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Amendment No. 1

SUPERCEDED

British Standard Specification for

Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete

Calcul, dimensionnement, pliage et découpage des armatures en acier de renforcement du béton – Spécifications

Einteilung, Bemessung, Biegen und Zuschneiden von Bewehrung aus Betonstahl

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Foreword

This British Standard has been prepared under the direction of the Iron and Steel Standards Policy Committee and is a revision of BS 4466 : 1981, which is withdrawn.

This British Standard applies to reinforcement complying with BS 4449, BS 4482, BS 4483 and BS 6744.

The purpose of this standard is to ensure uniformity of practice in the scheduling of steel for the reinforcement of concrete. To establish a clear and unambiguous system for scheduling, it is necessary to specify the method of indicating dimensions and the order in which the information is given on the schedule.

A major difference between this edition of BS 4466 and previous editions is that shape codes 60,81,72,73, 74 and 86, which are specified by their internal dimensions, have been deleted and replaced by shape codes 61,82,77 78,79 and 87, which are specified by their external dimensions. Shape code 83 has been deleted.

Product testing and certification. Attention is drawn to the provision in this British Standard of a facility for third party certification of product conformity with this British Standard based on testing and continuous product surveillance coupled with assessment of a supplier's quality systems against BS 5750 : Part 2.

Enquiries as to the availability of third party certification schemes and of competent test laboratories will be forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

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

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Specification

1 Scope

This British Standard specifies requirements for the scheduling, dimensioning, bending and cutting of steel reinforcement complying with BS 4449, BS 4482, BS 4483 and BS 6744.

NOTE, The titles of publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1 bar. A steel product of any cross section complying with BS 4449 or BS 6744.

2.2 wire. A steel product of any cross section complying with BS 4482.

2.3 size. The nominal size of a bar or wire in millimetres.

NOTE. This is given the symbol '*d*'.

2.4 nominal size. The diameter of a circle with an area equal to the effective cross-sectional area of the bar or wire.

2.5 mark number. An identifying number (which also appears on the delivery label) cross-referencing individual line entries on the schedule to the detailed drawing.

2.6 shape code. A two-digit coded definition of the reinforcement shape as given in tables 1 and 2.

2.7 pitch. The centre-to-centre spacing of bars or wires in a sheet of fabric or the longitudinal spacing of turns in a helix.

2.8 mesh. The rectangle defined by the pitch of the longitudinal wires and the pitch of the cross wires in a sheet of fabric.

2.9 fabric. A factory-made product of welded bars or wires complying with BS 4483.

NOTE. There are three categories of fabric as defined in 2.10 to 2.12.

2.10 designated fabric. Fabric reinforcement where the wire and mesh arrangement can be defined by an identifiable fabric reference.

NOTE. The British Standard range of preferred fabrics (see table 1 of BS 4483 : 1985) exemplifies designated fabrics.

2.11 scheduled fabric. Fabric reinforcement with a regular wire and mesh arrangement that can be defined by specifying the size and spacing in each direction using the notation shown in figure 1, which assumes that sheets are always viewed with their cross wires uppermost.

2.12 detailed fabric. Fabric reinforcement not covered by the definitions in 2.10 and 2.11.

NOTE. A dimensioned drawing is required to define the mesh arrangement.

2.13 fabric reference. An alpha numeric code defining the wire sizes and mesh dimensions of a sheet of designated 'fabric.

3 Notations

The type and grade of reinforcement shall be abbreviated using the following letters.

R grade 250 reinforcement complying with BS 4449

T grade 460 type 2 reinforcement complying with BS 4449 or BS 4482

S stainless reinforcement complying with the grade and type selected from BS 6744

W grade 460 plain reinforcement complying with BS 4482

D grade 460 type 1 reinforcement complying with BS 4482

X reinforcement of a type not included in the above list having material properties that are defined in the design or contract specification.

4 Form of schedule

4.1 For bar reinforcement, the form of schedule shown in figure 2 shall used.

NOTE. The schedule should be referred to as a 'bar schedule' since it is customary for the reinforcement fabricator to prepare separate cutting and bending lists for fabrication. The bar schedule is usually completed in sequence of structural units, whereas the cutting and bending lists are usually sorted into type and size of bar.

For cutting and bending purposes, schedules shall be provided on separate sheets of paper of size A4 of BS 4000 and not as part of the detailed reinforcement drawings.

Fabric reinforcement shall be specified on the fabric schedule form shown in figure 3.

When used for detailed fabric, the schedule shall include a cross-reference to the relevant dimensional drawing.

4.2 For schedules that are not produced on a computer, the minimum width of the columns in the bar and fabric schedules shall be as shown in figures 2 and 3.

For computer produced schedules, the column widths and the size of the schedule may vary from those shown in figures 2 and 3, but the sequence of columns shall be maintained. The schedule shall not be significantly larger than size A4 of BS 4000.

4.3 The schedule reference shall appear at the top right-hand corner of the schedule form end shall comprise consecutive numbers, which include a cross-reference to the drawing. Such terms as 'sheet number' or 'page number' shall not be used. The styles '1 (of 6)' and '6 (and last)' may be used on manually prepared schedules but the words in parentheses shall not form part of the schedule reference.

The first three characters of the schedule reference shall be the last three characters of the drawing number, starting at. for example, drawing number 001. The schedule number shall occupy the fourth and fifth spaces, starting at 01 and not exceeding 99 for any one drawing, The sixth space shall be used for schedule revision letters.

Example:

	Drawing	Schedule	Revision
Bar schedule reference	0 4 6	0 3	

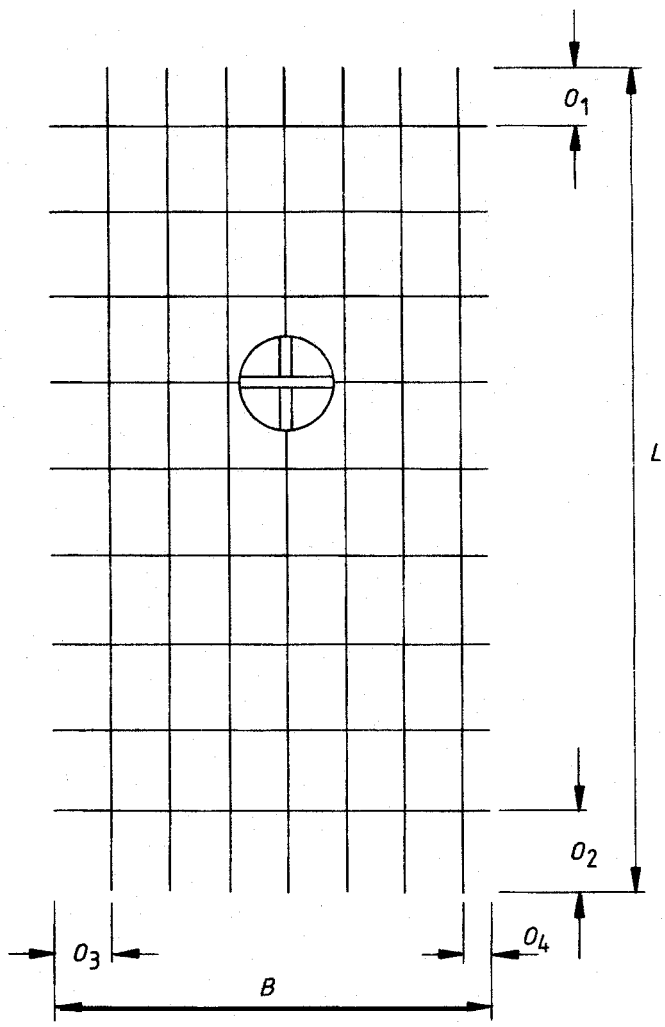
NOTE. Where e schedule revision is necessary, the line or liner affected may be indicated by a suitable reference on the schedule, e.g. 'A' at the right-hand side of the schedule in figure 2.

If a job contains more than 999 drawings it can be broken down into groups by the use of a job number, e.g. job number 1234A foundations and job number 1234B ground floor.

4.4 The bar or fabric schedule shall include the statement 'This schedule complies with BS 4466'.

4.5 The bar or fabric mark shall comprise simple and consecutive numbers or letters with a maximum of six characters. Where special end preparation is required (e.g. for couplers), the bar mark shall commence with 'E'.

4.6 In the 'Type and size' column, the notations specified in clause 3 for the type and grade of bar shall be given and this shall be followed by the nominal size of the bar in millimetres.



Key

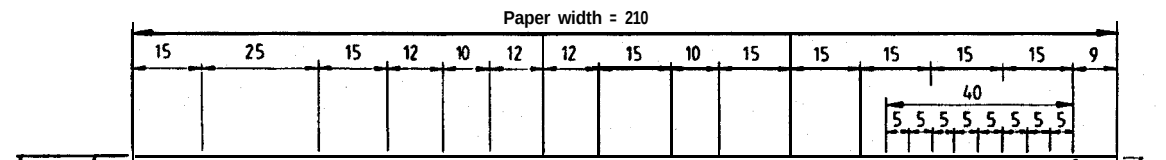
L is the length of the longitudinal wires (which are not necesserily the longer wires in the sheet).

B is the length of the cross wires.

O_1 and O_2 are the overhangs of the longitudinal wires.

O_3 and O_4 are the side overhangs of the cross wires.

Figure 1. Scheduled fabric



Rev fetter 5 5

XY and partners

Bar schedule ref : 0 4 6 | 0 3 | A

Site ref: Job number 1234
Physics block. Eastford

Date prepared 8.6.80 Date revised 31.9.80

Prepared by: A. B. C. Checked by: D. E. F.

Member	Bar mark	Type and size	No. of mbrs	No.of bars in each	Total no.	Length of each bar† mm	Shape code	A' mm	B* mm	C' mm	D' mm	E/R* mm	
Column 18	7	T25	1	5	5	5625	41	4000	600		~~80~~		
											100		A

10

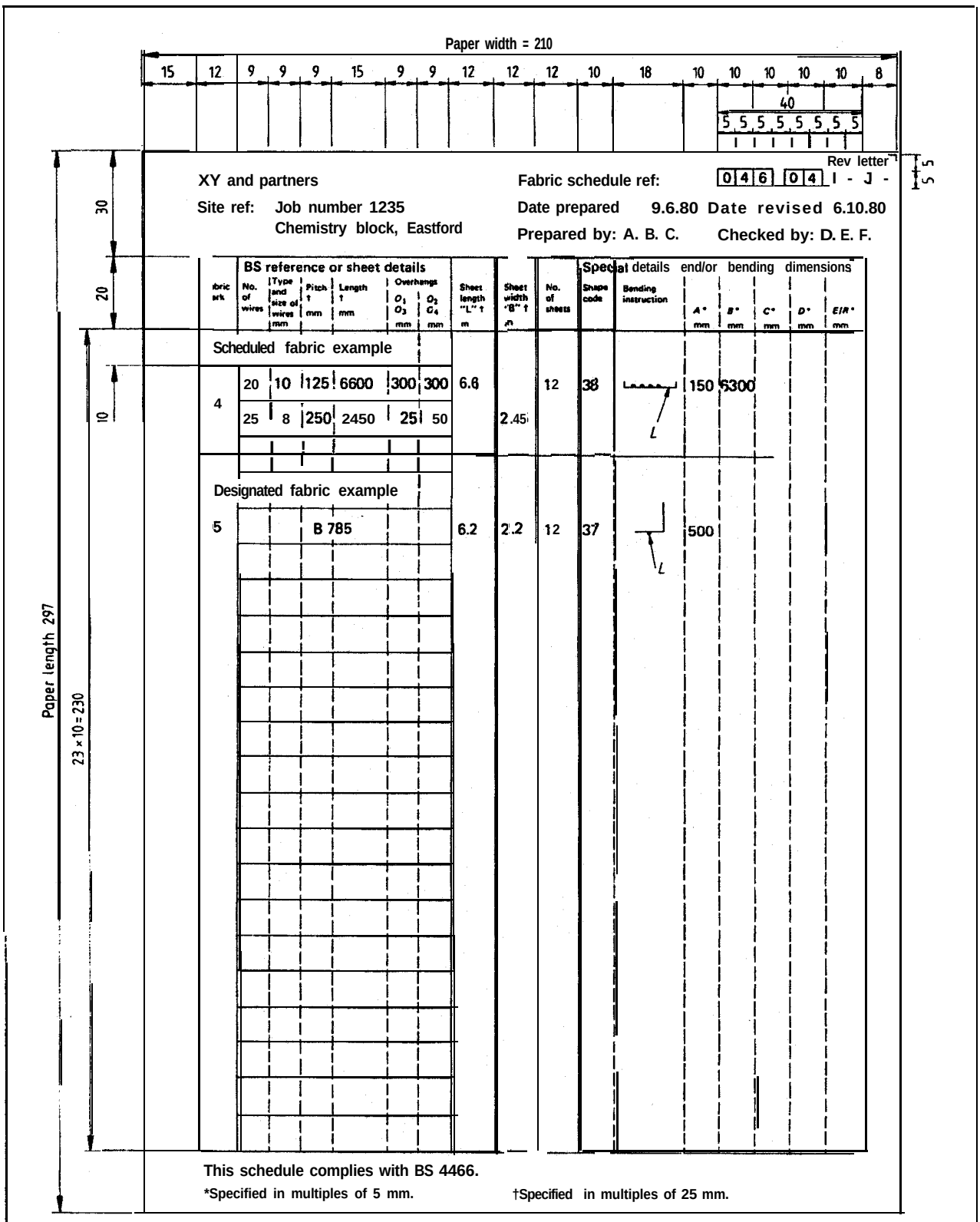
1p 30

This schedule complies with BS 4466.

*Specified in multiples of 5 mm. †Specified in multiples of 25 mm.

All dimensions are in millimetres.

Figure 2. Form of bar schedule



All dimensions are in millimetres.

Figure 3. Form of fabric schedule

Table 1. Preferred shapes, their method of measurement and calculation of length

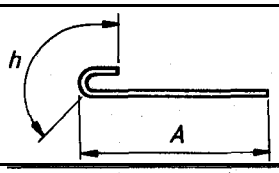
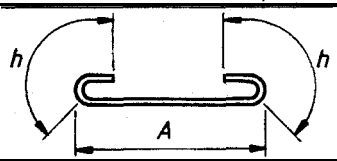
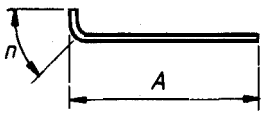
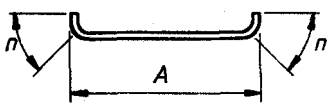
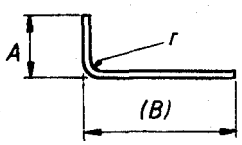
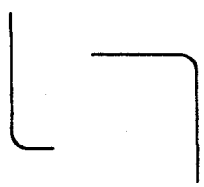
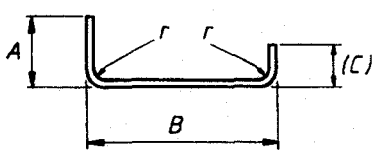
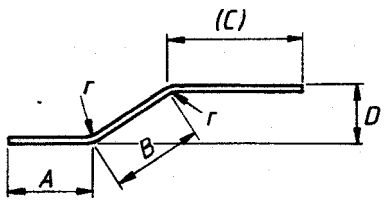
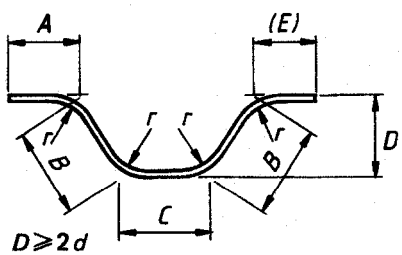
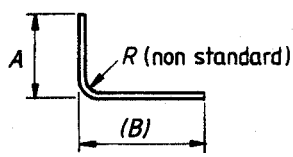
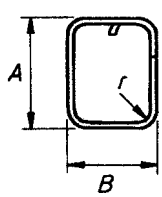
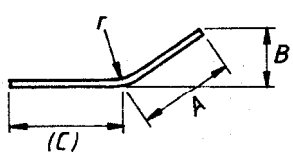
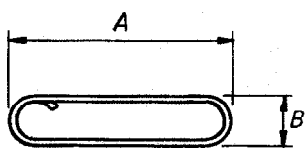
Shape code	Method of measurement of bending dimensions	Total length of bar (*L*) measured along centreline
20		mm *A*
32		*A+h*
33		*A + 2h*
34		*A+n* Where the overall dimension of the bob is critical, use shape code 37
35		*A + 2n* Where the overall dimension of either bob is critical, do not use this shape code
37	 or 	A + (B) - ½ *r* - *d* This formula is approximate Where *r* is greater than the minimum value in table 3 use shape code 51
38		*A+B+(C)-r-2d*

Table 1. *(concluded)*

Shape *code*	Method of measurement of bending dimensions	Total length of bar (*L*) measured along centreline
41	 $D \geqslant 2d$	mm If angles with the horizontal are 45 ° or less, $A+B+(C)$ See note 4
43	 $D \geqslant 2d$	If angles with the horizontal are 45 ° or less, $A+2B+C+(E)$ See note 4
51		$A + (B) - ½ R - d$ This formula is approximate If *R* is minimum, use shape code 37 If *R* is greater than 200 mm, see note 2 to clause 10
61		$2(A+B)+12d$ Neither *A* nor *B* are to be less than *12d* or 150 mm, whichever is the greater, for grade 460 in sizes not exceeding 20 mm nor less than *14d* for sizes of 25 mm and over Neither *A* nor *B* are to be less than *10d* for grade 250 with a minimum value of *A* and *B* of 100 mm See note 3
62		If angle with the horizontal is 45 ° or less, A + (C) See note 4
82	 $B \geq 2r+2d$	$2A+3B+18d$ If *B* is greater than 400 + 2 *d*, see note 2 to clause 10 See note 3

NOTE 1. *r* indicates the minimum value in table 3.

NOTE 2. The dimensions in parentheses are the free dimensions.

NOTE 3. To avoid separate equations for each steel grade and bending radius, simplified total length formulae are used for shape codes 61 and 82. These formulae are necessarily approximate.

NOTE 4. The length formula is approximate and when bending angles exceed 45 ° the length should be calculated more accurately allowing for the difference between the specified overall dimensions and the true length measured along the central axis of the bar or wire.

Table 2. Other shapes, their method of measurement and calculation of length

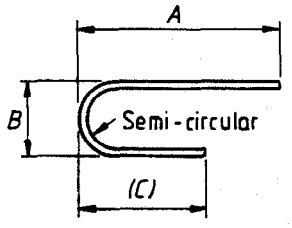
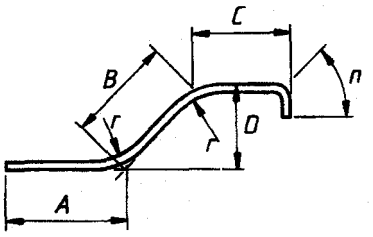
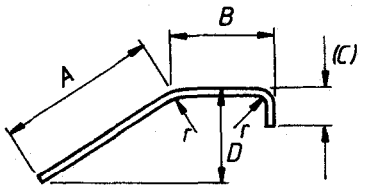
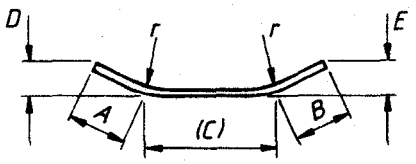
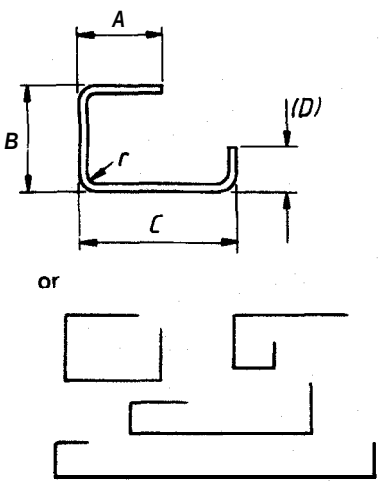
Shape code	Method of measurement of bonding dimensions	Total length of bar (*L*) measured along centreline
39	 $B \geqslant 2r + 2d$	mm $A + 0.57B + (C) - 1.57d$ If B is greater than $400 + 2d$, see note 2 to clause 10
42		If angle with horizontal is 45 ° or less, $A + B + C + n$ See note 4
45		If angle with horizontal is 45 ° or less, $A + B + (C) - \frac{1}{2}r - d$ See note 4
49		If angle with horizontal is 45 ° or less, $A + B + (C)$ See note 4
52		$A + B + C + (D) - 1\frac{1}{2}r - 3d$

Table 2. (continued)

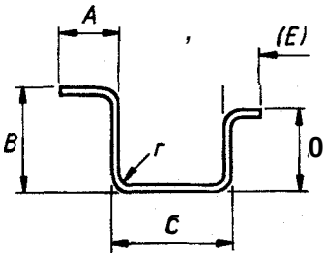
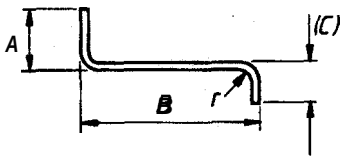
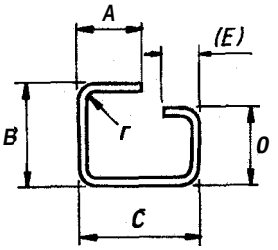
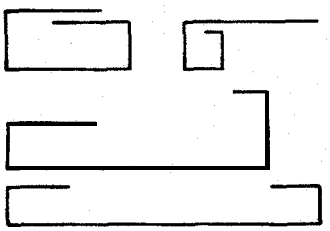
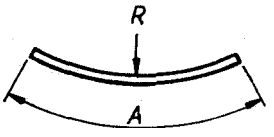
Shape code	Method of measurement of bonding dimensions	Total length of bar (*L*) measured along centreline
53		mm $A + B + C + D + (E) - 2r - 4d$
54		$A + B + (C) - r - 2d$
55	 or 	$A + B + C + D + (E) - 2r - 4d$
65	 These bars will be supplied straight when the radius is greater than that given in table 5	A

Table 2. *(continued)*

Shape code	Method of measurement of bending dimensions	Total length of bar (*L*) measured along centreline
77	r r A B	mm $2A + B + 20d$ *See* note 3
78	C I- A B	$2A + B + C + 3d$ *See* note 3
79	r A B	$2A + 3B + 10d$ Neither *A* nor *5* are to be less than $12d$ or 150 mm, whichever is the greater, for grade 460 in sizes not exceeding 20 mm nor less than $14d$ for sizes of 25 mm and over. Neither *A* nor *B* are to be less than $10d$ for grade 250 with a minimum value of *A* and *B* of 100 mm See note 3
85	Semi-circular B A r $C \geqslant 2r + 2d$	$A + B + 0.57C + (D) - {}^{1}/_{2}\, r - 2.57d$ If C is greater than $400 + 2d$, *see* note 2 to clause 10
87	A B	Where *5* is not greater than *A*/5 $\frac{C}{B}\,\pi\,(A - d) \quad (L \leqslant 12\ \text{m})$ where *A* is the external diameter (in mm) *B* is the pitch of helix (in mm) C is the overall height of helix (in mm) Where *5* is greater than *A/5* the formula does not apply. There shall be at least two full turns in the helix. NOTE. Unless A is small relative to *d*, this shape is fabricated in a closed form and pulled to shape on site.

7.5 Shapes with shape code **99** shall be drawn on the schedule over columns A to E using two parallel lines to indicate the reinforcement thickness, and the origin of projected surface intersection lines shall be used for dimensions. The methods of measurement shall be in accordance with those shown in tables 1 and 2 and **7.6** to **7.11** shall be complied with. The total length shall be given and, unless there is an end anchorage bend or hook, one bending dimension, preferably an end dimension, shall be indicated in parentheses as the free dimension to allow for the permissible deviations. The *r*, *n* and *h* values shall be given on the schedule if they differ from the values given in table **3.** The tolerances given in table 4 shall also apply to shape code **99.**

7.6 If the angle between two portions of the shape meeting at a bend is not a right angle, it shall be given and shall be defined by co-ordinates and not by degrees of arc.

7.7 Any shape including an acute angle shall be classified as a **99** shape code and drawn out in full with construction lines.

NOTE. The shape codes given in tables 1 and 2 do not include an acute angle.

When dimensioning an acute angle the tangential lines shown in figure 5 shall be used.

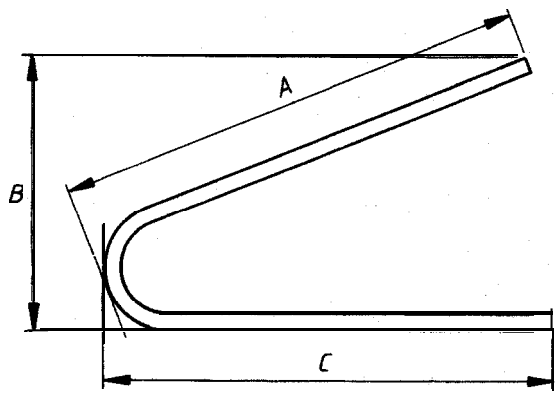


Figure **5.** Dimensioning of an acute angle

7.8 Bars bent in two planes shall be sketched isometrically or shown in two elevations, using first angle projection in accordance with BS **308** : Part **1.** The words 'bent in two planes' or 'isometric view' shall appear on the schedule.

7.9 The overall off-set dimension of a crank shall be not less than twice the size of the bar or wire. The angled length as shown in figure 6 shall be not less than **10***d* for grade **250** nor less than **12***d* for grade **460** in sizes of less than **20** mm nor less than **14***d* for grade **460** in sizes of **25** mm and over.

7.10 For all shapes with two or more bends in the same or opposite directions (whether in the same plane or not), the overall dimension given on the schedule shall always include a minimum straight of **4***d* between the curved portion-of the bends, as shown in figure **7.** The value of x in figure 7 shall be not less than the following:

(a) **10***d* for grade **250** material;

(b) **12***d* for grade **460** material not exceeding sizes of **20** mm;

(c) **14***d* for grade **460** material in sizes of **25** mm and over.

NOTE. The minimum values of *x* are expressed in terms of the nominal size of the reinforcement. In practice, rolling and bending tolerances. and the fact that the circumscribing diameter of deformed reinforcement may be up to **10** % greater than the nominal size, need to be considered. For example, the actual overall dimension of a hook bent in accordance with table 1 is greater than **2***r*+**2***d* and similarly two bends including a **4***d* straight have an actual overall x value greater than **2***r*+**6***d.*

7.11 The minimum length of material to be given on the schedule to form a bend or hook shall be as given for *n* or *h* respectively in table **3.**

NOTE. The reason for this is that existing bending equipment requires such a minimum length for the rotating pin to engage with the bar and bend it round the standard former. In giving this length on the schedule, due consideration should be given to the possibility of negative cutting tolerances (up to **25** mm) reducing the actual length of material. The smaller the bar size the more critical is the effect of the negative cutting tolerance, and this fact was considered when deciding on the length given in table 3 and the formulae given in tables 1 and **2.**

8 Bends and hooks

NOTE **1.** Minimum former radii are given in table **3.**

NOTE **2.** The overall dimension of a bend may vary from the design dimension by up to the sum of the cutting deviations (± 25 mm) and the cumulative bending deviations.

Before taking into account the cumulative cutting tolerances, the nominal value for y in table 3 shall be calculated as follows:

(a) for a bend, $n = 0.57r + 0.21d$;

(b) for a hook, $h = 2.14r - 0.57d$.

9 Tolerances on cutting and bending dimensions

The tolerances given in table 4 shall apply for cutting and/or bending dimensions and shall be taken into account when completing the schedule. The end anchorage or the dimension in parentheses in the shape codes given in tables 1 and 2 shall be used to allow for any permissible deviations resulting from cutting and bending.

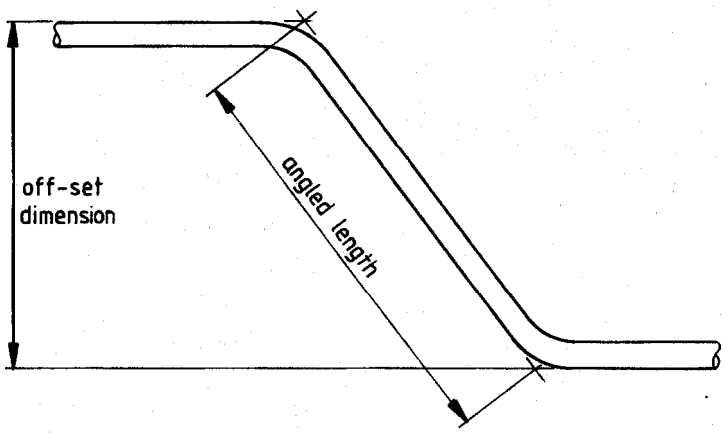


Figure 6. Dimensioning of cranked bars

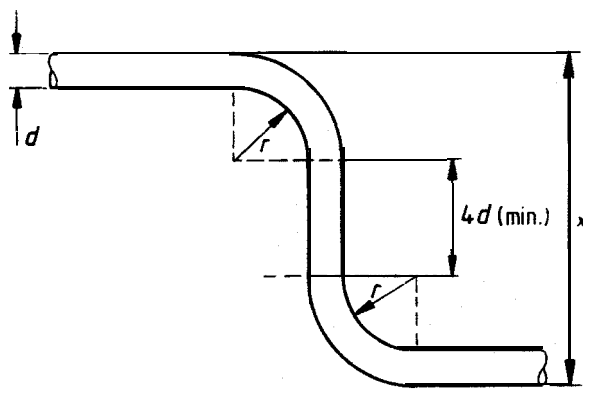


Figure 7. Example of bar with more than one bend

Table 4. Cutting and bending tolerances

	Tolerance
Cutting of straight lengths (including reinforcement for subsequent bending)	mm +25 −25
Bending ⩽ 1000 mm	+5 −5
> 1000 mm to ⩽ 2000 mm	+5 −10
> 2000 mm	+5 −25

10 Radius of banding

Reinforcement to be formed to a radius exceeding that given in table 5 shall be supplied straight.

NOTE 1. The required curvature may be obtained during placing.

NOTE 2. For shapes with straight and curved lengths (e.g. shape codes 39, 51, 82 and 85) the largest practical radius for the production of a continuous curve is 200 mm, and for larger radii the curve may be produced by a series of short straight sections.

11 Bending of fabric reinforcement

NOTE. The schedule for fabric reinforcement (see figure 3) includes a column headed 'Bending instruction' for the additional information that is required when specifying bent fabric. The three-dimensional characteristic of fabric reinforcement can give rise to ambiguities that are best overcome by means of a simple sketch in the 'Bending instruction' column.

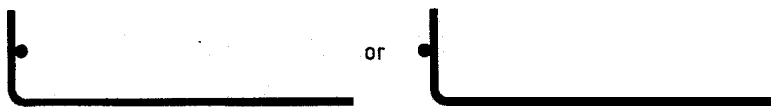
Table 5. Radius bending: maximum values requiring bending

Bar size (mm)	—	6	—	8	—	10	12	16	20	25	32	40
Wire size (mm)	5	6	7	6	9	10	12	—	—	—	—	—
Radius (m)	2.4	2.5	2.6	2.75	3.0	3.5	4.25	7.5	14.0	30.0	43.0	58.0

UDC 666.982.24 : 693.554.1 : ,
669.14.018.291 :
[658.512 + 531.71]

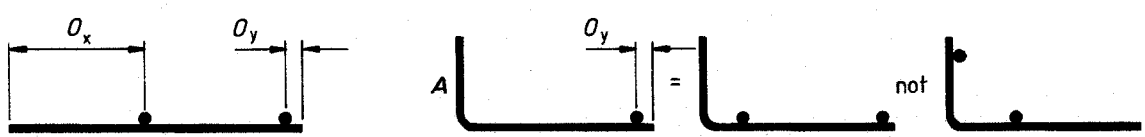
The sketch in the 'Bending instruction' column shall indicate the following.

(a) The direction of bending relative to the transverse wires



(b) The direction of the longitudinal wires of the sheet to ensure bending about the correct axis

(c) The correct orientation of an asymmetric sheet to ensure the correct setting out of bending dimensions



Sheet with unequal overhangs.

For all bent fabric reinforcement, the bending dimensions shall avoid welded transverse wires occurring within four diameters of the start of a bend (see figure 8).

12 Fabrication and routine inspection

12.1 Fabrication

12.1.1 Cutting to length shall be carried out using purpose-made shearing equipment. The tolerances given in table 4 shall apply to each length.

12.1.2 Bending shall be carried out on power bending machines. Plain smooth surfaces or rolls that do not offer resistance to longitudinal movement to the bars or fabric being bent shall be provided to ensure adequate support. The minimum former radii used in bending for the appropriate type and size of reinforcement shall be as given in table 3.

12.1.3 The fabricator shall ensure that cutting and bending machine operatives are trained in the skills necessary to produce cut and bent products of consistent quality within the permissible size deviations. A formal operative approval and testing system shall be implemented and operatives shall have been certified by the fabricator as having achieved minimum standards of competence.

12.2 Routine inspection

Routine inspection shall be carried out in accordance with the following clauses:

(a) A.1; and

(b) either of the following:

(i) for material covered by a third party certification scheme, A.2; or

(ii) for material not covered by a third party certification scheme, A.3.

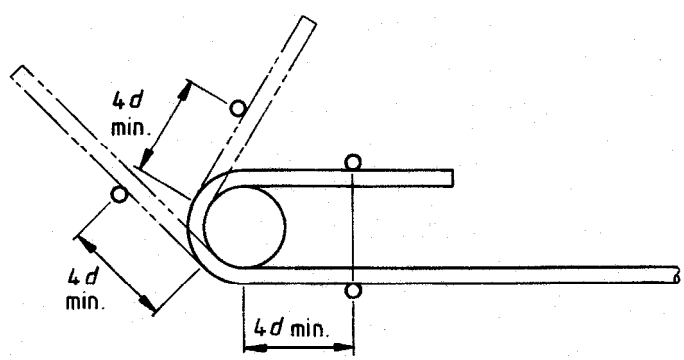


Figure 8. Position of welded transverse wires

Appendix

Appendix A. Inspection and certification

A.1 Fabricator's inspection

A.1.1 Extent of inspection

The fabricator shall carry out inspections of the following parameters of the schedules and of specimens of cut lengths and bent items at a frequency in accordance with **A.1.2**.

(a) *Cut lengths*

(i) The bar or fabric mark (see **4.5**).
(ii) The type and size of the specimens and the type and size given on the schedule (see **4.6**).
(iii) The length of the specimens and the length given on the schedule (see clause **9**).

(b) *Bent items*

(i) The bar or fabric mark (see **4.5**).

(ii) The type and size of the specimens and the type and size given on the schedule (see **4.6**).

(iii) The shape of the specimens and the shape code given on the schedule (see **7.2** to **7.7**).

(iv) The diameter of former used (by checking the bar) (see **12.1.2** for radii).

(v) The length of the specimens and the length given on the schedule (see clause **9**).

A.1.2 Frequency

The fabricator shall inspect daily and inspection records shall be retained for 10 years. Specimens shall be selected at random from a representative range of output items at the following frequency.

Where the output of the fabrication unit over the preceding full working week is less than 75 t	At least 10 specimens per day
Where the output of the fabrication unit over the preceding full working week is between 75 t and 150 t	At least 20 specimens per day
Where the output of the fabrication unit over the preceding full working week is greater than 150 t	At least 40 specimens per day

Where no records are available covering the preceding full working week, the lesser of either 40 specimens per day or the total output *per* day shall be inspected.

For inspection purposes, not more than 50 % of the specimens shall be selected from items having an identical bar mark.

If any of the specimens that are inspected are found to have parameters that do not comply with the appropriate requirements all the other bars or fabrics with the same mark number (or numbers) shall be inspected and they shall all comply with the appropriate requirements.

A2 Fabricated material covered by a third party product certification scheme

A.2.1 Consistency of production

For the purposes of determining the consistency of production, the long term quality level shall be assessed at regular intervals. No conclusions regarding compliance with this British Standard shall be made on the basis of this assessment.

A.2.2 Determination of the long term quality level

The third party certification authority shall assess the long term consistency of production (fabrication) by examining the fabricator's inspection records at regular intervals. No more than 5 % of the items inspected shall have failed to comply with the requirements before rectification.

A.3 Fabricated material not covered by a third party product certification scheme

A.3.1 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 Organization at the producer's works or in the stockholder's yard.

A.3.2 Extent of sampling and inspection/testing

For the purposes of inspection/testing, the delivery shall be subdivided into test units with a maximum mass of 10 t.

Specimens shall be taken from each test unit as follows:

(a) 15 specimens (if appropriate 60 specimens) of cut lengths;

(b) 15 specimens (if appropriate 60 specimens) of bent items.

A.3.3 Inspection by attributes

The following parameters of the schedule and of the specimens taken in accordance with **A.3.2** shall be inspected.

(a) *Cut lengths*

(i) The bar or fabric mark (see **4.5**).

(ii) The type and size of the specimens and the type and size given on the schedule (see **4.6**).

(iii) The length of the specimens and the length given on the schedule (see clause **9**).

(b) *Bent items*

(i) The bar mark (see **4.5**).

(ii) The type and size of the specimens and the type and size given on the schedule (see **4.6**).

(iii) The shape of the specimens and the shape code given on the schedule (see 7.2 to 7.7).

(iv) The diameter of former used (by checking the bar) (see 12.1.2 for radii).

(v) The length of the specimens and the length given on the schedule (see clause 9).

A.3.4 Evaluation of results

All the parameters inspected in accordance with A.3.3 for all the 15 specimens shall comply with the appropriate requirements.

If a maximum of two of the 15 results do not comply, a further 45 specimens shall be assessed so that a total of 60 specimens is assessed. The test unit shall be deemed to comply with this standard if no more than two of the 60 results do not comply with the appropriate requirements.

Publications referred to

BS 308	Engineering drawing practice Part 1 Recommendations for general principles
BS 4000	Specification for sizes of paper and board
BS 4449	Specification for carbon steel bars for the reinforcement of concrete
BS 4482	Specification for cold reduced steel wire for the reinforcement of concrete
BS 4483	Specification for steel fabric for the reinforcement of concrete
*BS 5750	Quality systems Part 2 Specification for production and installation
BS 6744	Specification for austenitic steinless steel bars for the reinforcement of concrete
BS 8110	Structural use of concrete Part 1 Code of practice for design and construction

*Referred to in the foreword only.

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Iron end Steel Standards Policy Committee (ISM/-) to Technical Committee ISM/9, upon which the following bodies were represented:

British Cement Association
British Independent Steel Producers' Association
British Precast Concrete Federation Ltd.
British Reinforcement Manufacturers' Association
British Steel Industry
British Steel Industry (Wire Section)
Concrete Society
County Surveyors' Society
Department of the Environment (Property Services Agency)
Department of Transport
Electricity Supply Industry in England and Wales
Fabric Reinforcement Development Association
Federation of Civil Engineering Contractors
High Yield Bar Development Association
Institution of Civil Engineers
Institution of Structural Engineers
UK Certification Authority Reinforcing Steels

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