Compendium of UK Standard Fire Test Data

Unprotected Structural Steel – 2

British Steel Technic
Swinden Laborator

ACKNOWLEDGEMENTS

The authors wish to thank the Sections Commercial Division of British Steel plc for sponsoring the preparation of this Compendium.

The authors also wish to thank Dr. R. Baker, Director, Research and Development, British Steel Technical for permission to publish this document.

Printed and Published by British Steel Technical, Swinden Laboratories 1989©

ISBN 0 900206 48 9

COMPENDIUM OF UK STANDARD FIRE TEST DATA UNPROTECTED STRUCTURAL STEEL - 2

by

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Ref. No. RS/R/S1199/8/88/B

FOREWORD

In 1987 research staff now at British Steel Technical, Swinden Laboratories prepared a Compendium of data on all fire resistance tests carried out in the UK according to BS476 : Part 8, on unprotected hot rolled structural steel sections.

The purpose of the compendium was to provide detailed information for researchers in the field of structural fire engineering and to help develop accurate calculation methods for the determination of high temperature performance and fire resistant design.

Following the final test reported in the first compendium, a further 10 tests have been completed by research staff at Swinden Laboratories and the data derived are presented in this subsequent document, Compendium No. 2.

As before, British Steel invites authors making use of the compendium to send copies of their papers to the address given below. British Steel also welcomes other international data and therefore, blank data sheets which may be copied, are provided for this purpose.

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PREFACE

This compendium is the second in its series which has been prepared covering recent fire resistance tests to BS476, carried out in the UK, on hot rolled structural steel sections.

Data on the behaviour of floor beams in the standard fire resistance test is presented in the same format as before in which the steelwork other than those parts in contact with the concrete floor slabs, was unprotected.

The fire tests have been carried out in the light of recent revisions and the introduction of the following British Standards:

BS476 : 1987 - Fire Tests on Building Materials and Structures

BS4360 : 1986 - Weldable Structural Steels

BS5950 : 1985 - Structural Use of Steelwork in Building

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COMPENDIUM OF UK STANDARD FIRE TEST DATA UNPROTECTED STRUCTURAL STEEL - 2

1. INTRODUCTION

Since the publication of 'Compendium of UK Standard Fire Test Data, Unprotected Structural Steel - 1' (Ref. 1) staff of the Swinden Laboratories, of British Steel Technical, have conducted further fire resistance tests to BS476 on unprotected structural steel members. This document has therefore been prepared as a sequel to Compendium No. 1 presenting data from these more recent tests.

Continuing the numerical sequence and the same format as before, the following tests are reported:

7 simply supported floor beams, data sheet Nos. 89-95
2 simply supported shelf angle floor beams, data sheet Nos. 96 and 97
1 full size unloaded (indicative) simply supported floor beam, data sheet No. 98

Unlike the previous document, analyses of the data have not been included since these will form part of a future publication on design. However, the drafting of BS5950 'Structural Use of Steelwork in Building: Part 8 - Code of Practice for Fire Resistant Design', has been completed and this does contain some aspects of designing for structural stability in fire.

It should also be noted that since the tests in the first compendium were conducted, a number of important changes have occurred in the following relevant British Standards:

BS476 - Fire Tests on Building Materials and Structures

BS4360 - Weldable Structural Steels

BS449 - The Use of Structural Steel in Building has now been superceded by the limit state design approach given in BS5950 - Structural Use of Steelwork in Building.

When using the information presented in this document, reference should be made to Compendium No. 1 for details describing the design, construction and test procedures of each assembly. Only those changes resulting from revision(s) of the appropriate British Standard which affect the tests will be highlighted in the following text.

As before, the fire tests being reported form part of an on-going research programme on the evaluation and prediction of the performance of steel in fire. Readers are therefore reminded to exercise caution in using any single test result and not to take it out of context of other tests of a similar nature.

2. BS476 FIRE TESTS ON BUILDING MATERIALS AND STRUCTURES

2.1 Test Procedures

The majority of fire tests reported in Compendium No. 1 were carried out in accordance with BS476 : Part 8 : 1972 incorporating Amendments 1873 (January 1976), 3816 (November 1981) and 4822 (May 1985). Since then, BS476 has been revised and the methods for the determination of the fire resistance of load bearing elements relevant to the tests presented in this document, are now given in BS476 : Parts 20 and 21 : 1987.

A number of changes regarding design, preparation, testing and reporting procedures have been introduced and these are briefly outlined in the Foreword to Part 20. However, it is worth highlighting several important points which affect the testing and reporting of fire tests on floor beams:

2.1.1 The time / temperature relationship given by the equation:-

$$T = 345 \log_{10}(8t + 1) + 20$$

where: T = the mean furnace temperature in °C

and t = the time in min

is now slightly different to that given in BS476 : Part 8 and ISO 834 in that the actual furnace temperature is given and not the temperature rise. It is also assumed that the initial ambient temperature is 20°C irrespective of its actual temperature, which is permitted to vary within the range 5°C-35°C.

2.1.2 The use of stability for load bearing elements has been clarified and reference is now made to load bearing capacity.

2.1.3 Failure of a floor beam is deemed to have occurred when the specimen is no longer able to support the test load. This is taken to be when either of the following is attained, whichever is exceeded first, of:-

(a) a deflection of $L/20$

(b) a rate of deflection described by the equation:-

$$R = \frac{L^2}{9000d}$$

where: L = the clear span in mm

d = the distance from the top of the structural section to the bottom of the design tension zone in mm.

and R is expressed in mm/min

However, the rate of deflection criterion shall not apply before a deflection of $L/30$ is exceeded.

The above clause was introduced into BS476 : Part 8 as Amendment No. 4822 (May 1985).

2.1.4 The re-load test following the heating cycle of the test specimen is now referred to as 'Evaluation of residual load bearing capacity'. Where a structure is known to have adequate residual strength or load bearing capacity, a re-load test would not normally be required. However, if a residual strength test is not carried out, or the construction collapses during the post heating period, a reduction of up to 20% in the load bearing capacity criterion may be necessary.

2.2 Steel Quality

In 1986, BS4360 was revised with the result that the minimum yield strengths for Grade 43 structural steel sections were raised as follows:-

Thickness Range mm	Yield Strength, N/mm²	
	1979 Specification	1986 Specification
≤16	255	275
>16 ≤25	245	265
>25 ≤40	240	
>40 ≤63	230	255
>63 ≤100	225	245

The yield strengths of Grade 50 steels were unaffected by this revision.

In the first compendium, tables were provided giving the elevated temperature properties for structural steels. Since the minimum yield strength for Grade 43 steels has been raised from 255 N/mm² to 275 N/mm² (for thickness ≤16 mm), this data has been revised to bring it in line with present day steels - see Table 1.

2.3 Dimensions and Section Properties

The nominal dimensions and section properties as specified in BS4 : Part 1 and BS4848 : Part 8 are given for each test element. In the first compendium, the actual dimensions of the member were recorded and these were used to recalculate the new section properties for determination of the required loadings. However, the section properties used in the loading calculations did not appear to take into account the small contribution made by the radii at the flange / web junctions to the overall capacity of the members. Consequently, the stresses acting on the systems were marginally overstated.

The actual section properties quoted in this compendium are the true values.

2.4 Structural Calculations

In Compendium No. 1 the load calculations were based upon the generation of the required stresses in the members using the design rules given in BS449. With the introduction of the new limit state design philosophy the calculated loads are also presented in terms of BS5950. However, as it is impossible to know how a member will be used in practice, the factored loads cannot be defined and therefore, the loads calculated using BS449 are presented as a proportion of the member's capacity. This is referred to as the load ratio and is given by:-

$$\frac{M_f}{M_c}$$

where: M_f = the applied moment at the fire limit state

and M_c = the moment capacity at 20°C

In calculating M_c, the design strength, p_y, corresponding to the minimum guaranteed yield strength for the grade of steel, is normally used. However, for the purpose of evaluating the effect of load ratio on limiting temperature, the influence of variations in the strength of the as-received material can be diminished by adopting the measured yield strength for p_y. These have been determined from samples removed from the members under test.

3. FIRE TESTS ON FLOOR BEAMS

3.1 Simply Supported Floor Beams Exposed to Fire on Three Sides

Details describing the fire tests on simply supported floor beams are given in Compendium No. 1. However, for ease of reference the general arrangement is also shown in Figs. 1(a) and 1(b). In all the tests the concrete topping was both segmented and non-composite. The non-composite action between the steel and concrete has recently been verified following loading tests conducted at ambient temperature (Ref. 2).

Despite the recent changes to BS476, the fire resistance of the members in these particular tests was still measured as the period of heating when the central vertical deflection attained $L/30$. At this point the rates of deflection had, with one exception, already exceeded the criterion of $L^2/9000d$.

Heating and deflection measurements taken during the tests are given in data sheet Nos. 89-95. These include the material and section properties for each member as well as a summary of the loading calculations using both BS449 and BS5950 design rules. An example of the full loading calculations is as follows:-

Steel section size:	356 x 171 mm x 67 kg/m universal beam
Steel quality:	BS4360 : Grade 43A : 1986

Actual dimensions and properties of the floor beam:

Depth of section:	(D)	= 366.5 mm
Breadth of section:	(B)	= 175.5 mm
Thickness of flange:	(T)	= 14.53 mm
Thickness of web:	(t)	= 9.55 mm
Mass:	(m)	= 66.0 kg/m
Moment of inertia (x - x):	(I)	= 19109 cm^4
Distance of neutral axis to base of beam:	(y)	= 183.25 mm
Effective span of beam:	(L)	= 4500 mm
Design strength:	(p_y)	= 296 N/mm^2 (as measured)
Classification:		= Class 1, plastic (Table 7, BS5950)
Plastic modulus (x - x):	(S)	= 1184 cm^3
Modulus of elasticity:	(E)	= 205 kN/mm^2
Elastic modulus (x - x):	(Z)	= 1043 cm^3

3.1.1 Calculations Based Upon BS449 : Part 2 : 1969

Maximum allowable bending stress, Table 2 (for steel with a minimum yield stress of 255 N/mm^2)

$$f_{max} = 165 \text{ N/mm}^2$$

Maximum bending stress required during the test

$$f = 113.95 \text{ N/mm}^2$$

Required bending moment $= \frac{fI}{y} = \frac{wL^2}{8}$

Therefore w, the load per metre run, is given by:

$$w = \frac{8fI}{yL^2}$$

w = 46.945 kN/m (units converted to kN/m)

Concrete cover slab:

Depth: = 126 mm

Width: = 665 mm

Mass: = 1.841 kN/m

Total self weight of beam and concrete cover slab (dead load)

w_1 = 2.488 kN/m

Total load to produce required bending stress

w_2 = 46.945 − 2.488 kN/m

w_2 = 44.457 kN/m

Therefore total imposed load

W = 200.06 kN

Using four point loads at $^1/_8$, $^3/_8$, $^5/_8$ and $^7/_8$ span equivalent to $W/4$

Loads applied = 50.01 kN

3.1.2 Calculations Based Upon BS5950 : Part 1 : 1985

Moment capacity of beam for a plastic or compact section, with assumed low shear load,

$M_c = p_y S$ but $\leq 1.2\, p_y Z$

$M_c = 296 \times 1184 \times 10^{-3}$ kN.m

M_c = 350.464 kN.m

Check if $p_y S \leq 1.2\, p_y Z$

$1.2\, p_y Z = 1.2 \times 296 \times 1043 \times 10^{-3}$ kN.m

$1.2\, p_y Z$ = 370.474 kN.m

From above, self weight of beam and concrete cover slab (dead load)

$$w_1 = 2.488 \text{ kN/m}$$

Moment produced by dead load:

$$\frac{w_1 L^2}{8} = 6.298 \text{ kN.m}$$

From above, total imposed load:

$$W = 200.06 \text{ kN}$$

Assuming UDL, moment produced by imposed load

$$\frac{WL}{8} = 112.534 \text{ kN.m}$$

Total moment applied (dead + imposed)

$$M_x = 6.298 + 112.534 \text{ kN.m}$$

$$M_x = 118.832 \text{ kN.m}$$

Since M_x also equals the applied moment at the fire limit state, M_f, then the load ratio,

$$\frac{M_f}{M_c} = \frac{118.832}{350.464}$$

Load ratio = 0.339

Check shear force (F_v) does not exceed shear capacity (P_v)

$$P_v = 0.6\, p_y A_v$$

where: A_v = the shear area
$Av = Dt$

$$P_v = 0.6 \times 296 \times 9.55 \times 366.5 \times 10^{-3} \text{ kN}$$

$$P_v = 621.61 \text{ kN}$$

Maximum shear force at ends

$$F_v = \frac{wL}{2}$$

$$F_v = (46.945 \times 4.5)/2 \text{ kN}$$

$$F_v = 105.626 \text{ kN}$$

Therefore since $F_v < P_v$ the low shear load calculation is acceptable.

3.2 Simply Supported Shelf Angle Floor Beams

A full description involving the preparation and testing of shelf angle floor beam assemblies is provided in Compendium No. 1.

For the two tests covered in this report, Figs. 2(a) and 2(b) show the general arrangement in which 150 mm deep solid concrete slab units with either square or chamfered ends were supported on the ledge angles. These units are detailed in Figs. 3(a) and 3(b) respectively. The purpose of the chamfered ends was to allow the vertical position of the angles to be raised, with respect to the web thereby exposing a greater area of steel surface to the fire.

In the fire tests, the vertical deflection at mid-span continued until it achieved $L/20$ at which time, the rate of deflection was still less than the limiting criterion given by $L^2/9000d$.

Relevant information from the two shelf angle floor beam tests are given in data sheet Nos. 96 and 97. These also include material and section properties as well as a summary of the loading calculations presented in terms of both BS449 and BS5950. An example of the full loading calculations is as follows:-

Section Size	Steel Quality
254 × 146 mm × 43 kg/m universal beam	BS4360 : Grade 43A : 1986
125 × 75 × 12 mm × 17.8 kg/m angle	BS4360 : Grade 50D : 1986

Dimensions and properties of the floor beam:

Depth of section	(D)	= 266.0 mm
Breadth of section	(B)	= 146.0 mm
Thickness of flange	(T)	= 12.30 mm
Thickness of web	(t)	= 8.10 mm
Mass	(m)	= 43.9 kg/m
Moment of inertia (x - x)	(I)	= 6804 cm^4
Distance of neutral axis to base of beam	(y)	= 133.0 mm
Effective span of beam	(L)	= 4500 mm
Design strength	(p_y)	= 278 N/mm^2
Classification		= Class 1, plastic, (Table 7, BS5950)
Plastic modulus (x - x)	(S)	= 579.5 cm^3
Modulus of elasticity	(E)	= 205 kN/mm^2
Elastic modulus (x - x)	(Z)	= 511.5 cm^3

Ignoring any contribution by the angles to the capacity of the member:

3.2.1 Calculations Based Upon BS449 : Part 2 : 1969

Maximum allowable bending stress, Table 2 (for steel with a minimum yield stress of 255 N/mm²)

$$f_{max} = 165 \text{ N/mm}^2$$

Maximum bending stress required during the test

$$f = 174.07 \text{ N/mm}^2$$

Therefore operating load, $wL = \dfrac{8fI}{yL}$

$$W = 158.3 \text{ kN}$$

Self weight of beam and sand (dead load)

$$W_1 = \sim 5.0 \text{ kN}$$

Self weight of concrete and load spreaders (dead load)

$$W_2 = \sim 53.0 \text{ kN}$$

Reaction on the angles, $W_2/2 = 26.5 \text{ kN}$

Imposed force required by the angles to produce bending stress in test beam:-

$$W_3 = W - W_1 - (W_2/2)$$

$$W_3 = 158.3 - 5.0 - 26.5 \text{ kN}$$

$$W_3 = 126.8 \text{ kN}$$

Therefore total load required on the load spreaders located 0.5 m on either side of the test beam (see Fig. 4)

$$W_4 = 126.8 \times (1.460 / 1.052) \text{ kN}$$

$$W_4 = 176.0 \text{ kN}$$

Using 8 rams positioned at $^1/_8$, $^3/_8$, $^5/_8$ and $^7/_8$ span on either side of the beam equivalent to $W_4/8$, load required by each ram:

$$= 176.0 / 8 \text{ kN}$$

Loads applied $= 22.0 \text{ kN}$

3.2.2 Calculations Based Upon BS5950 : Part 1 : 1985

Moment capacity of beam for a plastic or compact section with assumed low shear load,

$$M_c = p_y S \quad \text{but} \leq 1.2\, p_y Z$$

$$M_c = 278 \times 579.5 \times 10^{-3} \text{ kN.m}$$

$$M_c = 161.101 \text{ kN.m}$$

Check if $p_y S \leq 1.2\, p_y Z$

$$1.2\, p_y Z = 1.2 \times 278 \times 511.5 \times 10^{-3} \text{ kN.m}$$

$$1.2\, p_y Z = 170.636 \text{ kN.m}$$

Self weight of beam and sand (dead load)

$$W_1 = \sim 5.0 \text{ kN}$$

Moment produced by this dead load:

$$\frac{W_1 L}{8} = 2.813 \text{ kN.m}$$

Self weight of concrete and load spreaders (dead load)

$$W_2 = \sim 53.0 \text{ kN}$$

Reaction on the angles, $W_2/2 = 26.5$ kN

Moment produced by this reaction

$$W_2 L/16 = 14.906 \text{ kN.m}$$

Total hydraulic forces imposed upon the test beam through the angles:

$$W_3 = W - W_1 - (W_2/2)$$

$$W_3 = 126.8 \text{ kN}$$

Moment produced by these forces:

$$\frac{W_3 L}{8} = 71.325 \text{ kN.m}$$

Total moments applied to the test beam (dead + imposed from W_1, $W_2/2$ and W_3)

$$M_x = 2.813 + 14.906 + 71.325 \text{ kN.m}$$

$$M_x = 89.044 \text{ kN.m}$$

Since M_x also equals the applied moment at the fire limit state, M_f, then the load ratio:

$$\frac{M_f}{M_c} = \frac{89.044}{161.101}$$

Load ratio = 0.553

Check shear force (F_v) does not exceed shear capacity (P_v)

$$P_v = 0.6\, p_y A_v$$

where: A_v = the shear area
$A_v = Dt$

$$P_v = 0.6 \times 278 \times 8.10 \times 266.0 \times 10^{-3}\ \text{kN}$$

$$P_v = 359.39\ \text{kN}$$

Maximum shear force at ends

$$F_v = \frac{wL}{2}$$

$$F_v = 158.3 / 2\ \text{kN}$$

$$F_v = 79.15\ \text{kN}$$

Therefore since $F_v < P_v$ the low shear load calculation is acceptable.

3.3 Indicative Test on A Simply Supported Floor Beam Exposed to Fire on Three Sides

Heating data was obtained on one full length floor beam which is presented in data sheet No. 98. Apart from the fact that the applied load was limited to that due to the concrete cover slabs, the test arrangement was identical to that described for the loaded tests.

4. SUMMARY OF FIRE TESTS

An index to all the fire tests described in both this and Compendium No. 1 is contained in Appendix A.

5. REFERENCES

1. Wainman, D.E. and Kirby, B.R. 'Compendium of UK Standard Fire Test Data Unprotected Structural Steel - 1'. BSC Report RS/RSC/S10328/1/87/B.

2. Banks, G., Preston, R.R. 'An Investigation of Possible Composite Action between the Concrete Cover Slabs and the Upper Flanges of Steel Beams subjected to the BS476 : Part 21 Standard Fire Resistance Test. BSC Report RS/R/S1199/5/88/B.

ERRATUM

Data Sheet 37a of 'Compendium of UK Standard Fire Test Data - Unprotected Structural Steel - 1'

Note (b) should read:-

Height of exposed steel, h, = 282 mm and not 182 mm as printed.

TABLE 1
ELEVATED TEMPERATURE STRESS/STRAIN DATA FOR BS4360:1986 STRUCTURAL STEELS DERIVED FROM ANISOTHERMAL TENSILE TESTS

(a) Grade 43A

Strain %	Stress in N/mm² for Various Temperatures, °C																			
	20	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	*	*
0.01	18.4	18.4	18.4	17.3	16.5	15.7	15.7	14.6	13.2	11.8	9.3	6.9	5.5	4.1	1.9	1.9	1.6	*	*	*
0.02	36.9	36.9	35.8	35.2	33.0	31.9	31.4	28.9	26.7	23.4	19.0	13.5	11.6	8.3	4.1	3.9	3.3	*	*	*
0.03	55.3	54.4	54.4	53.6	49.8	47.6	46.7	43.5	39.9	35.2	28.6	20.4	17.1	12.4	6.1	5.8	5.5	*	*	*
0.04	73.7	72.9	72.0	70.9	66.3	63.5	62.4	57.8	53.3	46.7	38.2	27.0	22.5	16.5	8.3	8.0	7.4	*	*	*
0.05	92.1	89.9	90.5	88.6	82.8	79.2	78.1	72.3	66.8	58.6	47.6	33.8	28.3	20.6	10.4	9.9	9.3	*	*	*
0.06	110.6	109.7	107.8	106.2	99.0	95.2	93.8	86.9	80.0	70.1	56.9	40.7	34.1	24.8	12.4	11.8	11.3	*	*	*
0.07	128.7	127.3	126.2	123.8	115.5	111.1	109.4	101.2	93.2	82.0	66.8	47.3	39.6	28.9	14.6	13.8	12.9	*	*	*
0.08	147.1	145.5	143.8	142.2	132.3	126.8	124.8	115.8	106.4	93.5	76.2	54.2	45.1	32.7	16.5	15.4	14.3	*	*	*
0.09	165.8	163.9	162.3	159.5	148.8	142.7	133.7	125.4	117.4	105.3	85.5	60.8	48.9	36.0	18.7	16.5	14.6	*	*	*
0.10	184.3	182.3	179.8	177.1	165.3	158.7	140.3	132.0	123.8	112.8	95.2	67.7	52.3	38.5	20.6	17.9	14.9	*	*	*
0.12	221.1	218.3	215.6	212.3	198.3	183.4	152.4	144.6	136.9	122.7	104.5	81.4	58.0	42.9	24.8	19.8	15.4	*	*	*
0.14	256.6	249.7	238.4	230.7	212.6	194.7	161.4	154.3	147.1	131.4	113.6	88.6	63.5	45.9	27.2	21.2	15.4	*	*	*
0.16	264.0	256.9	249.1	241.2	223.3	205.1	169.4	162.3	154.8	138.6	119.9	95.7	67.7	48.7	29.1	22.5	15.7	*	*	*
0.18	271.4	264.5	259.6	248.9	231.6	211.8	176.0	168.9	161.7	144.9	126.2	101.5	71.8	51.1	31.1	23.4	16.0	*	*	*
0.20	275.0	266.8	262.6	251.4	237.1	216.4	182.3	174.9	167.8	149.9	131.4	106.2	75.6	53.1	32.7	24.5	16.2	*	*	*
0.25	275.0	267.3	264.5	255.5	246.7	224.4	195.3	188.1	180.7	161.4	142.4	113.8	82.8	58.3	37.1	26.7	16.8	*	*	*
0.30	275.0	267.6	265.1	258.2	252.2	230.4	206.8	199.4	191.7	171.1	151.3	119.3	89.4	63.0	41.0	28.9	17.3	*	*	*
0.35	275.0	267.6	265.4	260.1	256.0	234.3	215.3	207.9	200.5	179.6	157.8	124.6	94.3	67.4	44.3	30.8	17.9	*	*	*
0.40	275.0	267.6	265.6	261.3	258.0	237.1	223.3	215.3	207.4	186.5	163.4	128.7	98.4	70.4	47.0	32.5	18.4	*	*	*
0.50	275.0	267.9	265.9	263.2	260.1	243.1	234.8	227.1	219.4	198.3	171.1	135.3	104.0	74.0	51.1	34.9	19.5	*	*	*
0.60	275.0	267.9	265.9	263.5	260.7	248.1	243.4	235.7	228.0	207.6	178.5	142.2	108.4	76.4	53.3	36.0	20.6	13.8	*	*
0.70	275.0	267.9	266.2	263.7	261.3	251.9	248.9	242.8	236.8	215.6	185.9	148.2	111.9	78.6	54.7	36.9	21.7	14.9	*	*
0.80	275.0	267.9	266.2	264.0	261.8	256.0	253.8	249.7	245.3	222.2	191.1	153.2	115.8	80.8	55.8	37.7	22.8	15.7	*	*
0.90	275.0	267.9	266.2	264.3	262.1	259.6	257.4	254.1	251.1	227.4	195.5	157.3	118.8	82.5	56.9	38.2	23.9	16.5	*	*
1.00	275.0	267.9	266.2	264.5	262.6	261.8	260.1	258.5	255.5	231.6	198.6	160.6	120.4	83.9	57.8	39.1	25.0	17.3	*	*
1.20	*	*	*	*	*	*	264.8	262.9	259.1	238.7	202.9	164.4	123.2	86.3	59.4	40.2	27.2	18.7	*	*
1.40	*	*	*	*	*	*	*	265.1	261.8	244.2	206.3	167.2	125.4	88.6	60.8	41.3	29.1	19.8	16.0	*
1.60	*	*	*	*	*	*	*	*	264.0	249.4	209.0	169.4	127.3	90.5	61.9	42.1	30.3	20.6	16.5	*
1.80	*	*	*	*	*	*	*	*	265.6	253.8	211.5	171.1	129.0	91.8	63.0	42.9	31.1	21.5	16.8	*
2.00	*	*	*	*	*	*	*	*	*	256.9	213.4	172.4	130.3	92.7	63.8	43.5	31.6	21.7	17.1	14.3

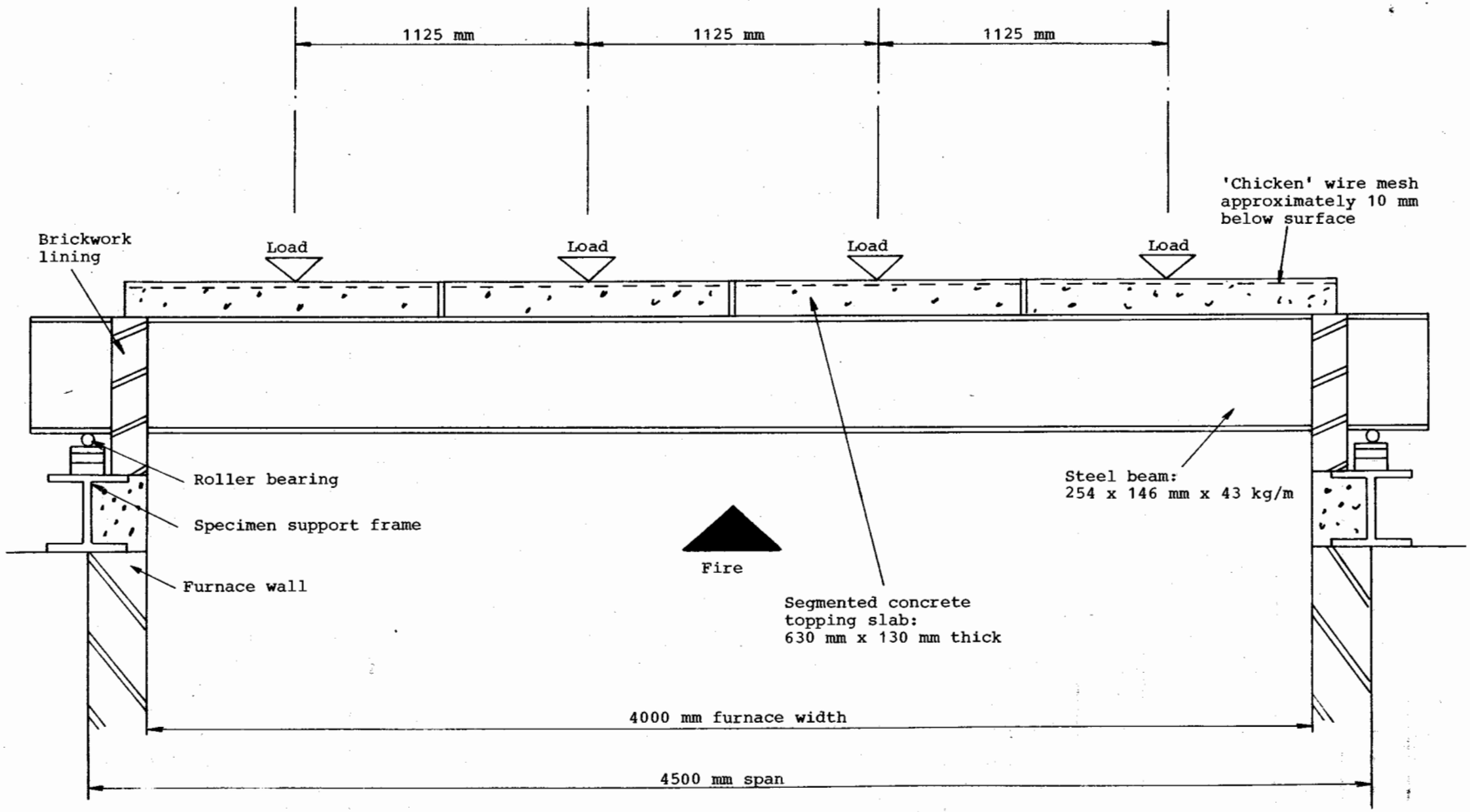
* Limit of Data

TABLE 1
(Continued)

(b) Grade 50B

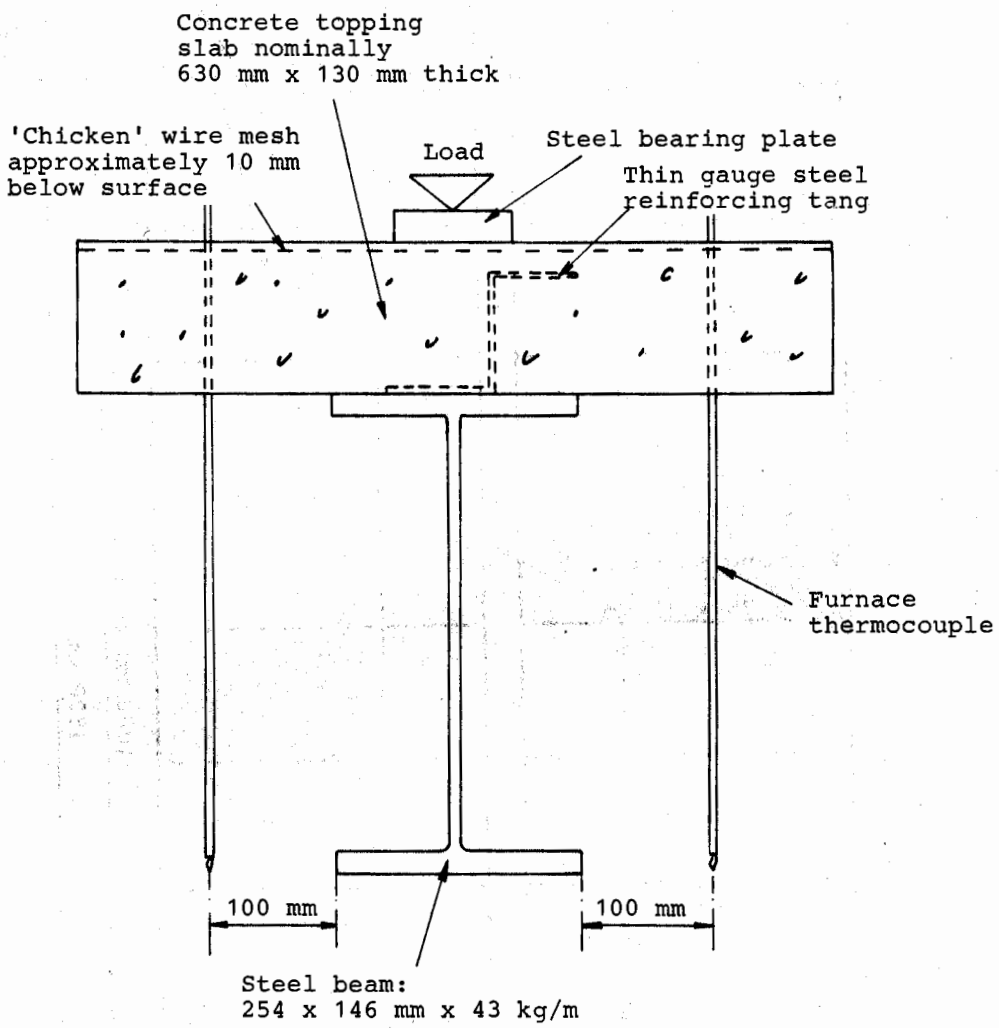
Strain %	Stress in N/mm² for Various Temperatures, °C																			
	20	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	*	*
0.01	18.8	18.8	18.8	17.8	16.3	15.6	15.6	14.6	13.1	11.7	9.6	6.7	5.7	4.3	2.1	2.1	1.8	*	*	*
0.02	37.6	37.6	36.6	35.9	33.0	31.6	31.2	28.8	26.6	23.4	18.8	13.5	11.4	8.2	4.3	3.9	3.9	*	*	*
0.03	56.1	55.4	55.4	54.3	49.3	47.2	46.5	43.3	39.8	35.1	28.4	20.2	17.0	12.4	6.0	6.0	5.7	*	*	*
0.04	74.9	74.2	73.1	72.4	65.7	63.2	62.1	57.5	53.3	46.5	38.0	27.0	22.4	16.3	8.2	7.8	7.5	*	*	*
0.05	93.7	92.7	91.9	90.2	82.4	78.8	77.7	72.1	66.4	58.2	47.6	33.7	28.0	20.6	10.3	9.9	9.2	*	*	*
0.06	112.5	111.5	109.7	107.9	98.7	94.8	93.4	86.6	79.5	69.9	56.8	40.5	33.7	24.5	12.4	11.7	11.4	*	*	*
0.07	131.0	129.2	128.5	125.7	115.0	110.4	109.0	100.8	93.0	81.7	66.4	47.2	39.4	28.8	14.2	13.8	13.1	*	*	*
0.08	149.8	148.0	146.3	144.5	131.7	126.4	124.3	115.4	106.1	93.4	76.0	54.0	45.1	32.7	16.3	15.6	14.9	*	*	*
0.09	168.6	166.9	165.1	162.2	148.0	142.0	139.9	129.6	119.3	105.1	85.2	60.7	50.8	36.9	18.5	17.8	16.7	*	*	*
0.10	187.4	185.7	182.8	180.3	164.4	158.0	155.1	143.8	132.4	116.4	94.8	67.4	56.4	40.8	20.6	19.5	18.5	*	*	*
0.12	224.7	222.2	219.4	215.8	197.4	189.6	183.2	171.1	159.0	139.5	113.6	80.9	66.0	49.0	24.5	22.0	19.9	*	*	*
0.14	262.3	259.5	256.0	252.4	230.4	221.2	198.8	188.5	177.9	158.0	132.8	94.4	74.2	53.6	28.8	24.5	19.9	*	*	*
0.16	299.6	296.1	292.5	288.3	263.4	251.0	211.6	201.6	191.3	170.0	145.2	107.9	81.7	58.2	33.0	26.6	20.2	*	*	*
0.18	337.3	333.7	328.4	313.8	287.9	264.8	221.9	212.6	203.1	180.3	156.2	120.3	88.0	62.5	36.6	28.4	20.6	*	*	*
0.20	355.0	345.1	333.7	318.8	300.7	273.0	231.8	222.2	213.0	188.5	165.8	130.6	94.1	66.0	39.8	30.2	20.9	*	*	*
0.25	355.0	348.6	338.7	326.6	316.3	287.2	250.6	241.8	232.5	206.3	182.8	145.6	105.1	74.5	46.2	33.7	21.7	*	*	*
0.30	355.0	349.7	341.2	332.6	325.2	296.8	267.0	257.0	247.4	220.5	195.3	154.1	115.0	81.3	51.5	36.6	22.4	*	*	*
0.35	355.0	350.0	342.6	336.5	330.5	302.5	278.0	268.4	258.8	231.8	203.8	160.8	121.8	87.0	57.2	39.8	23.1	*	*	*
0.40	355.0	350.0	344.0	338.7	333.0	306.0	288.3	278.0	267.7	240.7	210.9	166.1	127.1	90.9	60.7	41.9	23.8	*	*	*
0.50	355.0	350.4	345.4	340.8	335.8	313.8	303.2	293.2	283.3	256.0	220.8	174.7	134.2	95.5	66.0	45.1	25.2	*	*	*
0.60	355.0	350.4	345.8	341.2	336.5	320.2	314.2	304.2	294.3	268.0	230.4	183.5	139.9	98.7	68.9	46.5	26.6	17.8	*	*
0.70	355.0	350.7	346.1	341.9	337.3	325.2	321.3	313.5	305.7	278.3	240.0	191.3	144.5	101.5	70.6	47.6	28.0	19.2	*	*
0.80	355.0	350.7	346.5	342.2	338.0	330.5	327.7	322.3	316.7	286.8	246.7	197.7	149.5	104.4	72.1	48.6	29.5	20.2	*	*
0.90	355.0	350.7	346.8	342.6	338.3	335.1	332.3	328.0	324.1	293.6	252.4	203.1	153.4	106.5	73.5	49.3	30.9	21.3	*	*
1.00	355.0	351.1	347.2	343.3	339.0	338.0	335.8	333.7	329.8	298.9	256.3	207.3	155.5	108.3	74.5	50.4	32.3	22.4	*	*
1.20	*	*	*	*	*	*	341.9	339.4	334.4	308.1	262.0	212.3	159.0	111.5	76.7	51.8	35.1	24.1	*	*
1.40	*	*	*	*	*	*	*	342.2	338.0	315.2	266.3	215.8	161.9	114.3	78.5	53.3	37.6	25.6	20.6	*
1.60	*	*	*	*	*	*	*	*	340.8	322.0	269.8	218.7	164.4	116.8	79.9	54.3	39.0	26.6	21.3	*
1.80	*	*	*	*	*	*	*	*	342.9	327.7	273.0	220.8	166.5	118.6	81.3	55.4	40.1	27.7	21.7	*
2.00	*	*	*	*	*	*	*	*	*	331.6	275.5	222.6	168.3	119.6	82.4	56.1	40.8	28.0	22.0	18.5

* Limit of Data



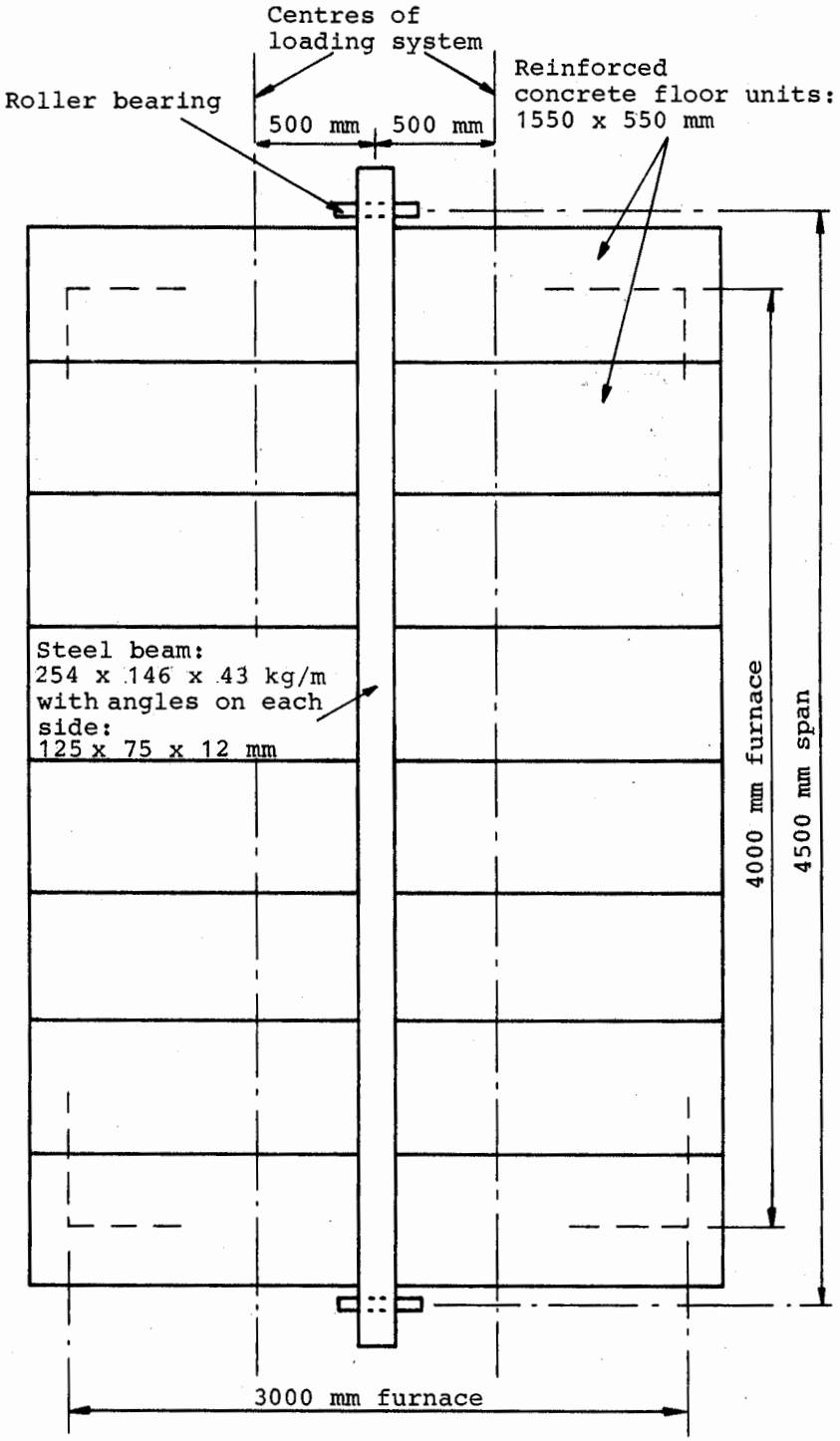
LONGITUDINAL SECTION SHOWING THE GENERAL ARRANGEMENT FOR A SIMPLY SUPPORTED FLOOR BEAM TEST ASSEMBLY

FIG. 1(a)
(R2/7085)



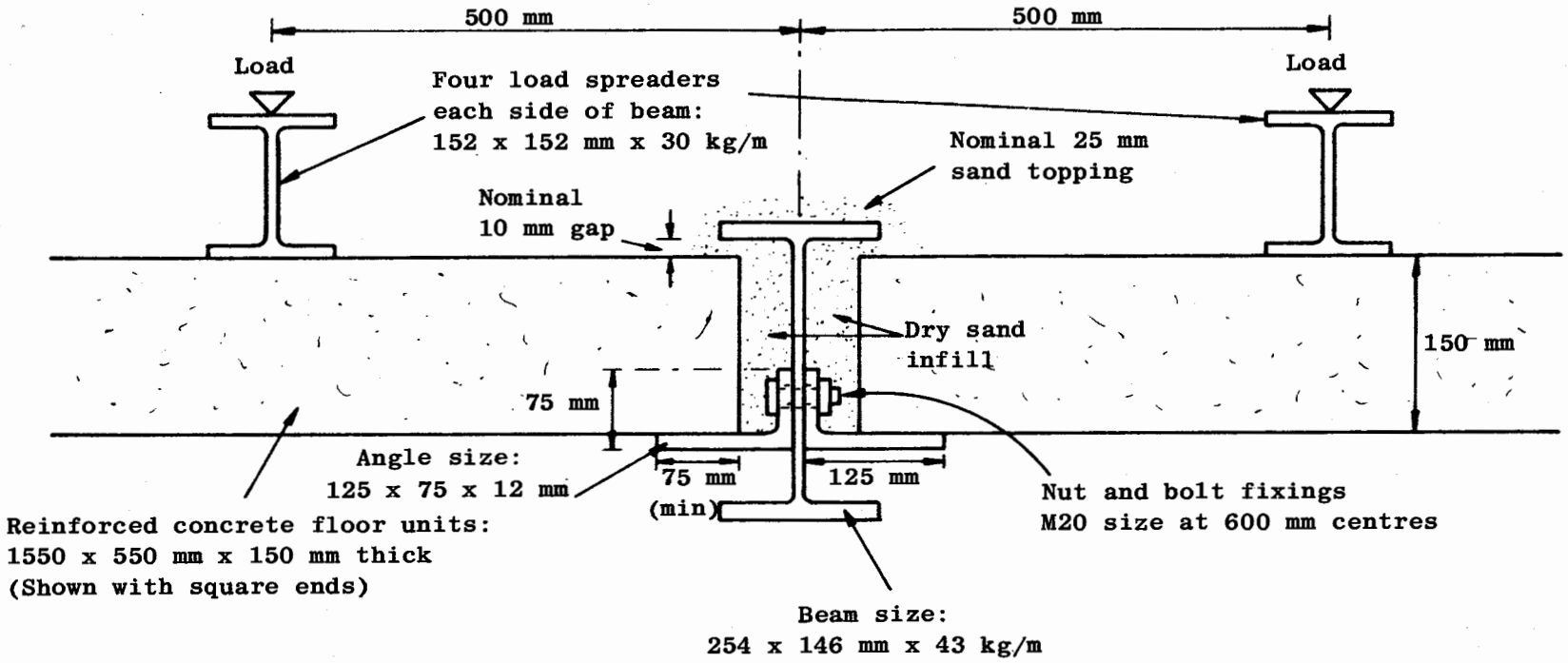
VERTICAL SECTION THROUGH A FLOOR BEAM TEST ASSEMBLY

FIG. 1(b)
(R2/7086)



GENERAL PLAN VIEW OF A SHELF ANGLE FLOOR BEAM TEST ASSEMBLY

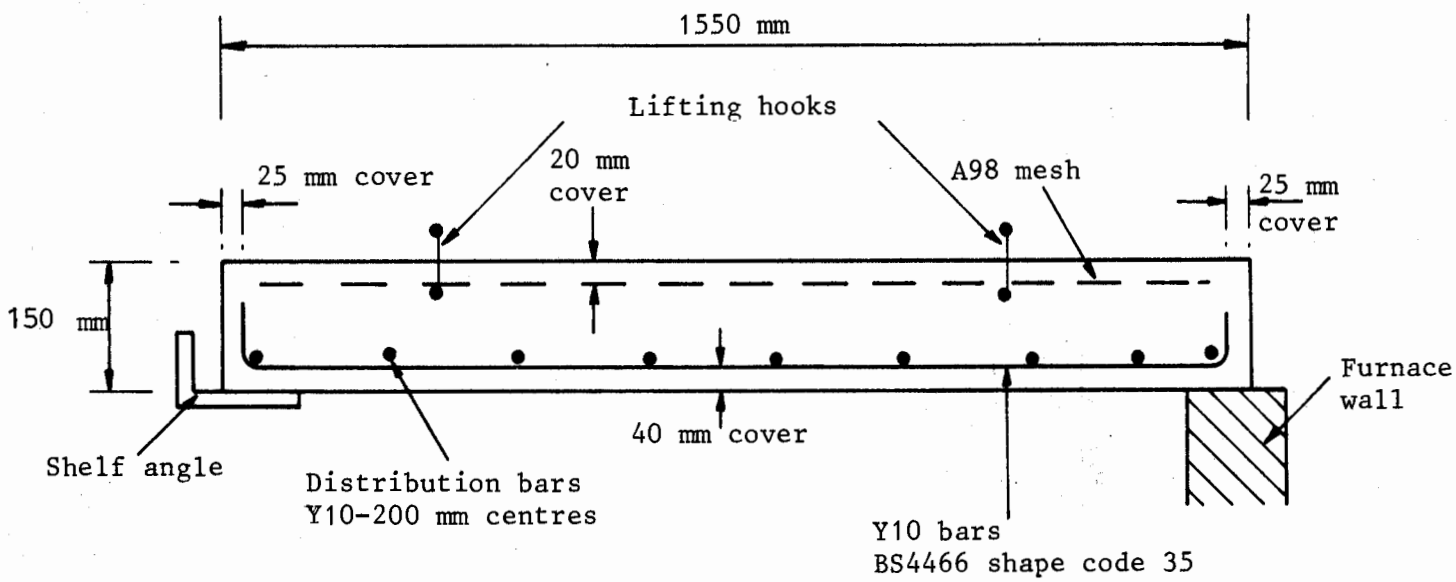
FIG. 2(a)
(R2/7097)



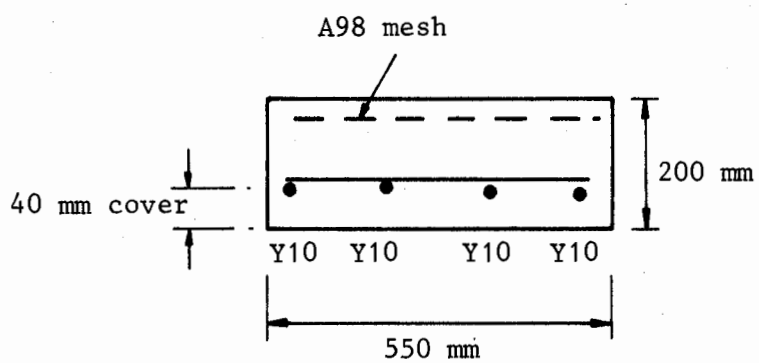
VERTICAL SECTION THROUGH A SHELF ANGLE FLOOR BEAM

FIG. 2(b)
(R3/1396A)

Longitudinal Section



Transverse Section



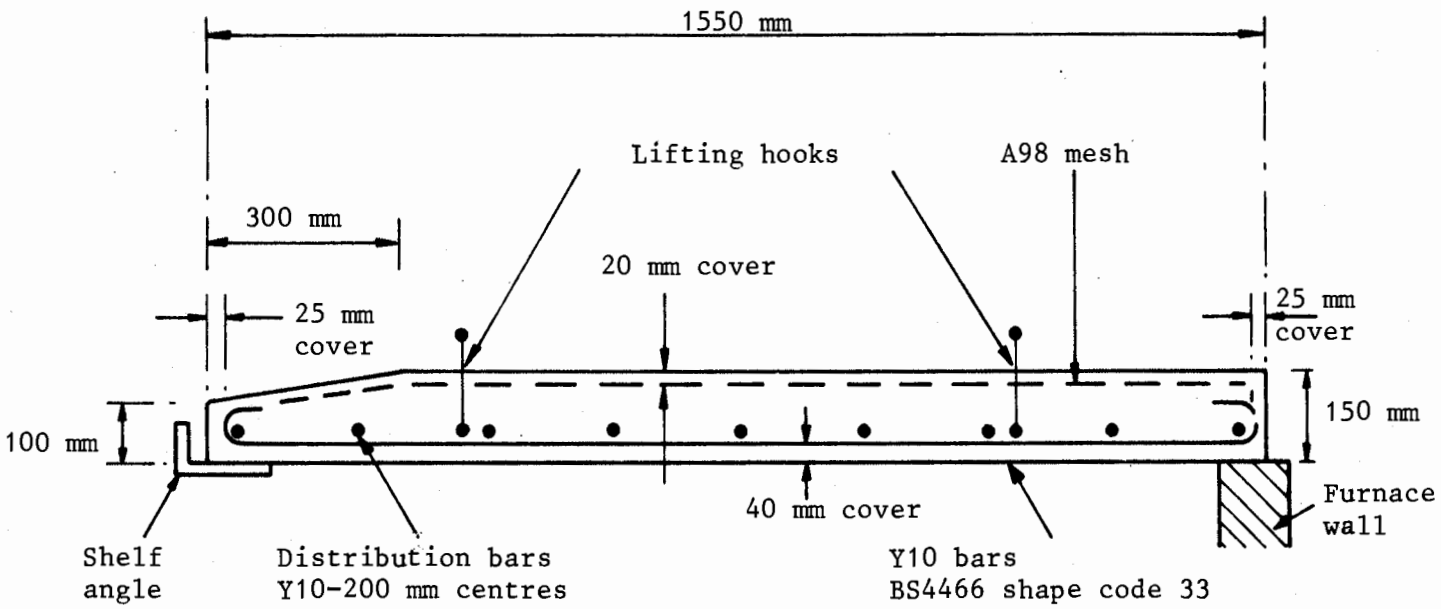
Concrete crushing strength: 25 N/mm² at 28 days

Reinforcement: cold worked high yield bar to BS4461

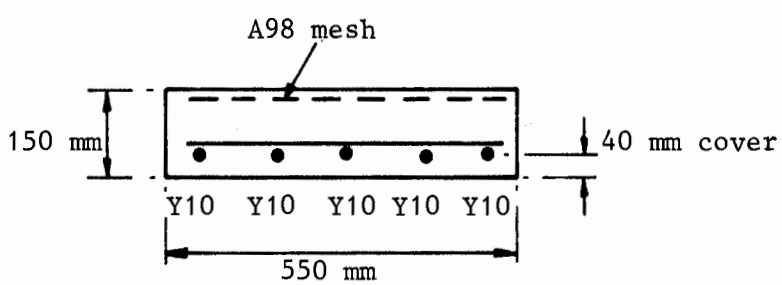
DESIGN DETAILS OF THE REINFORCED CONCRETE FLOOR UNITS WITH SQUARE ENDS

FIG. 3(a) (R2/7099)

Longitudinal Section



Transverse Section

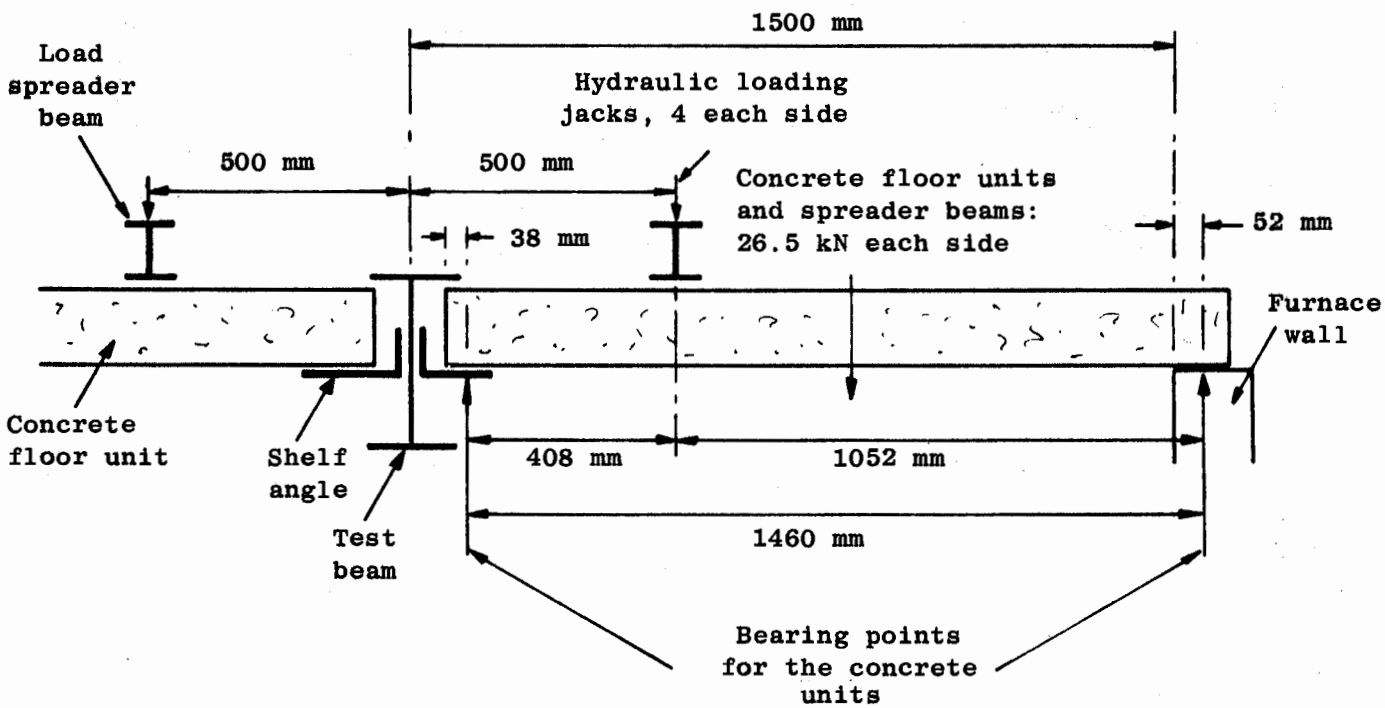


Concrete crushing strength: 25 N/mm² at 28 days

Reinforcement: cold worked high yield bar to BS4461

DESIGN DETAILS OF THE REINFORCED CONCRETE FLOOR UNITS WITH TAPERED ENDS

FIG. 3(b) (R2/7100)



DESIGN DETAILS FOR LOADING A SHELF ANGLE FLOOR BEAM ASSEMBLY

FIG. 4
(R2/7101)

APPENDIX A

INDEX TO ALL DATA SHEETS

COMPENDIA OF UK STANDARD FIRE TEST DATA - Nos. 1 AND 2
UNPROTECTED STRUCTURAL STEEL

INDEX TO ALL BEAM AND COLUMN TESTS

(These tests give data on fire resistance time, temperature profile and heating rate)

Test Configuration	Serial Size mm x mm x kg/m	Steel Grade	Data Sheet Numbers
Simply Supported Floor Beam	254 x 146 x 43 UB	43A	1, 3, 10, 11, 14
	254 x 146 x 43 UB	50B	2, 4, 13
	305 x 165 x 46 UB	50D	8
	305 x 165 x 54 UB	50D	7
	356 x 171 x 67 UB	43A	5, 12, 89, 90, 91
	356 x 171 x 67 UB	50B	9
	IPE 360	St 37	94, 95
	406 x 178 x 54 UB	43A	92
	406 x 178 x 60 UB	50D	6
	838 x 292 x 194 UB	43A	93
Simply Supported Floor Beam with Composite Action between the Steel and Concrete	254 x 146 x 43 UB	43A	15, 16
Floor Beam with Applied Rotational End Restraining Moments	203 x 133 x 30 UB	50B	20, 21, 22
	254 x 146 x 43 UB	43A	17, 18, 28
	254 x 146 x 43 UB	50B	19, 23
	203 x 203 x 52 UC	43A	24
	203 x 203 x 52 UC	50B	25, 26, 27
Floor Beam with Applied Rotational and Longitudinal Thermal Restraint	254 x 146 x 43 UB	43A	29, 30, 31
Shelf Angle Floor Beam	254 x 146 x 43 UB	43A	96, 97
	305 x 165 x 40 UB	43A	33
(Angles 125 mm x 75 mm x 12 mm	406 x 178 x 54 UB	43A	32, 35, 36, 37
Grade 50B/D for all tests)	406 x 178 x 54 UB	50B	34
Slim Floor Beam	254 x 254 x 73 UC	43A	38
	254 x 254 x 89 UC	43A	39
Column	203 x 203 x 52 UC	43A	41
	305 x 305 x 198 UC	43A	40
	6" x 6" x 122.4 lb/ft (Solid)	*	42
	HD 400 x 400 x 744	St 37	43
Column with Blocked - In Web	152 x 152 x 23 UC	43A	46
	203 x 203 x 46 UC	43A	47
	203 x 203 x 52 UC	43A	44, 45
Columns in Wall	203 x 203 x 52 UC	43A	48, 49
Columns in Wall with Blocked - In Webs	203 x 203 x 52 UC	43A	51, 52, 53
	356 x 171 x 67 UB	50B	50

COMPENDIA OF UK STANDARD FIRE TEST DATA - Nos. 1 AND 2
UNPROTECTED STRUCTURAL STEEL

INDEX TO ALL INDICATIVE BEAM AND COLUMN TESTS

(These tests give data on temperature profile and heating rate only)

Test Configuration	Serial Size mm x mm x kg/m	Member Size	Data Sheet Numbers
Indicative Floor Beam	254 x 146 x 43 UB	4.5 m span	54, 55, 56
	356 x 171 x 67 UB	4.5 m span	98
	533 x 210 x 101 UB	1 m length	57
	610 x 229 x 113 UB	1 m length	58
	610 x 305 x 149 UB	1 m length	60
	838 x 292 x 194 UB	1 m length	63
	914 x 305 x 201 UB	1 m length	59
	254 x 254 x 89 UC	1 m length	62
	305 x 305 x 118 UC	1 m length	61
Indicative Perimeter Beam	305 x 127 x 37 UB	1 m length	64
Indicative Shelf Angle Floor Beam	406 x 178 x 54 UB	4.5 m span	65
Indicative Slim Floor Beam	254 x 254 x 107 UC	1.585 m length †	66
	254 x 254 x 132 UC	1.585 m length †	68
	254 x 254 x 167 UC	1.33 m length †	67
Indicative Column	203 x 203 x 52 UC	3.0 m height	80, 82
	254 x 254 x 107 UC	3.0 m height	81
	254 x 254 x 132 UC	1 m height	69, 70
	305 x 305 x 118 UC	1 m height	71
	305 x 305 x 283 UC	3.0 m height	83
	533 x 210 x 101 UB	1 m height	75
	610 x 229 x 113 UB	1 m height	76
	254 x 254 x 71 BP	1.1 m height	72, 73, 74
Indicative Column with Blocked - In Web	203 x 203 x 52 UC	0.9 m height	77, 78, 79

Notes:

UC = Universal Column Section
UB = Universal Beam Section
BP = Universal Bearing Pile Section

* Assumed to be BS15:Grade 3:1961 (Mild steel)

† These 3 pieces were welded together to form a single unit with a span of 4.5 m

APPENDIX B

DATA SHEET NUMBERS 89-98

DATA SHEET NUMBER **89A**

SIMPLY SUPPORTED FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
356 x 171 Beam	Nominal	67	364.0	173.2	9.1	15.7	1073	157.3	1213	243.0	19536	1362
	Actual	66.9	369	172	9.13	15.55	1079	153.6	1221	237.7	19901	1321

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade 43A	0.20	0.26	0.69	0.022	0.021	0.03	0.005	0.02	0.005	-	0.005	0.005	0.0065

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS N/mm^2	TS N/mm^2	Elong. %
Flange	292	480	32.5

NOTES

(a) Slab size = 127 mm thick x 673 mm wide
Slab mass per metre = 1.878 kN
(b) Equals 98.7% of the maximum allowable bending stress for a BS4360 : Grade 43 : 1979 steel section.
(c) Actual LYS
(d) The limiting rate of deflection (6.1 mm/min) was exceeded before L/30 was achieved.
(e) Initial ambient temperature = 15 deg. C.
(f) Based on an initial ambient temperature of 20 deg. C
(g) Heating continued with no load

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m

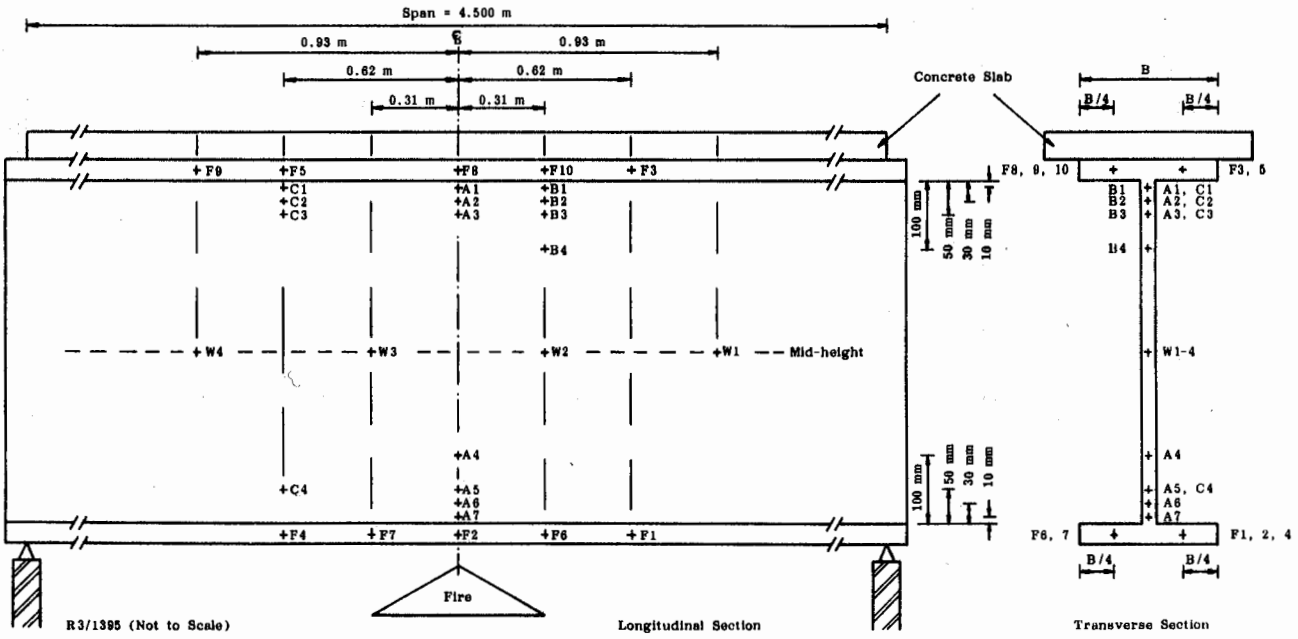
BS449 : PART 2 : 1969

MAXIMUM BENDING STRESS IN LOWER FLANGE : 162.90 N/mm^2 (b)
TOTAL LOAD : 69.415 kN/m
DEAD LOAD : 2.534 kN/m
IMPOSED LOAD REQUIRED : 66.881 kN/m
LOADS APPLIED : 75.24 kN

BS5950 : PART 1 : 1985

DESIGN STRENGTH : 292 N/mm^2 (c)
MOMENT CAPACITY : 356.532 kN.m
MOMENT DUE TO DEAD LOAD : 6.414 kN.m
MOMENT DUE TO IMPOSED LOAD : 169.293 kN.m
TOTAL MOMENT : 175.707 kN.m
LOAD RATIO : 0.493

THERMOCOUPLE POSITIONS



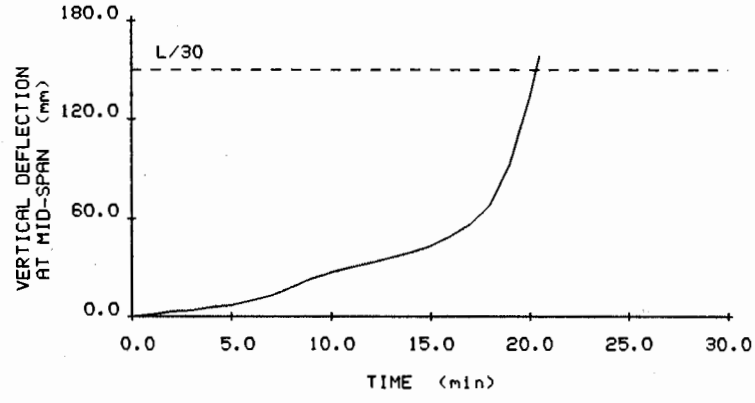
TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 4th NOVEMBER 1987
TEST NUMBER	: W.R.C.S.I. 41711

BS476 : PARTS 20 & 21 : 1987 RESULTS

TIME TO L/30	(d)	: 20 MINUTES
RE-LOAD TEST		: SATISFIED
LOAD BEARING CAPACITY		: 20 MINUTES
FIRE RESISTANCE		: 20 MINUTES

DATA SHEET NUMBER **89B**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																	
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	35
Upper Flange	F3	89	90	121	152	183	217	255	293	336	383	427	468	500	537	563	585	612	622
	F5	62	76	110	143	181	215	253	291	329	372	424	470	505	541	564	589	612	622
	F8	81	96	133	166	205	241	283	323	365	422	473	520	550	581	594	610	628	638
	F9	69	75	104	137	172	208	247	287	327	373	419	462	493	526	549	575	597	606
	F10	71	79	117	149	190	240	276	320	365	419	471	514	543	577	595	616	636	643
Mean		74	83	117	149	186	224	263	303	344	394	443	487	518	552	573	595	617	626
Web	A1	86	109	154	197	244	289	335	377	420	468	518	561	592	620	640	658	675	683
10 mm from UF	B1	98	117	164	211	260	306	352	393	439	487	534	572	604	631	654	673	689	696
	C1	74	96	139	181	226	267	309	351	391	434	480	523	557	589	613	636	656	665
Mean		86	107	152	196	243	287	332	374	417	463	511	552	584	613	636	656	673	681
Web	A2	106	135	193	249	307	362	411	456	499	545	588	627	654	680	695	711	726	733
30 mm from UF	B2	130	149	211	269	326	379	427	469	513	557	599	632	659	684	702	717	732	736
	C2	126	149	208	263	318	362	407	449	486	528	566	603	631	658	678	697	714	721
Mean		121	144	204	260	317	368	415	458	499	543	584	621	648	674	692	708	724	730
Web	A3	134	169	238	302	368	426	478	522	563	607	644	678	702	722	736	748	759	768
50 mm from UF	B3	116	148	215	282	349	410	465	510	554	596	633	667	690	712	729	741	753	760
	C3	137	165	229	292	355	406	455	499	536	576	611	644	670	693	709	726	738	744
Mean		129	161	227	292	357	414	466	510	551	593	629	663	687	709	725	738	750	757
Web 100 mm from UF	B4	142	180	258	338	413	478	533	576	617	655	684	710	729	745	752	766	782	789
Web	W1	135	172	244	321	396	463	521	567	610	642	670	697	708	731	738	745	758	765
Centre-line	W2	143	183	262	346	426	493	552	596	638	671	699	724	737	750	756	771	788	795
	W3	149	191	273	359	440	506	561	605	643	676	706	730	743	755	764	780	796	802
	W4	151	184	258	338	415	480	537	581	620	652	681	707	724	742	747	759	773	781
Mean		145	183	259	341	419	486	543	587	628	660	689	715	728	745	751	764	779	786
Web 100 mm from LF	A4	138	178	257	337	417	487	547	595	636	674	704	731	747	756	770	784	801	808
Web	A5	118	154	227	305	383	455	518	572	618	660	693	721	741	750	762	777	794	803
50 mm from LF	C4	124	159	228	303	380	449	510	562	605	648	681	707	727	743	749	762	777	785
Mean		121	157	228	304	382	452	514	567	612	654	687	714	734	747	756	770	786	794
Web																			
30 mm from LF	A6	117	151	224	300	376	446	510	565	613	655	690	719	739	750	759	775	793	801
10 mm from LF	A7	82	125	193	268	347	422	491	550	600	646	682	711	734	746	754	771	790	799
Lower Flange	F1	106	132	197	268	343	414	483	540	592	635	670	699	718	739	742	754	770	777
	F2	83	123	192	270	349	424	493	553	605	649	685	716	737	747	762	779	797	804
	F4	90	134	203	279	356	428	493	551	602	645	682	712	733	747	756	772	789	797
	F6	111	145	217	296	375	449	517	573	622	664	698	723	741	750	764	781	798	806
	F7	114	150	224	301	381	452	517	573	623	664	697	724	742	754	766	782	799	806
Mean		101	137	207	283	361	433	501	558	609	651	686	715	734	747	758	774	791	798
Mean Furnace Gas	(e)	573	519	605	650	689	713	737	762	784	796	812	821	830	840	851	860	871	873
Standard Curve	(f)	445	544	603	645	678	705	728	748	766	781	796	809	820	832	842	851	860	865
Deflection mm		3	6	10	18	27	33	39	49	68	133	(g)							
Deflection rate mm/min		2	2	3	5	4	3	3	6	12	40								



DATA SHEET NUMBER **90A**

SIMPLY SUPPORTED FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
356 x 171 Beam	Nominal	67	364.0	173.2	9.1	15.7	1073	157.3	1213	243.0	19536	1362
	Actual	64.3	365	175	9.35	14.15	1012	144.8	1149	224.7	18470	1267

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade 43A	0.20	0.25	0.74	0.033	0.025	-	-	-	0.005	-	0.005	0.005	-

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS N/mm^2	TS N/mm^2	Elong. %
Flange	298	487	34.3

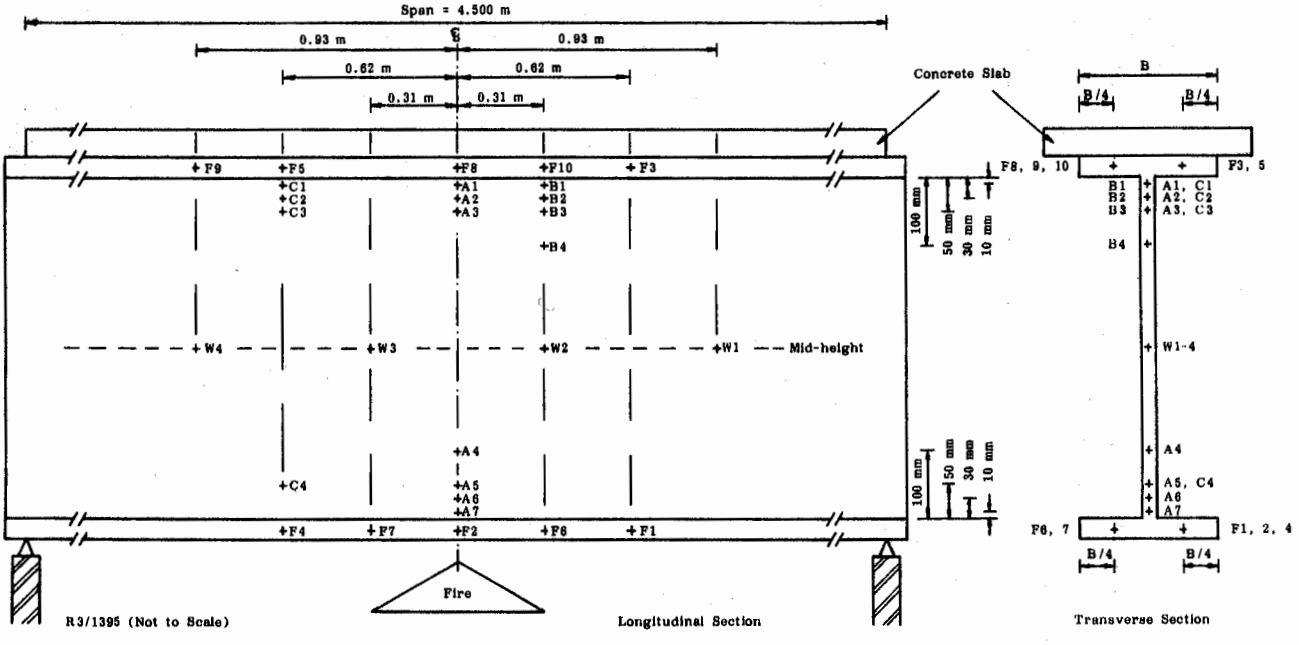
NOTES

(a) Slab size = 127.5 mm thick x 670 mm wide
Slab mass per metre = 1.877 kN
(b) Equals 130.8% of the maximum allowable bending stress for a BS4360 : Grade 43 : 1979 steel section.
(c) Actual LYS
(d) The limiting rate of deflection (6.2 mm/min) was exceeded before L/30 was achieved.
(e) Initial ambient temperature = 26 deg. C.
(f) Based on an initial ambient temperature of 20 deg. C
(*) No data recorded

TEST CONDITIONS

END CONDITIONS	: SIMPLY SUPPORTED	
COVER SLAB (a)	: DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	: 4.500 m	
BS449 : PART 2 : 1969		
MAXIMUM BENDING STRESS IN LOWER FLANGE	: 215.82 N/mm^2	(b)
TOTAL LOAD	: 86.288 kN/m	
DEAD LOAD	: 2.507 kN/m	
IMPOSED LOAD REQUIRED	: 83.781 kN/m	
LOADS APPLIED	: 94.25 kN	
BS5950 : PART 1 : 1985		
DESIGN STRENGTH	: 298 N/mm^2	(c)
MOMENT CAPACITY	: 342.402 kN.m	
MOMENT DUE TO DEAD LOAD	: 6.346 kN.m	
MOMENT DUE TO IMPOSED LOAD	: 212.063 kN.m	
TOTAL MOMENT	: 218.409 kN.m	
LOAD RATIO	: 0.638	

THERMOCOUPLE POSITIONS



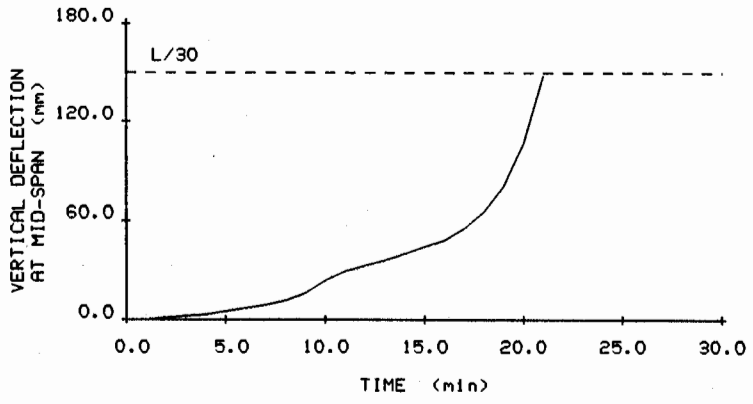
TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 9th SEPTEMBER 1987
TEST NUMBER	: W.R.C.S.I. 41712

BS476 : PARTS 20 & 21 : 1987 RESULTS

TIME TO L/30	(d)	: 21 MINUTES
RE-LOAD TEST		: SATISFIED
LOAD BEARING CAPACITY		: 21 MINUTES
FIRE RESISTANCE		: 21 MINUTES

DATA SHEET NUMBER **90B**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)										
		2	4	6	8	10	12	14	16	18	20	21
Upper Flange	F3	44	69	88	116	144	174	206	242	279	320	343
	F5	51	80	104	137	167	200	231	269	303	345	362
	F8	40	68	94	126	157	191	227	266	305	353	376
	F9	42	71	93	123	154	189	221	256	294	341	366
	F10	48	79	105	141	174	213	250	288	329	378	403
Mean		45	73	97	129	159	193	227	264	302	347	370
Web	A1	*	*	*	*	*	*	*	*	*	*	*
10 mm from UF	B1	44	82	120	165	207	252	296	340	383	429	454
	C1	49	87	121	161	198	237	274	314	352	393	411
Mean		47	85	121	163	203	245	285	327	368	411	433
Web	A2	54	105	153	207	259	308	354	401	444	490	511
30 mm from UF	B2	69	125	174	230	281	331	378	424	467	510	532
	C2	62	117	163	215	263	311	354	398	438	480	497
Mean		62	116	163	217	268	317	362	408	450	493	513
Web	A3	67	130	185	248	307	362	412	461	505	547	566
50 mm from UF	B3	55	115	172	234	294	351	403	454	497	541	562
	C3	63	127	183	243	301	356	404	450	492	533	550
Mean		62	124	180	242	301	356	406	455	498	540	559
Web 100 mm from UF	B4	56	125	194	270	343	409	467	519	562	601	618
Web	W1	69	143	203	275	350	418	478	530	573	612	630
Centre-line	W2	58	129	202	284	362	435	497	549	593	632	649
	W3	80	161	232	318	395	464	522	571	612	651	666
	W4	78	160	228	303	377	444	498	545	586	624	639
Mean		71	148	216	295	371	440	499	549	591	630	646
Web 100 mm from LF	A4	79	149	207	277	346	417	480	537	582	624	641
Web	A5	62	122	181	252	322	393	457	516	566	611	630
50 mm from LF	C4	57	116	179	252	327	400	464	523	570	615	632
Mean		60	119	180	252	325	397	461	520	568	613	631
Web 30 mm from LF	A6	44	95	154	223	294	366	433	494	547	594	614
10 mm from LF	A7	59	118	175	241	307	376	438	498	549	595	615
Lower Flange	F1	56	109	163	228	301	373	439	500	554	600	622
	F2	40	88	144	205	272	342	410	472	528	578	600
	F4	50	108	170	238	312	385	451	511	563	610	630
	F6	50	106	167	239	313	389	459	521	573	622	641
	F7	63	133	196	278	353	426	490	547	595	639	656
Mean		52	109	168	238	310	383	450	510	563	610	630
Mean Furnace Gas	(e)	432	565	596	657	689	716	737	761	779	801	809
Standard Curve	(f)	445	544	603	645	678	705	728	748	766	781	789
Deflection mm		1	3	7	12	24	33	40	48	65	107	148
Deflection rate mm/min		1	1	2	3	8	4	4	4	10	26	41



DATA SHEET NUMBER **91A**

SIMPLY SUPPORTED FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
356 x 171 Beam	Nominal	67	364.0	173.2	9.1	15.7	1073	157.3	1213	243.0	19536	1362
	Actual	66.0	366.5	175.5	9.55	14.53	1043	149.5	1184	232.1	19109	1312

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade 43A	0.20	0.25	0.73	0.033	0.024	-	-	-	0.005	-	0.005	0.005	-

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS N/mm^2	TS N/mm^2	Elong. %
Flange	296	491	33.4

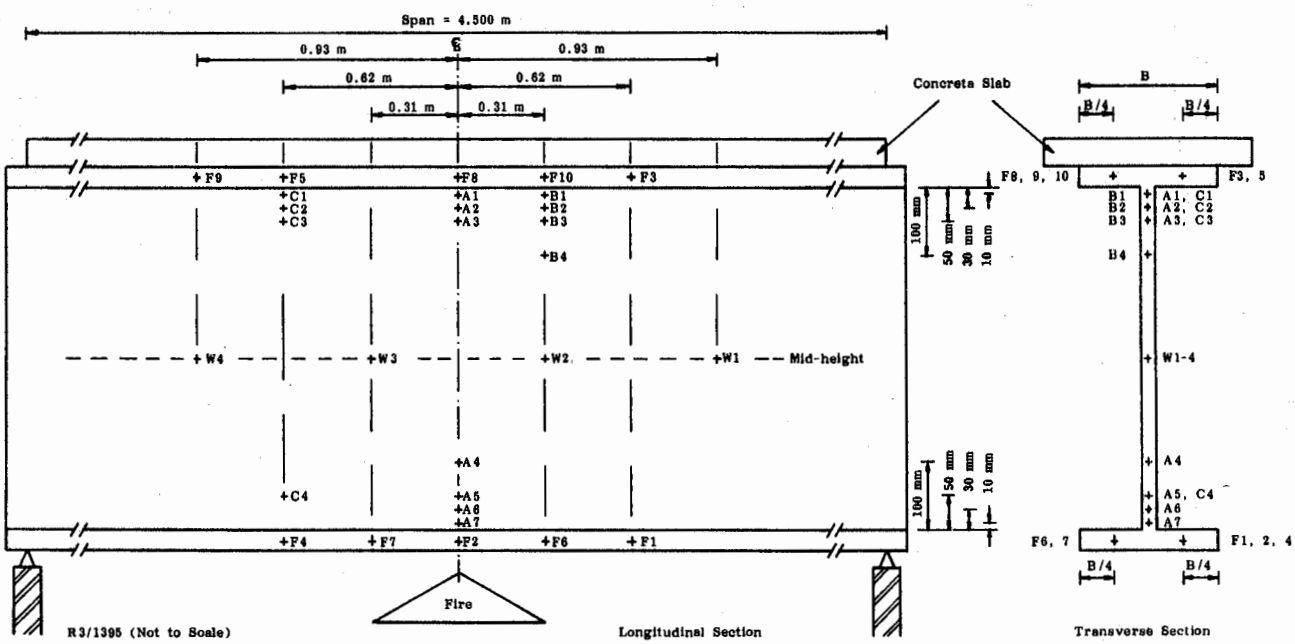
NOTES

(a) Slab size = 126 mm thick x 665 mm wide
Slab mass per metre = 1.841 kN
(b) Equals 69.1% of the maximum allowable bending stress for a BS4360 : Grade 43 : 1979 steel section.
(c) Actual LYS
(d) The limiting rate of deflection (6.1 mm/min) was exceeded before L/30 was achieved.
(e) Initial ambient temperature = 24 deg. C.
(f) Based on an initial ambient temperature of 20 deg. C
(g) Heating continued with no load

TEST CONDITIONS

END CONDITIONS	: SIMPLY SUPPORTED	
COVER SLAB (a)	: DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	: 4.500 m	
BS449 : PART 2 : 1969		
MAXIMUM BENDING STRESS IN LOWER FLANGE	: 113.95 N/mm^2	(b)
TOTAL LOAD	: 46.945 kN/m	
DEAD LOAD	: 2.488 kN/m	
IMPOSED LOAD REQUIRED	: 44.457 kN/m	
LOADS APPLIED	: 50.01 kN	
BS5950 : PART 1 : 1985		
DESIGN STRENGTH	: 296 N/mm^2	(c)
MOMENT CAPACITY	: 350.464 kN.m	
MOMENT DUE TO DEAD LOAD	: 6.298 kN.m	
MOMENT DUE TO IMPOSED LOAD	: 112.534 kN.m	
TOTAL MOMENT	: 118.832 kN.m	
LOAD RATIO	: 0.339	

THERMOCOUPLE POSITIONS



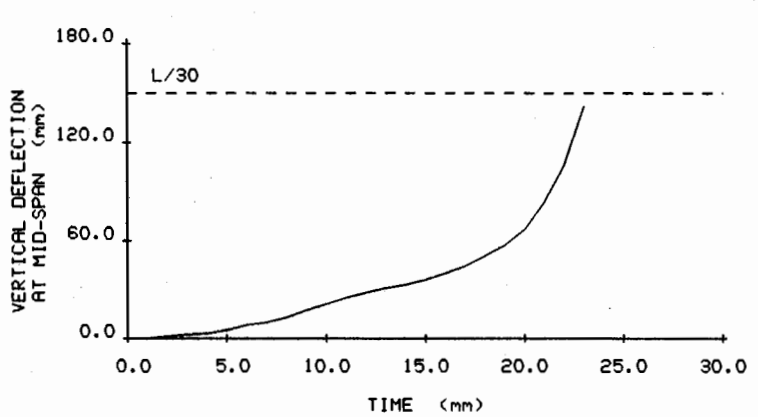
TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 16th SEPTEMBER 1987
TEST NUMBER	: W.R.C.S.I. 41713

BS476 : PARTS 20 & 21 : 1987 RESULTS

TIME TO L/30	(d) :	23 MINUTES
RE-LOAD TEST	:	SATISFIED
LOAD BEARING CAPACITY	:	23 MINUTES
FIRE RESISTANCE	:	23 MINUTES

DATA SHEET NUMBER **91B**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)															
		2	4	6	8	10	12	14	16	18	20	22	23	24	26	28	30
Upper Flange	F3	51	79	113	145	179	212	248	288	327	366	408	428	447	488	521	553
	F5	80	107	150	185	218	255	288	328	368	399	440	460	483	524	553	580
	F8	53	83	128	162	201	238	280	321	363	396	434	456	477	517	549	579
	F9	60	84	124	158	194	233	272	314	353	391	433	459	483	526	559	590
	F10	53	77	114	151	187	227	270	313	355	400	450	478	502	544	577	602
Mean		59	86	126	160	196	233	272	313	353	390	433	456	478	520	552	581
Web	A1	71	110	164	211	261	309	356	400	442	480	514	533	551	586	616	642
10 mm from UF	B1	56	94	146	193	238	285	332	377	418	460	504	528	548	586	617	643
	C1	61	97	148	194	239	285	329	373	414	450	490	510	530	569	598	624
Mean		63	100	153	199	246	293	339	383	425	463	503	524	543	580	610	636
Web	A2	77	132	202	264	324	382	437	481	523	560	592	611	623	651	678	700
30 mm from UF	B2	103	153	222	281	333	383	433	477	513	551	588	608	623	655	680	702
	C2	82	130	197	256	310	363	411	457	498	531	568	585	601	634	658	681
Mean		87	138	207	267	322	376	427	472	511	547	583	601	616	647	672	694
Web	A3	86	148	227	298	365	428	483	529	569	602	633	651	661	686	709	728
50 mm from UF	B3	87	147	224	293	354	413	470	514	552	589	622	641	653	681	705	725
	C3	83	140	217	289	354	416	468	515	555	586	620	635	649	677	699	718
Mean		85	145	223	293	358	419	474	519	559	592	625	642	654	681	704	724
Web 100 mm from UF	B4	91	161	257	342	416	483	538	584	619	650	678	694	703	725	742	751
Web	W1	100	163	255	334	413	482	539	586	622	653	692	711	721	731	749	763
Centre-line	W2	87	163	265	357	439	510	567	613	647	678	704	717	726	745	755	769
	W3	92	162	261	356	441	516	573	620	655	684	712	724	735	753	761	777
	W4	110	174	266	349	427	497	552	599	634	663	690	703	713	733	746	756
Mean		97	166	262	349	430	501	558	605	640	670	700	714	724	742	753	766
Web 100 mm from LF	A4	91	163	252	333	414	489	550	600	643	673	700	714	725	747	753	768
Web	A5	92	155	238	314	393	467	529	584	629	662	693	706	720	744	753	766
50 mm from LF	C4	75	141	233	322	407	485	548	599	639	669	699	710	723	742	750	766
Mean		84	148	236	318	400	476	539	592	634	666	696	708	722	743	752	766
Web																	
30 mm from LF	A6	92	154	230	298	374	447	511	568	614	650	682	697	710	734	747	758
10 mm from LF	A7	66	124	198	274	352	428	495	555	604	643	677	693	706	732	749	756
Lower Flange	F1	94	155	229	300	378	449	512	569	616	652	686	700	710	733	745	759
	F2	69	130	210	284	361	438	504	564	613	651	685	700	713	739	750	771
	F4	73	129	206	285	363	441	509	569	617	655	688	703	715	737	747	763
	F6	70	126	208	289	368	446	516	575	621	660	693	708	719	740	750	766
	F7	68	127	213	301	381	459	526	583	628	665	698	712	725	745	754	772
Mean		75	133	213	292	370	447	513	572	619	657	690	705	716	739	749	766
Mean Furnace Gas	(e)	460	520	607	648	686	718	739	757	773	792	809	818	820	834	844	856
Standard Curve	(f)	445	544	603	645	678	705	728	748	766	781	796	802	809	820	832	842
Deflection mm		1	3	8	13	21	28	33	40	50	67	106	142	(g)			
Deflection rate mm/min		1	1	3	3	4	3	2	4	6	10	23	36				



DATA SHEET NUMBER **92A**

SIMPLY SUPPORTED FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
406 x 178 Beam	Nominal	54	402.6	177.6	7.6	10.9	927.4	114.8	1051	177.9	18668	1019
	Actual	51.4	408	175	7.2	10.5	898.3	107.4	1017	166.3	18324	939.4

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade 43A	0.14	0.03	1.37	0.012	0.009	0.02	0.005	0.02	0.005	0.02	0.005	0.005	0.0030

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS N/mm^2	TS N/mm^2	Elong. %
Flange	288	458	37.0

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m

BS449 : PART 2 : 1969

MAXIMUM BENDING STRESS IN LOWER FLANGE : 16.22 N/mm^2 (b)
TOTAL LOAD : 5.754 kN/m
DEAD LOAD : 2.380 kN/m
IMPOSED LOAD REQUIRED : 3.374 kN/m
LOADS APPLIED : 3.796 kN

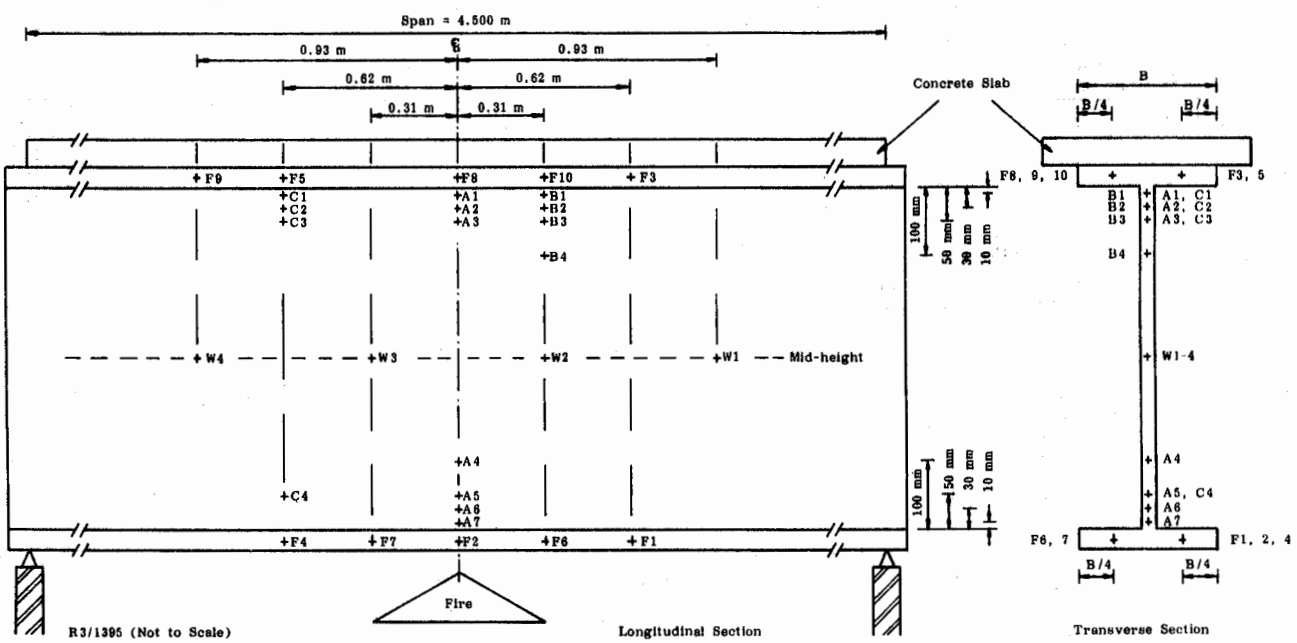
BS5950 : PART 1 : 1985

DESIGN STRENGTH : 288 N/mm^2 (c)
MOMENT CAPACITY : 292.896 kN.m
MOMENT DUE TO DEAD LOAD : 6.027 kN.m
MOMENT DUE TO IMPOSED LOAD : 8.539 kN.m
TOTAL MOMENT : 14.566 kN.m
LOAD RATIO : 0.05

NOTES

(a) Slab size = 127.5 mm thick x 670 mm wide
Slab mass per metre = 1.877 kN
(b) Equals 9.83% of the maximum allowable bending stress for a BS4360 : Grade 43 : 1979 steel section.
(c) Actual LYS
(d) Although the limiting rate of deflection (5.5 mm/min) was not exceeded before L/30 was achieved the test was terminated at 117 minutes.
(e) Initial ambient temperature = 11 deg. C.
(f) Based on an initial ambient temperature of 20 deg. C
(*) No data recorded

THERMOCOUPLE POSITIONS



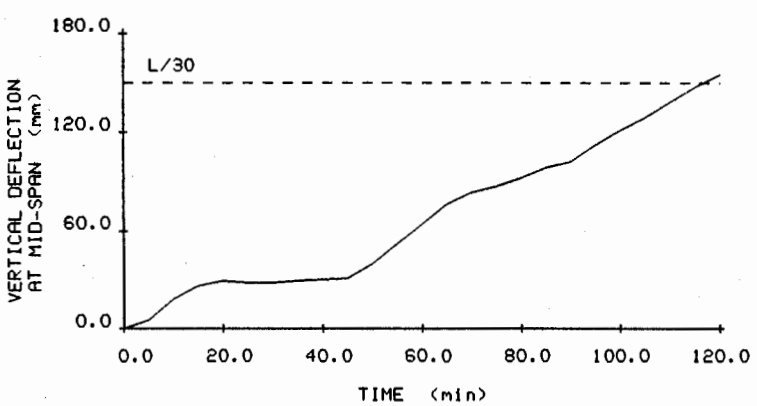
TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 9th DECEMBER 1987
TEST NUMBER	: W.R.C.S.I. 42784

BS476 : PARTS 20 & 21 : 1987 RESULTS

TIME TO L/30	(d) :	117 MINUTES
RE-LOAD TEST	:	SATISFIED
LOAD BEARING CAPACITY	:	117 MINUTES
FIRE RESISTANCE	:	117 MINUTES

DATA SHEET NUMBER **92B**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																	
		3	6	9	12	15	18	21	24	27	30	40	50	60	70	80	90	100	117
Upper Flange	F3	91	148	210	271	324	384	437	486	529	572	678	755	815	873	915	948	976	1017
	F5	71	122	180	240	297	357	408	457	501	545	655	736	799	862	908	942	971	1013
	F8	78	140	202	272	341	408	468	523	570	610	709	766	832	883	920	949	975	1012
	F9	57	102	162	228	295	357	414	464	511	548	644	717	782	836	895	936	965	1003
	F10	86	145	214	294	362	423	477	527	569	603	696	755	814	872	915	944	971	1012
Mean		77	131	194	261	324	386	441	491	536	576	676	746	808	865	911	944	972	1011
Web	A1	91	165	244	327	400	466	523	573	613	649	735	800	851	898	934	963	989	1025
10 mm from UF	B1	111	180	256	336	403	463	518	564	603	634	721	784	838	888	926	955	983	1022
	C1	85	149	218	289	351	413	463	509	551	589	690	766	829	885	926	959	988	1027
Mean		96	165	239	317	385	447	501	549	589	624	715	783	839	890	929	959	987	1025
Web	A2	108	197	292	385	459	523	575	618	655	685	764	821	878	920	950	977	1003	1038
30 mm from UF	B2	123	214	310	403	474	535	584	623	658	685	761	822	872	914	948	977	1002	1038
	C2	114	197	287	374	440	501	549	590	625	657	740	813	871	907	947	980	1006	1042
Mean		115	203	296	387	458	520	569	610	646	676	755	819	874	914	948	978	1004	1039
Web	A3	124	227	338	439	514	574	622	659	690	716	789	845	902	925	960	989	1014	1048
50 mm from UF	B3	126	232	342	443	517	574	621	658	687	713	783	844	884	928	958	987	1012	1046
	C3	140	235	339	432	499	557	600	635	665	693	766	831	885	926	957	984	1010	1046
Mean		130	231	340	438	510	568	614	651	681	707	779	840	890	926	958	987	1012	1047
Web 100 mm from UF	B4	150	274	400	507	578	627	666	695	720	740	805	859	899	936	964	990	1014	1050
Web	W1	126	248	373	484	561	614	652	683	708	729	786	833	885	924	953	981	1005	1040
Centre-line	W2	139	272	406	517	590	639	677	705	729	743	810	853	902	937	963	988	1011	1045
	W3	136	268	401	515	590	639	677	704	729	742	810	863	911	943	971	998	1022	1054
	W4	146	256	381	491	570	621	659	687	712	732	794	852	894	929	961	990	1015	1049
Mean		137	261	390	502	578	628	666	695	720	737	800	850	898	933	962	989	1013	1047
Web 100 mm from LF	A4	180	304	413	517	589	644	682	712	733	749	814	870	907	944	972	998	1022	1055
Web	A5	106	232	361	483	571	633	677	708	732	745	815	871	911	945	973	998	1021	1054
50 mm from LF	C4	107	221	350	470	557	620	663	695	720	736	802	861	905	931	963	992	1015	1048
Mean		107	227	356	477	564	627	670	702	726	741	809	866	908	938	968	995	1018	1051
Web																			
30 mm from LF	A6	101	225	356	479	569	633	677	709	732	745	815	871	913	942	972	997	1020	1054
10 mm from LF	A7	97	218	351	476	571	637	683	716	736	753	821	879	920	952	978	1004	1027	1058
Lower Flange	F1	123	242	369	484	570	633	678	708	729	742	807	861	903	944	972	999	1023	1055
	F2	117	241	378	500	589	650	695	726	740	762	828	884	921	955	983	1007	1031	1062
	F4	109	227	356	480	573	638	684	717	737	757	825	882	924	953	982	1009	1032	1064
	F6	115	236	376	501	589	649	694	724	742	760	825	882	917	949	977	1002	1026	1061
	F7	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Mean		116	237	370	491	580	643	688	719	737	755	821	877	916	950	979	1004	1028	1061
Mean Furnace Gas	(e)	488	565	655	706	731	764	778	796	811	823	867	903	938	968	988	1015	1035	1064
Standard Curve	(f)	502	603	663	705	739	766	789	809	826	842	885	918	945	968	988	1006	1022	1045
Deflection mm		*	*	15	*	26	*	*	29	*	28	30	40	64	83	92	102	121	150
Deflection rate mm/min		*	*	*	*	1	*	*	*	*	0	0	3	2	1	2	0	2	2



DATA SHEET NUMBER **93A**

SIMPLY SUPPORTED FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
838 x 292 Beam	Nominal	194	840.7	292.4	14.7	21.7	6642	620.1	7640	973.8	279175	9066
	Actual	194.2	842	290	14.6	22.1	6686	621.2	7685	974.9	281493	9008

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade 43A	0.17	0.18	0.96	0.024	0.019	0.02	0.005	0.02	0.005	0.03	0.005	0.031	0.0050

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS N/mm^2	TS N/mm^2	Elong. %
Flange	307	485	30.0

NOTES

(a) Slab size = 128 mm thick x 782 mm wide
Slab mass per metre = 2.199 kN
(b) Equals 19.7% of the maximum allowable bending stress for a BS4360 : Grade 43 : 1979 steel section.
(c) Actual LYS
(d) The limiting rate of deflection (2.7 mm/min) was exceeded before L/30 was achieved.
(e) Time intervals erratic due to intermittent data logger malfunction
(f) Initial ambient temperature = 11 deg. C.
(g) Based on an initial ambient temperature of 20 deg. C
(*) No data recorded

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m

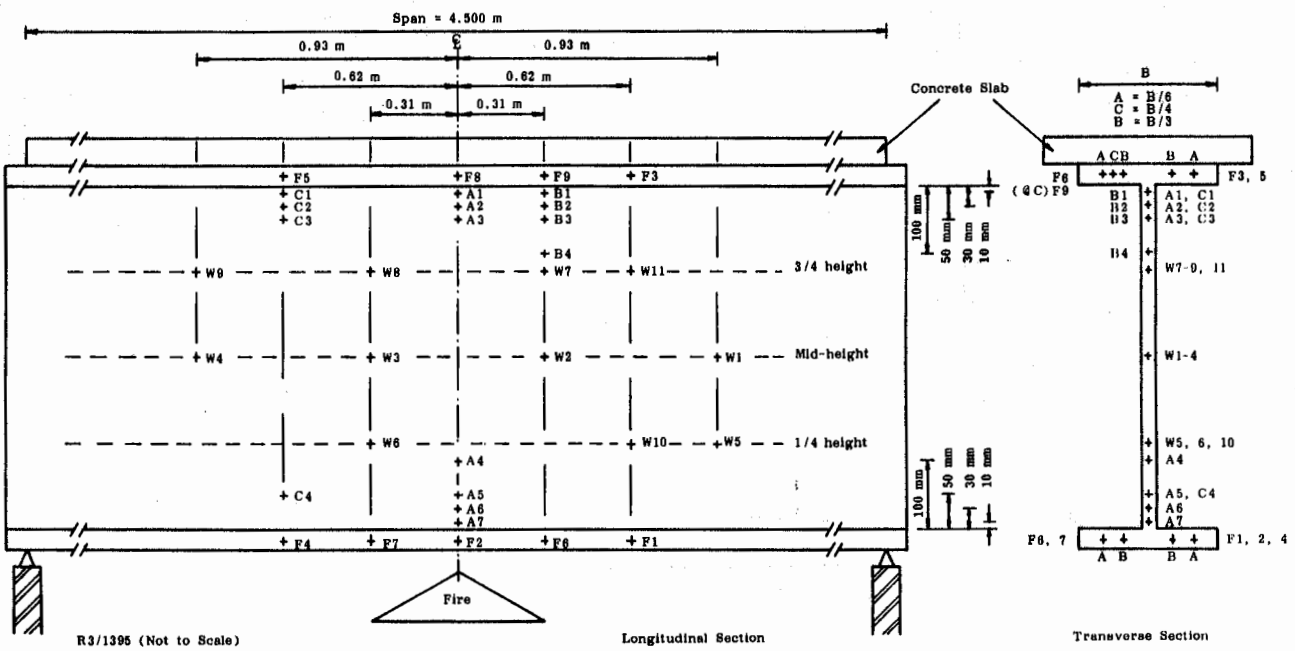
BS449 : PART 2 : 1969

MAXIMUM BENDING STRESS IN LOWER FLANGE	:	32.50 N/mm^2	(b)
TOTAL LOAD	:	85.842 kN/m	
DEAD LOAD	:	4.103 kN/m	
IMPOSED LOAD REQUIRED	:	81.739 kN/m	
LOADS APPLIED	:	91.96 kN	

BS5950 : PART 1 : 1985

DESIGN STRENGTH	:	307 N/mm^2	(c)
MOMENT CAPACITY	:	2359.295 kN.m	
MOMENT DUE TO DEAD LOAD	:	10.385 kN.m	
MOMENT DUE TO IMPOSED LOAD	:	206.901 kN.m	
TOTAL MOMENT	:	217.286 kN.m	
LOAD RATIO	:	0.092	

THERMOCOUPLE POSITIONS



R3/1395 (Not to Scale)

Longitudinal Section

Transverse Section

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 10th FEBRUARY 1988
TEST NUMBER	: W.R.C.S.I. 43187

BS476 : PARTS 20 & 21 : 1987 RESULTS

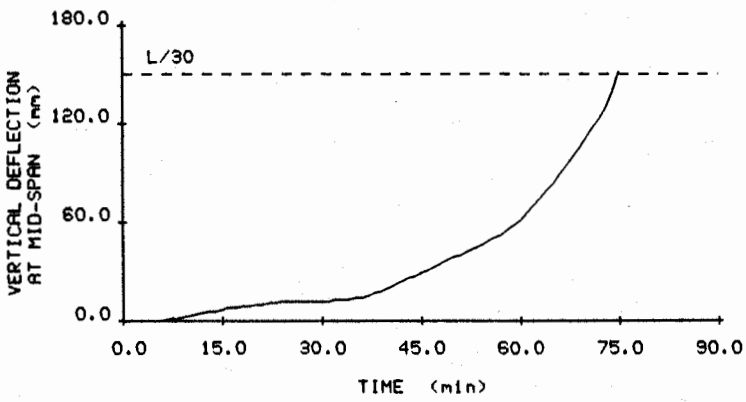
TIME TO L/30	(d) :	75 MINUTES
RE-LOAD TEST	:	SATISFIED
LOAD BEARING CAPACITY	:	75 MINUTES
FIRE RESISTANCE	:	75 MINUTES

DATA SHEET NUMBER **93B**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES) (e)																		
		2	14	16	18	20	26	28	48	50	52	55	58	62	65	68	70	74	75	76
Upper Flange	F3A	34	179	204	234	263	361	397	673	690	705	741	753	778	787	861	881	891	*	894
45 mm from Flange	F5A	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Tip	F8A	82	252	283	322	357	453	485	713	731	745	763	778	795	816	828	837	854	*	863
Mean		58	216	244	278	310	407	441	693	711	725	752	766	787	802	845	859	873	*	879
Upper Flange 65 mm from Flange Tip	F9C	81	233	257	285	317	407	440	663	683	702	748	764	774	799	816	828	849	*	860
Upper Flange	F3B	54	192	216	245	276	369	403	661	681	698	722	742	761	777	793	804	824	*	835
90 mm from Flange	F5B	61	190	213	241	271	360	395	648	668	685	711	731	759	773	785	795	815	*	826
Tip	F8B	70	238	272	307	344	442	472	685	699	715	739	755	772	787	802	809	830	*	842
Mean		62	207	234	264	297	390	423	665	683	699	724	743	764	779	793	803	823	*	834
UF Overall Mean		64	214	241	272	305	399	432	674	692	708	737	754	773	790	814	826	844	*	853
Web	A1	92	299	331	369	406	505	538	742	751	763	787	804	825	841	854	862	876	*	885
10 mm from UF	B1	52	249	279	312	346	440	474	700	717	733	754	774	799	816	832	842	860	*	872
	C1	55	222	248	278	309	400	434	670	688	704	728	748	774	794	806	813	827	*	836
Mean		66	257	286	320	354	448	482	704	719	733	756	775	799	817	831	839	854	*	864
Web	A2	63	316	351	390	430	533	567	764	776	787	816	833	849	868	879	886	896	*	904
30 mm from UF	B2	61	297	330	367	404	500	534	738	752	767	811	829	834	863	874	883	895	*	902
	C2	88	291	322	356	390	484	518	733	747	762	790	808	830	848	859	867	876	*	883
Mean		71	301	334	371	408	506	540	745	758	772	806	823	838	860	871	879	889	*	896
Web	A3	69	357	394	434	474	575	607	796	811	822	840	855	876	890	900	905	912	*	918
50 mm from UF	B3	90	360	393	431	469	563	594	785	801	812	832	847	868	882	892	898	909	*	916
	C3	77	328	362	399	436	533	568	767	783	797	824	841	861	879	887	895	902	*	906
Mean		79	348	383	421	460	557	590	783	798	810	832	848	868	884	893	899	908	*	913
Web 100 mm from UF	B4	81	424	463	504	543	632	661	828	841	850	869	881	894	908	915	920	927	*	933
Web	W7	76	468	510	554	593	677	703	863	871	876	891	900	*	928	932	936	940	*	945
3/4 Height	W8	84	469	509	552	591	677	703	863	873	882	893	903	*	*	935	938	941	*	945
	W9	64	431	472	516	558	649	677	844	855	864	918	898	*	*	932	937	941	*	944
	W11	*	472	516	557	*	678	705	860	871	*	*	*	*	*	936	941	939	*	*
Mean		75	460	502	545	581	670	697	858	868	874	901	900	*	928	934	938	940	*	945
Web	W1	74	455	501	547	590	681	707	861	871	875	890	899	911	925	932	936	938	*	943
Centre-line	W2	76	483	527	574	615	702	727	881	890	894	906	915	928	940	946	951	955	*	959
	W3	73	480	524	569	611	697	721	879	885	889	906	915	921	939	944	949	950	*	954
	W4	67	451	495	543	586	677	706	877	887	894	901	914	926	942	950	954	956	*	959
Mean		73	467	512	558	601	689	715	875	883	888	901	911	922	937	943	948	950	*	954
Web	W5	92	443	489	539	584	680	708	873	882	886	893	905	*	932	939	942	945	*	949
1/4 Height	W6	63	455	503	553	597	692	720	885	894	900	912	921	*	946	953	958	959	*	965
	W10	*	455	504	*	*	689	712	879	888	*	*	912	*	*	944	948	953	*	*
Mean		78	451	499	546	591	687	713	879	888	893	903	913	*	939	945	949	952	*	957
Web 100 mm from LF	A4	64	431	480	533	579	683	712	878	885	890	916	925	927	946	953	957	961	*	966
Web	A5	72	420	471	523	572	679	710	897	907	911	913	926	929	958	964	968	971	*	976
50 mm from LF	C4	55	379	429	483	533	646	679	863	876	883	912	924	912	949	954	958	963	*	964
Mean		64	400	450	503	553	663	695	880	892	897	913	925	921	954	959	963	967	*	970
Web																				
30 mm from LF	A6	48	407	458	513	564	675	707	898	910	915	916	928	939	957	963	968	973	*	976
10 mm from LF	A7	46	405	458	512	563	675	707	895	907	914	928	938	949	959	966	971	974	*	977
Lower Flange	F1A	61	451	499	552	599	702	729	898	906	910	919	927	939	950	956	961	966	*	970
45 mm from Flange	F2A	77	469	519	571	616	717	741	909	916	920	934	940	951	962	968	973	979	*	984
Tip	F4A	54	432	482	536	585	690	720	895	903	908	935	942	943	963	968	972	977	*	980
	F6A	47	396	447	502	550	655	687	863	878	887	915	925	929	949	956	959	963	*	965
	F7A	78	451	497	549	595	697	725	903	912	918	924	933	944	956	962	965	968	*	970
Mean		63	440	489	542	589	692	720	894	903	909	925	933	941	956	962	966	971	*	974
Lower Flange	F1B	57	432	482	536	586	693	723	895	905	910	926	933	944	955	962	967	970	*	974
90 mm from Flange	F2B	57	441	493	547	595	702	732	909	918	923	935	942	955	965	972	977	983	*	988
Tip	F4B	50	407	457	512	562	676	708	899	911	917	930	939	952	964	971	975	979	*	983
	F6B	55	382	432	486	536	640	676	868	886	898	905	919	933	950	957	962	966	*	968
	F7B	50	417	468	522	572	681	712	903	916	923	925	938	947	966	972	976	979	*	982
Mean		54	416	466	521	570	678	710	895	907	914	924	934	946	960	967	971	975	*	979
LF Overall Mean		59	428	478	531	580	685	715	894	905	911	925	934	944	958	964	969	973	*	976
Mean Furnace Gas (f)		581	748	759	783	799	835	858	945	941	*	*	962	*	*	988	990	985	*	992
Standard Curve (g)		445	728	748	766	781	820	832	912	918	924	932	940	950	957	964	968	977	979	981
Deflection mm		0	6	8	9	10	12	12	35	39	42	48	55	70	83	99	111	139	151	184
Deflection rate mm/min		0	0	1	1	1	0	0	2	2	2	2	3	5	4	5	6	10	12	33

DATA SHEET NUMBER **93C**

SIMPLY SUPPORTED FLOOR BEAM



DATA SHEET NUMBER **94A**

SIMPLY SUPPORTED FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
IPE 360 Beam	Nominal	57.1	360	170	8.0	12.7	903.6	122.8	1019	191.1	16266	1043
	Actual	55.9	359	171	7.8	12.4	886.2	121.3	998.1	188.6	15908	1037

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade St 37	0.11	0.07	0.60	0.011	0.021	0.05	0.005	0.02	0.005	0.02	0.005	0.005	0.0051

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS N/mm²	TS N/mm²	Elong. %
Flange	244	383	34.1

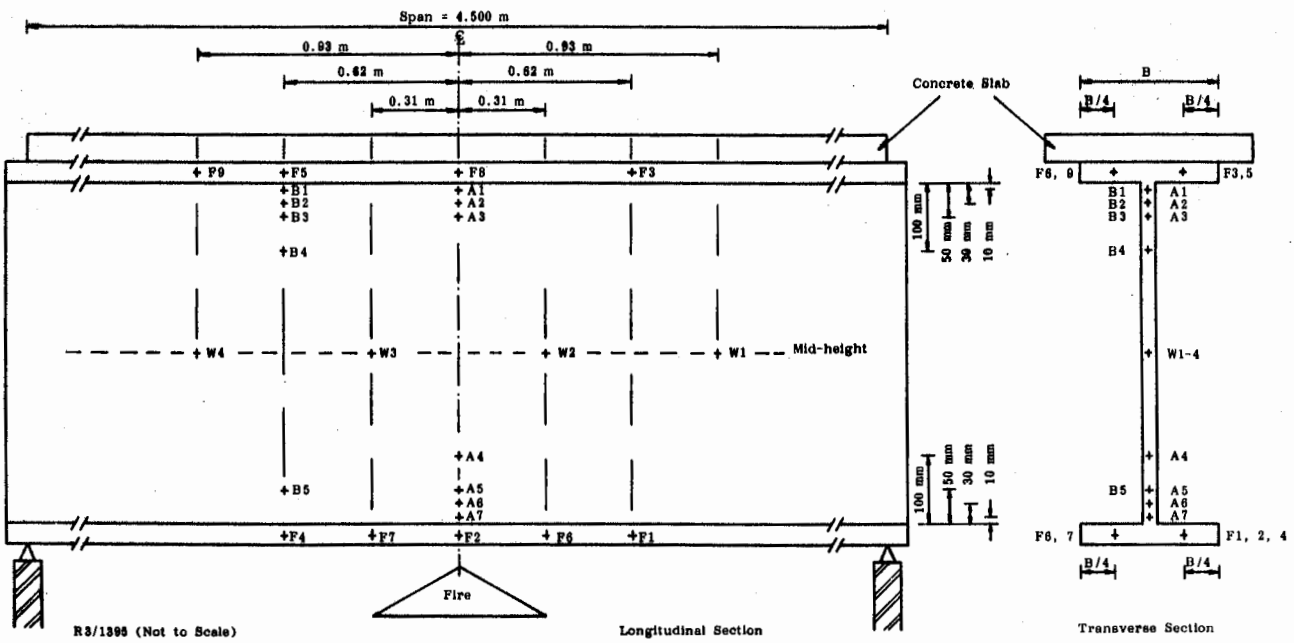
NOTES

(a) Slab size = 128 mm thick x 665 mm wide
Slab mass per metre = 1.870 kN
(b) Equals 129.2% of the maximum allowable bending stress for a DIN 17100 : Grade St 37 steel section.
(c) Actual LYS
(d) The limiting rate of deflection (6.3 mm/min) was exceeded before L/30 was achieved.
(e) Initial ambient temperature = 19 deg. C.
(f) Based on an initial ambient temperature of 20 deg. C
(g) Heating continued with no load

TEST CONDITIONS

END CONDITIONS	: SIMPLY SUPPORTED	
COVER SLAB (a)	: DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	: 4.500 m	
BS449 : PART 2 : 1969		
MAXIMUM BENDING STRESS IN LOWER FLANGE	: 196.44 N/mm²	(b)
TOTAL LOAD	: 68.776 kN/m	
DEAD LOAD	: 2.418 kN/m	
IMPOSED LOAD REQUIRED	: 66.358 kN/m	
LOADS APPLIED	: 74.653 kN	
BS5950 : PART 1 : 1985		
DESIGN STRENGTH	: 244 N/mm²	(c)
MOMENT CAPACITY	: 243.536 kN.m	
MOMENT DUE TO DEAD LOAD	: 6.121 kN.m	
MOMENT DUE TO IMPOSED LOAD	: 167.969 kN.m	
TOTAL MOMENT	: 174.090 kN.m	
LOAD RATIO	: 0.715	

THERMOCOUPLE POSITIONS



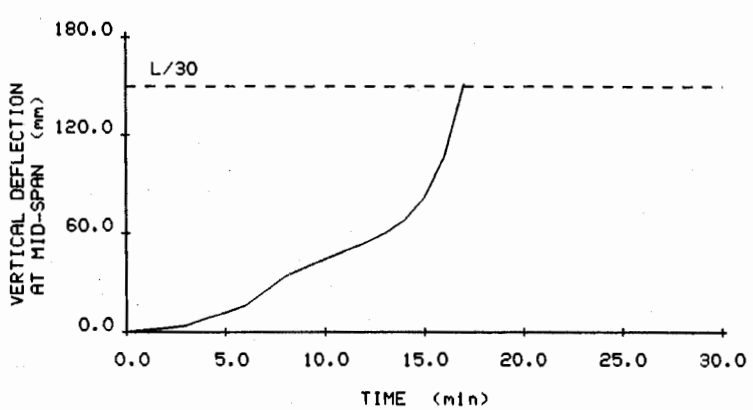
TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 7th APRIL 1988
TEST NUMBER	: W.R.C.S.I. 43199

BS476 : PARTS 20 & 21 : 1987 RESULTS

TIME TO L/30	(d) :	17 MINUTES
RE-LOAD TEST	:	SATISFIED
LOAD BEARING CAPACITY	:	17 MINUTES
FIRE RESISTANCE	:	17 MINUTES

DATA SHEET NUMBER **94B**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		2	4	6	8	10	12	14	16	17	18	20	22	24	26	28	30	32	36	40
Upper Flange	F3	41	68	104	142	185	227	262	301	319	344	387	432	464	493	522	547	573	626	673
	F5	52	84	129	166	207	250	291	344	376	405	456	500	535	563	590	607	633	679	717
	F8	38	65	100	138	180	227	272	321	345	371	420	467	506	536	564	588	612	654	693
	F9	39	65	112	147	197	244	287	333	359	387	431	477	511	538	565	593	616	658	693
Mean		43	71	111	148	192	237	278	325	350	377	424	469	504	533	560	584	609	654	694
Web	A1	53	95	142	187	233	283	330	378	403	428	472	517	553	583	609	631	652	690	725
10 mm from UF	B1	64	110	160	206	251	298	341	392	421	447	491	537	569	599	623	645	668	710	746
Mean		59	103	151	197	242	291	336	385	412	438	482	527	561	591	616	638	660	700	736
Web	A2	106	171	237	292	344	400	443	490	507	534	572	609	643	668	691	708	727	761	794
30 mm from UF	B2	89	150	215	273	326	381	425	473	498	521	560	601	629	657	678	699	717	754	789
Mean		98	161	226	283	335	391	434	482	503	528	566	605	636	663	685	704	722	758	792
Web	A3	101	175	248	312	368	430	476	521	541	565	601	637	669	693	714	730	748	783	814
50 mm from UF	B3	85	156	228	294	351	414	462	510	534	555	592	631	657	683	703	721	738	774	809
Mean		93	166	238	303	360	422	469	516	538	560	597	634	663	688	709	726	743	779	812
Web 100 mm from UF	B4	95	184	279	361	430	500	549	591	611	627	656	684	705	727	742	754	769	808	835
Web	W1	122	209	297	375	439	500	550	587	604	624	653	680	704	723	741	750	764	799	825
Centre-line	W2	106	206	302	391	462	529	579	620	638	653	680	707	729	744	760	773	788	822	845
	W3	115	210	315	403	474	541	589	630	646	660	683	710	726	744	757	772	787	822	846
	W4	103	187	282	364	440	510	563	604	622	640	665	690	710	731	745	757	772	809	835
Mean		112	203	299	383	454	520	570	610	628	644	670	697	717	736	751	763	778	813	838
Web 100 mm from LF	A4	79	166	267	358	439	514	570	616	635	655	684	711	734	748	764	777	794	827	851
Web	A5	76	155	249	336	417	492	552	604	630	654	685	712	737	753	767	778	796	829	855
50 mm from LF	B5	74	148	236	323	402	479	540	590	614	633	662	692	715	735	746	761	776	814	840
Mean		75	152	243	330	410	486	546	597	622	644	674	702	726	744	757	770	786	822	848
Web 30 mm from LF	A6	71	145	233	318	399	476	538	591	613	635	669	700	725	743	757	771	790	825	850
10 mm from LF	A7	60	132	218	304	384	464	529	583	607	629	665	697	722	741	753	769	787	824	850
Lower Flange	F1	70	145	230	315	393	470	533	585	607	629	666	700	726	743	759	773	790	824	850
	F2	70	146	236	323	405	486	551	603	622	646	684	715	739	756	773	790	808	841	867
	F4	88	166	253	332	409	485	547	598	621	642	667	709	734	750	768	782	799	835	860
	F6	78	162	245	331	407	479	543	593	616	639	671	703	729	745	761	776	793	827	852
	F7	67	141	226	314	393	474	539	594	617	638	671	703	726	742	760	777	795	830	857
Mean		75	152	238	323	401	479	543	595	617	639	672	706	731	747	764	780	797	831	857
Mean Furnace Gas	(e)	434	528	616	654	693	721	738	760	767	781	800	812	827	836	849	855	871	892	904
Standard Curve	(f)	445	544	603	645	678	705	728	748	757	766	781	796	809	820	832	842	851	869	885
Deflection mm		2	8	16	34	44	54	68	107	151	(g)									
Deflection rate mm/min		1	4	4	9	5	5	8	25	44										



DATA SHEET NUMBER **95A**

SIMPLY SUPPORTED FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
IPE 360 Beam	Nominal	57.1	360	170	8.0	12.7	903.6	122.8	1019	191.1	16266	1043
	Actual	55.9	359	171	7.8	12.4	886.2	121.3	998.1	188.6	15908	1037

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt %)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade St 37	0.11	0.07	0.60	0.011	0.021	0.05	0.005	0.02	0.005	0.02	0.005	0.005	0.0051

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS N/mm^2	TS N/mm^2	Elong. %
Flange	252	382	34.0

NOTES

(a) Slab size = 135 mm thick x 610 mm wide
Slab mass per metre = 1.809 kN
(b) Equals 18.97% of the maximum allowable bending stress for a DIN 17100 : Grade St 37 steel section
(c) Actual LYS
(d) The limiting rate of deflection (6.3 mm/min) was exceeded before L/20 was achieved
(e) Initial ambient temperature = 20 deg. C.
(f) Based on an initial ambient temperature of 20 deg. C
(g) Heating continued with no load

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m

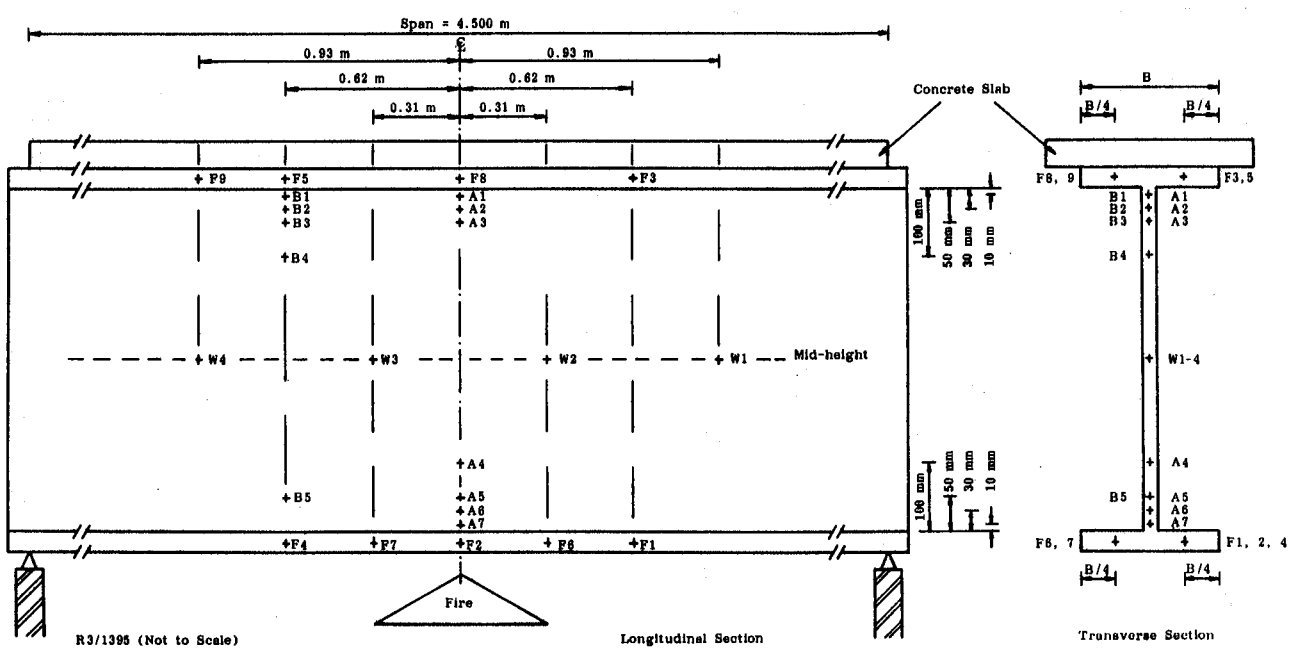
BS449 : PART 2 : 1969

MAXIMUM BENDING STRESS IN LOWER FLANGE : 28.83 N/mm^2 (b)
TOTAL LOAD : 10.094 kN/m
DEAD LOAD : 2.358 kN/m
IMPOSED LOAD REQUIRED : 7.736 kN/m
LOADS APPLIED : 8.703 kN

BS5950 : PART 1 : 1985

DESIGN STRENGTH : 252 N/mm^2 (c)
MOMENT CAPACITY : 251.521 kN.m
MOMENT DUE TO DEAD LOAD : 5.969 kN.m
MOMENT DUE TO IMPOSED LOAD : 19.583 kN.m
TOTAL MOMENT : 25.552 kN.m
LOAD RATIO : 0.102

THERMOCOUPLE POSITIONS



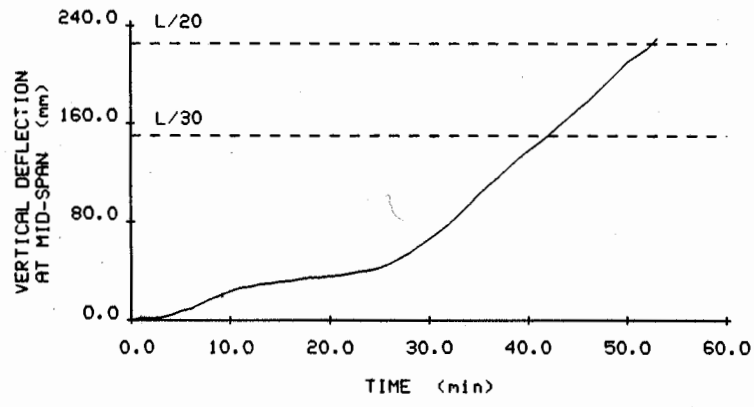
TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 21st SEPTEMBER 1988
TEST NUMBER	: W.R.C.S.I. 44991

BS476 : PARTS 20 & 21 : 1987 RESULTS

TIME TO $L^2/9000d$	(d) :	43 MINUTES
RE-LOAD TEST	:	SATISFIED
LOAD BEARING CAPACITY	:	43 MINUTES
FIRE RESISTANCE	:	43 MINUTES

DATA SHEET NUMBER **95B**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	43	48	52	54	60
Upper Flange	F3	67	120	183	242	297	357	417	471	521	562	600	632	662	689	696	733	754	764	790
	F5	53	114	180	240	298	359	419	472	521	564	599	632	664	691	700	736	756	764	792
	F8	69	138	217	291	360	428	493	547	597	631	658	679	703	726	734	764	792	805	839
	F9	52	111	180	243	307	377	445	505	553	590	619	649	680	708	717	752	780	795	836
Mean		60	121	190	254	316	380	444	499	548	587	619	648	677	704	712	746	771	782	814
Web	A1	88	169	250	323	390	453	513	563	609	643	672	693	717	739	746	778	805	817	853
10 mm from UF	B1	87	159	234	298	357	417	474	522	567	608	639	669	700	726	735	774	800	810	842
Mean		88	164	242	311	374	435	494	543	588	626	656	681	709	733	741	776	803	814	848
Web	A2	110	219	319	399	465	525	581	626	667	698	724	744	765	787	794	826	849	859	890
30 mm from UF	B2	121	219	312	384	445	504	560	603	643	679	706	732	758	781	789	825	849	857	886
Mean		116	219	316	392	455	515	571	615	655	689	715	738	762	784	792	826	849	858	888
Web	A3	162	286	392	470	530	582	631	667	703	728	750	770	791	811	817	845	866	875	903
50 mm from UF	B3	131	247	356	434	495	553	605	644	681	713	736	759	784	806	813	844	868	876	902
Mean		147	267	374	452	513	568	618	656	692	721	743	765	788	809	815	845	867	876	903
Web 100 mm from UF	B4	150	288	415	502	560	614	658	691	721	744	764	787	811	829	835	862	886	892	916
Web	W1	185	305	427	512	579	630	672	706	732	754	775	797	818	837	843	868	891	901	925
Centre-line	W2	150	297	430	525	584	637	678	707	734	753	774	797	817	834	840	866	888	897	920
	W3	143	291	432	527	587	637	678	710	736	756	778	802	821	840	845	871	893	900	923
	W4	119	261	401	501	568	624	668	703	730	751	773	796	816	834	839	863	887	895	918
Mean		149	289	423	516	580	632	674	707	733	754	775	798	818	836	842	867	890	898	922
Web 100 mm from LF	A4	120	265	409	517	587	642	686	717	744	762	784	807	827	843	849	875	896	904	927
Web	A5	95	231	376	490	568	630	678	711	740	757	780	803	823	840	845	872	894	902	924
50 mm from LF	B5	121	246	381	488	566	628	677	711	740	760	781	805	827	843	849	876	899	905	927
Mean		108	239	379	489	567	629	678	711	740	759	781	804	825	842	847	874	897	904	926
Web																				
30 mm from LF	A6	92	224	365	480	560	624	673	708	738	755	777	801	821	839	844	871	893	902	924
10 mm from LF	A7	86	214	353	468	551	617	668	705	735	751	775	799	820	838	843	872	894	903	925
Lower Flange	F1	121	236	364	475	557	625	677	717	744	766	790	812	833	851	856	885	906	915	938
	F2	106	242	379	491	573	638	688	724	750	771	794	815	835	852	857	885	907	915	937
	F4	107	231	369	479	562	630	682	718	744	768	790	812	833	848	854	881	903	910	932
	F6	116	239	375	487	566	631	682	718	743	766	789	813	832	849	854	883	903	912	936
	F7	122	252	394	504	579	640	687	725	748	773	798	821	840	859	864	893	912	920	944
Mean		114	240	376	487	567	633	683	720	746	769	792	815	835	852	857	885	906	914	937
Mean Furnace Gas	(e)	523	619	683	704	750	774	803	816	834	850	862	878	892	901	906	928	943	947	969
Standard Curve	(f)	502	603	663	705	739	766	789	809	826	842	856	869	881	892	896	912	924	930	945
Deflection mm		2	9	20	27	31	34	36	40	49	65	85	109	131	150	157	194	221	(g)	
Deflection rate mm/min		1	2	3	1	1	1	1	1	4	5	7	8	7	6	7	8	6		



DATA SHEET NUMBER **96A**

SHELF ANGLE FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
254 x 146 Beam	Nominal	43	259.6	147.3	7.3	12.7	505.0	92.0	567.7	141.2	6554	677.4
	Actual	41.9	261	145	7.3	12.3	489.7	86.3	551.3	132.7	6391	625.9
125 x 75 x 12 Angle	Nominal	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5
	Actual	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade 43A	0.15	0.16	0.79	0.030	0.011	0.03	0.005	0.04	0.005	0.03	0.005	0.035	0.0061
Angle	Grade 50D	0.13	0.33	1.31	0.013	0.014	0.03	0.005	0.02	0.06	0.03	0.005	0.042	0.0097

ROOM TEMPERATURE TENSILE PROPERTIES

Product	LYS N/mm^2	TS N/mm^2	Elong. %
Beam	301	466	35.0
Angle	398	544	31.0

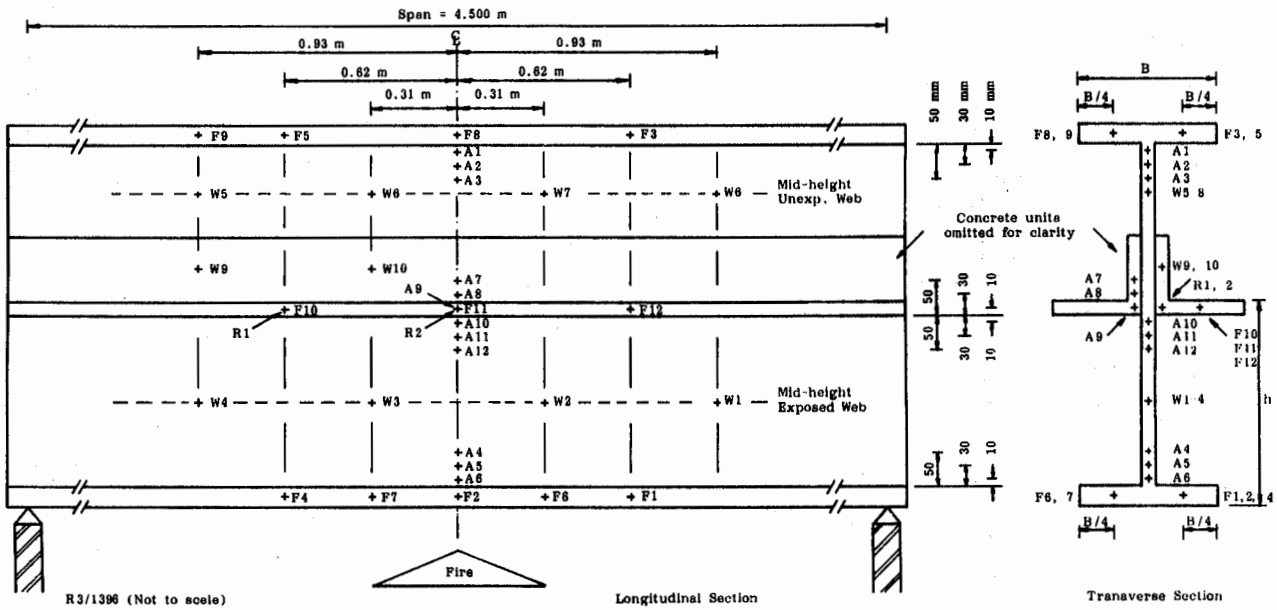
NOTES

(a) Height of exposed steel, h, = 82 mm
(b) Equals 110.7% of the maximum allowable bending stress for a BS4360 : Grade 43A : 1979 steel section
(c) Applied 0.5 m from the centre-line of the beam
(d) To each of the 8 rams
(e) The limiting rate of deflection (8.6 mm/min) was not exceeded before L/20 was achieved
(f) Initial ambient temperature = 18 deg. C
(g) Based on an initial ambient temperature of 20 deg C
(*) No data recorded

TEST CONDITIONS

END CONDITIONS	: SIMPLY SUPPORTED		
EFFECTIVE SPAN	: 4.500 m		
CONCRETE FLOOR UNITS	: SOLID, 150 mm deep (a)		
BS449 : PART 2 : 1969			
MAXIMUM BENDING STRESS REQUIRED	: 182.68	N/mm^2	(b)
OPERATING LOAD REQUIRED	: 159.05	kN	
DEAD LOAD (BEAM + SAND)	: ~5.0	kN	
DEAD LOAD (CONCRETE + LOAD SPREADERS)	: ~54.5	kN	
REACTION ON THE ANGLES	: 27.25	kN	
TOTAL IMPOSED FORCE REQD.	: 126.8	kN	
TOTAL LOAD REQUIRED	: 176.0	kN	(c)
LOADS APPLIED	: 22.0	kN	(d)
BS5950 : PART 1 : 1985			
MOMENT CAPACITY OF BEAM	: 165.941	kN.m	
MOMENT DUE TO BEAM + SAND:	2.813	kN.m	
MOMENT DUE TO CONCRETE + LOAD SPREADERS	: 15.328	kN.m	
MOMENT DUE TO IMPOSED FORCE	: 71.325	kN.m	
TOTAL MOMENTS APPLIED	: 89.466	kN.m	
LOAD RATIO	: 0.539		

THERMOCOUPLE POSITIONS



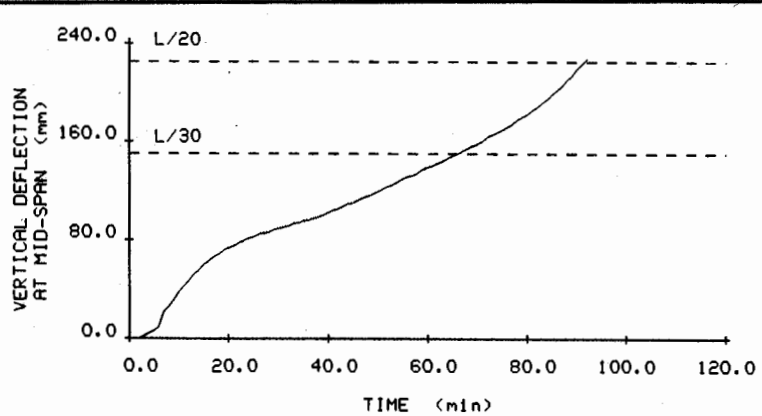
TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 9th MARCH 1988
TEST NUMBER	: W.R.C.S.I. 42785

BS476 : PARTS 20 & 21 : 1987 RESULTS

TIME TO L/20	(e) :	91 MINUTES
RE-LOAD TEST	:	SATISFIED
LOAD BEARING CAPACITY	:	91 MINUTES
FIRE RESISTANCE	:	91 MINUTES

DATA SHEET NUMBER **96B**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	35	40	45	50	60	66	70	80	91
Upper Flange	F3	16	15	15	15	16	19	22	27	37	49	70	88	97	97	97	98	100	105	114
	F5	16	15	15	16	19	21	25	34	48	67	97	101	101	103	112	116	122	141	164
	F8	15	14	14	15	16	19	23	28	37	47	64	80	92	95	97	99	103	113	111
	F9	16	15	14	15	17	19	22	26	29	34	46	64	93	96	99	102	107	121	142
Mean		16	15	15	15	17	20	23	29	38	49	69	83	96	98	101	104	108	120	133
Unexposed Web																				
10 mm from UF	A1	16	15	16	18	20	26	32	42	53	64	81	96	102	102	113	121	128	146	154
30 mm from UF	A2	16	16	17	23	28	37	50	66	78	88	100	103	105	115	149	166	177	204	219
50 mm from UF	A3	16	16	20	27	36	53	74	90	101	102	103	107	113	133	183	208	224	259	286
Unexposed Web	W5	16	17	20	27	36	46	58	69	81	91	101	104	107	122	168	196	213	248	285
	W6	16	18	21	30	42	67	89	100	106	109	119	134	150	171	210	232	247	283	315
	W7	16	18	23	30	40	53	69	81	90	97	102	106	113	128	171	198	214	252	289
	W8	17	18	21	27	35	46	58	70	79	85	93	101	102	106	142	169	187	223	259
Mean		16	18	21	29	38	53	69	80	89	96	104	111	118	132	173	199	215	252	287
Exposed Web																				
10 mm below Angle	A10	119	173	250	313	368	410	444	474	506	535	582	623	659	692	751	783	800	846	899
30 mm below Angle	A11	82	150	234	316	385	437	477	511	543	573	619	658	690	722	784	817	832	882	930
50 mm below Angle	A12	83	167	262	353	430	486	527	559	589	617	659	691	718	747	807	838	846	891	946
Exposed Web	W1	85	154	233	306	372	420	463	494	521	542	578	617	652	679	734	763	800	852	893
	W2	72	152	232	310	378	429	473	504	531	553	593	634	665	697	757	791	814	861	917
	W3	70	140	225	313	387	447	493	532	561	589	629	666	695	724	784	816	832	880	927
	W4	85	137	211	288	360	414	457	498	531	555	598	635	664	691	748	779	799	844	892
Mean		78	146	225	304	374	428	472	507	536	560	600	638	669	698	756	787	811	859	907
Exposed Web																				
50 mm from LF	A4	85	137	191	257	317	363	400	435	469	500	549	592	628	660	725	758	783	835	885
30 mm from LF	A5	115	181	251	333	402	452	490	523	555	583	627	662	693	722	785	817	836	884	928
10 mm from LF	A6	106	183	271	371	452	511	552	585	613	639	677	708	730	758	818	846	859	908	946
Lower Flange	F1	141	237	346	448	524	580	619	647	669	683	716	749	766	789	837	863	881	919	958
	F2	129	231	349	459	540	598	640	669	695	706	737	772	790	815	861	886	903	937	975
	F4	130	226	341	450	534	593	636	668	692	707	737	772	789	811	854	878	902	936	975
	F6	117	216	331	440	523	581	624	656	681	692	724	759	774	796	845	871	889	928	967
	F7	122	222	343	450	536	593	634	666	691	709	739	770	792	814	852	870	913	946	976
Mean		128	226	342	449	531	589	631	661	686	699	731	764	782	805	850	874	898	933	970
Exposed Flange Angle	F10	81	142	215	284	348	404	447	481	513	553	602	647	680	711	767	808	821	880	937
	F11	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	F12	83	139	191	250	299	325	341	366	424	465	526	589	634	673	736	768	796	855	912
Mean		82	141	203	267	324	365	394	424	469	509	564	618	657	692	752	788	809	868	925
Unexposed Flange Angle																				
10 mm from Base	A9	26	47	76	112	147	180	210	243	278	317	380	435	481	521	593	630	652	704	759
30 mm from Base	A8	21	36	59	93	125	158	185	213	243	273	327	377	418	457	526	563	584	635	686
50 mm from Base	A7	19	30	48	75	106	134	158	183	209	237	285	332	372	410	478	513	535	586	640
Unexposed Flange	W9	21	35	57	90	130	169	201	232	260	287	331	373	409	444	512	550	574	626	675
Angle	W10	20	35	56	89	130	167	200	228	253	279	324	373	415	455	525	561	585	637	690
Mean		21	35	57	90	130	168	201	230	257	283	328	373	412	450	519	556	580	632	683
Angle Root	R1	29	53	86	132	181	227	270	309	344	380	433	478	517	555	624	661	684	741	808
	R2	32	57	90	127	174	222	266	306	343	378	432	482	526	564	632	667	691	746	809
Mean		31	55	88	130	178	225	268	308	344	379	433	480	522	560	628	664	688	744	809
Mean Furnace Gas	(f)	502	597	683	722	755	769	784	798	810	821	843	869	885	903	933	950	963	990	1011
Standard Curve	(g)	502	603	663	705	739	766	789	809	826	842	865	885	902	918	945	960	968	988	1008
Deflection mm		2	9	32	47	59	68	75	81	85	89	95	102	110	119	138	150	158	182	223
Deflection rate mm/min		2	3	6	5	4	2	2	2	1	1	1	2	1	2	2	2	2	3	4



DATA SHEET NUMBER **97A**

SHELF ANGLE FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
254 x 146 Beam	Nominal	43	259.6	147.3	7.3	12.7	505.0	92.0	567.7	141.2	6554	677.4
	Actual	43.9	266	146	8.1	12.3	511.5	87.6	579.5	135.3	6804	639.2
125 x 75 x 12 Angle	Nominal	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5
	Actual	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade 43A	0.22	0.03	1.07	0.009	0.028	0.02	0.005	0.02	0.005	0.02	0.005	0.005	0.0044
Angle	Grade 50D	0.12	0.33	1.32	0.012	0.014	0.03	0.005	0.02	0.06	0.03	0.005	0.043	0.0086

ROOM TEMPERATURE TENSILE PROPERTIES

Product	LYS N/mm^2	TS N/mm^2	Elong. %
Beam	278	492	34.0
Angle	395	545	33.0

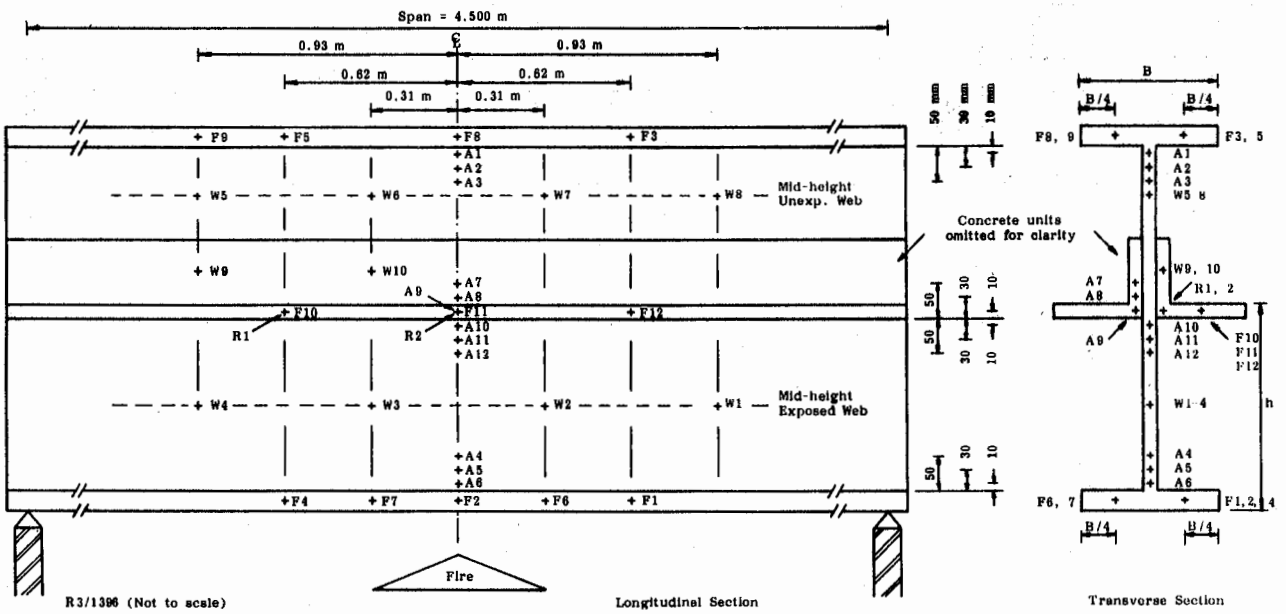
NOTES

(a) 50 mm deep x 300 mm taper at one end
(b) Height of exposed steel, h, = 114 mm
(c) Equals 105.5% of the maximum allowable bending stress for a BS4360 : Grade 43A : 1979 steel section
(d) Applied 0.5 m from the centre-line of the beam
(e) To each of the 8 rams
(f) The limiting rate of deflection (8.5 mm/min) was not exceeded before L/20 was achieved
(g) Initial ambient temperature = 18 deg. C
(h) Based on an initial ambient temperature of 20 deg. C

TEST CONDITIONS

END CONDITIONS	: SIMPLY SUPPORTED		
EFFECTIVE SPAN	: 4.500 m		
CONCRETE FLOOR UNITS	: SOLID, 150 mm deep		(a) (b)
BS449 : PART 2 : 1969			
MAXIMUM BENDING STRESS REQUIRED	: 174.07	N/mm^2	(c)
OPERATING LOAD REQUIRED	: 158.3	kN	
DEAD LOAD (BEAM + SAND)	: ~5.0	kN	
DEAD LOAD (CONCRETE + LOAD SPREADERS)	: ~53	kN	
REACTION ON THE ANGLES	: 26.5	kN	
TOTAL IMPOSED FORCE REQD.	: 126.8	kN	
TOTAL LOAD REQUIRED	: 176.0	kN	(d)
LOADS APPLIED	: 22.0	kN	(e)
BS5950 : PART 1 : 1985			
MOMENT CAPACITY OF BEAM	: 161.101	kN.m	
MOMENT DUE TO BEAM + SAND	: 2.813	kN.m	
MOMENT DUE TO CONCRETE + LOAD SPREADERS	: 14.906	kN.m	
MOMENT DUE TO IMPOSED FORCE	: 71.325	kN.m	
TOTAL MOMENTS APPLIED	: 89.044	kN.m	
LOAD RATIO	: 0.553		

THERMOCOUPLE POSITIONS



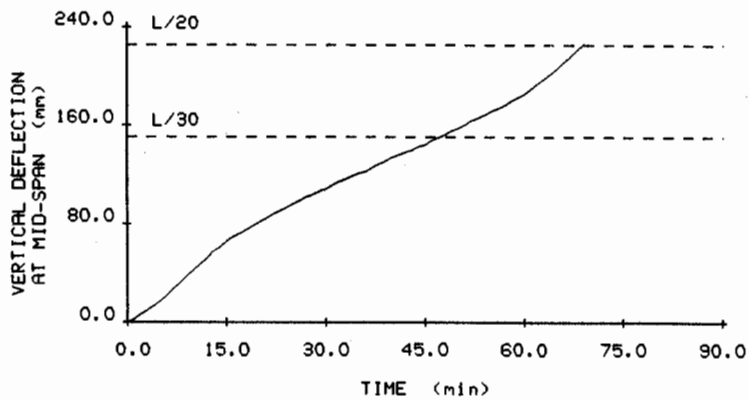
TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 23rd MARCH 1988
TEST NUMBER	: W.R.C.S.I. 42786

BS476 : PARTS 20 & 21 : 1987 RESULTS

TIME TO L/20	(f)	: 69 MINUTES
RE-LOAD TEST		: SATISFIED
LOAD BEARING CAPACITY		: 69 MINUTES
FIRE RESISTANCE		: 69 MINUTES

DATA SHEET NUMBER **97B**

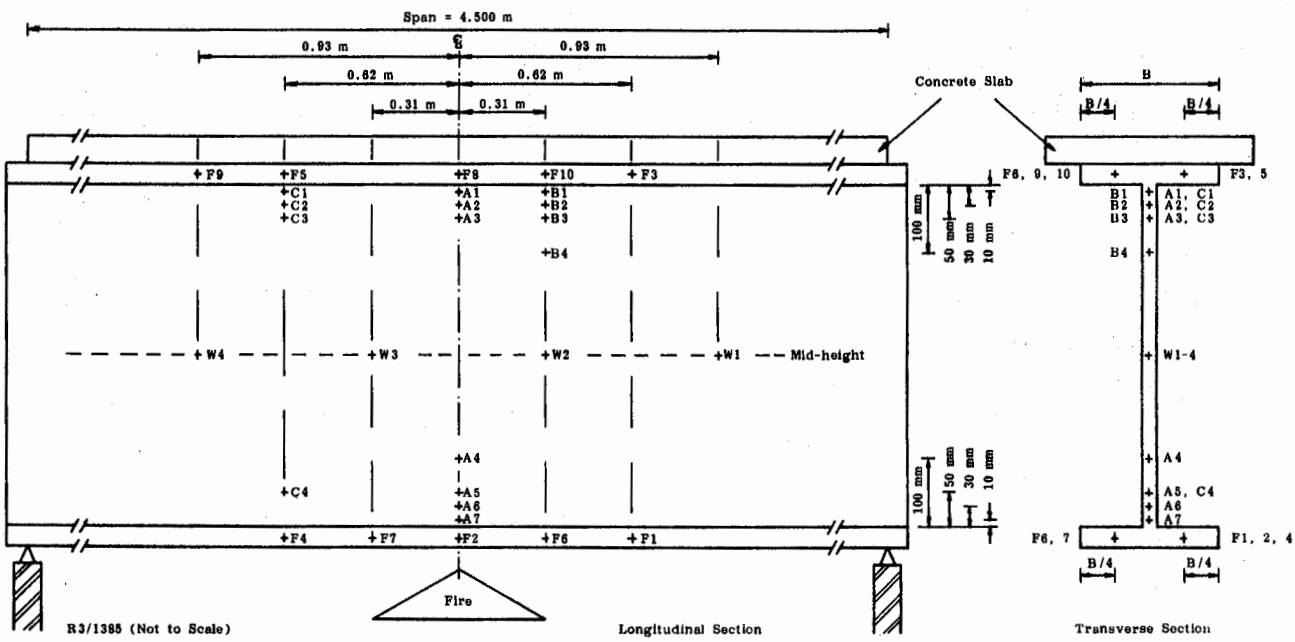
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	35	40	45	47	50	55	60	65	69
Upper Flange	F3	15	14	16	17	22	26	32	40	50	63	88	97	100	101	105	110	119	131	144
	F5	15	15	16	19	22	27	31	39	49	59	81	98	106	110	117	130	142	158	170
	F8	15	16	17	19	23	28	34	43	58	76	98	102	106	109	111	115	110	127	146
	F9	15	16	17	19	23	28	34	42	55	72	100	105	114	118	124	136	148	161	171
Mean		15	15	17	19	23	27	33	41	53	68	92	101	107	110	114	123	130	144	158
Unexposed Web																				
10 mm from UF	A1	15	17	20	26	32	41	57	85	97	102	115	128	137	141	145	153	154	174	193
30 mm from UF	A2	16	19	24	32	42	61	100	102	104	106	110	124	156	166	181	201	226	243	259
50 mm from UF	A3	18	25	37	53	73	97	122	141	158	173	203	238	267	278	292	315	332	353	373
Unexposed Web	W5	17	21	29	41	56	72	99	107	114	122	140	170	194	204	217	237	258	274	288
	W6	16	20	29	42	55	71	89	108	122	133	156	188	211	221	234	256	283	299	310
	W7	16	21	29	41	54	70	85	104	124	138	146	186	209	218	231	252	276	295	307
	W8	16	20	27	39	75	98	101	103	109	117	127	138	160	171	187	212	232	254	272
Mean		16	21	29	41	60	78	94	106	117	128	142	171	194	204	217	239	262	281	294
Exposed Web																				
10 mm below Angle	A10	127	189	258	330	392	447	492	528	562	592	638	674	710	720	741	770	801	827	850
30 mm below Angle	A11	123	197	276	359	428	485	531	568	601	629	673	707	740	750	771	803	835	860	880
50 mm below Angle	A12	108	193	285	375	452	512	560	597	629	657	696	726	755	768	790	822	850	874	891
Exposed Web	W1	113	183	260	344	405	460	504	539	570	598	639	674	703	714	732	759	793	822	842
	W2	128	197	280	362	429	485	530	566	597	627	665	698	731	741	760	792	825	850	872
	W3	120	197	292	381	454	514	561	596	629	655	694	725	751	763	785	814	844	867	883
	W4	106	182	267	359	431	489	535	574	605	632	673	706	734	745	764	796	825	850	867
Mean		117	190	275	362	430	487	533	569	600	628	668	701	730	741	760	790	822	847	866
Exposed Web																				
50 mm from LF	A4	128	206	282	361	434	489	534	571	604	634	675	708	739	752	772	805	835	860	879
30 mm from LF	A5	223	298	356	426	492	544	582	613	641	668	707	734	764	777	797	826	854	877	894
10 mm from LF	A6	106	203	305	404	484	546	592	628	657	683	717	740	772	785	805	836	862	883	899
Lower Flange	F1	131	236	341	444	517	576	618	650	676	698	730	750	776	788	806	832	860	881	898
	F2	154	264	377	474	549	606	647	678	704	726	752	774	806	817	834	861	883	901	916
	F4	150	254	372	478	555	613	654	686	711	730	757	781	810	822	839	865	886	906	917
	F6	140	246	357	462	539	600	642	673	698	722	750	771	801	812	828	854	879	897	914
	F7	141	246	365	472	553	612	656	687	712	733	755	784	814	823	841	866	886	904	917
Mean		143	249	362	466	543	601	643	675	700	722	749	772	801	812	830	856	879	898	912
Exposed Flange	F10	112	180	249	321	383	439	487	526	561	591	638	677	712	725	744	772	802	832	853
Angle	F11	88	143	199	267	337	393	444	488	527	564	617	660	699	714	735	764	797	830	852
	F12	83	141	197	264	322	379	424	464	500	533	581	622	659	674	695	730	762	796	823
Mean		94	155	215	284	347	404	452	493	529	563	612	653	690	704	725	755	787	819	843
Unexposed Flange Angle																				
10 mm from Base	A9	30	58	91	132	177	224	267	312	352	389	444	491	533	548	570	604	632	658	677
30 mm from Base	A8	27	46	77	116	161	203	241	279	315	349	401	445	486	501	522	555	581	605	623
50 mm from Base	A7	22	39	65	100	140	181	217	253	286	317	366	407	443	458	477	507	529	551	569
Unexposed Flange	W9	25	47	76	110	147	186	213	241	277	313	367	416	458	473	495	530	561	587	606
Angle	W10	26	48	80	117	162	207	249	288	322	355	402	445	485	499	521	552	578	604	623
Mean		26	48	78	114	155	197	231	265	300	334	385	431	472	486	508	541	570	596	615
Angle Root	R1	36	63	102	150	205	260	309	356	399	436	492	538	579	593	615	649	680	707	727
	R2	38	68	107	155	206	259	306	352	394	431	490	538	581	596	619	654	684	711	732
Mean		37	66	105	153	206	260	308	354	397	434	491	538	580	595	617	652	682	709	730
Mean Furnace Gas	(g)	530	612	675	716	735	757	765	785	793	809	829	850	867	873	885	900	918	931	945
Standard Curve	(h)	502	603	663	705	739	766	789	809	826	842	865	885	902	909	918	932	945	957	966
Deflection mm		9	22	37	52	65	75	84	93	101	108	120	133	144	149	157	171	185	206	226
Deflection rate mm/min		3	5	5	5	4	3	3	3	3	2	2	3	2	2	2	3	3	5	5



DATA SHEET NUMBER **98A**

INDICATIVE FLOOR BEAM

THERMOCOUPLE POSITIONS



INDICATIVE FLOOR BEAM

DATA SHEET NUMBER **98B**

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FULL LENGTH MEMBER

DIMENSIONS AND PROPERTIES (NOMINAL)

Section Type	Serial Size mm	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
Beam	356 x 171	67	364.0	173.2	9.1	15.7	1073	157.3	1212	243.0	19522	1362

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)												
		2	4	6	8	10	12	14	16	18	20	22	24	26
Upper Flange	F3	72	92	129	161	193	228	265	303	342	380	419	461	497
	F5	62	83	111	138	167	200	235	273	312	350	390	434	467
	F8	72	96	129	161	189	227	266	304	344	384	420	457	491
	F9	63	81	110	140	177	216	253	293	333	373	412	462	496
	F10	88	109	144	179	223	264	305	353	396	441	483	529	560
Mean		71	92	125	156	190	227	265	305	345	386	425	469	502
Web 10 mm from UF	A1	92	125	167	210	250	295	341	383	426	467	505	538	570
	B1	69	102	145	188	237	284	329	377	421	466	507	549	582
	C1	67	96	133	170	210	251	291	333	376	416	455	497	530
Mean		76	108	148	189	232	277	320	364	408	450	489	528	561
Web 30 mm from UF	A2	114	157	212	266	316	369	417	460	504	542	576	608	633
	B2	104	146	201	256	315	369	419	468	511	553	587	624	650
	C2	106	145	195	244	298	347	394	438	482	520	558	593	620
Mean		108	149	203	255	310	362	410	455	499	538	574	608	634
Web 50 mm from UF	A3	106	158	221	283	345	404	457	505	549	587	619	648	672
	B3	113	164	227	290	356	414	466	516	557	596	626	658	680
	C3	107	155	215	274	337	394	444	494	537	573	607	638	662
Mean		109	159	221	282	346	404	456	505	548	585	617	648	671
Web 100 mm from UF	B4	140	198	269	342	418	480	535	583	621	656	681	707	724
Web Centre-line	W1	117	176	248	323	403	470	527	576	616	646	672	695	712
	W2	126	189	266	345	426	494	550	601	639	673	696	720	736
	W3	117	186	266	345	422	488	544	596	636	670	696	720	734
	W4	125	184	254	326	403	470	526	576	617	650	677	703	717
Mean		121	184	259	335	414	481	537	587	627	660	685	710	725
Web 100 mm from LF	A4	232	286	343	412	453	512	562	601	640	672	697	719	736
Web 50 mm from LF	A5	97	157	225	302	376	450	514	572	619	658	689	715	734
	C4	115	175	244	315	392	462	524	576	621	656	686	710	729
Mean		106	166	235	309	384	456	519	574	620	657	688	713	732
Web 30 mm from LF	A6	96	153	219	293	367	440	505	564	613	653	684	711	731
10 mm from LF	A7	72	128	194	267	344	419	488	549	601	643	677	705	727
Lower Flange	F1	70	120	181	249	327	402	472	535	587	631	666	695	717
	F2	81	136	203	277	353	427	495	556	606	648	682	709	731
	F4	90	145	208	273	346	418	485	545	597	639	674	703	724
	F6	105	154	221	296	377	451	520	581	628	668	697	723	743
	F7	95	146	214	291	370	445	512	573	623	665	697	725	737
Mean		88	140	205	277	355	429	497	558	608	650	683	711	730
Mean Furnace Gas	(a)	500	529	589	637	678	712	737	765	784	797	810	821	833
Standard Curve	(b)	445	544	603	645	678	705	728	748	766	781	796	809	820

NOTES:- (a) Initial ambient temperature = 21 deg. C
(b) Based on an initial ambient temperature of 20 deg. C

DATA SHEET NUMBER

TEST ELEMENT CONFIGURATION

DIMENSIONS AND PROPERTIES

Section Serial Size and Type mm	Dimensions and Properties	Mass Per Metre kg	Depth of Section mm	Width of Section mm	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web mm	Flange mm	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^3	Axis y-y cm^3	Axis x-x cm^4	Axis y-y cm^4
	Nominal											
	Actual											

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

Product	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS N/mm^2	TS N/mm^2	Elong. %
Flange			

TEST CONDITIONS

NOTES

FIGURE SHOWING DETAILS OF TEST CONFIGURATION AND LOCATION OF THERMOCOUPLES

TEST CENTRE : TEST DATE : TEST NUMBER :	FIRE TEST STANDARD ASSESSMENT	DATA SHEET NUMBER

THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)
Mean Furnace Gas Standard Curve Deflection mm Deflection rate mm/min	