BAR Reinforcement Toolkit

BAR
BRITISH ASSOCIATION OF REINFORCEMENT

www.uk-bar.org

Introduction

This BAR reinforcement desktop toolkit provides information on the design and detailing of reinforced concrete structures. It is intended to be used by engineers and technicians of all levels for scheme design and standard detailing guidance. The information provided should always be viewed in accordance with current British and European standards.

Contents

British Association of Reinforcement

The British Association of Reinforcement (BAR) provides the industry focus and marketing champion for the UK's reinforcement industry. BAR has grown to include UK reinforcement mills, fabricators and accessory suppliers. Its membership has representation on British Standards and CARES. Further information on BAR may be found at www.uk-bar.org

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EC2 Design – Flexure

Procedure for determining flexural reinforcement

Carry out analysis of beam to determine design moments (M) (see Table 1)

Concrete class ≤ C50/60?

No → Outside scope of this guide

Yes → Determine K from $K = \dfrac{M}{bd^2 f_{ck}}$

Determine K' from $K' = 0.60\delta - 0.18\delta^2 - 0.21$ where $\delta \leq 1.0$

is $K \leq K'$?

Yes → No compression reinforcement required

Obtain lever arm z from Table 2 or $z = \dfrac{d}{2}\left\{1 + \sqrt{1 - 3.53K}\right\} \leq 0.95d$

Calculate tension reinforcement required from $A_s = \dfrac{M}{f_{yd} z}$

No → Compression reinforcement required

Calculate lever arm z from $z = \dfrac{d}{2}\left\{1 + \sqrt{1 - 3.53\,K'}\right\}$

Calculate compression reinforcement required from $A_s' = \dfrac{(K-K')f_{ck}bd^2}{f_{sc}(d-d_2)}$ where $f_{sc} = \dfrac{700\,[x_u - d_2]}{x_u} \leq f_{yd}$ & $x_u = (\delta - 0.4)d$

Calculate tension reinforcement required from $A_s = \dfrac{K' f_{ck} bd^2}{f_{yd} z} + \dfrac{A_s' f_{sc}}{f_{yd}}$

Check minimum reinforcement requirements $A_{s,min} = \dfrac{0.26\,f_{ctm}\,b_t d}{f_{yk}}$ where $f_{ck} \geq 25$

Check maximum reinforcement requirements $A_{s,max} = 0.04\,A_C$ for tension or compression reinforcement outside lap locations

Design complete

Table 1 Bending moment and shear coefficients for beams

	Moment	Shear
Outer support	25% of span moment	0.45 $(G + Q)$
Near middle of end span	0.090 Gl + 0.100 Ql	
At first interior support	– 0.094 $(G + Q)\,l$	0.63 $(G + Q)$[a]
At middle of interior spans	0.066 Gl + 0.086 Ql	
At interior supports	– 0.075 $(G + Q)\,l$	0.50 $(G + Q)$

KEY

a 0.55 $(G + Q)$ may be used adjacent to the interior span.

NOTES

1 Redistribution of support moments by 15% has been included.

2 Applicable to 3 or more spans only and where $Q_k \geq G_k$. (They may also be used for 2 span beams but support moment coefficient = 0.106 and internal shear coefficient = 0.63 both sides).

3 Minimum span ≥ 0.85 longest span.

4 l is the span, G is the total of the ULS permanent actions, Q is the total of the ULS variable actions.

EC2 Design – Flexure

Table 2 z/d for singly reinforced rectangular sections

K	z/d	K	z/d
0.01	0.950a	0.11	0.891
0.02	0.950a	0.12	0.880
0.03	0.950a	0.13	0.868
0.04	0.950a	0.14	0.856
0.05	0.950a	0.15	0.843
0.06	0.944	0.16	0.830
0.07	0.934	0.17	0.816
0.08	0.924	0.18	0.802
0.09	0.913	0.19	0.787
0.10	0.902	0.20	0.771

KEY

a Limiting z to 0.95d is not a requirement of Eurocode 2, but is considered to be good practice.

EC2 Design – Shear

Procedure for determining vertical shear reinforcement

Determine v_{Ed} where: v_{Ed} = design shear stress $[v_{Ed} = V_{Ed}/(b_w z) = V_{Ed}/(0.9\,b_w d)]$

Determine the concrete stut capacity $v_{Rd,\,max\,cot\,\theta = 2.5}$? from Table 3

Is $v_{Ed} < v_{Rd,\,max\,cot\,\theta = 2.5}$?

Yes → $(\cot\theta = 2.5)$

No → Is $v_{Ed} < v_{Rd,\,max\,cot\,\theta = 1.0}$? (see Table 3)

No → Redesign section

Yes → Determine θ from: $\theta = 0.5 \sin^{-1}\left[\dfrac{v_{Ed}}{0.20\,f_{ck}\,(1 - f_{ck}/250)}\right]$

Calculate area of shear reinforcement $\dfrac{A_{sw}}{s} = \dfrac{v_{Ed}\,b_w}{f_{ywd}\cot\theta}$

Check maximum spacing for vertical shear reinforcement: $s_{l,\,max} = 0.75d$

Table 3 Minimum and maximum concrete strut capacity in terms of stress

f_{ck}	$v_{Rd,\,max\,cot\,\theta\,=\,2.5}$	$v_{Rd,\,max\,cot\,\theta\,=\,1.0}$
20	2.54	3.68
25	3.10	4.50
28	3.43	4.97
30	3.64	5.28
32	3.84	5.58
35	4.15	6.02
40	4.63	6.72
45	5.08	7.38
50	5.51	8.00

Based on guidance in "How to Design Concrete Structures Using Eurocode 2" by The Concrete Centre.

EC2 Design – Deflection

Procedure for assessing deflection

Determine basic l/d and k from Figure 1

▼

Determine Factor 1 (F1)
For Flanged sections
F1 = 1 - 0.1 $((b_f/b_w) - 1) \geq 0.8$†
(b_f is flange breadth and b_w is rib breadth)
Otherwise F1 = 1.0

▼

Determine Factor 2 (F2)
Where the slab span exceeds 7m
and it supports brittle partitions,
F2 = $7/l_{eff} \leq 1.0$
Otherwise F2 = 1.0

►

Determine Factor 3 (F3)
F3 = $310/\sigma_s$
Where σ_s = Stress in reinforcement at serviceability limit state σ_s may assumed to be 310 MPa (i.e. F3 = 1.0)
where $A_{s,prov} = A_{s,req'd}$
Note: $A_{s,prov} \leq 1.5\, A_{s,req'd}$
(UK National Annex)

▲

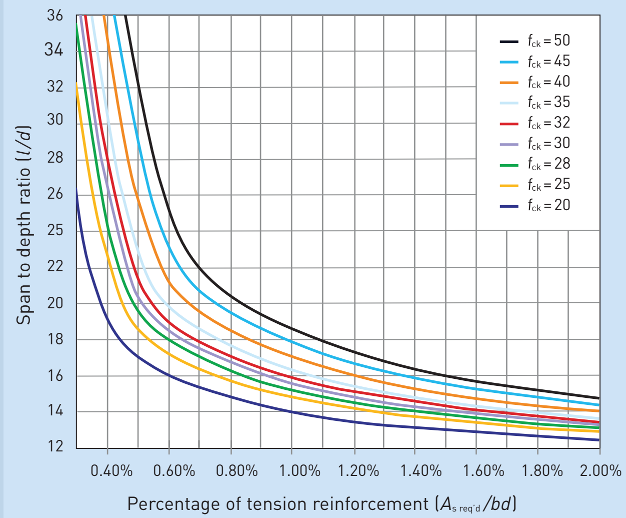
Is basic l/d x K x F1 x F2 x F3 ≤ Actual l/d?

Yes ▲ **Check complete**

No ► Increase $A_{s,prov}$ or f_{ck} ► (back to Determine Factor 3)

† The Eurocode is ambiguous regarding linear interpolation. It is understood that it was the intention of the drafting committee that linear interpolation be used and this is in line with current UK practice.

Figure 1 Basic span-to-effective-depth ratios



NOTES

1 This graph assumes simply supported span condition
(K = 1.0)
K = 1.5 for interior span condition
K = 1.3 for end span condition
K = 1.2 for flat slabs
K = 0.4 for cantilevers

2 Compression reinforcement, ρ', has been taken as 0.

3 Curves based on the following expressions:

$$\frac{l}{d} = K\left[11 + \frac{1.5\sqrt{f_{ck}}\,\rho_0}{\rho} + 3.2\sqrt{f_{ck}}\left(\frac{\rho_0}{\rho} - 1\right)^{1.5}\right]$$

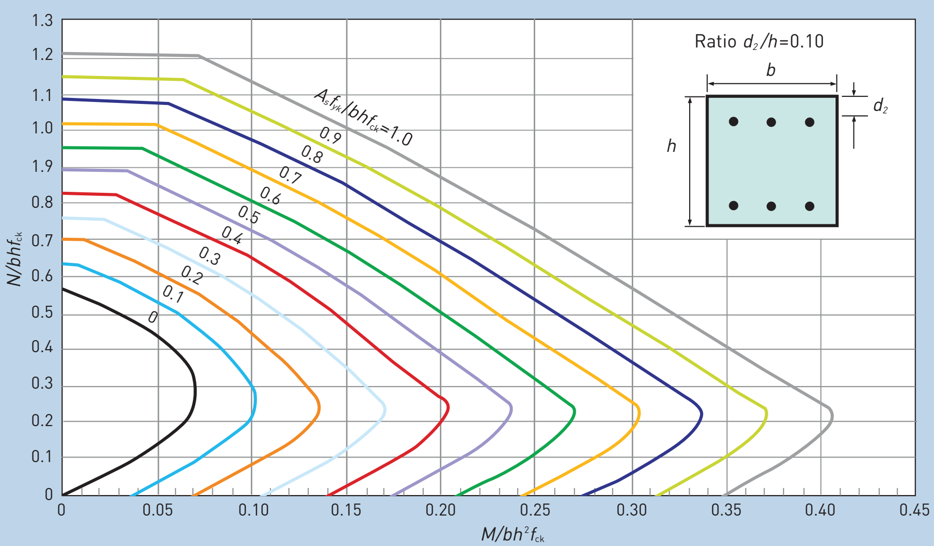
where $\rho \leq \rho_0$

$$\frac{l}{d} = K\left[11 + \frac{1.5\sqrt{f_{ck}}\,\rho_0}{(\rho - \rho')} + \frac{\sqrt{f_{ck}}}{12}\sqrt{\frac{\rho'}{\rho_0}}\right]$$

where $\rho > \rho_0$

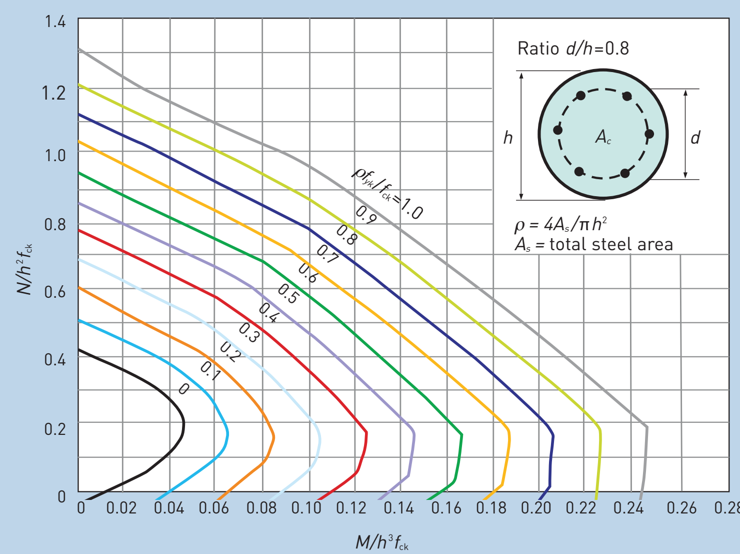
EC2 Design – Axial

Column design chart 1



Further column charts can be found at www.eurocode2.info

Column design chart 2



Based on guidance in "How to Design Concrete Structures Using Eurocode 2" by The Concrete Centre.

eurocode 2

BS 8110 Design – Flexure

Procedure for determining flexural reinforcement

- Carry out analysis of beam to determine design moments (M) (see Table 1)
- Concrete class ≤ C50/60?
  - **No** → Outside scope of this guide
  - **Yes** → Determine K from $K = \dfrac{M}{bd^2 f_{cu}}$
- $K' = 0.156$ where redistribution ≤10%
  $K' = 0.402\,(\beta_b - 0.4) - 0.18\,(\beta_b - 0.4)^2$ where redistribution >10%
- is $K \le K'$?
  - **Yes** → No compression reinforcement required
    - Obtain lever arm z from Table 2 or use $z = d\left\{0.5 + \sqrt{0.25 - \dfrac{K}{0.9}}\right\} \le 0.95d$
    - Calculate tension reinforcement required from $A_s = \dfrac{M}{0.87\, f_y\, z}$
    - Check minimum reinforcement requirements
    - Check maximum reinforcement requirements
  - **No** → Compression reinforcement required
    - Calculate lever arm z from $z = d\left\{0.5 + \sqrt{0.25 - \dfrac{K'}{0.9}}\right\}$
    - Calculate compression reinforcement required from $A_{s'} = (K - K')f_{cu}bd^2/0.87f_y\,(d-d')$
    - Calculate tension reinforcement required from $A_{s'} = (K' f_{cu} bd^2/0.87 f_y z) + As'$
    - Check maximum reinforcement requirements $A_{s,max} = 0.04\,A_C$ for tension or compression reinforcement outside lap locations
- **Design complete**

Table 1 Design ultimate bending moments and shear forces for beams

	At outer support	Near middle of end span	At first interior support	At middle of interior spans	At interior supports
Moment	0	0.09Fl	−0.11Fl	0.07Fl	−0.08Fl
Shear	0.45F	—	0.6F	—	0.55F

NOTE
l is the effective span;
F is the total design ultimate load $(1.4G_k + 1.6Q_k)$.
No redistribution of the moments calculated from this table should be made.

Characteristic imposed load Qk may not exceed characteristic dead load Gk;
Loads should be substantially uniformaly distributed over three or more spans;
Variations in span length should not exceed 15% of longest.

To be used for BS8110 design only. For EC2 design, please refer to Table 1 on page 6.

Based on Table 3.5 of BS 8110

Table 2 z/d for singly reinforced rectangular sections

K	z/d	K	z/d
0.05	0.94	0.11	0.86
0.06	0.93	0.12	0.84
0.07	0.91	0.13	0.82
0.08	0.90	0.14	0.81
0.09	0.89	0.15	0.79
0.10	0.87	0.156	0.78

BS 8110 Design – Deflection

Table 5 Modification factor for tension reinforcement

Service stress	M/bd^2 0.50	0.75	1.00	1.50	2.00	3.00	4.00	5.00	6.00
100	2.00	2.00	2.00	1.86	1.63	1.36	1.19	1.08	1.01
150	2.00	2.00	1.98	1.69	1.49	1.25	1.11	1.01	0.94
(f_y = 250) 167	2.00	2.00	1.91	1.63	1.44	1.21	1.08	0.99	0.92
200	2.00	1.95	1.76	1.51	1.35	1.14	1.02	0.94	0.88
250	1.90	1.70	1.55	1.34	1.20	1.04	0.94	0.87	0.82
300	1.60	1.44	1.33	1.16	1.06	0.93	0.85	0.80	0.76
(f_y = 500) 333	1.41	1.28	1.18	1.05	0.96	0.86	0.79	0.75	0.72

NOTE 1 The values in the table derive from the equation:

$$\text{Modification factor} = 0.55 + \frac{(477 - f_s)}{120\left(0.9 + \dfrac{M}{bd^2}\right)} \le 2.0$$

where
M is the design ultimate moment at the centre of the span or, for a cantilever, at the support.

NOTE 2 The design service stress in the tension reinforcement in a member may be estimated from the equation:

$$f_s = \frac{2 f_y A_{s\,req}}{3 A_{s\,prov}} \times \frac{1}{\beta_b}$$

NOTE 3 For a continuous beam, if the percentage of redistribution is not known but the design ultimate moment at mid-span is obviously the same as or greater than the elastic ultimate moment, the stress f_s in this table may be taken as $2/3f_y$.

Based on Table 3.10 of BS 8110

Table 6 Modification factor for compression reinforcement

$\dfrac{100\,A'_{s\,prov}}{bd}$	Factor
0.00	1.00
0.15	1.05
0.25	1.08
0.35	1.10
0.50	1.14
0.75	1.20
1.0	1.25
1.5	1.33
2.0	1.40
2.5	1.45
≥3.0	1.50

NOTE 1 The area of compression reinforcement A used in this table may include all bars in the compression zone, even those not effectively tied with links.

Based on Table 3.11 of BS 8110

Table 7 Basic span/effective depth ratio for rectangular or flanged beams

Support conditions	Rectangular section	Flanged beams with $\dfrac{b_w}{b} \le 0.3$
Cantilever	7	5.6
Simply supported	20	16.0
Continuous	26	20.8

NOTE 1 For spans exceeding 10m, Table 7 should be used only if it is not necessary to limit the increase in deflection after the construction of partitions and finishes. Where limitation is necessary, the values in Table 7 should be multiplied by 10/span except for cantilevers where the design should be justified by calculation.

Based on Table 3.9 of BS 8110

BS 8110 Design – Shear

Table 3 Form and area of shear reinforcements in beams

Value of v N/mm²	Form of shear reinforcement to be provided	Area of shear reinforcement to be provided
Less than $0.5\,v_c$ throughout the beam	See NOTE 1	—
$0.5\,v_c < v < (v_c + 0.4)$	Minimum links for whole length of beam	$A_{sv} \geq 0.4\,b_v s_v / 0.87 f_{yv}$ (see NOTE 2)
$(v_c + 0.4) < v < 0.8\sqrt{f_{cu}}$ or 5 N/mm²	Links or links combined with bent-up bars. Not more than 50% of the shear resistance provided by the steel may be in the form of bent-up bars (see NOTE 3)	Where links only provided: $A_{sv} \geq b_v s_v (v - v_c)/0.87 f_{yv}$ Where links and bent-up bars provided: see 3.4.5.6 of BS 8110

NOTE 1 While minimum links should be provided in all beams of structural importance, it will be satisfactory to omit them in members of minor structural importance such as lintels or where the maximum design shear stress is less than half v_c.

NOTE 2 Minimum links provide a design shear resistance of 0.4 N/mm².

NOTE 3 See 3.4.5.5 of BS 8110 for guidance on spacing of links and bent-up bars.

Based on Table 3.7 of BS 8110

Table 4 Values of v_c design concrete shear stress

$\frac{100A_s}{b_v d}$	Effective depth mm							
	125 N/mm²	150 N/mm²	175 N/mm²	200 N/mm²	225 N/mm²	250 N/mm²	300 N/mm²	400 N/mm²
≤ 0.15	0.45	0.43	0.41	0.40	0.39	0.38	0.36	0.34
0.25	0.53	0.51	0.49	0.47	0.46	0.45	0.43	0.40
0.50	0.67	0.64	0.62	0.60	0.58	0.56	0.54	0.50
0.75	0.77	0.73	0.71	0.68	0.66	0.65	0.62	0.57
1.00	0.84	0.81	0.78	0.75	0.73	0.71	0.68	0.63
1.50	0.97	0.92	0.89	0.86	0.83	0.81	0.78	0.72
2.00	1.06	1.02	0.98	0.95	0.92	0.89	0.86	0.80
≥ 3.00	1.22	1.16	1.12	1.08	1.05	1.02	0.98	0.91

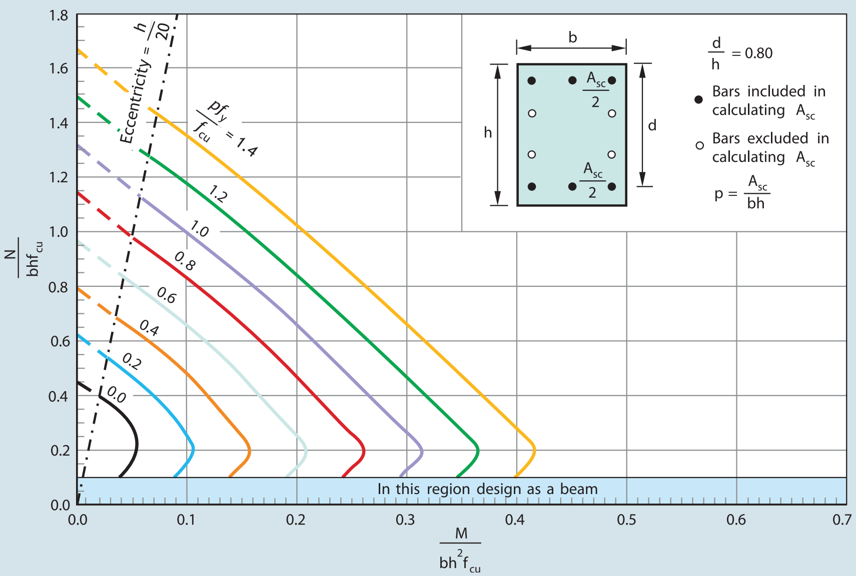
NOTE 1 Allowance has been made in these figures for a γm of 1.25.

NOTE 2 For characteristic concrete strength greater than 25 N/mm², the values in this table may be multiplied by $(f_{cu}/25)^{1/3}$, the value of f_{cu} should not be taken as greater than 40.

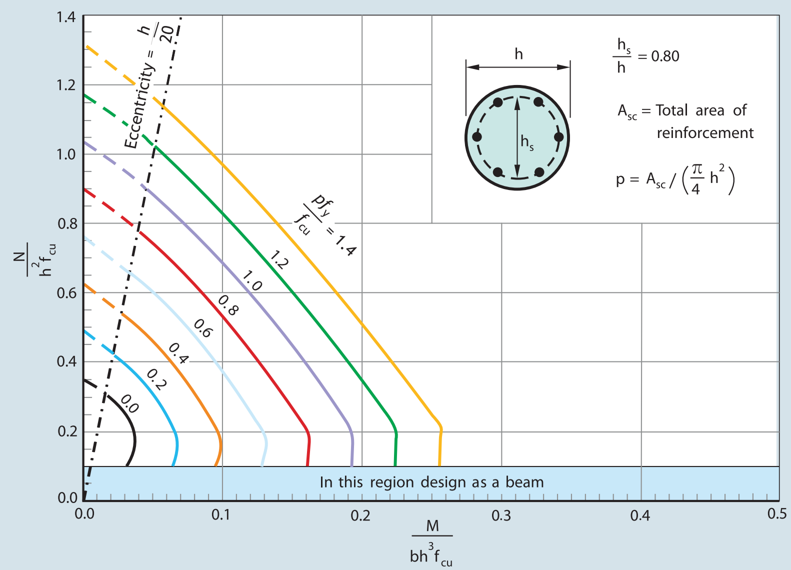
Based on Table 3.8 of BS 8110

BS 8110 Design – Axial

Column design chart for rectangular column d/h = 0.80



Column design chart for circular column h_s/h = 0.8



Based on figures C.4d and C.5b of "Concrete Buildings Scheme Design Manual."

Rebar Tables BS 8666:2005 User Guide

Notation of steel reinforcement

Type of steel reinforcement	Notation
For diameters ≤ 12mm, Grade B500A, Grade B500B or Grade B500C conforming to BS 4449:2005 For diameters > 12mm, Grade B500B or Grade B500C conforming to BS 4449:2005	H
Grade B500A conforming to BS 4449:2005	A
Grade B500B or Grade B500C conforming to BS 4449:2005	B
Grade B500C conforming to BS 4449:2005	C
A specified grade and type of ribbed stainless steel conforming to BS 6744:2001	S
Reinforcement of a type not included in the above list having material properties that are defined in the design or contract specification	X

NOTE: In the Grade description B500A, etc., "B" indicates reinforcing steel.

BS5400 Ultimate anchorage bond lengths and lap lengths as a multiple bar size (for grade 500, type 2 deformed bars)

Condition	Tension for Values of f_{cu} (N/mm²)				Compression for Values of f_{cu} (N/mm²)			
	20	25	30	≥ 40	20	25	30	≥ 40
Anchorage length	50	44	39	33	41	35	31	27
Lap length (α_1=1.0)	50	44	39	33	41	35	31	27
Lap length (α_1=1.4)	70	62	55	47	57	49	44	37
Lap length (α_1=2.0)	100	88	78	66	81	70	62	53

NOTE: 1. ∝ = 1.0 for lapped bars in the corner of a section where the cover to both faces is at least 2ϕ and, for sets of bars in the same layer, the gaps between the sets are at least 150mm.
2. ∝ = 2.0 if either or both of the conditions above are not satisfied and the bars are at the top of a section as cast.
3. ∝ = 1.4 for all other conditions.

Sectional areas per metre width for various bar spacings (mm²/m)

Bar Size (mm)	Number of Bars									
	1	2	3	4	5	6	7	8	9	10
6*	28.3	56.6	84.9	113	142	170	198	226	255	283
8	50.3	101	151	201	252	302	352	402	453	503
10	78.5	157	236	314	393	471	550	628	707	785
12	113	226	339	452	566	679	792	905	1020	1130
16	201	402	603	804	1010	1210	1410	1610	1810	2010
20	314	628	943	1260	1570	1890	2200	2510	2830	3140
25	491	982	1470	1960	2450	2950	3440	3930	4420	4910
32	804	1610	2410	3220	4020	4830	5630	6430	7240	8040
40	1260	2510	3770	5030	6280	7540	8800	10100	11300	12600
50	1960	3930	5890	7850	9820	11800	13700	15700	17700	19600

Sectional areas of groups of bars (mm²)

Bar Size (mm)	Spacing of Bars									
	75	100	125	150	175	200	225	250	275	300
6*	377	283	226	189	162	142	126	113	103	94.3
8	671	503	402	335	287	252	224	201	183	168
10	1050	785	628	523	449	393	349	314	285	262
12	1510	1130	905	754	646	566	503	452	411	377
16	2680	2010	1610	1340	1150	1010	894	804	731	670
20	4190	3140	2510	2090	1800	1570	1400	1260	1140	1050
25	6550	4910	3930	3270	2810	2450	2180	1960	1790	1640
32	10700	8040	6430	5360	4600	4020	3570	3220	2920	2680
40	16800	12600	10100	8380	7180	6280	5580	5030	4570	4190
50	26200	19600	15700	13100	11200	9820	8730	7850	7140	6540

NOTE: The above Tables have been calculated to three significant figures according to the B.S.I. recommendations.

* Denotes non-preferred sizes.

BS 8110 Ultimate anchorage bond lengths and lap lengths C20-30

	Bar size								
	8	10	12	16	20	25	32	40	50
Concrete strength class C20/25									
Lap lengths or tension anchorage	360	440	530	710	880	1100	1410	1760	2200
1.4 _ tension lap	500	620	750	1000	1240	1550	1990	2480	3100
2.0 _ tension lap	710	880	1060	1410	1760	2200	2820	3520	4400
Compression anchorage length	280	350	420	560	700	880	1120	1400	1750
Concrete strength class C25/30									
Lap lengths or tension anchorage	320	400	480	640	800	1000	1280	1600	2000
1.4 _ tension lap	450	560	680	900	1120	1400	1800	2240	2800
2.0 _ tension lap	640	800	960	1280	1600	2000	2560	3200	4000
Compression anchorage length	260	320	390	520	640	800	1030	1280	1600

BS 8110 Ultimate anchorage bond lengths and lap lengths C28-40

	Bar size								
	8	10	12	16	20	25	32	40	50
Concrete strength class C28/35									
Lap lengths or tension anchorage	310	380	460	610	760	950	1220	1520	1900
1.4 _ tension lap	420	520	630	840	1040	1300	1670	2080	2600
2.0 _ tension lap	600	750	900	1200	1500	1880	2400	3000	3750
Compression anchorage length	240	300	360	480	600	750	960	1200	1500
Concrete strength class C32/40									
Lap lengths or tension anchorage	280	350	420	560	700	880	1120	1400	1750
1.4 _ tension lap	400	490	590	790	980	1230	1570	1960	2450
2.0 _ tension lap	560	700	840	1120	1400	1750	2240	2800	3500
Compression anchorage length	230	280	340	450	560	700	900	1120	1400

EC2 Ultimate anchorage bond lengths and lap lengths

		Bond condition	Reinforcement in tension, bar diameter, ϕ (mm)									Reinforcement in compression
			8	10	12	16	20	25	32	40	50	
Anchorage length, l_{bd}	Straight bars only	Good	230	320	410	600	780	1010	1300	1760	2020	40
		Poor	330	450	580	850	1120	1450	1850	2510	2890	58
	Other bars	Good	320	410	490	650	810	1010	1300	1760	2020	40
		Poor	460	580	700	930	1160	1450	1850	2510	2890	58
Lap length, l_o	Half the bars lapped in one location	Good	320	440	570	830	1090	1420	1810	2460	2830	57
		Poor	460	630	820	1190	1560	2020	2590	3520	4040	81
	Third of the bars lapped in one location	Good	270	360	470	690	900	1170	1490	2020	2330	66
		Poor	380	520	670	980	1280	1660	2130	2890	3320	46

NOTES

1. Cover to all sides and distance between bars ≥ 25 mm (i.e. $\alpha_2 < 1$)
2. $\alpha_1 = \alpha_3 = \alpha_4 = \alpha_5 = 1.0$
3. Design stress has been taken as 435 MPa. Where the design stress in the bar at the position from the where the anchorage is measured, σ_{sd}, is less than 435 the figures in this table can be factored by $\sigma_{sd}/435$
4. The anchorage and lap lengths have been rounded up to the nearest 10 mm
5. Where all the bars are lapped in one location, increase the lap lengths for 'Half the bars lapped in one location' by a factor of 1.07
6. The figures in this table have been prepared for concrete class C25/30; the following factors may be used for other concrete classes

Concrete class	C20/25	C28/35	C30/37	C32/40
Factor	1.16	0.93	0.89	0.85
Concrete class	C35/45	C40/50	C45/50	C50/60
Factor	0.80	0.73	0.68	0.63

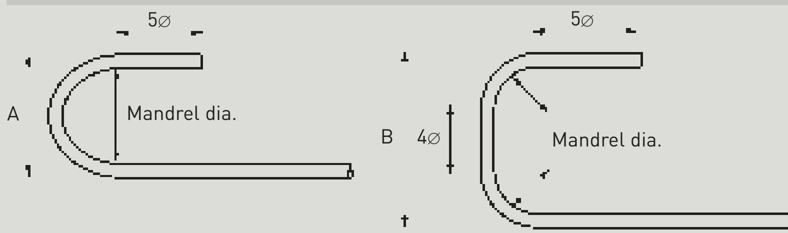
Rebar Tables BS 8666:2005 User Guide

Minimum overall depth of various U-bars

British Standard Reference	Longitudinal wires size mm	Longitudinal wires pitch mm	Longitudinal wires area mm²/m	Cross wires size mm	Cross wires pitch mm	Cross wires area mm²/m	Mass kg/m²	Mass kg/sheet
Square Mesh Fabric								
A 393	10	200	393	10	200	393	6.16	70.96
A 252	8	200	252	8	200	252	3.95	45.50
A 193	7	200	193	7	200	193	3.02	34.79
A 142	6	200	142	6	200	142	2.22	25.57
Structural Fabric								
B1131	12	100	1131	8	200	252	10.9	125.57
B 785	10	100	785	8	200	252	8.14	93.77
B 503	8	100	503	8	200	252	5.93	68.31
B 385	7	100	385	7	200	193	4.53	52.19
B 283	6	100	283	7	200	193	3.73	42.97
Long Mesh Fabric								
C 785	10	100	785	6	400	70.8	6.72	77.41
C 636	9	100	636	6	400	70.8	5.55	63.94
C 503	8	100	503	6	400	70.8	4.51	50.00
C 385	7	100	385	6	400	70.8	3.58	39.28
C 283	6	100	283	6	400	70.8	2.78	30.07
Wrapping Mesh Fabric								
D 98	5	200	98	5	200	98	1.54	17.74
D 49	2.5	100	49	2.5	100	49	0.77	8.87

Fabric to BS 4483 – Preferred meshes in stock size sheets 4.8m long 2.4m wide

Hook **Trombone**

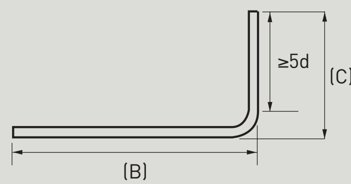


f_y = 500MPA
Minimum mandrel diameter:
for ϕ ≤16mm Mandrel dia. = 4ϕ
for ϕ >16mm Mandrel dia. = 7ϕ

Bar Size	6	8	10	12	16	20	25	32	40	50
Hook A	40	50	60	75	100	180	225	290	360	450
Trombone B	60	80	100	120	160	260	325	420	520	650

Minimum L bar dimensions

Bar Size (mm)	6	8	10	12	16	20	25	32	40	50
Minimum radius for scheduling (mm)	12	16	20	24	32	70	87	112	140	175
Minimum end projection [C] (mm)	110	115	120	125	130	190	240	305	380	475



Mass of groups of bars (kg per metre run)

Bar Size (mm)	Number of Bars 1	2	3	4	5	6	7	8	9	10
6*	0.222	0.444	0.666	0.888	1.110	1.332	1.554	1.776	1.998	2.220
8	0.395	0.790	1.185	1.580	1.975	2.370	2.765	3.160	3.555	3.950
10	0.616	1.232	1.848	2.464	3.080	3.696	4.312	4.928	5.544	6.160
12	0.888	1.776	2.664	3.552	4.440	5.328	6.216	7.104	7.992	8.880
16	1.579	3.158	4.737	6.316	7.895	9.474	11.053	12.632	14.211	15.790
20	2.466	4.932	7.398	9.864	12.330	14.796	17.262	19.728	22.194	24.660
25	3.854	7.708	11.562	15.416	19.270	23.124	26.970	30.832	34.686	38.540
32	6.313	12.626	18.939	25.252	31.565	37.878	44.191	50.504	56.817	63.130
40	9.864	19.728	29.592	39.456	49.320	59.184	69.048	78.912	88.776	98.640
50	15.413	30.826	46.239	61.652	77.065	92.478	107.891	123.304	138.717	154.130

NOTE: The weights in the Table for groups of bars are the B.S.I. exact values. *Denotes non-preferred sizes.

Mass in kg per sq metre for various spacings

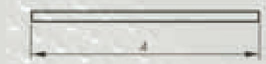
Bar Size (mm)	Spacing of Bars (millimetres) 75	100	125	150	175	200	225	250	275	300
6*	2.960	2.220	1.776	1.480	1.269	1.110	0.987	0.888	0.807	0.740
8	5.267	3.950	3.160	2.633	2.257	1.975	1.756	1.580	1.436	1.317
10	8.213	6.160	4.928	4.107	3.520	3.080	2.738	2.464	2.240	2.053
12	11.840	8.880	7.104	5.920	5.074	4.440	3.947	3.552	3.229	2.960
16	21.053	15.790	12.632	10.527	9.023	7.895	7.018	6.316	5.742	5.263
20	32.880	24.660	19.728	16.440	14.091	12.330	10.960	9.864	8.967	8.220
25	51.387	38. 540	30.832	25.693	22.023	19.270	17.129	15.416	14.015	12.647
32	84.173	63.130	50.504	42.087	36.074	31.565	28.058	25.252	22.956	21.043
40	131.520	98.640	78.912	65.760	56.366	49.320	43.840	39.456	35.869	32.880
50	205.507	154.130	123.304	102.753	88.074	77.065	68.502	61.652	56.047	51.377




BS 8666:2005 Standard Shapes 00 - 99

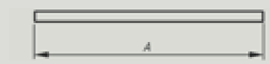
Note: Some shape codes with 3 or more bends may have health & safety implications during manufacture.
For more information and advice on the production of BS8666 shape codes, please contact BAR.

00



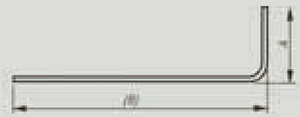
Total length (L) = A

01



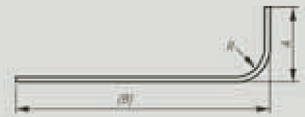
Total length (L) = A, stock lengths

11



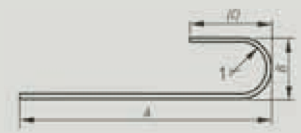
Total length (L) = A + (B) - 0.5r - d

12



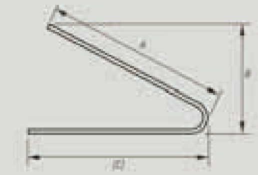
Total length (L) = A + (B) - 0.5r - d

13



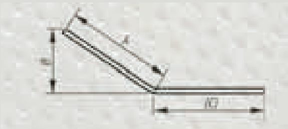
Total length (L) = A + 0.57B + (C) - 1.6d

14



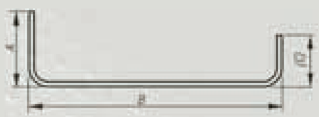
Total length (L) = A + (C) - 4d

15



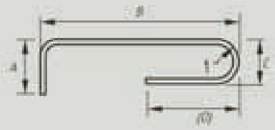
Total length (L) = A + (C)

21



Total length (L) = A + B + (C) - r - 2d

22

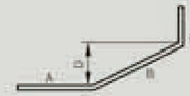


Total length (L) = A + B + C + (D) - 1.5r - 3d

23

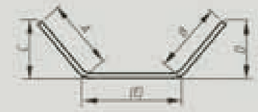
Total length (L) = A + B + (C) - r - 2d

24



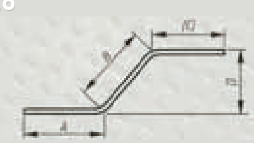
Total length (L) = A + B + (C)

25



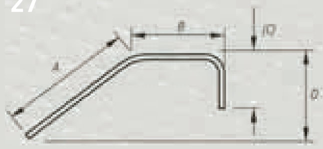
Total length (L) = A + B + (E)

26



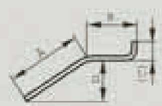
Total length (L) = A + B + (C)

27



Total length (L) = A + B + (C) - 0.5r - d

28

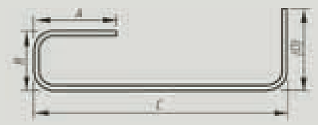


Total length (L) = A + B + (C) - 0.5r - d

29

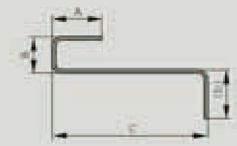
Total length (L) = A + B + (C) - r - 2d

31



Total length (L) = A + B + C + (D) - 1.5r - 3d

32

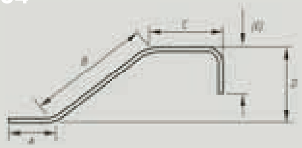


Total length (L) = A + B + C + (D) - 1.5r - 3d

33

Total length (L) = 2A + 1.7B + 2(C) - 4d

34

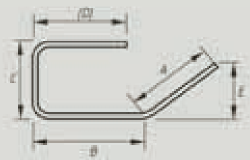


Total length (L) = A + B + C + (E) - 0.5r - d

35

Total length (L) = A + B + C + (E) - 0.5r - d

36

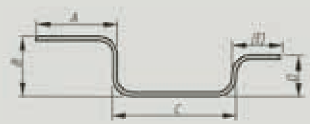


Total length (L) = A + B + C + (D) - r - 2d

41

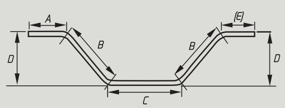
Total length (L) = A + B + C + D + (E) - 2r - 4d

44

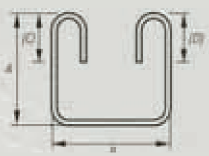


Total length (L) = A + B + C + D + (E) - 2r - 4d

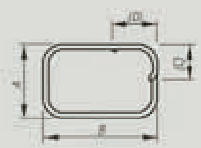
46



47

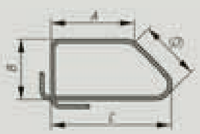


51



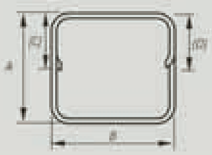
Total length (L) = 2(A + B + (C)) - 2.5r - 5d

56



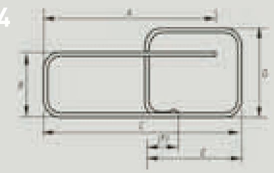
Total length (L) = A + B + C + (D) + 2(E)
- 2.5r - 5d

63



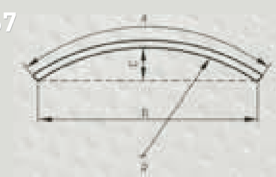
Total length (L) = 2A + 3B + 2(C) - 3r - 6d

64



Total length (L) = A + B + C + 2D + E + (F)
- 3r - 6d

67



Total length (L) = A

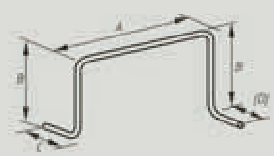
75

Total length (L) = π (A - d) + (B)

77

Total length (L) = C.π. (A - d)

98



Total length (L) = A + 2B + C + (D) -2r - 4d

99

All other shapes where standard shapes cannot be used. No other shape code number, form of designation or abbreviation shall be used in scheduling. A dimensioned sketch shall be drawn over the dimension columns A to E. Every dimension shall be specified and the dimension that is to allow for permissible deviations shall be indicated in parenthesis, otherwise the fabricator is free to choose which dimension shall allow for tolerance.

BAR Membership Directory

BAR members are fully supportive of the Association's objectives aimed at raising the bar for the UK reinforcement sector by:

- Providing a forum in which common issues facing the UK reinforcement industry can be addressed.
- Forwarding and supporting the market share of reinforced concrete against competitive structural materials
- The Association cannot dictate material sourcing but expects its members to, wherever possible, to forward and support the UK steel and reinforcement sectors
- Improving overall quality of the product and service within the UK reinforcement industry, through representation on the Board of CARES (Certification Authority for Reinforcing Steels) and on relevant BSI Technical Committees.
- Improving the health and safety record of the UK reinforcement industry.
- Improving the environmental record of the UK reinforcement industry.
- Actively promoting the UK reinforcement industry's products and capabilities to relevant target audiences.
- Representing the UK reinforcement industry with HM Government, in Europe and with other decision makers.

ArcelorMittal Kent Wire Limited

ArcelorMittal Steel Kent Wire is a wholly owned subsidiary of ArcelorMittal Hamburg, one of Europe's leading wire rod manufacturers and a member of ArcelorMittal, the world's largest steel producer. Kent Wire is the UK's leading manufacturer of fabric reinforcement with a manufacturing capacity of more than 100,000 tpa. Our reinforcement is supplied via a network of specialised stockists in the UK, Ireland and Norway.

ArcelorMittal Kent Wire also supply Pre-Fabricated reinforcement elements through its' trading division ArcelorMittal Chatham Reinforcement Solutions (AMCRS). Prefabricated rebar elements are supplied in the form of specialist pile cages or diaphragm wall panels for building foundations

ArcelorMittal Kent Wire Limited
Chatham Dock, Chatham, Kent ME4 4SW
Tel: 01634 830964
Fabric Supplies
Email: saless@arcelormittalkentwire.co.uk
Web: http://www.arcelormittalkentwire.co.uk
Refabricated Rebar Products
Email: Finbarr@amcs.uk.net
Web: **amcs.uk.net**

BRC Ltd

BRC is the largest supplier of steel reinforcement and associated products in the UK offering a diverse range of reinforcement solutions tailored to meet the specific needs of our customers.

Since our inception in 1908, BRC have been instrumental in the development and advancement of the UK steel reinforcement market. The company has seen strategic incremental growth, expanding its network of depots and portfolio of products and services to meet the dynamic needs of the market. Our responsive and innovative approach to business, coupled with a clear commitment to customer service excellence has galvanized our market position.

Committed to being a sustainable manufacturer and supplier, BRC is certified to ECO Reinforcement and BES 6001, BRE's Framework Standard for the Responsible Sourcing of Construction Products. Furthermore, all BRC depots are certified to ISO 9001, ISO 14001, OHSAS 18001 and are also fully CARES approved.

BRC Ltd
Corporation Road, Newport,
South Wales NP19 4RD
Tel: 01633 280816
Email: enquiries@brc.ltd.uk
Web: **www.brc-reinforcement.co.uk**

Celsa Steel (UK) Ltd

Celsa Steel UK is the largest reinforcement producer in the UK and one of the largest manufacturers of other steel long products. From our Cardiff facilities, including a state-of-the-art shop and production facilities for reinforcing products and wire rod and for merchant bar and light sections, we have the capacity to annually produce and deliver around 1.2 million tonnes of finished product mainly to the UK and Irish markets. Celsa Steel UK is part of the Celsa Group of companies, one of the largest steel producers in Europe.

All product is manufactured via the electric arc furnace method of steel production where we buy scrap metal as raw material and recycle it into finished product.

We supply around 70% of the UK's bar and coil requirements. Celsa produce only the highest grade of reinforcing steel which can be specified in current British and European standards: high ductility Grade B500C to BS 4449:2005.

Celsa Steel UK is certified by CARES to ISO 9001:2008 and by Bureau Veritas to ISO 14001:2004 and OHAS 18001: 2007. In 2008, Celsa became the first steel manufacturer in the world to be certified to ECO Reinforcement and BES 6001, BRE's Framework Standard for the Responsible Sourcing of Construction Products.

Celsa Steel (UK) Ltd
Building 58 East Moors Road, Cardiff CF24 5NN
Tel: 029 2035 1800
Email: general@celsauk.com
Web: **www.celsauk.com**

Dextra

Dextra Manufacturing - UK

Established since 1983, Dextra is a leading manufacturer of engineered construction products for the building and civil works industries. Dextra's quality management system has been ISO 9001-certified since 1996 and ASME-certified since 2009. Our solutions include:

- Mechanical rebar splices, couplers and equipment
- Tension rods for roofs and facades
- Post-tensioning systems
- Marine tie rods
- Ground anchors for soil retention
- Tunneling rockbolts
- Glass fibre and carbon fibre reinforcement
- Sonic tubes for CSL testing

Dextra owns the engineering and manufacturing process of its rebar coupler systems, which have been granted 6 certificates of approval by the UK Certification Authority for Reinforcing Steels (CARES) since 2002. Dextra also designs and manufactures its own rebar preparation equipment, which are maintained in the UK by a local team of engineers, guaranteeing superior level of service and productivity.

Dextra rebar couplers are used every day in high-rise buildings and civil infrastructure projects, in the UK and on all continents. Recent high-profile projects include the T5 and T2B terminals at Heathrow Airport, numerous stations of the London Crossrail project, the Tyne Tunnel in Newcastle, the new Flamanville nuclear power plant in France, the Pentagon headquarters of the ministry of defence in Paris and the Dunkirk LNG terminal in northern France.

Dextra Manufacturing - UK
C16, Langland Park West, Newport, NP19 4PT, United Kingdom
Tel: +44 (0) 114 3211868
Email: rgoodman@dextragroup.com
Web: **www.dextragroup.com**

Express Reinforcements Ltd.

Express Reinforcements Ltd

Express Reinforcements is a market leader in the supply of reinforcing products via its four UK-based fabrication facilities. Our products are all CARES approved and include modular pre-assembly, piling reinforcement, reinforcing bar, Rollmat, fabric reinforcement, couplers and accessories. Our significant capital investment programme enables us to cost effectively provide a wide range of high quality products. In addition, we believe in investing and building long-term business relationships via preferred supplier or supply chain partnering arrangements.

Above all, we are:

- Committed to product and customer service innovation and development
- Dedicated to continual health and safety and environmental improvements
- Focused on delivery and customer satisfaction.

Our range of customer services that includes a design team offering time and cost saving solutions, provision of risk assessment and method statements and customer online order tracking, all combine to provide added value.

Committed to being a sustainable manufacturer and supplier, Express is certified to ECO Reinforcement and BES 6001, BRE's Framework Standard for the Responsible Sourcing of Construction Products. Furthermore, all Express depots are certified to ISO 9001, ISO 14001 and OHSAS 18001.

Express Reinforcements Ltd
Eaglebush Works, Miland Road, Neath, West Glamorgan SA11 1NJ
Tel: 01639 645555
Email: commercial@expressreinforcements.co.uk
Web: **www.expressreinforcements.co.uk**

FRANK®

Max Frank Ltd

Max Frank Ltd. is part of a leading international group which designs, manufactures and supplies a diverse range of structural products and services to enhance the quality and durability of reinforced concrete construction.

Established for almost 60 years, the company's product range includes:

- Fibre concrete block and bar spacers
- Permanent formwork, ground heave solutions and formwork liners

- CARES approved punching shear reinforcement and concrete connections
- Waterstops, sealants and injection hose systems
- Sound absorbing spacers and decoupling products

Max Frank produce and supply individual and coherent project solutions from its Staffordshire-based manufacturing centres. The highest product quality and diversity, paired with comprehensive service to reinforced concrete industries, makes Max Frank the partner of choice for Contractors, Engineers and Architects. Further information can be viewed and downloaded from our website.

Max Frank Ltd
Whittle Road, Meir, Stoke-on-Trent,
Staffordshire ST3 7HF
Tel: 01782 598041
Email: info@maxfrank.co.uk
Web: **www.maxfrank.co.uk**

PENTAIR

Pentair Electrical & Fastening Solutions (ERICO International Corporation)

Pentair Technical Solutions is a global leader of systems and solutions that safeguard industrial controls, electrical components, communications hardware, electronic devices, pipelines, processes and buildings. Pentair Electrical & Fastening Solutions (EFS), offered through CADDY, ERICO, ERIFLEX and LENTON, manufacture and market superior engineered electrical and fastening products for niche electrical, mechanical and concrete applications.

Headquartered in Solon, Ohio, USA, Pentair EFS operations span more than 30 countries and sales distribution facilities worldwide. Products are sold under market-leading brands:

- CADDY—Fixing, fastening and support products for use in electrical installation, datacom, telecom, fire protection, seismic and HVAC applications;
- ERICO—Grounding, bonding, lightning protection and electrical rail connection solutions for commercial, industrial, utility, rail, alternative energy and telecom end-user groups;
- ERIFLEX—Low-voltage power and grounding connections for original equipment manufacturers, panel builders and targeted industries;
- LENTON—Engineered products for concrete reinforcing steel connections.

LENTON® mechanical rebar splicing systems provide superior continuity and structural integrity to reinforced concrete construction on many prestigious projects worldwide. LENTON mechanical couplers are used worldwide and have many product approvals, including CARES, IAPMO, ASME, DIBT and AFCAB.

As a pioneer in the construction industry, ERICO has the experience and resources to help select the LENTON® system to best meet your cast-in-place or precast applications. LENTON products also provide solutions for specialized market applications, including nuclear, cryogenic and masonry.

Pentair Electrical & Fastening Solutions
20-22 Bedford Row, London, WC1R 4JS
Tel: 07887 764 210
Email: mark.allen@pentair.com
Web: **www.erico.pentair.com**

outokumpu
stainless steel & high performance alloys

Outokumpu Stainless Limited

Our integrated mill features one of the most advanced melt shops and continuous casting operations in Europe. Capable of 500,000 tons per year, it feeds billets to the neighbouring ASR Rod Mill in Sheffield, UK, for hot rolling into CARES approved BS6744 rebar diameters 8m to 25mm. The rebar is first produced in coils and then pickled to form the protective oxide film that makes stainless steel the obvious choice for corrosion resistant reinforcement.

The ASR mill is capable of 50,000 tonnes of rod coil production per year in a large array of stainless alloy designations. The coils are then forwarded to bar finishing for either dispatch as coils, straightenend into standard 12m lengths or cut and bent to CARES approved BS8666 to your rebar schedule. Delivery is either by truck for continental Europe or in containers for intercontinental shipping.

We are committed to maintaining quality systems and producing quality products and have the following accreditions: ISO 9001: 2015 for Quality; ISO 14001: 2015 for Environment; OHSAS 18001: 2007 for Health and Safety.

Outokumpu Stainless Limited
P.O. Box 161, Europa Link, Sheffield, S9 1TZ
Tel: 0114 2615234
Email: sales.rebar@outokumpu.com
Web: **www.outokumpu.com**

RFA-Tech Ltd

Established for over forty years as one of the UK's leading specialist construction accessory suppliers, RFA-Tech has built-up an enviable reputation for providing a wide product range together with a rapid and efficient service. RFA-Tech is recognised as a market leader, supplying major contractors and blue-chip companies, and our continual development maintains and enhances this prominent position. Our product range and market coverage includes:-

RFA-Tech Construction Accessories supply the industry tailor-made and stocked accessory items directly from our well-stocked regional depots throughout the UK.

RFA-Tech Engineered Solutions manufacturing facility in Sheffield has ISO9001 and ISO14001 accreditation, and we are proud members of the 'Made in Sheffield' trademark group. With over 30 years of manufacturing experience in reinforcement connection systems, we have the flexibility to produce bespoke solutions to suit individual site requirements, offering a rapid response as well as full technical support.

RFA-Tech Precast Lifting Solutions supplies an extensive range of precast lifting and fixing products and systems for concrete manufacturers. We provide engineered solutions for bespoke precast applications and have a dedicated team of experienced personnel offering sales and technical support to assist in all types of projects.

Our test and inspection laboratory situated in Lichfield, has a comprehensive range of test and inspection equipment calibrated to UKAS standards.

RFA-Tech
RFA-Tech Ltd Eastern Avenue Trent Valley
Lichfield Staffs WS13 6RN.
Tel: 0870 0112881
Email: sales@rfa-tech.co.uk
Web: **www.rfa-tech.co.uk**

ROM UK Ltd

ROM is one of the UK's leading specialist reinforcement manufacturers. ROM is a tried, tested and trusted company with a reputation for quality and service. Rom not supply fabric and bar reinforcement but also a complete range of associated accessories in order to provide a one-stop option.

ROM have set in place a policy of continuous improvement in all of our business activities. Working as a team, its steadfast intent is to develop the skills and knowledge of all our employees to create a culture where faultless service and zero defects are the norm. Our production processes and products are CARES approved.

We want our customers to think first of ROM and join us in a partnership in of co-operation that promotes best practice and innovative solutions.

All ROM depots are CARES approved. ROM is also certified to ISO 9001, ISO 14001, OHAS 18001. To demonstrate our commitment to being a sustainable manufacturer, we have achieved accreditation to Eco-Reinforcement, and BES 6001, BRE's Framework Standard for the Responsible Sourcing of Construction Products.

ROM UK Ltd
Eastern Ave, Trent Valley, Lichfield,
Staffordshire WS13 6RN
Tel: 0870 011 2883
Email: sales@rom.co.uk
Web: **www.rom.co.uk**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