

**SRI LANKA STANDARD 1189 : PART 1 :1999**  
**UDC 692.4 : 693.5**

**SPECIFICATION FOR**  
**CONCRETE ROOFING SEMI-SHEETS, TILES**  
**AND FITTINGS**  
**PART 1 – REQUIREMENTS**

**SRI LANKA STANDARDS INSTITUTION**



**SPECIFICATION FOR CONCRETE ROOFING SEMI-SHEETS,  
TILES AND FITTINGS  
PART 1 - REQUIREMENTS**

**SLS 1189 Part 1 : 1999**

**Gr. 12**

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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.

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TILES AND FITTINGS  
PART 1 - REQUIREMENTS**

**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 Sri Lanka Standard Institution on 1999-02-11.

Micro-concrete roofing, a newly introduced roofing material in Sri Lanka, is prepared using concrete with small size aggregates but without reinforcements. This can be made as a semi-sheet or a tile, but the semi-sheet is more popular.

Micro-concrete semi-sheets and roofing tiles, developed using economic, simple and labour intensive technology as an alternative to asbestos roofing sheets, gained popularity in Sri Lanka rapidly, and is now used in housing as well as institutional buildings. Their advantages are : asbestos free and, hence, more environmentally friendly; labour intensive production process with even unskilled workers; economical compared to asbestos or burnt clay roofing; capital investment required is small; avoids use of scarce materials like clay and firewood; lighter than burnt clay tiles and, hence, a lighter roof structure is required; good fire resistance; uses more local materials easy to obtain; provides good thermal control inside the building; production can be set up in a location with meagre infrastructure facilities; can be coloured; good roof drainage and, hence, roof slope can be 20<sup>0</sup> and above; can be cut to shape with a hack-saw or pincers; and a unit can be removed and replaced from inside the roof. Their disadvantages are: Machine and moulds are imported still; greater care needed during transport to minimise breakages; although skills needed are easily learned; greater supervisory effort is needed at all stages of production and delivery; at ridges, more effort and materials are required to close openings; not intended to be walked on without a crawling board or roof ladder; and more prone to breakage by impact. Emergence of new manufacturers and new users emphasise that advantages seem to outweigh the disadvantages of these roofing units.

Sri Lanka Standard on these roofing units was considered opportune to ensure good quality control, build up manufacturer and user confidence, introduce technological changes more suited to local conditions, and to stimulate this industry to grow rapidly.

This part of the standard gives the requirements, while Part 2 of this standard specifies the test methods.

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 **CS 102**. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

The Sri Lanka Standards Institution gratefully acknowledge the use of the following standards and publications as guidance documents in the preparation of this standard:

AS 4046 . 1 : 1992	-	Method of testing roof tiles
BS 473, 550 : Part 2 : 1971	-	Concrete roofing tiles and fittings
BS EN 490 : 1994	-	Concrete roofing tiles and fittings - Product specifications
BS. EN 491 : 1994	-	Concrete roofing tiles and fittings - Test methods
SABS 542 : 1990	-	Concrete roofing tiles
SS 310 : 1996	-	Concrete interlocking roofing tiles
ICTAD/GEN/MCR/01	-	Micro-concrete roofing tiles

## 1 SCOPE

This Sri Lanka standard specification covers the requirements for concrete roofing semi-sheets, tiles and fittings, for assembly into pitched roof coverings.

## 2 REFERENCES

BS 410	Test sieves
BS 1014	Pigments for Portland cement and portland cement products
SLS 107	Ordinary Portland cement
SLS 522	Water for making concrete
SLS 1144	Ready mixed concrete Part 1 Requirements Part 2 Test methods
SLS 1189	Concrete roofing semi-sheets, tiles and fittings Part 2 Test Methods

## 3 DEFINITIONS

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

**3.1 addition** : Finely divided material that may be added to concrete in order to improve certain properties or to achieve special properties.

**3.2 admixture** : Product which is added in small quantities by mass of the cement before or during mixing or during an additional mixing operation, causing required modifications to the properties.

**3.3 aggregate** : Concrete component consisting of uncrushed and/or crushed natural and/or artificial mineral substances with particle sizes and shapes suitable for the production of concrete.



**3.4 cement** : Hydraulic binder, i.e. finely ground inorganic material, which, when mixed with water, forms a paste which sets, by means of hydration reactions and processes and which, after hardening, retains its strength and stability.

**3.5 characteristic transverse strength** : The value of transverse strength for which 95 per cent of the individual transverse strength results are calculated to be greater than or equal to this value (AQL 5 per cent).

**3.6 defective** : A tile that fails in one or more respects to comply with the appropriate requirements of the specification.

**3.7 eaves** : The overhanging lower edge of a roof slope.

**3.8 end cover** : Fitting for use at a meeting of a ridge tile and a semi-sheet.

**3.9 fitting** : Component, mainly of concrete, that is complementary to the semi-sheets or tiles and has a special function.

#### NOTE

*Examples include ridge tile, hip tile and valley tile.*

**3.10 hip** : The sloping intersection of two inclined roof surfaces that meet at a salient angle.

**3.11 hip tile** : The special tile designed to be placed over a hip of a roof.

#### NOTE

*This is normally a ridge tile*

**3.12 interlocking tile** : Profiled or flat tile which has a side lock with or without a head lock feature.

**3.13 micro-concrete** : A concrete made from water, cement, sand, small stone (chips) and additions or admixtures (if any), where the usual mixes are 1 cement : 1 sand : 2 stonechips, 1 : 1 ½ : 1 ½ or 1:2:1. The latter mixes are preferred when sand contains more of large particles. Sometimes fine quarry dust is used instead of sand or as a partial replacement of sand.

**3.14 non-interlocking tile** : Generally flat, cross cambered and/or longitudinally cambered tile, which is generally rectangular in shape, with or without a featured front edge.

**3.15 pigment** : Addition, inert, to the ingredients of concrete and intended to provide colour to the concrete.

**3.16 quality control test** : Test performed on samples drawn either from continuous production or from a consignment of finished products, to establish whether a batch of products conforms to this standard.

**3.17 ridge** : The horizontal junction between two roof slopes at the apex.

**3.18 ridge tile** : The special tile designed to be placed over a ridge of a roof.

**3.19 semi-sheet** : A corrugated sheet roof covering of square shape and side of each 600 mm where corrugations provide strength and drainage.

**3.20 stone chip** : A small piece of broken stone of size normally ranging from 2 mm to 8 mm.

**3.21 tile with an irregular front edge** : Tile (interlocking and non-interlocking) which, by design, has an irregular varying hanging length across the width.

**3.22 tile with a regular front edge** : Tile (interlocking and non-interlocking) which, by design has a constant or regularly varying hanging length across the width.

**3.23 type test** : Test concerned with one or more of the following, the effect of which cannot be anticipated on the basis of previous test results:

- a) the introduction of a new product;
- b) a fundamental change in formulation;
- c) a fundamental change in method of manufacture; and
- d) a change in product design.

**3.24 valley** : The sloping intersection of two inclined roof surfaces that meet at a re-entrant angle.

**3.25 valley tile** : The special tile designed to be placed over a valley of a roof.

**3.26 verge** : The edge of a roof surface at a gable.

## **4 MATERIALS**

### **4.1 Cement**

The cement used in the manufacture of the products shall comply with the requirements of **SLS 107**. Coloured Portland cement may be used provided that it complies with the physical test requirements of **SLS 107** and that the pigments used to colour the Portland cement comply with **4.4**.

## 4.2 Water

Water shall be clean and free of suspended external matters or impurities liable to have a deleterious effect on concrete. Water used, during both mixing and curing, shall conform to the requirements of **SLS 522**.

## 4.3 Aggregate

The aggregate shall be clean and shall be siliceous sand, crushed stone or a combination of them.

Sand shall be sieved through 2 mm mesh to remove any organic matter such as roots and leaves. Clay or silt content of sand shall not exceed 4 per cent as it causes shrinkage and porosity problems in the tile. Sand with angular particles is preferable than rounded particles. Where good quality quarry dust is available, sand can be partially or fully replaced by quarry dust.

Stones should range in size from 2 mm to 4 mm for 6 mm thick tiles, or 2 mm to 5 mm for 8 mm thick tiles or 2 mm to 7 mm for 10 mm thick tiles. Quarry stone chips are usually a good source of stones needed. Maximum stone size should not exceed two thirds of the thickness of the product.

If blended aggregate is to be used rather than nominally mixed sand and stones, suitable gradings are given in Table 1. If other gradings are to be used, the manufacturer should ensure their suitability before using such aggregate.

**TABLE 1 - Suitable grading of aggregate**

Aggregate size (1)	Product thickness		
	6 mm (2)	8 mm (3)	10 mm (4)
Maximum grain size	4 mm	5 mm	7 mm
Component above 2 mm	0 - 10 per cent	30 - 50 per cent	35 - 55 per cent
Component 0.5 - 2 mm	20 - 50 per cent	10 - 55 per cent	10 - 50 per cent
Component below 0.5 mm	15 - 45 per cent	15 - 45 per cent	15 - 40 per cent

Since certain types of stone having all the above characteristics may be unsuitable as aggregate for concrete roofing products, the manufacturers shall ensure their suitability before using such aggregates.

Different sized aggregates shall be thoroughly screened to pass through relevant test sieve sizes complying with **BS 410**.

#### **4.4 Pigments**

The pigments used shall comply with the requirements of **BS 1014**.

#### **4.5 Admixtures**

The admixtures used shall comply with the requirements of **SLS 1144**.

#### **4.6 Concrete.**

The concrete used in the manufacture of roofing products shall be formed by mixing cement, aggregate and water and produced by the hardening of the cement paste (cement and water). Besides the basic components, the concrete may also contain pigments, admixtures and/or additions.

The mix proportion shall not be leaner than 1 cement : 1 sand : 2 stones (chips) by volume. In general sand used should contain more small particles, in order to give a smooth appearance to the tile, although some large particles are permissible. Presence of more larger particles will make the mix coarse and difficult to work with and in such instances the mix can be changed to 1 cement : 1 ½ sand : 1 ½ stone chips, or 1 cement : 2 sand : 1 stone chips. When quarry dust is used, mix can be changed as follows, 1 cement : 1 sand : 1 quarry dust : 1 stone chips; 1 cement : ¾ sand : ¼ quarry dust : 2 stone chips. Use of a high cement content may lead to shrinkage cracking and higher cost. Lower cement content may lead to inadequate strength and uneven surface with holes.

Water/cement ratio shall not exceed 0.65 and shall be just sufficient to achieve the required workability during casting. Water/cement ratio can be approximately considered to be satisfactory if water does not flow along the fingers when the concrete mix is squeezed on the palm of the hand and the mix remains as a lump without disintegrating when placed on a flat surface thereafter.

Pigments (if any) shall be within 3 to 5 per cent of the cement content (by weight) used in the concrete mix.

### **5 MANUFACTURE**

All concrete roofing products pass through the stages of measuring mix constituents, mixing, moulding, compaction, setting, demoulding and curing. The use of vibration, to ensure compaction of the mortar and expulsion of air bubbles, permits a relatively lean mix, lower water/cement ratio, and a thin product leading to most economic use of resources, especially cement.

Currently used manufacturing process is given in Appendix **B**.

## 6 REQUIREMENTS

### 6.1 Concrete Semi-sheets

#### 6.1.1 *Hanging length and squareness*

The semi-sheet hanging length shall be 550 mm. The value of  $l_1$  (hanging length of semi sheet as defined in 4.2 of **SLS 1189 : Part 2 : 1999**) shall be  $550 \pm 4$  mm when tested according to 4.2 of **SLS: 1189 : Part 2 : 1999**.

The squareness of a semi-sheet, when tested according to 4.2 of **SLS 1189 : Part 2 : 1999**, shall be calculated as the difference between values  $l_2$  and  $l_3$  (hanging edge length, as defined in 4.2 of **SLS 1189 : Part 2 : 1999**;) and shall be not greater than 4 mm.

#### 6.1.2 *Covered width*

Covered width of the semi-sheet shall be 500 mm.

When semi sheets are tested according to 4.3 of **SLS 1189 : Part 2 : 1999**, the average covered width shall be  $500 \pm 3$  mm.

#### 6.1.3 *Flatness*

When semi-sheets are tested according to 4.4 of **SLS 1189 : Part 2 : 1999**, the gap between any desired contact point and the flat surface shall not exceed 3 mm.

#### 6.1.4 *Mass*

The mass of a semi-sheet shall be 9.5 kg.

When semi-sheets are tested according to 4.5 of **SLS 1189 : Part 2 : 1999**, the mass shall be  $9.5 \pm 0.95$  kg.

#### 6.1.5 *Transverse strength*

When semi-sheets are tested in accordance with 4.6 of **SLS 1189 : Part 2 : 1999**, the value of  $F_c$  (characteristics transverse strength of semi-sheets) shall not be less than 550 N. Alternatively, the number of individual semi-sheets with transverse strength values less than 550 N, shall be not more than the appropriate acceptance value in Table 2.

### 6.1.6 Impermeability

When semi-sheets are tested in accordance with 4.7 of **SLS 1189 : Part 2 : 1999**, the underside of the semi-sheets may show drops of water but no drops shall fall before the completion of the test (20 h).

**TABLE 2 - Sampling plan 1.**

Test	Type tests	Certification of a consignment of finished products		Quality disputes
		Consignment quantity 2000 to 50 000	Greater than 50 000	
(1)	Sample size (2)	(3)	(4)	(5)
1. Hanging length & squareness	3	3	5	3
2. Covered width	10	10	10	10
3. Flatness	3	3	5	3
4. Mass	3	3	5	3
5. Transverse strength	5	3	5	3
6. Impermeability	3	3	5	3
7. Nib support	3	N/A	N/A	3
8. General characteristics	5	3	5	3
9. Shape of overlapping ends	5	N/A	N/A	3
10. Pore and crack test	5	3	5	3
11. Ring test	5	3	5	3
12. Water absorption	5	N/A	N/A	3
13. Thickness	3	3	5	3

N/A - Not applicable

### 6.1.7 Nib support

Semi-sheets shall be tested in accordance with 4.8 of **SLS 1189 : Part 2 : 1999**, the semi-sheet nibs shall support the semi-sheet in the test position such that semi-sheet does not fall.

### 6.1.8 General characteristics

Semi-sheets and fittings shall be true to shape and shall be free from all objectionable excrescences and depressions, and, in fracture, the interior of the product shall show an uniform structure.

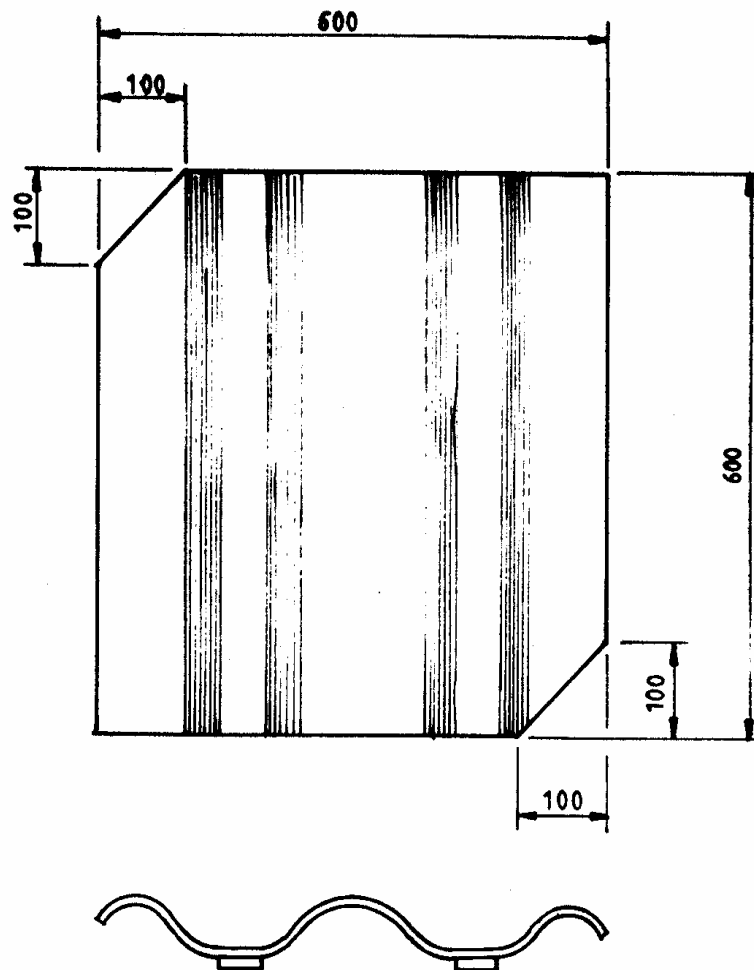
The exposed surface of the semi-sheets and fittings should have a structure which gives a harmonious appearance to the finished roof. However, slight colour variations that may occur as a consequence of the production process can be ignored.

Superficial, non-continuous cracks on the unexposed surfaces of the semi-sheet or fitting, which are the result of the method of production, and scratches and abrasions caused by packing,

loading and transport, are permissible provided they do not prejudice the other quality requirements.

Under the influence of natural weathering, changes in colour and appearance will occur which can be ignored. The semi-sheets and fittings may show slight efflorescence, which is permissible provided other quality requirements are satisfied.

A semi-sheet or fitting that does not satisfy the above criteria is deemed to have failed this requirement.



Dimensions in millimetres

**FIGURE 1 - Micro concrete roofing semi-sheets**

### **6.1.9** *Shape of overlapping ends.*

Semi-sheets shall be tested in accordance with **4.9** of **SLS 1189 : Part 2 : 1999**.

Maximum deviation of the right hand edge, left hand edge or bottom edge of the tested semi-sheet shall not exceed 3 mm.

### **6.1.10** *Pore and crack test*

When a semi-sheet is tested in accordance with **4.10** of **SLS 1189 : Part 2 : 1999**, to satisfy this requirement, it should not be rejected. A semi-sheet is rejected if it has one or more of the following defects:

- i) Surface pores deeper than 2 mm;
- ii) Surface pores with a diameter greater than 5 mm;
- iii) More than six surface pores with a diameter greater than 2 mm; and
- iv) Visible cracks longer than 5 mm.

### **6.1.11** *Ring test*

When a semi-sheet is tested in accordance with **4.11** of **SLS 1189 : Part 2 : 1999**, to pass this test, a clear ring sound shall be produced by the semi-sheet.

### **6.1.12** *Water absorption*

When a semi-sheet is tested in accordance with **4.12** of **SLS 1189 : Part 2 : 1999**, percentage of water absorption shall not be more than 10 per cent.

### **6.1.13** *Thickness*

When a semi-sheet is tested in accordance with **4.13** of **SLS 1189 : Part 2: 1999**, average thickness shall be within 8 and 12 mm.

## **6.2** **Concrete roof tiles**

### **6.2.1** *Hanging length and squareness*

The hanging length of the concrete roof tile shall be 450 mm. The value of  $l_1$  (hanging length of a roof tile as defined in **4.2** of **SLS 1189 : Part 2 : 1999**) shall be  $450 \pm 4$  when tested in accordance with **4.2** of **SLS 1189 : Part 2 : 1999**



The squareness of the concrete roof tile, when tested in accordance with **4.2** of **SLS 1189 : Part 2 : 1999** shall be calculated as the difference between value  $l_2$  and  $l_3$  (hanging edge length, as defined in **4.2** of **SLS 1189 : Part 2 : 1999**) and shall be not greater than 4 mm.

### **6.2.2** *Covered width*

Covered width of a concrete roof tile shall be 150 mm.

When concrete roof tiles are tested in accordance with **4.3** of **SLS 1189: Part 2 : 1999**, the average covered width shall be  $150 \pm 3$  mm.

### **6.2.3** *Flatness*

When the concrete roof tiles are tested in accordance with **4.4** of **SLS 1189 : Part 2 : 1999**, the gap between any desired contact point and the flat surface shall not exceed 3 mm.

### **6.2.4** *Mass*

The mass of a concrete roof tile shall be 2.15 kg. When concrete roof tiles are tested according to **4.5** of **SLS 1189 : Part 2 : 1999**, the average mass shall be  $2.15 \pm 0.22$  kg.

### **6.2.5** *Transverse strength*

When concrete roof tiles are tested in accordance with **4.6** of **SLS 1189 : Part 2 : 1999**, the value of  $F_c$  (characteristic transverse strength of concrete roof tiles) shall not be less than 230 N.

Alternatively, the number of individual concrete roof tiles with transverse strength values less than 230 N, shall be not more than the appropriate acceptance value in Table 2.

### **6.2.6** *Impermeability*

When concrete roof tiles are tested in accordance with **4.7** of **SLS 1189 : Part 2 : 1999**, the underside of the concrete roof tile may show drops of water but no drops shall fall before the completion of the test (20 h).

### **6.2.7** *Nib support*

The concrete roof tiles shall be tested in accordance with **4.8** of **SLS 1189 : Part 2 : 1999**. The concrete roof tile nibs shall support the tile in the test position, such that tile does not fall.

### **6.2.8** *General characteristics*

Concrete roof tiles and fittings shall be true to shape and shall be free from all objectionable excresecnces and depressions, and, on fracture, the interior of the product shall show an uniform structure.

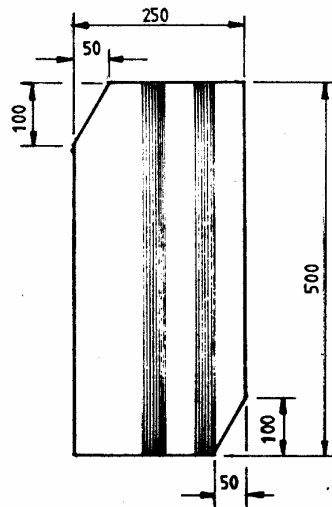
The exposed surface of the concrete roof tiles and fittings should have a structure which gives a harmonious appearance to the finished roof. However, slight colour variations that may occur as a consequence of the production process can be ignored.

Superficial, non continuous cracks on the roof tiles or fittings, which are the result of the method of production, and scratches and abrasions caused by packing, loading and transport, are permissible provided they do not prejudice the other quality requirements.

Under the influence of natural weathering, changes in colour and appearance will occur which can be ignored.

The concrete roof tiles and fittings may show slight efflorescence, which is permissible provided other quality requirements are satisfied.

The concrete roof tile or fitting that does not satisfy the above criteria is deemed to have failed this requirement.



Dimensions in millimetres

**FIGURE 2 - Micro concrete roofing tile**

### **6.2.9** *Shape of overlapping ends*

The concrete roof tiles shall be tested in accordance with **4.9** of **SLS 1189 : Part 2 : 1999**. Maximum deviation of the right hand edge, left hand edge or bottom edge of the tested tile shall not exceed 3 mm.

### **6.2.10** *Pore and crack test*

When a concrete roof tile is tested in accordance with **4.10** of **SLS 1189 : Part 2 : 1999**, to satisfy this requirement, it should not be rejected. A concrete roof tile is rejected if it has one or more of the following defects:

- i) Surface pores deeper than 2 mm;
- ii) Surface pores with a diameter greater than 5 mm;
- iii) More than three surface pores with a diameter greater than 2 mm; and
- iv) Visible cracks longer than 5 mm.

### **6.2.11** *Ring test*

When a concrete roof tile is tested in accordance with **4.11** of **SLS 1189 : Part 2 : 1999**, to pass this test, a clear ring sound shall be produced by the concrete roof tile.

### **6.2.12** *Water absorption*

When a concrete roof tile is tested in accordance with **4.12** of **SLS 1189 : Part 2 : 1999**, percentage of water absorption shall not be more than 10 per cent.

### **6.2.13** *Thickness*

When a concrete roof tile is tested in accordance with **4.13** of **SLS 1189 : Part 2 : 1999**, average thickness shall be within 6 mm and 9 mm.

## **7 SAMPLING AND COMPLIANCE**

### **7.1 Sampling**

#### **7.1.1 Sampling for type tests**

Semi-sheets, concrete roof tiles and valley tiles shall be sampled in accordance with sampling plan 1 (see Table 2) and Appendix A.

**7.1.2 Sampling for certification of a consignment of finished products.**

The sampling shall be in accordance with sampling plan 1 (see Table 2) and Appendix A. If the results of tests undertaken on the first sample are inconclusive, a second sample shall be taken in accordance with sampling plan 2 (see Table 3) and Appendix A.

**7.1.3 Sampling for resolution of quality disputes**

Sampling plan 1 (see Table 2) gives the sample size appropriate to the tests to be undertaken. In the event that tests on the first semi-sheets or tiles sample selected in compliance with Appendix A, do not resolve the dispute, a second sample shall be taken in accordance with sampling plan 2 (see Table 3) and Appendix A. Tests shall only be undertaken on those properties that are in dispute.

**TABLE 3 Sampling plan 2**

Batch	Sample size	Acceptance (maximum number of failures)
(1)	(2)	(3)
< 151	3	0
151 to 3200	13	1
3201 to 35 000	20	2
35 001 to 50 000	32	3
50 001 <	32	5

**NOTES**

1. *Ten semi-sheets or concrete roof tiles are required for the covered width test. Hence for the covered width test, sample size should be increased to 10 for a batch less than 151.*
2. *To use this table, batch size shall be identified and the appropriate sample size taken.*
3. *Each of the semi-sheets, concrete roof tiles or valley tiles is in the sample tested, and if the number of failures in the sample is not more than the number given in the acceptance column, then the batch complies with the requirements. /*
4. *For transverse strength test, a value given in 6.1.5 or 6.2.5, as appropriate, shall be used as the acceptance level. The individual transverse strength test results,  $F_i$  shall be compared with this value. Determine the number of semi-sheets or concrete roof tiles with transverse strength results less than this value. If this number of semi-sheets or concrete roof tiles is not more than the number in the acceptance column of this table, the batch complies with the requirements.*

## 7.2 Compliance

### 7.2.1 Type testing

The list of type tests is given in Table 4.

Semi-sheets, concrete roof tiles and valley tiles comply with this standard when all of those sampled fulfil the requirements of this standard.

### 7.2.2 Certification of a consignment of finished products and quality disputes.

The list of quality tests applicable, is given in Table 4.

Semi-sheets, concrete roof tiles and valley tiles comply with this standard when the sample fulfil the requirements of this standard. However, when sampling plan 2 (see Table 3) is used, specified acceptance value (see Table 3) will define compliance with this standard.

**TABLE 4 - Type tests and quality control tests**

Test	Subclause reference (this part of the standard)	Test method (SLS 1189 ; Part 2 : 1999) subclause reference	Type control tests	Quality control tests
(1)	(2)	(3)	(4)	(5)
1. Hanging length and squareness	6.1.1 & 6.2.1	4.2	+	+
2. Covered width	6.1.2 & 6.2.2	4.3	+	+
3 Flatness	6.1.3 & 6.2.3	4.4	+	+
4. Mass	6.1.4 & 6.2.4	4.5	+	+
5. Transverse strength	6.1.5 & 6.2.5	4.6	+	+
6. Impermeability	6.1.6 & 6.2.6	4.7	+	+
7. Nib support	6.1.7 & 6.2.7	4.8	+	-
8. General characteristics	6.1.8 & 6.2.8	--	+	+
9. Shape of overlapping ends	6.1.9 & 6.2.9	4.9	+	-
10. Pore and crack test	6.1.10 & 6.2.10	4.10	+	+
11. Ring test	6.1.11 & 6.2.11	4.11	+	+
12. Water absorption	6.1.12 & 6.2.12	4.12	+	-
13. Thickness	6.1.13 & 6.2.13	4.13	+	+
+ To be tested				
- Not to be tested				

## **8 MARKING**

### **8.1 Products**

Concrete roofing semi-sheets or concrete roof tiles complying with this Standard shall be marked with the name of the manufacturer or trade mark or other equivalent means of identification. Fittings given as examples in **3.9** shall be similarly marked.

### **8.2 Documents**

The following particulars shall be indicated clearly on the delivery note or invoice or supplier's certificate, supplied with the consignment of concrete semi-sheets, concrete roof tiles or fittings:

- a) the name or trade mark or other means of identification of the manufacturer;
- b) batch number; and
- c) date of casting concrete.

## **9 INDEPENDENT TESTS**

If the purchaser or his representative requires independent tests, the samples shall be taken before or immediately after delivery at the option of the purchaser or his representative. The tests shall be carried out in accordance with this standard on the written instructions of the purchaser or his representative.

Unless otherwise specified at the time of inquiry and order, the cost of tests shall be borne by the manufacturer, in the event of results showing that the semi-sheets, concrete roof tiles or fittings do not comply with the standard, and by the purchaser, in the event of the results showing that the semi-sheets concrete roof tiles or fittings comply with the standard.

## **APPENDIX A SAMPLING PROCEDURE**

### **A.1 Sampling from the roof or unpacked consignment**

The sampling method shall be such that every semi-sheet, roof tile or fitting in the consignment has an equal chance of being selected for the sample. Select the appropriate number of semi-sheets, roof tiles or fittings at random from positions throughout the consignment without any consideration being given to the condition or quality of the selected semi-sheets, roof tiles or fittings.

### **A.2 Sampling from stacks**

When sampling in accordance with **A.1** is impractical or not convenient, e.g. when the semi-sheets, roof tiles or fittings form a large stack or a stack with ready access to only a limited number of locations, the procedure described below shall be used.

Divide the stack of semi-sheets, roof tiles or fittings into real or imaginary sections, each of similar size. Select an equal number from different parts of each section in order to give the required number of samples without any consideration being given to the condition or quality of the selected product.

#### **NOTE**

*It may be necessary to remove some sections of the stack in order to gain access to the products within the body of the stack.*

### **A.3 Dividing the sample**

When the sample is to provide semi-sheets, roof tiles or fittings for more than one test, the total number shall be collected together and then divided by taking products from different parts of the total sample.

## APPENDIX B DETAILS OF MANUFACTURE

### B.1 Concrete Semi-sheets

Currently used manufacturing process of a concrete semi-sheet can be summarised as follows:

- 1) Use the batching boxes to measure the correct proportions of cement, sand, stone chips and quarry dust (if any);
- 2) Mix on a clean cement floor. Spread the larger aggregate particles first, then the next sizes progressively with the cement layer placed last. Mix thoroughly by heaping into a cone and flattening till uniform colour. Make a central hole and pour water into it. Shovel the mortar mix from the periphery to the central hole, preventing water leakages on to the floor. Mix thoroughly by heaping into a cone and flattening till uniform colour. Alternatively, the concrete mix can be prepared in a standard concrete mixer by feeding the dry materials first, mixing, feeding water and again mixing till uniform colour;
- 3) Clean the table surface and frame, free of mortar. Place the plastic interface sheet in position (Figure **3a**). Close the frame and tighten the four clips. Ensure that interface sheet is free of holes;
- 4) Take the specified number of scoops (Figure **3b**) of the mix required for one semi-sheet. Place this mortar on interface sheet. Scoops are discharged apart (Figure **3c**) to aid in screeding. Wet mix should be used within 60 minutes of its preparation;
- 5) Switch the vibrator on and screed the mortar layer smooth and flat, spreading mortar well into the corners (Figure **3d**). Stop vibration when scum appears on the mortar surface, after air bubbles are driven out. Overvibration will lead to segregation of the mix which in turn will lower the quality of the semi-sheet;
- 6) Fill the nib boxes and switch the vibrator on again briefly while levelling. Run trowel round the frame to clear off any surplus mortar (Figure **3e**);
- 7) Incline the table (Figure **3f**) and raise the screeding frame (Figure **3g**), leaving the screed on the interface sheet. Rest the frame on the pivot bar.
- 8) Place the mould on the traversing frame (Figure **3h**). Push the mould under table until rubber lining mat leads on to the mould (Figure **3i**). Pull interface sheet and screed slowly down on to the mould, lining up the edge of screed accurately with the front edge of the leading trough of the mould (Figure **3j**);
- 9) Place thumbs firmly on the interface sheet (Figure **3k**) to hold it down onto the mould, and with the fingers hold onto the traversing frame. While holding firmly, full mould (Figure **3l**) and traversing frame quickly until screed is clear of the table (Figure **3m**);



- 10) Use the screed checking guage (Figure **3n**) to adjust the semi-sheet into the correct position on the mould. The edges of the semi-sheet should be parallel to the sides of the screed checking guage. If hair cracks appearing on the top surface, lightly brush over cracks to remove them;
- 11) Lift the mould and put onto stack (Figure **3p**) where it will remain for 24 hours. The top sheet must always be covered by an empty mould or a plastic sheet to maintain humidity;
- 12) Keep the demoulding tool over the mould. Holding the mould and demoulding tool together, roll the two over so that mould comes onto the top. Remove the mould and clean it. Peel off the interface sheet sideways to avoid creasing. Clean the interface sheet. Any rough edges on the semi-sheet is trimmed off using a blunt knife or scraper;
- 13) Transfer the semi-sheet into a curing tank so that it is fully immersed in water. Generally semi-sheets should be cured for 7 days making sure curing water is drained monthly to stop it becoming caustic;

Alternatively, curing can be done in an air-tight space with very humid atmosphere. A tank with a concrete base slab and masonry walls, covered on top with a fairly water-tight material like tarpaulin, plastic or steel sheet may be used. Tiles should be placed over a layer of stone packing with the water level maintain just below the bottom of the tiles. Generally semi-sheets should be cured for 7 days. If production is to be expedited, steam curing can be used.

- 14) Cure the semi-sheet for a further two weeks under air curing before it is used in a roof; and
- 15) Alternatively, other manufacturing methods using advanced technology such as hydraulic presses are permitted provided the semi-sheet meets the requirements in Clause **6**.

## **B.2 Concrete Roofing Tiles**

Manufacturing process of a concrete roofing tile is similar to that of a concrete semi-sheet as described in **B.1**, except that moulding table, mould and other accessories are of a different size.

# How to Make a Semi-sheet

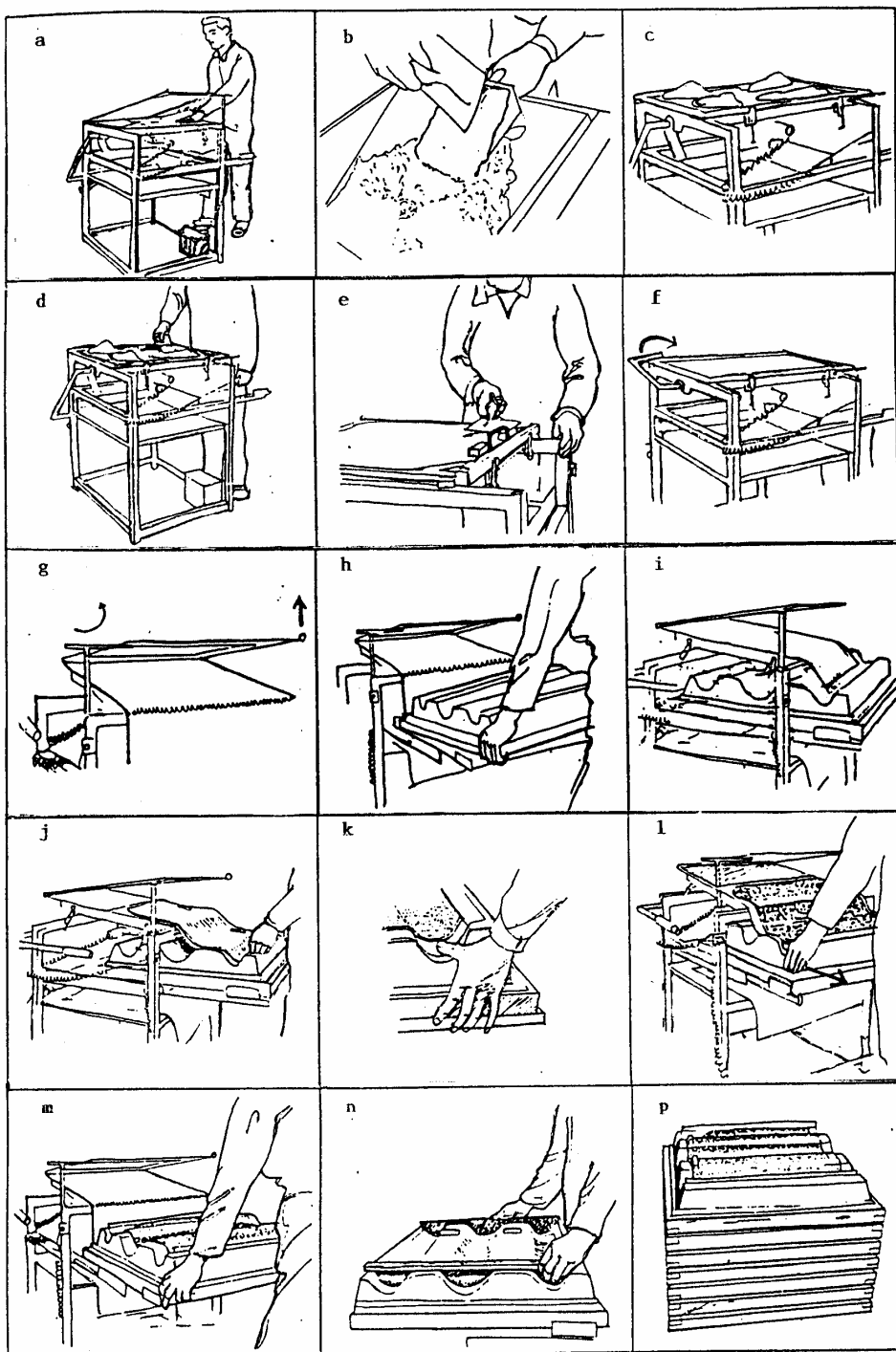


FIGURE 3 -

How to make a semi-sheet

## APPENDIX C USAGE

For fixing concrete roofing tiles or semi-sheets, pitch of the roof shall be not less than 20 degrees.

Double pitched or mono-pitched roof arrangements are preferred over hipped roofs. Minimum size of timber battens are given in Table 5.

**TABLE 5 - Minimum sizes of timber battens**

Rafter spacing (mm) (1)	Batten size mm (2)
Up to 600	50 x 25
600 - 900	75 x 38
900 - 1200	75 x 50

Batten spacing shall be 500 mm. Distance of top batten from ridge shall be 50 mm, while spacing of bottom 2 battens shall be 330 mm. (430 mm for semi-sheets ) to allow tile or semi-sheet to project outside the roof structure to discharge rain-water to the gutters.

Battens should be fixed from top using a template to keep batten spacing at 500 mm. Each batten should be levelled with a spirit level.

Lay a complete row of tiles or semi-sheets from left to right across the roof. Use this row to sort out the overhang on each side so that it is roughly even. The overhang will normally be one or two tile widths. Take out this row leaving just the starting tile or semi-sheet.

In the case of tiles, having determined the starting point fix a timber section 50 x 38 mm up the roof at right angles to the battens. The tiles should be placed so that their edges correspond to the edge of the timber section to prevent rocking of the tile. Nail the timber section to each and every one of the tile battens.

Tiles or semi-sheets are laid from the bottom left hand corner, doing a complete column up the roof at a time. Hook the tile or semi-sheet nib over the batten and pull the tile or semi-sheet down so that there is no gap.

Ensure that the overlap on one tile or semi-sheet completely covers the mitred corner of the preceding one.

If possible lay a “dry ridge” special tile at the top of the row next to the ridge.

When laying tiles or semi-sheets, it is easiest to have one person on the ground who will eye up each column of tiles or semi-sheets to see if they are straight. This person can then shout out instructions as to how to adjust the position of the tile or semi-sheet. After each column has been laid it should be checked by eye.

Every third column should be checked by running a piece of string from the top tile or semi-sheet to the bottom. Any tiles or semi sheets which are out of line should be adjusted. String should be at right angles to the battens.

When laying the second side of the roof, ridge tile should be laid as the work proceeds.

The last few columns of tiles or semi-sheets will need to be laid from the gable end, and scaffolding or good ladders should be used.

Lay the template over the joint between two ridge tiles. Fill the gap with mortar (1 cement : 3 sand) and smoothen the surface to level with the template. The template can be removed immediately.

Tile or semi-sheet can be cut by a tungsten carbide blade fixed to a 300 mm hack-saw. Alternatively, a pair of carpenter’s pincers can be used to carefully break off small pieces of the tile or semi-sheet.

Operatives should not walk on tiles or semi-sheets at any stage, and a roof ladder should be used.

If the tiles or semi-sheets are laid properly, following can be observed:

- a) No light should show between tiles or semi-sheets;
- b) The exterior of the roof should be even with no tile edges sticking up; and
- c) All rows shall be straight and at right angles to the battens.

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