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Ships and marine technology — Fibre-reinforced plastic gratings

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Foreword

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This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 8, *Ship design*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ships and marine technology — Fibre-reinforced plastic gratings

1 Scope

This document specifies the structure, technical requirements and test methods of gratings for fibre-reinforced plastics (FRP) in the marine industry. It also defines terms related to FRP gratings.

This document is applicable to the design, manufacture and inspection of self-support FRP gratings used for pedestrian pathways and platforms on ships or offshore platforms.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4892-3:2016, *Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 14125, *Fibre-reinforced plastic composites — Determination of flexural properties*

IMO, *International Code for Application of Fire Test Procedures (FTP Code)*, 2010

IMO, *International Convention for the Safety of Life at Sea (SOLAS)*, 1974 *and amendment*

ASTM D2047, *Test method for static coefficient of friction of polish-coated flooring surfaces as measured by the James machine*

ASTM E84, *Standard test method for surface burning characteristics of building materials*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
fibre reinforced plastic
FRP
composite material made of resin reinforced with fibre

Note 1 to entry: Glass fibres are widely used as reinforced fibre.

3.2
skid resistance
property of the trafficked surface which limits the relative movement between the contact patch of pedestrian footwear or a vehicle tyre and the surface

4 Classification

4.1 Types

4.1.1 General

Fibre reinforced plastic (FRP) grating is a kind of composite panel material with a certain aperture ratio, which is based on thermosetting resin and reinforced with fibreglass roving, and processed by special technology. The raw materials shall meet recognized standards and be specified in the technical specification, so as to ensure its continuous and stable performance.

FRP gratings are generally divided into two types, moulded or pultruded FRP gratings. For typical examples, see Figure 1 and Figure 2.

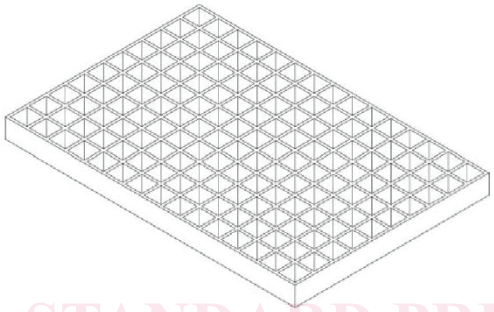

Figure 1 — Moulded grating

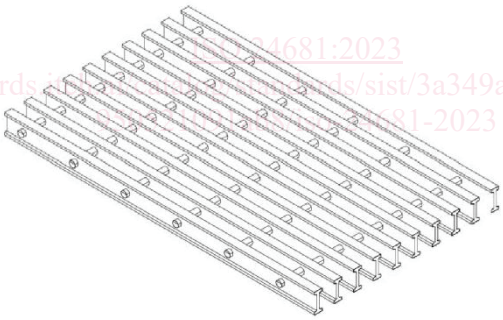

Figure 2 — Pultruded grating

4.1.2 Moulded grating

Moulded FRP gratings are produced by the open mould process in which thermosetting resin and dry glass fibre are placed in the mould in cross directions. After filling the mould with the designated amount of material, the resin is allowed to cure in the open mould. Moulded grating is usually manufactured in square mesh or rectangular mesh configurations. Square mesh moulded grating has nearly equal strength in longitudinal and transverse directions. Rectangular mesh has better strength along longitudinal direction. For the common mesh configuration, see Table 1.

Table 1 — Common moulded FRP grating configuration

Dimensions in millimetres

Mesh size	Height	Web thickness Bottom thickness / top thickness
25,4 × 25,4	50	6/8
38,1 × 38,1	25	5/6,35
38,1 × 38,1	30	5/6,6
38,1 × 38,1	38	5/7
38,1 × 38,1	50	5,8/8,5
38,1 × 38,1	50	9/11,5
38,1 × 38,1	63	5,8/9
38,1 × 38,1	63	9/12
50,7 × 50,7	50	5/8,3
25,4 × 50,8	50	9/11,5
25,4 × 152,4	38	5/7
38,1 × 101,6	38	5/7
38,1 × 152,4	50	7/9

NOTE Moulded FRP gratings are in general with inverted trapezoidal web section. The bottom thickness is smallest depending on the mould. The top thickness is greater depending on the height.

4.1.3 Pultruded grating

Pultruded grating consists of longitudinal bearing bars secured in position by transverse bars. The reinforced fibre is impregnated by thermosetting resin and pultruded to make shaped bearing bar under compression and heat. The bearing bar profile is generally “I” or “T” shaped. The product has high strength along bearing bars direction and is suitable for large span use. Common specifications are shown in Table 2.

Table 2 — Common pultruded FRP grating configuration

Dimensions in millimetres

Bearing bar	Width	Space	Height
I	15	10/15/23	25/30/38
T	25,4	12,7/25,4	50,8

NOTE The common transverse securing bar is arranged in 152,4 mm interval.

4.1.4 Other type gratings

Authorities are responsible for confirming other types of gratings of occupied areas for workers or machinery.

5 Technical requirements

5.1 Appearance

5.1.1 FRP grating shall be smooth and flat, with no obvious stratification, burr, crack, fibre exposure and impurities.

5.1.2 No pores larger than 3 mm in diameter are allowed. The number of pores between 1 mm and 3 mm in any 300 mm × 300 mm area shall not exceed 10.

5.1.3 The warpage shall be not more than 2,5 mm/m along bearing bar direction and not more than 5 mm/m in other directions.

5.2 Load-bearing capacity

5.2.1 The flexural strength of the FRP grating panel shall be not less than 345 MPa.

5.2.2 No crack, stratification or other destructive damage shall be observed when the FRP grating is subject to 1,5 times design load.

5.2.3 The design load of the FRP grating used in pedestrian pathways and platform of ship shall be 4 kN/m^2 uniform load or equivalent. The design load may be other than specified if it is dedicated for a certain load condition. The grating deflection in the middle point of span shall not be greater than 1/120 of the span under design load, and the maximum deflection shall not exceed 9 mm.

5.2.4 For FRP grating used as steps of stair ladders, 2 kN concentrated load applied at the middle of step shall also be considered. The deflection of the middle point of the tread shall not be greater than 1/200 of its span, and the maximum deflection shall not exceed 6 mm.

5.3 Corrosion resistance

FRP grating should have good corrosion resistance. Gratings used for exposed area or ballast tanks shall be designed with good resistance to sea water and high salt fog conditions. After the salt spray test, the load-bearing capacity shall meet the requirements of 5.2.1.

5.4 Skid resistance

FRP gratings should have good skid resistance. The average coefficient of friction of upper surface shall be not less than 0,75 for dry weather conditions.

5.5 Flame spread characteristics

When FRP grating is required to have low flame spread characteristics, the product shall be tested in accordance with the test for surface flammability specified in IMO FTP Code 2010, Annex 1, Part 5. The result shall meet the requirements for ceiling, bulkhead, or shall be in accordance with other equivalent standards such as ASTM E84, which specifies a flame spread index (FSI) of ≤25.

5.6 Smoke and toxicity

When the FRP grating is required to not produce excessive quantities of smoke and toxic products or to not give rise to toxic hazards at high temperature, it shall be tested in accordance with the smoke and toxicity test specified in IMO FTP Code 2010, Annex 1. The result shall meet the requirements for ceiling, bulkhead, or shall be in accordance with other equivalent standards such as ASTM E84, which specifies a smoke development index (SDI) of ≤450.

5.7 Anti-electrostatic property

FRP grating used in hazardous areas (as defined by IEC 61892-7) shall be of anti-electrostatic property, and their surface shall be conductive to avoid static accumulation. The resistance value shall not be greater than 10^5 Ω for any 1 m range of any two points on the surface of the grating. The electrical conductivity shall not degrade due to slight wear on the surface and the static shall be transferable to the metal frame by means of securing fixture or other effective means. The grounding resistance at any point of the grating surface shall not be greater than 10^6 Ω.

5.8 Fire integrity

5.8.1 When fire integrity is required to be maintained for the pedestrian pathways and platform, the self-support FRP grating shall pass the fire integrity test level 1 (L1) or level 2 (L2), as specified in Annex B.

5.8.2 The FRP grating without fire integrity requirements and not subject to fire resistance test shall be classed as level 0 (L0). L0 FRP grating may be used on a steel deck, operation platform, cargo hold access, void space and other areas.

5.8.3 For design and application of FRP grating, refer to Annex C.

5.9 UV resistance

When used in weather exposed areas, the FRP grating should be UV resistant to avoid damage to its structural strength due to long-term weather exposure.

5.10 Asbestos-free requirement

The FRP grating shall meet the asbestos-free requirement of IMO, SOLAS, 1974, chapter II-1.

6 Inspection and test methods

6.1 Appearance

6.1.1 Appearance and pores shall be subject to visual inspection.

6.1.2 The warpage of the grating shall be measured. Place the grating face up horizontally on a flat surface and draw a straight line in the direction of extension and width. Measure the distance between the midpoint of the line and the top of the grating to check the degree of warping.

6.2 Load-bearing capacity test

6.2.1 The flexural strength of the FRP grating shall be tested in accordance with ISO 14125.

6.2.2 Load-bearing capacity of the FRP grating shall be tested in accordance with Annex A. Loading force shall be increased evenly to design load. Deflection under groups of typical Span-Load shall be recorded including deflection under maximum span and applied design load.

6.2.3 When loading to 1,5 times design load, examine whether there are cracks, delamination phenomena on the grating.

6.3 Corrosion resistance

The corrosion resistance of FRP grating test shall be conducted in accordance with ISO 9227. The endurance test time shall be 720 h.

6.4 Skid resistance

The skid resistance of FRP grating test shall be conducted in accordance with ASTM D2047.

6.5 Flame spread characteristics

Flame spread characteristics shall be tested in accordance with the test for surface flammability specified in the IMO FTP Code, Annex 1, Part 5, or in accordance with equivalent standards such as ASTM E84.

6.6 Smoke and toxicity

Smoke and toxicity testing shall be conducted in accordance with the IMO FTP Code, Annex 1, Part 2, or in accordance with equivalent standards such as ASTM E84.

6.7 Anti-electrostatic property

A calibrated resistance measuring instrument shall be used to measure the resistance of two points of space which are 1 m apart. At least 3 groups shall be measured and no value shall exceed 10^5 Ω.

6.8 Fire integrity

The fire integrity of FRP grating shall be tested in accordance with Annex B.

6.9 UV resistance

The FRP grating shall be subject to the accelerated weathering test for at least 720 h in accordance with ISO 4892-3:2016, Table 1 (Method A). No damage such as fracture, crack, blister, delamination or fibre exposure shall be found.

7 Marking, packing and transportation

7.1 Marking

7.1.1 FRP gratings that a pass fire integrity test shall be marked with "L1" or "L2" in a prominent location. FRP gratings that are not subject to fire integrity tests shall be marked with "L0" in a prominent location.

7.1.2 FRP gratings that pass UV resistance tests shall be marked with "UV" in a prominent location.

7.2 Packing

7.2.1 FRP grating shall be packed with cardboard on the edge and tied properly.

7.2.2 Each FRP grating packing shall display handling instructions and transportation notice.

7.3 Transportation

7.3.1 The FRP grating shall be placed on a flat panel and safely secured on a vehicle.

7.3.2 It is not permitted to throw the grating during handling.

Annex A
(normative)

Load-bearing capacity test (three-point bending method)

A.1 Test principle

Apply a linear load to the FRP grating for the three-point bending test. The load-bearing capacity is determined by measuring the deflection at the mid-point of the span under the corresponding load.

A.2 Test equipment

A.2.1 The test should be carried out on the universal material testing machine or a self-designed testing device. The loading capacity of the testing machine (or device) shall be more than 25 % higher than the required specimen test load.

A.2.2 The load measurement shall be accurate to 1 %.

A.2.3 Equipment for deflection measurement shall be accurate to 0,01 mm.

A.3 Specimen preparation

A.3.1 The length of the grating specimen shall be determined by Formula (A.1):

$$C \geq A + 150 \quad \text{(A.1)}$$

where

A is the test span, expressed in millimetres (mm);

NOTE Typical test spans can be: 300 mm, 450 mm, 600 mm, 750 mm, 900 mm, 1 050 mm, 1 200 mm and 1 500 mm.

C is the specimen length, expressed in millimetres.

A.3.2 Specimen width should be about 300 mm and shall include at least 6 bearing bars.

A.3.3 Each set of specimens shall not be less than 3 pieces.

A.4 Test conditions and equipment

A.4.1 The laboratory standard environmental conditions are ambient environment temperature 23 °C ± 2 °C and relative humidity 50 % ± 5 %. If the laboratory standard environmental conditions are not available, other laboratories close to environmental standards should be selected.

A.4.2 The support and loading bars for test equipment should be smooth steel round bars of 310 mm long and 25 mm diameter, and the steel bars shall be properly fixed and shall not deform or rotate under load. The test load shall be applied at the middle of the transverse bar relative to support bar, as shown in Figure A.1.