SRI LANKA STANDARD 2 : 2016

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SPECIFICATION FOR
CLAY ROOFING TILES
(Second Revision)

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard

SPECIFICATION FOR CLAY ROOFING TILES

(Second Revision)

SLS 2 : 2016

(Attached AMD 515)

Gr. 14

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Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

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Sri Lanka Standard
SPECIFICATION FOR CLAY ROOFING TILES
(Second Revision)

FOREWORD

This standard was approved by the Sectoral Committee on Building and Construction Materials and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2016-11-24.

Sri Lanka Standard for Clay Roofing Tiles first published in 1967 and revised in 1975 is superseded by this second revision. Subsequent introduction of new production technologies accompanied by different tile profiles and the requirements generated by export and import demands necessitated this revision.

This second revision of the standard, which takes into account the above developments provides for several types of tiles based on cross sectional profiles and three categories of tiles based on water absorption . Methods of testing tiles for the requirements specified in the standard have been brought in line with international practices. The current revision includes the technical procedure of determination of dry transverse strength of tiles as an optional requirement and its permissible limits, in line with current regulatory limits given in international standards. In addition, a test for efflorescence was introduced.

For the purpose of installation of tiles on roofs under windy and other unusual conditions, it is expected that the manufacturer will provide the necessary guidelines to the user.

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 an analysis, shall be rounded off in accordance with SLS 102. The number of significant figures retained in the rounded off value shall be the same as that of the specified value in this standard.

In the preparation of this standard the assistance derived from the publications of the European Committee for Standardization (CEN) and the American Society for Testing and Materials (ASTM) is gratefully acknowledged.

1. SCOPE

This standard covers clay tiles intended for use as roof covering where strength, durability and appearance are required to provide a weather-resistant surface.

This standard pertains to three categories of tiles based on water absorption.

Tiles manufactured for special applications, such as restoration of ancient buildings and for specific architectural designs are not covered by this standard. In addition, tiles which are glazed, engraved or coloured have been excluded.

2. REFERENCES

SLS 102	-	Rules for rounding off numerical values
SLS 297 Part 4	-	Rubber, vulcanized or thermoplastic -- Determination of hardness (hardness between 10 IRHD and 100 IRHD)
SLS 428	-	Random sampling methods
SLS EN 539-1	-	Clay roofing tiles for discontinuous laying - Determination of physical characteristics-Part 1: Impermeability test
SLS EN 1024	-	Clay roofing tiles for discontinuous laying - Determination of geometric characteristics
SLS ISO 2859-1	-	Sampling procedures for inspection by attributes -- Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection

3. DEFINITIONS

For the purpose of this standard, the following definitions shall apply:

3.1 black core

Tiles that, when broken, have a dark area that has a steely appearance and is sharply delineated from the surrounding normal color of tile. This dark area is known as black core.

3.2 blisters :

Superficial localized raisings of material occurring during manufacture.

3.3 bloating :

Swelling of surface of tile on firing due to entrapped air or gases of decomposition in the clay body.

3.4 break :

Separation of tile into two or more fragments.

3.5 camber :

Deviation from the straight line.

3.6 chips :

A fragment broken off from the edges, corners or surface of the tile.

3.7 clay roofing tiles :

Products for discontinuous laying on pitched roofs, which are manufactured by shaping (extrusion and or pressing), drying and firing of the prepared clay, with or without additives.

3.8 cover length :
Length of the exposed part of the fixed tile, measured longitudinally.

3.9 cover width :
Width of the exposed part of the tile as laid, measured transversely.

3.10 defect :
Surface or structural imperfection of a roofing tile

3.11 defective tile :
A tile having one or more defects.

3.12 deficiency :
Irregularity due to absence of materials on the tile.

3.13 efflorescence :
Deposition of water soluble salts present in clay due to evaporation on the surface of tile on drying and firing, usually as a white, powdery substance.

3.14 extruded tiles :
Tile whose body is shaped in the plastic state in an extruder, the column obtained being cut into tiles of pre-determined dimension.

3.15 fittings :
Products complimentary to tiles and having a technical function.

3.16 fixing hole (nailing hole) :
A small opening passing partially or totally through the tiles to allow the penetration of a nail, screw, or other approved fastener for the purpose of fastening the tile to the support.

3.17 head lap :
The measurement of the overlap between a course (row) of roofing tiles and the course above.

3.18 holding nibs (batten lugs/anchor lugs) :
Protrusions on the underside of the tile designed to engage over the upper edge of the batten so as to support the tile without allowing it to slip when the tile is laid on the roof.

3.19 lap
Part of a roofing tile that covers dined portion of the same or another type of adjacent tile or other roofing component.

3.20 interlocking tiles :
Tile with a system of ribs or grooves enabling the joining of adjacent tiles in the same roof in sloping direction or horizontal direction.

NOTE

*Three examples of interlock are shown in Figure **1**. The arrangement of ribs and grooves limits the extent of movement between the tiles and improves the resistance to the ingress of water.*

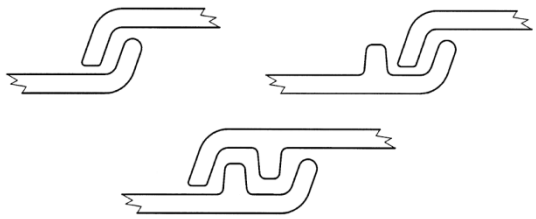


FIGURE 1:Examples of interlock

3.21 longitudinal interlock (side lock) :
System allowing two tiles in the same horizontal course to be fitted together.

3.22 lot:
Any number of clay roofing tiles of the same type, category and belonging to one batch of manufacture.

3.23 non-interlocking tiles:
Tiles that do not have vertical rib(s) or groves creating an interlocking tile.

3.24 nose lugs:
Protrusions on the top side of over tile close to the small curvature edge, to support the over tile without allowing it to slip and to provide sufficient overlap when the tile is laid on the roof.

3.25 over tiles:
Tiles designed to relay with their concave side facing downward and under tiles.

3.26 overall length:
The maximum overall dimension of the tile as measured parallel to the direction of the water course.

3.27 overall width:
The maximum overall dimension of the tile as measured perpendicular to the direction of the water course.

3.28 overlapping tile:
Tiles which have no side lock or headlock and are profiled in “S” shape.

3.29 pit:
A surface defect caused by a fraction of material detached from the body of the tile on the visible surface of the tile.

3.30 plain tiles:
Tiles usually with a flat surface that can be slightly cross cambered or longitudinally cambered and which have no interlocking system.

3.31 pressed tiles:
Tiles formed from a finally milled body mixture and shaped in moulds at high pressure.

3.32 profile:
The contour of the top surface of the tiles when viewed from the nose end.

3.33 profiled tiles:
Tiles having a rise to width ratio greater than 1:5, measured in the installed condition (example "S" tile).

3.34 ridge:
Highest point on the roof, represented by a horizontal line where two roof areas intersect, running the length of the area.

3.35 ridge tiles:
Tiles that are bent in cross section, used to cover the ridge of a roof.

3.36 sample:
Number of tiles taken on random or in accordance with a specified sampling plan, from a large quantity or from a fixed lot, relating to the intended tests.

3.37 slippage:
Relative lateral movement of roofing tiles installed on sloped roof away from an original or secure position.

3.38 structural cracks:
Regular cracks running through the entire thickness of the tile or fitting and visible to the naked eye.

3.39 under tiles:
Tiles designed to be laid with their concave side facing upward and resting on the roofing support

3.40 water course
The valley portion of profiled tiles along with water drain.

4. DESIGN AND MANUFACTURE

4.1 Design of tiles

4.1.1 *Types of tiles*

The shape of the tile shall be designed by the manufacturer ensuring the conformity of product with the requirements of this standard. Several typical profiles of clay roofing tiles that are commonly available are given in Appendix **A**.

4.1.2 *Category of tile*

Three categories of tiles based on water absorption are specified in this standard and relevant requirements shall be as in Table 1.Refer **5.6.3** Method of testing for water absorption.

TABLE 1 – Requirements for water absorption

Category of tile	**Total water absorption of tiles (Maximum) (WA) %**	
(1)	**Average (2)**	**Individual (3)**
AAA	10	12
AA	15	18
A	18	20

4.2 Manufacture

Tiles are manufactured from clay, shale, or similar naturally occurring earthy substances and subjected to heat treatment at elevated temperatures (firing), to provide the strength and durability requirements of this specification.

Tiles are shaped during manufacture by extrusion and or pressing and it is permitted to use the shaping method to describe the tiles.

Tiles are generally planar or undulating rectangular shapes, available in a variety of profiles and sizes. Special texture may also be added in surface treatment. Manufacturer shall provide interchangeable tiles of uniform size and shape.

Tile**s** may be manufactured with interlocks (interlocking tiles) or without interlocks (non-interlocking tiles).

5. REQUIREMENTS

5.1 Structural and surface characteristics

5.1.1 *Structural characteristics*

Tiles shall be free of structural defects such as breaks, structural cracks, loss of broken holding nibs (where applicable), loss of fixing holes (where applicable), loss of broken nose lug (where applicable) and other defects which reasonably affect the performance and durability characteristics of the tile. The edges of the tile shall be smooth and the longitudinal edges shall be reasonably straight.
Where the solid webs designed to reinforce the profile of tile and other protrusions designed to support firm laying of tiles on the roof, which are present on underside of the tile, shall be free of defects.
Tiles shall be free of foreign materials such as solid particles, burnt shell, clay grit, etc.

NOTE:
Presence of black core regardless of the size in the tile that otherwise meets the physical performance of this specification, shall not be considered as a structural defect.

5.1.2 *Surface characteristics*

Tile shall be free of surface imperfections such as blisters, pits and chips of maximum dimension greater than or equal to 5 mm, deficiency, bloating, surface cracks and other defects which reasonably affect the performance characteristics as well as appearance of the tile. The upper surface of the tile shall be reasonably uniform in texture and colour.

For evaluation of surface characteristics, the product shall be examined at a distance of 300 mm to 400 mm, under a minimum light intensity of 1200 lux, by an observer with normal vision.

5.2 Fixing characteristics

Suitable fixing mechanism (tile fastening system) shall be incorporated with the tile where needed. Tiles in which holding nibs or fixing holes, as the fixing mechanism are provided, holding nibs and fixing holes shall conform to the requirements given in **5.2.1** and **5.2.2** respectively. Any other suitable means of fixing may also be permitted.

5.2.1 *Holding nibs*

When provided with holding nibs, each tile shall have either a continuous nib not less than 75 mm in base length centrally located or nibs each with a base of not less than 20 mm of length and 10 mm of width. Under tile may have a single nib with a base of not less than 20 mm in length and 10 mm in width.

The projection of nibs from the surface shall be not less than 10 mm.

The nibs shall have such a shape and strength so as to support the tile without allowing it to slip or damage when the tile shall be hung freely as per the method described in Appendix **B**. Tile which fail this test will be considered as a defective.

NOTE
For tiles with nail holes, and tiles with nibs that are not centrally located and to which the adjacent tile provides support to prevent the slippage, the test described in Appendix B shall not be applicable.

5.2.2 *Fixing holes (Nailing hole)*

When the tile is provided with fixing holes, the minimum diameter of fixing hole, shall be 5 mm for the tiles of mass greater than 1.5 kg, and 4 mm for other tiles.

5.2.3 *Other means of fixing*

When the tile is provided with other means of fixing, manufacturer shall verify the suitability of the fixing mechanism.

5.3 Interlocking characteristics

The tile with longitudinal interlock (side lock) or transverse interlock (headlock) shall be designed to ensure firm assembly of adjoining tiles. The ribs and grooves in the locks shall have ability to limit the extent of movement between the tiles and to prevent ingress of water.

5.4 Geometrical characteristics

5.4.1 *Regularity of shape*

5.4.1.1 *Twist*

The coefficient of twist (C) measured and calculated as per the method described in **SLS EN 1024** shall conform to the requirements specified in Table **2**.

TABLE 2 – Requirements for coefficient of twist, longitudinal and transverse camber

Overall length of tile mm **(1)**	**Coefficient of twist (Maximum) (C) % (2)**	**Longitudinal and transverse camber (Maximum) (R_A) & (R_B) % (3)**
≤ 300	2.0	2.0
> 300	1.5	1.5

NOTE
The above values of coefficient of twist shall not be applicable for over tiles and under tiles, ridge tiles and S type tiles.

5.4.1.2 *Uniformity of transverse profile*

This shall be applicable only for the over tiles and under tiles.

The uniformity of the transverse profile of tile (E_1-E_2) shall be evaluated by the difference between the widths of narrowest (E_1) and widest (E_2) cross-section of the tile and shall not exceed 15mm. Width of each cross-section shall be measured as per the method described in **SLS EN 1024**.

5.4.2 *Camber*

The mean value of the longitudinal camber (R_A), and the mean value transverse camber (R_B) measured and calculated as per the method described in **SLS EN 1024** shall conform to the requirements specified in Table **2**. Transverse camber can be measured only for plain tiles and tiles having a significant plain area.

5.4.3 *Dimensions*

Overall dimensions and cover dimensions shall be measured for tiles with interlocks (headlock and sidelock).

5.4.3.1 *Overall dimensions*

The overall length (L_T) and Overall width (l_T) of the tile shall be declared by the manufacturer.

The overall length and overall width of tile shall be measured and percentage deviation of mean overall length and overall width in relation to the declared overall length and width

shall be calculated as per the method described in **SLS EN 1024**. The percentage deviation of each mean overall dimension in relation to the declared dimension shall be within ± 2.0 %.

5.4.3.2 *Cover dimensions*

The mean cover length (*L*) and mean cover width (*l*) of the tile shall be declared by the manufacturer.

The cover dimensions shall not be applicable for over tile, under tiles and ridge tiles and the manufacturer shall declare the minimum nominal overlap dimensions for these tiles.

The mean values for each cover dimensions of tile shall be determined as the method described in **SLS EN 1024.** The percentage deviation of each mean cover dimension in relation to the declared cover dimension shall be within ± 2.0 %.

5.5 Mass characteristics

5.5.1 *Mass of tiles per unit area of roof*

When determined as per Appendix **C**, mass of tiles per unit area (M) excluding ridge tiles of roof shall not exceed following requirements.

i. for profiled tiles :50 kg/m^2 , excluding over and under tiles. See note below.

ii. for other tiles (other than profiled tiles) :45 kg/m^2

NOTE
Manufacturer's process control system should ensure that the maximum mass per unit area of roof including both tiles (i.e. over and under tiles) shall not exceed 80 kg/m^2.

5.5.2 *Variation in Mass*

The percentage of variation in mass (D_m) determined as per the method described in Appendix **C** shall not exceed ± 5 % of the average mass.

5.6 Physical and Mechanical characteristics

5.6.1 *Permeability*

When tested for permeability as per the Method **2** of **SLS EN 539-1** and examined within 24 ± 1 h, formation of water droplets shall not be observed on the underside of tile. Permeability test shall not be applicable for ridge tiles.

NOTE: *The test shall be performed at the room temperature of 27 ± 2 ^{0}C and relative humidity of 65 ± 5 %.*

5.6.2 *Efflorescence*

When tested for *efflorescence* as per the method described in Appendix **D**, efflorescence shall not be observed.

5.6.3 *Water absorption*

The total water absorption percentage (WA) determined as per the method described in Appendix **E** shall conform to the requirements given in Columns **2** and **3** of Table **1**.

5.6.4 *Transverse strength*

Transverse strength shall not be applicable for over and under tiles, and ridge tiles.

5.6.4.1 Wet transverse strength

The wet transverse strength determined as per the method described in Appendix **F** shall conform to the requirements given in Columns **2** and **3** of Table **3**.

5.6.4.2 Dry transverse strength

5.6.4.3 For the purposes of manufacturer's process control system or the special request of end user, it is permitted to perform dry transverse strength determined as per the method described in Appendix **G** and tile shall conform to the requirements given in Columns **4** and **5** of Table **3**.

TABLE 3 – Requirements for transverse strength

Type of the tile	**Transverse strength N (Minimum) for test span of 300 mm**			
	Wet transverse strength		**Dry transverse strength**	
(1)	**Average (2)**	**Individual (3)**	**Average (4)**	**Individual (5)**
Profiled tiles	1400	1200	1800	1600
Other tiles (other than profiled tiles)	1000	900	1400	1200

NOTES

*1. When a shorter span is used for the test, the minimum values in Table **3** shall be multiplied by the factor of 305/span used.*

*2. For tiles with width greater than 350 mm the minimum values in Table **3** shall be increased by multiplying by the factor of width/356.*

5.6.5 *Load bearing capacity*

Load bearing capacity shall be applicable only for over and under tiles, and ridge tiles.

5.6.5.1 *Wet load bearing capacity*

The wet load bearing capacity determined as per the method described in Appendix **G** on ridge tiles, and over and under tiles shall conform to the requirements given in Columns **2** and **3** of Table **4**.

5.6.5.2 *Dry load bearing capacity*

For the purposes of manufacturer's Process Control system or the special request of end user, it shall be permitted to perform dry load bearing capacity determined as per the method described in Appendix **G** on ridge tiles and over and under tiles and shall conform to the requirements given in Columns **4** and **5** of Table **4**.

TABLE 4 – Requirements for load bearing capacity

Type of the tile	**Load bearing capacity (Minimum) kN/m**			
	Wet load bearing capacity		**Dry load bearing capacity**	
(1)	**Average (2)**	**Individual (3)**	**Average (4)**	**Individual (5)**
Over and under tiles	14.0	12.0	18.0	16.0
Ridge tiles	3.0	2.5	4.0	3.5

5.7 Fire performance

Whenever fire resistance regulations come into effect, fire performance test needs to be performed.

When fire performance is determined as per the method described in relevant regulation, tile shall conform to the requirements given in the regulation.

5.8 Dangerous substance

Whenever dangerous substance regulations come into effect, dangerous substance test need to be performed.

When dangerous substance is determined as per the method described in relevant regulation, tile shall conform to the requirements given the regulation.

6. MARKING ON THE TILE

The following markings shall be marked legibly, indelibly and permanently on the back side of the clay roofing tile

a) Manufacturer's trade name or trade mark, and
b) Batch identification code or date of pressing
c) Water absorption category as per Table **1 .**
   eg. AAA

NOTE
Attention is drawn to the certification facilities offered by the Sri Lanka Standards Institution. See the inside back cover of this standard.

7. INFORMATION TO BE PROVIDED BY THE MANUFACTURER AT THE POINT OF DELIVERY

7.1 Product information

The following particulars related to the clay roofing tile shall be provided in the Delivery Note, Invoice or Mill Report supplied with each consignment of tiles

a) Name, address and trade mark or trade name where available
b) Water absorption category
c) Wet transverse strength in N
d) Overall dimensions
e) Cover dimensions or overlap dimensions as appropriate; and
f) Mass of tiles per unit area of roof in , kg/ m^2
g) Manufacturer's information

(To provide traceability, the following details shall be given;
- the production period, the year, in figures or in code;
- a name or code for the production site, if the manufacturer is producing in different sites, nationally and/or internationally.)

NOTE
At the request of the user, manufacturer shall provide dry transverse strength of tile in N.

7.2 Installation requirements

Guidelines for installation of product shall be provided by the manufacturer.

8. SAMPLING

Where the compliance of a lot to the requirements of this standard is to be assessed based on statistical sampling and inspection, the sampling scheme given in **H.1** of Appendix **H** shall be applicable.

In case of sample required for independent tests, it shall be taken at the option of the end-user or his/her representative, before delivery or within one week after delivery of tiles as per the scheme given in Appendix **H**.
Where compliance with this specification is to be assured based on manufacture's process control systems coupled with type testing and check tests or any other procedures, appropriate scheme of sampling and inspection shall be adopted.

9. COMPLIANCE OF A LOT

Compliance shall be in accordance with **H.3** of Appendix **H**

APPENDIX A
TYPES AND TYPICAL OVERALL DIMENSIONS OF CLAY ROOFING TILES

A.1 Types of clay roofing tiles

Typical profiles of tiles commonly available are given below for purposes of illustration.

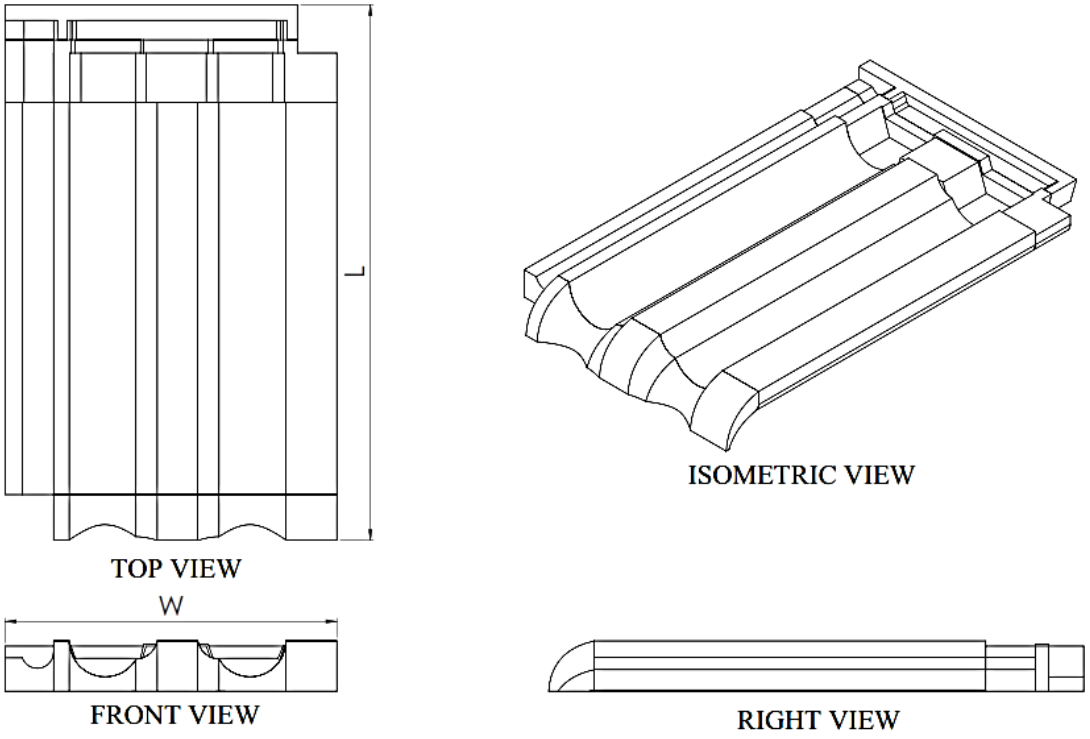


FIGURE A1 – Shape and profile of Calicut (Mangalore) type

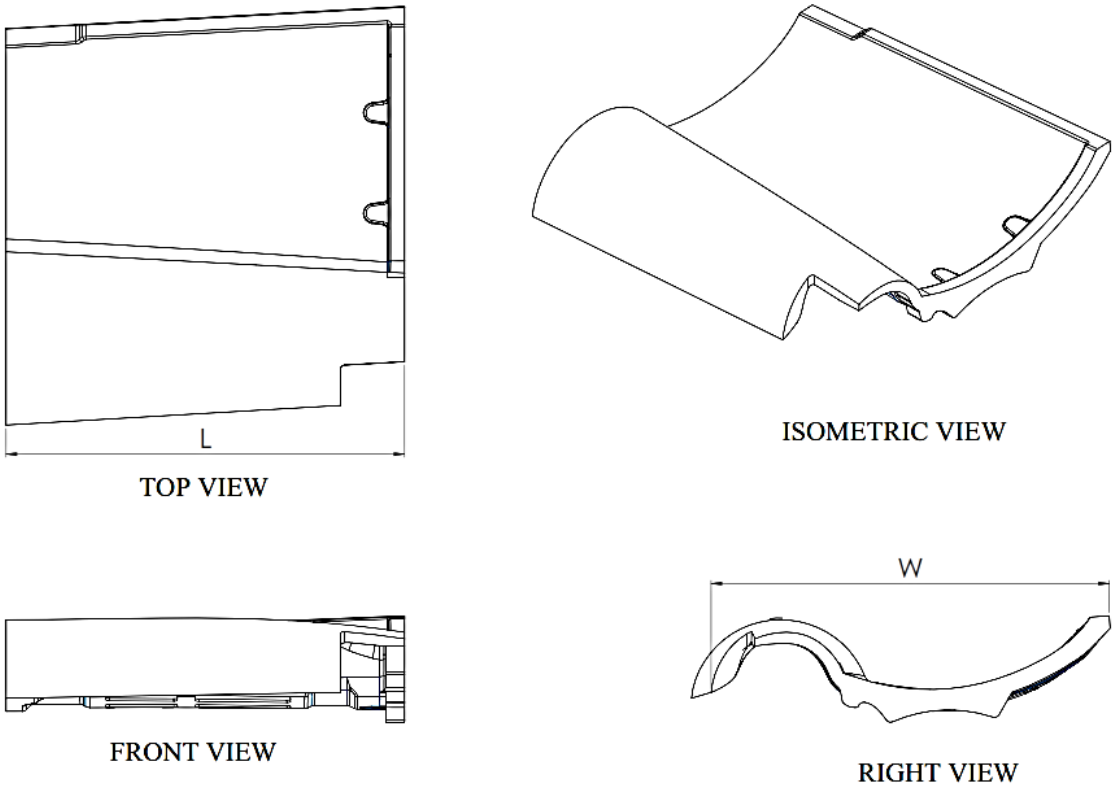


FIGURE A2– Shape and profile of S type

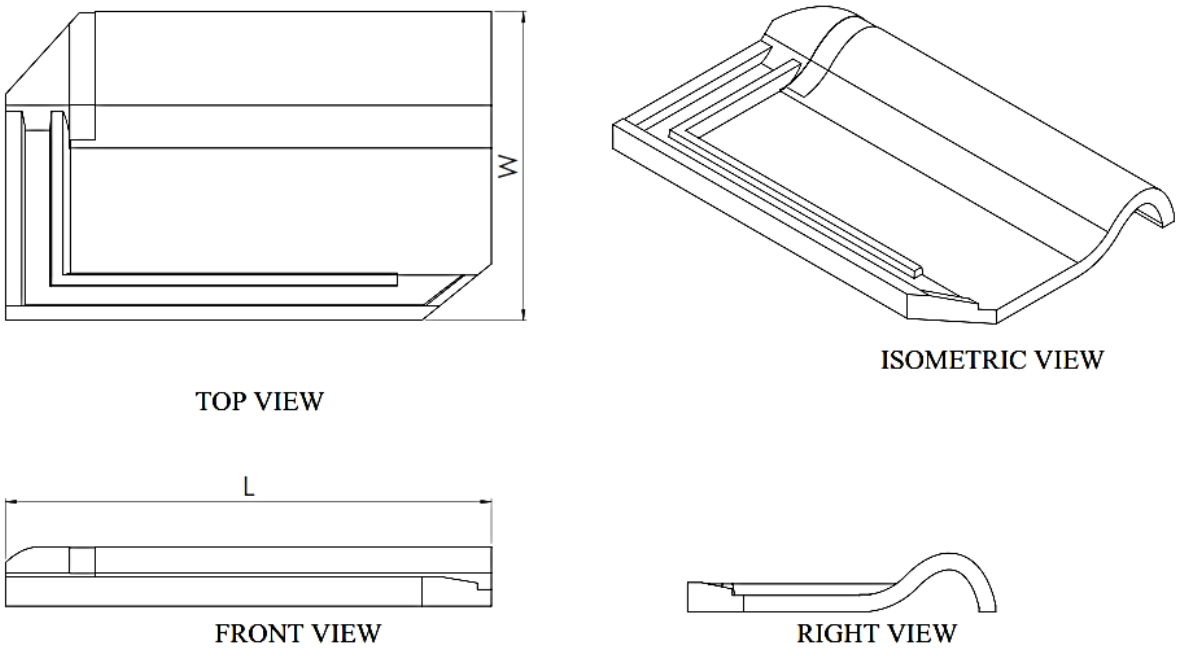


FIGURE A3– Shape and Profile of J-1 (Euro) type

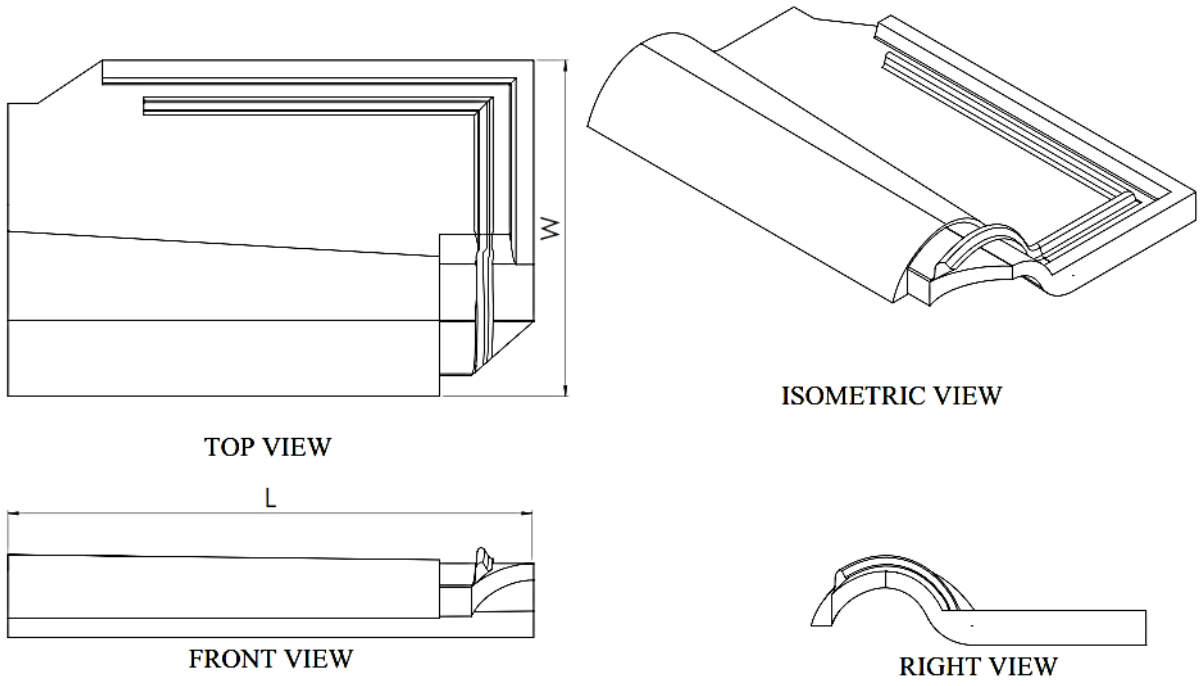


FIGURE A4 – Shape and Profile of J-2 (Roman) type

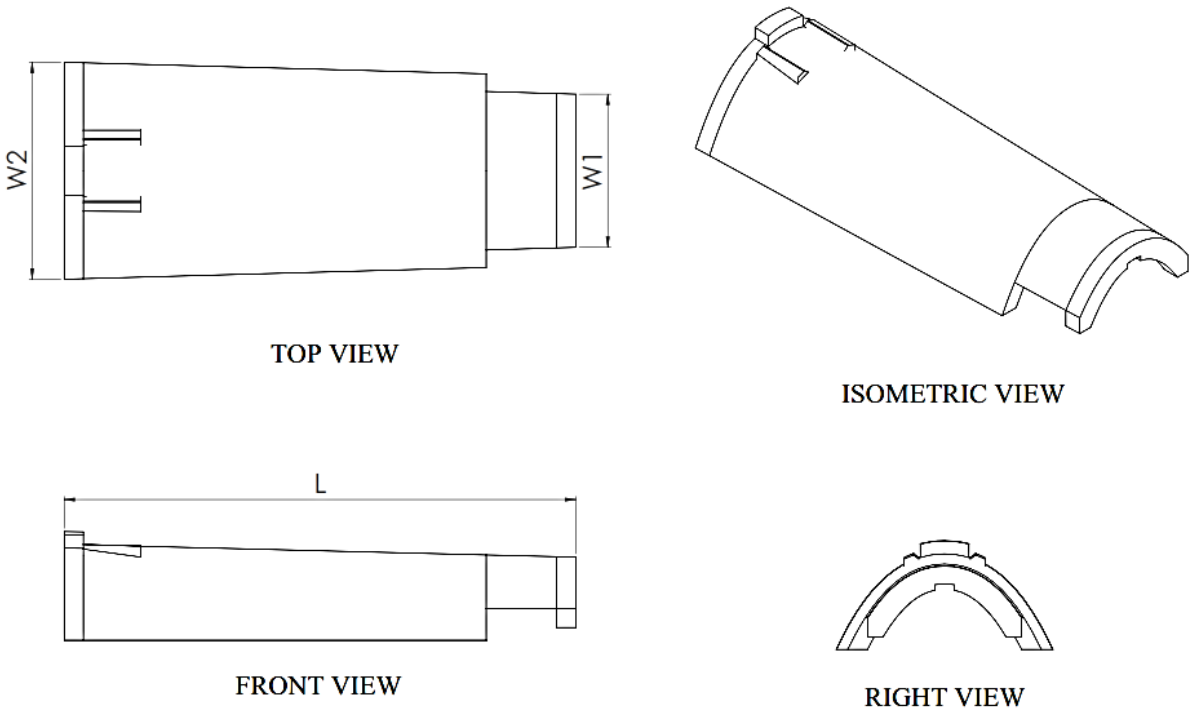


FIGURE A5a – Shape and Profile of Half Round -1 (Spanish) lower type

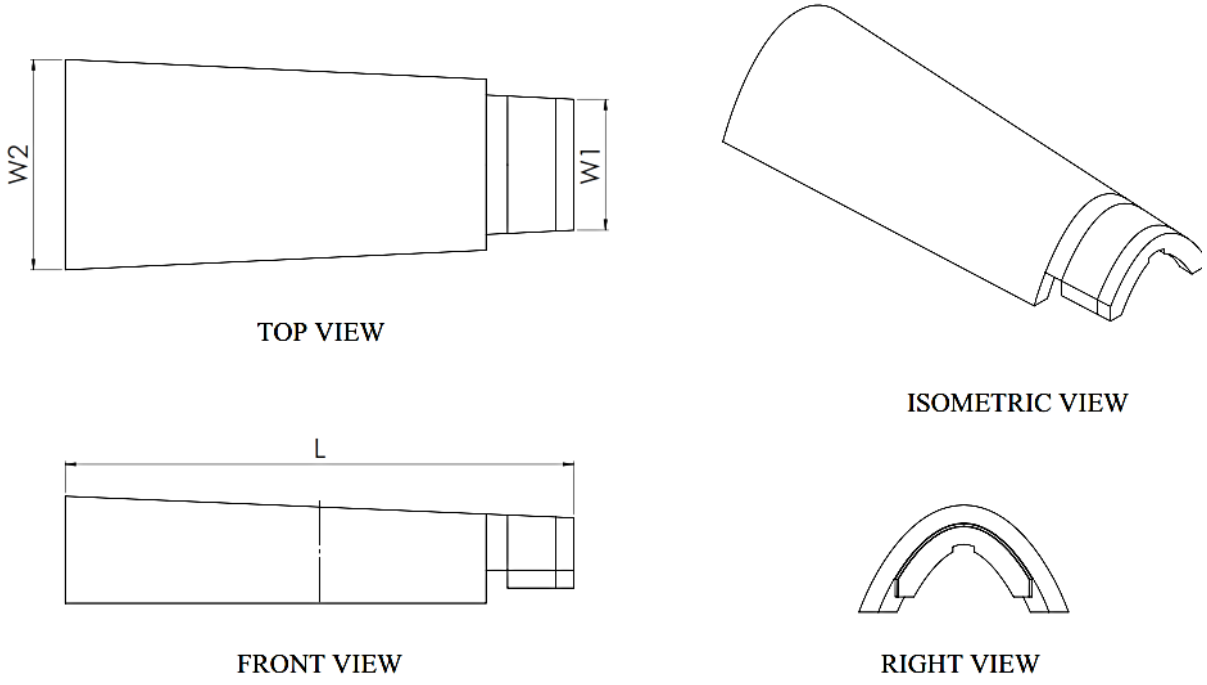


FIGURE A5b – Shape and Profile of Half Round -1 (Spanish) upper type

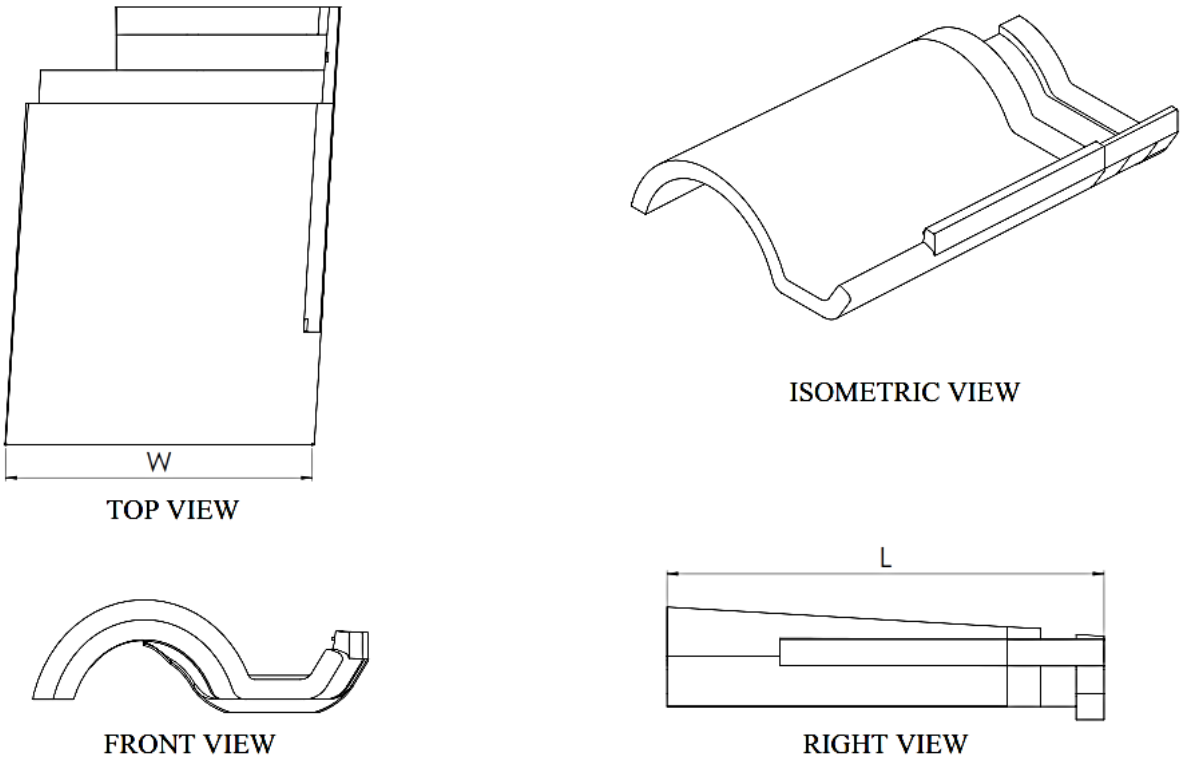


FIGURE A6 – Shape and Profile of Half Round -2 (Sihala) type

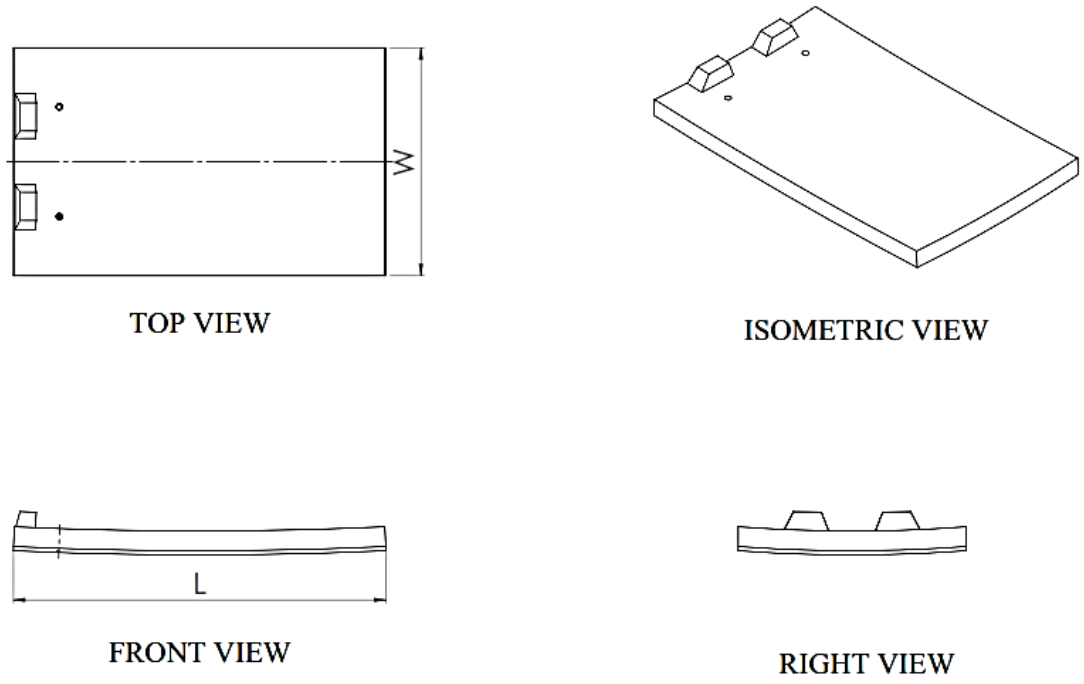


FIGURE A7 – Shape and Profile of Plain type

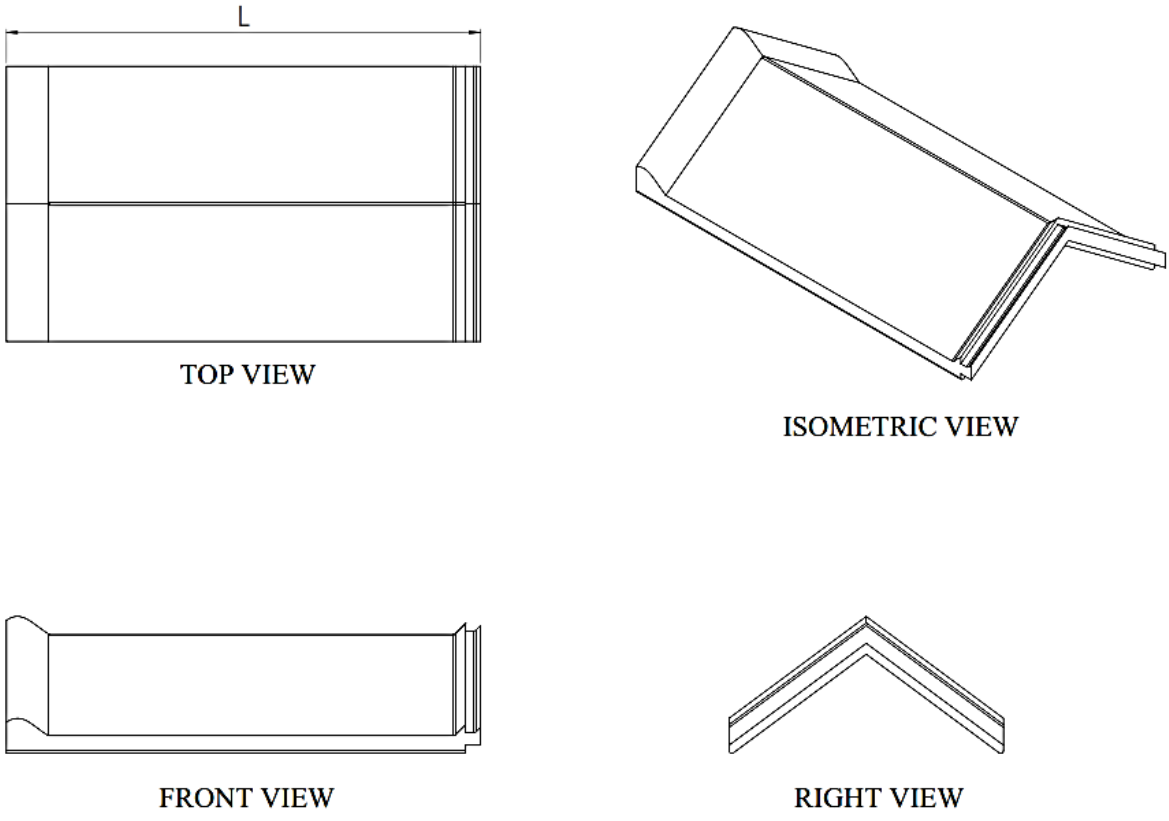


FIGURE A8– Shape and Profile of Angular type ridge

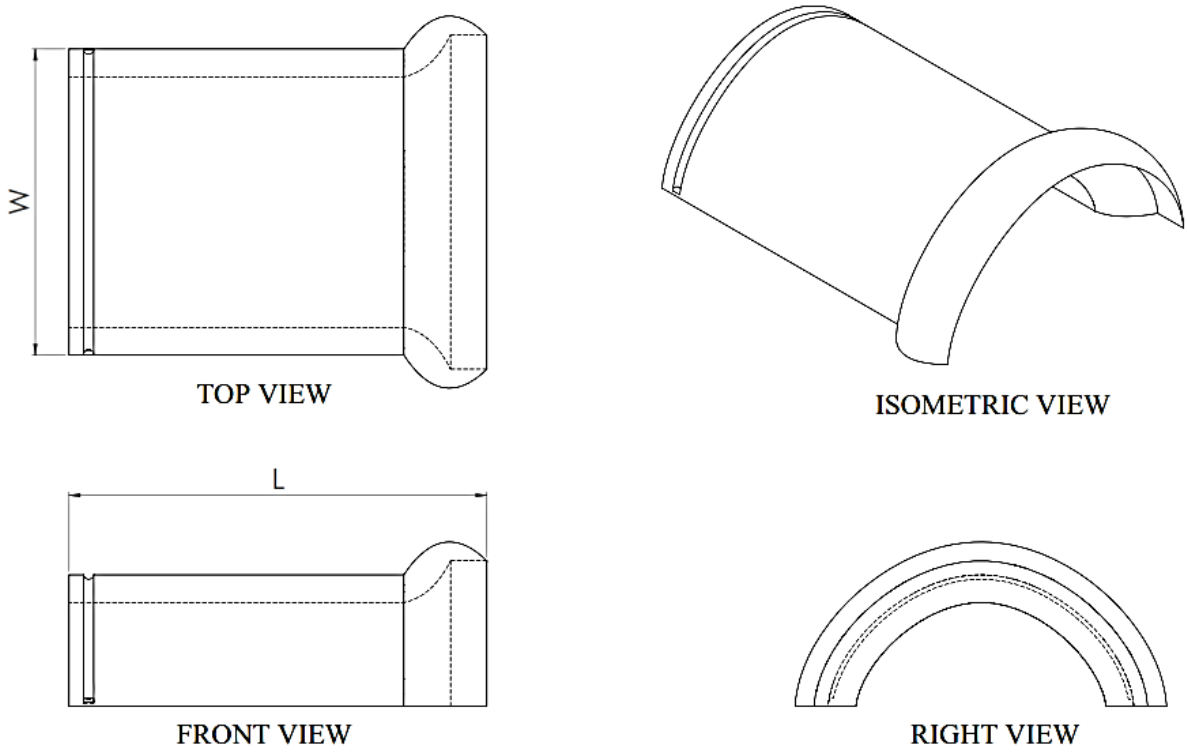


FIGURE A9a– Shape and Profile of Euro /Spanish / S type ridge

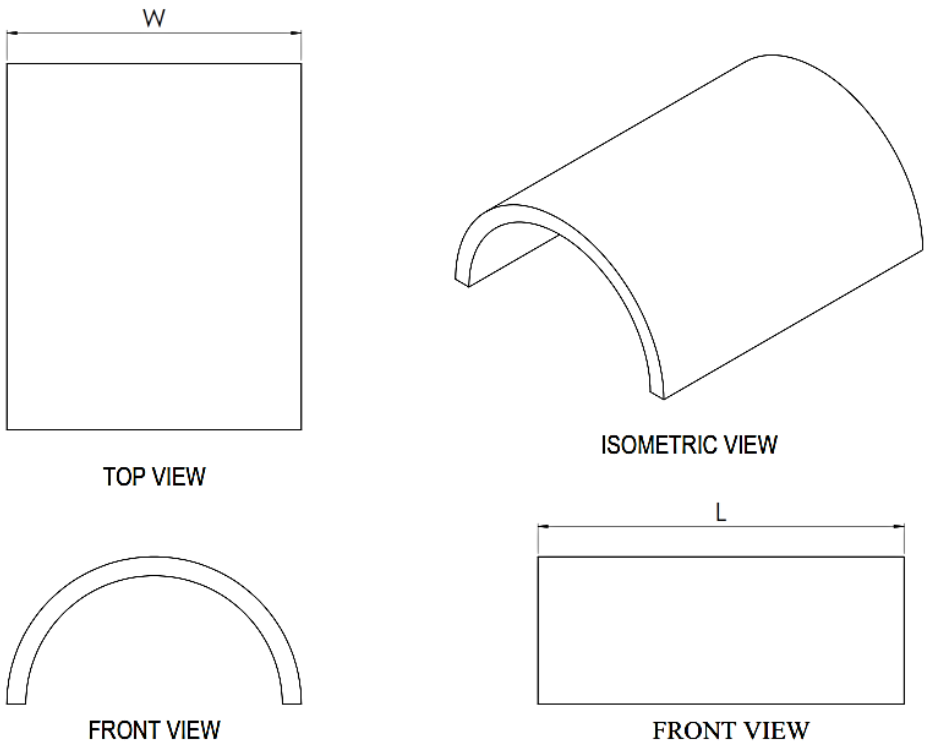


FIGURE A9b– Shape and Profile of Half round ridge

A.2 Typical overall dimensions

TABLE A1– Nominal overall dimensions

Figure No. (1)	Type of the tile (2)	Length (L) mm (3)	Width (W)	
			Longest Width (W1) mm (4)	Shortest Width (W2) mm (5)
Figure A1	Calicut (Mangalore)	410	250	
Figure A2	S	310	305	
Figure A3	J-1 (Euro)	385	245	
FigureA4	J-2 (Roman)	405/385	255/240	
Figure A5a	Half round -1 (Spanish) -lower	400	170	120
Figure A5b	Half round -1 (Spanish) -upper	400	165	100
Figure A6	Half round -2 (Sihala)	255	250	
Figure A7	Plain	265	160	
Figure A8	Angular ridge	425	250	
Figure A9a	Euro/S/Spanish ridge	300	245	
Figure A9b	Segmental ridge	455	250	

APPENDIX B
TEST FOR HOLDING CAPABILITY OF HOLDING NIBS

B.1 Apparatus

Well shaped straight rectangular batten with a nominal cross section of 50 mm x 25 mm. The batten used shall be of hard wood or suitable metal

B.2 Test specimens

Each of the tiles in the sample

B.3 Procedure

Fix the batten horizontally. Position the wider side of it in vertical plane and narrow side in horizontal plane. Hang the tile freely on the reeper or batten with support of the holding nibs and ensure the stability of tile. Inspect the verticality of side edges of tile visually. The test should be carried out separately on each of the tile in the sample.

NOTE
Tiles with no holding nibs or broken holding nibs shall not be tested for holding capability and recorded as failures.

B.4 Expression of test results

Where failures occur, record the slippage, any damage of the holding nibs and noticeable deviation of side edges from verticality, when the tile is hung on the batten.

APPENDIX C
DETERMINATION OF MASS

C.1 Apparatus

C.1.1 *Drying oven*

Ventilated oven capable of being operated at 110 ± 5 ^{0}C

Microwave, infrared or other drying system may be used where it is proven that the same results could be achieved as in the case of ventilated oven.

C.1.2 *Balance*

Accurate to 0.05 % of the mass of the test specimen.

C.2 Test specimens

Each of the tiles in the sub sample

C.3 Procedure

Dry the tiles in ventilated oven adjusted to 110 ± 5 ^{0}C, until constant mass is reached, i.e. until the difference between two successive weighing at intervals of 2 h is less than 0.1 %. Cool the tile in desiccator over suitable desiccant at room temperature (27 ± 2 ^{0}C) for at least 4 h. Measure the dry mass of each tile to an accuracy of 1 g.

C.4 Calculation

C.4.1 *Mass of tiles per unit area of roof*

The mass of tiles per unit area M in kg/m^2 is calculated using the following equation

$$M = \frac{m_{av}}{Ll} \; x \; 100$$

Where,

m_{av} is the average mass of dried tiles in g

L is the mean cover length in mm

l is the mean cover width in mm

C.4.2 *Deviation of mass*

For each tile, the percentage deviation of the mass D_m from the average mass of the sub sample, express as a percentage of average mass of the sub sample, is calculated using the following equation.

$$D_m = \frac{(\mathrm{m} - \mathrm{m_{av}}) \; \mathrm{x} \; 100}{\mathrm{m_{av}}}$$

Where,

m is the mass of the dried tile in g

m_{av} is the average mass of tiles in g

C.5 Expression of test results

C.5.1 *Mass of tiles per unit area of roof*

Report the calculated value to the nearest whole number.

C.5.2 *Deviation of mass*

Report the each of the test results to the first decimal and maximum deviation rounded to the nearest whole number.

APPENDIX D
TEST FOR EFFLORESCENCE

D.1 Apparatus

D.1.1 *Drying oven*

As per **C.1.1**

D.1.2 *Drying room/cabinet*

Drying room maintained at a room temperature of 27 ± 2 ^{0}C with a relative humidity (RH) *65 ± 5 %*.

D.1.3 *Pan or trays*

Water tight shallow pan or tray made of corrosion-resistance metallic material or other material that will not provide soluble salt when in contact with distilled water containing leaching from the tile. The pan shall be of such dimensions that it will provide not less than 25 mm depth of water. Unless the pan provides an area such that the total volume of water is large in comparison with the amount evaporated each day, suitable apparatus shall be provided for keeping a constant level of water in than pan.

D.1.4 *Brush*

A soft-bristle brush

D.2 Test specimens

Each of the tiles in the sub sample

D.3 Procedure

The ten specimens in the sub sample shall be sorted into five pairs so that both specimens of each pairs are similar in appearance.

Remove by brushing any adhering dirt to avoid mistaking it for effloresces.

Dry the tile in ventilated oven (**D.1.1**) adjusted to 110 ± 5 ^{0}C, until constant mass is reached, i.e. until the deference between two successive weighing at intervals of 2 h is less than 0.2 %.

After drying, place the specimens separately in the drying room/cabinet (**D.1.2**) for a period of at least 4 h (until the surface temperature of the tile is ± 3 ^{0}C of the room temperature) and store them under the same condition until tested.

Set one specimen from each of the five pairs, with appropriate support formed from corrosion-resistance material to maintain the tile in an approximately vertical position, on its nose end, partially immersed in distilled water to a depth of approximately 25 mm for seven days in drying room. When several specimens are tested in same container, separate the individual specimen by a spacing of at 50 mm.

Store the second specimen from each of the five pairs in the drying room/cabinet (**D.1.2**) without contact with water.

At the end of seven days, inspect the first set of specimen and then place both sets in the drying oven without contact with each other for 24 h.

After drying, examine and compare each pair of specimen, observing all faces of each specimen from the distance of 1 m under a minimum light intensity of 1200 lux by an observer with normal vision.

When under these conditions no precipitation is noted, report the rating as "not effloresced" and when precipitation occurs, report the rating as "effloresced"

NOTE

1 *Do not test specimens from different sources simultaneously in the same container, because specimen with a considerable content of soluble salt will contaminate salt-fee specimen.*

2*. Empty and clean the pan or tray after each test.*

D.4 Expression of test results

Record the number of effloresced tiles, where observed.

APPENDIX E
TEST FOR WATER ABSORPTION

E.1 Apparatus

E.1.1 *Drying oven*

As per **C.1.1**

E.1.2 *Balance*

As per **C.1.2**

E.1.3 *Water bath*

Suitable water bath with clean water capable to accommodate the entire tile in the sub sample

E.2 Test specimens

Each of the tiles in the sub sample

E.3 Procedure

Dry the tile in the oven adjusted to 110 ± 5 ^{0}C, until constant mass is reached, i.e. until the deference between two successive weighing at intervals of 2 h is less than 0.1 %. Cool the tile

in desiccator over suitable desiccant at room temperature (27 ± 2 ^{0}C) for at least 4 h. Measure the dry mass of each tile to the accuracy of 1.0 g.
Place the tiles vertically, with no contact between them in the water bath maintained at room temperature so that there is a depth of 50 mm of water above and below the tiles. Maintain the water level at 50 mm above the tiles throughout the test. Keep tiles in water for a period of 48 ± 4 h. Remove each tile one by one, wipe off the surface water carefully with a damp cloth and measure the wet mass of each tile immediately to the accuracy of 1.0 g.

E.4 Calculation

For each tile, the water absorption (WA) expressed as a percentage of the dry mass, is calculated using the following equation

$$WA = \frac{(m_w - m_d)}{m_d} \text{ x } 100$$

Where,

m_d is the mass of the dried tile

m_w is the mass of the wet tile

E.5 Expression of test results

Report each of the test results rounded off to the first decimal, and average and maximum water absorption values rounded to the nearest whole number.

APPENDIX F
TEST FOR TRANSVERSE STRENGTH

F.1 Apparatus

F.1.1 *Drying oven, loading device or apparatus and test assembly*

Conforms to the requirements of **C.1.1**.

F.1.2 *Water bath*

Conforming to the requirements of **E.1.3**

F.1.3 *Loading device or apparatus*

A device that is capable of measuring the applied load to an accuracy of 2.0 % and a loading rate 0.05 kN/s

F.1.4 Test assembly

The test assembly illustrated in Figure **F1** shall be used for the test.

The two supporting and loading members of the assembly shall be of metal or hard wood with thickness of 25 mm ± 5%. The loading and load bearing face of loading and supporting members shall be shaped (see Note) to closely conform to the profile of the surface of tile upon which they bear during the test. The height of the members shall not be more than 25 mm from the peak of the tile profile. If the members are hardwood, they shall be backed up with steel bearing plates at least 10 mm thick. A rubber strip of 5 mm ± 10 % thick and I.R.H.D. hardness 50 ± 5 measured as per SLS 297 Part 4 and 25 mm ± 5% wide, shall be placed between the face of the support and loading members and the surface of the tile.

The length of the supporting and loading members shall be greater than the width of the tile.

The supporting and loading members shall be free to rotate in the longitudinal and transverse directions of the test specimen and be adjusted so that they will exert no force in these directions. It is permitted to accomplish this by spherically seated steel balls with appropriate supporting springs.

NOTE: *The intent of the defined loading system is*

i *to apply the bending force with a loading member that pushes against as much of the profile surface of the tile as is practical.*

ii *to support tile on members that support as much of the profile surface of the tile as is practical; and*

iii *to ensure that the contact area of both the loading and support members be equally distributed on either side of the length centerline on the tile to avoid non-symmetrical loading*

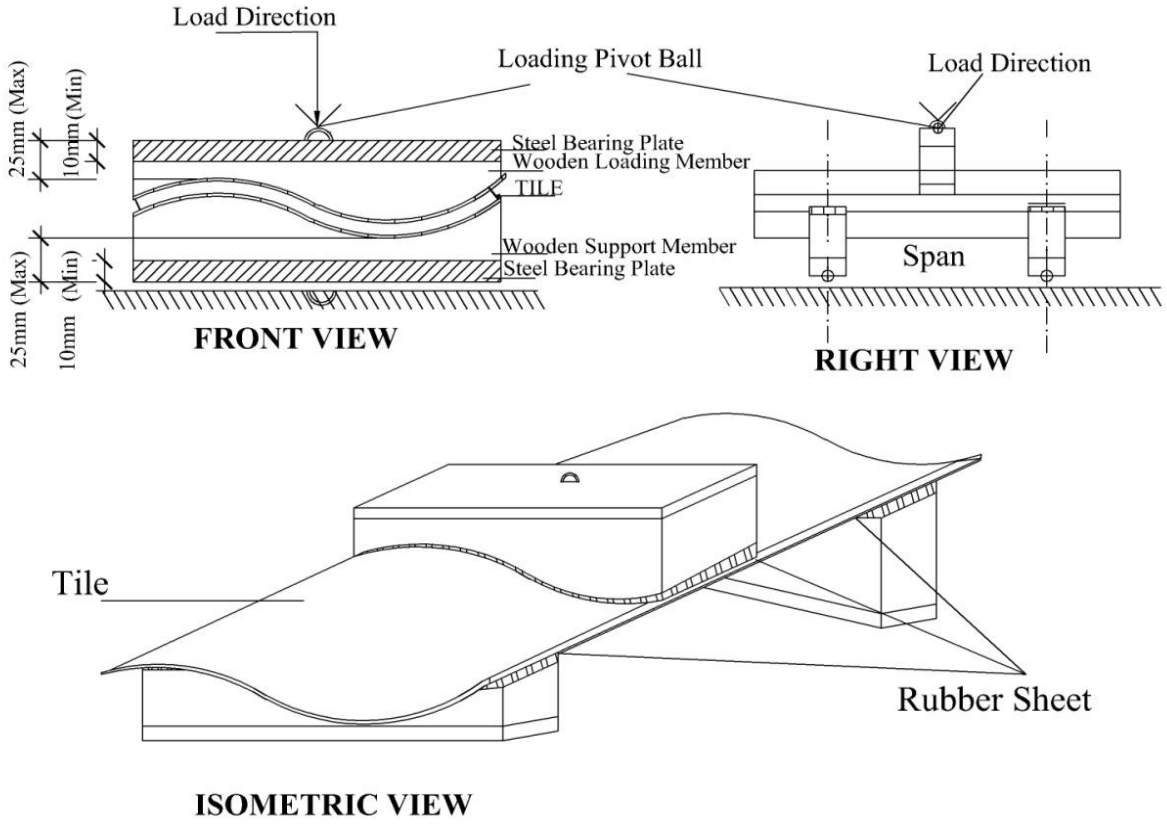


FIGURE F1 – Schematic assembly for transverse strength testing (Loading and Supporting members made of hard wood)

F.2 Test span

The span shall be 300 ± 5 mm. The span is measured between the centers of the supporting members (see Figure **F1**).

When it is not possible to use above span, it shall be permitted to use shorter span. In that case, a shorter span, not less than 2/3 of the length of the tile shall be used.

F.3 Test specimens

Each of the tiles in the sub sample

F.4 Procedure

F.4.1 *Wet transverse strength*

The tile shall be submerged in water bath at room temperature for 24 h. Immediately after removing the tile from water bath wipe off the surface water carefully with a damp cloth. Place the tile on the assembly and it shall be loaded uniformly and continually without shock, at specified rate of loading, until fracture observed.

Record the wet transverse breaking load as wet transverse strength.

F.4.2 *Dry transverse strength*

Dry the tile in the oven adjusted to 110 ± 5 ^{0}C, until constant mass is reached, i.e. until the deference between two successive weighing at intervals of 2 h is less than 0.1 %. Cool the tile in desiccator over suitable desiccant at room temperature (27 ± 2 ^{0}C) for at least 4 h. Place the tile on the assembly and it shall be loaded uniformly and continually without shock, at specified rate until fracture observed.

Record the dry transverse breaking load as dry transverse strength.

F.5 Expression of test results

Report each of the wet transverse strength / dry transverse strength test results to the first decimal, and average and minimum individual result rounded to the nearest whole number.

APPENDIX G
TEST FOR LOAD BEARING CAPACITY

G.1 Apparatus

G.1.1 Drying oven

Conforming to the requirements of **C.1.2**.

G.1.2 Water bath and loading device or apparatus

Conforming to the requirements of **E.1.3** and **F.1.2** respectively

G.1.3 Test assembly

The test assembly illustrated in Figure **G1** shall be used for the test.

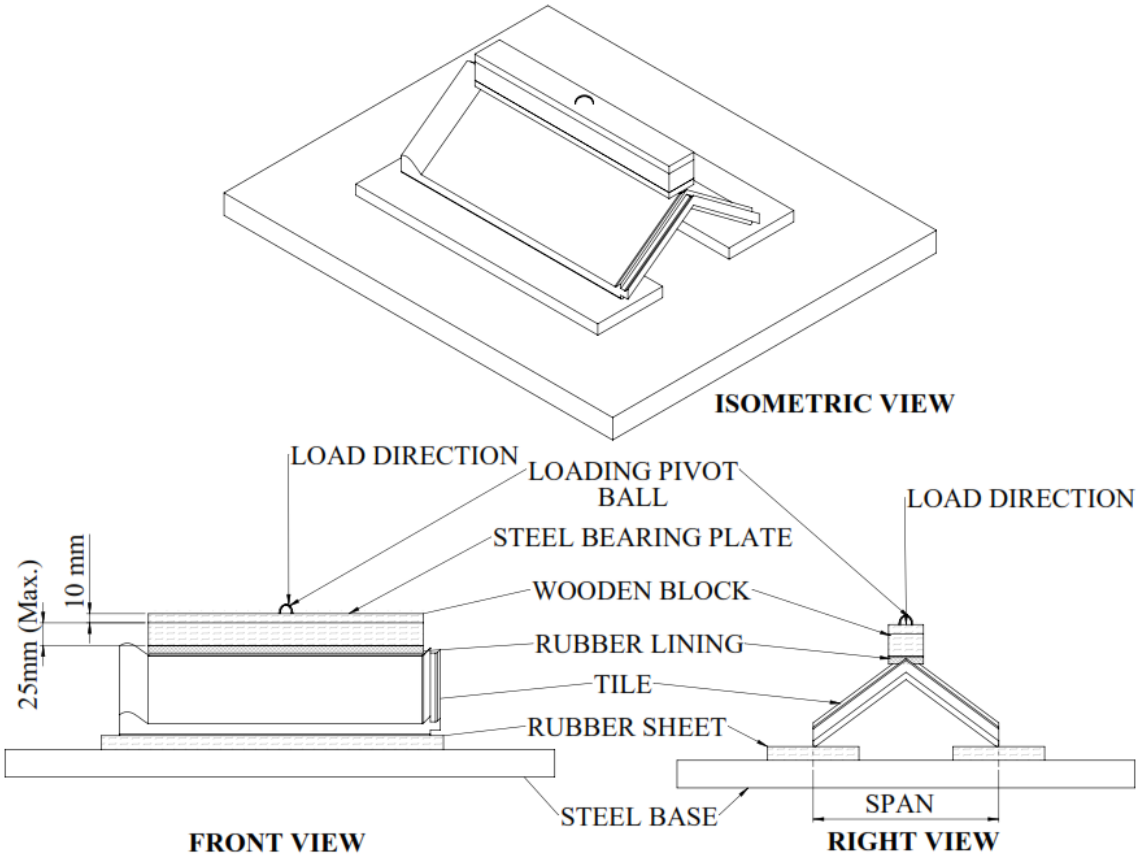


FIGURE G1- Test assembly for load bearing test (Loading and supporting members made of hard wood)

The loading member of the assembly shall be of metal or hard wood with cross-section of each dimension of 25 mm ± 5% and length shall be extended to cover almost of upmost longitudinal line of the tile except interlocks. It shall not more than 25 mm in height. If the loading member is hardwood, it shall be backup with steel bearing plates at least 10 mm thick. A rubber strip of 5 mm ± 10 % thick and I.R.H.D. hardness 50 ± 5 measured as per SLS 297 Part 4 and 25 mm ± 5% wide shall be placed between the loading member and the upmost longitudinal line of the tile except interlocks.

The loading members shall be free to rotate in the longitudinal directions of the test specimen and be adjusted so that they will exert no force in this direction.

A rubber sheet of 5 mm ± 10 % thick and I.R.H.D. hardness 50 ± 5 measured as per SLS 297 Part 4, shall be placed between the tile and supporting base.

G.2 Test specimens

Each of the tiles in the sub sample

G.3 Procedure

G.3.1 *Wet load bearing capacity*

The tile shall be submerged in water bath at room temperature for 24 h. Immediately after removing the tile from water bath, wipe off the surface water carefully with a damp cloth, place the tile on the supporting base and it shall be loaded longitudinally as shown in Figure **G1**, uniformly and continually without shock, at specified rate of loading, until fracture occurred.

Record the wet load bearing capacity in N.

G.3.2 *Dry load bearing capacity*

Dry the tile in the oven adjusted to 110 ± 5 ^{0}C, until constant mass is reached, i.e. until the deference between two successive weighing at intervals of 2 h is less than 0.1 %. Cool the tile in desiccator over suitable desiccant at room temperature (27 ± 2 ^{0}C) for at least 4 h, place the tile on the supporting base and it shall be loaded longitudinal direction as shown in Figure **G1** uniformly and continually without shock, at specified rate until fracture occurred.

Record the dry load bearing capacity in N.

G.4 Calculation

The load bearing capacity shall be determined by dividing the breaking load by the length of the tile.

G.5 Expression of test results

Report the each of the *Wet load bearing capacity*/*Dry load bearing capacity* test results to the second decimal, and average and minimum individual result rounded to the first decimal.

APPENDIX H
SAMPLING AND CRITERIA FOR CONFORMITY

Samples shall be drawn from each lot as per the sampling scheme and shall be tested separately for ascertaining the conformity of the lot to the requirements of this specification.

H.1 SCALE OF SAMPLING

H.1.1 The number of clay roofing tiles to be selected from the lot shall be in accordance with column **2** of Table **H1.** The tiles shall be selected at random. In order to ensure randomness of selection, random number tables as given in **SLS 428** shall be used.

TABLE H1 – Scale of sampling

Number of clay roofing tiles in a lot (1)	Number of tiles to be selected (2)	Acceptance number (3)
Up to 1 200	36	02
1 201 to 3 200	50	03
3 201 to 10 000	80	05
10 001 to 35 000	125	07

NOTE
*The Table **H1** was prepared in accordance with **ISO 2859-1:1999**, General inspection level II AQL=1.5%.*

H.1.2 When the tests are required to be performed on regulatory requirement/s, the additional sub sample/s of size/s given in test method/s specified by the relevant regulation/s shall be selected as appropriate, in addition to the samples selected as per **H.1.1**.

H.2 NUMBER OF TESTS

H.2.1 Each tile selected as in **H.1.1** shall be inspected for following requirements as appropriate;

H.2.1.1 *Structural and surface characteristics (see **5.1**),*

H.2.1.2 *Fixing characteristics (see **5.2**),*

H.2.1.3 *Interlocking characteristics (see **5.3**),* and

H.2.1.4 *Marking requirements (see Clause **6**)*

H.2.2 From the tiles drawn as in H.1.1, 24 numbers of tiles shall be selected at random and shall be inspected for geometrical characteristics (see **5.4**)

H.2.3 Five numbers of sub samples of size given in column **3** of Table **H2** shall be selected from the tiles selected as in **H.1.1** (including 24 tiles inspected as in **H.2.2**) and tested for mass, physical and mechanical requirements given in column **2** of Table **H2**.

TABLE H2 – Sizes of sub samples

Sub sample number (1)	Test parameter (Clause No.) (2)	Size of sub sample (3)
01	Mass characteristics (see **5.5**)	08
02	Permeability (see **5.6.1**)	05
03	Efflorescence (see **5.6.2**)	10
04	Water absorption (see **5.6.3**)	05
05	Wet transverse strength (see **5.6.4.1**) or Wet load bearing capacity (see **5.6.5.1**)	08

H.2.4 When required, all the tiles in sub sample 1 shall be tested for the dry transverse strength (see **5.6.4.2**) or dry load bearing capacity (see **5.6.5.2**) soon after the dried mass measurements have been taken.

H.2.5 When required, the additional sub samples selected as per **H.1.2** shall be tested for Fire performance (see **5.7**) and Dangerous substance (see **5.8**) as appropriate.

H.3 CRITERIA FOR CONFORMITY

H.3.1 A lot shall be declared as conforming to the requirements of this standard, if the conditions given below are satisfied.

H.3.1.1 When the tiles inspected in accordance with **H.2.1**, number of defectives conform to the corresponding acceptance number given in column **3** of Table **H1**.

H.3.1.2 When the tiles are inspected in accordance with **H.2.2,**

a. for requirements in **5.4.1** and **5.4.2**, the acceptance number is one.

b. for requirements in **5.4.3**, shall comply with the specification.

H.3.1.3 The sub sample **1, 2, 3** and **4** tested in accordance with **H.2.3** shall comply with the specifications in **5.5**, **5.6.1**, **5.6.2** and **5.6.3**.

H.3.1.4 The sub sample **5** tested in accordance with **H.2.4** shall comply with the specification in **5.6.4.1** or **5.6.5.1** as appropriate.

H.3.2 When required, the additional sub samples tested in accordance with **H.2.5** shall comply with the specifications in the relevant regulations.

AMENDMENT No.01 approved on 2018- 10-10 to SLS 2: 2016

SRI LANKA STANDARD SPECIFICATION FOR CLAY ROOFING TILES

(SECOND REVISION)

Page 6

3.30 plain tiles:

Add the following note at end of the definition of plain tiles.

"***NOTE:***

These tiles are generally rectangular, but can have a specially shaped tail (eg. fish-scale tiles with a rounded or sharp front edge)."

Page 9

5.2.1 *Holding nibs*

Delete the first paragraph and substitute the following

"When provided with holding nibs, each tile shall have either a continuous nib not less than 65 mm in base length or nibs each with a base of not less than 20 mm of length and 10 mm of width. Under tile may have a single nib with a base of not less than 20 mm in length and 10 mm in width."

5.2.2 *Fixing holes (Nailing holes)*

Delete "5" in line one of first paragraph and substitute "4", and

delete "4" in line two of first paragraph and substitute "3".

Page 10

5.4.1.2 *Uniformity of transverse profile*

Delete "15mm." at the end of line two of paragraph two and "15 mm for 200 mm length".

AMD 515

Page 11

5.5.1 *Mass of tiles per unit area of roof*

NOTE given under the clause

Delete "both tiles (i.e. over and under tiles)" in line two and substitute "Plain tiles, Half Round -2 (Sihala) and both including over & under tiles of Half Round -1 (Spanish)", and

delete "80 kg/mm^2" in last line and substitute "90 kg/mm^2"

5.6.1 *Permeability*

Delete the first sentence of existing paragraph and substitute the following.

"When tested for permeability as per the Method given in Appendix **J**, and examined at the end of six hours, no water shall have dripped from the underside of the any of the specimens."

5.6.2 *Efflorescence*

Add the following note at end of the paragraph.

"NOTE:

Efflorescence test needs to be performed as agreed between the manufacturer and the buyer."

Page 12

TABLE 3 – *Requirements for transverse strength*

Delete the existing table and substitute the following table.

Type of the tile	Transverse strength (Minimum) for test span of 300 mm N			
	Wet transverse strength		Dry transverse strength	
(1)	Average (2)	Individual (3)	Average (4)	Individual (5)
Plain tiles	500	400	600	500
Profiled tiles	1400	1200	1800	1600
Other tiles (other than Profiled tiles) except Plain tiles	1000	900	1400	1200

Page 13

TABLE 4 – *Requirements for load bearing capacity*

Delete the existing table and substitute the following table.

Type of the tile	Load bearing capacity (Minimum) kN/m			
	Wet transverse strength		Dry transverse strength	
	Average	Individual	Average	Individual
(1)	(2)	(3)	(4)	(5)
Over and under tiles of Half Round -1 (Spanish)	5.0	4.0	7.0	6.0
Ridge tiles	3.0	2.5	4.0	3.5

Page 23

C.4.1 *Mass of tiles per unit area of roof*

Delete the existing formula given and substitute the following

$$"M = \frac{m_{av}}{Ll} \times 1000$$

Page 33

Insert the Appendix J,after Appendix H

APPENDIX J

DETERMINATION OF WATER PERMEABILITY OF CLAY ROOFING TILES AND FITTINGS

J.1Apparatus

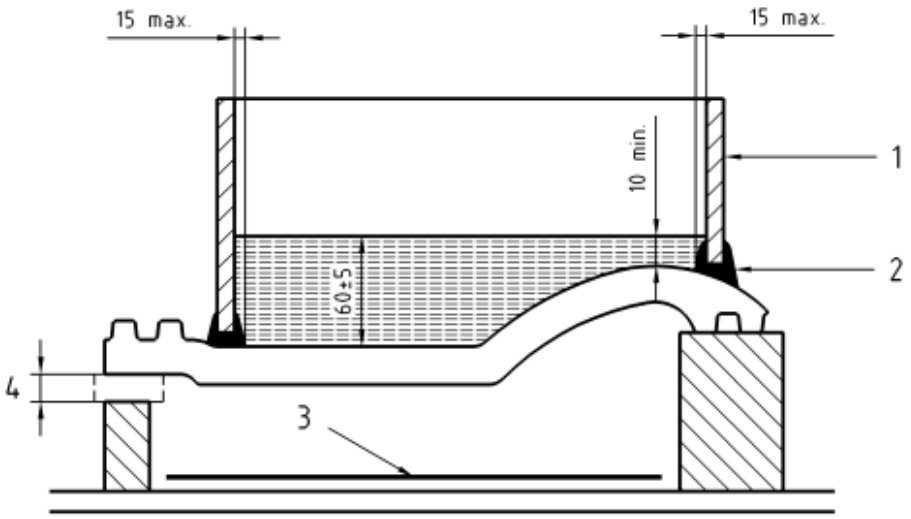
J.1.1A frame as shown in Figures J-1 and J-2, in which internal dimensions correspond to put on the surface of the tile or around the tile, allowing test surface not less than 50 % of the total surface of the tile.

J.1.2 Suitable means for the transverse adjustment to level between the highest and lowest points on the surface of the test tile.

J.2 Test specimens

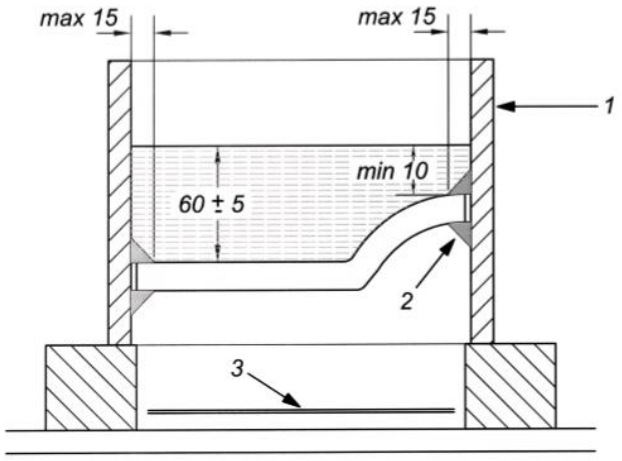
Each tiles in the sub sample

Dimensions in millimeters



Key
1 Frame
2 Mastic
3 Mirror
4 Adjust level (see J.4)

FIGURE J1 -Test Equipment



Key
1 Frame
2 Silicone
3 Mirror or measuring device

FIGURE J2- Frame around the tile

J.3 Preliminary treatment

Preliminary treatment consists of the following operations.

The tiles shall be immersed in tap water at room temperature for (48 ± 4) h.

The tiles shall then be dried at a temperature of (110 ± 5) °C until the difference between the two successive weighing at 24 h and cooled at room temperature for at least 4 h.

If the test is carried out on kiln fresh tiles, they shall, before their immersion in water for 48 h, be held for a period of time at room temperature.

J.4 Procedure

The tile to be tested is fitted with a frame on the surface or around the tiles as shown in FigureJ-1 or Figure J-2.

The testing area on the exposed face of the tile does not include interlock, which is covered when in use. The frame shall be cleaned (e.g. with compressed air) before sealing with silicone or by other suitable means. The width of sealing band on the tile shall not exceed 15 mm.

The tile shall be supported in such a manner that it is horizontal within ± 5°.

In cases where the difference between the lowest and highest point on the surface of the tile is more than 50 mm tilt the tile in a transverse direction by adjusting the supports to ensure that the water level shall be, at the lowest point of the tile's exposed surface, 60 ± 5 mm and, at the highest point of the tile's exposed surface, 10 ± 5 mm.

Some types of tile will not have a point to correspond to this minimum water height, e.g. under and over tiles; in these circumstances, only the maximum depth applies.

Into the receptacle thus formed, pour tap water at 27 ± 2 °C continuously until the water level is 60 ± 5 mm above the lowest point of the tile. Once this level has been reached do not add any further water.

The assembly shall be stored in room with the temperature of 27 ± 2 °C and the relative humidity of 60 ± 5 %. The testing room shall be protected from draughts in such a way that any dripping is not disturbed.

After a period of not less than 06 hours examine the lower surface of the specimen for dripping of water droplets.

J.5 Expression of test results

Report the number of tiles, where the dripping of water droplets are observed.

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