft for **wide circulation** for one month to elicit the public comments on the draft Indian standard.

6.2 Precast Paving Flags - Specification

The Committee considered the draft Indian Standard on above subject and opined that this product is similar to Paver blocks (IS 15658) which is already existing standard with more than 2000 BIS operative licensees in India and the draft is prepared after taking the due cognizance of various International Standards and data from various manufacturers in India. The Committee also noted that Shri R, P. Mathur and Dr Somit Neogi also visited lab in Surat to test these products. In view of that, the Committee deliberated that no further R&D is required on the above subject and the draft may be expedited towards publication. However, Shri Vijay Kumbhani, PBMA was requested to submit the report to BIS secretariat for record purpose.

Considering the above, the Committee decided to send the modified draft for **wide circulation** for one month to elicit the public comments on the draft Indian standard.

6.3 Amendment to IS 17682: 2021 Aluminium Composite Panel — Specification

The Committee discussed the modified amendment no.1 to IS 17682:2021 as received from Aludecor for WC. The Committee authorized the Chairman and Bureau Secretariat to update the draft amendment as discussed during the meeting and decided to send the modified draft for **wide circulation** for one month to elicit the public comments on the draft Amendment.

6.4 Revision of IS 1542: 1992 Sand for Plaster – Specification

The Committee discussed the working draft circulated along with the agenda. The Committee noted that this draft was prepared based on the research done at NCCBM, Ballabhgarh and CSIR-CRRI, New Delhi. NCCBM and CRRI were requested to submit the R&D papers/reports to BIS secretariat for record purpose. In view of that, the Committee deliberated that no further R&D is required on the above subject and the draft may be expedited towards publication.

Considering the above, The Committee decided to send the modified draft for **wide circulation** for one month to elicit the public comments on the draft Indian standard.

6.5 Guidelines for Installation of Tiles and Stones — Code of Practice

6.5.1 ***Tiles and Stones — Guidelines: Part 1 - Characteristics and Requirements of Tile, Stone Laying, Materials Required, Design Data for Laying***

6.5.2 ***Tiles and Stones — Guidelines: Part 2 Laying Methodology and Maintenance***

The Committee noted that these drafts were already prepared approved for wide-circulation with modifications and yet to be modified. The Committee requested Dr Gaurav Shrivastava to review the draft Indian Standards and to submit the report for the need of R&D on the above subject and to prepare the ToR with BIS secretariat.

6.6 Installation of Aluminium Composite Panels – Code of Practice

The Committee noted that draft for Installation of Aluminium Composite Panels – Code of Practice is awaited. The Committee requested the Convener to conduct the meetings of the WG06 for preparation and discussions on the draft and share the recommendation and other meeting details along with the draft to BIS Secretariat for review.

6.7 New Indian Standard on Aluminium Honeycomb Panels – Specification

The Committee also requested the Convener to conduct the meetings of the WG06 for preparation and discussions on the drafts and share the recommendation and other meeting details along with the draft to BIS Secretariat for review.

6.8 Amendment NO. 1 to IS 15477

The committee considered the comments received from Shri K. P. Paulsen on the draft Amendment No. 1 IS 15477: 2019. The Committee requested Shri Radhakanth N. and Shri K. P. Paulsen to prepare the modify draft amendment. The Committee authorized the Chairman to approve the modified draft for wide-circulation for a period of one month.

Item 7 ANY OTHER BUSINESS

7.1 The Committee considered the comments received from Mr Richard Bowman regarding Indian Standard on Slip Resistance (IS 18433-1 : 2023) and suggested to review the Indian Standards with respect to the latest revised International Standards ASTM E303-22 and EN 16165 so that necessary amendment may be issued, if any. He had also shared his comments on IS 18433-1 as given in Annex 2. The Committee requested the concerned working group under the convenership of Dr Gaurav Shrivastava, IIT Gandhinagar to review the Indian Standard based on the comments received from Mr Bowman and recently published International Standards to issue a suitable amendment to IS 18433 (Part 1) : 2023.

7.2 Considering the second email from Mr Richard Bowman regarding his visit to India for Safety 2024 *, a WHO conference* in 2-4 September 2024, the Committee decided invite him for workshop with various stakeholders in India for Slip resistance on tiles in IIT Gandhinagar (Gujarat State, India) on 05 Sep 2024 after his event *at Safety 2024, a WHO conference from 2 to 4 September*.

The Committee requested Dr Gaurav Srivastava, IIT Gandhinagar to hold the workshop on 05 Sep 2024 in association with BIS.

7.3 In the last, the members joined the Member-Secretary in thanking the Chairman for guidance and smooth conduct of the meeting leading to fruitful discussions and decisions. The Member-Secretary also thanked all the members for their keen interest and valuable inputs during the deliberations in the meeting.

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ANNEX 1
Updating of IS 4441, IS 4442 and IS 4443

IS 4441, IS 4442 and IS 4443 have been prepared to address various acid resistant mortars for acid alkali resistant treatment. These codes are titled as mentioned below.

IS 4441: CODE OF PRACTICE FOR USE OF SILICATE TYPE CHEMICAL RESISTANT MORTARS.

IS 4442: CODE OF PRACTICE FOR USE OF SULPHUR TYPE CHEMICAL RESISTANT MORTARS.

IS 4443: CODE OF PRACTICE FOR USE OF RESIN TYPE CHEMICAL RESISTANT MORTARS

All these IS Codes were established for the first time in year 1980. Subsequently they were updated with inclusion of relevant details in line with the development in materials and application methods of these mortars.

Sanctity of having these IS Codes in practice is explained below.

Concrete has been a boon for construction industry since last almost two centuries. All out efforts are always being made to ensure that quality parameters of concrete are well defined and implemented in field. Codal provisions for this activity are also continuously being reviewed and revised to make them stringent as well as implementable.

Concrete has few serious and significant limitations although it is undoubtedly a versatile matrix. It has poor resistance to chemicals with more than 15 pH at high temperature and less than 4 pH even at normal temperature. Hydrated matrix of concrete starts losing its homogeneity and integrity due to which the process of concrete corrosion sets in; which is the beginning of the end for that concrete element.

As it is evident in current scenario, chemical industries are growing with their new inceptions at exponential rate. Chemicals which are beneficial for different purposes like pharmaceuticals, agro-chemicals, petro-chemicals, dyestuff industries etc have their aggressively corrosive effects on concrete and hence it becomes essentially mandatory to update the chemical resistant treatment methodology with innovation about the new range of materials to protect concrete structures from attack of such highly corrosive chemicals.

Additionally the surrounding conditions for concrete structures exposed to corrosive chemicals are also becoming severe with the type of chemical manufacturing industry. Corrosive chemicals often attack under different atmospheric conditions like high humidity, high or low temperature, gaseous fumes of corrosive chemicals attacking from surrounding area, chemical splash under high pressure etc. Concrete structure is just unable to sustain these severe conditions which makes is=t necessary to protect it from such situation.

These are few of many situations under which concrete needs to be protected with

compatible and the most suitable protective treatment. The IS Codes which are being discussed under this note relate to this subject.

Concrete protection system:

The concrete protection system includes following broad methods.

1. Acid resistant bricks / tiles / stones laid in acid alkali resistant mortars compatible to resist the corrosive attack.
2. Monolithic (joint-less or seamless) treatment like epoxy screed or epoxy lining or resin based lining.
3. Factory made hard sheet lining laid under very specialized procedure.

IS 4441 and IS 4442 deal with the conditions mentioned at point No. 1 above. Bricks or tiles or stones are hard and acid alkali resistant. They also successfully resist wear & tear or abrasive conditions. They have to be laid and their joints have to be filled with the acid alkali resistant mortar which can also equally resist acid alkali attack.

Many optional materials are available for manufacturing of such mortars which can effectively resist acid alkali attack. One of them is silicate mortar and another is sulfate mortar.

IS 4441 addresses silicate mortar and IS 4442 addresses sulfate mortar for laying and jointing the acid resistant bricks or tiles or stones.

IS 4441 for Silicate mortar:

There are two major types of silicate mortars viz. potassium silicate and sodium silicate. While sodium silicate mortar is having good viscosity, potassium silicate mortar has higher resistant to corrosive attack of severely corrosive chemicals hence IS 4441 addresses potassium silicate mortar. As this IS Code addresses the code of practice for use of silicate mortars, the application methodology and aspects related to the same are addressed in the code.

It covers following topics.
Scope,
Terminology,
Storage,
Mixing,
Application,
Curing,
Chemical resistance of silicate mortars.

As the document is only for single material (silicate mortar) and is only for application methodology, it has undergone a review and revision for its up-gradation considering these aspects. The points of revision which have been proposed in the document have been picked up from large experience of the members of working group 3, CED 5 of execution of the actual assignment in field with reference to change in chemical and atmospheric conditions as mentioned in earlier part of this note. There is no specific alteration in the list of chemicals to which silicate mortar is resistant to from the list as mentioned in IS 4441. Majority of alterations made in IS 4441 are tabulated below.

No	Clause No.	Existing text	Revised text	Justification
1	FOREWARD		'Chemical' has	The entire document

			been added as prefix before environment everywhere.	deals with 'chemical' atmosphere / environment.
2		… jointing acid proof bricks and tiles.	… bedding and jointing acid proof bricks and tiles.	The mortar is also utilised as bedding for bricks and tiles.
3	4.1 MIXING	… but it is important to have a mortar that is fluid enough to be workable	… but it is important to have a mortar that is ~~fluid enough~~ in paste form to be workable	Better and Technical word.
4	4.6	…cement concrete surface.	… cement concrete surface which is still wet and has not yet set / cured.	Silicate mortar doesn't perform under wet or humid condition.
5	4.7	… special precautions shall be taken.	… special precautions shall be taken by addressing the mixing ratio of the ingredients.	Lower temperature and higher temperature other than the thermal curing range of silicate mortars affects the curing process. If temperature is at variance than its curing range, then the mixing ratio of resin : hardener can be adjusted to achieve desired curing at that temperature.

6	5.1 Surface preparation		Add: The surface on which the lining is proposed should be constructed out of RCC using Portland cement and should be designed to take the dead load as per IS 456. Layout of the structure should be done in such a way so that there are no expansion joints with in the area proposed for acid lining. In case of acid alkali resistant flooring, the lining should be provided with curbs and it should be ensured that in no case acid should come out on concrete surface. The floors should be provided with	These are some of the prime and basic essentials for preparing the surface to lay acid alkali resistant brick or tile lining in solicate mortar.

			slope and ensured that in case of spillage acids are quickly collected in acid spillage *tanks where primary treatment is possible,	
7	5.1.1 Membrane	conforming to IS : 158-1981‡.	conforming to IS : 158-1981‡ if specified in specifications of the entire treatment. This is because when there are oxidizing agents coming in contact with the treatment in totality, use of bitumen primer may be critically evaluated before its application.	Silicate mortar is resistant to few of the oxidising agents. Bitumen primer has adverse effects with oxidising agents to be used as first primer. Hence the chemicals to which the surface is going to be exposed must be examined before application of bitumen primer and if it is not compatible to those chemicals, it should be avoided.

IS 4441 was reaffirmed in year 2001.

It must have been observed that the alterations which have been affected in the original

IS Code 4441 have been on account of field application conditions and methodology of surface preparation. These have been precipitated out of experience of performance of the acid alkali resistant treatment with silicate mortars exposed to variety of chemicals and atmospheric / surrounding conditions. Growing chemical industrial sector which comes up with variety of chemicals and operating conditions have necessitated these alterations for ultimate success of the treatment.

As IS 4441 applies to method statement for application of acid alkali resistant silicate mortar, it has been reviewed with the compatibility of the material and its application conditions with respect to the pre-requisites like surface preparation and post application care such that it provided the perfect guidance to the end-user and the Engineer who specifies of this treatment.

This area doesn’t fall under a specific research involving laboratory testing and data analysis. An effort has been made here to fine tune the usability of silicate mortar for acid proofing treatment with respect to the emerging revolutions of its application conditions and chemicals to which it can successfully resist.

IS 4442 for Sulfur mortar:

IS 4442 addresses sulfur mortar. As this IS Code addresses the code of practice for use of sulfur mortars, the application methodology and aspects related to the same are addressed in the code.

It covers following topics.
Scope,
Terminology,
Storage,
Safety precautions,
Equipment,
Melting and Pouring,
Application,
Chemical resistance of sulfur mortars.

Sulfur has adequate resistance to many chemicals and corrosive conditions but has one very significant aspect which makes it to attract highly focused attention during its handling and application in field. The sulfur mortar is to be melted and applied at field for laying and jointing the acid alkali resistant bricks or tiles. Melting is to be done by heating it to more than 135^0 C temperature. This heating process can cause health hazard so very careful and cautious procedure is required to be followed during application of sulfur mortar for the assignment. Pouring of sulfur mortar is also to be carried out in its sequential manner and with complete safety measure through GI bucket as specified in IS 4442.

Very explicit notes are mentioned in IS 4442 for acid alkali resistant bricks and tiles to be

applied with sulfur mortar for floors and walls. Methods for application with different mortars for bedding and jointing involving one of them as sulfur based mortar has also been specified in IS 4442 which makes it a good guideline for the end user as well as a specification maker for the system.

It is noteworthy that use of sulfur mortar for applying acid alkali resistant bricks or tiles has been quite trimmed off because of health hazards involved in handling this material at field because even one lapse in safety precaution during its handling and laying can cause serious injuries to the handler of this material. There is no specific alteration in the list of chemicals to which sulfur mortar is resistant to from the list as mentioned in IS 4442.
Majority of alterations made in IS 4442 are tabulated below.

No	Clause No.	Existing text	Revised text	Justification
1	3.1		Add … Manufacturer should recommend the storage temperature. Generally, it should be covered area and well protected from sun, wind and rain.	It is necessary to specify the storage conditions because any slippage from them would affect the life of material.
2	4.2	Soda acid type fire extinguishing equipment and wet cloth shall be made available for extinguishing fire or preventing its spread.	Soda acid type fire extinguishing equipment and wet cloth or asbestos cloth shall be made available for extinguishing fire or preventing its spread.	Asbestos cloth has excellent fire extinguishing properties

3	7.1		Add … Sulphate resistant cement should be used in construction of structure where this lining is proposed.	This is to utilise properties of sulphur resistant cement for protecting the concrete matrix from attack of sulphur to be used for acid alkali resistant treatment.

As the document is only for single material (sulfur mortar) involving safety measures, its handling and application methodology, it has undergone a thorough review and revision for its up-gradation considering these aspects. The points of revision which have been proposed in the document have been picked up from large experience of the members of working group 3, CED 5 of execution of the actual assignment in field with reference to change in chemical and atmospheric conditions as mentioned in earlier part of this note.

IS 4443 for Resin mortar:

IS 4443 addresses resin mortar. As this IS Code addresses the code of practice for use of resin mortars, the application methodology and aspects related to the same are addressed in the code.

It covers following topics.
Scope,
Terminology,
Storage,
Safety precautions,
Equipment,
Mixing,
Handling,
Application,
Cleaning,
Curing,
Chemical resistance of resin mortars.

Resin mortars have a special method of protecting the concrete surface against corrosive chemical attack. Different resins have their exclusive functioning depending upon their completion as well as the surrounding atmospheric situation. Viscosity of respective resin also plays a part in its selection for acid alkali resistant treatment.

Polyester resins have a fair resistance to mild chemical conditions. Their resistance to humidity, temperature and ultra violet rays depends on their exposure to the set of

chemicals.

Epoxy resins have excellent bond strength and resistance to a large range of corrosive chemicals. However their resistance to ultra violet rays is poor as their polymerized cross link breaks open when it is exposed to ultra violet rays. They have also a significant limitation of poor polymerization under humid conditions.

Vinylester resin is extended version of polyester resin having better properties than botht eh above mentioned resins. It has an additional advantage of its low viscosity which makes its useful functionality for many applications. There is no specific alteration in the list of chemicals to which resin mortar is resistant to from the list as mentioned in IS 4443.

Majority of alterations made in IS 4443 are tabulated below.

No	Clause No.	Existing text	Revised text	Justification
1	6 Mixing:		Add … Mixing will be carried out by moving spetula in clockwise direction with its sharp edge placed such that it doesn't interrupt the initial setting process of the mortar during its mixing process..	It is necessary to specify this method to ensure that initial reaction between both the components of resin (hardener and resin) takes place without any mechanical damage.
2	8.1	The surface on which chemically resistant bricks conforming to IS 4860 or tiles conforming to IS 4457are to be laid, shall be free from dirt and dampness	The surface on which chemically resistant bricks conforming to IS 4860 or tiles conforming to IS 4457are to be laid, shall be free from dirt and dampness and	Dry condition right upto core concrete is a mandatory pre-requisite for application of resin mortar.

		and shall be properly cured and dried.	shall be properly cured and dried till the core of concrete.	
3	8.1.1	The surface after preparation shall be applied with a coat of bitumen primer conforming to IS 384. The primed surface shall be subsequently applied with a uniform coat of bitumen conforming to IS 1580. If the bedding material is epoxy or polyester resin, the tiles or bricks can be laid directly on to the surfaces without application of bitumen primer. In case of furane, cashew nut shell liquid and phenolic type resin, a coat of bitumen primer conforming to IS 3384 shall be used subject to service conditions. Other	The surface after preparation shall be applied with a coat of bitumen primer conforming to IS 384. The primed surface shall be subsequently applied with a uniform coat of bitumen conforming to IS 1580. If the bedding material is epoxy or polyester resin, the tiles or bricks can be laid directly on to the surfaces without application of bitumen primer. The primer in these cases will be a thin coat of the same resin which is going to be used for manufacturing the mortar. In case of furane, cashew nut shell liquid and phenolic type resin, a coat of bitumen	Primer has a specific function for such treatments. It acts as a medium to bond subsequent coat or layer with the mother surface. When the acid alkali resistant treatment is proposed with resin mortar, the compatible primer is essentially required to be of same resin for establishing perfect bond and for its effective=ve function as a primr.

		membranes such as rubber, lead, poly isobutane, and fibre-reinforced plastics canal so be used in place of bitumen primer.	primer conforming to IS 3384 shall be used subject to service conditions. Other membranes such as rubber, lead, poly isobutane, and fibre-reinforced plastics canal so be used in place of bitumen primer.	
4	8.2.1 and 8.2.2	Spread the resin type mortar 6 to 8 mm thick on the back of the tile or brick. Smear two adjacent sides of the tile or brick with 4 to 6 mm thick mortar. Press the tile or brick into the bed and push against the floor and the tile or brick until the joint in each case is 2 to 3 mm thick. Trim off excess mortar and allow it to harden fully. Cure with acid as given in 8.4 except for epoxy and polyester resins.	Spread the resin type mortar 6 to 8 mm thick on the back of the tile or brick. ~~Smear~~ Join two adjacent sides of the tile or brick with 4 to 6 mm thick mortar. Press the tile or brick into the bed and push against the floor and the tile or brick until the joint in each case is 2 to 3 mm thick. Trim off excess mortar and allow it to harden fully. Cure with acid as given in 8.4 except for epoxy and polyester resins. For tiles / bricks laid in epoxy and polyester	Resin mortars generate exothermic thermal energy at high temperature during the polymerisation of its both the components. This heat is essentially required to be ventilated out of the medium for protecting the treatment layer from internal crevices.

			based mortars, the bedding will not be more than 5 mm and joints between tiles / bricks will be 5 to 6 mm wide to allow heat of exotherm to escape.	
5	8.4	Except for epoxy and polyester resins, cure the joints for a minimum period of 72 hours with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulphuric acid before applying the resin type mortars. After acid curing, wash the free acid in the joints with clean water and allow sufficient time for thorough drying. Resin mortars shall then be filled into the joints.	Except for epoxy and polyester resins, cure the joints for a minimum period of 72 hours with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulphuric acid before applying the resin type mortars. After acid curing, wash the free acid in the joints with soap water followed by clean water and allow sufficient time for thorough drying. Resin mortars shall then be filled into the joints.	Alteration is suggested to improve the effectiveness of curing.
6	9.2	Equipment should be cleaned	Equipment should be cleaned frequently with	If burning is required to be exercised, then it must be carried out

		frequently with solvent mixtures containing ketones, such as acetone, or with the solvent as recommended by the manufacturer. Hardened mortars may be removed from metal equipment by burning.	solvent mixtures containing ketones, such as acetone, or with the solvent as recommended by the manufacturer. Hardened mortars may be removed from metal equipment by careful burning.	with due care.

IS 4443 was revised in July 1992 with following changes.

(*Page* ***6***, *clause***8.1.1**) – Substitute 'IS 158 : 1981+' *for* 'IS: 3384 : 1965' and 'IS 9510 : 1980' *for* 'IS 1580 : 1968.'

(*Page***6**, *foot-notes marked with* '+' *and* 't' *marks*) – Substitute the following for the existing foot-notes:

+Specification for bilumen primer for use in water-proofing and damp-proofing (*first revision*)

+Specification for bitumen mastic, acid-resisting grade.'

ANNEX 2
Comments on IS 18433 (Part 1) from DR Richard Bowman

According to colleagues' discussions with the recognised suppliers of rubber sliders for pendulum testing, Smithers Rapra rubber slider 96 (FourS) is the most used rubber. While EN 16165 coined the term slider 57 to include the Smithers slider 55 (TRL) and the BAM slider 59 (CEN), I understand that slider 55 has 75% of the soft rubber market. As the two rubbers sometimes yield divergent results, and the BAM slider fails to comply with the slider 55 resilience results that are given in Table C2 of EN 16165, I anticipate that in its revised adoption of the EN 16165 pendulum test method, the Australian version will not accept the use of the BAM slider. There may be many other rubbers that comply with clause 5.2 of IS 18433.2, but they may give quite different results to the Smithers and BAM sliders. I don't have access to IS 4588, but you effectively specify natural or synthetic rubber, where you have failed to state a Shore hardness scale and lack any resiliency requirements, storage controls or temperature corrections.

If you look at Table 2 in https://www.researchgate.net/publication/335096951_Beware_of_conflicting_stone_slip_resistance_reports, reproduced below, you can see the effect of preparation on the soft rubber sliders. In the case of this relatively smooth planar surface, there is relatively little difference between the two rubber suppliers. Given that ASTM E303 was based on the use of slider 55, I will refer to those results.

Granite	Rz	Grade 60 paper		P 400 paper		Lapping film	
finish	μm	TRL	CEN	TRL	CEN	TRL	CEN
120 grit	11.5	42	41	34	36	27	28
180 grit	11.4	42	41	35	33	25	26
320 grit	10.7	39	41	29	35	16	17
400 grit	9.1	36	35	25	28	15	14
600 grit	6.5	30	30	23	23	14	12

Table 2 Mean slip resistance values (BPN) for a series of granites that had been honed or polished to different finishes.

ASTM E303 was a skid resistance test method where grade 60 SiC paper has traditionally been used. P400 paper has traditionally been used for skid resistance testing. Pye's risk analysis was produced at a time when P400 paper was being used, where a value of 35 BPN was considered to represent a one in a million risk of a slip, and a value of 24 BPN, a risk of one in 20.

Lapping film was adopted in BS 7976.2:2002. Although this change occurred without any supporting study, Australia followed changed from P400 paper to lapping film for slider preparation in its 2013 versions of AS 4586 and AS 4663 based predominantly on the logic that it provided better discrimination at the slippery end of the slip resistance spectrum. While many people still use Pye's analysis, I found one tile that decreased from 40 to 16 BPN when we changed the preparation methods for slider 96. A product that was originally regarded as safely slip resistant might now be regarded as quite dangerous. One obviously needs to ensure that any interpretive a new frame of reference is appropriate.

Looking at the Grade 60 paper results and 18433.1 Table 1, you would seem to suggested that the 400 grit granite can be used anywhere, even where oil is spilled, whereas the conventional interpretation was that there would be a risk of about 1 in 20 people slipping on a water spillage. Clause 11.1 mandates that

surfaces be classified and interpreted as given in Table 1. This sends shivers down my spine. Any cursory comparison with EN 16165 pendulum data might lead to false perceptions that Indian products are much safer. Given that many products rapidly lose much slip resistance such that ex-factory results should be regarded as transient and a poor indicator of probable long term performance. I anticipate that manufacturers may soon need to declare reference service life values of slip resistance after the products have received undergone an appropriate accelerated conditioning protocol. This should have a significant effect on any embodied carbon calculations, as tile removal and replacement may be mandated in situations where the floor is no longer sufficiently safe. I briefly introduced some of this material and further advanced concepts at the recent ISO/TC 189 meeting after having spoken in greater detail at the preceding World Ceramic Tile Forum.

In my opinion the best aspect of EN 16165 was the new pendulum calibration procedure that my Australian colleague, Carl Strautins, contributed. Your ASTM E303 procedure has been mocked in some scientific papers. While cheap Chinese pendulums might be capable of being calibrated to E303, owners have been told to throw them away because they can't be calibrated to EN 16165. The accuracy of pendulum testing as determined by various proficiency studies has improved considerably due to greater attention being paid to the finer details of testing. IS 18443 lacks the fine detail that is present in EN 16165, where the existing Australian standards have even more such detail.

The pendulum measures loss of energy rather than slip resistance. It might provide a good indication of slip resistance on relatively smooth flat surfaces where the laws that relate to squeeze-film formation apply. However, on other types of surfaces consistent results can be obtained, where these might be considered to provide useful indications of probable slip resistance performance. There are too many factors involved to neatly summarise all the relevant aspects.

ASTM committee Subcommittee E17.23 on Surface Characteristics Related to Tire Pavement Slip Resistance has unfortunately mislaid the ancient ASTM E303 Precision and Bias data. The standard deviation of 1.2 BPN units is much lower than many might expect, but would certainly be a function of what was tested.

While I could write in much greater depth, I had been preparing an abstract for Safety 2024. They have just extended the deadline from 1 December to 10 January. My working title has been "The dangers of divergent national slip resistance standards". When a recent Standards Australia news item affirmed that "it is key that we keep our adoptions up-to-date with the status of the corresponding international publication", it confirmed in my mind that "it is key that any new slip resistance standards keep up-to-date with the detail of the corresponding international publications". While IS 18443 was based on two superseded standards, I intend to mainly focus on ASTM E303 in my abstract. I would hope that by the time of my presentation, much progress will have been made on revising the gross errors introduced in IS 18443. Any fine errors might be left to a subsequent second revision.

I have copied this email to Carl Strautins, chair of SA committee BD-094, and Steve Thorpe, chair of the UK Slip Resistance Group and a fellow member of BSI B507/7. They might be interested in participating in the proposed workshop on 5 September, but may not have considered participating in Safety 2024, where we still have the option of proposing a workshop.

We are always in need of more evidence-based data, where some form of pre- and post- workshop proficiency testing might be of value.

At present I have no knowledge of how many Indian laboratories may have received the equivalent of ILAC accreditation for slip resistance testing, but https://indiastandardsportal.org/AccrediationBodies.aspx#:~:text=NABL%20provides%20laboratory%20accreditation%20services,Testing%20laboratories indicates that NABL has 91 accreditation bodies. Such

accreditation is useful in slowly improving the performance of testing laboratories but it depends very much on the proficiency of the pendulum experts who are involved in the accreditation (of both the testing and calibration procedures). This raises the possibility of masterclasses. These might be better held in March rather than September.

You would seem to have a considerable amount of work to undertake. I'm always busy and have to strictly ration my pro bono involvements both locally and internationally. Slip resistance standardisation is an expensive hobby. The longer you allow the current status quo to perpetuate, the harder it might be to overcome the problems that might devolve from your past decisions. The most efficient rectification procedure would ideally be based on a greater knowledge of the state of play throughout all of the involved sectors. I'm reluctant to invest any of my time, or that of Carl or Steve, unless I can be assured that the matter will be given appropriate priority and resourcing.

Kind regards,

Richard

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