British Standard

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BRITISH STANDARD

BS 3974-2:
1978

Incorporating Amendment No. 1

Specification for

Pipe supports —

Part 2: Pipe clamps, cages, cantilevers and attachments to beams

Cooperating organizations

The Mechanical Engineering Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

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Association of Consulting Engineers
Association of Hydraulic Equipment Manufacturers
Association of Mining Electrical and Mechanical Engineers
British Compressed Air Society
British Electrical and Allied Manufacturers Association (BEAMA)
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High Pressure Pipework Consultative Committee
Low Pressure Pipework Conference

This British Standard, having been prepared under the direction of the Mechanical Engineering Standards Committee, was published under the authority of the Executive Board on 31 August 1978

The following BSI references relate to the work on this standard:
Committee reference MEE/160
Draft for comment 76/77099 DC

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Amendments issued since publication

Amd. No.	Date of issue	Comments
3790	December 1981	Indicated by a sideline in the margin

Contents

Foreword

This Part of BS 3974 is an extension of the metric revision of BS 3974-1 which was published in 1974 under the direction of the Mechanical Engineering Standards Committee.

It gives requirements for the manufacture of further components used in connection with pipe supports. It also gives guidance on design data and formulae for pipe support calculations and methods of fixing.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 44, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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1 Scope

This Part of BS 3974 specifies dimensions of pipe clamps, cages, cantilevers and beam attachments and is an extension of Part 1. Temperature conditions are specified for certain components.

NOTE Unless otherwise specified, all the dimensions given in this standard are in millimetres.

2 References

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

3 Definitions

For the purposes of this Part of BS 3974 the following definitions apply (see also BS 3974-1).

3.1
beam clips

components that attach a supplementary steelwork member to the base of structural steelwork beams thus avoiding drilling or welding

3.2
riser clamp

a component for supporting vertical pipework

3.3
spring cage

a U-shaped component that can be attached to horizontal steelwork from which a sling rod can be hung. The cage is of sufficient size to hold a variable load spring

3.4
sling rod cage

similar to a spring cage, the cage to be of sufficient size to hold a spherical washer

3.5
restraint

a device that partially or totally restricts movement in one or more directions

4 Materials

The following are the preferred materials from which components of pipe support assemblies are to be manufactured. Other materials may be used providing they have equal or higher physical properties:

Schedule of materials	
Component	**Material reference**
Beam clips	BS 4360: grade 43A
Spring cages	BS 4360: grade 43A
Sling rod cages	BS 4360: grade 43A
Dee shackles	BS 970-1. grades 080A27, 080A30 or 150M28
Riser clamps Range A: – 20 °C to 100 °C Range B: – 20 °C to 400 °C Range C: Over 400 °C to 470 °C	 BS 4360: grade 43A BS 1501-151[a]: grade 26B and BS 1501-161[a]: grade 26B
Support feet	See text
Tubular components	BS 1387, medium or heavy, BS 1775 HFS13 or HFW13
Bolts and nuts For riser clamps over 400 °C For other uses	 BS 3692: grade 8.8 BS 4190: grade 4.6
[a] See BS 1501-1.	

5 Beam clips

5.1 Universal beam clip

5.1.1 *Materials and dimensions*. Beam clips for universal beam applications shall be constructed preferably from materials specified in clause **4**.

Dimensions shall be as given in Table 1(a) and Table 1(b) and as illustrated in Figure 1.

5.1.2 *Design*. The following notes refer to Table 1(a) and Table 1(b).

a) All the clip loads (*W*) have been calculated with the bolt stress as the limiting factor.

b) Allowable stresses and bolt hole to edge of clip dimensions from BS 449-2. Bolt stresses were derated by 25 % to allow for shock loading.

Maximum bolt loads for BS 4190: grade 4.6 steel bolts are:

M16:1 560 kg

M20:2 435 kg

M22:3 012 kg

c) The dimensions *C* conform to bar diameters specified in BS 4229-2.

d) Rolled steel angles (RSA) shall be as specified in BS 4848-4.

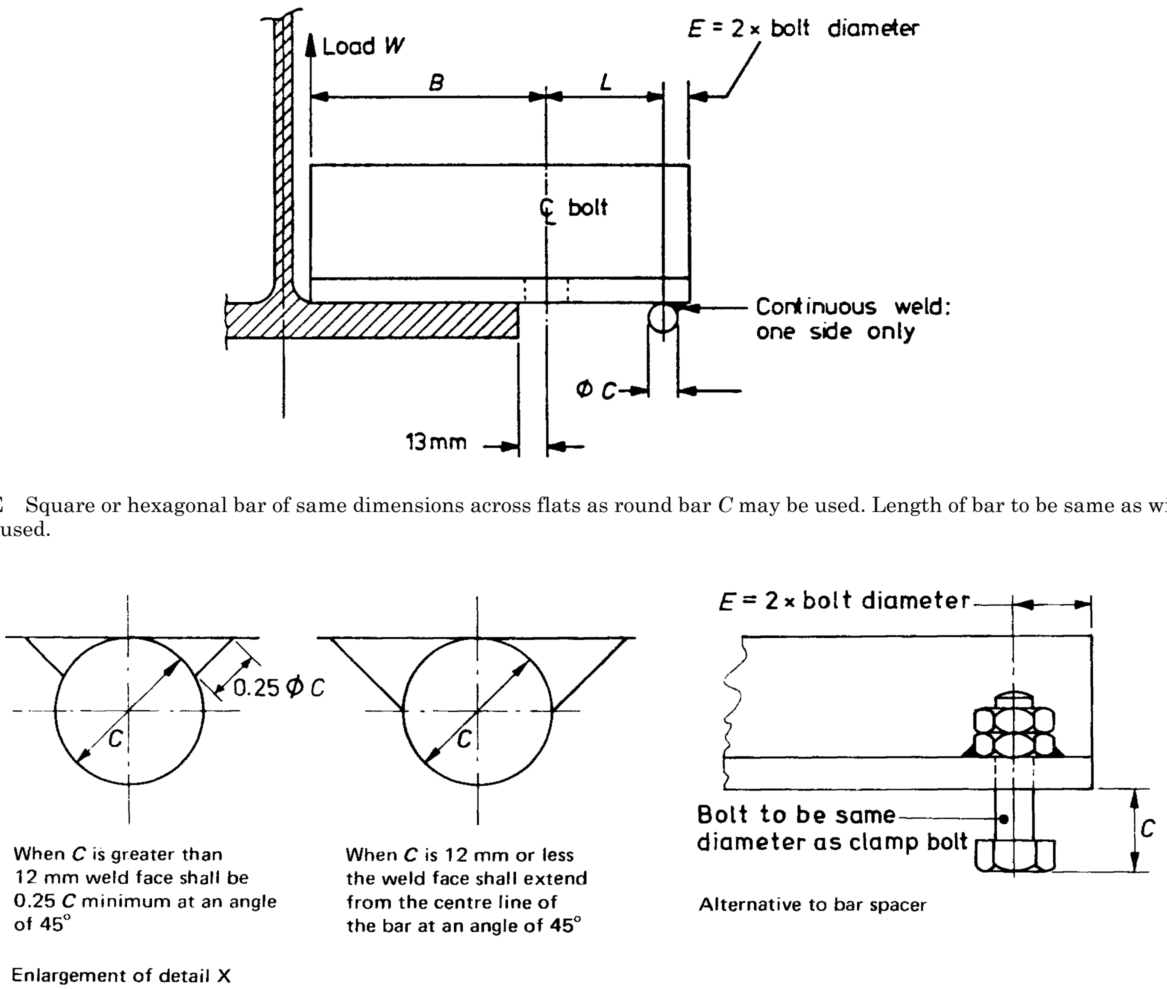
e) The beam clip allowable loads *W* are determined by the strength of the clip and bolt only. Due account shall be taken of the strength of the universal beam.

f) The method of calculating the load *W* is given in Appendix D.

g) The beam clip dimensions and loads given in Table 1(a) and Table 1(b) are suitable for use with universal beams with taper flanges.

5.2 Rolled steel joist (RSJ) clips. The beam clips specified in **5.1** may be adapted for rolled steel joists provided dimension *C* in Table 1(a) is suitably modified.

5.3 Applications. Typical applications in the use of beam clips are shown in Figure 2.



NOTE Square or hexagonal bar of same dimensions across flats as round bar *C* may be used. Length of bar to be same as width of angle used.

Figure 1 — Universal beam clip

Table 1(a) — Dimensions of clips for universal beams *(see Figure 1)*

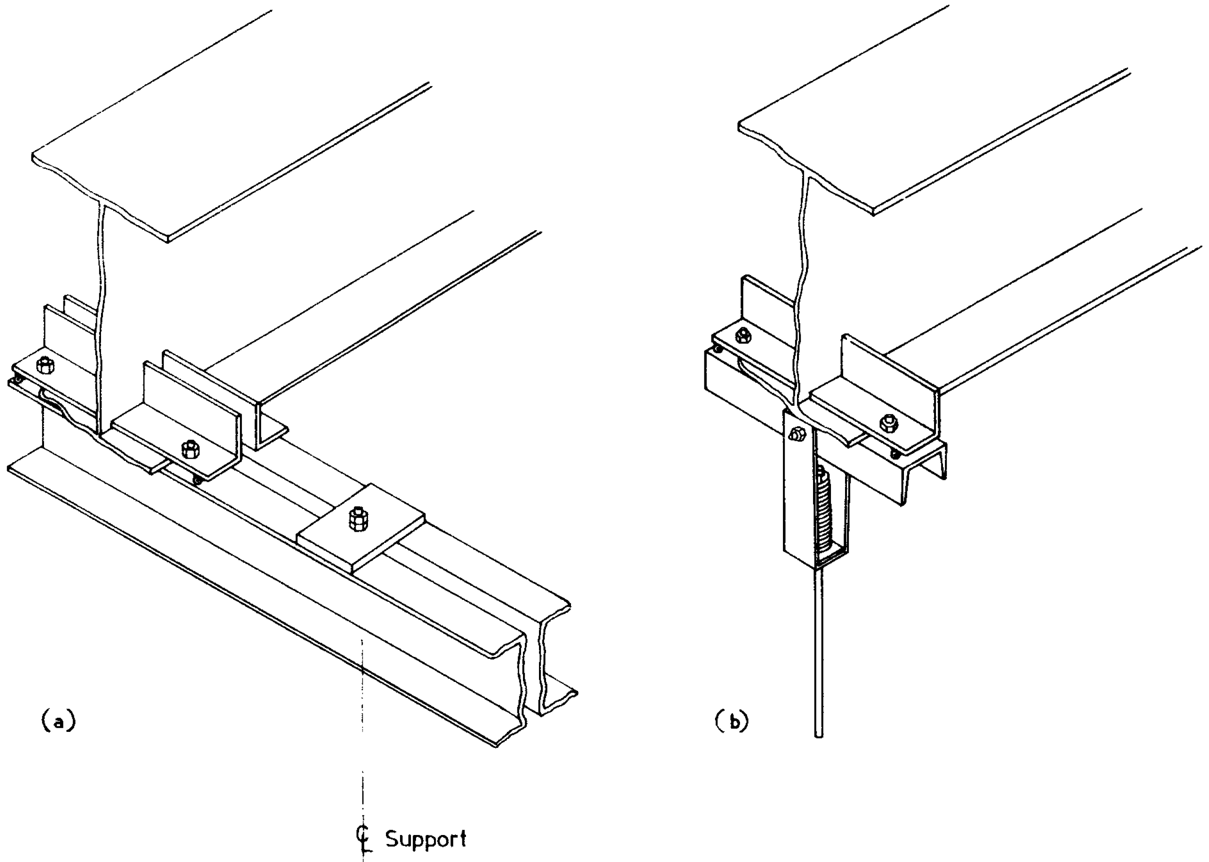
Beam: Depth × width	Beam: Mass/length (kg/m)	Beam clip dimensions: *B*	Beam clip dimensions: *C*
914 × 419	388	188	40
	343		35
914 × 305	289	137	35
	253		30
	224		25
	201		25
610 × 305	238	127	32
	179		25
	149		20
838 × 292	226	133	30
	194		25
	176		20
762 × 267	197	122	30
	173		25
	147		20
686 × 254	170	117	25
	152		25
	140		20
	125		20
610 × 229	140	108	25
	125		20
	113		20
	101		16
533 × 210	122	99	25
	109		20
	101		20
	92		16
	82		16
457 × 191	98	93	20
	89		20
	82		16
	74		16
	67		16
406 × 178	74	87	16
	67		16
	60		16
	54		12
356 × 171	67	84	16
	57		16
	51		12
	45		10
305 × 165	54	83	16
	46		12
	40		12
457 × 152	82	75	20
	74		20
	67		16
	60		16
	52		12
254 × 146	43	75	16
	37		12
	31		10
406 × 140	46	70	12
	39		10
203 × 133	30	68	10
	25		8
356 × 127	39	62	12
	33		10
305 × 127	48	62	16
	42		16
	37		12
305 × 102	33	52	12
	28		10
	25		8
254 × 102	28	52	10
	25		10
	22		8

NOTE Dimension *A* as shown in Figure 1 and Table 1(a) is the thickness of the beam flange at the point of contact of the beam clip on beams rolled with a taper flange only; for dimension *L*, size of RSA size of bolt and corresponding maximum load *W*, see Table 1(b).

Table 1(b) — Maximum loads "*W*" for beam clips for universal beam application *(see Figure 1)*

Length *L*	Rolled steel angle size	Bolt size	Length *B*															
			52	62	68	70	75	83	84	87	93	99	108	117	122	133	137	188
			Maximum load *W* (in kg)															
35	70 × 70 × 10	M16	630	565	530	520	495	465	460	450	425	410	380	360	350	325	315	245
	80 × 80 × 10	M20	980	880	825	810	775	720	715	700	665	635	595	560	545	505	495	380
	90 × 90 × 12	M22	1 210	1 085	1 025	1 005	960	895	885	865	825	785	735	695	670	630	615	475
50	70 × 70 × 10	M16	765	695	660	650	620	585	580	565	545	520	490	465	450	425	415	325
	80 × 80 × 10	M20	1 190	1 085	1 030	1 010	970	915	905	885	850	815	770	725	705	665	650	510
	90 × 90 × 12	M22	1 475	1 340	1 275	1 255	1 200	1 130	1 120	1 095	1 050	1 010	950	900	875	820	805	630
75	70 × 70 × 10	M16	920	850	815	805	780	740	735	720	695	670	635	605	590	560	550	445
	80 × 80 × 10	M20	1 435	1 330	1 275	1 255	1 215	1 155	1 145	1 125	1 085	1 045	995	950	925	875	860	690
	90 × 90 × 12	M22	1 775	1 645	1 575	1 555	1 505	1 425	1 420	1 390	1 340	1 295	1 230	1 175	1 145	1 085	1 065	855
100	70 × 70 × 10	M16	1 025	960	925	915	890	850	845	830	805	780	750	715	700	665	655	540
	80 × 80 × 10	M20	1 600	1 500	1 445	1 430	1 390	1 330	1 320	1 300	1 260	1 220	1 170	1 120	1 095	1 045	1 025	845
	90 × 90 × 12	M22	1 980	1 855	1 790	1 770	1 720	1 645	1 635	1 610	1 560	1 510	1 445	1 385	1 355	1 290	1 270	1 045
125	70 × 70 × 10	M16	1 100	1 040	1 010	1 000	975	935	930	920	895	870	835	805	785	755	740	620
	80 × 80 × 10	M20	1 720	1 625	1 575	1 560	1 520	1 460	1 455	1 435	1 395	1 355	1 305	1 255	1 230	1 180	1 160	970
	90 × 90 × 12	M22	2 125	2 010	1 950	1 930	1 880	1 810	1 800	1 775	1 725	1 680	1 615	1 555	1 520	1 455	1 435	1 200
150	70 × 70 × 10	M16	1 155	1 100	1 070	1 060	1 040	1 000	1 000	985	960	940	905	875	860	825	815	690
	80 × 80 × 10	M20	1 805	1 720	1 675	1 660	1 620	1 565	1 560	1 540	1 500	1 465	1 415	1 365	1 340	1 290	1 270	1 080
	90 × 90 × 12	M22	2 235	2 130	2 070	2 050	2 005	1 935	1 930	1 905	1 855	1 810	1 750	1 690	1 660	1 595	1 570	1 335
175	70 × 70 × 10	M16	1 200	1 150	1 120	1 110	1 090	1 055	1 050	1 040	1 015	995	965	935	915	885	875	750
	80 × 80 × 10	M20	1 875	1 795	1 750	1 735	1 705	1 650	1 645	1 625	1 590	1 555	1 505	1 455	1 435	1 380	1 365	1 170
	90 × 90 × 12	M22	2 320	2 220	2 165	2 150	2 105	2 040	2 035	2 010	1 965	1 920	1 860	1 805	1 775	1 710	1 685	1 450

NOTE The load given above refers to the load taken by each individual beam clip.



NOTE The strength and stability of the supporting steelwork shown requires separate consideration

Figure 2 — Typical applications of beam clips

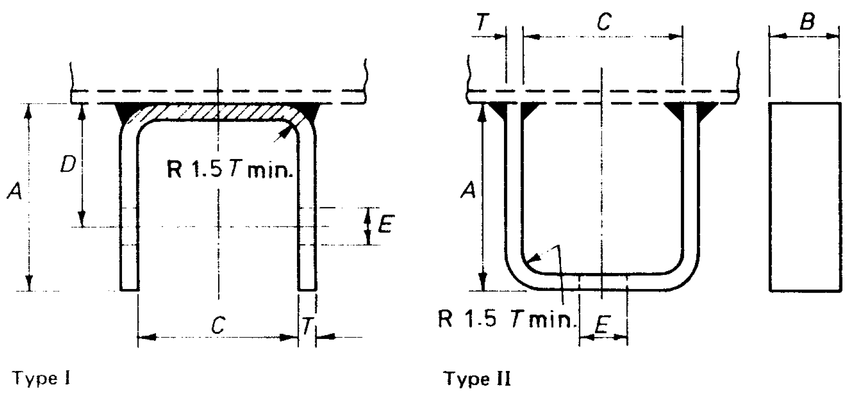


Figure 3 — Beam welding attachments

6 Beam welding attachments

Two types of beam welding attachments are specified:

Type I: Inverted U-shape attachment

Type II: U-shape attachment.

6.1 Details and dimensions. The dimensions of attachments shall be as given in Figure 3 and Table 2. Account shall be taken of the strength of welds and, in this respect, reference shall be made to clause **12**.

6.2 Interchangeability. These attachments are interchangeable if supplied with all three holes drilled, as given in Table 2.

Table 2 — Dimensions of U-shape and inverted U-shape beam welding attachments

Sling rod diameter	Material size $B \times T$	*A*	*C*	*D*	Hole diameter *E*	Bolt or rod diameter	Safe working load kg
8	50 × 6	75	40	50	14	12	230
10	50 × 6	75	40	50	14	12	360
12	50 × 6	75	40	50	18	16	550
16	75 × 10	85	60	55	22	20	1 010
20	75 × 12	85	70	55	27	24	1 580
24	100 × 12	115	75	80	33	30	2 280

7 Cages

7.1 General. Cages are designed to be attached to the underside of beams and joists for the purpose of suspending sling rods.

Cages are included for use with or without springs and for attachment to rolled steel joists and universal beams.

They are included for rolled steel joists to cater for existing structures.

Sling rod cages and spring cages type "U" are intended for use on universal beams having parallel or taper flanges and shall not be used on rolled steel joists.

Sling rod cages and spring cages type "R" are intended for use on rolled steel joists having 5° taper flanges and shall not be used on universal beams.

7.2 Spring cages. Spring cages are illustrated in Figure 4 for type "U" and in Figure 5 for type "R". Dimensions shall be as given in Table 3 and Table 4 respectively.

Spring cages shall be constructed from materials specified in clause **4**.

The depth of the cage shall allow for the "free" length of the spring plus an allowance for the thickness of spring washers, sling rod nuts, etc.

The inside dimension of the base (*Y*) shall be equal to the maximum diameter of the lower spring washer plus approximately 10 mm.

The inside dimension of the cage at the top attachment shall be not less than dimension *Y*.

When used on beams or joists having flanges greater than the selected dimension "Y", the sides of the cage shall be inclined to suit but this inclination shall not exceed 25° from the vertical for standard cages. If necessary, spring cages may be increased in depth in order to comply with this limitation on inclination.

NOTE Where the limit on inclination would be exceeded and the cage cannot be increased in depth, standard cages should not be used unless a design check is carried out. Alternatively, the standard form of cage may be used but the method of attachment to beams, etc., has to receive special consideration.

An illustration of a typical spring cage assembly is shown in Figure 6.

7.2 Sling rod cages. Sling rod cages are illustrated in Figure 7 for type "U" and in Figure 8 for type "R".

Dimensions shall be as given in Table 5 and Table 6 respectively.

Sling rod cages shall be constructed from materials specified in clause **4**.

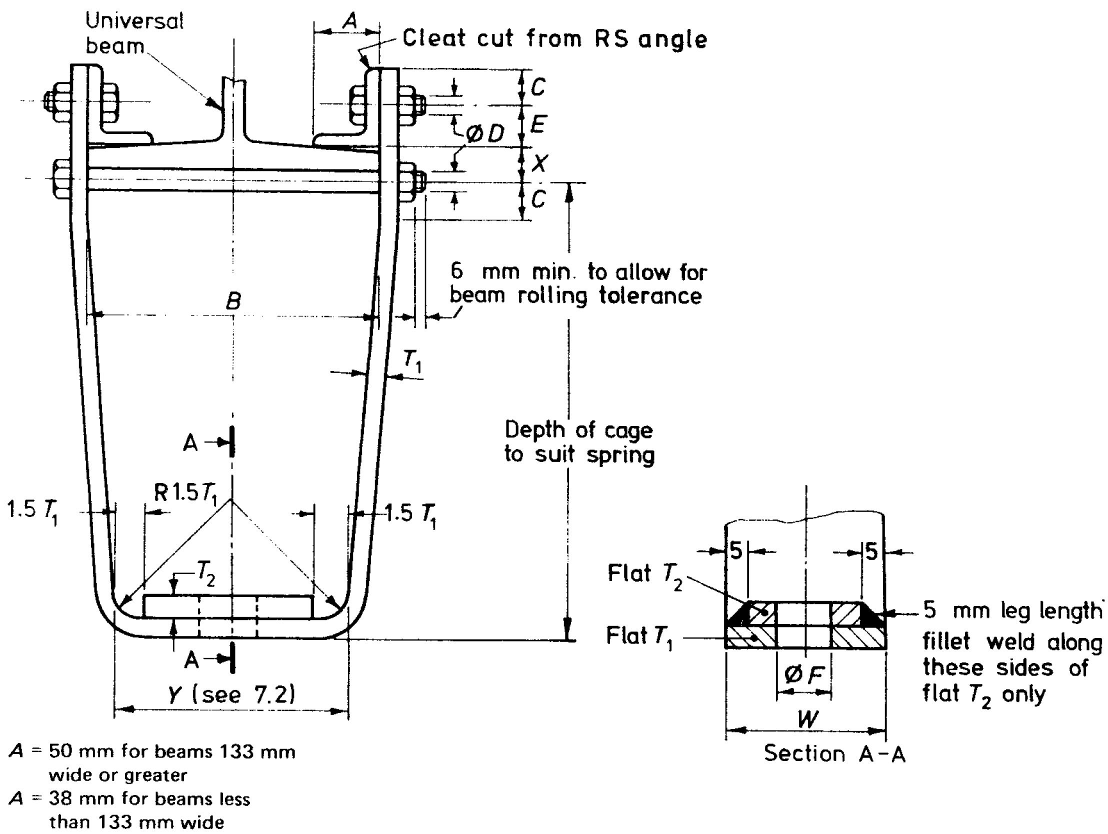
When used on wide beams the depth (*H*) of the standard cage may be increased if necessary so that the inclination of the sides does not exceed 25° from the vertical.

As a guide, the maximum beam widths for which the standard sling rod cage depths are suitable, are as follows:

Sling rod diameter	8	10	12	16	20	24	30	36	42
Maximum beam width	191	191	191	210	229	254	292	330	330

NOTE Where the limit on inclination would be exceeded and the cage cannot be increased in depth, standard cages should not be used unless a design check is carried out. Alternatively, the standard form of cage may be used but the method of attachment to beams, etc., has to receive special consideration, see Figure 9.

7.4 Attachment to universal beams. Where cages are attached in the lower flanges of universal beams, the loading on the lower flange shall be considered to act at the toe of the flange (see **13.2**).



NOTE 1 *B* is the "width of section" given in BS 4-1.

NOTE 2 $X = T + \frac{D}{2}$, where *T* is the "flange thickness" given in BS 4-1.

Figure 4 — Spring cage, type U: universal beam

Table 3 — Dimensions of spring cage, type U: universal beam

Sling rod diameter *D*	Width *W* for flat T_1 and cleats — Spring inside diameter 45 to 65	100	140	Thickness of flats T_1	T_2	Hole diameter *F*	Angle size	Bolt size *D*	Bolt hole	*C*	*E*	Safe working load
												kg
8	80	—	—	6	8	12	*A* × 30 × 5	M8	9	10	20	230
10	80	—	—	6	—	16	*A* × 40 × 6	M10	11	15	25	360
12	80	100	130	8	10	18	*A* × 50 × 8	M12	14	20	30	530
16	80	100	130	10	10	22	*A* × 65 × 8	M16	18	30	35	1 010
20	80	100	130	10	12	30	*A* × 75 × 8	M20	22	35	40	1 580
24	90	100	130	12	15	33	*A* × 100 × 12	M24	26	45	55	2 280
30	90	100	130	15	20	43	*A* × 100 × 12	M30	33	45	55	3 650
36	—	100	130	20	25	48	*A* × 125 × 12	M36	39	60	65	5 340
42	—	100	130	25	35	56	*A* × 150 × 15	M42	45	75	75	7 400

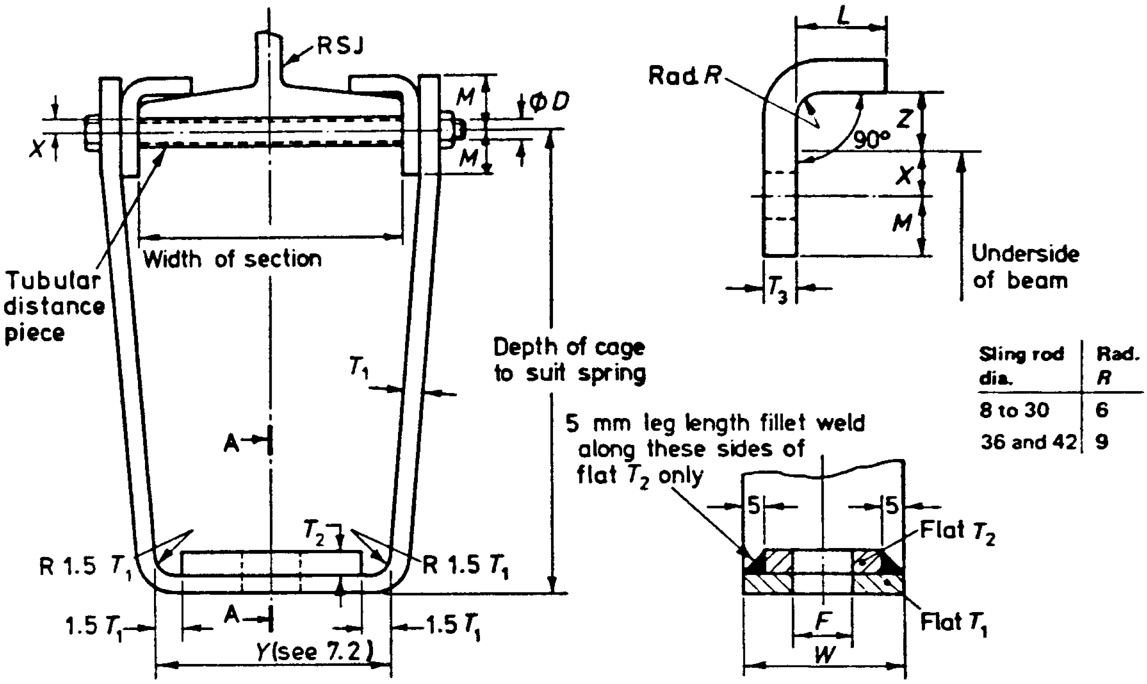


Figure 5 — Spring cage, type R: rolled steel joist

Table 4 — Dimensions of spring cage, type R: rolled steel joist

Sling rod diameter	Width W for flats T_1 and cleats T_3 — Spring inside diameter			Thickness of flats T_1 T_2 — Spring inside diameter			T_3	Hole Diameter F	Bolt size D	Bolt hole diameter	Tubular distance piece. Nominal size	Cleat				Safe working load
	45 to 65	100	140	45 to 65 (T_1)	45 to 65 (T_2)	100 to 140						L	M	X	Z	kg
8	80	—	—	6	8	—	8	12	M8	9	8	15	20	8	10	230
10	80	—	—	6	10	—	8	16	M10	11	10	20	20	9	10	360
12	80	100	130	8	10	10	10	18	M12	14	15	20	25	10	10	530
16	80	100	130	10	10	10	10	22	M16	18	20	20	30	12	10	1 010
20	80	100	130	10	12	12	15	30	M20	22	20	25	30	14	12	1 580
24	90	100	130	12	12	15	15	33	M24	26	25	25	40	18	12	2 280
30	90	100	130	15	15	20	20	43	M30	33	32	25	50	20	12	3 650
36	—	100	130	20	—	25	25	48	M36	39	40	30	65	24	12	5 340
42	—	100	130	25	—	35	25	56	M42	45	50	20	75	28	14	7 400

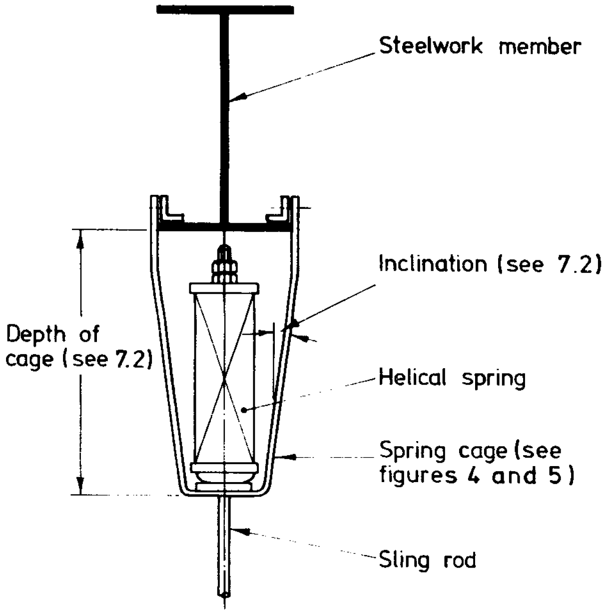
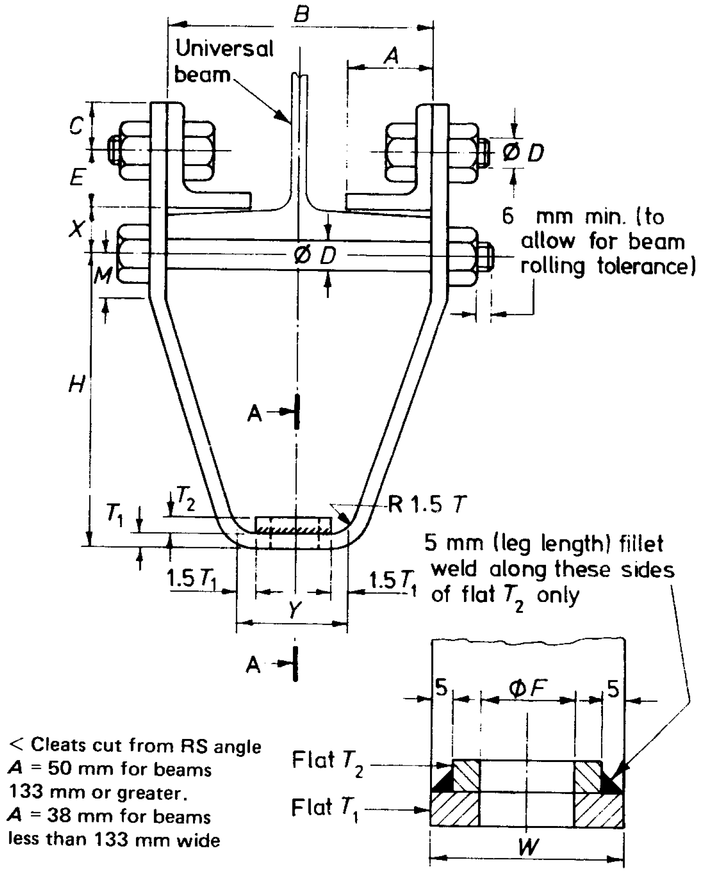


Figure 6 — Typical spring cage assembly



NOTE 1 *B* is the "width of section" given in BS 4-1.

NOTE 2 $X = T + \frac{D}{2}$, where *T* is the "flange thickness" given in BS 4-1.

Figure 7 — Sling rod cage, type U: universal beam

Table 5 — Dimensions of sling rod cage, type U: universal beam

Sling rod diameter	Width W for flat T_1 and cleat	Thickness of flats		Size of angle	Dimensions					Hole diameter F	Bolt size D	Bolt hole diameter	Safe working load
		T_1	T_2		C	E	H	M	Y				kg
8	35	8	8	A × 30 × 5	10	20	165	20	50	12	M8	9	230
10	35	8	8	A × 40 × 6	15	25	170	20	50	16	M10	11	360
12	45	8	8	A × 50 × 8	20	30	170	25	55	18	M12	14	530
16	45	10	10	A × 65 × 8	30	35	180	30	70	22	M16	18	1 010
20	60	15	10	A × 75 × 8	35	40	200	30	90	30	M20	22	1 580
24	80	15	10	A × 100 × 12	45	55	210	40	95	33	M24	26	2 280
30	90	15	15	A × 100 × 12	45	55	240	50	115	43	M30	33	3 650
36	100	20	20	A × 125 × 12	60	65	275	65	140	48	M36	39	5 340
42	130	25	25	A × 150 × 15	75	75	305	75	165	56	M42	45	7 400

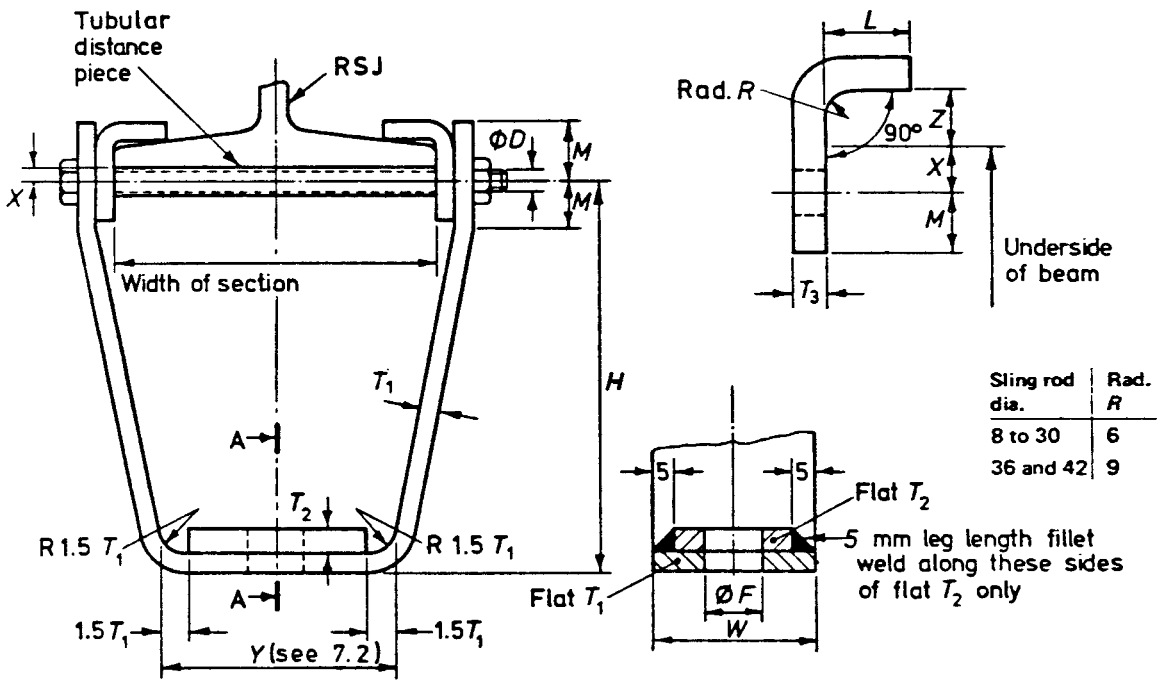


Figure 8 — Sling rod cage, type R: rolled steel joist

Table 6 — Dimensions of sling rod cage, type R: rolled steel joist

Sling rod diameter	Width *W* for flats T_1 and T_3	Thickness of flats			*H*	Y	Hole diameter *F*	Bolt size *D*	Bolt hole diameter	Tubular distance piece. Nominal size	Cleat				Safe working load
		T_1	T_2	T_3							*L*	*M*	*X*	*Z*	
															kg
8	35	8	8	8	165	50	12	M8	9	8	15	20	8	10	230
10	35	8	8	8	170	50	16	M10	11	10	20	20	9	10	360
12	45	8	8	10	170	55	18	M12	14	15	20	25	10	10	530
16	45	10	10	10	180	70	22	M16	18	20	20	30	12	10	1 010
20	60	15	10	15	200	90	30	M20	22	20	25	30	14	12	1 580
24	80	15	10	15	210	95	33	M24	26	25	25	40	18	12	2 280
30	90	15	15	20	240	115	43	M30	33	32	25	50	20	12	3 650
36	100	20	20	25	275	140	48	M36	39	40	30	65	24	12	5 340
42	130	25	25	25	305	165	56	M42	45	50	30	75	28	14	7 400

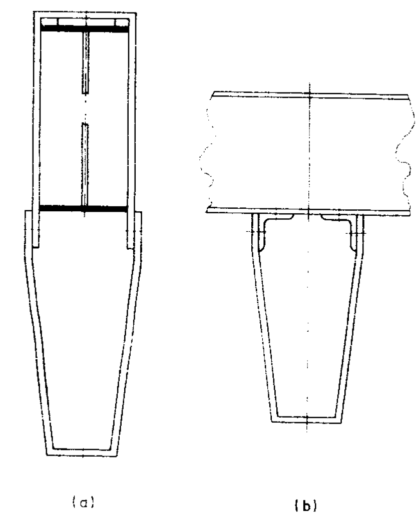


Figure 9 — Alternative methods of attaching cages

8 Dee shackles

8.1 The dimensions of dee shackles shall be as given in Figure 10 and Table 7 and shall be manufactured from materials specified in clause **4**.

The dee shackles specified are metric equivalents of the small dee shackles derived from BS 3032 but have plain instead of threaded holes. The shouldered bolt for support applications is detailed and shall be manufactured from metric size materials.

8.2 A typical method of suspending dee shackles is shown in Figure 11.

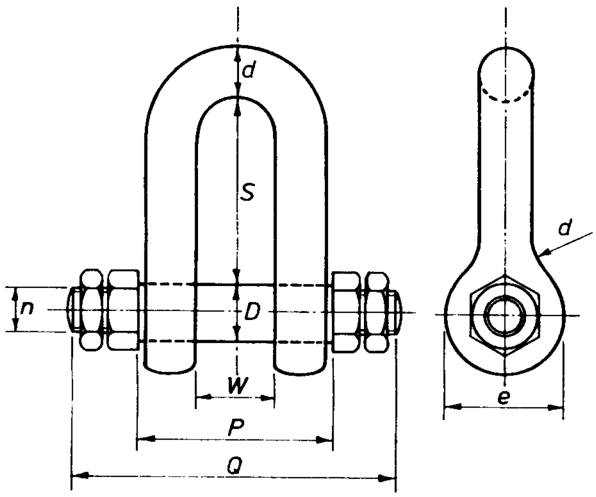


Figure 10 — Dee shackles

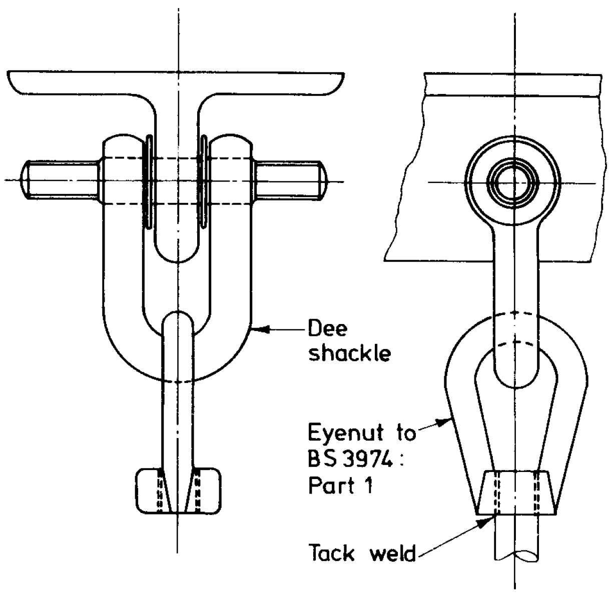


Figure 11 — Typical method of suspending dee shackles and weldless eyenuts

Table 7 — Dimensions of dee shackles

Associated sling rod diameter	Safe working load	*d*	*D*	*W*	*S*	*e*	*P*	*Q*	*n*
	kg								
8	230	6.3	10	9.5	22	19	25	45	M6
10	360	9.5	12	16	35	25	38	76	M10
12	530								
16	1 010	12.7	16	22	48	32	51	97	M12
20	1 580	16	20	25	57	38	60	120	M16
24	2 280	19	24	32	70	44	73	133	M20
30	3 650	25	30	38	92	57	91	180	M24
36	5 340	32	36	48	114	70	115	225	M30
42	7 400	38	42	60	140	89	139	271	M36

NOTE The safe working load specified is based upon the safe working load of associated sling rods. The actual safe working loads for shackles complying with BS 3032 are higher than those given in the table.

9 Riser pipe clamps

9.1 Design temperature. For the purposes of this British Standard the design temperature for clamps in direct contact with the pipe shall be that of the fluid in the pipe. However, where the clamp is in direct contact with load bearing insulation, the design temperature shall be that of the outer surface of the insulation.

9.2 Tubular distance pieces. The lengths *J* given in Table 8(a), Table 9(a) and Table 10 are based on using the sling rod with a screwed, machined eye in accordance with Figure 1 of Part 1:1974 of this standard. Where sling eyes in accordance with Figures 2 or 3 of Part 1:1974 are used, suitable packing pieces shall be made on each side of the eye, allowing a total clearance of 3 mm.

9.3 Support lugs. Design methods are available, such as in BS 5500, that will enable a check to be made on the suitability of the pipe to withstand the stresses imposed upon it by the support lugs.

9.4 Riser pipe clamps for maximum temperature of 400 °C. Riser pipe clamps, suitable for temperatures up to and including 400 °C, illustrated in Figure 12 and Figure 13, shall be constructed from materials specified in clause **4** for the appropriate temperature range.

Dimensions for riser pipe clamps up to 300 mm nominal size are given in Table 8(a) and for sizes ranging from 350 mm to 600 mm are given in Table 9(a). The maximum load to be applied to riser clamps detailed in Table 8(a) and Table 9(a) are listed in Table 8(b) and Table 9(b) respectively.

9.5 Riser pipe clamps for maximum temperature of 470 °C. Riser pipe clamps, suitable for temperatures up to and including 470 °C, illustrated in Figure 14 shall be constructed from materials specified in clause **4** for the appropriate temperature range. The tubular distance piece shall be manufactured from heavy tube complying with the requirements of BS 1387 or from tube of equivalent cross-sectional area.

Dimensions for riser clamps up to and including 600 mm nominal size are given in Table 10.

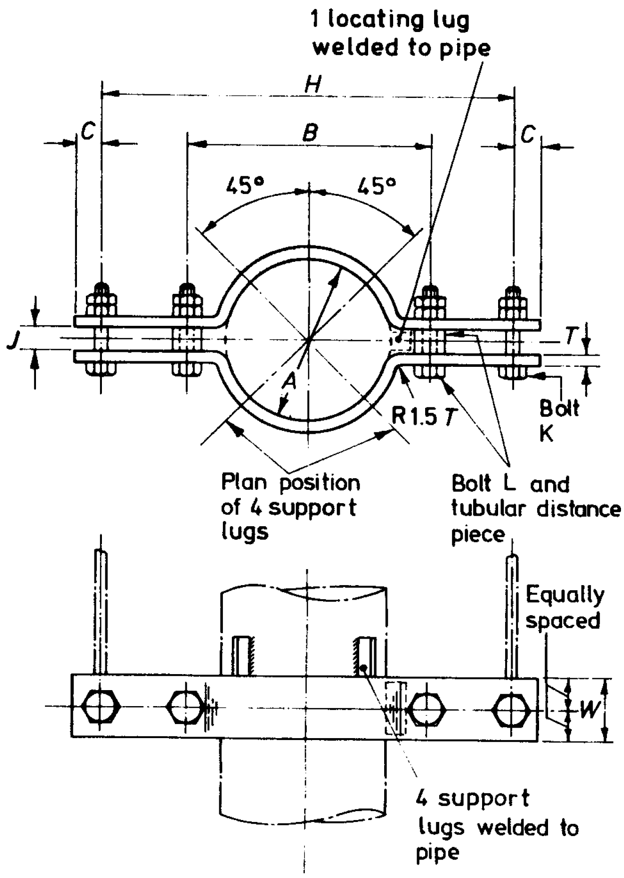


Figure 12 — Riser clamps for pipes up to and including 300 mm nominal size (ranges A and B)[a]

[a] Range A: – 20 °C to 100 °C
Range B: – 20 °C to 400 °C

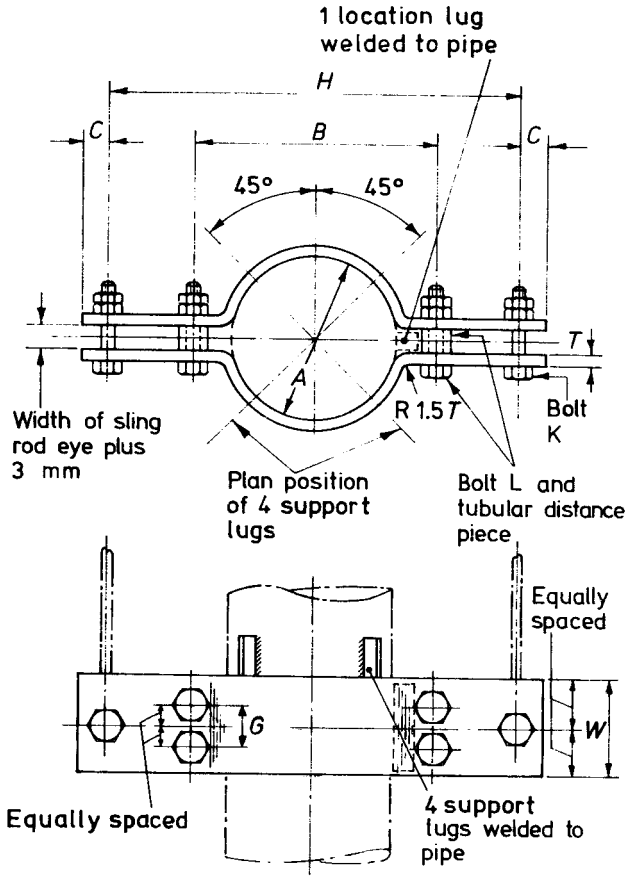


Figure 13 — Riser clamps for pipes over 300 mm nominal size (ranges A and B)[a]

[a] Range A: – 20 °C to 100 °C
Range B: – 20 °C to 400 °C

Table 8(a) — Dimensions of riser clamps for pipes up to and including 300 mm nominal size (ranges A and B)[a]

Pipe		Sling rod diameter	*W* × *T*	*A*	*B*	*C*	Tubular distance piece		Bolt size		Bolt hole diameter	
Nominal size	Outside diameter						Nominal size	Length *J*	K	L	K	L
100	114.3	12	90 × 10	118	210	40	25	25	M12	M12	14	14
125	139.7	12	100 × 10	144	235	40	25	25	M12	M12	14	14
150	168.3	20	100 × 15	172	290	40	25	25	M20	M20	22	22
175	193.7	20	100 × 15	198	315	40	25	25	M20	M24	22	26
200	219.1	20	100 × 15	224	340	40	25	25	M20	M24	22	26
225	244.5	20	120 × 15	248	375	50	32	31	M20	M24	22	26
250	273	20	120 × 15	278	410	50	32	31	M20	M24	22	26
300	323.9	24	120 × 20	330	480	50	32	31	M24	M24	26	26

[a] Range A: – 20 °C to 100 °C
Range B: – 20 °C to 400 °C

Table 8(b) — Maximum loads for riser clamps in accordance with Table 8(a)

Pipe Nominal size	Min. *H*	Max. load at min. *H*	Increment over min. *H*									
			20	40	60	80	100	120	140	160	180	200
			Maximum load (in kg)									
		kg										
100	360	800	760	720	680	640	600	560	520	480	440	400
125	390	810	765	730	695	665	630	595	565	525	495	460
150	445	1 060	1 045	1 030	990	940	900	860	820	780	740	715
175	465	1 050	1 005	965	920	885	845	810	775	735	695	665
200	490	1 000	940	900	865	830	795	760	725	690	650	615
225	540	1 400	1 355	1 305	1 260	1 210	1 160	1 115	1 070	1 020	975	925
250	585	1 200	1 155	1 105	1 055	1 010	960	910	865	815	765	725
300	655	1 700	1 650	1 600	1 550	1 500	1 450	1 400	1 350	1 300	1 250	1 200

Table 9(a) — Dimensions of riser clamps for pipes over 300 mm nominal size (ranges A and B)[a]

Pipe		Sling rod diameter	*W* × *T*	*A*	*B*	*C*	Tubular distance piece		Bolt size		Bolt hole diameter		Bolt hole centres *G*
Nominal size	Outside diameter						Nominal size *P*	Length *J*	*K*	*L*	*K*	*L*	
350	355.6	24	150 × 20	362	510	50	32	35	M24	M24	26	26	75
400	406.4	24	150 × 20	412	575	50	32	35	M24	M24	26	26	75
450	457	30	150 × 25	464	650	50	32	35	M30	M24	32	26	75
500	508	30	180 × 25	516	705	50	32	35	M30	M24	32	26	100
550	559	30	180 × 25	566	755	50	32	35	M30	M24	32	26	100
600	610	30	200 × 25	618	805	50	32	41	M30	M30	32	32	100

[a] Range A: – 20 °C to 100 °C
Range B: – 20 °C to 400 °C

Table 9(b) — Maximum loads for riser clamps in accordance with Table 9(a)

Pipe nominal size	Min. *H*	Max. load	Increment over min. *H*											
			20	40	60	80	100	120	140	160	180	200	220	240
			Maximum loads (in kg)											
		kg												
350	660	2 225	2 180	2 132	2 080	2 030	1 972	1 920	1 870	1 820	1 760	1 710	1 660	1 600
400	755	2 000	1 950	1 900	1 840	1 780	1 725	1 670	1 615	1 570	1 500	1 440	1 390	1 320
450	825	2 700	2 660	2 610	2 560	2 510	2 460	2 405	2 360	2 310	2 260	2 210	2 160	2 100
500	910	3 000	2 960	2 915	2 860	2 815	2 760	2 715	2 660	2 615	2 560	2 515	2 460	2 400
550	935	2 800	2 760	2 710	2 660	2 610	2 580	2 516	2 460	2 415	2 360	2 310	2 260	2 200
600	985	3 200	3 160	3 115	3 060	3 010	2 960	2 910	2 860	2 815	2 760	2 710	2 660	2 600

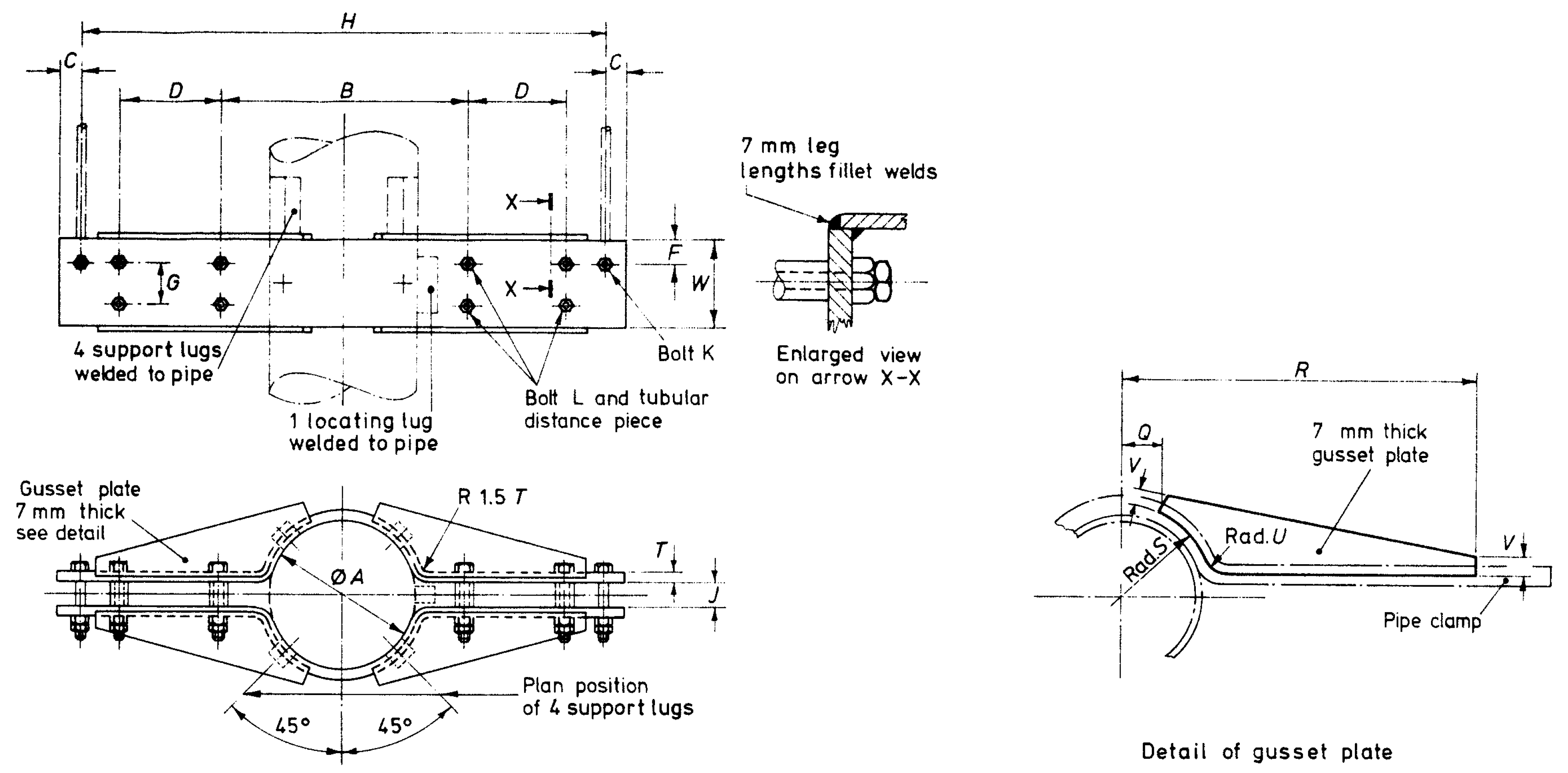


Figure 14 — Riser clamps for pipes up to and including 600 mm nominal size (range C: Over 400 °C to 470 °C)

Table 10 — Dimensions of riser clamps for pipes up to and including 600 mm nominal size (range C: Over 400 °C to 470 °C)

Pipe		Sling rod diameter	Riser clamps								Tubular distance piece		Bolt size		Bolt hole diameter		Gusset plate					Safe working load
Nominal size	Outside diameter		*W* × *T*	*A*	*B*	*C*	*D*	*F*	*G*	*H*	Nominal size	Length *J*	K	L	K	L	*Q*	*R*	*S*	*U*	*V*	kg
200	219.1	20	130 × 25	224	458	50	200	42	65	1 065	20	35	M20	M16	22	18	50	483	119	57	38.1	2 268
225	244.5	20	130 × 25	248	508	50	175	42	65	1 065	20	35	M20	M16	22	18	63	483	132	57	38.1	2 268
250	273	20	155 × 25	278	508	50	250	42	75	1 220	20	35	M20	M16	22	18	63	559	146	57	38.1	2 268
300	323.9	30	205 × 25	330	560	70	225	50	100	1 220	25	53	M30	M20	33	22	76	559	171	57	38.1	3 628
350	355.6	30	205 × 25	362	610	70	200	50	100	1 220	25	53	M30	M20	33	22	89	559	187	57	38.1	3 628
		36	230 × 38	362	610	80	280	60	115	1 370	32	58	M36	M24	39	26	89	635	200	95	50.8	7 257
400	406.4	30	230 × 25	412	660	70	225	50	115	1 370	25	53	M30	M20	33	22	100	635	213	57	38.1	3 628
		36	230 × 38	412	660	80	225	60	115	1 370	32	58	M36	M24	39	26	100	635	213	95	50.8	7 257
450	457	30	205 × 38	464	710	70	225	50	100	1 370	32	53	M30	M24	33	26	114	635	241	95	50.8	4 536
		36	255 × 38	464	710	80	225	60	130	1 370	32	58	M36	M24	39	26	114	635	241	95	50.8	7 257
500	508	30	205 × 38	516	762	70	280	50	100	1 525	32	53	M30	M24	33	26	127	711	267	95	50.8	4 536
		36	255 × 38	516	762	80	280	60	130	1 525	32	58	M36	M24	39	26	127	711	267	95	50.8	7 257
550	559	30	205 × 38	566	812	70	255	50	100	1 525	32	53	M30	M24	33	26	140	711	292	95	50.8	4 536
		36	280 × 38	566	812	80	255	60	155	1 525	32	58	M36	M24	39	26	140	711	292	95	50.8	7 257
600	610	30	205 × 38	618	864	70	225	50	100	1 525	32	53	M30	M24	33	26	152	711	317	95	50.8	4 536
		36	280 × 38	618	864	80	225	60	155	1 525	32	58	M36	M24	39	26	152	711	317	95	50.8	7 257

10 Support feet

10.1 General

10.1.1 Figure 15 illustrates typical support feet indicating that these can be constructed from tube, or from rolled steel sections.

Where horizontal movement is expected to occur, consideration should be given to the use of low friction bearing pads in order to decrease the coefficient of friction. Guidance on such pads is given in **6.3** of Part 1:1974 of this standard.

10.1.2 A vent hole shall be provided when welding a tubular foot to a pipe and a support plate.

10.1.3 Account shall be taken of the necessity for fitting a suitable doubling plate, e.g. where carbon steel supports are welded to alloy pipes, or reinforcement where required.

10.2 Considerations for design

10.2.1 It should be appreciated that the design of support feet falls into two parts:

a) consideration of the stresses set up in the pipe wall itself;

b) consideration of the load-carrying capacity of the foot and base plate.

This standard does not take into account the effect, as given in a) above, on the pipeline of employing a support foot and particular attention shall be given to the effect on the pipeline where it is highly stressed due to conditions either of pressure or temperature.

10.2.2 The information given in Table 11(a) and Table 11(b) is confined to **10.2.1** b) and on the following basis:

a) the base of the foot is free to move horizontally in all directions;

b) the coefficient of friction at the sliding surfaces is taken as 1.0;

c) the deflection of the foot is limited to $L/325$ as given in clause **31** b) of BS 449-2:1969, where L is as shown in Figure 15;

d) the allowable bending stress in the foot does not exceed 165 N/mm^2.

10.2.3 Guidance on design is given in Appendix A.

10.3 Size of support feet. Table 11(a) and Table 11(b) give typical sizes of feet together with their length, size of baseplate and the maximum allowable load that these feet can carry. Table 11(a) gives details for tubular feet and Table 11(b) for feet manufactured from rolled steel sections.

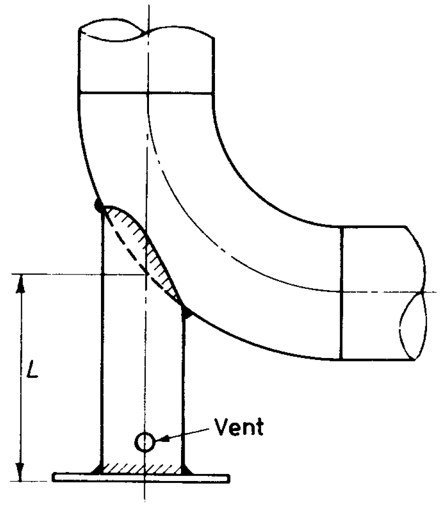
The height of the foot, L, given in Table 11(a) and Table 11(b) is a maximum and should be reduced where possible. There shall be a clearance of not less than 25 mm between the outside of any insulation and the bearing surface.

Support feet shall rest on concrete plinths or steelwork members, the strength of which shall be taken into account separately.

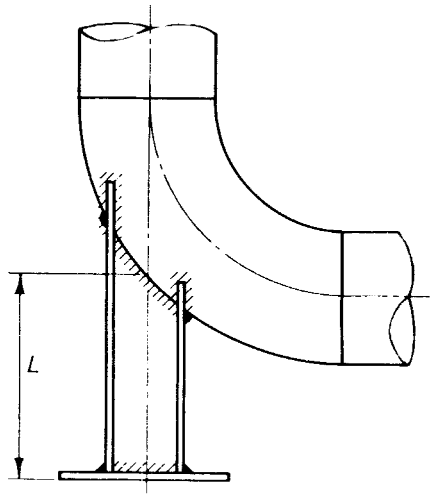
Table 11(a) — Maximum loads for tubular support feet

Tubular support dimensions			Maximum allowable supported load	Baseplate dimensions	
Maximum height *L*	Nominal size	Thickness		Size	Thickness
			kg		
230	25	4.5 4.9 6.3	150 170 185	100 × 100	8
	40	4.0 5.1 7.1	400 470 580	125 × 125	8
300	50	3.9 5.6 6.3	490 640 700	125 × 125	8
	80	4.0 5.4 6.3 7.2	1 140 1 400 1 650 1 900	150 × 150	10
	100	4.5 6.0 8.0	2 070 2 600 3 400	200 × 200	12
	150	4.9 7.1 9.5	4 900 6 800 8 800	250 × 250	12
460	200	4.9 6.3 8.2 11.0	5 600 7 100 8 900 11 800	300 × 300	15

NOTE 1 if the support is to be used as a sliding support on a bearer, the minimum length required for the baseplate shall be as given in Figure 17 of BS 3974-1:1974.
NOTE 2 Thickness of increased sizes of baseplate shall be checked using the method given in clause **38** b) of BS 449-2:1969.

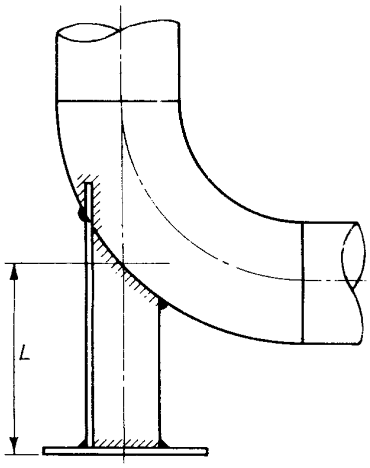


(a) Tubular foot

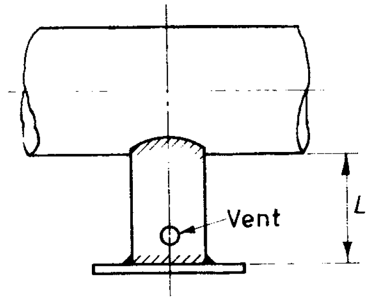


(b) UC or UB foot

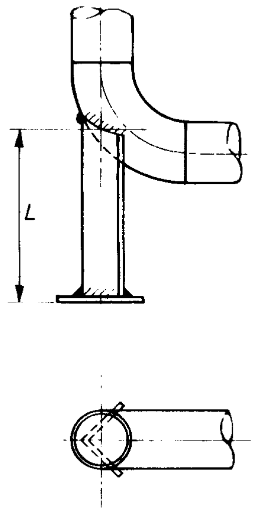
Figure 15 — Typical support feet *(continued)*



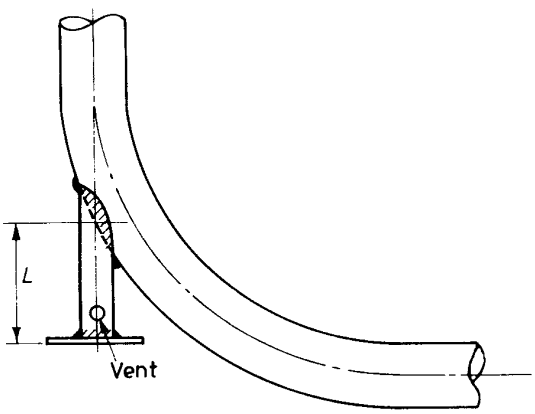
(c) Tee foot



(f) Tubular foot



(d) Angle foot



(e) Tubular foot

Figure 15 — Typical support feet *(concluded)*

Table 11(b) — Maximum loads for sectional support feet

Sectional support dimensions				Maximum allowable supported load	Baseplate dimensions	
Maximum height *L*	**Section and size**	**Thickness**	**Mass/length**		**Size**	**Thickness**
			kg/m	kg		
230	Rolled steel angle 50 × 50	8	—	250	125 × 125	8
	Rolled steel angle 70 × 70	8 10	—	490 570	150 × 150	10
300	Tee 76 × 76	—	10.73	1 500	150 × 150	10
	Tee 102 × 102		14.53 19.04	3 110 3 820	200 × 200	12
	Tee 127 × 102	—	16.45 21.63	3 620 4 500	200 × 200	12
	Universal columns 152 × 152	—	23 30	7 750 10 500	300 × 300	15
	Universal beam 203 × 133	—	25 30	10 300 12 500	300 × 300	15
460	Universal columns 152 × 152	—	30 37	7 300 9 200	300 × 300	15
	Universal beam 203 × 133	—	25 30	7 200 8 800	300 × 300	15

NOTE 1 If the support is to be used as a sliding support on a bearer, the minimum length required for the baseplate shall be as given in Figure 17 of BS 3974-1:1974.
NOTE 2 Thickness of increased sizes of baseplate shall be checked using the method given in clause **38** b) of BS 449-2:1969.

11 Pipeline anchors and guides

11.1 The use of anchors and guides. Long pipelines or pipelines subject to large temperature changes will be subject to movements which may not be tolerable due to the magnitude of the movement itself or because of high stresses or forces which may be generated on the pipework and/or connected equipment.

The common method employed to control thermal effects is to prevent or restrict movement of the pipeline at selected points with anchors or guides. This requires that flexibility has to be considered between anchor or guide points in the form of bends, expansion loops or expansion bellows to ensure that unacceptable stresses are not imposed on the pipework.

The positioning of anchors will be governed by pipeline flexibility and thermal movement considerations together with the availability of suitable anchor attachment points.

Where additional flexibility is provided in the form of expansion loops or bellows it will be necessary to provide guides to ensure their safe and efficient operation.

Where expansion bellows are used the manufacturer's advice shall be sought.

NOTE Attention is drawn to BS ....**"Selection and application of metallic bellows units for use in pressure systems"*.

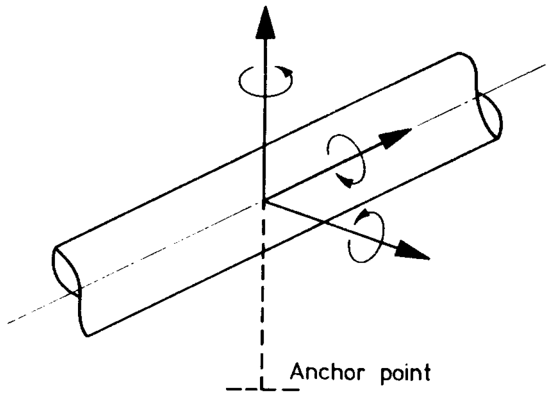


Figure 16 — Forces and moments acting on three axes of an anchor

Account shall also be taken of the following, where applicable:

a) the effect of the resultant forces and moments from the external attachments on the stress level in the pipe;

b) stress level in the weld between anchor and pipe;

c) stress level in the anchor;

d) rigidity of the anchor foundation;

e) strength of the anchor foundation;

f) strength of the load bearing insulation.

Differential thermal expansion between pipe and welded-on anchor can produce high stresses in the pipe leading to wall damage or failure.

11.2.1.2 *Vapour barrier sealing*. Where a vapour barrier is required it shall be sealed to the anchor which should be designed using the least complicated shape.

11.2.1.3 *Non-welded anchors*. Where a strap or U-bolt is employed as a simple anchor and is used on a pipeline operating below ambient conditions account shall be taken of the possible reduction of the pipeline diameter thus rendering this type less efficient.

11.2.1.4 *Provision for insulation*. Because most pipelines subjected to significant thermal effects and requiring anchor points will also require insulation, it is usual to make provision for this by raising the anchor and slipper above bearer level to accommodate the insulation thickness or alternatively by hanging the pipe from suitable supporting structures.

11.2.1.5 *Heat treatment*. Account shall be taken of the necessity to pre-heat and post-heat treatment of all welds of anchors, particularly those attaching the anchor to the pipeline. In this respect reference shall be made to BS 2633.

11.2.2 *Guides*. Where applicable, the considerations given in **11.2.1** shall apply in the design of guides.

11.3 Types of anchor and guide. The selection will depend very much on the application. While it is impossible to standardize on any one type, examples are shown in Figure 17, and in Appendix D of Part 1:1974 of this standard.

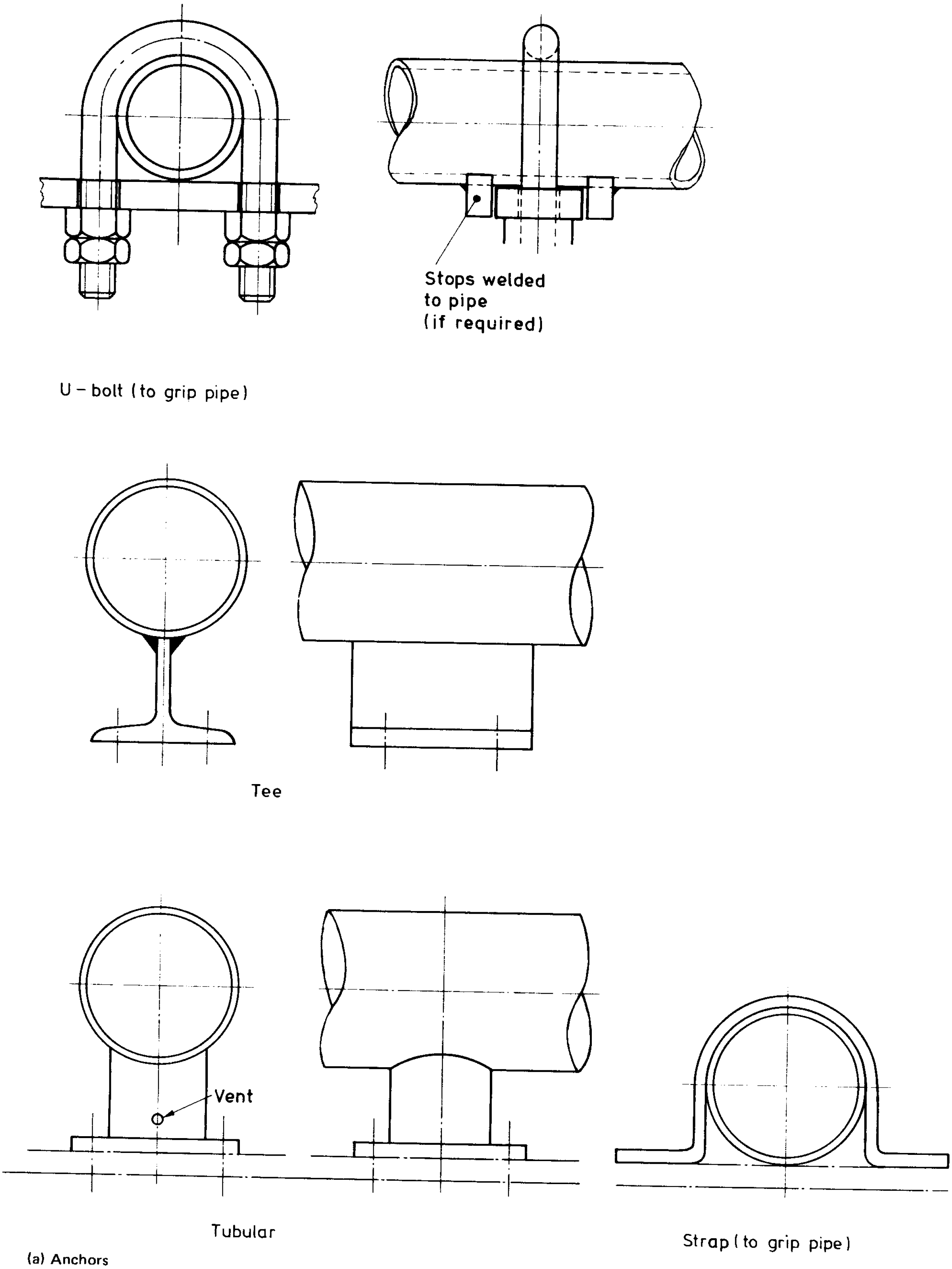


Figure 17 — Typical anchors and guides *(continued)*

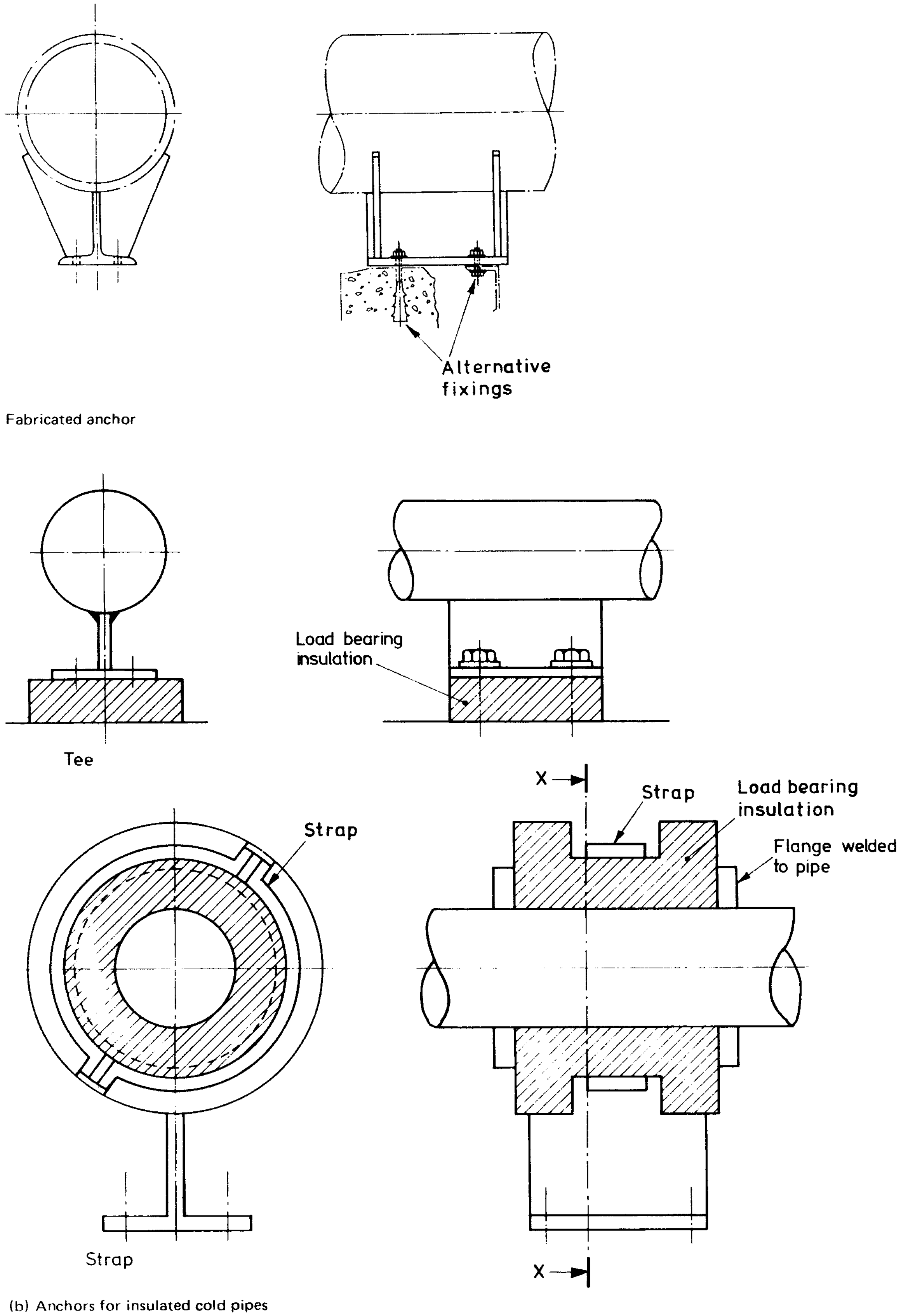
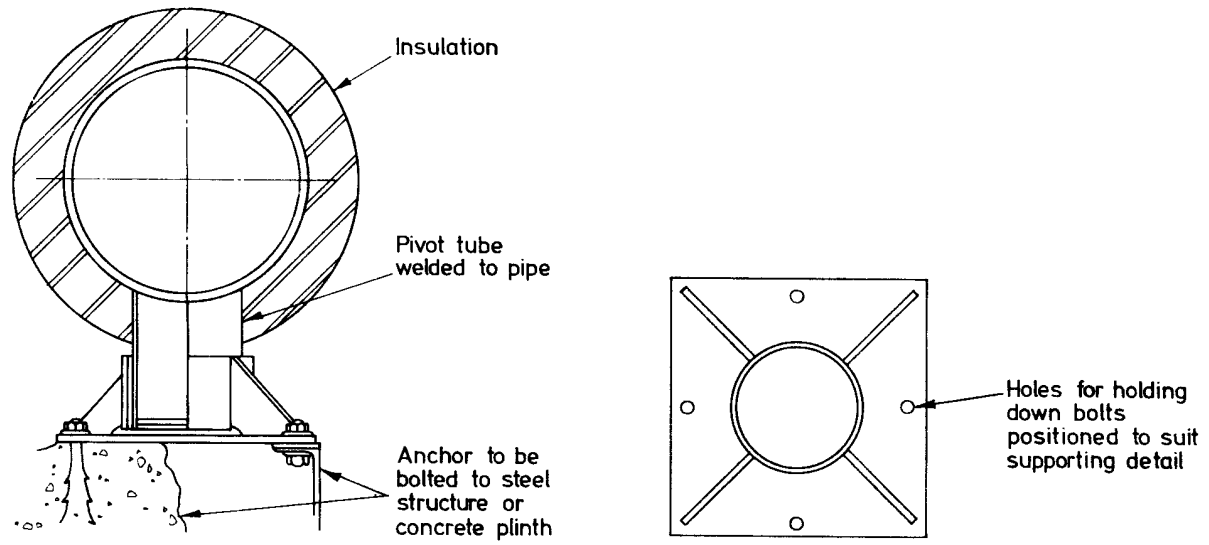
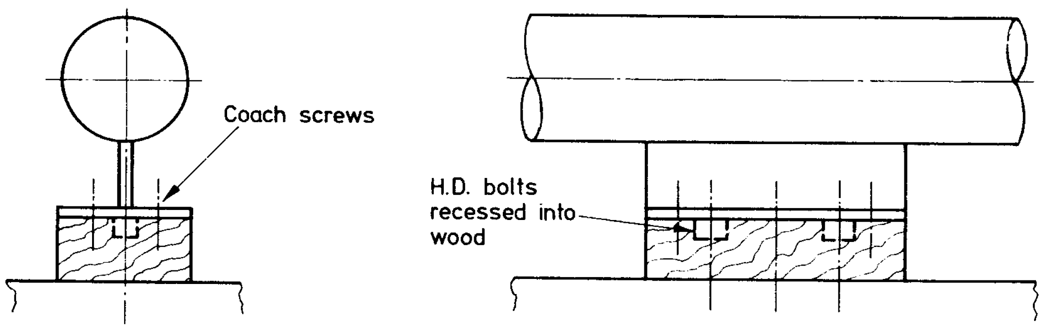


Figure 17 — Typical anchors and guides *(continued)*

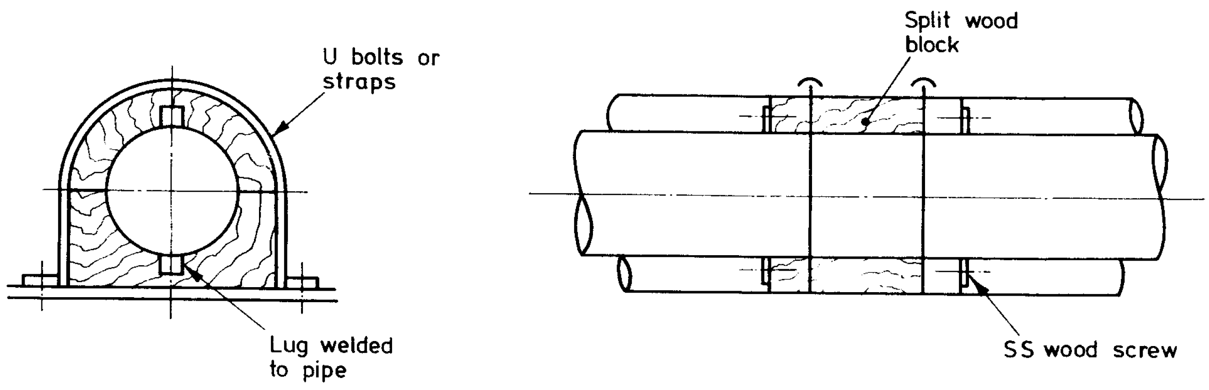


Pivot



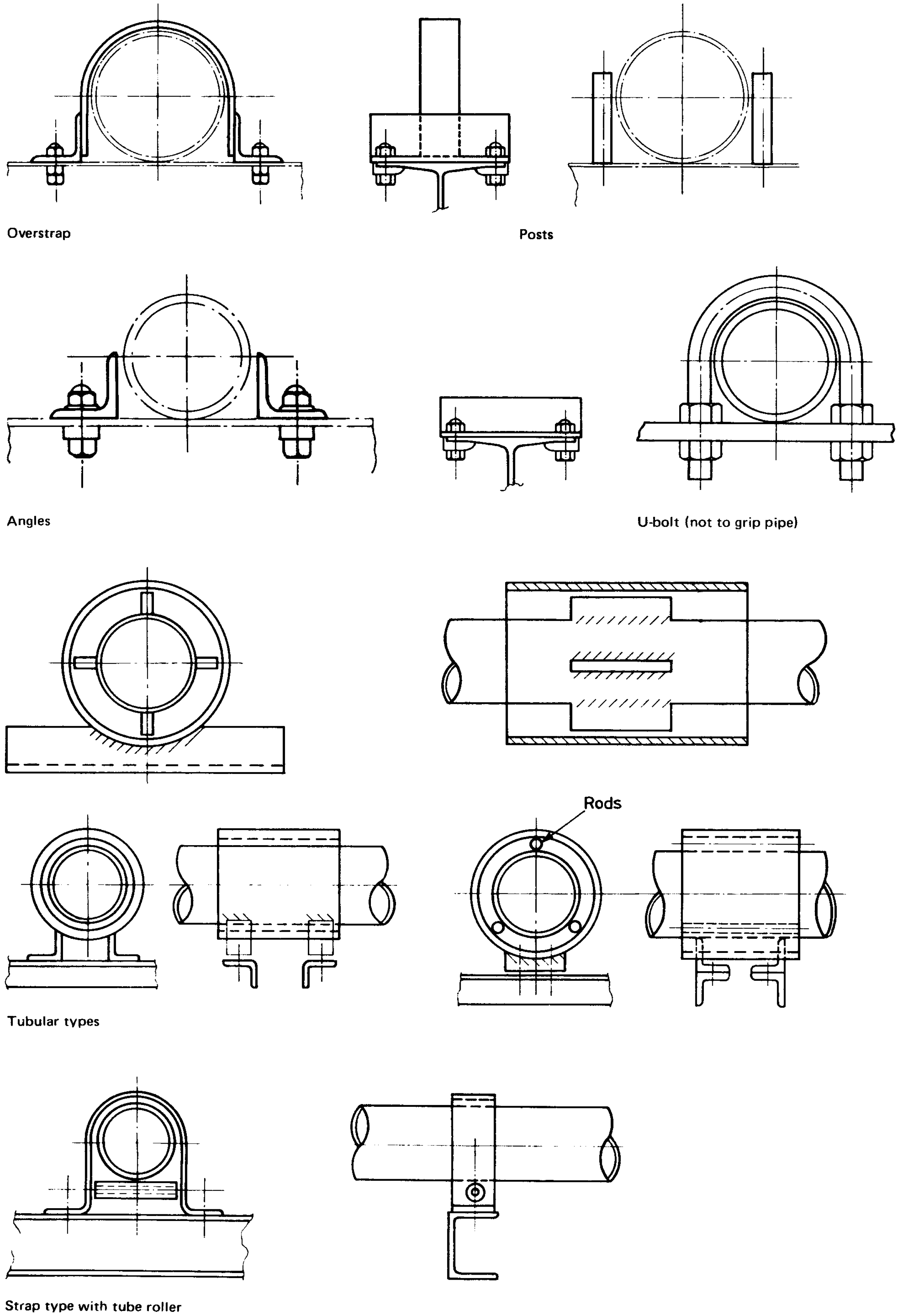
No direct cold path between pipe and structure. Design limit is shear value of coach screws in wood

Bolted anchor



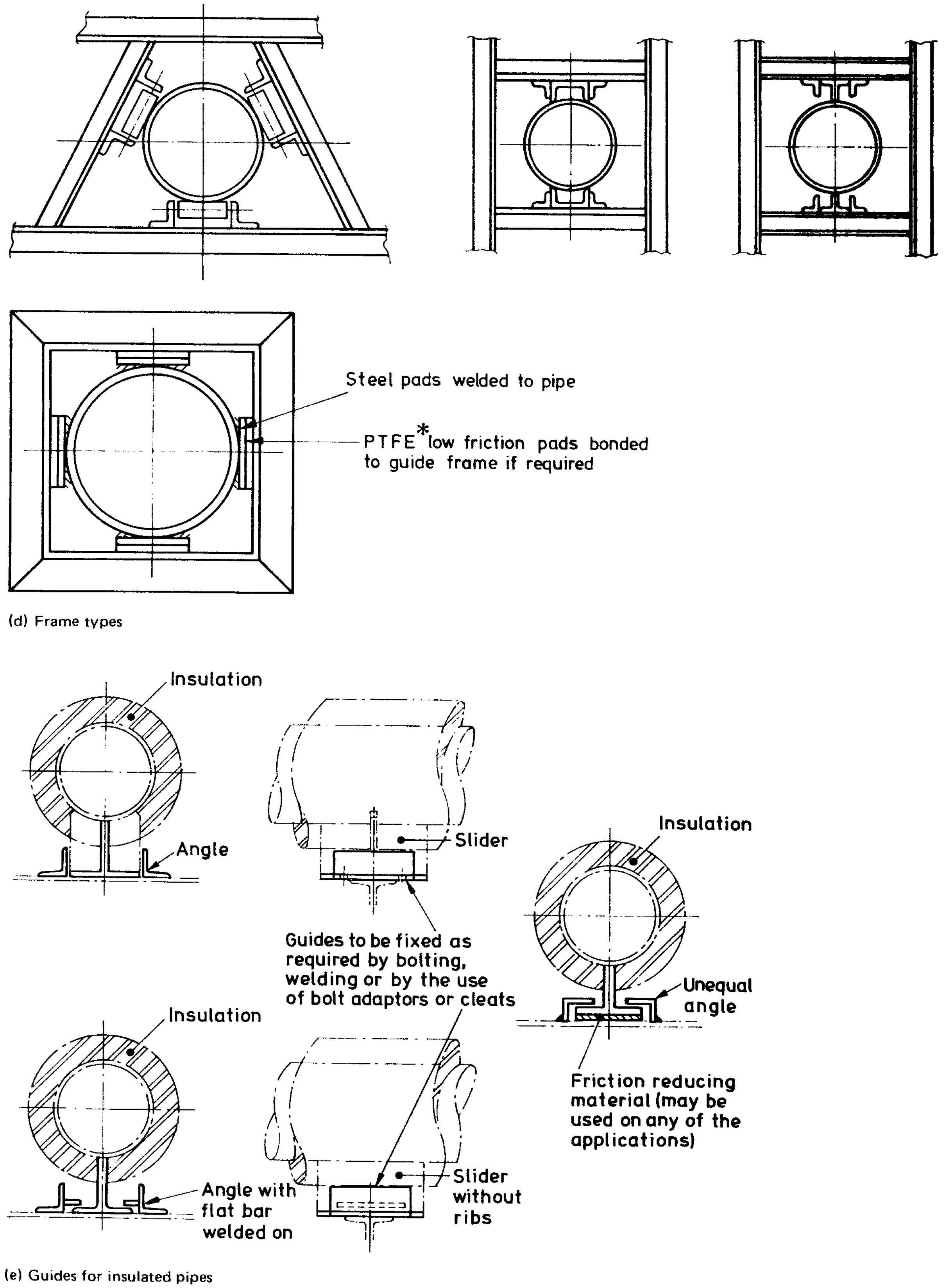
Strap anchor

Figure 17 — Typical anchors and guides *(continued)*



(c) Guides for uninsulated pipes

Figure 17 — Typical anchors and guides *(concluded)*



* Polytetrafluoroethylene

Figure 17 — Typical anchors and guides *(Continued)*

12 Welding of support components

12.1 Welding practice. The welding of a fabricated support to the pipeline shall be in accordance with the appropriate welding code for the pipeline. The requirements specified in **12.2** and **12.3** apply to the fabrication of components but do not refer to the welding of support components to the pipeline.

Steel to BS 4360: grade 43A and to BS 1501 – 151[1)] and BS 1501 – 161 [1)] shall be welded as specified in BS 5135. Special attention is directed to the recommendations in BS 5135 regarding pre-heat.

BS 5135 and BS 639, covering welding and electrodes, shall be referred to for the fabrication of support components.

12.2 Strength of fillet welds

12.2.1 The allowable stress in fillet welds using electrodes to BS 639 and steel to BS 4360 shall be 115 N/mm^2 for grade 43A steel as given in BS 449-2.

The safe working load (SWL) for a fillet weld in both tension and compression shall be derived from the following formula:

SWL = stress × 0.7 fillet leg length (L) × effective length of weld.

The effective length of weld is the total length of weld less 2L to allow for the crater formed at the beginning and end of a run.

12.2.2 In the following table the safe working loads per mm of length are indicated for four leg lengths of fillet weld on steel to BS 4360: grade 43A.

Leg length of fillet weld (*L*) (see Figure 18)	**Safe working load per mm**
	kg/mm
4	32.8
6	49.4
8	65.7
10	82.1

Where it is positively known that the steel is of higher grade than 43A and where the appropriate electrodes are employed as given in BS 449-2, the fillet welds shall be capable of carrying higher safe working loads which can be calculated using the appropriate stresses given in BS 449 and using them in the formula in **12.2.1**.

12.3 Fillet welds. Fillet welds shall be specified by "leg length" shown as "*L*" in Figure 18.

Fillet welds joining two members at right angles are considered to be at 45°, but the weld face may be mitred or flat [Figure 18 (a)], convex [Figure 18 (b)] or concave [Figure 18 (c)]. The design throat thickness of a fillet weld shall be not less than 0.7 nor greater than 0.8 times the leg length "*L*".

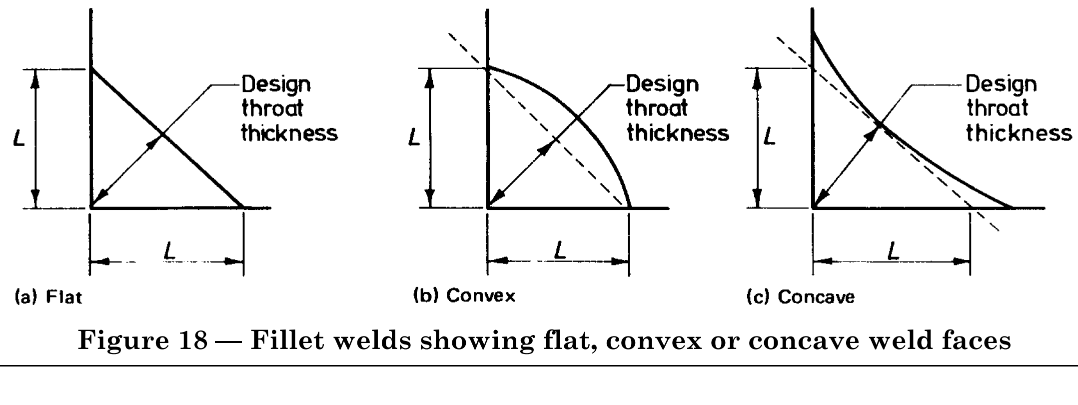


Figure 18 — Fillet welds showing flat, convex or concave weld faces

[1)] See BS 1501-1.

13 Supplementary supporting steelwork

13.1 Use of supplementary steelwork. Pipe supports are often required in positions where building steel work is not located immediately above the point of support. In these instances it will be necessary to provide supplementary steelwork members to obtain a point of support.

In general the strength of supplementary steelwork members may be calculated in accordance with the requirements specified in BS 449 noting that where the loads at the points of attachment on to the main building steelwork are of significant proportions, the main building steelwork contractor shall be consulted and acceptance of these loads obtained.

Where the lower flanges of supplementary steelwork beams are loaded, transverse bending stresses are induced in the flange. The stress system is complex since these transverse stresses have also to be combined with the longitudinal stresses to obtain a principal stress.

In cases where pipework slung from the bottom flanges of supplementary steelwork causes excessive stress to be set up in the flanges, the typical method shown in Figure 9 (a) may be adopted provided that clearance is available at the top of the member for such attachments. Where supports are to be slung from the bottom members consideration has to be given to the use of welded-in gusset plates to improve stability.

13.2 Attachment to universal beams. Where supports are to be attached to the lower flanges of universal beams, the maximum spans and loads for the two conditions of loading given in Appendix B shall apply. Unless it can be shown otherwise, loads should be assumed to act at the toe of the lower flanges as shown in Figure 21 in Appendix B. A similar complex stress system is also set up in the top flanges of universal beams where they are attached to the main building steelwork.

13.3 Cantilever supports. Cantilever supports shall be employed only where the additional moments applied to building steelwork, etc., are acceptable.

Figure 19 illustrates typical cantilever supports and the methods of attachment to the building structure. The moment for each type is also indicated.

The maximum load a cantilever member will carry will vary with:

a) the cross section of the member;

b) the length of the cantilever (moment arm);

c) the stress limitation in the member;

d) the deflection limitation of the member.

Table 12 gives the maximum vertical loads on cantilevers of various sections in increments of moment arm length L up to 1.25 m, the figures to the left of the heavy line being limited by stress and those to the right of the heavy line being limited by deflection.

Table 12 has been calculated from the data given in Appendix C and this appendix shall be used to calculate members not covered in the tables.

If universal beams are used as cantilevers a complex system of stresses may be set up in the top flange of the cantilever member as described in **13.1**.

The maximum loads given in the tables are based on consideration of the strength of the cantilever member only and not on the strength of the attachment to the building structure nor on the strength of the building structure itself. Both of these have to be considered separately.

14 Manufacture

Components may be formed either hot or cold but account shall be taken of the need for heat treatment on cold formed components of thickness 10 mm and over.

Where material for the manufacture of clips is cut from plate, the cut edges shall be ground smooth prior to forming.

15 Protection

If required, pipe supports shall be protected against corrosion in accordance with the requirements specified by the purchaser.

16 Inspection

The need for and the extent of inspection of components during manufacture shall be agreed between the purchaser and the manufacturer.

17 Marking

Pipe clamps and riser clamps shall be identified by marking in accordance with the requirements specified in BS 5383 as follows:

Ranges B and C: Dark grey

Range A clamps are not colour marked.

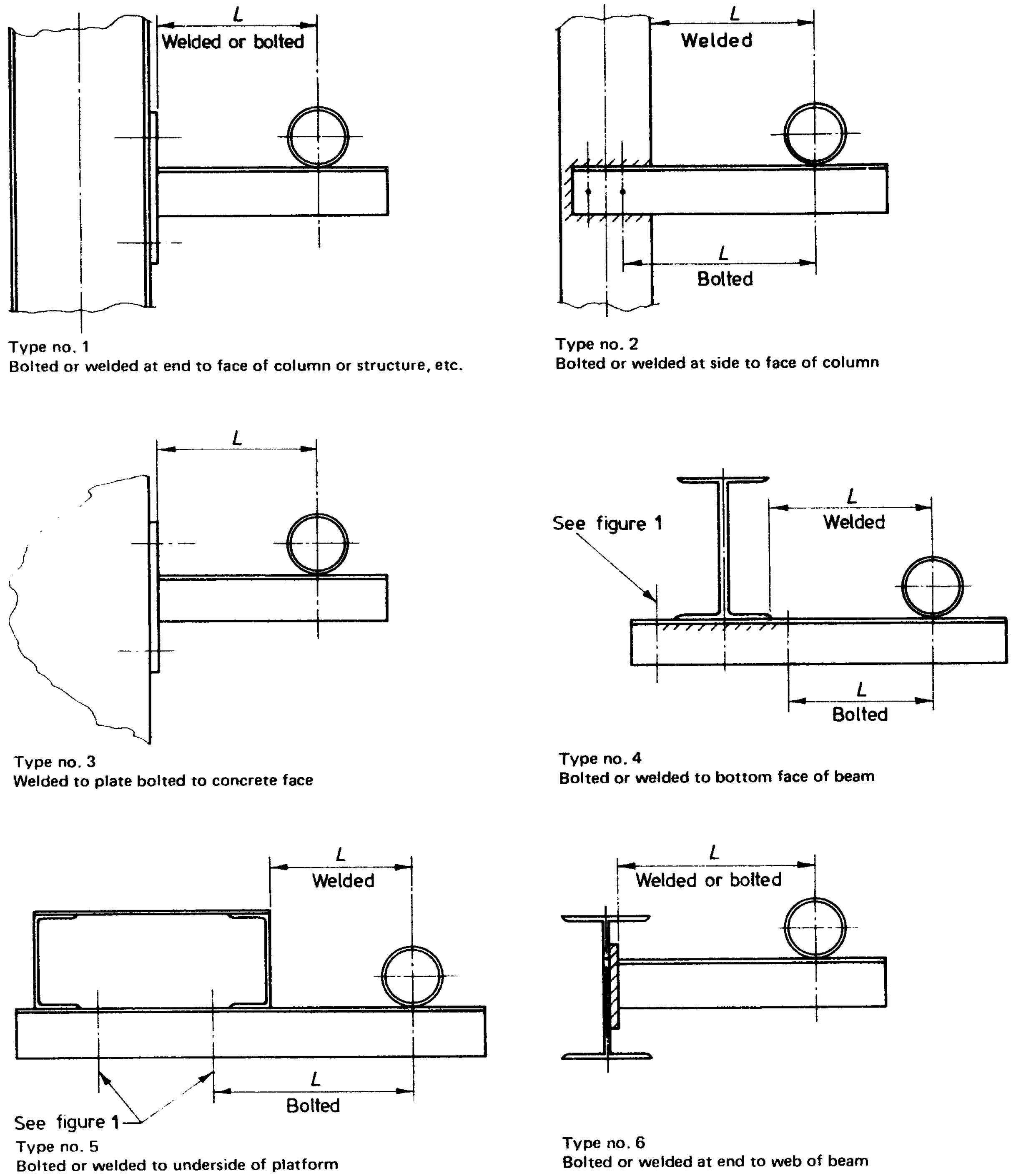


Figure 19 — Typical cantilever supports showing moment arm "*L*"

Table 12 — Maximum vertical loads on cantilevers of various sections *(see Figure 19)*

Section	Mass/length	Moment arm *L* (in m)												
		0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**1.1**	**1.2**	**1.25**
Equal angles		**Maximum vertical loads** (in kg)												
	kg/m													
30 × 30 × 3	1.36	110	55	28	16	10	7	5	4	3	3	2	2	2
50 × 50 × 5	3.77	515	260	170	125	78	54	40	31	24	20	16	14	13
60 × 60 × 5	4.57	750	370	250	185	140	96	71	54	43	35	29	24	22
70 × 70 × 6	6.38	1 220	612	405	300	239	185	135	105	81	66	54	46	42
80 × 80 × 6	7.34	1 540	770	510	380	305	250	205	155	125	100	82	69	64
90 × 90 × 6	8.30	1 870	930	620	465	370	310	260	224	175	145	120	99	92
100 × 100 × 8	12.2	3 290	1 640	1 090	820	650	540	460	400	320	260	215	180	165
120 × 120 × 8	14.7	4 450	2 230	1 470	1 110	880	730	620	545	480	430	375	315	290
150 × 150 × 10	23.0	8 700	4 350	2 900	2 160	1 730	1 440	1 230	1 070	950	855	770	705	675
200 × 200 × 16	48.5	26 760	13 380	8 920	6 650	5 320	4 430	3 000	3 300	2 940	2 643	2 390	2 175	2 090
Unequal angles														
40 × 25 × 4	1.91	245	120	77	43	28	19	14	11	9	7	6	5	4
60 × 30 × 5	3.37	620	310	205	150	110	77	57	43	34	28	23	19	18
65 × 50 × 5	4.35	810	405	265	195	155	115	84	65	51	41	34	29	26
75 × 50 × 6	5.65	1 260	625	415	305	245	200	150	115	89	72	60	50	46
80 × 60 × 6	6.37	1 440	715	475	355	280	230	190	145	115	92	76	64	59
100 × 65 × 7	8.77	2 440	1 210	800	600	480	395	335	290	250	200	165	140	130
100 × 75 × 8	10.6	3 070	1 535	1 020	765	605	500	425	370	295	235	195	165	150
125 × 75 × 8	12.2	4 045	2 020	1 340	1 000	795	665	565	495	435	390	350	305	280
150 × 75 × 10	17.0	7 025	3 510	2 320	1 740	1 390	1 150	990	865	765	680	615	560	535
150 × 90 × 10	18.2	7 450	3 720	2 480	1 860	1 480	1 230	1 060	920	810	725	650	600	575
200 × 100 × 10	23.0	9 790	4 890	3 260	2 450	1 960	1 620	1 390	1 210	1 080	960	875	790	760
200 × 150 × 12	32.0	16 260	8 130	5 420	4 035	3 230	2 690	2 310	2 000	1 780	1 600	1 460	1 325	1 270
Channels														
102 × 51	10.42	6 880	3 440	2 290	1 720	1 380	1 030	755	580	455	370	305	255	235
127 × 64	14.90	12 790	6 390	4 260	3 200	2 560	2 131	1 760	1 350	1 060	860	710	600	550
152 × 76	17.88	18 810	9 410	6 270	4 700	3 760	3 135	2 690	2 350	1 880	1 520	1 260	1 060	970
178 × 76	20.84	25 310	12 660	8 440	6 330	5 060	4 217	3 620	3 160	2 810	2 390	1 970	1 660	1 530
203 × 76	23.82	32 310	16 160	10 770	8 080	6 460	5 385	4 620	4 040	3 590	3 230	2 870	2 420	2 230
Joists														
102 × 64	9.65	7 210	3 600	2 400	1 800	1 440	1 080	790	605	480	390	320	270	250
127 × 76	13.36	12 610	6 300	4 200	3 150	2 520	2 100	1 730	1 320	1 050	850	700	590	545
152 × 89	17.09	19 450	9 730	6 480	4 860	3 890	3 240	2 780	2 430	1 940	1 570	1 300	1 090	1 010
178 × 102	21.54	28 760	14 350	9 570	7 180	5 740	4 790	4 100	3 590	3 190	2 710	2 240	1 880	1 730

NOTE The loads given in Table 12 are on the basis of the longer leg of unequal angles and the webs of channels and joists being in the vertical plane.

Appendix A Design guidance for pipe support feet

A.1 A support foot fixed to a horizontal pipeline but not fixed at its base is assumed to be subject to the following forces when the pipeline is allowed to move:

a) a vertical load due to the weight of pipe and contents, etc. supported;

b) a horizontal force determined in magnitude by the limiting friction between the support foot and its support and in direction by the direction of pipe movement.

The forces described in a) and b) will give compressive and bending stresses in the support which have to be combined to determine the maximum load which can be carried. The method given in clause **14** a) of BS 449-2:1969 is used, i.e.:

$$\frac{f_c}{p_c} + \frac{f_{bc}}{p_{bc}} \leqslant 1$$

where

f_c is the compressive stress

f_{bc} is the bending stress

p_c is the maximum allowable compressive stress

p_{bc} is the maximum allowable bending stress

A.2 The compressive stress f_c is determined from $\frac{\text{load } W}{\text{area } A}$

where

W is the load the support foot will carry (in kg)

A is the cross-sectional area of support foot

A.3 The maximum allowable compressive stress p_c is found from Table 17(a) of BS 449-2:1969, using effective length l as twice the support length ($l = 2\,L$).

A.4 The bending stress f_{bc} is determined by designing the support as a cantilever assuming the coefficient of friction $\mu = 1$. The small additional increase in bending moment due to deflection of the support is generally insignificant and, for purposes of calculation, is ignored.

$$f_{bc} = \frac{WL_y}{I}$$

where

W is the load the support foot will carry (in kg)

L is the length of support foot

y is the distance from neutral axis to extreme fibres of section used

I is the moment of inertia of section used

Where a non-symmetrical section is to be employed, bending has to be considered in both planes. f_{bc} has to be calculated using the maximum value of the expression $\frac{y}{I}$.

A.5 The maximum allowable bending stress p_{bc} is found from clause **19** d) of BS 449-2: clause **19** d).

A.6 Having determined the maximum allowable load that the support can sustain, a check is made to determine that the deflection of the support is within the allowable maximum deflection taken as $\frac{L}{325}$ from clause **31** b) of BS 449-2:1969. The actual deflection is taken as that for a cantilever, but additional increase in deflection due to the vertical eccentric load is ignored in this standard.

$$\text{Deflection } (\delta) = \frac{WL^3}{3EI}$$

where W, L and I are as in **A.4**.

$$E = \frac{2.10 \times 10^5}{9.806}\ (\text{N/mm}^2)$$

Where a non-symmetrical section is to be employed, the deflection shall be calculated in the weakest direction. Therefore, the smallest moment of inertia shall be used in the calculation.

NOTE Pipe support feet selected for this standard and given in Table 11(a) and Table 11(b) are chosen to be as short as practicable and to minimize the bending moment generated at the pipe wall.

A.7 Baseplate thicknesses, suitably rounded off, are designed as specified in paragraph 1 of clause **38** b) of BS 449-2:1969.

A.8 A reduction in the length of support will increase its load-carrying capacity and reduce the pipe wall bending moment while an increase in length will reduce its load-carrying capacity and increase the pipe wall bending moment in the case where pipe movement is greater than support deflection.

Further increases in support length will eventually have the effect of limiting the load that can be carried by the allowable deflection condition rather than the maximum combined stress condition.

A.9 Design methods are available, such as that in BS 5500, that will enable a check to be made on the suitability of the pipe to withstand the stresses imposed on it by the support feet.

Appendix B Maximum spans for simply supported universal beams

Table 13 and Table 14 give the maximum allowable spans and loads for centrally loaded beams for given beam dimensions and loads acting at:

a) *B*/4 from toe to lower flange: see Figure 20 and Table 13;

b) toe of lower flange: see Figure 21 and Table 14.

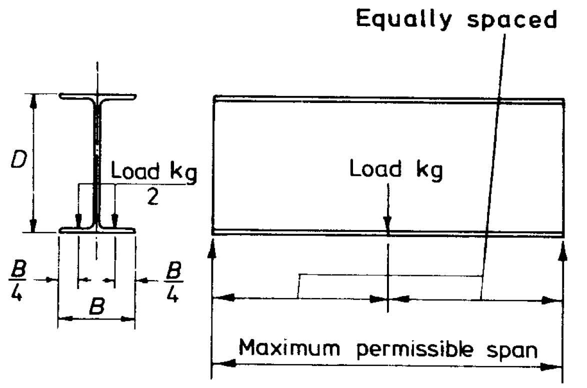


Figure 20 — Universal beam, load acting at *B*/4 from toe of lower flange

NOTE 1 Beam loaded on lower flange as shown in Figure 20.
NOTE 2 Load assumed to act at *B*/4 from toe, (i.e. approximate centre of gravity of cleat landing).
NOTE 3 Maximum bending stress: 165 N/mm^2.
NOTE 4 Permissible compressive bending stress in accordance with Table 3(a) of BS 449-2:1969.
NOTE 5 Maximum principal stress: 230 N/mm^2.
NOTE 6 Average shear stress: 100 N/mm^2.
NOTE 7 Maximum deflection: span/360.
NOTE 8 Where constant spans appear for a range of loads, this derives from the stability criteria of the compression flange.
NOTE 9 Beam lengths are given in metres.
NOTE 10 Beam material is BS 4360: grade 43A.
NOTE 11 *T* is the mean thickness of the flange in millimetres.

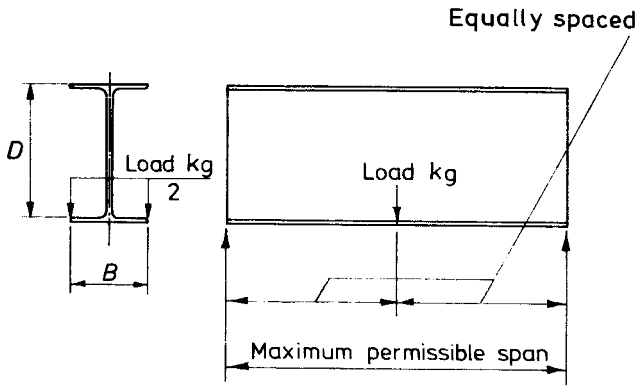


Figure 21 — Universal beam, load acting at toe of lower flange

NOTE 1 Beam loaded on lower flange as shown in Figure 21.
NOTE 2 Load assumed to act at toe.
NOTE 3 Maximum bending stress: 165 N/mm².
NOTE 4 Permissible compressive bending stress in accordance with Table 3(a) of BS 449-2:1969.
NOTE 5 Maximum principal stress: 230 N/mm².
NOTE 6 Average shear stress: 100 N/mm².
NOTE 7 Maximum deflection: span/360.
NOTE 8 Where constant spans appear for a range of loads, this derives from the stability criteria of the compression flange.
NOTE 9 Beam lengths are given in metres.
NOTE 10 Beam material: BS 4360 grade 43A.
NOTE 10 Beam material is BS 4360: grade 43A.
NOTE 11 *T* is the mean thickness of the flange in millimetres.

Table 13 — Maximum permissible single span, simply supported, universal beams when loaded at *B*/4 from toe of flange

Beam size																															
D × *B* mm	**Mass/length** kg/m	*T* mm	**Load** kg																												
			400	450	500	750	1 000	1 250	1 500	1 750	2 000	2 250	2 500	2 750	3 000	3 250	3 500	3 750	4 000	4 250	4 500	4 750	5 000	5 250	5 500	5 750	6 000	6 250	6 500	6 750	7 000
152 × 89	17.09	8.3	6.9	6.8	6.5	5.1	4.3	2.7	1.4																						
178 × 102	21.54	9.0	7.9	7.9	7.9	6.6	5.6	5.0	3.3	2.0																					
203 × 102	25.32	10.4	7.8	7.8	7.8	7.7	6.5	5.8	5.2	4.5	3.2	2.2																			
203 × 133	25	7.8	10.3	10.3	10.0	8.0	6.9	4.3																							
203 × 133	30	9.6	10.7	10.7	10.7	9.7	8.3	7.3	6.5	4.4	2.8																				
254 × 102	22	6.8	7.1	7.1	7.1	5.9	4.7																								
254 × 102	25	8.4	7.4	7.4	7.4	6.9	6.0	5.3	3.6																						
254 × 102	28	10	7.7	7.7	7.7	7.7	7.0	6.2	5.7	5.1	3.8	2.4																			
254 × 146	31	8.6	11.2	11.2	11.2	9.9	8.7	7.7	5.7																						
254 × 146	37	10.9	11.7	11.7	11.7	11.7	10.6	9.4	8.5	7.8	7.3	5.3	3.8																		
254 × 146	43	12.7	12.0	12.0	12.0	12.0	12.0	10.8	9.8	9.0	8.3	7.8	7.4	6.0	4.8	3.8	2.9														
305 × 102	25	6.8	6.8	6.8	6.8	6.2	5.3																								
305 × 102	28	8.9	7.2	7.2	7.2	7.2	6.3	5.9	5.4	3.7																					
305 × 102	33	10.8	7.5	7.5	7.5	7.5	7.5	6.9	6.3	5.8	5.4	4.8	3.4																		
305 × 127	37	10.7	9.1	9.1	9.1	9.1	9.1	8.1	7.5	6.9	6.4	5.3	3.7																		
305 × 127	42	12.1	9.2	9.2	9.2	9.2	9.2	9.1	8.3	7.7	7.1	6.7	6.2	5.4	4.1	3.0															
305 × 127	48	14.0	9.5	9.5	9.5	9.5	9.5	9.5	9.5	8.8	8.1	7.6	7.2	6.8	6.5	6.2	5.3	4.4	3.6	2.9											
305 × 165	40	10.2	12.9	12.9	12.9	12.9	11.6	10.5	9.5	8.8	7.4	4.9																			
305 × 165	46	11.8	13.1	13.1	13.1	13.1	13.1	11.8	10.8	10.0	9.2	8.7	7.9	6.0	4.4																
305 × 165	54	13.7	13.4	13.4	13.4	13.4	13.4	13.4	12.4	11.4	10.6	10.0	9.3	8.9	8.5	7.5	6.1	5.0	4.0	3.1											
356 × 127	33	8.5	8.7	8.7	8.7	8.7	8.0	7.0	6.5																						
356 × 127	39	10.7	9.1	9.1	9.1	9.1	9.1	8.5	7.8	7.3	6.8	6.4	4.4																		
356 × 171	45	9.7	12.6	12.6	12.6	12.6	12.0	10.8	9.8	9.1	7.4																				
356 × 171	51	11.5	13.0	13.0	13.0	13.0	13.0	12.3	11.3	10.5	9.8	9.2	8.7	6.5	4.4																
356 × 171	57	13.0	13.3	13.3	13.3	13.3	13.3	13.3	12.6	11.6	10.9	10.3	9.7	9.1	8.8	7.5	5.9	4.5													
356 × 171	67	15.7	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	12.8	12.1	11.4	10.8	10.3	9.8	9.5	9.1	8.7	8.1	7.0	6.0	5.1	4.3	3.5						
381 × 152	52	12.4	11.2	11.2	11.2	11.2	11.2	11.2	10.8	10.0	9.4	8.9	8.4	8.0	7.4	5.7	4.2														
381 × 152	60	14.4	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.4	10.6	10.1	9.5	9.0	8.6	8.3	7.9	7.6	6.4	5.2	4.2										
381 × 152	67	16.3	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.2	10.6	10.1	9.6	9.2	8.9	8.6	8.2	8.0	7.7	7.0	6.1	5.2	4.5	3.8	3.1				
406 × 140	39	8.6	9.6	9.6	9.6	9.6	9.3	8.3	7.5																						
406 × 140	46	11.2	10.3	10.3	10.3	10.3	10.3	10.3	9.3	8.7	8.2	7.7	7.4	5.4																	
406 × 152	60	13.9	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.1	10.3	9.8	9.3	8.9	8.5	8.1	7.8	7.0	5.7	4.5											
406 × 152	67	16.0	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.2	10.5	10.1	9.6	9.1	8.8	8.5	8.2	7.9	7.7	7.0	6.0	5.2	4.4	3.6					
406 × 152	74	18.1	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.2	10.7	10.2	9.9	9.5	9.1	8.8	8.6	8.3	8.0	7.9	7.6	7.0	6.3	5.6	4.9	4.4	3.8
406 × 178	54	10.9	12.9	12.9	12.9	12.9	12.9	12.5	11.4	10.6	9.9	9.4	8.0																		
406 × 178	60	12.8	13.4	13.4	13.4	13.4	13.4	13.4	13.0	12.0	11.4	10.7	10.2	9.7	9.2	8.1	6.2														

Table 13 — Maximum permissible single span, simply supported, universal beams when loaded at *B*/4 from toe of flange

Beam size																															
D × *B* mm	Mass/length kg/m	*T* mm	Load kg																												
			400	450	500	750	1 000	1 250	1 500	1 750	2 000	2 250	2 500	2 750	3 000	3 250	3 500	3 750	4 000	4 250	4 500	4 750	5 000	5 250	5 500	5 750	6 000	6 250	6 500	6 750	7 000
406 × 178	67	14.3	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.4	12.4	11.8	11.3	10.7	10.2	9.7	9.4	9.1	7.7	6.3	5.0										
406 × 178	74	16.0	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.1	12.3	11.8	11.2	10.7	10.3	9.9	9.5	9.3	9.0	7.9	6.8	5.8	4.9	4.0					
457 × 152	67	15.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.6	10.0	9.6	9.3	8.9	8.5	8.2	8.0	7.7	6.8	5.6									
457 × 152	74	17.0	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	10.8	10.2	9.9	9.6	9.2	8.8	8.6	8.3	8.1	7.8	7.6	7.0	6.1	5.3	4.5	3.8		
457 × 152	82	18.9	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	10.9	10.4	10.0	9.8	9.4	9.1	8.8	8.6	8.4	8.2	7.9	7.7	7.6	7.1	6.4	5.7
457 × 191	67	12.7	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.1	12.2	11.6	11.1	10.5	10.1	9.7	7.4														
457 × 191	74	14.5	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	13.7	12.8	12.3	11.8	11.3	10.9	10.3	10.0	9.7	8.2	6.7	5.3	4.5								
457 × 191	82	16.0	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.2	13.3	12.7	12.3	11.8	11.3	11.0	10.6	10.2	9.9	9.6	8.4	7.2	6.0	4.9					
457 × 191	89	17.7	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.0	13.3	12.8	12.4	11.8	11.4	11.1	10.8	10.5	10.1	9.8	9.6	8.9	7.9	6.9	6.1	5.3	4.5
457 × 191	98	19.6	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.7	14.1	13.5	13.1	12.6	12.2	11.8	11.5	11.2	10.9	10.6	10.3	10.1	9.9	9.6	9.1	8.2
533 × 210	82	13.2	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.4	13.6	12.9	12.2	11.7	11.3	10.9	9.9													
533 × 210	92	15.6	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	14.7	14.1	13.5	13.1	12.6	12.2	11.8	11.4	11.1	10.8	9.7	8.1	6.7						
533 × 210	101	17.4	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.4	14.8	14.1	13.6	13.3	13.0	12.5	12.2	11.9	11.5	11.2	10.9	10.7	9.7	8.4	7.3	6.2	
533 × 210	109	18.8	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.3	14.7	14.1	13.7	13.4	13.1	12.6	12.3	12.0	11.7	11.4	11.1	10.9	10.6	10.0	8.9
533 × 210	122	21.3	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.5	14.9	14.5	14.1	13.8	13.4	13.0	12.6	12.4	12.2	12.0	11.7	11.4
533 × 330	167	22	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.3	25.3	24.4	23.6	23.0	22.3	21.6	21.0	20.6	20.1	19.7	19.3	18.8	18.3	18.0
533 × 330	189	25	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	25.7	25.1	24.4	23.7	23.1	22.6	22.1	21.6	21.2	20.7	20.3
533 × 330	212	27.8	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	26.7	26.1	25.6	25.0	24.3	23.7	23.2	22.8	22.4
610 × 229	101	14.8	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.8	15.1	14.5	13.8	13.3	12.7	12.4	12.1	11.8	10.5									
610 × 229	113	17.3	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.4	15.7	15.1	14.7	14.3	13.9	13.5	13.2	12.8	12.5	12.2	12.0	11.7	10.3	8.9	7.6	
610 × 229	125	19.6	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.8	16.2	15.7	15.2	14.8	14.5	14.2	13.9	13.5	13.2	13.0	12.7	12.4	12.2	11.9
610 × 229	140	22.1	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.1	16.6	16.1	15.6	15.3	15.0	14.7	14.4	14.1	13.7	13.5	13.3
610 × 305	149	19.7	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.3	22.4	21.6	20.9	20.5	20.0	19.5	19.0	18.5	18.1	17.7	17.2	16.8	16.6	16.2	15.9
610 × 305	179	23.6	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	23.5	22.8	22.1	21.5	21.2	20.7	20.2	19.8	19.3	18.9	18.6
610 × 305	238	31.4	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.3	23.9
686 × 254	125	16.2	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.0	16.4	15.9	15.2	14.8	14.2	13.9	13.6	13.4	13.1	11.7					
686 × 254	140	19.0	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	17.9	17.4	16.9	16.3	16.0	15.7	15.3	15.0	14.7	14.4	14.0	13.7	13.6	13.3
686 × 254	152	21.0	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.4	17.8	17.4	16.8	16.5	16.2	15.9	15.6	15.3	15.0	14.8	14.5
686 × 254	170	23.7	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.4	18.0	17.5	17.1	16.7	16.5	16.3	16.0
762 × 267	147	17.5	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	17.5	17.0	16.5	16.1	15.6	15.2	14.6	14.3	14.1	13.9	13.8	12.8	10.9
762 × 267	173	21.6	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	18.5	18.1	17.7	17.3	16.9	16.7	16.4	16.1	15.8
762 × 267	197	25.4	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.4	19.0	18.7	18.3	17.9
838 × 292	176	18.8	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.6	19.2	18.7	18.3	17.9	17.3	16.9	16.6	16.0	15.7	15.5
838 × 292	194	21.7	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.3	19.9	19.5	19.0	18.7	18.3	18.0	17.7
838 × 292	226	26.8	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.3	20.9

Table 14 — Maximum permissible single span, simply supported, universal beams when loaded at toe of flange

Beam size																															
D × *B* mm	**Mass/length** kg/m	*T* mm	**Load** kg																												
			400	450	500	750	1 000	1 250	1 500	1 750	2 000	2 250	2 500	2 750	3 000	3 250	3 500	3 750	4 000	4 250	4 500	4 750	5 000	5 250	5 500	5 750	6 000	6 250	6 500	6 750	7 000
152 × 89	17.09	8.3	6.9	6.8	6.5	5.1	2.7																								
128 × 102	21.54	9.0	7.9	7.9	7.9	6.6	5.6	2.8																							
203 × 102	25.32	10.4	7.8	7.8	7.8	7.7	6.5	5.8	3.9	2.2																					
203 × 133	25	7.8	10.3	10.3	10.0	8.0																									
206 × 133	30	9.6	10.7	10.7	10.7	9.7	8.3	6.1	3.1																						
254 × 102	22	6.8	7.1	7.1	7.1	5.4																									
254 × 102	25	8.4	7.4	7.4	7.4	6.9	6.1																								
254 × 102	28	10	7.7	7.7	7.7	7.7	7.0	6.2	4.5																						
254 × 146	31	8.6	11.2	11.2	11.2	9.9	8.7																								
254 × 146	37	10.9	11.7	11.7	11.7	11.7	10.6	9.4	8.5	5.7																					
254 × 146	43	12.7	12.0	12.0	12.0	12.0	12.0	10.8	9.8	9.0	8.1	5.8	4.0																		
305 × 102	25	6.8	6.8	6.8	6.8	6.2																									
305 × 102	28	8.9	7.2	7.2	7.2	7.2	6.5	5.2																							
305 × 102	33	10.8	7.5	7.5	7.5	7.5	7.5	6.9	6.3	5.1																					
305 × 127	37	10.7	9.1	9.1	9.1	9.1	9.1	8.1	7.5	5.6																					
305 × 127	42	12.1	9.2	9.2	9.2	9.2	9.2	9.1	8.3	7.7	7.1	4.8																			
305 × 127	48	14.0	9.5	9.5	9.5	9.5	9.5	9.5	9.5	8.8	8.1	7.6	7.2	5.7	4.2																
305 × 165	40	10.2	12.9	12.9	12.9	12.9	11.6	10.5	8.9	6.7																					
305 × 165	46	11.8	13.1	13.1	13.1	13.1	13.1	11.8	10.8	10.0	7.9	5.0																			
305 × 165	54	13.7	13.4	13.4	13.4	13.4	13.4	13.4	12.4	11.4	10.6	9.9	8.6	6.4	4.6																
356 × 127	33	8.5	8.7	8.7	8.7	8.7	8.0																								
356 × 127	39	10.7	9.1	9.1	9.1	9.1	9.1	8.5	7.8																						
356 × 171	45	9.7	12.6	12.6	12.6	12.6	12.0	10.8	8.5																						
356 × 171	51	11.5	13.0	13.0	13.0	13.0	13.0	12.3	11.3	10.5	8.6																				
356 × 171	57	13.0	13.3	13.3	13.3	13.3	13.3	13.3	12.6	11.6	10.9	10.2	8.2	5.6																	
356 × 171	67	15.7	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	12.8	12.1	11.4	10.8	10.3	9.6	7.7	6.0	4.6												
381 × 152	52	12.4	11.2	11.2	11.2	11.2	11.2	11.2	10.8	10.0	9.4	8.8	5.9																		
381 × 152	60	14.4	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.4	10.6	10.1	9.5	9.0	7.6	5.6															
381 × 152	67	16.3	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.2	10.6	10.1	9.6	9.2	8.9	7.3	5.9	4.6											
406 × 140	39	8.6	9.6	9.6	9.6	9.6	9.3																								
406 × 140	46	11.2	10.3	10.3	10.3	10.3	10.3	10.3	9.3	8.7	7.0																				
406 × 152	60	13.9	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.1	10.3	9.8	9.3	8.9	6.6																
406 × 152	67	16.0	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.2	10.5	10.1	9.6	9.2	8.8	7.2	5.7												
406 × 152	74	18.1	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.2	10.7	10.2	9.9	9.5	9.1	8.8	7.7	6.4	5.3	4.3							
406 × 178	54	10.9	12.9	12.9	12.9	12.9	12.9	12.5	11.4	10.6																					
406 × 178	60	12.8	13.4	13.4	13.4	13.4	13.4	13.4	13.0	12.0	11.4	10.7	8.8																		

Table 14 — Maximum permissible single span, simply supported, universal beams when loaded at toe of flange

Beam size			Load kg																												
$D \times B$ mm	Mass/length kg/m	T mm	400	450	500	750	1 000	1 250	1 500	1 750	2 000	2 250	2 500	2 750	3 000	3 250	3 500	3 750	4 000	4 250	4 500	4 750	5 000	5 250	5 500	5 750	6 000	6 250	6 500	6 750	7 000
406 × 178	67	14.3	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.4	12.4	11.8	11.3	10.7	9.2	6.7															
406 × 178	74	16.0	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.1	12.3	11.8	11.2	10.7	10.1	8.1	6.3												
457 × 152	67	15.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.6	10.0	9.6	9.3	8.9	6.9														
457 × 152	74	17.0	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	10.8	10.2	9.9	9.6	9.2	8.8	7.6	6.1										
457 × 152	82	18.9	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	10.9	10.4	10.0	9.8	9.4	9.1	8.8	8.0	6.8	5.8	4.8					
457 × 191	67	12.7	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.1	12.2	11.6	10.4																		
457 × 191	74	14.5	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	13.7	12.8	12.3	11.8	11.3	9.0															
457 × 191	82	16.0	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.2	13.3	12.7	12.3	11.8	11.3	10.0	7.9												
457 × 191	89	17.7	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.0	13.3	12.8	12.4	11.8	11.5	11.1	9.5	7.8	6.3								
457 × 191	98	19.6	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.7	14.1	13.5	13.1	12.6	12.2	11.8	11.4	11.1	10.0	8.7	7.4	6.3				
533 × 210	82	13.2	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.4	13.6	12.9	12.3																	
533 × 210	92	15.6	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	14.7	14.1	13.5	13.1	12.6	11.4													
533 × 210	101	17.4	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.4	14.8	14.1	13.6	13.3	13.0	12.5	11.5	9.3									
533 × 210	109	18.8	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.3	14.7	14.1	13.7	13.4	13.1	12.6	12.3	10.6	8.9	7.3					
533 × 210	122	21.3	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.5	14.9	14.5	14.1	13.8	13.4	13.0	12.7	12.4	12.0	10.7	9.4	8.2
533 × 330	167	22	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.3	25.3	24.4	23.6	23.0	22.3	21.6	21.0	20.6	20.1	19.7	19.3	17.6	15.8	14.0
533 × 330	189	25	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	25.7	25.1	24.4	23.7	23.1	22.6	22.1	21.6	21.2	20.7	20.3
533 × 330	212	27.8	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	26.7	26.1	25.6	25.0	24.3	23.7	23.2	22.8	22.4
610 × 229	101	14.8	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.8	15.1	14.5	13.8	13.0														
610 × 229	113	17.3	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.4	15.7	15.1	14.7	14.3	13.9	13.5	11.4									
610 × 229	125	19.6	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.8	16.2	15.7	15.2	14.8	14.5	14.2	13.9	13.6	12.4	10.5	8.8			
610 × 229	140	22.1	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.1	16.6	16.1	15.6	15.3	15.0	14.7	14.4	14.1	13.7	13.5	12.9
610 × 305	149	19.7	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.3	22.4	21.6	20.9	20.5	20.0	19.5	19.0	18.5	18.1	16.1	13.7	11.5			
610 × 305	179	23.6	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	23.5	22.8	22.1	21.5	21.2	20.7	20.2	19.8	19.3	18.9	18.6
610 × 305	238	31.4	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.3	23.9
686 × 254	125	16.2	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.0	16.4	15.9	15.2	14.1											
686 × 254	140	19.0	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	17.9	17.4	16.9	16.3	16.0	15.7	15.3	14.9	12.6					
686 × 254	152	21.0	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.4	17.8	17.4	16.8	16.5	16.2	15.9	15.6	15.3	15.0	13.5	11.6
686 × 254	170	23.7	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.9	18.4	18.0	17.5	17.1	16.7	16.5	16.3	16.0
762 × 267	147	17.5	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	17.5	17.0	16.5	16.1	15.3								
762 × 267	173	21.6	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	18.5	18.1	17.7	17.3	16.9	16.7	16.4	16.1	15.7
762 × 267	197	25.4	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.4	19.0	18.7	18.3	17.9
838 × 292	176	18.8	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.6	19.2	18.7	18.3	17.9	17.2					
838 × 292	194	21.7	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.3	19.9	19.5	19.0	18.7	18.3	18.0	17.7
838 × 292	226	26.8	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.3	20.9

Appendix C Method of calculating maximum loads on cantilevers

C.1 Introduction

The methods given in this appendix assume no torsion of the cantilever section. In the case of channels loaded with the webs in the plane of bending and all cases of angles, there will be torsion and/or warping due to the non-coincidence of the sectional caniloids and shear centres. The method given below assumes an ideal situation with no torsion or warping and will usually prove satisfactory. Where the aspect ratio of the cantilever is slim, due attention has to be paid to the torsion/warping problem.

C.2 Maximum loads on cantilevers

Table 12 gives the maximum load which may be carried on various steelwork sections when used as cantilevers.

These loads are limited either by a stress or by a deflection condition in the cantilever and have been calculated using formulae obtained from BS 449-2:1969.

C.3 Stress limited loads

Refer to BS 449-2:1969 as follows:

a) Clause **19** a) for rolled steel joists, universal beams, universal columns and channels when loaded with the web in the plane of bending or at right angles to the plane of bending and the flanges in a state of tension. In these cases the allowable stresses in bending (P_{bc} and P_{bt}) shall be obtained as appropriate from Tables 2 and 3(a) of BS 449-2:1969.

b) Clause **19** c) for equal and unequal angles when loaded with the flange or table in compression where the allowable stresses shall be obtained as in a).

c) Clause **19** c) for equal and unequal angles and channels when loaded with the leg or legs in compression where the allowable compressive stress in bending shall be obtained from Table 8 of BS 449-2:1969 using the value of C_s (in N/mm^2) as calculated from clause **20**, case III of BS 449-2:1969 and as set out below.

$$C_s = (A + K_2B)\ \frac{Y_c}{Y_t}$$

where

$$A = \left(\frac{1675}{l/r_y}\right)^2 \sqrt{1 + \frac{1}{20}\left(\frac{lT}{r_yD}\right)^2}$$

= $2L$ from clause **26** c) of BS 449-2:1969

L is the cantilever length, see Figure 19 of this Part of this standard

r_y is the radius of gyration about Y–Y axis

D is the depth of section

T is the effective thickness of compression flange as given in BS 4-1

K_2 = – 1.0 from clause **19** c) of BS 449-2:1969

$$B = \left(\frac{1675}{\mathrm{I}/r_y}\right)^2$$

y_c = the distance from the neutral axis to extreme fibre in compression

y_t = the distance from the neutral axis to extreme fibre in tension

The maximum load (W) (in kg) the cantilever can carry shall be calculated from:

$$W = \frac{P_{bc}\,Z}{9.866L}$$

where Z is the section (or elastic) modulus (mm^3) from BS 4-1.

C.4 Deflection limited loads

Deflection (δ) shall not exceed 1/360 of the cantilever length, as given in clause **15** of BS 449-2:1969.

The maximum load (*W*) (in kg) the cantilever can carry is given by:

$$W = \frac{3\,\delta\,E\,I}{L^3} = \frac{3\,L\,E\,I}{360\,L^3} = \frac{E\,I}{120\,L^2}$$

where

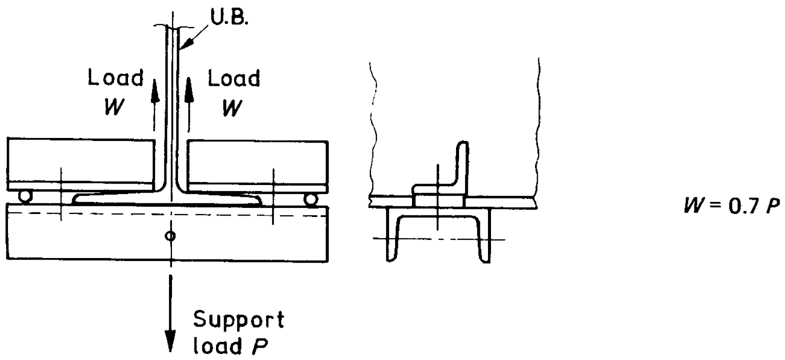
$$E = \frac{2.10 \times 10^5}{9.806}\ (\text{N/mm}^2)$$

I is the moment of inertia (mm^4) about x–x axis of section, as given in BS 4-1;

L is the cantilever length (mm)

Appendix D Method of calculating universal beam clip design load "*W*" (see 5.1)

D.1 Centrally loaded beam



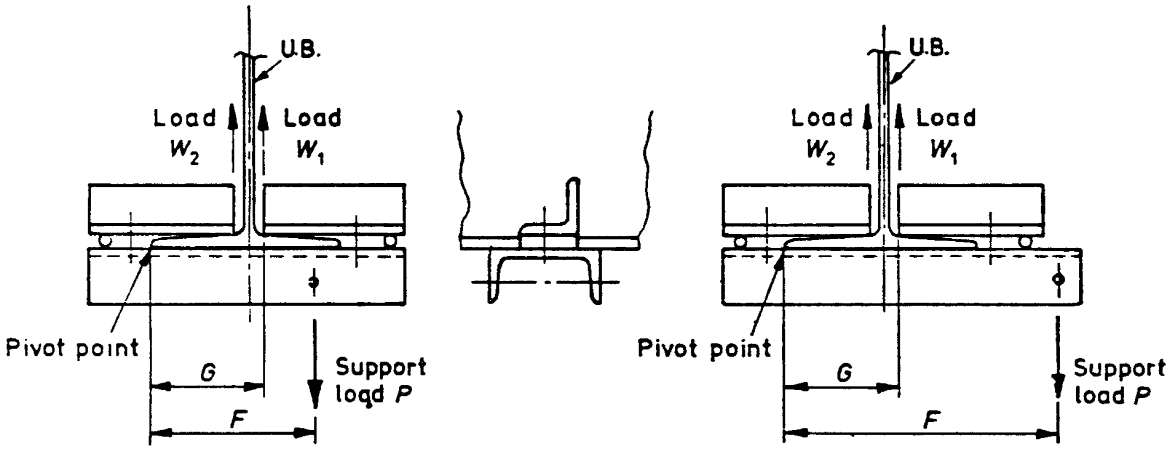
D.2 Eccentrically loaded beam

Eccentric loading, as shown below, produces a pivot point at the toe of the bottom flange. Hence, W_1 will be greater than W_2.

By taking moments:

$$W_1 = \frac{PF}{G}$$

For design purposes of the clip $W_2 = W_1$ and is to be taken as *W* in Table 1(b).



NOTE The "*H* dimension" has been deleted in these figures.

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Publications referred to

BS 4, *Structural steel sections.*
BS 4-1, *Hot-rolled sections.*
BS 449, *The use of structural steel in building.*
BS 449-2, *Metric units.*
BS 639, *Covered electrodes for the manual metal-arc welding of carbon and carbon manganese steels.*
BS 970, *Wrought steels in the form of blooms, billets, bars and forgings.*
BS 970-1, *Carbon and carbon manganese steels including free cutting steels.*
BS 1387, *Steel tubes and tubulars suitable for screwing to BS 21 pipe threads.*
BS 1501, *Steels for fired and unfired pressure vessels. Plates.*
BS 1501-1, *Carbon and carbon manganese steels: Imperial units.*
BS 1775, *Steel tubes for mechanical, structural and general engineering purposes.*
BS 2633, *Class 1 arc welding of ferritic steel pipework for carrying fluids.*
BS 3032, *Higher tensile steel shackles.*
BS 3692, *ISO metric precision hexagon bolts, screws and nuts.*
BS 3974, *Pipe supports.*
BS 3974-1, *Pipe hangers, slider and roller type supports.*
BS 4190, *ISO metric black hexagon bolts, screws and nuts.*
BS 4229, *Recommendations for metric sizes of non-ferrous and ferrous bars.*
BS 4229-2, *Ferrous bars.*
BS 4360, *Weldable structural steels.*
BS 4848, *Hot-rolled structural steel sections.*
BS 4848-4, *Equal and unequal angles.*
BS 5135, *Metal-arc welding of carbon and carbon managanese steels.*
BS 5383, *Specification for material marking and colour coding of metal pipes end piping system components in steel, nickel alloys and titanium alloys.*
BS 5500, *Unfired fusion welded pressure vessels.*
BS 0000, *Selection and application of metallic bellows units for use in pressure systems*[2)].

[2)] In course of preparation

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