MALAYSIAN STANDARD

MS 145:2014

**Steel fabric for the reinforcement of concrete
- Specification
(Fourth revision)**

ICS: 77.140.15

Descriptors: steel fabric, reinforcement of concrete, requirement, dimension, quality, testing

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Association of Consulting Engineers Malaysia
Association of Marine Industries of Malaysia
Construction Industry Development Board Malaysia
Department of Standards Malaysia
Federation of Malaysian Manufacturers
IKRAM QA Services Sdn Bhd
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The Technical Committee on Steel Bars, Wire Rods and Wire Products which developed this Malaysian Standard consists of representatives from the following organisations:

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Construction Industry Development Board Malaysia
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Southern Steel Berhad
Southern Steel Mesh Sdn Bhd

Foreword

This Malaysian Standard was developed by the Technical Committee on Steel Bars, Wire Rods and Wire Products under the authority of the Industry Standards Committee on Metallic Materials and Semi-finished Products.

Major modifications in this revision are as follows:

a) the title of this standard has been amended from "Welded steel fabric for the reinforcement of concrete - Specification" to "Steel fabric for the reinforcement of concrete - Specification";

b) all steel fabric conforming to this standard is to be made using ribbed bar in accordance with MS 146:2013 or made from wire in accordance to MS 144:2013 for wrapping fabrics D49 and D98; and

c) to replace the fabric reference in MS 145:2006 with the following in Table A.1:

Fabric reference in MS 145:2006	New fabric reference in this standard
Square mesh	
A13	A664
A12	A565
A11	A475
A10	A393
A9	A318
A8	A252
A7	A193
A6	A142
A5	A98
A4	A63
Rectangular mesh	**Structural mesh**
B13	B1328
B12	B1131
B11	B950
B10	B785
B9	B636
B8	B503
B7	B385
B6	B283
B5	B196
Long mesh	
C13	C1328
C12	C1131
C11	C950
C10	C785
C9	C636
C8	C503
C7	C385
C6	C283
C5	C196

Foreword *(continued)*

Fabric reference in MS 145:2006	New fabric reference in this standard
Small square mesh	Wrapping mesh
D13	D1328
D12	D1131
D11	D950
D10	D785
D9	D636
D8	D503
D7	D385
D6	D283
D5	D196
D4	D126

This standard has been developed so that it can be used in conjunction with MS EN 10080:2013. Definitions, symbols, steelmaking and manufacturing processes, routine inspection and testing, test methods, identification of the manufacturer and technical class and verification of mechanical properties in the case of dispute are all taken from MS EN 10080:2013.

This Malaysian Standard cancels and replaces MS 145:2006, *Welded steel fabric for the reinforcement of concrete - Specification (Third revision)*.

Compliance with a Malaysian Standard does not of itself confer immunity from legal obligations.

Steel fabric for the reinforcement of concrete - Specification
(Fourth revision)

1 Scope

This Malaysian Standard specifies requirements for sheets of factory-made machine-welded steel fabric for the reinforcement of concrete, manufactured from ribbed bars conforming to MS 146:2013, or manufactured from wire conforming to MS 144:2013 for wrapping fabrics D49 and D98.

NOTE. Where the term "bar" is used in this standard, it includes bar or decoiled product conforming to MS 146:2013. For clarity only, it can also include wire conforming to MS 144:2013 for wrapping fabrics only.

2 Normative references

The following normative references are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the normative reference (including any amendments) applies.

MS 144:2013, *Steel wire for the reinforcement* of concrete *products - Specification*

MS 146:2013, *Steel for the reinforcement of concrete - Weldable reinforcing steel - Bar,* coil *and decoiled product - Specification*

MS ISO 15630-1, *Steel for the reinforcement and prestressing of concrete - Test* methods - *Part 1: Reinforcing bars, wire rod and wires*

MS ISO 15630-2, *Steel for the reinforcement and prestressing of concrete - Test methods - Part 2: Welded fabric*

MS EN 10080:2013, *Steel for the reinforcement of concrete - Weldable reinforcing steel - General*

BS 8666, *Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete - Specification*

3 Terms and definitions

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

3.1 batch

Quantity of welded fabric of one type produced by one manufacturer and presented for examination at any one time.

3.2 bundle

Two or more sheets of fabric bound together.

3.3   characteristic value

Value of a material or product having a prescribed probability of not being attained in a hypothetical unlimited test series.

3.4   factory production control

Permanent internal control of production performed by the manufacturer.

3.5   length of a welded fabric sheet

Longest side of a sheet of welded fabric, irrespective of the manufacturing direction.

3.6   longitudinal bar

Reinforcing steel in the manufacturing direction of the welded fabric.

3.7   maximum value

Value which no test result is exceed.

3.8   minimum value

Value below which no test result is fall.

3.9   nominal diameter

Diameter of a circle with an area equal to the nominal cross-sectional area of the bar.

3.10   overhang of welded fabric

Length of longitudinal or transverse bars projecting beyond the centre of the outer crossing bar in a sheet of welded fabric.

3.11   pitch of welded fabric

Centre-to-centre distance of bars in a sheet of welded fabric.

3.12   purpose made welded fabric

Welded fabric manufactured according to user's specific requirements.

3.13   special property

Property which is not determined as part of the factory production control requirements for every test unit.

3.14   standard property

Property which is part of the routine inspection and test requirements for every test unit.

2

3.15   standard welded fabric

Welded fabric reinforcement where the bar and mesh arrangement can be defined by an identifiable fabric reference.

3.16   transverse bar

Reinforcing steel perpendicular to the manufacturing direction of the welded fabric.

3.17   welded fabric

Arrangement of longitudinal and transverse bars of the same or different nominal diameter and length that are arranged substantially at right angles to each other and factory electrical resistance welded together by automatic machines at all points of intersection.

3.18   width of a welded fabric sheet

Shortest side of a sheet of welded fabric, irrespective of the manufacturing direction.

4   Symbols

For the purposes of this standard, a list of symbols reproduced from MS EN 10080:2013 given in Table 1 apply.

Table 1. List of symbols

Symbol	Description	Unit
A_n	Nominal cross-sectional area	mm^2
A_{gt}	Percentage total elongation at maximum force	%
B	Length of transverse bar in welded fabric	mm
C_v	Specified characteristic value	[a]
d	Nominal diameter of the reinforcing steel	mm
d_c	Diameter of transverse bars in welded fabric	mm
d_L	Diameter of longitudinal bars in welded fabric	mm
k	Coefficient as a function of the number of test results	-
x	Average value of test results	[a]
R_e	Yield strength	MPa
R_{eH}	Upper yield strength	MPa
R_m	Tensile strength	MPa
R_m R_e	Ratio tensile strength/yield strength	-
$R_{p0.2}$	0.2 % proof strength, non proportional extension	MPa
s	Estimate of the standard deviation	[a]
L	Length of longitudinal bar in welded mesh	mm
N_c	Number of transverse bars in welded fabric	-

Table 1. List of symbols *(continued)*

Symbol	Description	Unit
N_L	Number of longitudinal bars in welded fabric	-
P_c	Pitch of transverse bars in welded fabric	mm
P_L	Pitch of longitudinal bass in welded fabric	mm
F_s	Shear force of welded connections in welded fabric	kN
$R_{e,act}$	Actual value of yield strength	MPa
$R_{e,nom}$	Specified value of yield strength	MPa
a_1, a_2, a_3, a_4	Increment (specified in product specification)	a
O_1, O_2	Overhang of the longitudinal bars in welded fabric	mm
O_3, O_4	Overhang of the transverse bar in welded fabric	mm
NOTE. A comparison between the symbols used in this standard and those used in MS EN 1992-1-1:2010 and MS EN 1992-1-1:2010 (NATIONAL ANNEX) is given in Annex C.		
a The unit depends on the property.		

5   Designation

Welded fabric shall be designated with the following information:

a)   designation of the product form (welded fabric);

b)   the number of this standard (i.e. MS 145:2013);

c)   the nominal dimensions of the product (dimensions of the bars, dimensions of the sheet, pitch of the bars, overhangs) (see Note); and

d)   the grades of the steel(s) to be used to manufacture the welded fabric.

For ordering purposes, the notation specified in BS 8666 shall be used.

NOTE. Brief designations are widely used to describe standard welded fabric (see Annex A).

Purpose made welded fabric may be described using the indications given in Annex A, or by a fully dimensioned drawing (see Figure A.1) and should be identified by the user's reference.

6   Manufacturing processes

All welded fabric shall be factory made and machine welded. The joints, at the intersection of the longitudinal bars and the transverse bars, shall be made by electrical resistance welding to provide a specified shear resistance.

Welded fabric can be composed of a different steel grade in each direction.

7 Product characteristics

7.1 Chemical composition

The chemical composition of the bars shall conform to the requirements of MS 144:2013 and MS 146:2013.

7.2 Mechanical properties of welded fabric

7.2.1 General

The characteristic value is (unless otherwise indicated) the lower or upper limit of the statistical tolerance interval at which there is a 90 % probability ($1 - \alpha = 0.90$) that 95 % ($p = 0.95$) or 90 % ($p = 0.90$) of the values are at or above the lower limit, or at or below the upper limit respectively. This quality level refers to the long-term quality level of production.

7.2.2 Conditions of testing

All test pieces shall be in the aged condition.

Ageing method: heat the test piece to 100 °C, maintain at this temperature (± 10 °C) for a period of $60 \, {}^{+15}_{0}$ min, and then cool in still air to room temperature. The method of heating shall be left to the discretion of the manufacturer.

7.2.3 Tensile properties

The specified values for the tensile properties (R_e, R_m R_e, A_{gt}) shall be the corresponding specified characteristic value with $p = 0.95$ for R_e and $p = 0.90$ for A_{gt} and R_m R_e. Tensile properties (R_e, R_m R_e, A_{gt}) shall comply with the requirements of 8.1.3.1.

Determine R_e and R_m using the nominal cross-sectional area of the product.

For yield strength (R_e) the upper yield strength (R_{eH}) shall apply. Determine the yield strength (R_e) from the 0.2 % proof strength ($R_{p0.2}$) if a yield phenomenon is not present.

NOTE. For wrapping fabrics D49 and D98 minimum yield strength only, in accordance with MS 144:2013, is required.

7.2.4 Shear force of welded joints

The shear force of welded joints in welded fabric shall not be less than $0.25 \times R_e \times A_n$,

where

R_e is the specified characteristic yield strength; and

A_n is the nominal cross-sectional area of the larger bar of the welded joint.

For standard fabrics B1131 and above, and C785 and above, the minimum shear force required shall be calculated using the nominal cross-sectional area of the smaller bar of the welded joint, unless otherwise agreed at the time of enquiry, in which case, the minimum shear force required may be calculated using the nominal cross-sectional area of the larger bar.

7.2.5   Bend performance

Bend performance shall be demonstrated by means of the following rebend test method (from MS ISO 15630-1).

Bend the test pieces through an angle of 90°, around a mandrel with a diameter not exceeding those specified in Table 2, age the test piece and then bend back by at least 20°. The bend test shall be conducted on the thicker bar.

After the test the specimen shall show no sign of fracture or cracks to a person of normal or corrected vision.

Table 2. Mandrel diameter for the rebend test

Nominal diameter, d (mm)	Maximum mandrel diameter
≤ 16	$4d$

7.3   Dimensions, mass and tolerances

7.3.1   The relative diameters of bars in a sheet of fabric shall meet the following requirement:

$$d_{\min} \geq 0.6 d_{\max}$$

where

$d_{\max}$ is the nominal diameter of the thickest bar; and

$d_{\min}$ is the nominal diameter of the crossing bar.

Other requirements may be agreed at the time of enquiry and order.

7.3.2   The cross-sectional area and mass of an individual sheet shall be derived from the specified dimensions of the sheet, the nominal bar sizes and the specified pitches for the bars.

The pitch of longitudinal bars and transverse bars shall not be less than 50 mm.

The permitted deviations for welded fabric are:

a)   length and width: ± 25 mm or ± 0.5 % whichever is the greater;

b)   bar pitch: ± 10 mm or ± 5 % whichever is the greater; and

c)   overhangs: to be agreed at the time of enquiry and order.

7.3.3   Missing bars resulting from test sampling in accordance with this standard shall not be considered a defect.

7.3.4   The number of broken welds shall not exceed 4 % of the total number of cross welded joints in the sheet, nor exceed half the number of cross welded joints along any one bar.

8   Evaluation of conformity

8.1   Routine inspection and testing

8.1.1   General

Reinforcing steels shall be produced under a permanent system of routine inspection and testing, which shall include evaluation of specified properties, as described in 8.1.2 and 8.1.3.

8.1.2   Sampling and testing of finished product

The test unit shall be composed of sheets with the same combination of reinforcing steel grades and diameters produced on the same welding machine of a maximum mass of 50 t.

NOTE. Wherever practicable test samples should be taken from the edge of a sheet where it is likely to be lapped in use.

For verification of properties, samples shall be taken in accordance with Table 3. These samples may be taken according the producer's choice, either from one sheet or from different sheets provided that different bars are tested.

All specified welded fabric dimensions (length, width, pitch, and overhang) shall be measured.

The chemical composition (cast analysis) of the material shall be determined by the steel producer.

Conformance shall be confirmed to the welded fabric manufacturer, which shall include a statement of the chemical composition, if required by the customer.

Table 3. Sampling plan for welded fabric

Property	Number of samples per test unit
R_e	2[a]
R_m R_e	2[a]
A_{gt}	2[a]
Dimensions	1
Shear force	2
Nominal mass[b]	2[a]
Rebend[c]	2[a]
Surface geometry	2[a]

[a] One sample for the longitudinal direction and one for the transverse direction.

[b] This may be measured before welding.

[c] This may be evaluated on constituent bars before welding.

8.1.3   Evaluation of test results

8.1.3.1   Tensile properties

8.1.3.1.1   Where the characteristic value C_v is specified in MS 146:2013 as a lower limit, the results shall be deemed to conform to this standard if either:

a)   all individual values are greater than or equal to the specified characteristic value C_v; or

b) $x \geq C_v + a_1$

where

   a_1 is 10 MPa for R_e, zero for R_m R_e and 0 % for A_{gt}; and

all individual values are greater than or equal to the minimum values given in Table 4.

Table 4. Absolute minimum and maximum values of tensile properties

Performance characteristic	Minimum value			Maximum value		
	B500A	**B500B**	**B500C**	**B500A**	**B500B**	**B500C**
R_e, (MPa)	485	485	485	650	650	650
R_m R_e	1.03[a]	1.06	1.13	N/A	N/A	1.38
A_{gt} (%)	2.0[b]	4.0	6.0	N/A	N/A	N/A

[a] 1.01 for sizes below 8 mm.

[b] 0.8 % for sizes below 8 mm.

8.1.3.1.2   Where the characteristic value C_v is specified in MS 146:2013 as an upper limit (i.e. for R_m R_e of grade B500C), the results shall be deemed to conform to this standard if either:

a)   all individual values of R_m R_e are equal to or lower than the specified upper characteristic value of 1.35; or

b) $x \leq 1.35$ for R_m R_e and all individual values for R_m R_e are equal to or lower than the maximum values given in Table 4.

8.1.3.2   Bendability, shear force, geometry, nominal mass

In the rebend test, all test pieces shall fulfill the requirements of MS 146:2013.

If testing the shear force of the welded joints, all individual values shall fulfill the requirements of 7.2.4.

If testing the surface geometry, the results shall meet the requirements of MS 146:2013.

If testing the nominal mass of the individual bars, no individual value shall be outside the tolerances specified in MS 146:2013.

8.1.3.3 Retests

Test units which do not conform to the requirements specified in 8.1.3.1 and 8.1.3.2 may be retested by selecting two further samples. If both additional test specimens meet the requirements, the batch shall be deemed to conform to this standard. If either of the additional test specimens fails to meet the requirements, the batch shall be deemed not to conform to this standard.

8.1.4 Traceability

Delivered batches shall be identifiable and traceable to the manufacturer and to their production data. The manufacturer shall establish and maintain the records required and shall identify the products and their delivery documentation accordingly.

8.2 Assessment of the long term quality level

8.2.1 Material not covered by a third party product certification scheme

Material not covered by a third party product certification scheme shall be assessed by acceptance tests on each batch (see Annex B).

8.2.2 Material produced under a third party certification scheme

The results of tests on all test units of continuous production shall be collated and statistically evaluated for R_e, Act, and R_m/R_e taking either the number of results corresponding to the preceding six months operation or the last 200 results, whichever is the greater.

8.2.3 Evaluation of the test results of the preceding six months operation

The evaluation shall be carried out per nominal diameter.

The following requirements shall be satisfied for R_e, A_{gt} and R_m R_e:

$$x - ks \geq C_v$$

where

x is the average value;

s is the estimate of the standard deviation of the population;

k is the coefficient listed in Table 5 for R_e, and in Table 6 for A_{gt} and R_m R_e; and

C_v is the specified characteristic value.

The foregoing is based on the assumption that the distribution of a large number of results is normal but this is not a requirement of this standard. However, the following alternative methods maybe used to establish conformity of the production with the requirements of this standard:

a)   graphical methods including control charts; and

b)   non-parametric statistical techniques.

Table 5. R_e coefficient (k) as a function of the number (n) of test results (for a reliable failure rate of 5 % [$p = 0.95$] at a probability of 90 %

n	k	n	k
5	3.40	30	2.08
6	3.09	40	2.01
7	2.89	50	1.97
8	2.75	60	1.93
9	2.65	70	1.90
10	2.57	80	1.89
11	2.50	90	1.87
12	2.45	100	1.86
13	2.40	150	1.82
14	2.36	200	1.79
15	2.33	250	1.78
16	2.30	300	1.77
17	2.27	400	1.75
18	2.25	500	1.74
19	2.23	1 000	1.71
20	2.21	∞	1.64

Table 6. A_{gt} and R_m R_e coefficient (k) as a function of the number (n) of test results (for a reliable failure rate of 10 % [$p = 0.90$] at a probability of 90 %

n	k	n	k
5	2.74	30	1.66
6	2.49	40	1.60
7	2.33	50	1.56
8	2.22	60	1.53
9	2.13	70	1.51
10	2.07	80	1.49
11	2.01	90	1.48
12	1.97	100	1.47
13	1.93	150	1.43
14	1.90	200	1.41
15	1.87	250	1.40
16	1.84	300	1.39
17	1.82	400	1.37
I8	1.80	500	1.36
19	1.78	1 000	1.34
20	1.77	∞	1.28

9 Test methods

For welded fabric, the requirements of MS ISO 15630-2 apply regarding the tensile test, rebend test, the determination of shear force of joints and the methods for chemical analysis. Measurement of the surface geometry and the determination of the relative rib area f_R shall be in accordance with MS ISO 15630-1.

10 Identification of the manufacturer and steel grade

The manufacturer's identification mark applied to the individual bars shall be as described in MS 146:2013 or MS 144:2013.

In addition to the manufacturer's identification marks applied to the individual bars, a label shall be attached to the welded fabric to indicate the manufacturer of the welded fabric and the steel grade(s).

11 Packing and marking

The manufacturer shall ensure that each coil and bundle is securely tied with not less than four binders, and shall attach to every coil or bundle a durable label(s) with the following information:

a) the number of this standard, i.e. MS 145:2013;

b) the grade of fabric;

c) the type of fabric;

d) the name of fabric manufacturer;

e) the dimension of fabric; and

f) number of sheet.

12 Verification of mechanical properties in the case of dispute

12.1 Whenever the determination of a property specified in this standard as a characteristic value creates a dispute, the value shall be verified by selecting and testing three test pieces from various sheets from the batch under examination.

If one test result is less than the specified characteristic value, both the test piece and the test method shall be carefully examined. If there is a local fault in the test piece or reason to believe that an error has occurred in the test, the test results shall be ignored. In this case a further single test shall be carried out.

If the three valid test results are equal or greater than the specified characteristic value the batch shall be deemed to conform to this standard. If not, the requirements of 12.2 shall apply.

12.2 If 12.1 is not fulfilled, 10 additional test pieces shall be selected from different sheets in the batch.

The batch shall be deemed to conform to this standard if the average test result of the 10 test pieces is higher than the characteristic value and the individual values are higher than the minimum and lower than the maximum values given in either MS 146:2013 or this standard as appropriate.
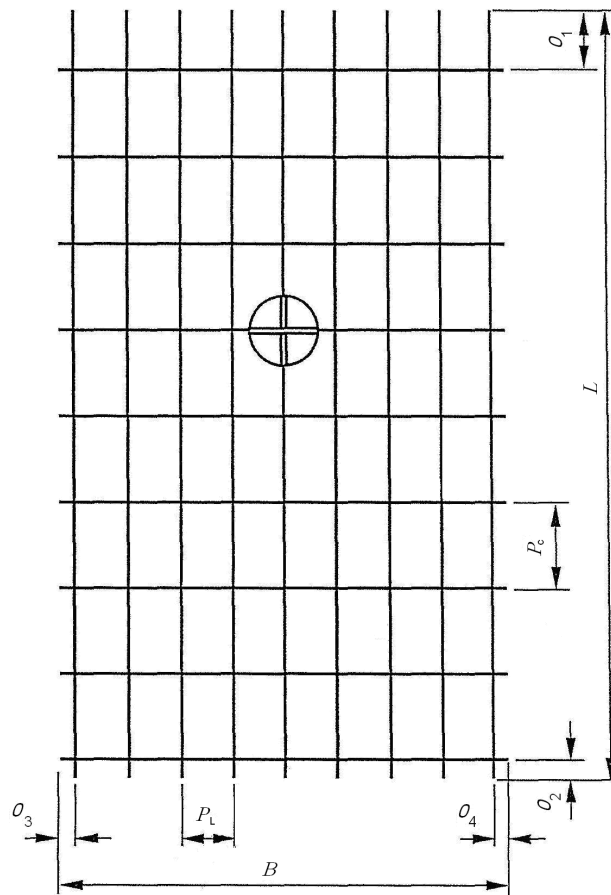
If not, the batch shall be rejected.

Annex A
(informative)

Notation and classification of fabric

A.1 General

Figure A.1 gives an example of notation that should be used for ordering sheets of fabric described and classified as specified in BS 8666.

Key

P_L	Pitch of longitudinal bars	O_1	Overhang of the longitudinal bars
P_c	Pitch of transverse bars	O_2	Overhang of the longitudinal bars
L	Length of longitudinal bar	O_3	Overhang of the transverse bars
B	Length of transverse bar	O_4	Overhang of the transverse bars

Figure A.1. Geometric characteristics of purpose-made welded fabric

A.2 Standard fabric

Standard fabric has defined mesh arrangements and bar sizes and should be specified by designated reference numbers. BS 8666 gives a table of standard fabrics with an alphanumeric reference to define the size and pitch of the longitudinal bars and cross bars. This is reproduced in Table A.1.

Table A.1. Preferred range of designated fabric types and stock sheet size

Fabric reference	Longitudinal bars			Transverse bars			
	Nominal bar size (mm)	Pitch (mm)	Area (mm^2/m)	Nominal bar size (mm)	Pitch (mm)	Area (mm^2/m)	Mass (kg/m^2)
Square mesh							
A664	13	200	664	13	200	664	10.42
A565	12	200	565	12	200	565	8.88
A475	11	200	475	11	200	475	7.46
A393	10	200	393	10	200	393	6.16
A318	9	200	318	9	200	318	4.99
A252	8	200	252	8	200	252	3.95
A193	7	200	193	7	200	193	3.02
A142	6	200	142	6	200	142	2.22
A98	5	200	98	5	200	98	1.54
A63[a]	4	200	63	4	200	63	0.99
Structural mesh							
B1328	13	100	1 328	10	200	252	13.51
B1131	12	100	1 131	8	200	252	10.85
B950	11	100	950	8	200	252	9.44
B785	10	100	785	8	200	252	8.14
B636	9	100	636	8	200	252	6.97
B503	8	100	503	8	200	252	5.93
B385	7	100	385	7	200	193	4.53
B283	6	100	283	7	200	193	3.73
B196	5	100	196	7	200	193	3.05
Long mesh							
C1328	13	100	1 328	8	400	126	11.41
C1131	12	100	1 131	8	400	126	9.87
C950	11	100	950	8	400	126	8.44
C785	10	100	785	6	400	70.8	6.72
C636	9	100	636	6	400	70.8	5.55
C503	8	100	503	6	400	49	4.51
C385	7	100	385	6	400	49	3.58
C283	6	100	283	6	400	49	2.78
C196	5	100	196	5	400	49	1.93

Table A.1. Preferred range of designated fabric types and stock sheet size *(continued)*

Fabric reference	Longitudinal bars			Transverse bars			Mass (kg/m²)
	Nominal bar size (mm)	Pitch (mm)	Area (mm²/m)	Nominal bar size (mm)	Pitch (mm)	Area (mm²/m)	
Wrapping mesh							
D1328	13	100	1 328	13	100	1 328	20.85
D1131	12	100	1 131	12	100	1 131	17.76
D950	11	100	950	11	100	950	14.92
D785	10	100	785	10	100	785	12.32
D636	9	100	636	9	100	636	9.98
D503	8	100	503	8	100	503	7.90
D385	7	100	385	7	100	385	6.04
D283	6	100	283	6	100	283	4.44
D196	5	100	196	5	100	196	3.08
D126[a]	4	100	126	4	100	126	1.97
D98[a]	5	200	98	5	200	98	1.54
D49[a]	2.5	100	49	2.5	100	49	0.77

NOTES:

1. Stock sheet size: length, 6 m; width, 2.2 m; sheet area, 13.2 m².

2. Fabric references as in BS 4483.

[a] Generally use as an anti-crack reinforcement.

A.3 Purpose-made fabric

When the standard form of schedule is used to define more complicated arrangements, involving longitudinal bars of different sizes or irregular spacings in one or both directions, a fully dimensioned diagram should supplement the schedule (see for example Figure A.2).

Title of project: Physics block, Eastford	Drawing No		0	4	6
Name of client: Eastford University	Sheet No	0	3	Revision	B
Name of structural designer: Jim Smith	**Preparation date:** 15.04.04		Status		C
Preparation by: A. Jones	**Date revised** : 16.06.04			
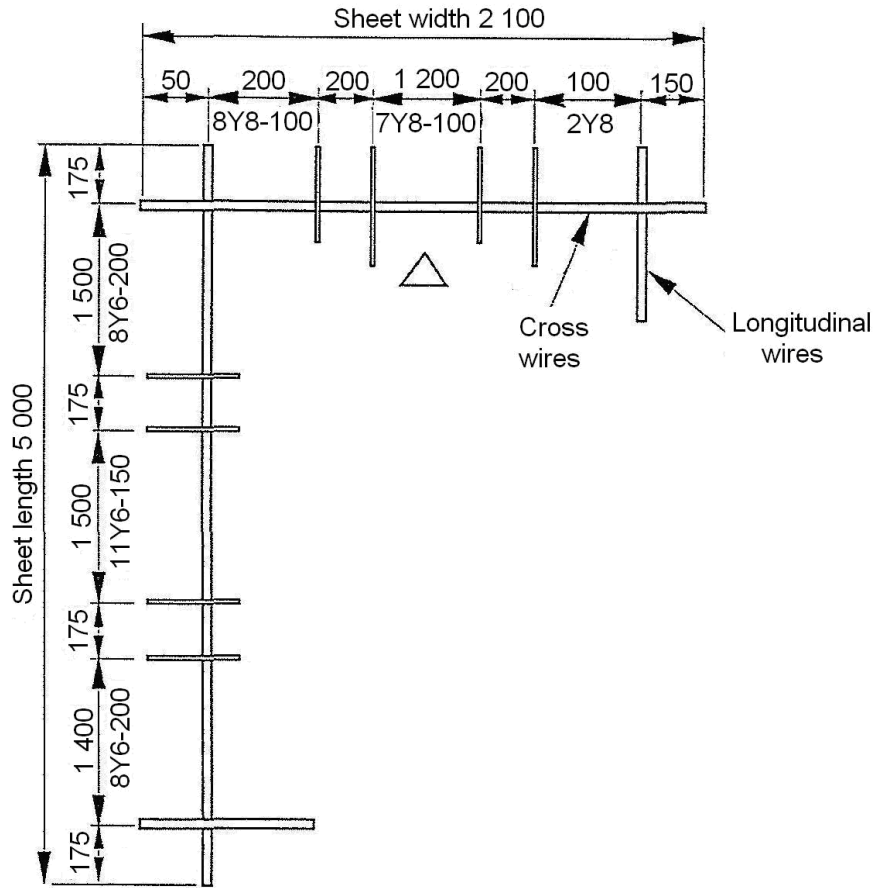
	No. per sheet	Size (mm)	Length (m)	Mass (kg/m)	Mass/sheet (kg)	No. of sheets	Total mass (t)
Longitudinal	12	F8	5 000	0.395	23.700	15	0.355
Cross	27	F6	2 100	0.222	12.587		0.189
Fabric to MS 145:2013		Bending to BS 8666			36.287		0.544

Figure A.2. Purpose-made fabric example

Annex B
(normative)

Material not covered by a third party product certification scheme

B.1 General

Material not covered by a third party product certification scheme shall be assessed by acceptance tests on each batch. Sampling and testing shall be carried out by an independent organisation at the producer's works or in the stockholder's yard.

B.2 Extent of sampling and testing

For testing purposes, the batch shall be divided into test units with a maximum mass of 50 t. Each test unit shall comprise products of the same steel grade (or grades) and type of fabric. The manufacturer shall certify that all products in the test unit originate from the same production batch.

Test specimens shall be taken from each test unit as follows:

a) 20 specimens [or 80 specimens if appropriate, see B.4.1 b)] from different sheets of fabric, for testing in accordance with B.3 a) and B.3 b); and

b) four test specimens, from different fabrics, for testing in accordance with B.3 c).

Preparation of the test specimens shall be carried out as described in 7.2.2.

B.3 Properties to be tested

Specimens selected in accordance with B.2 shall be tested for the following.

a) Inspection by variables:

  i)   yield strength R_e;

  ii) tensile/yield strength ratio, R_m R_e; and

  iii) total elongation at maximum force, A_{gt}.

b) Inspection by attributes:

  i)   behaviour in the rebend test;

  ii) deviations from the nominal cross section;

  iii) rib geometry/bond test; and

  iv) shear force of welded joints.

c)   Chemical composition according to the product analysis.

All elements listed in MS 146:2013 or MS 144:2013, as appropriate, and the carbon equivalent shall be determined.

The test procedures shall be in accordance with Clause 9.

B.4   Evaluation of results

B.4.1   Inspection by variables

Inspection by variables shall be carried out as follows:

a)   The following shall be determined for the performance characteristics listed in B.3 a):

i)   all individual values for each of the performance characteristics;

ii)   the mean value m_{25} for each of the performance characteristics;

iii)   the standard deviation s_{20} for each performance characteristic.

The test unit shall be deemed to conform to this standard if the following conditions are met:

m_{20} - 2.21 x s_{20} ≥ C_v for R_e, and

m_{20} - 1.77 x s_{20} ≥ C_v for R_m R_e and A_{gt}

b)   If the conditions in a) are not fulfilled, a secondary calculation (the acceptability index k) shall be determined, where:

$$k = \frac{m_{20} - C_v}{s_{20}}$$

If k ≥ 2, for R_e, and k ≥ 1.6 for R_m R_e and A_{gt}, testing shall continue. 60 further test specimens shall be taken and tested from different sheets in the test unit, so that a total of 80 test results are available (n = 80).

The test unit shall be deemed to conform to this standard if the following conditions are fulfilled:

m_{80} - 1.89 x s_{80} ≥ C_v for R_e, and

m_{80} - 1.49 x s_{80} ≥ C_v for R_m R_e, and A_{gt}

B.4.2   Inspection by attributes

Either:

a) if the results of tests on the properties listed in B.3 b) conform to the appropriate material standard, i.e. MS 146:2013 or MS 144:2013, for all 20 test specimens, the test unit shall be deemed to conform to this standard; or

b) if a maximum of two of the 20 results do not conform to a), 60 further test specimens shall be taken and tested from different fabrics in the test unit, making 80 test results available; the unit shall be deemed to conform to this standard if no more than two of the 80 test specimens fail the tests.

B.5 Test report

A test report shall be produced containing the following data:

a) the name of the fabric manufacturer;

b) the place of manufacture of the fabric;

c) the type of fabric;

d) the grade of the reinforcing steel;

e) the date of testing;

f) the mass of the test unit;

g) results of tests in accordance with Clause B.3;

h) an official stamp of the inspection authority; and

i) marking on the reinforcing, steel (if appropriate).

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Annex C
(informative)

Comparison of symbols used in this standard with those used in MS EN 1992-1-1:2010 and MS EN 1992-1-1:2010 (NATIONAL ANNEX)

Description	MS 145:2013	MS EN 1992-1-1:2010 and MS EN 1992-1-1:2010 (NATIONAL ANNEX)
Yield strength	R_e	f_y
0.2 % proof strength	$R_{p0.2}$	$f_{p0.2}$
Tensile strength	R_m	f_t
Ratio tensile strength/yield strength	$R_m\ R_e$	$f_t\ f_y$
Percentage total elongation at maximum force	A_{gt}	ε_u
Nominal diameter	d	$\varnothing$

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Bibliography

[1] BS 4483, *Steel fabric for the reinforcement of concrete - Specification*

[2] MS EN 1992-1-1:2010*, Eurocode 2: Design of concrete structures: Part 1-1: General rules and rules for buildings*

[3] MS EN 1992-1-1:2010 (NATIONAL ANNEX)*, Malaysian National Annex to Eurocode 2: Design of concrete structures: Part 1-1: General rules and rules for buildings*

Acknowledgements

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