



Addendum No. 1 (April 1975) to BS 449 : Part 2 : 1969

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Specification for

The use of cold formed steel sections in building

Incorporating amendments issued May 1975 (AMD 1765)
and March 1976 (AMD 1929)

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Co-operating organizations

The Technical Committee of the Building Divisional Council responsible for the preparation of this addendum consists of representatives from the following Government departments and industrial organizations:

Association of Municipal Corporations	Greater London Council
*British Constructional Steelwork Association	Institute of Building
*British Steel Industry	Institution of Civil Engineers
British Railways Board	Institution of Municipal Engineers
Constructional Steel Research and Development Organization	*Institution of Structural Engineers
*Department of the Environment	National Federation of Building Trades Employers
*Department of the Environment, Building Research Establishment	The Concrete Society
District Surveyors' Association	Royal Institute of British Architects
	Welding Institute

The Government departments and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this addendum:

Cold Rolled Sections Association

This addendum makes reference to the following British Standards:

- BS 449 Use of structural steel in building
Part 2. Metric units
- BS 1140 General requirements for spot welding of light assemblies in mild steel
- BS 1449 Steel plate, sheet and strip
- BS 2989 Hot-dip galvanized plain steel sheet and coil
- BS 2994* Cold rolled steel sections
- BS 4604 The use of high strength friction grip bolts in structural steelwork. Metric Series
- BS 4870 Approval testing of welding procedures
Part 1 Fusion welding of steel
- BS 4871 Approval testing of welders working to approved welding procedures
Part 1 Fusion welding of steel
- BS 4872 Approval testing of welders when welding procedure approval is not required
Part 1 Fusion welding of steel
- DD 24 Recommendations for methods of protection against corrosion on light section steel used in building

*Metric edition in course of preparation.

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Foreword

In design and construction entailing the use of cold formed steel sections in building the requirements are in most respects similar to those for structural steelwork of hot rolled sections and plate, and most of the clauses of BS 449 apply equally to both. The present addendum therefore deals only with requirements that are special to the use of cold formed sections, and specifically excludes or amends such clauses of BS 449 as do not apply.

To facilitate cross reference, the numbering of the chapters in the addendum agrees with that of BS 449. The clauses, however, to avoid confusion are numbered consecutively beginning with 101.

It is to be noted that all references to BS 449 in this addendum are to be understood as references to BS 449: Part 2: 1969.

Specification

Scope

101. This addendum to BS 449: Part 2: 1969 specifies requirements for the use in building of sections cold formed from steel plate, sheet or strip not more than 6 mm thick. It is specified that:

- (a) sections, which may be either closed (continuously welded) or open, shall be made up of flat elements bounded either by free edges or by bends with included angles not exceeding 135° ;
- (b) the inside radius of bend shall normally be not less than the thickness, t , of the material, except for 180° bends in symmetrical tee sections, and shall not exceed $3t$;
- (c) sections shall be formed by cold rolling, pressing or other process in such a way as to minimize work hardening;
- (d) the proportions of a section shall be within the range for which information is given in the tables of this addendum;
- (e) a section shall be without holes or openings other than those needed for normal structural connections and for access;
- (f) sections other than those covered by (a) to (e) above may be dealt with on an experimental basis as specified in clause 9c of BS 449.

All references to BS 449 in this addendum shall be understood as references to BS 449: Part 2: 1969.

Appendices A, D and E of BS 449 apply to this addendum. Appendices B and C do not apply.

References

The titles of the British Standards referred to in this addendum are listed on page 2.

1. Definitions

102. The following definitions, in addition to those of clause 2 of BS 449, apply to cold formed sections.

unstiffened plate component. A flat element adequately supported at only one longitudinal edge.

stiffened plate component. A flat element adequately supported at both longitudinal edges.

adequate edge support. The support provided when the adjoining component has an overall width, measured at right angles, of not less than one fifth that of the component to be stiffened.

plate component width-to-thickness ratio. The ratio of the flat width, b , of a plate component to its thickness, t . The flat width is the distance between tangent points or between tangent point and edge. It will normally be the overall width minus (two internal radii plus $2t$) for a stiffened plate component and minus (internal radius plus t) for an unstiffened one.

local plate stress factor (C_L). A factor depending on the b/t ratio of the plate component and on its edge stiffening. Values of C_L are given in table 5. (See also weighted mean stress factor, defined in clause 117).

yield stress (Y_s). The yield stress (or proof stress), see BS 1449.

2. Materials

103. Clause 3 (but only insofar as it applies to electrodes, bolts, nuts and washers), clause 4 and clause 5 of BS 449 apply.

104. All steel used in the manufacture of cold formed sections for use as structural members in building shall, before fabrication, comply with the requirements of BS 1449 or BS 2989, and shall have Y_s not less than 200 N/mm^2 .

105. Properties of basic shapes are given in BS 2994.

Other shapes may also be used, subject to the design requirements of this addendum.

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3. Loads

106. Clauses 6, 7 and 8 of BS 449 apply.

4. Design and details of construction

A. General

107. Clauses 9 to 14 of BS 449, excluding clause 14*d* and table 1, apply, as also do clauses 16 and 17. Clauses 15 and 18 do not apply.

Thickness of metal

108. The provisions of this addendum govern the use of cold formed sections of thickness less than is specified in clause 12 of BS 449.

All sections shall be protected as required by clause 131.

Combined stresses

109. For combined bending, shear and axial stresses generally, clause 14 of BS 449, excluding clause 14*d* and table 1, applies.

In no case shall the equivalent stress, calculated with the use where appropriate of a reduced section modulus as in clause 111, exceed $0.9 Y_s$, e.g. 228 N/mm^2 where Y_s is 250 N/mm^2 .

For combined bending and torsion the sum of the longitudinal stress due to bending and that due to torsional warping restraint shall not exceed Y_s .

In all cases of combined stresses the stress due to bending alone shall not exceed $0.65 Y_s$ (see clause 111).

B. Design of members subject to bending

110. Clauses 24 to 26 of BS 449 apply. Clauses 19 to 23 and 27 to 29, and tables 2 to 16 do not apply.

Bending stresses

111. The provisions of this clause apply only, except for a symmetrical section as dealt with in the last paragraph of this clause, to a beam adequately restrained along its length against twisting. Any other beam shall be dealt with either by a proven design method or on an experimental basis as specified in clause 9*c* of BS 449.

For the design of purlins see clause 123.

The bending stresses in a beam shall be calculated on a reduced section modulus obtained on the assumption that the effective width of the plate component in compression is $C_L b$, where C_L is the local plate stress factor (see table 5) of the flange component in which the extreme compression fibre stress occurs, and b is its flat plate width. In the calculation of the section modulus the area of all inward lips shall be included, but outward lips shall be treated as follows.

(a) Where an outward lip adjoins a compression flange and has a flat width not greater than $10t\sqrt{250/Y_s}$, its whole area shall be included.

(b) Where an outward lip adjoins a compression flange and has a flat width exceeding $10t\sqrt{250/Y_s}$, it shall not be included.

(c) Where an outward lip adjoins a tension flange it shall be included.

The bending tensile stress, calculated on the reduced section modulus in tension, shall not exceed $0.65 Y_s$, e.g. 163 N/mm^2 where Y_s is 250 N/mm^2 .

The bending compressive stress calculated on the reduced section modulus in compression shall not exceed either $0.65 Y_s$ or, for a laterally unrestrained symmetrical I section fabricated from two channel sections adequately connected, by welding or otherwise, back to back, the permissible stress p_{bc} obtained from table 1, where l , r_y , D and T are as defined in clause 19 of BS 449.

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Table 1. Permissible stress p_{bc} (N/mm²) for symmetrical I-sections not restrained laterally (for all steels)

l/r_y	D/T								
	20	30	40	50	60	70	80	90	100
0	173	173	173	173	173	173	173	173	173
10	166	166	166	166	166	166	166	166	166
20	160	159	159	159	159	159	159	159	159
30	153	152	152	152	152	152	152	152	152
40	147	145	145	145	145	145	145	145	145
50	141	139	139	139	139	139	139	139	139
60	135	133	131	131	131	131	131	131	131
70	130	127	124	124	124	124	124	124	124
80	124	120	118	118	118	118	118	118	118
90	119	115	111	111	111	111	111	111	111
100	114	110	105	105	104	104	104	104	104
110	111	105	100	100	98	98	98	98	98
120	107	100	95	95	93	93	93	93	93
130	104	96	91	91	86	86	86	86	86
140	101	93	87	85	82	82	81	81	81
150	99	90	83	82	77	77	76	76	76
160	96	86	80	78	73	73	71	71	71
170	94	83	76	74	69	69	67	67	67
180	91	80	74	71	66	66	63	63	63
190	89	77	70	67	62	62	60	59	59
200	86	74	67	63	59	59	57	56	56
210	84	71	64	60	56	56	54	52	52
220	83	69	62	57	53	53	51	49	49
230	81	67	59	54	51	50	48	46	46
240	79	65	57	52	49	47	46	44	43
250	78	63	55	49	46	45	43	42	40
300	71	56	46	40	37	34	32	31	31

Deflections

112. The deflection of a beam shall be such as will not impair the strength and efficiency of the structure, lead to damage to finishes or be unsightly. Measures may be taken to nullify the effects of the deflection due to dead load by cambering or by adjustment of the casing.

The following deflection limits under total load are recommended as a guide.

For beams supporting plasterwork	span/325
For beams supporting timber or particle-board flooring	span/300
For beams supporting corrugated asbestos sheeting or light gauge metal decking	span/240
For beams supporting corrugated steel or aluminium sheeting	span/180

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Shear stresses

114. (a) *Members subjected to bending.* Separate calculations shall be made for maximum and average shear stresses in the case of members subjected to bending.
- (b) *Maximum shear stress.* The maximum shear stress p_q , having regard to the elastic stress distribution in the member, shall not exceed $0.46Y_s$, e.g. 115 N/mm^2 where $Y_s = 250 \text{ N/mm}^2$.
- (c) *Average shear stress in webs.* The average shear shall not exceed the value of p_q as obtained from (1) or (2), whichever is the lesser, as follows. The web area shall be taken as the overall depth of the beam at the web multiplied by the total thickness of the web metal. Where there are large apertures in the web, calculations shall be made to show that the maximum shear stress does not exceed the value given in (b).
- (1) $p_q = 0.39Y_s$, e.g. 97.5 N/mm^2 where Y_s is 250 N/mm^2 ;
- (2) p_q is as given in table 2 for all steels.

Web buckling

115. The concentrated load or reaction on the unstiffened web of a beam shall not exceed $p_{cw}Bl'$ where

p_{cw} is the lesser of the values computed as in (a) and (b) or (a) and (c) as follows:
 B is the length of web immediately underneath the load;
 t' is the total thickness of web metal;
 t is the thickness of the thinnest web plate;
 D is the overall depth of beam at the web.

- (a) $p_{cw} = 0.59Y_s$, e.g. 148 N/mm^2 where Y_s is 250 N/mm^2 .
- (b) For end reactions and for concentrated loads on the outer ends of cantilevers, where the inside corner radius, r , of the section equals the thickness of the thinnest web component, p_{cw} for steel with Y_s of 250 N/mm^2 is given in table 3. For steel where Y_s is other than 250 N/mm^2 , the value from table 3 shall be multiplied by:

$$\frac{Y_s}{250} \left(1.33 - \frac{0.33Y_s}{250} \right)$$

and for a corner radius exceeding t the value obtained as above shall be multiplied by:

$$\left(1.15 - \frac{0.15r}{t} \right)$$

- (c) For reactions at intermediate supports and for concentrated loads within a span, where the inside corner radius, r , of the section equals the thickness of the thinnest web component, p_{cw} for steel with Y_s of 250 N/mm^2 is given in table 4. For steel where Y_s is other than 250 N/mm^2 , the value from table 4 shall be multiplied by:

$$\frac{Y_s}{250} \left(1.22 - \frac{0.22Y_s}{250} \right)$$

and for a corner radius exceeding t the value obtained as above shall be multiplied by:

$$\left(1.06 - \frac{0.06r}{t} \right)$$

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Table 3. Permissible stress p_{cw} (N/mm²) for end reactions and for concentrated loads at outer ends of cantilevers

B/D D/t	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
10	401	278	216	179	154	136	123	113	104
20	214	152	121	103	90.3	81.4	74.8	69.7	65.6
30	150	109	88.5	76.2	68.0	62.1	57.7	54.3	51.5
40	118	86.8	71.4	62.1	56.0	51.6	48.3	45.7	43.7
50	97.4	72.7	60.4	53.0	48.1	44.6	42.0	39.9	38.3
60	83.3	62.8	52.6	46.4	42.3	39.4	37.2	35.5	34.1
70	72.8	55.3	46.5	41.2	37.7	35.2	33.3	31.9	30.7
80	64.5	49.2	41.5	36.9	33.8	31.6	30.0	28.7	27.7
90	57.7	44.1	37.3	33.2	30.4	28.5	27.0	25.9	25.0
100	51.9	39.6	33.5	29.9	27.4	25.7	24.3	23.3	22.5
110	46.8	35.7	30.2	26.8	24.6	23.0	21.8	20.9	20.2
120	42.4	32.2	27.1	24.0	22.0	20.6	19.5	18.6	17.9
130	38.3	28.9	24.2	21.4	19.5	18.2	17.2	16.4	15.8
140	34.6	25.9	21.6	18.9	17.2	16.0	15.0	14.3	13.7
150	31.2	23.1	19.0	16.6	14.9	13.8	12.9	12.2	11.7

NOTE 1. Values below stepped line apply where Y_s is 250 N/mm².

NOTE 2. For other yield stresses see clause 115; note that p_{cw} shall not exceed $0.59Y_s$.

Table 4. Permissible stress p_{cw} (N/mm²) for reactions at intermediate supports and for concentrated loads between supports

B/D D/t	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
10	1150	775	585	472	396	342	301	269	244
20	575	389	296	240	202	176	156	140	128
30	382	260	199	162	138	120	107	96.8	88.7
40	285	195	150	123	105	91.9	82.2	74.7	68.7
50	226	156	120	98.9	84.8	74.7	67.1	61.2	56.5
60	187	129	100	82.8	71.2	63.0	56.8	51.9	48.1
70	159	110	85.8	71.1	61.4	54.4	49.2	45.1	41.9
80	138	95.7	74.8	62.2	53.8	47.9	43.4	39.9	37.1
90	121	84.3	66.0	55.1	47.8	42.6	38.7	35.6	33.2
100	107	75.0	58.9	49.3	42.8	38.2	34.8	32.1	29.9
110	96.1	67.4	53.0	44.4	38.6	34.5	31.5	29.1	27.2
120	86.6	60.8	47.9	40.2	35.0	31.4	28.6	26.4	24.7
130	78.5	55.2	43.6	36.6	31.9	28.6	26.1	24.1	22.6
140	71.5	50.3	39.7	33.3	29.1	26.1	23.8	22.0	20.6
150	65.3	45.9	36.3	30.5	26.6	23.8	21.7	20.1	18.8

NOTE 1. Values below stepped line apply where Y_s is 250 N/mm².

NOTE 2. For other yield stresses see clause 115; note that p_{cw} shall not exceed $0.59Y_s$.

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C. Design of compression members

116. Clauses 31, 32*b*, 34 to 37, 38*a*, 39 and 40 of BS 449 apply. Clauses 30, 32*a*, 33, 38*b* and table 17 do not apply.

Axial stresses in struts

117. *Uncased struts.* The permissible stress on the gross area of an axially loaded strut shall not exceed the lesser of $0.59Y_s$ and p_c obtained from table 6, in which:

al/r is the factored slenderness ratio

where

l is the effective length (see clause 31*a* of BS 449);

r is the appropriate radius of gyration;

a is a factor taking account of torsional-flexural instability (see appendix A);

C_{Lm} is the weighted mean stress factor for the cross section, determined as follows.

(a) For steel where Y_s is 250 N/mm² the value of the stress factor C_L for each constituent flat plate component is obtained from table 5, in which b/t is the width-to-thickness ratio. The weighted mean stress factor is then compounded from the C_L values by the formula:

$$C_{Lm} = \frac{\sum C_L b t}{\sum b t}$$

(b) For steel where Y_s is greater than 250 N/mm² the procedure in (a) shall be followed except that in entering table 5 to obtain C_L the value of b/t shall be modified by multiplying it by $\sqrt{Y_s/250}$; and that the values of C_L so obtained shall be then multiplied by $Y_s/250$ before they are used in the formula for C_{Lm} .

The formula from which table 6 is derived is given in appendix B of BS 449, Y_s being taken as $250C_{Lm}$.

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Table 5. Stress factor C_L for plate components in compression

Unstiffened components		Stiffened components					
b/t	C_L	b/t	C_L	b/t	C_L	b/t	C_L
1	1.000	1	1.000	51	0.809	105	0.375
2	1.000	2	1.000	2	0.793	110	0.360
3	1.000	3	1.000	3	0.778	115	0.346
4	1.000	4	1.000	4	0.762	120	0.333
5	1.000	5	1.000	5	0.747	125	0.322
6	1.000	6	1.000	6	0.731	130	0.312
7	0.999	7	1.000	7	0.717	135	0.304
8	0.997	8	1.000	8	0.703	140	0.296
9	0.995	9	1.000	9	0.688	145	0.288
10	0.991	10	1.000	60	0.675	150	0.281
1	0.986	1	1.000	1	0.661	155	0.275
2	0.977	2	1.000	2	0.648	160	0.269
3	0.962	3	1.000	3	0.636	165	0.263
4	0.939	4	1.000	4	0.625	170	0.258
5	0.906	5	1.000	5	0.614	175	0.253
6	0.864	6	1.000	6	0.603	180	0.248
7	0.818	7	1.000	7	0.593	185	0.244
8	0.771	8	1.000	8	0.583	190	0.240
9	0.726	9	1.000	9	0.574	195	0.236
20	0.684	20	1.000	70	0.564	200	0.231
1	0.646	1	0.999	1	0.555	205	0.227
2	0.612	2	0.999	2	0.546	210	0.224
3	0.581	3	0.998	3	0.538	215	0.220
4	0.553	4	0.998	4	0.530	220	0.216
5	0.529	5	0.997	5	0.522	225	0.213
6	0.508	6	0.996	6	0.514	230	0.210
7	0.489	7	0.995	7	0.507	235	0.207
8	0.470	8	0.994	8	0.500	240	0.204
9	0.454	9	0.992	9	0.494	245	0.201
30	0.438	30	0.990	80	0.487	250	0.199
		1	0.989	1	0.481	255	0.196
		2	0.987	2	0.475	260	0.194
		3	0.984	3	0.469	265	0.191
		4	0.982	4	0.464	270	0.188
		5	0.978	5	0.458	275	0.186
		6	0.974	6	0.453	280	0.184
		7	0.970	7	0.448		
		8	0.964	8	0.442		
		9	0.958	9	0.437		
		40	0.951	90	0.432		
		1	0.943	1	0.428		
		2	0.934	2	0.423		
		3	0.924	3	0.419		
		4	0.912	4	0.415		
		5	0.900	5	0.411		
		6	0.885	6	0.406		
		7	0.871	7	0.402		
		8	0.856	8	0.399		
		9	0.840	9	0.395		
		50	0.825	100	0.392		

NOTE 1. Values given apply where Y_s is 250 N/mm². For other yield stresses see clause 117.

NOTE 2. For limiting dimensions of plate components see clause 118.