Compendium of UK Standard Fire Test Data

Unprotected Structural Steel – 1

Department of Environment
Building Research Establishment
Fire Research Station

British Steel Corporation
Research Services
Swinden Laboratories

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COMPENDIUM OF UK STANDARD FIRE TEST DATA UNPROTECTED STRUCTURAL STEEL - 1

by

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FOREWORD

This compendium of unprotected steel fire test data has been prepared by research staff at the Swinden Laboratories and published on behalf of the UK Department of the Environment Fire Research Station and the British Steel Corporation.

Its main purpose is to provide data for researchers in the study of 'fire resistance of steel structures' particularly in the development of accurate calculation methods, for the determination of high temperature performance and fire resistant design.

It has long been recognised that fire resistance is influenced by section dimensions (H_p/A) and load, and the data published here clearly identifies a third major parameter - the temperature profile through the cross section. It is hoped that the information given on temperature profiles will be used to improve the accuracy of models on the behaviour of steel in fire.

In order to encourage rapid dissemination of information in this field, the publishers invite authors making use of the compendium to send copies of their papers to the Swinden Laboratories address below, so that a reference library covering the behaviour of steel in fire can be evolved for the benefit of other researchers.

Test data on unprotected steelwork from other countries would also be welcomed in order to build up a comprehensive data base and to make available an international compendium in the same format. Blank data sheets, which may be copied, have been included for this purpose and acknowledgement of sources will of course be given.

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PREFACE

This compendium has been prepared covering all the fire tests carried out in the UK, according to BS476:Part 8:1972, on hot rolled structural steel sections in which the members were either completely unprotected, or partially protected by materials used only in the fabric of a structure, such as concrete, brick and blockwork.

The information is presented in the form of a detailed description of the design, preparation and construction for each type of test element and is accompanied in an Appendix, by a series of data sheets. These include information given in much greater detail than that normally reported by the testing stations so that further analysis of the behaviour of the elements under test, can readily be made. In the compendium two further fire tests are reported; one on a square solid steel section carried out to BS476:Part 1:1953 and a single international test on an HD column section following ISO:834.

From the fire test results reported, relationships between heating rate, member size, applied load and fire resistance have been established for several types of load bearing elements based upon analyses carried out by staff at the Swinden Laboratories of the British Steel Corporation.

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COMPENDIUM OF UK STANDARD FIRE TEST DATA
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1. INTRODUCTION

One of the aims of the UK Building Regulations is to restrict the spread of fire and minimise the injury and loss of life which could occur should part, or whole of a structure collapse. To this end the 1985 Building Regulations Approved Guidance Document B2/3/4 specifies minimum periods of fire resistance for elements of construction. These range from nil to 4 h depending upon the occupancy and dimensions of the building and reflect the degree of fire safety required for the structure as a whole.

The fire resistance periods stipulated in the Approved Document are those required by parts of a structure (usually as single elements) when subjected to a British Standard 476:Part 8:1972 fire resistance test. However, the substantial costs involved in carrying out fire tests dictate that fire testing programmes are limited and therefore, greater emphasis is now being placed upon the interpolation and extrapolation of results with the aid of computer modelling techniques.

During the last few years, the British Steel Corporation has carried out a considerable number of standard fire tests to examine the performance of structural steelwork without the application of lightweight fire protection products. A range of construction methods has been evaluated reflecting current design practices, as well as alternative forms of construction which are expected to become more widespread.

Some of the information gathered is already being incorporated into British Standards as well as in the preparation of Design Guides for the building industry to permit the safe use of structural steelwork without the need for specialist applied fire protection. However, it is also considered that the fire test data would be of interest to other research, testing and building design organisations internationally as well as in the UK. For this reason, the British Steel Corporation and the Department of the Environment have jointly sponsored the preparation of a compendium of all standard fire tests carried out in the UK, on hot rolled universal sections which were either completely unprotected, or partially protected by materials used only in the fabric of a structure, such as brick, concrete and blockwork.

Many of the fire tests reported in this Compendium form part of ongoing research programmes. Therefore, where appropriate and to assist fire engineers, relationships which have been established between the various parameters are given. However, as further data or alternative analyses become available, these may be modified at some future date. Care must also be taken against using a single test result out of context with other results from tests of a similar nature.

2. BS476:PART 8 FIRE TESTS

The British Standard fire test was first introduced in 1932 and was largely based upon fire testing practices already operating in several other countries, such as the USA. In subsequent years the procedures have been modified and at the present time, the fire resistance of load bearing structural elements is currently assessed in the UK, in accordance with the British Standard 476:Part 8:1972 incorporating Ammendments; 1873 (January 1976), 3816 (November 1981) and 4822 (May 1985). However, this standard is currently under review and is expected to be superceded by BS476:Parts 20, 21 and 22.

For a full description of the requirements in the standard, the reader is referred to the standard itself. But briefly, a fire resistance test is carried out on a specimen which as far as possible is representative of the element of construction used in service in terms of its size, materials and workmanship. In the case of structural elements, loads are also applied to simulate the same magnitude and type of stresses generated in practice, although other loadings can be used. The test specimen is heated in a gas fired furnace in which the temperature is controlled to vary with time in

accordance with the ISO recommendations:-

$$T-T_o = 345 \log_{10} (8t + 1), \ ^oC$$

where t = time of test, min

T = furnace temperature, ^oC, at time t

T_o = initial furnace temperature, ^oC

The heating curve is also graphically illustrated in Fig. 1.

The fire test is terminated either at the request of the sponsor, or when the limiting requirements for maintaining the relevent criteria for stability, integrity and insulation are achieved. At the end of the heating period, the loads are removed on structual elements and then reapplied 24 h later. Should collapse occur at any time during the test procedure, the notional period of stability is taken as 80% of the time to collapse or the duration of heating, if failure occurs during the reload test. In the proposed new fire testing standard the reload test will be optional.

All the tests reported in this Compendium and carried out in the UK were conducted at either the Warrington Research Centre, or at FIRTO - Borehamwood in appropriate gas fired furnaces. Reference is made to the relevent fire test numbers for which certificates have been issued.

Since a range of systems have been evaluated in either a floor, column or wall furnace, the fire tests have been placed in one of three categories and subdivided as follows:-

1. Floor Beam Tests

(a) Simply supported floor beam

(b) Simply supported floor beam with composite action between the steel and concrete

(c) Floor beam with applied rotational end restraining moments

(d) Floor beam with applied rotational end restraining moments and longitudinal thermal restraint

(e) Shelf angle floor beam

(f) 'Slim' floor beam

2. Column Tests

(a) Column

(b) Column with blocked in web

3. Wall Tests

(a) Columns in wall

(b) Columns or beams in wall with blocked in webs

For each system, a detailed description is provided of the specimen design, preparation and construction with appropriate figures, together with an example of the full loading calculations.

In addition to the fire tests on loaded sections, a series of unloaded, indicative tests have been carried out. Samples of structural sections were placed within the furnaces to obtain further data on the heating rates of the steelwork while the atmosphere followed the ISO heating curve.

All the information derived from the BS476:Part 8 fire tests is presented as a series of data sheets given in Appendix A. These contain data not normally

reported by the test centres and have been presented in such a way that further analyses of the structural behaviour of the elements during the fire tests can be made. The information provided therefore includes the room temperature properties and chemical composition of the member under evaluation, as well as comprehensive temperature profiles of the section at regular intervals during the test.

2.1 Steel Quality

Unless specifically stated, all the steel members were manufactured by the British Steel Corporation and supplied to the requirements of BS4360:1979:Grades 43A, 50B and occasionally to 50D. Details of the chemical compositions and minimum tensile properties required by these particular steel qualities are given in Tables 1 and 2.

2.2 Dimensions and Section Properties

The relevent nominal dimensions and section properties as specified in BS4:Part 1 and BS4848:Part 4 have been provided for each loaded test element. Where the actual dimensions of the member were measured, these are also included, and for the floor beam tests, the section properties were usually recalculated in order to determine the required loadings.

3. OTHER TESTS

In addition to the BS476:Part 8 fire test results, it was considered that for the purpose of research and further structural analyses, data on the high temperature properties of samples removed from the unheated portions of the fire tested members were relevent to this Compendium. This information was derived from a number of anisothermal tensile tests in which a predescribed stress was applied to a specimen at room temperature, which was then heated at a set rate within the range of 2.5-20^{o}C/min. The resulting strain (elastic and plastic) was measured by an extensometer fixed to the specimen. In Appendix B anisothermal high temperature data is therefore presented with cross references to the appropriate members evaluated in the BS476:Part 8 fire test.

4. DESIGN, CONSTRUCTION AND TEST PROCEDURES FOR FLOOR BEAMS

The design and preparation of the various types of floor beam assemblies are individually described in the following sections and therefore at this point, a description is only given of the general arrangements and procedures common to all the tests.

All the floor beam tests were carried out at the Warrington Research Centre. For illustrative purposes, Figs. 2(a) and (b) show the furnace used and a floor beam carrying a concrete cover slab on its upper flange being removed after a completed fire test.

The test assembly was mounted in the furnace roof on roller bearing supports set in the walls, to provide an effective span of approximately 4500 mm* and an exposed length of 4000 mm, as stipulated in the standard. The opening in the furnace roof was completely closed by either a concrete slab cast on top of the upper flange of the beam, or by a series or precast concrete units spanning between the side walls and the floor beam itself.

In addition to the normal requirements of the standard, all the beams were instrumented with 3 mm diamter mineral insulated sheath thermocouples to obtain detailed temperature profiles across the section at various times during the test. Generally the flange temperatures were measured at the $^{1}/_{4}$ flange width position (i.e. midway between the flange tip and the centreline of the web), whereas the web temperatures were usually measured at the mid-height of the section. In each case the thermocouple ends were placed in holes predrilled to mid-thickness thereby ensuring bulk steel temperatures were always measured.

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* During the period over which fire tests were carried out, repairs and modifications made to the furnace have resulted in small variations in the length of the beam between the two roller bearing supports.

The floor beams were loaded either through the concrete cover slab, or the precast units using hydraulic jacks normally located at four points, viz $^1/8$, $^3/8$, $^5/8$ and $^7/8$ span. The loads were calculated in order to develop the required bending stress at the centre of the member appropriate to the grade of steel, taking into acccount the design and dead load of the construction itself*. For the sizes of sections evaluated, the maximum permissible bending stresses at mid-span according to BS449:1969, are 165 and 230 N/mm^2 for BS4360:1979:Grades 43 and 50 respectively. Where design levels other than the maximum permissible were used, these have been identified as appropriate on the Appendix sheets. It was also assumed that the manner of loading adopted simulated a uniform load distribution along the beam.

An example of the loading calculations is included at the end of the sections dealing with each type of test assembly, and for all the tests described in the Appendix, the key parameters in the calculations are highlighted.

During the test, the furnace temperature was measured and controlled to within the requirements of BS476:Part 8:1972 from six or eight thermocouples symmetrically distributed on both sides of the beam. These were positioned so that their hot junctions were level with the soffit of the beam's flange and 100 mm from the beam.

A potentiometric gauge fixed to the beam at mid-span measured the vertical deflection and within the standard, up to 150 mm (span/30) of movement for a clear span (L) of 4500 mm was permitted. Note however, that in May 1985, Ammendment 4822 was introduced which allowed the deflection to proceed beyond L/30 and until whichever was first exceeded of:-

(a) A deflection of L/20, or

(b) A rate of deflection described by the equation

$$R = \frac{L^2}{9000d} \quad \text{in mm/min}$$

where L = the clear span, mm

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

Graphs showing deflection v time are included for each test.

Once the heating period was terminated, the loads on the test assembly were removed and then reapplied 24 h later after the system had cooled back to ambient temperature.

4.1 Simply Supported Floor Beams Exposed to Fire on Three Sides

Reference is made to Figs. 3(a) and (b) showing longitudinal and vertical sections of a simply supported floor beam test assembly.

A non-structural grade of concrete (density ~2240 kg/m^3) was cast onto the upper flange of the test beam to provide a cover slab nominally 650 mm wide x 135 mm thick. This was usually segmented into four units which were held in position by thin gauge steel tangs previously welded to the beam and cast into the concrete. The concrete was allowed to dry out to remove excess moisture prior to testing.

For testing, the beam was positioned in the furnace roof on the roller bearing supports so that the ends were free to move without any restraining action being applied.

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* Unless otherwise stated, all the loads were calculated using elastic design in accordance with BS449.

The loads applied to a simply supported floor beam were calculated as follows:-

Steel size : 406 x 178 mm x 60 kg/m universal beam
Steel quality : BS4360:Grade 43A:1979

Actual dimensions and properties of the floor beam:

Depth of section	(D) = 403 mm
Width of section	(B) = 174 mm
Thickness of flange	(T) = 12.83 mm
Thickness of web	(t) = 8.28 mm
Mass	(m) = 59.8 kg/m
Moment of inertia (x-x)	(I) = 20 706 cm^4
Distance of neutral axis to the base of beam	(y) = 201.5 mm
Effective span of the beam	(L) = 4500 mm

Maximum allowable bending stress to BS449:Part 2:1969, Table 2

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

Maximum bending stress required during the test

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

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

Therefore $w = \frac{8fI}{yL^2}$ = load per metre run (units converted to kN/m)

$$= 66.984 \text{ kN/m}$$

Concrete cover slab:

Depth	= 125 mm
Width	= 665 mm
Mass	= 1.827 kN/m

Total self weight of beam and concrete cover slab

$$= 2.413 \text{ kN/m}$$

Imposed load to produce required bending stress

$$= 66.984 - 2.413 \text{ kN/m}$$

$$= 64.571 \text{ kN/m}$$

Therefore total imposed load = 290.57 kN

Using four point loads at $^1/8$, $^3/8$, $^5/8$ and $^7/8$ span equivalent to $\frac{wL}{4}$

Loads applied = 72.64 kN

4.2 Simply Supported Floor Beams Exposed to Fire on Three Sides with Composite Action Between the Steel and Conrete Cover Slab

Two tests are reported in which the concrete slab prepared on the upper flange of the beam was cast in reinforced concrete around shear studs welded to the beam. This provided composite action between the steel and concrete.

Reference is made to Figs. 4(a) and (b) showing longitudinal and vertical sections of the test assembly which was designed following the recommendations of CP117:Part 1:1965.

32 shear studs, 75 mm long x 19 mm diameter were welded in two rows along the upper flange of a 254 x 146 mm x 43 kg/m universal beam section to provide the composite action between the steel and concrete. B503 reinforcing mesh was located nominally 35 mm from the upper surface of the flange with any joints overlapping on either side of a shear stud. The size of the mesh measured 200 x 100 mm x a bar diameter of 8 mm, and was placed with the 100 mm bar spacing transverse to the longitudinal axis of the test beam.

The floor slab was cast as two units using concrete supplied to CP110:Part 1:Grade 30:1972 and having a 2 inch slump. Finally an anti-crack chicken wire mesh was incorporated nominally 10 mm below the upper concrete surface.

The design of the shear studs and reinforcement were determined as follows:-

Data Used in the Calculations

Concrete slab:

Width	= 635 mm
Depth	= 135 mm
Cube strength	= 30 N/mm^2

Steel beam:

Depth of section	(D)	= 257 mm
Width of section	(B)	= 146 mm
Flange thickness	(T)	= 12.6 mm
Web thickness	(t)	= 7.6 mm
Area of section	(A)	= 55.1 cm^2
Yield stress, min	(σ_y)	= 255 N/mm^2

Moment capacity = 257.2 kN (factored) (1)

Load on concrete = 1143 kN

Design of Shear Studs

Try 19 mm diameter headed studs 75 mm high

Design load per stud = 76.2 kN (CP117)

Number of studs required on each half span

$$= \frac{1143}{76.2} = 15 \text{ (use 8 pairs)}$$

Length of beam = 4535 mm

Spacing of studs = 283 mm

Design of Transverse Reinforcement

CP117 specifies a method of sizing:

For low yield bar A_t = 4.71 cm^2/m run.

For high yield bar A_t = 2.61 cm^2/m run

Therefore use either:-

low yield bar, 10 mm diameter at 150 mm spacing, or,
high yield bar, 8 mm diameter at 150 mm spacing.

Design of Top Reinforcement

Use A142 mesh or equivalent.

Two identically prepared assemblies were tested. One was loaded as for a simply supported BS4360:Grade 43A beam according to BS449:Part 2:1969, and

ignoring any contribution to the stength and stiffness of the beam by the composite action. The second assembly was loaded taking the composite action into account following CP117:Part 1:1965, and using a load factor of 1.75 in the calculations.

Details of the loading calculations for the two beams are as follows:-

Simply supported floor beam - composite action is ignored.

Section size : 254 x 146 mm x 43 kg/m universal beam
Steel quality : BS4360:Grade 43A:1979

Actual dimensions and properties of the floor beam:

Depth of section	(D) = 257 mm
Width of section	(B) = 146 mm
Thickness of flange	(T) = 12.45 mm
Thickness of web	(t) = 7.08 mm
Mass	(m) = 41.6 kg/m
Moment of inertia (x-x)	(I) = 6177.7 cm^4
Distance of neutral axis to the base of beam	(y) = 128.5 mm
Effective span of the beam	(L) = 4530 mm

Maximum allowable bending stress to BS449:Part 2:1969, Table 2

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

Maximum bending stress required during the test (ignoring any composite action)

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

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

Therefore $w = \frac{8fI}{yL^2}$ = load per metre run (units converted to kN/m)

$$= 30.925 \text{ kN/m}$$

Concrete slab:

Depth	= 130 mm
Width	= 632 mm
Mass	= 1.834 kN/m

Total self weight of beam and concrete slab

$$= 2.242 \text{ kN/m}$$

Imposed load to produce required bending stress

$$= 30.925 - 2.242 \text{ kN/m}$$

$$= 28.683 \text{ kN/m}$$

Therefore total imposed load = 129.93 kN.

Using four point loads at $^1/8$, $^3/8$, $^5/8$ and $^7/8$ span, equivalent to $\frac{wL}{4}$

Loads applied = 32.47 kN

The proportion of the applied loads to the working load of the composite beam can be calculated as follows:-

Modular ratio = 15
Moment capacity = 247.2 kN m
Load in concrete = 1113 kN
Section modulus = 756 cm^3
Load factor = 1.75

Steel stess at working load $= \frac{247.2}{1.75} \times \frac{10^3}{756}$ N/mm^2

$= 187\ N/mm^2$

Applied moment $= \frac{165}{10^2} \times \frac{6178}{128.5}$ kN m

$= 79.33$ kN m

Steel stress at applied moment $= \frac{79.33 \times 1.75 \times 187}{247.2}$ N/mm^2

$= 105\ N/mm^2$

Therefore proportion of full load applied

$$= \frac{105\ N/mm^2}{187\ N/mm^2} = 0.56$$

Alternatively, proportion of full stress based upon the beam only

$$= \frac{105\ N/mm^2}{165\ N/mm^2} = 0.64$$

Simply supported floor beam - composite action taken into account.

Section size : 254 x 146 mm x 43 kg/m universal beam
Steel quality : BS4360:Grade 43A:1979.

Actual dimensions and properties of the floor beam:

Depth of section	(D) = 257 mm
Width of section	(B) = 146 mm
Thickness of flange	(T) = 12.6 mm
Thickness of web	(t) = 7.57 mm
Mass	(m) = 41.6 kg/m
Moment of inertia (x-x)	(I) = 6284.7 cm^4
Distance of neutral axis to the base of beam	(y) = 128.5 mm
Effective span of the beam	(L) = 4530 mm

Concrete slab:-

Width = 642 mm
Depth = 130 mm
Mass = 1.834 kN/m

Moment capacity = 257.2 kN m (factored)[1]

Required bending moment, $\frac{wL^2}{8}$ $= 257.2 \times \frac{1}{1.75}$

$= 146.97$ kN m

Therefore load per metre run, w, = 57.296 kN/m

Total self weight of beam and concrete slab

$= 2.242$ kN/m

Imposed load to produce required bending moment

= 57.296 - 2.242 kN/m

= 55.054 kN/m

Therefore total imposed load = 249.40 kN

Using four point loads at $^1/8$, $^3/8$, $^5/8$ and $^7/8$ span, equivalent to $\frac{wL}{4}$

Loads applied = 62.36 kN

4.3 Floor Beams Exposed to Fire on Three Sides with Applied Rotational End Restraining Moments

In Section 4.1, fire tests are described in which floor beams were tested as simply supported members without any restriction on movement being made at the ends. The tests reported in this section show the influence of either variable or constant applied rotational end restraining moments on the fire resistance of floor beams when exposed to fire on three sides. Descriptions of each test assembly are given below together with examples of the loading calculations.

4.3.1 Variable Rotational End Restraint

Figures 5(a), (b) and (c) show longitudinal and vertical sections of the steel beam assembly designed for variable rotational end restraint.

The steel beam provided for a test was extended by welding 0.8 m lengths of the same section size onto each end, using flange and web stiffeners at the joints. In a similar manner described in the preparation of a simply supported floor beam, non-structural concrete (density ~2240 kg/m^3) was cast onto the upper flange to provide a segmented cover slab.

Once the concrete had dried out and the beam instrumented with thermocouples and strain gauges, the test assembly was mounted in the furnace roof on roller bearing supports set 4500 mm apart. The beam projected beyond the furnace at each end by approximately 1 m.

The ends of the beam were bolted to the restraining frame and prior to loading, the fastenings were adjusted for zero restraint. Initially the beam was loaded as for a simply supported member, using jacks applied at four points along the span to generate a maximum tensile stress of 165 N/mm^2 in the lower flange. From the strain gauge measurements, restraint against rotation occurred about the supports equivalent to a tensile stress of 15% of that for the simply supported condition. Therefore, to restore a maximum bending stress of 165 N/mm^2 at mid-span, the applied loads were increased by a further 15%.

During the actual fire test, the restraint at the ends of the beam was allowed to change naturally until a deflection of 90 mm (L/50) was achieved at mid-span, at which time the applied loads were reduced to those normally applied for a fully stressed simply supported member. The test continued until the deflection attained 150 mm (L/30).

Details of the loading calculations are as follows:-

Section size : 254 x 146 mm x 43 kg/m universal beam
Steel quality : BS4360:Grade 43A:1979

Actual dimensions and properties of the floor beam:

Depth of section	(D) = 254 mm
Width of section	(B) = 145 mm
Thickness of flange	(T) = 12.61 mm
Thickness of web	(t) = 7.57 mm
Mass	(m) = 42.4 kg/m
Moment of inertia (x-x)	(I) = 6087.3 cm^3
Distance of neutral axis to the base of beam	(y) = 127 mm

Effective span of the beam (L) = 4500 mm

Maximum allowable bending stress to BS449:Part 2:1969, Table 2

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

Required bending stress based upon a simply supported member

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

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

Therefore $w = \frac{8fI}{yL^2}$ = load per metre run (units converted to kN/m)

$$= 31.244 \text{ kN/m}$$

Concrete cover slab:

Depth	= 130 mm
Width	= 635 mm
Mass	= 1.814 kN/m

Total self weight of beam and concrete cover slab

$$= 2.230 \text{ kN/m}$$

Imposed load to produce required bending stress

$$= 31.244 - 2.230 \text{ kN/m}$$

$$= 29.014 \text{ kN/m}$$

Therefore total imposed load = 130.56 kN

Using four points loads at $^1/8$, $^3/8$, $^5/8$ and $^7/8$ span, equivalent to $\frac{wL}{4}$

Loads applied = 32.64 kN

When end restraint is applied at each end of a simply supported beam, the load required to produce a working stress of 165 N/mm^2 must be increased to maintain this stress.

Therefore with end restraint at 15% then the new load per metre run

$$w = 31.244 + 0.15\ (31.244) \text{ kN/m}$$

$$= 35.934 \text{ kN/m}$$

Imposed load required = 35.934 - 2.230 (beam + concrete) kN/m

$$= 33.704 \text{ kN/m}$$

Therefore total imposed load = 151.67 kN

Using four point loads at $^1/8$, $^3/8$, $^5/8$ and $^7/8$ span, equivalent to $\frac{wL}{4}$

Loads applied = 37.92 kN

4.3.2 Constant Rotational End Restraint

Figures 6(a), (b) and (c) show longitudinal and vertical sections of the floor beam assembly designed so that the restraining moments applied at the ends could be held constant during a test.

In these tests, the length of beams supplied enabled approximately 1 m at each

end to project outside the furnace over which the end restraining moments could be applied. A non-structural grade of concrete (density ~2240 kg/m^3) was cast on to the upper flange over the central 4500 mm portion of the beam, to provide a cover slab as described previously in Section 4.1

Once the concrete had dried out and the beam instrumented, the test assembly was mounted centrally in the furnace roof on roller bearing supports set 4500 mm apart. Each end of the steel beam was held in a cradle arrangement containing a load cell and hydraulic jack. These were fixed to the external restraining frame surrounding the furnace and set at a distance of 0.715 m outside the supports.

Prior to testing, the beam was loaded through the concrete at four points viz, $^1/8$, $^3/8$, $^5/8$ and $^7/8$ span. The applied loads were calculated for a simply supported beam, i.e. equivalent to maximum bending stresses up to 165 and 230 N/mm^2 for Grades 43 and 50 steels respectively. Depending upon the degree of rotational end restraint required, external loads were also applied through the cradle arrangements to provide the necessary bending moments over the supports.

During the fire tests all the loads were held constant until the vertical deflection at mid-span attained L/30.

Details of the load calculations are as follows:-

Section size : 254 x 146 mm x 43 kg/m universal beam
Steel quality : BS4360:Grade 43A:1979.

Actual dimensions and properties of the floor beam:

Depth of section	(D) = 256 mm
Width of section	(B) = 147 mm
Thickness of flange	(T) = 12.47 mm
Thickness of web	(t) = 7.05 mm
Mass	(m) = 41.7 kg/m
Moment of inertia (x-x)	(I) = 6165.2 cm^4
Distance of neutral axis to the base of beam	(y) = 128 mm
Effective span of the beam	(L) = 4530 mm

Maximum allowable bending stress to BS449:Part 2:1969, Table 2

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

Required bending stress based upon a simply supported member

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

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

Therefore $w = \frac{8fI}{yL^2}$ = load per metre run (units converted to kN/m)

$$= 30.983 \text{ kN/m}$$

Concrete cover slab:

Depth	= 130 mm
Width	= 630 mm
Mass	= 1.800 kN/m

Total self weight of beam and concrete cover slab

$$= 2.209 \text{ kN/m}$$

Imposed load to produce required bending stress

= 30.983 - 2.209 kN/m

= 28.774 KN/m

Therefore total imposed load = 130.35 kN

Using four point loads at $^1/8$, $^3/8$, $^5/8$ and $^7/8$ span, equivalent to $\frac{wL}{4}$

Loads applied = 32.59 kN

Rotational end restraint:

Central bending moment of a simply supported beam

$$\frac{wL^2}{8} = 73.809 \text{ kN m}$$

where w = 30.983 kN m

L = 4.530 m

Rotational end restraint required ≡ 30% of of the bending moment of a simply supported beam (without end restraint).

This is achieved by applying loads at the ends of the beam to generate end moments over the roller bearing supports equivalent to 30% of the central moment.

Therefore end moments required = 30% of 73.809 kN m

= 22.143 kN m

Distance between the roller bearing supports and applied end loads

= 0.715 m

Therefore applied end loads = 30.97 kN

4.4 Floor Beams Exposed to Fire on Three Sides with Applied Rotational End Restraining Moments and Longitudinal Thermal Restraint

In Section 4.3.2 fire tests on floor beams are described in which additional loads were applied outside the furnace on extended members to provide rotational end restraining moments over the supports. This approach has been extended so that restraint was provided by restricting longitudinal thermal expansion as well as applying the end moments over the supports.

In addition to the furnace frame providing a reaction for the end moments, a second steel 'picture frame' was constructed around the furnace roof, level with the test beam as shown schematically in Fig. 7(a). This was fabricated by bolting 254 x 254 mm x 73 kg/m universal column sections to 914 x 305 mm x 224 kg/m universal beam sections.

A segmented non-structural concrete cover slab (density ~2240 kg/m^3) was cast onto the upper flange along the beam's 4500 mm long central portion and allowed to dry out prior to testing. Apart from instrumenting the beam with thermocouples, strain gauges were also attached to those parts located outside the furnace. As before, the test assembly was mounted in the furnace roof on roller bearing supports set nominally 4500 mm apart and with the ends of the beam positioned inside the thermal restraining frame. Shims were used to take up any clearance gaps. Between the furnace supports and the thermal restraining frame each end of the beam was also held in a cradle arrangement housing a load cell and hydraulic jack, see Fig. 7(b). This was fixed to the separate restraining frame surrounding the furnace and as described in the

previous section, was used to apply and maintain constant rotational end restraining moments over the supports.

Prior to testing, the beam was loaded through the concrete at four points, viz, $^1/_8$, $^3/_8$, $^5/_8$ and $^7/_8$ span. The applied loads were calculated for a simply supported beam, i.e. equivalent to maximum bending stresses up to 165 and 230 N/mm^2 for Grades 43 and 50 steels respectively. Depending upon the degree of rotational end restraint required, external loads were also applied through the cradle arrangements to provide the necessary bending moments over the supports.

During the fire test all the loads were held constant until the heating period was terminated, when the vertical deflection at mid-span attained L/30. The load calculations were identical to those already described in Section 4.3.2 for a floor beam with applied constant rotational end restraining moments.

4.5 Simply Supported Shelf Angle Floor Beams

Reference is made to Figs. 8(a) and (b) showing the plan view and vertical cross section of a shelf angle floor beam test assembly.

A shelf angle floor beam was fabricated by bolting 125 x 75 mm x 12 mm thick steel angles through the shorter leg, onto each side of the web of the beam. Grade 8.8, M20 size bolts were generally used throughout and these were spaced at 600 mm centres. The position of the angles with respect to the beams upper flange was governed by the thickness of the precast units to be placed on the angles, with an additional clearance gap of nominally 10 mm being allowed between the underside of the top flange and the unexposed surface of the concrete. Once fabricated, the beam and angles were instrumented with thermocouples to provide detailed heating data during the test.

The beam assembly was mounted in the furnace roof on roller bearing supports set nominally 4500 mm apart. A series of 16 (8 each side) reinforced precast concrete floor units, nominally 1550 mm long x 550 mm wide, were positioned to span between the furnace side walls and the shelf angle floor beam. Each unit utilised a minimum 75 mm load bearing length on the shelf angles thereby leaving a gap of approximately 50 mm between the ends of the units and the section's web. A gap of 12 mm was also left between the units and the end walls to allow uninterrupted movement for when the beam deflected vertically during the test. Ceramic fibre was used to cover the gaps to prevent undue heat loss.

The precast reinforced units used in these tests were manufactured either as a uniform 200 mm deep section, or a 150 mm deep section with a 50 mm x 300 mm long taper at one end which fitted into the steel beam. Design details for the two units are shown in Figs. 9(a) and (b). Note that given in the notes for each of the relevent data sheets is the height of the exposed steel measured from the underside of the beams lower flange to the underside of the concrete floor units.

Normal site practice entails laying a floor screed over the shelf angle floor and therefore to simulate similar thermal characteristics, dry sand was used to fill the 50 mm gap between the slab ends and the beam, and to provide a 25 mm cover over the upper flange.

Unlike the floor beam tests described previously, a shelf angle floor beam was loaded through the concrete units 0.5 m from its centreline. This was achieved by applying loads using hydraulic jacks at eight points ($^1/_8$, $^3/_8$, $^5/_8$ and $^7/_8$ span on each side) onto 1 m lengths of 152 x 152 mm universal column section to act as load spreaders.

The fire test procedures were carried out in a similar manner to other floor beam tests. However, at the time the tests were conducted, it was the intention to incorporate Ammendment 4822 (May 1985) into BS476:Part 8 and therefore, several tests were allowed to proceed until the vertical deflection at mid-span attained L/20.

Details of the load calculations are as follows in which reference is made to Fig. 10:-

Section Size	Steel Quality
406 x 178 mm x 54 kg/m universal beam	BS4360:Grade 43A:1979
125 x 75 x 12 mm x 17.8 kg/m angle	BS4360:Grade 50B:1979

Nominal dimensions and properties of the floor beam:

Depth of section	(D) = 402.6 mm
Width of section	(B) = 177.6 mm
Thickness of flange	(T) = 10.9 mm
Thickness of web	(t) = 7.6 mm
Mass	(m) = 54 kg/m
Moment of inertia (x-x)	(I) = 18626 cm^4
Distance of neutral axis to the base of beam	(y) = 201.3 mm
Effective span of beam	(L) = 4500 mm

Maximum allowable bending stress to BS449:Part 2:1969, Table 2

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

Required bending stress based upon a simply supported member

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

Therefore safe working load, wL, $= \frac{8fI}{yL}$

$$= 271.4 \text{ kN}$$

Note: Any contribution made by the angles towards the moment capacity of the beam is ignored.

Operating load required = 271.4 kN

Self weight of beam and sand = ~5.5 kN

Therefore total force required to act through the angles

= 265.9 kN

Forced required to act through each angle

= 133.0 kN

Self weight of concrete units and load spreaders

= ~72 kN

Reaction on each angle $= \frac{72}{2} \times \frac{1}{2} = 18$ kN

Imposed force required on each angle to produce working stress in test beam

= 115.0 kN

Load required on each side of the test beam 0.5 m from its centreline (see Fig. 10)

$$= 115 \times \frac{1.460}{1.052} \text{ kN}$$

$$= 159.6 \text{ kN}$$

Load required by each jack = 39.90 kN

4.6 Simply Supported 'Slim' Floor Beams

Figures 11(a) and (b) show the plan view and vertical cross section of a simply supported 'slim floor' beam test assembly.

A 'slim' floor was prepared by mounting a 5 m long 254 x 254 mm universal column section instrumented with thermocouples in the furnace roof on roller bearing supports set 4500 mm apart. Using a similar arrangement to a shelf angle floor beam, two rows of precast, concrete floor units were placed to span between the furnace walls and the upper face of the column's lower flange. The concrete units were supplied either by Richard Lees Ltd. as standard prestressed 'Spiroll' hollow units, 1550 mm long x 550-590 mm wide x 200 mm deep, or, as solid reinforced concrete units, 1550 mm long x 550 mm wide x 200 mm deep. Their design details are given in Figs. 12(a) and (b) which shows one end of the hollow units having a 100 mm x 250 mm long taper. This end was located in the steel column between the flanges.

In constructing the 'slim' floor, the concrete units utilised a minimum load bearing length of 75 mm on the columns' lower flange which left a gap of approximately 48 mm between the tapered edge and the section's web. A 12 mm gap was also left at each end of the column between the concrete units and the furnace walls to allow uninterrupted movement as the member deflected vertically during the test. This was covered with ceramic fibre to prevent undue heat loss.

Finally to simulate the thermal characteristics of a floor screed, the construction was completed by placing sand in the void between the floor units and column section as well as over the upper flange of the section itself.

A 'slim' floor was loaded in an identical manner to a shelf angle floor in which eight hydraulic jacks (four on each side) applied loads at $^1/_8$, $^3/_8$, $^5/_8$ and $^7/_8$ span onto 1 m long load spreaders. These were set 0.5 m from the centreline of the beam.

The loading applied to a slim floor test assembly was calculated as follows:- Initially the hydraulic loads required to generate near maximum permissible bending stresses in the member's lower flange were estimated. These were then used to accurately calculate the total stresses in the system by specifically defining the longitudinal bending stresses and secondary stresses acting in the lower flange.

Section size : 254 x 254 mm x 89 kg/m universal column
Steel quality : BS4360:Grade 43A:1979

Nominal dimensions and properties of the floor beam:

Depth of section	(D) = 260.4 mm
Width of section	(B) = 255.9 mm
Thickness of flange	(T) = 17.3 mm
Thickness of web	(t) = 10.5 mm
Mass	(m) = 89 kg/m
Moment of inertia (x-x)	(I) = 14307 cm^4
Distance of neutral axis to the base of beam	(y) = 130.2 mm
Effective span of beam	(L) = 4500 mm

Maximum allowable bending stress to BS449:Part 2:1969, Table 2

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

Required bending stress based upon a simply supported member

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

Therefore safe working load, wL, $= \frac{8fI}{yL}$

$$= 322.3 \text{ kN}$$

Operating load required = 322.3 kN

Self weight of column and sand = ~5.5 kN

Therefore total force required to act through the lower flanges

= 316.8 kN

Force required to act through each flange

= 158.4 kN

Self weight of concrete and load spreaders

= ~72 kN

Reaction on each flange $= \frac{72}{2} \times \frac{1}{2}$ = 18 kN

Imposed force required on each flange to produce working stress in member

= 140.4 kN

Estimate of loads required to generate near maximum working stresses in the 'slim' floor member taking into account local bending and shear stresses in the lower flange = 171 kN (applied on either side at a distance of 0.5 m from its centreline).

Load required by each jack = 42.75 kN

Calculation of actual stress produced:-

Force on each flange due to imposed load (see Fig. 13)

$$= 171 \times \frac{1.050}{1.461} = 122.9 \text{ kN}$$

Force on each flange due to dead load (concrete + load spreaders)

= 18 kN

The manner in which the concrete units rest on the lower flanges can be considered either, as a uniformly distributed load (UDL) over the bearing length, or, as a point load of contact. Both cases are analysed:

(a) UDL Case

Compressive bending stress/flange due to imposed load $\left(\frac{M}{Z}\right)$

$$= \frac{122.9 \times 72 \times 6 \times 1000}{4.5 \times 1000 \times (17.3)^2} = -39.4 \text{ N/mm}^2$$

Compressive bending stress/flange due to dead load $\left(\frac{M}{Z}\right)$

$$= \frac{18 \times 72 \times 6 \times 1000}{4.5 \times 1000 \times (17.3)^2} = -5.8 \text{ N/mm}^2$$

Total (σ_2) = -45.2 N/mm^2

Longitudinal stress at mid-span (σ_1) = $\frac{wyL^2}{8I}$

$$= \frac{\left\{\frac{287.3 \times 1000}{4500}\right\} \times 130.2 \times (4500)^2}{8 \times 14\ 307 \times 10^4}$$

$= 147.1\ N/mm^2$

Therefore combined stress on lower flange

$$\sigma = \frac{1}{\sqrt{2}} [(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2]^{\frac{1}{2}}$$

$$= 0.707 [(192.3)^2 + (45.2)^2 + (147.1)^2]^{\frac{1}{2}}$$

$$= \underline{174.1\ N/mm^2}$$

(b) Point Load Case

Compressive bending stress/flange due to imposed load $\left(\frac{M}{Z}\right)$

$= -18.6\ N/mm^2$

Compressive bending stress/flange due to dead load $\left(\frac{M}{Z}\right)$

$= -2.7\ N/mm^2$

Total $(\sigma_2) = -21.3\ N/mm^2$

Longitudinal stress at mid-span (σ_1)

$= 147.1\ N/mm^2$

Therefore combined stress on lower flange

$$\sigma = \frac{1}{\sqrt{2}} [(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2]^{\frac{1}{2}}$$

$$= 0.707 [(168.4)^2 + (21.3)^2 + (147.1)^2]^{\frac{1}{2}}$$

$$= \underline{158.8\ N/mm^2}$$

From the above analyses, the loads applied to the floor assembly produced a maximum stress in the member's lower flange of either 174.1 N/mm^2 or 158.8 N/mm^2 depending upon the assumed area of contact between the concrete units and the steel. These represent 105.5% and 96.2% respectively of the maximum permissible load according to BS449:1969.

5. DESIGN, CONSTRUCTION AND TEST PROCEDURES FOR COLUMNS

The design and construction of column test assemblies are given below and briefly cover the general arrangement and procedures common to all the tests. However, as an exception, one international test sponsored by Arbed SA in Belgium on a particulary heavy HD column section has been included.

All the UK column tests reported were conducted at FIRTO, Borehamwood. For illustrative purposes, Figs. 14(a) and (b) show a bare column positioned in the furnace prior to testing and a similar column section but with its web blocked in, after a completed test.

A test specimen was prepared by welding steel plates, 406 x 406 mm x 19 mm thick onto each end of a 3.64 mm long column section. This was mounted vertically on a similar steel plate which formed the base of the loading frame. Concrete caps were cast around both ends to leave a 3.00 m length of section

exposed to the fire. The caps were used solely as a means of closing the furnace ends and were not reinforced.

In addition to the requirements of the testing station, the column was instrumented with 3 mm diameter mineral insulated sheath thermocouples to obtain detailed temperature profiles across the section at various times during the test. The locations and temperature data recorded from the thermocouples are given for each individual test in Appendix A.

Generally, the flange temperatures were measured at the 1/4 width position (i.e., midway between the flange tip and the centreline of the web), whereas the web temperatures were usually measured at the centre position between the two flanges. In each case the thermocouple ends were placed in holes predrilled to mid-thickness thereby ensuring bulk steel temperatures were always measured.

A split vertical furnace was positioned around the column and its temperature rise measured and controlled to follow the ISO heating curve using six thermocouples. These were located symmetrically inside the furnace with their hot junctions located 100 mm from the column. During the test the vertical deflection of the column was measured by a displacement transducer.

Prior to lighting the furnace, a column was loaded by hydraulic jacks for which the applied loads were calculated in accordance with BS449:Part 2:1969. Since the column was effectively held in position and restrained in direction by the loading system end fixity was assumed, and therefore, in calculating the axial loadings an effective length of 0.7L was adopted.

Within BS476:Part 8:1972, the fire resistance of a column is judged by its compliance with the criterion for stability only, and therefore a fire test is terminated at any time up to the point when the axial load can no longer be maintained. At the end of the heating period, the load was removed and then reapplied 24 h later when the test specimen had returned back to ambient temperature.

5.1 Column Exposed on Four Sides (UK Tests)

Figure 15 shows the test arrangement for a steel column exposed to fire on four sides. The test procedures have already been described in Section 5 and therefore the applied loads were calculated as follows:

Section size : 203 x 203 mm x 52 kg/m universal column
Steel quality : BS4360:Grade 43A:1979

Dimensions and properties of the column:

Depth of section	(D)	= 204.5 mm
Width of section	(B)	= 204.0 mm
Thickness of flange	(T)	= 12.5 mm
Thickness of web	(t)	= 8.0 mm
Radius of gyration	(r_{yy})	= 5.16 cm
Area of cross section	(A)	= 66.4 cm^2
Exposed column length	(L)	= 300 cm
Effective column length	(l)	= 0.7 x L = 210 cm
Slenderness ratio	(l/r_{yy})	= $\frac{210}{5.16}$ = 40.69 (41 assumed)

Maximum allowable axial stress to BS449:Part 2:1969, Table 17(a)

$$P_c = 138 \text{ N/mm}^2$$

Therefore maximum permissible load = P_c x A (units converted to kN)

= 916 kN

Load applied = 550 kN (60% of maximum permissible load)

5.1.1 Columns Exposed on Four Sides (International Test)

The result of one test conducted at the fire station at Ghent Univeristy, Belgium, and sponsored by Arbed SA is reported. This was carried out on a particularly heavy 400 x 400 x 744 kg/m HD section following the test procedures given in ISO:834.

One notable difference of this test compared to those conducted in the UK, is the testing of columns in pairs with the loading applied eccentrically through the flanges, see Fig. 16.

5.2 Columns with Blocked in Webs Exposed to Fire on Four Sides

A description has already been given of the construction and test procedures for an unprotected steel column exposed on four sides, and therefore the following information principally covers details concerning the protection of the web of the section by lightweight aerated pulverised fuel ash (pfa) blockwork.

Figures 17(a) and (b) show the general arrangement for a steel column exposed on four sides with its web protected by blockwork.

Blocks of lightweight aerated pfa were built between the column flanges to protect the web over its entire exposed length. Depending upon the manufacturer, the blocks were supplied to the following dimensions; 440 x 290 x 100 mm or 450 x 225 x 100 mm. These were cut to fit into the web with a standard mortar joint. No mechanical fixing was used to tie the blockwork into the steel. A 13 mm gap lightly filled with ceramic fibre, was left at the top of the construction between the blockwork and the concrete cap to ensure that the former remained non-load bearing during the test.

Prior to testing, time was given for the mortar to dry and for the blockwork to condition itself to the environmental conditions inside the testing station. On the day of the test, both the oven dry density and moisture content from a sample of blockwork were determined.

The axial loads applied to a column were calculated as follows:

Section size : 203 x 203 mm x 46 kg/m universal column
Steel quality : BS4360:Grade 43A:1979

Dimensions and properties of the column:

Depth of section	(D)	= 203.0 mm
Width of section	(B)	= 202.0 mm
Thickness of flange	(T)	= 10.5 mm
Thickness of web	(t)	= 7.0 mm
Radius of gyration	(r_{yy})	= 5.11 cm
Area of cross section	(A)	= 58.8 cm^2
Exposed column length	(L)	= 300 mm
Effective column length	(l)	= 0.7 x L = 210 cm
Slenderness ratio	(l/r_{yy})	= $\frac{210}{5.11}$ = 41.09

Maximum allowable axial stress to BS449:Part 2:1969, Table 17(a) (for the steel column only) P_c = 138 N/mm^2

Therefore maximum permissible load = p_c x A (converting units to kN)

= 811 kN

Load applied = 811 kN

6. DESIGN, CONSTRUCTION AND TEST PROCEDURES FOR COLUMNS AND BEAMS BUILT INTO CAVITY WALLS

The following section covers fire resistance tests on vertical separating elements carried out at FIRTO, Borehamwood. These consisted of universal columns or beams built into a cavity wall construction so that either one flange or a flange + part of the web from each section, was exposed to the fire.

Figure 18 schematically illustrates the type of construction under evaluation and in Figs. 19(a)-(e), photographs show the steelwork during fabrication as well as the exposed and unexposed wall surfaces before and after a test.

Details covering the two systems are given individually and therefore the following description is a summary of the test procedures common to all the wall tests.

A wall structure measuring at least 2.5 m high x 2.5 m long was constructed on a concrete base which was embedded in a loading frame placed in front of the furnace. In constructing a wall, care was taken to prevent any restraint ocurring around the edges by leaving clearance gaps lightly packed with mineral fibre. The ISO heating curve was monitored and controlled via sixteen thermocouples positioned symmetrically in the furnace. These were located so that their hot junctions were situated 100 mm from the exposed wall face. In addition, heat transmitted through the wall was measured by seven thermocouples fixed to the unexposed surface on to copper discs which were then covered by non-asbestos mill board pads.

Any horizontal movement perpendicular to the wall structure occurring during a test, was measured at mid-height. This was achieved by two displacement transducers connected by wire to steel rods protruding through the brick wall and welded to the columns. The mean longitudinal extension in the wall was also measured by displacement transducers fitted at each end of the cross-head.

In addition to the thermocouples placed around the wall assembly by the testing station, 3 mm diameter mineral insulated sheath thermocouples were embedded into the steel columns to obtain temperature profiles across the sections at various height positions. These are identified on each of the Appendix sheets. Generally, the flange temperatures were measured at the $^1/_4$ width position (i.e. mid-way between the flange tip and the centreline of the web), whereas the temperatures in the web were measured at various locations depending on the construction. However, in each case the thermocouple ends were placed in holes predrilled to mid-thickness thereby ensuring bulk steel temperatures were always measured.

The wall structure was loaded through the end plate welded to the steel sections and maintained for the duration of the test. Once the heating period was terminated, the loads were removed and then reapplied 24 h later when the test assembly had cooled back to ambient temperature.

The fire resistance of a load bearing separating element is determined from when the test is terminated or when failure occurs under any one of the following criteria; stability, integrity and insulation.

6.1 Columns in Walls

Reference is made to Figs. 20(a)-(c) showing the general arrangements for the wall construction.

End plates, 406 mm square x 20 mm thick were welded to a pair of 2.92 m long 203 x 203 mm x 52 kg/m universal column sections. These in turn were welded or bolted to two steel plates 3050 x 580 mm x 20 mm thick to form a frame with the columns at 1.02 m centres, and positioned equidistant from the centre width of the assembly.

A concrete slab, 2050 x 580 mm x 250 mm thick was cast on top of the bottom steel plate around the columns bases. This slab had a nominal density of 2210 kg/m^3 and apart from an anti-cracking mesh, did not contain any reinforcement. A 3.08 m long x 2.68 m high cavity wall with an overall thickness of 250 mm was

built up from the concrete base. This comprised a 102 mm thick fletton brick wall located 12 mm from one of the outside faces of the steel columns, a 50 mm cavity and a second wall 100 mm thick built using aerated pulverised fuel ash concrete blocks which abutted up to the columns' webs. Butterfly wire wall ties (3.2 mm diameter) held the two wall leaves together and six were evenly spaced on every sixth cours of fletton bricks. Throughout the construction a 1:6 ordinary mortar mix with an added plasticiser was used.

Between the top steel plate and the wall construction, a 30 mm gap was left to ensure that the load was only carried by the columns. Gaps approximately 40 mm wide were also left between the wall's vertical edges and the loading rig to prevent any restraining action. All the gaps were lightly filled with mineral wall. On the blockwork (fire) side, mineral fibre was fitted around the top of the specimen to protect the upper steel plate. This reduced the height of the exposed wall structure to 2.5 m.

Prior to testing, the wall structure was given a conditioning period to remove excess moisture from the mortar and blockwork.

The loads placed upon the wall constructions were calculated as tollows:

Section size : 203 x 203 mm x 52 kg/m universal column
Steel quality : BS460:Grade 43A:1979

Dimensions and properties of the columns:

Depth of section	(D)	= 206.2 mm
Width of section	(B)	= 203.9 mm
Thickness of flange	(T)	= 12.5 mm
Thickness of web	(t)	= 8.0 mm
Radius of gyration	(r_{xx})	= 8.90 mm
Radius of gyration	(r_{yy})	= 5.16 cm
Area of cross section	(A)	= 66.4 cm^2
Column length	(L)	= 300 cm (ignoring the concrete base)

The columns are regarded as being effectively held in position at both ends and restrained in direction at one end.

Therefore effective length (l) = 0.85 x L = 255 cm

Slenderness ratio (l/r_{xx}) = 28.65

Maximum allowable axial stress to BS449:Part 2:1969, Table 17(a)

$$P_c = 143.5 \text{ N/mm}^2$$

Therefore maximum permissible load per column

$= P_c \times A$ (converting units to kN)

= 953 kN

Total load applied = 953 kN (50% of maximum permissible load)

6.2 Columns and Beams in Walls with Blocked in Webs

Reference is made to Figs. 21(a)-(c) showing the general arrangement for the wall construction.

End plates 406 mm square x 20 mm thick were welded to a pair of 2.92 m long universal column or beam sections. These in turn were welded to two steel plates 3050 x 580 mm x 20 mm thick to form a frame with the members at 1.02 m centres, and positioned equidistant from the centre width of the assembly.

A concrete slab, 3050 x 580 mm x 250 mm thick was cast on top of the bottom steel plate around the members bases. The slab had a nominal density of 2210 kg/m^3 and apart from an anti-cracking mesh did not contain any reinforcement.

A cavity wall 3.08 m long x 2.68 m high with an overall thickness of 250 mm was built up from the conrete base. This comprised, a 102 mm thick fletton brick wall positioned approximately 25 mm from one of each of the column flanges, a 50 mm cavity and a second wall 100 mm thick built from aerated pfa concrete blocks. The blocks abutted up to the webs of the sections and a 12 mm mortar joint was also made between the blockwork and the inside face of the back (cavity) flanges. Butterfly wire wall ties (3.2 mm diameter) held the two wall leaves together and six were evenly spaced on every sixth course of fletton bricks. The space between the outer face of the blockwork wall and the exposed flanges was completely filled with blockwork and keyed into the wall to leave only the outer faces and edges exposed to fire. Throughout the construction a 1:6 ordinary mortar mix with an added plasticiser was used.

The remainder of the detailing was identical to that already described in Section 6.1.

The loadings placed upon the wall constructions were calculated as shown below. However, following the tests on columns in walls, described in Section 6.1, examination of the test behaviour indicated that alternative values regarding the effective length were more appropriate in the calculation procedures.

Section size : 203 x 203 mm x 52 kg/m universal column
Steel quality : BS4360:Grade 43A:1979

Dimensions and properties of the column:

Depth of section	(D)	= 206.2 mm
Width of section	(B)	= 203.9 mm
Thickness of flange	(T)	= 8.0 mm
Thickness of web	(t)	= 12.5 mm
Radius of gyration	(r_{xx})	= 8.90 cm
Radius of gyration	(r_{yy})	= 5.16 cm
Area of cross section	(A)	= 66.4 cm^2
Column height	(L)	= 300 cm (ignoring the concrete base)

Examination of the test behaviour suggests that:-

for the x-x axis the effective length factor = 1.0 to 1.2 (estimate)
for the y-y axis the effective length factor = 1.0.

Therefore effective length, l_{xx}, = L x 1.2 = 360 cm
and effective length, l_{yy}, = L x 1.0 = 300 cm

Slenderness ratio (l/r_{xx}) = 40.45

Slenderness ratio (l/r_{yy}) = 58.14

Hence y-y axis dominates collapse and the maximum allowable axial stress to BS449:Part 2:1969, Table 17(a).

p_c = 127 N/mm^2 (for l/r = 58)

Therefore maximum permissible load per column

= P_c x A (converting units to kN)

= 843.3 kN

Total load applied = 1686.6 kN

7. INDICATIVE TESTS

Indicative tests are reported on full size universal sections when heated in a column or floor furnace without the application of any loading. Further data is also given on short lengths of steel sections approximately 1 m long positioned in the floor furnace to simulate the effect of either heating a

floor beam exposed on three sides, or a column or beam exposed on four sides. For the former, the beams were bolted to the underside of the roof and projected at an angle towards the furnace centre from the corners, see Fig. 22, whereas the columns were generally placed upright along the furnace centreline on plinths, see Fig. 23. In addition, heating data were obtained for a universal beam section built into the wall of the 1 m cube indicative furnace at the Warrington Research Centre to simulate the conditions of a perimeter beam exposed only on one side, see Figs. 24(a) and (b).

In Appendix A data sheets are presented showing the type of test with detailed heating data across the profile of the section as the furnace atmosphere followed the ISO heating curve.

8. DATA ANALYSIS

Analysis of the data by staff of Swinden Laboratories of the British Steel Corporation has established several relationships between heating rate, member size, applied load and fire resistance for several types of load bearing elements. These are highlighted as follows:-

8.1 Section Factor (H_p/A) and Heating Rates for Unprotected Floor Beams and Columns

The H_p/A concept is widely used by fire engineers and fire protection designers to relate the size and shape of a member with its heating rate in both natural and standard fire test conditions. H_p is the heated perimeter of the member (m) and A is its cross section area (m^2). Values of H_p/A for hot rolled universal beams and columns manufactured by BSC are given in Table 3. Therefore for a particular element of construction a section rolled with thick flanges and web will under the same fire conditions, heat up more slowly than a light section which has relatively thin flanges and web.

While the relationships between heating and H_p/A are not exact due to, for example, members having dissimilar radiation view factors but identical values of H_p/A, Figs. 25 and 26 present heating curves for a range of section factors covering universal beam and column sizes currently manufactured by BSC. In Fig. 25, the heating curves relate to the lower flanges of floor beams exposed to fire on three sides, whereas those given for Fig. 26 are the mean between the two flanges and web when the columns are fully exposed to fire on four sides.

8.2 Fire Resistance of Simply Supported Floor Beams

The fire resistance of simply supported floor beams covering the entire range of BSC sections available cannot be evaluated in existing test facilities. They can however, be calculated using finite element computer models and checked against limited experimental data. In view of the limitations in terms of span, size and loading of steel members in the fire test furnaces, data obtained from the tests reported have been used in conjunction with the computer model, FASBUS II, to extrapolate beyond the scope of full scale testing.

FASBUS II is a finite element model developed by Messrs. Bressler and Iding of Weiss, Janney Elstner and Associates for predicting the behaviour of floors in fire by combining a thermal analysis with a structural analysis.

8.2.1 Influence of Section Factor (H_p/A) on Fire Resistance

Figure 27, based upon the FASBUS II model, illustrates the influence of H_p/A on the fire resistance of bare steel floor beams when tested at full design loading (to BS449:1969) in a 4.5 m span floor furnace. The fire resistance period is the time taken for the vertical deflection at mid-span to attain L/30. In addition it is worth noting that since high rates of deflection are achieved towards the latter stages of the test, the fire resistance times predicted would not be altered when evaluated in consideration of Ammendment 4822 (May 1985) to BS476:Part 8:1972. This is due to the limitng rate of deflection, $L^2/9000$ d, being exceeded before the mid-span vertical deflection attains L/30.

8.2.2 Influence of Design Stress on Limiting (L/30) Temperature

Data from the fire tests carried out on fully stressed (to BS449:1969) simply supported floor beams, show that the temperatures attained in the lower flange at the limit of deflection, fall within the range of 634-683°C with a mean of 660°C. These high temperatures, in excess of the traditionally quoted 550°C, are due, at least in part, to the temperature gradient experienced down through the section where the upper flange temperatures were only about 440°C at the limiting deflection. Again using the FASBUS II model, Fig. 28, illustrates the influence of design stress on the temperature attained at L/30 in the lower flanges of 254 x 146 mm x 43 kg/m universal beams tested in the floor furnace. Under BS449:1969 a tensile stress of 165 N/mm^2 in the lower flange of a floor beam corresponds to the maximum permissible design load for a Grade 43A steel section. A beam under a reduced design stress of 83 N/mm^2 would be stable up to a limiting temperature of approximately 750°C.

8.3 Influence of Composite Action on Fire Resistance

Two tests were carried out to examine the effect on fire resistance of providing composite action between a reinforced concrete floor slab and the steel beam. When a 254 x 146 mm x 43 kg/m universal beam section is loaded without the increase in moment capacity of the assembly being taken into account, i.e. the beam is not at full working load, a marked improvement in fire resistance is achieved. In contrast, by loading a composite beam assembly to maximise the permitted available moment capacity, then a similar fire resistance to that of a simply supported beam with a non-structural, non-composite segmented cover slab is obtained.

8.4 Influence of Rotational End Restraining Moments and Thermal Restraint on The Fire Resistance of Floor Beams

The test data show that a marked improvement in the fire resistance is obtained when end restraining moments are applied to floor beams. These results have been used to obtain an approximate relationship between H_p/A and the % rotational end restraint necessary to achieve 30 min fire resistance for Grade 43A and 50B structural sections. This is shown in Fig. 29 and applies to beams loaded to generate a maximum tensile stress of 165 N/mm^2 in the lower flange (irrespective of Grade) for a simply supported end condition. Needless to say a Grade 50B steel section would be understressed.

From the tests using the thermal restraining frame, restraint on expansion was found not to be detrimental to the fire resistance of floor beams.

8.5 Shelf Angle Floor Systems

At the present time only a limited number of tests have been carried out on this form of construction. However, the results reported have demonstrated that by selecting suitable combinations of steel beam size and depth of concrete floor unit, fire resistance periods of ½ h, 1 h and 1½ h are possible without the need for applied, lightweight fire protection. All the tests used a sand infill to simulate the thermal characteristics of a concrete screed. In practice, a concrete screed with reinforcing mesh is normally placed across the beams and floor units which will provide some additional degree of composite and continuous action. While this effect as yet, cannot be quantified, it will always provide an improvement in the fire resistance periods so far achieved. Consequently the test assemblies constructed have examined the most pessimistic situation likely to be encountered in practice.

From the tests so far carried out, Fig. 30 illustrates the influence of design loading on the fire resistance of a typical size of shelf angle floor beam and depth of concrete unit. The fire resistance periods for other combinations have been determined using finite element analysis.

It is also worth noting that the rates of vertical deflection experienced during the latter stages of a fire test on a shelf angle floor beam, are slow (typically 2-3 mm/min) in comparison to a similar size of section evaluated as a simply supported member, exposed to fire on three sides. Therefore, while Ammendment 4822 (May 1985) to BS476:Part 8:1972, was not in force at the time the tests were conducted, the criterion, L/20, for assessing stability would

have applied, thereby extending the fire resistance to times beyond those quoted.

8.6 'Slim' Floor Systems

Fire tests on universal column sections used as floor beams with precast concrete units resting on the lower flanges, have demonstrated the beneficial effect of this form of construction on the fire resistance of unprotected steel. Although further evaulation of the system is required including a more detailed examination of the secondary stresses, the results so far indicate that fire resistance periods of ½, 1 and 1½ h are possible, without the need for applied lightweight fire protection.

8.7 Fire Resistance of Bare Columns

Figure 31 shows the effect of section factor on the fire resistance of bare steel columns. The data also include tests on full length unloaded sections in the column furnace as well as short 1 m lengths of section standing upright inside the floor beam furnace at the Warrington Research Centre. In plotting the curve the fire resistance is taken either as the time to the limit of stability or the limiting mean steel temperature of 550°C, for members loaded to their maximum permissible design stress. It is therefore clear from Fig. 31, that bare columns with section factors up to 55 m^{-1} (4 sided exopsure) have a fire resistance of 30 min when working at full design loading (to BS449:1969).

The test carried out on a 6 inch square solid billet is also shown in Fig. 31 which when considered in relation to the point at which the fire tests on the other sections were terminated, corroborates the curve at low values of H_p/A.

8.8 Columns with Blocked in Webs

A series of tests is reported in which lightweight aerated pulverised fuel ash concrete blocks were built up into the web of column sections to leave only the outside flanges exposed to fire. By protecting the web of the section using traditional building materials and skills, a relatively low cost method is available for achieving 30 min fire resistance over a wide range of sections used as columns or stanchions.

A design guide covering this form of construction 'Fire Resistant Steel Structures - Free Standing Blockwork Filled Columns and Stanchions', has already been issued as a BRE Digest[2], which also considers loading the members to the new structural steel design code BS5950:Part 1:1985.

8.9 Columns and Beams in Walls

Buildings constructed with load bearing columns and beams set within the walls are commonplace. The tests reported demonstrate the potentially high levels of fire resistance available with either the exposed web left bare, or filled in with lightweight building blocks. For example, Fig. 32 illustrates the effect of design load on the fire resistance of 203 x 203 mm x 52 kg/m universal column sections used in this fashion.

In the fire tests, the exposed portions of the members attained very high temperatures, ~1000°C. Despite the low strength of steel at temperatures of this magnitude, the applied loads were still supported by the much cooler areas of the sections' profile that were protected by the blockwork. However due to the steep temperature gradients created across the sections' profile, bowing arising from differential thermal expansion occurs. Therefore, designers must be aware of the potential damaging effects of lateral movement in the structure on the integrity of the walls. This is particularly important where the height of the wall is considerably greater than that evaluated in the fire test.

8.10 Elevated Temperature Anisothermal Tensile Tests

Appendix B contains data sheets on the anisothermal tensile tests carried out on samples of steel removed from the unheated portions of members evaluated in the fire test furnaces. These results have been used in conjunction with similar tests on material removed from other structural sections to provide

stress/strain curves for Grades 43A and 50B steel manufactured to BS4360:1979, see Tables 4(a) and (b). Since this work was carried out, BS4360 was revised in August 1986 and the minimum yield stress of Grade 43A structural steel was raised from 255 N/mm^2 to 275 N/mm^2. Therefore a small increase in the stress values covering the plastic portion of the stress strain curves can be expected for the higher strength steel, and it would not be unreasonable to expect the uplift to be approximately in the proportion of 275/255.

The data presented in Tables 4(a) and (b) are based upon a steel heating rate of 10°C/min. However, there is a small dependency of strength on heating rate due to 'creep' at longer heating times and therefore at 1% total strain, the following adjustments can be made relative to 10°C/min.

20°C/min +15°C

5°C/min -15°C

2.5°C/min -25°C

9. REFERENCES

1. Noble, P.W. and Leech, L.V., Design Tables for Composite Steel and Concrete Beams for Buildings, Published by CONSTRADO.

2. Fire Resistant Steel Structures - Free Standing Blockwork Filled Columns and Stanchions, BRE Digest 317, 1986.

DTP

TABLE 1 GENERAL PRODUCT COMPOSITION LIMITS FOR THE BS4360:1979 GRADE 43 AND 50 STEEL SECTIONS REPORTED IN THIS COMPENDIUM

Grade	Chemical Composition, Wt. %						
	C max.	Si	Mn max.	P max.	S max.	Nb*	V*
43A	0.30	0/0.55	1.70	0.06	0.06	-	-
50B	0.24	0/0.55	1.60	0.06	0.06	0.003/0.10	0.003/0.10
50D	0.22	0/0.55	1.60	0.05	0.05	0.003/0.10	0.003/0.10

* Nb and V in combination must not exceed 0.10%

TABLE 2 TENSILE PROPERTIES SPECIFIED FOR THE BS4360:1979 GRADES 43 AND 50 STEEL SECTIONS REPORTED IN THIS COMPENDIUM

Grade	Tensile Properties			
	Yield Strength min.*		Tensile Strength N/mm^2	Elongation $5.65\sqrt{S_o}$ %
	Up to 16 mm N/mm^2	Over 16 mm Up to 25 mm N/mm^2		
43A	255	245	430-540**	22
50B	355	345	490-620	20
50D	355	345	490-620	20

* The test piece is normally taken from the flange. Where the yield strength is obtained from test pieces taken from the web, the minimum value shall be at least 15 N/mm^2 greater than the specified minimum.

** For sections other than universal beams, columns and bearing piles the maximum tensile strength is reduced to 510 N/mm^2.

TABLE 3 H_p/A VALUES FOR UNIVERSAL BEAM AND COLUMN SECTIONS

Serial Size mm	Universal Beams		
	Mass/m kg	H_p/A (4)	H_p/A (3)
914 x 419	388	70	61
	343	78	69
914 x 305	289	82	73
	253	93	83
	224	104	94
	201	115	103
838 x 292	226	97	87
	194	113	101
	176	124	111
762 x 267	197	102	91
	173	115	103
	147	134	120
686 x 254	170	109	97
	152	121	108
	140	130	116
	125	145	129
610 x 305	238	81	70
	179	106	92
	149	126	109
610 x 229	140	118	105
	125	131	117
	113	144	128
	101	160	143
533 x 210	122	121	108
	109	135	120
	101	145	128
	92	158	140
	82	177	157
457 x 191	98	133	118
	89	145	129
	82	158	139
	74	173	153
	67	191	169
457 x 152	82	144	129
	74	157	141
	67	174	156
	60	196	176
	52	222	199
406 x 178	74	159	140
	67	175	154
	60	196	173
	54	217	191
406 x 140	46	228	204
	39	270	241
356 x 171	67	162	142
	57	190	166
	51	211	185
	45	238	208
356 x 127	39	239	213
	33	279	249
305 x 165	54	184	160
	46	212	184
	40	241	209
305 x 127	48	179	158
	42	203	180
	37	226	200
305 x 102	33	241	217
	28	275	247
	25	316	283
254 x 146	43	196	169
	37	226	195
	31	265	229
254 x 102	28	250	221
	25	279	247
	22	313	277
203 x 133	30	243	208
	25	283	242

Serial Size mm	Universal Columns		
	Mass/m kg	H_p/A (4)	H_p/A (3)
356 x 406	634	31	26
	551	35	29
	467	41	34
	393	47	39
	340	54	45
	287	63	52
	235	76	63
Column core	477	40	33
356 x 368	202	85	70
	177	96	80
	153	110	91
	129	130	107
305 x 305	283	54	45
	240	62	52
	198	74	62
	158	91	76
	137	104	87
	118	121	100
	97	145	120
254 x 254	167	74	62
	132	91	76
	107	111	92
	89	132	109
	73	160	133
203 x 203	86	112	93
	71	134	111
	60	159	132
	52	180	149
	46	202	167
152 x 152	37	192	160
	30	235	195
	23	299	247

H_p (4) infers total perimeter

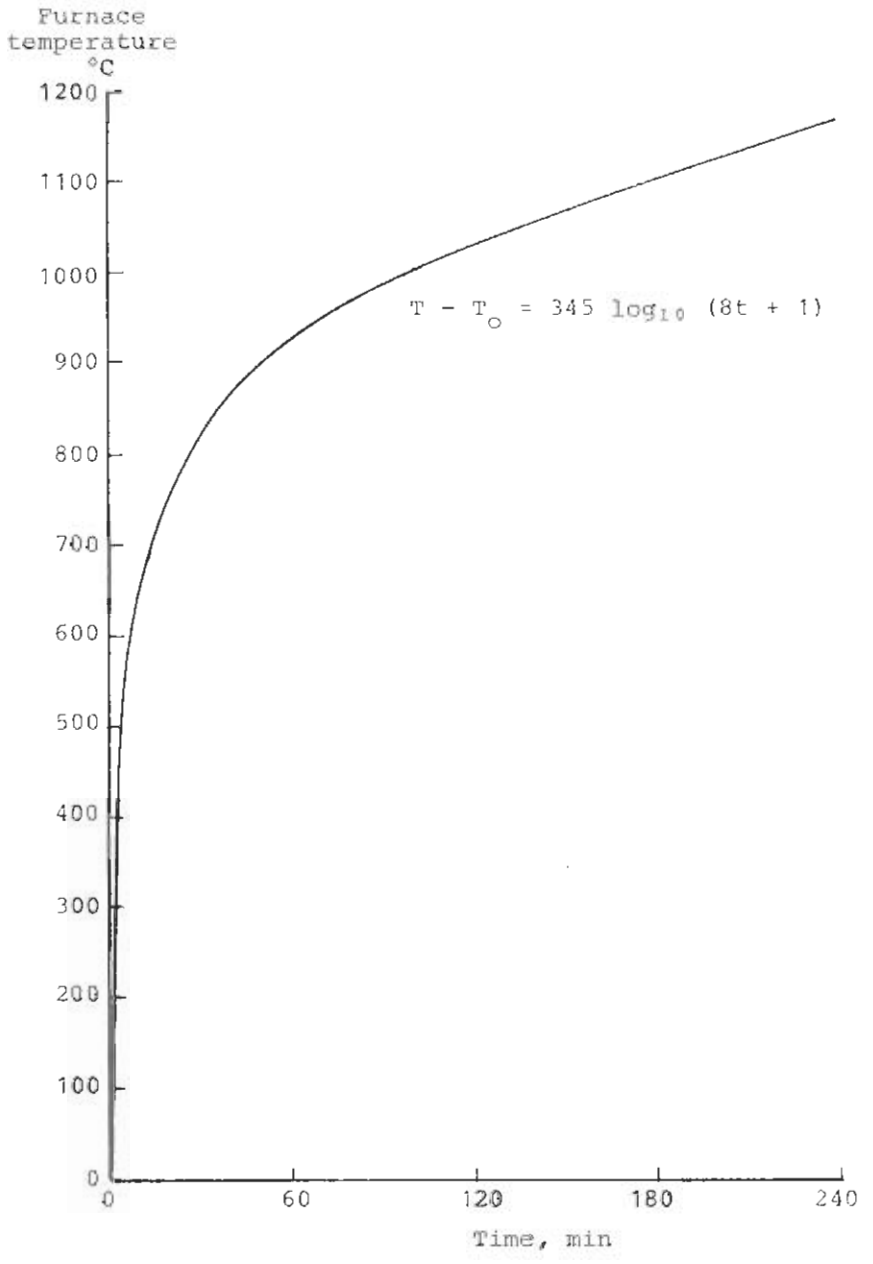
H_p (3) infers total perimeter less the width of one flange

In deriving the above values H_p is in metres and A in square metres.

TABLE 4
ELEVATED TEMPERATURE STRESS/STRAIN DATA FOR BS4360:1979 STRUCTURAL STEELS DERIVED FROM ANISOTHERMAL TENSILE TESTS

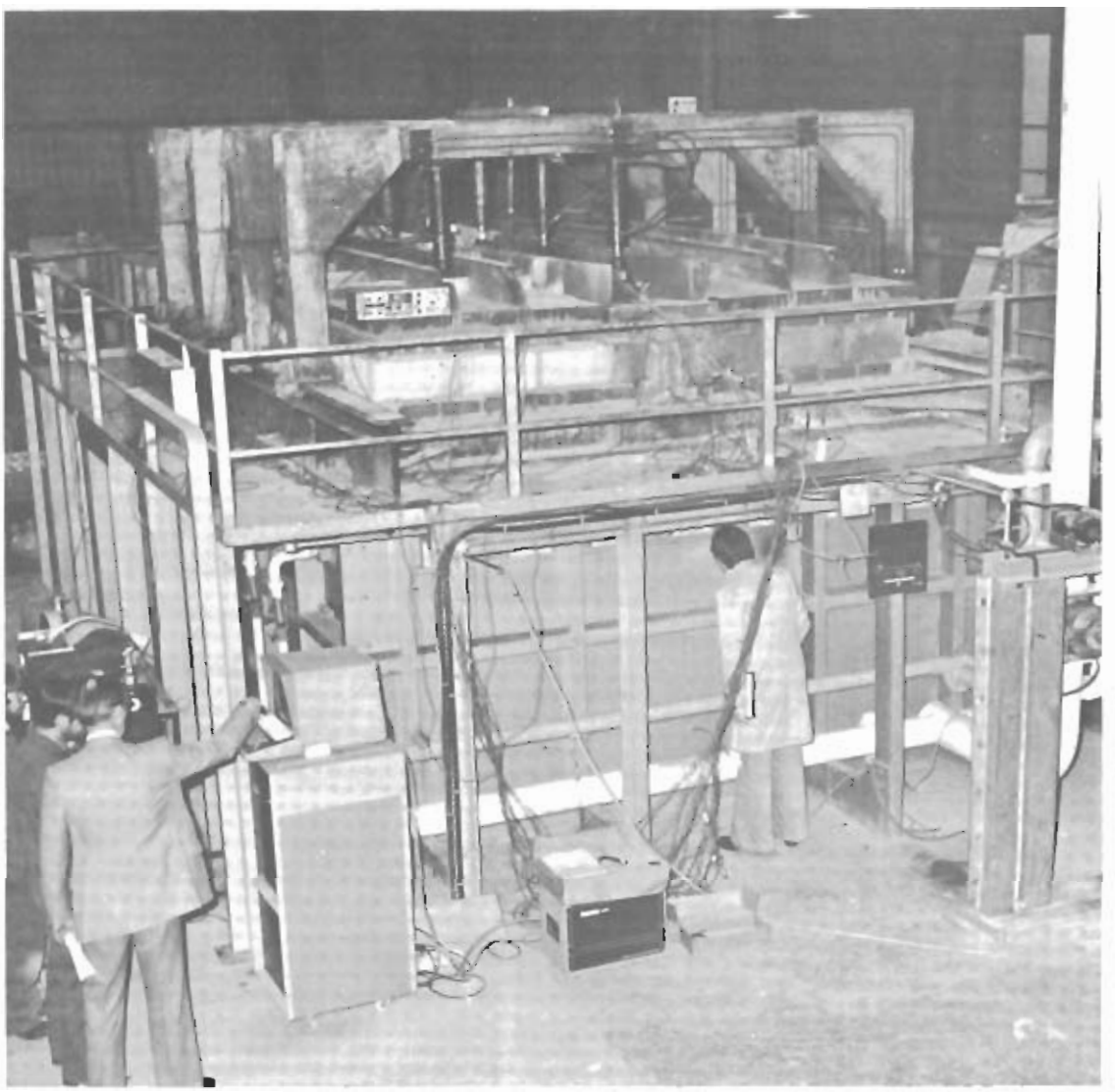
Strain %	Stress in N/mm² for Various Temperatures, °C																			
	20	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950
(a) Grade 43A																				
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*	*	*
0.01	18.4	18.4	18.4	17.3	16.6	15.8	15.6	14.5	13.3	11.7	9.4	6.9	5.6	4.1	2.0	2.0	1.8	*	*	*
0.02	36.7	36.7	35.7	34.9	33.2	31.9	31.4	29.1	26.8	23.5	19.1	13.5	11.5	8.2	4.1	3.8	3.3	*	*	*
0.03	55.1	54.1	54.1	53.3	49.7	47.7	46.9	43.3	40.0	35.2	28.6	20.4	17.1	12.2	6.1	5.9	5.6	*	*	*
0.04	73.4	72.4	71.7	70.6	66.3	63.5	62.5	57.9	53.3	46.9	38.3	27.0	22.7	16.6	8.2	7.9	7.4	*	*	*
0.05	91.8	89.3	90.0	88.2	82.9	79.3	78.0	72.4	66.8	58.6	47.7	33.9	28.3	20.7	10.5	9.9	9.4	*	*	*
0.06	110.2	109.1	107.4	105.6	99.2	95.4	93.8	87.0	80.1	70.1	57.1	40.8	34.2	24.7	12.5	11.7	11.2	*	*	*
0.07	128.3	126.7	125.7	123.2	115.8	111.2	109.4	101.2	93.3	81.9	66.8	47.4	39.8	28.8	14.5	13.8	13.0	*	*	*
0.08	146.6	144.8	143.3	141.5	132.3	127.0	124.9	115.8	106.6	93.6	76.2	54.3	45.1	32.9	16.6	15.3	14.0	*	*	*
0.09	165.0	163.2	161.7	158.9	148.9	143.1	132.1	124.4	116.8	105.3	85.7	60.9	48.4	36.0	18.6	16.3	14.0	*	*	*
0.10	183.3	181.6	179.0	176.5	165.5	158.9	136.4	129.0	121.6	111.7	95.4	67.8	51.3	38.0	20.7	17.3	14.0	*	*	*
0.12	220.1	217.5	214.7	211.4	198.6	181.8	144.6	138.0	131.6	118.3	102.3	81.3	56.1	41.3	24.7	19.4	14.3	*	*	*
0.14	255.0	247.1	234.1	225.4	208.1	188.2	152.2	145.9	139.5	124.7	108.6	87.2	60.7	43.9	26.8	20.4	14.3	*	*	*
0.16	255.0	247.1	238.4	229.5	213.4	193.8	158.9	152.2	145.9	130.8	113.5	92.6	64.3	46.2	28.1	21.4	14.5	*	*	*
0.18	255.0	247.1	242.3	232.6	217.5	198.4	164.5	157.8	151.2	135.9	118.6	96.9	67.6	48.2	29.6	22.2	14.8	*	*	*
0.20	255.0	247.1	244.8	234.6	221.1	202.2	169.8	163.2	156.3	140.3	122.9	100.0	70.9	50.0	31.1	23.0	15.0	*	*	*
0.25	255.0	247.1	246.1	237.7	229.2	208.8	181.3	174.7	167.8	150.2	132.3	105.8	77.3	54.3	34.9	25.0	15.6	*	*	*
0.30	255.0	247.1	246.1	239.7	233.8	213.9	191.8	184.9	177.7	158.9	140.3	110.7	82.9	58.4	38.3	27.0	16.1	*	*	*
0.35	255.0	247.1	246.1	241.0	237.4	217.3	199.7	192.8	185.9	166.5	146.4	115.5	87.5	62.5	41.1	28.6	16.6	*	*	*
0.40	255.0	247.1	246.1	241.7	239.2	219.8	207.1	199.7	192.3	172.9	151.5	119.3	91.3	65.3	43.6	30.1	17.1	*	*	*
0.50	255.0	247.1	246.1	243.8	241.2	225.4	217.8	210.6	203.5	183.9	158.6	125.5	96.4	68.6	47.4	32.4	18.1	*	*	*
0.60	255.0	247.1	246.1	244.0	241.7	230.0	225.7	218.5	211.4	192.5	165.5	131.8	100.5	70.9	49.5	33.4	19.1	12.8	*	*
0.70	255.0	247.1	246.1	244.3	242.3	233.6	230.8	225.2	219.6	199.9	172.4	137.4	103.8	72.9	50.7	34.2	20.1	13.8	*	*
0.80	255.0	247.1	246.1	244.5	242.8	237.4	235.4	231.5	227.5	206.0	177.2	142.0	107.4	75.0	51.8	34.9	21.2	14.5	*	*
0.90	255.0	247.1	246.1	244.5	243.0	240.7	238.7	235.6	232.8	210.9	181.3	145.9	110.2	76.5	52.8	35.4	22.2	15.3	*	*
1.00	255.0	247.1	246.1	244.8	243.5	242.8	241.2	239.7	236.9	214.7	184.1	148.9	111.7	77.8	53.5	36.2	23.2	16.1	*	*
1.20	*	*	*	*	*	*	245.6	243.8	240.2	221.3	188.2	152.5	114.2	80.1	55.1	37.2	25.2	17.3	*	*
1.40	*	*	*	*	*	*	*	245.8	242.8	226.4	191.3	155.0	116.3	82.1	56.4	38.3	27.0	18.4	14.8	*
1.60	*	*	*	*	*	*	*	*	244.8	231.3	193.8	157.1	118.1	83.9	57.4	39.0	28.1	19.1	15.3	*
1.80	*	*	*	*	*	*	*	*	246.3	235.4	196.1	158.6	119.6	85.2	58.4	39.8	28.8	19.9	15.6	*
2.00	*	*	*	*	*	*	*	*	*	238.2	197.9	159.9	120.9	85.9	59.2	40.3	29.3	20.1	15.8	13.3
(b) Grade 50B																				
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

* No Data

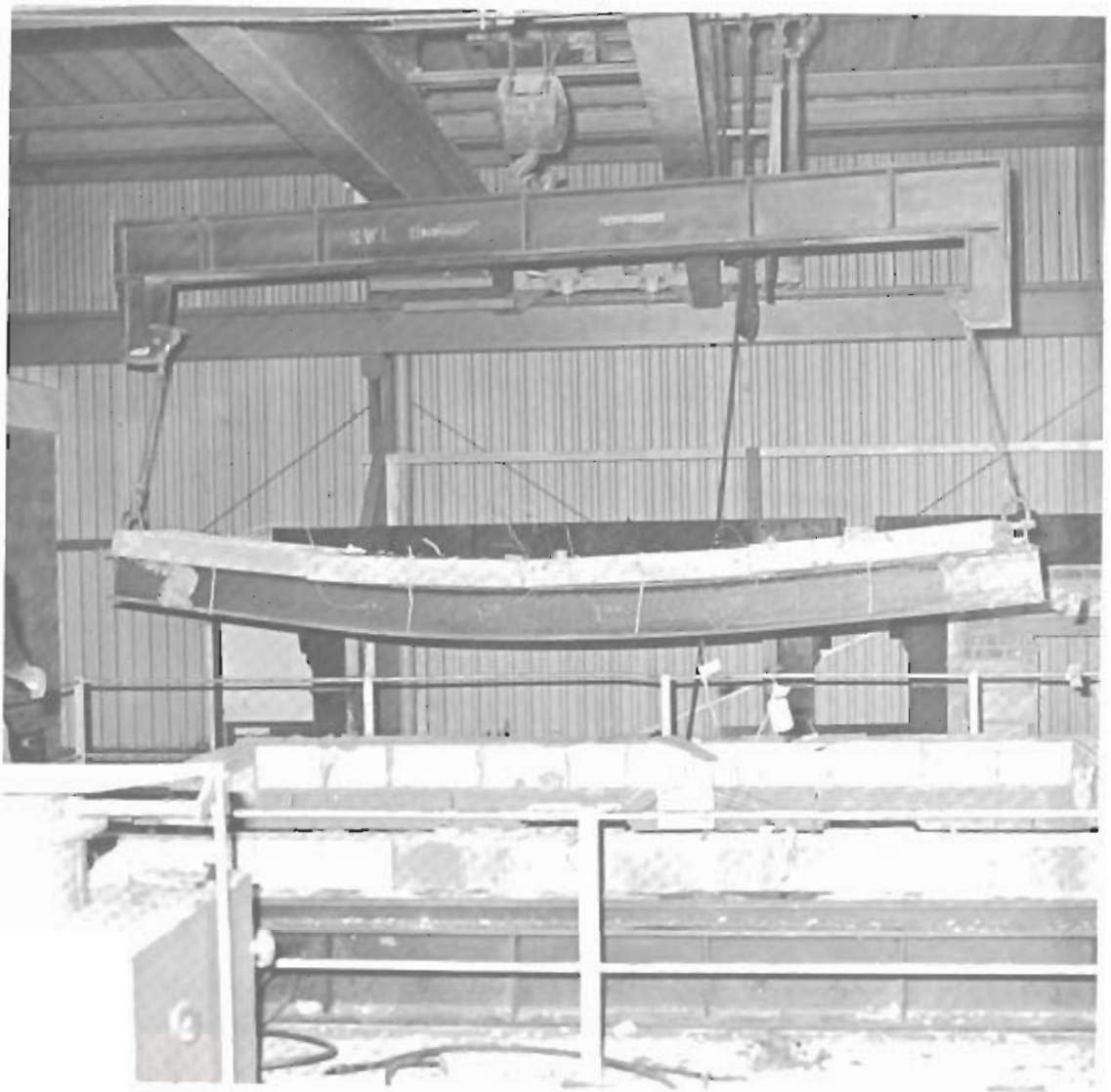


BS476:PART 8:1972 FURNACE HEATING CURVE

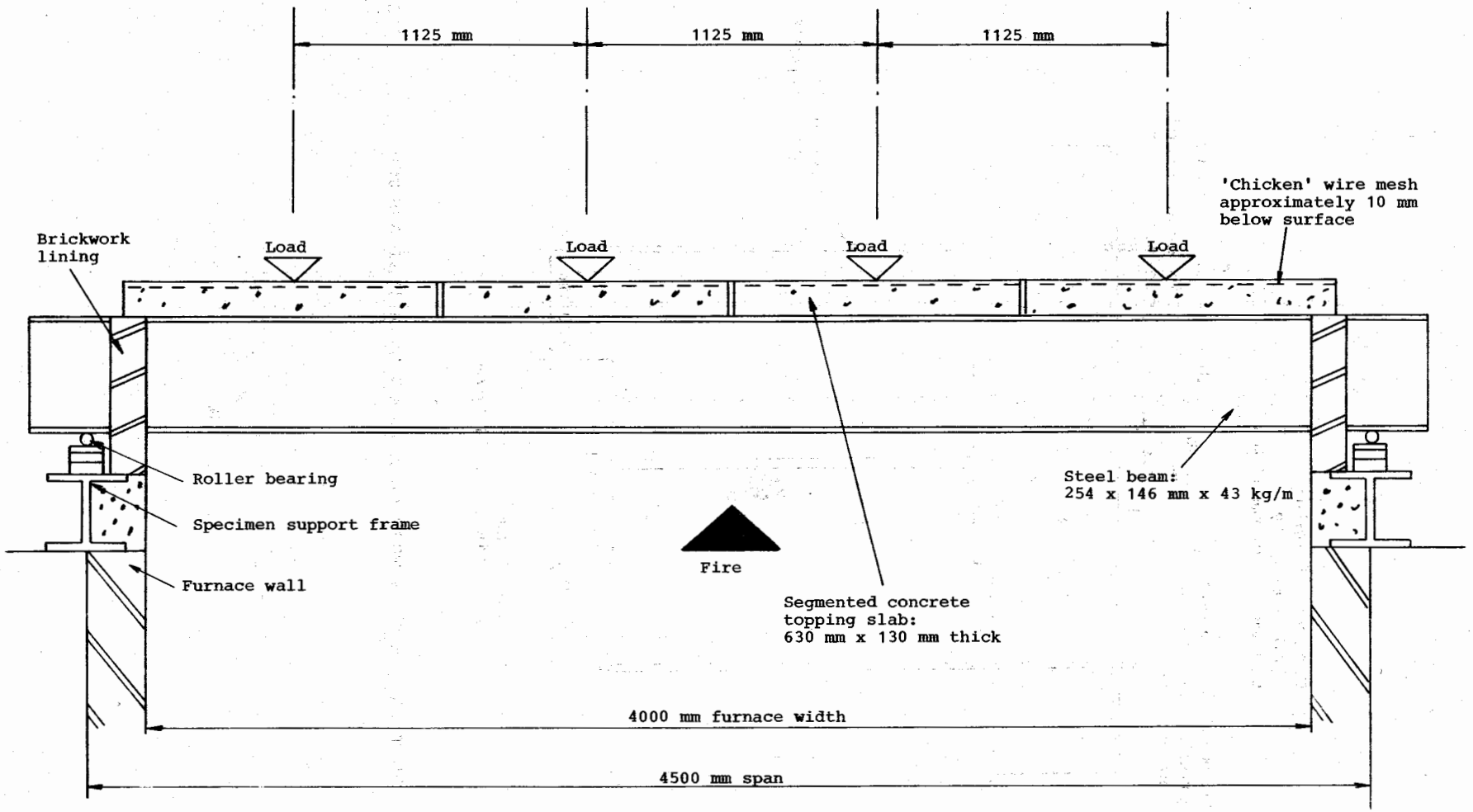
FIG. 1
(R2/7084)



THE FLOOR BEAM FURNACE FIRE TEST FACILITY
AT WARRINGTON RESEARCH CENTRE
FIG. 2(a)

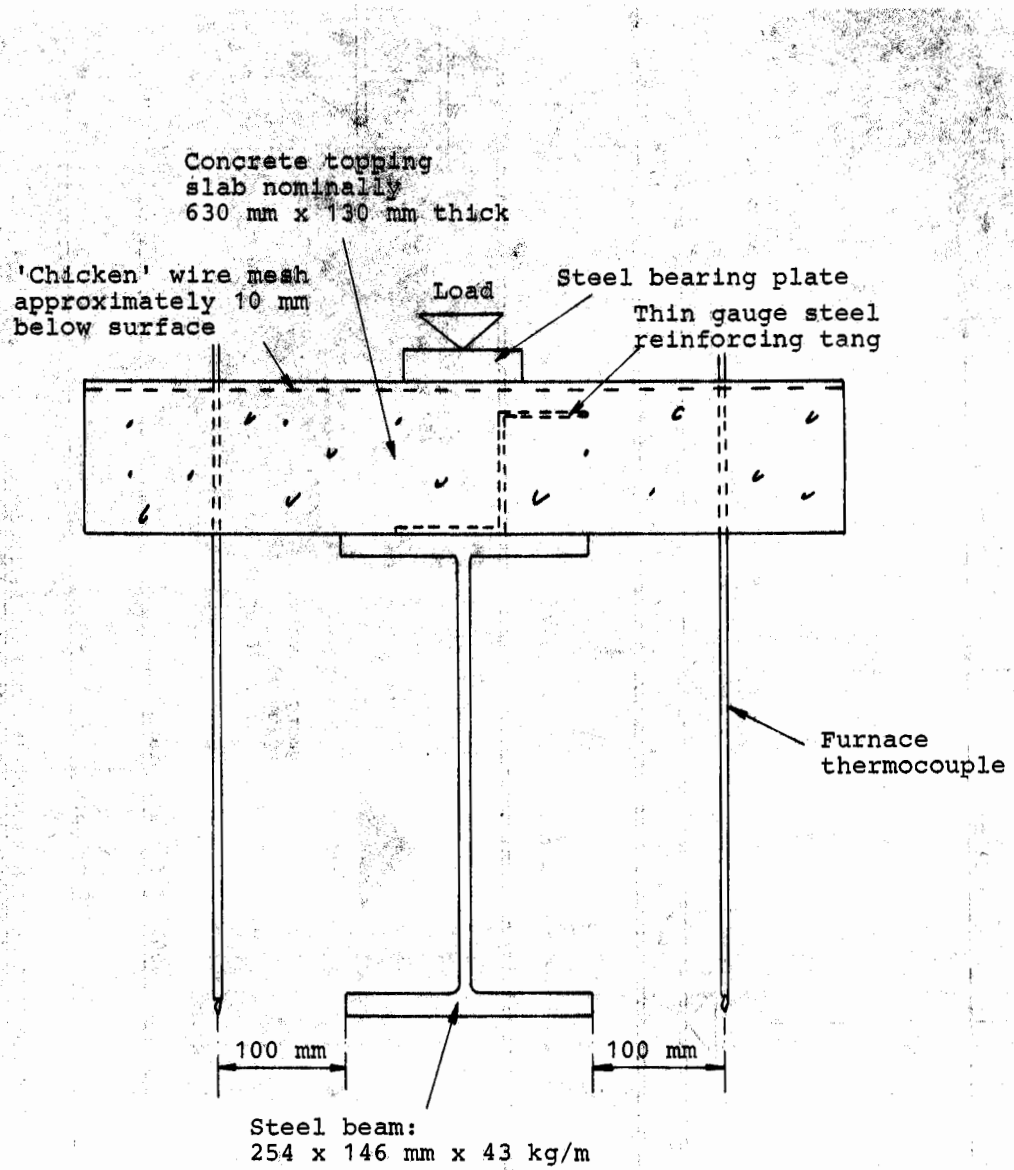


A 4.5 m LONG FLOOR BEAM BEING REMOVED FROM THE FURNACE FOLLOWING A FIRE TEST FIG. 2(b)



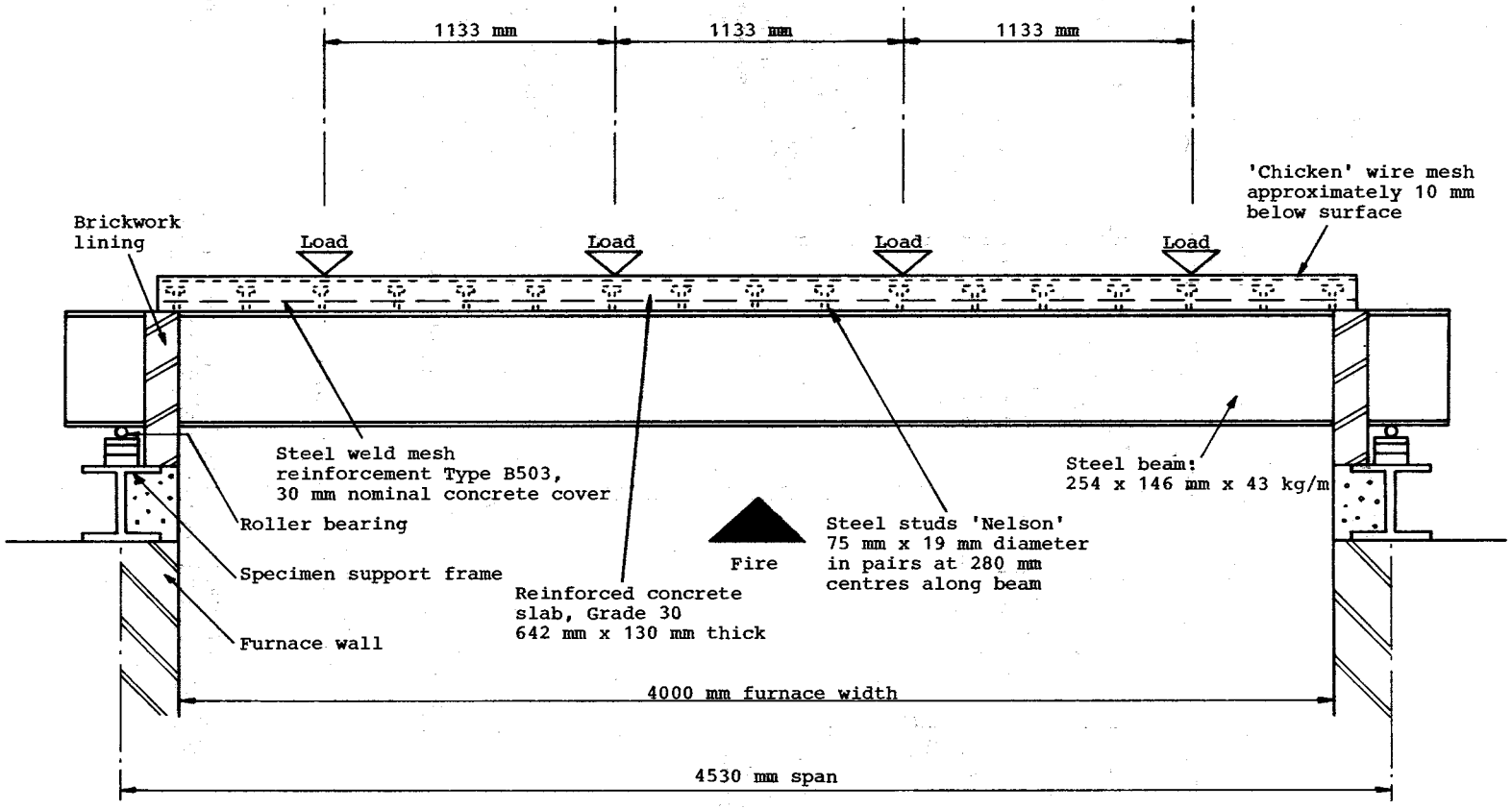
LONGITUDINAL SECTION SHOWING THE GENERAL ARRANGEMENT FOR A SIMPLY SUPPORTED FLOOR BEAM TEST ASSEMBLY

FIG. 3(a)
(R2/7085)



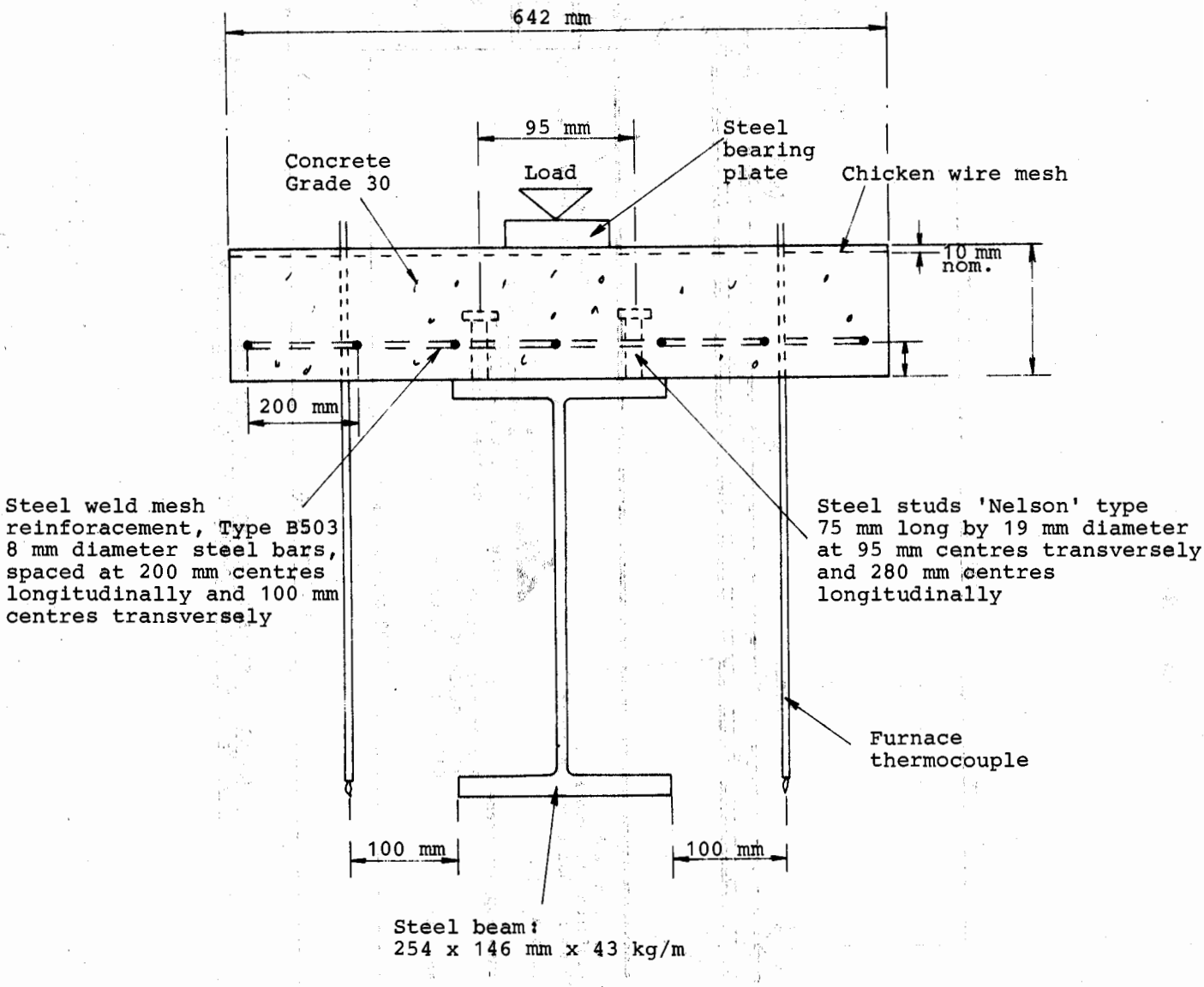
VERTICAL SECTION THROUGH A FLOOR BEAM TEST ASSEMBLY

FIG. 3(b)
(R2/7086)



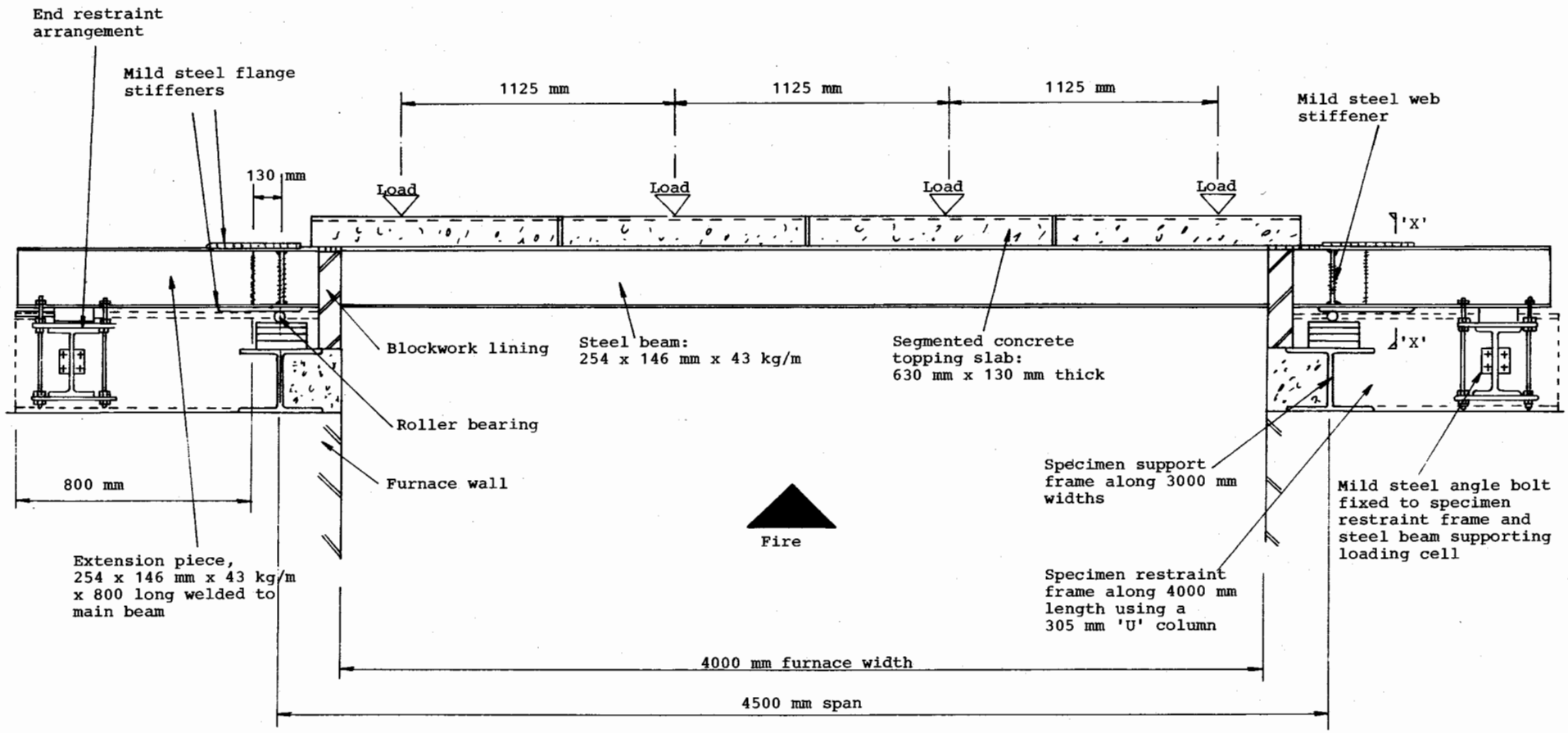
LONGITUDINAL SECTION SHOWING THE GENERAL ARRANGEMENT FOR A SIMPLY SUPPORTED COMPOSITE FLOOR BEAM TEST ASSEMBLY

FIG. 4(a)
(R2/7087)



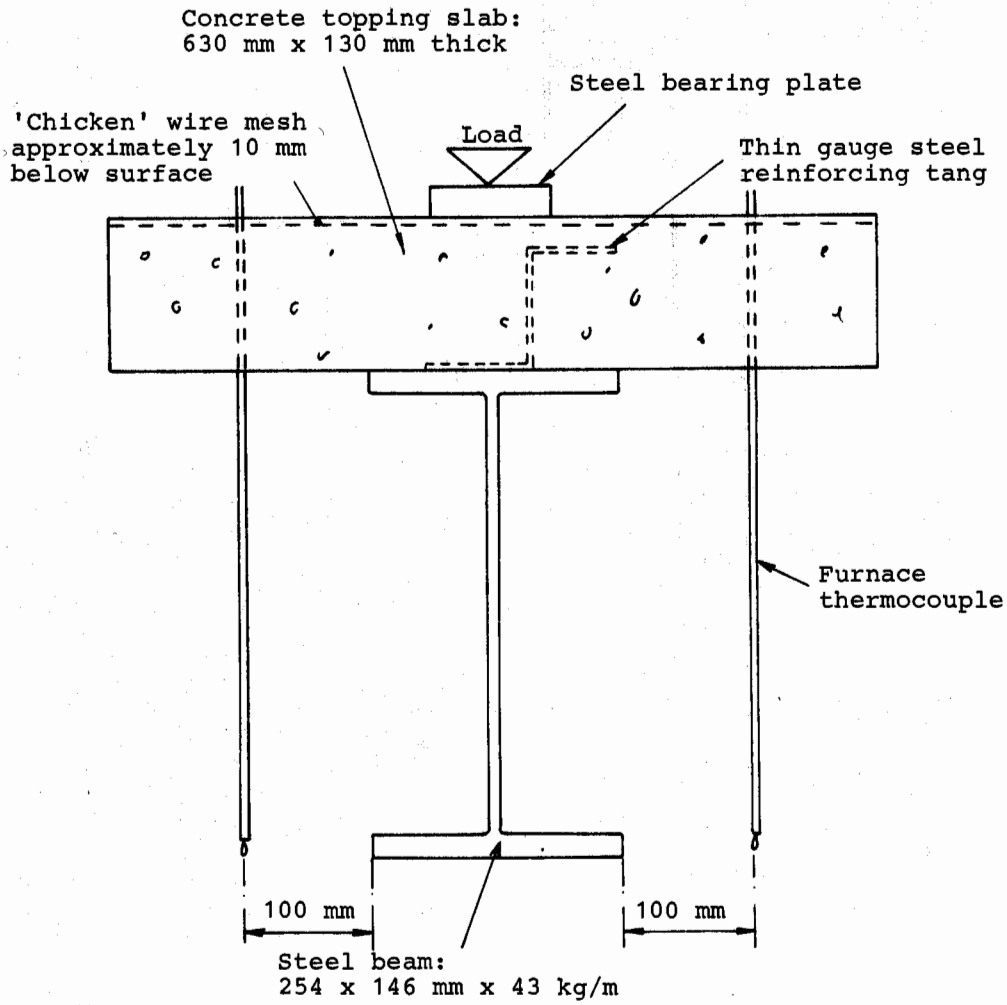
VERTICAL SECTION THROUGH A STEEL BEAM AND REINFORCED COMPOSITE CONCRETE SLAB

FIG. 4(b)
(R2/7088)



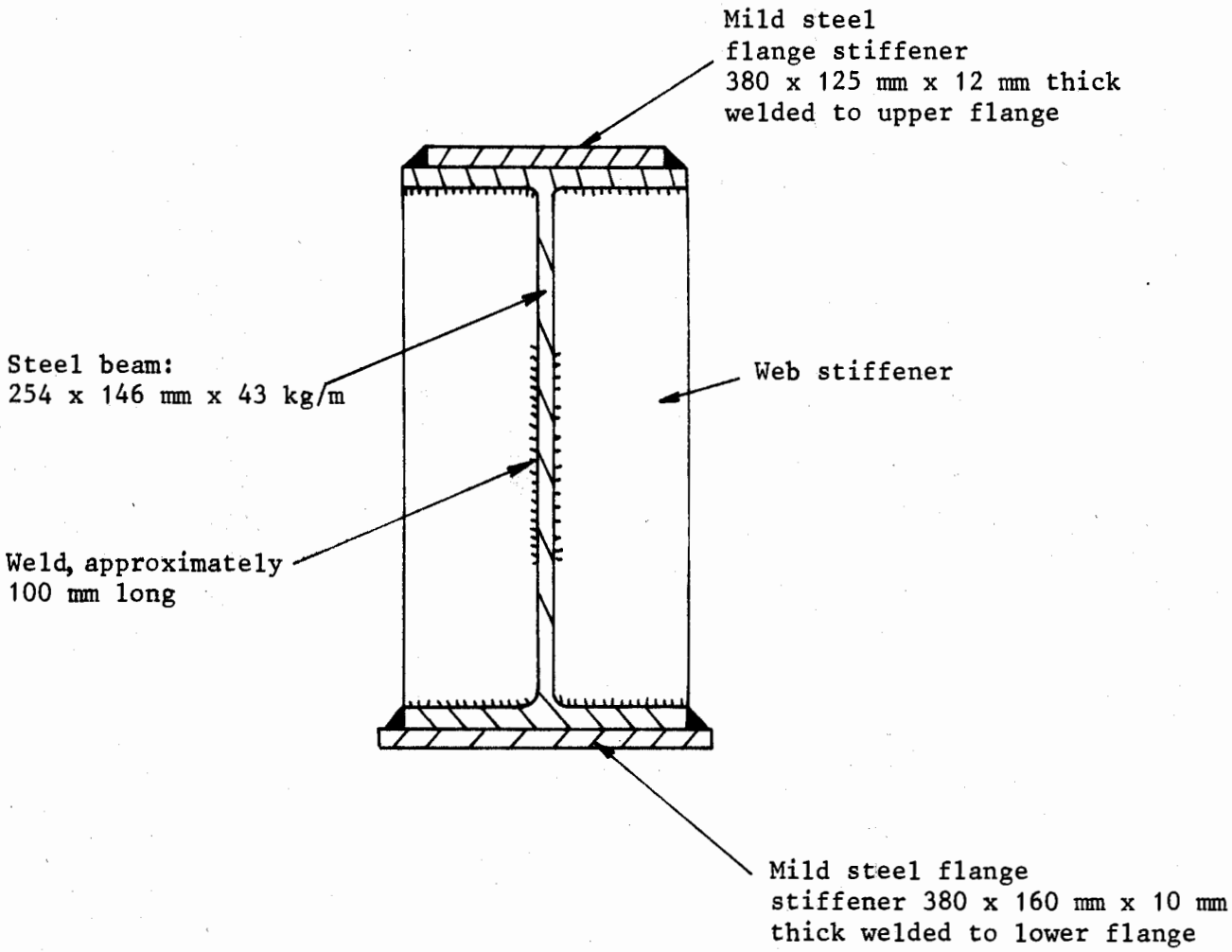
LONGITUDINAL SECTION SHOWING THE GENERAL ARRANGEMENT FOR A FLOOR BEAM WITH VARIABLE ROTATIONAL END RESTRAINT

FIG. 5(a)
(R2/7089)



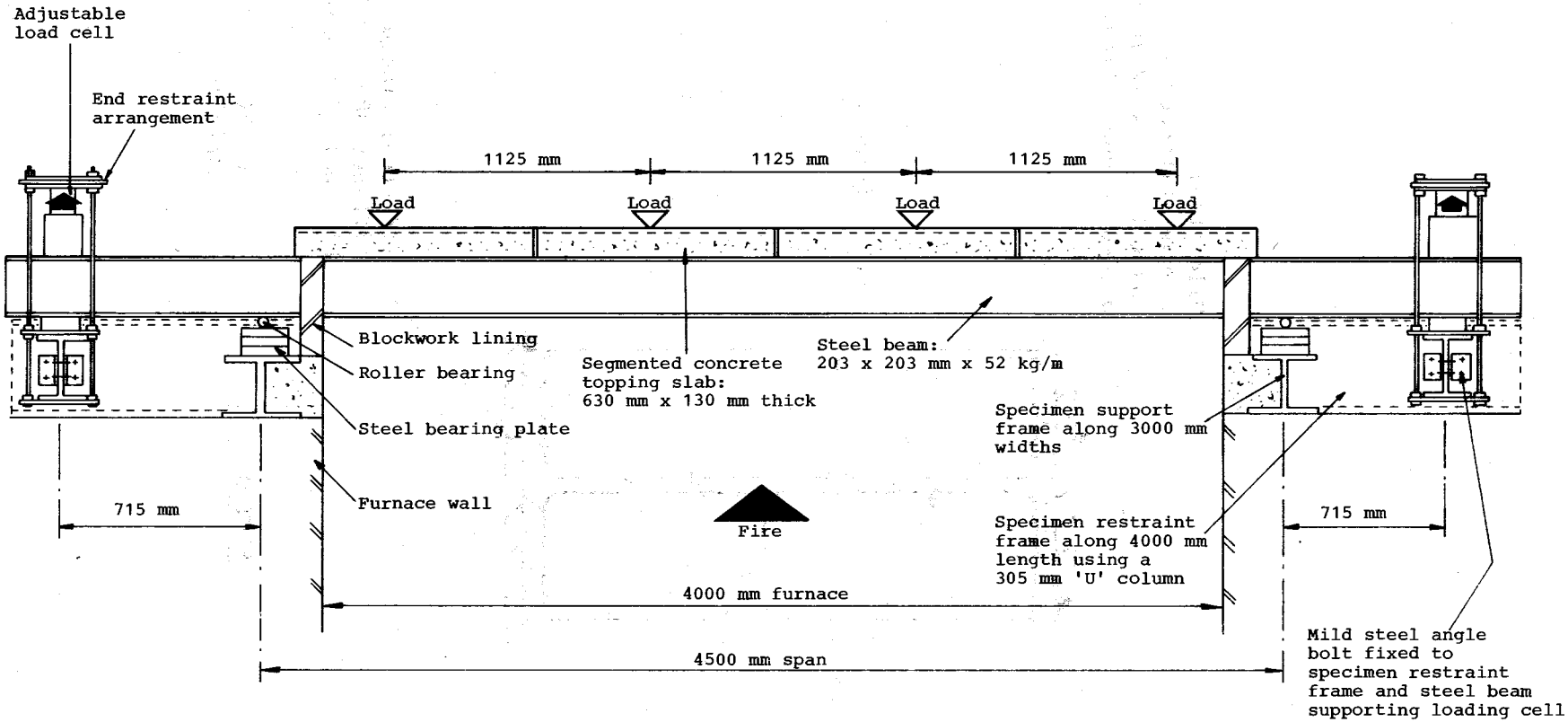
VERTICAL SECTION THROUGH A FLOOR BEAM TEST ASSEMBLY WITH ROTATIONAL END RESTRAINT

FIG. 5(b)
(R2/7090)



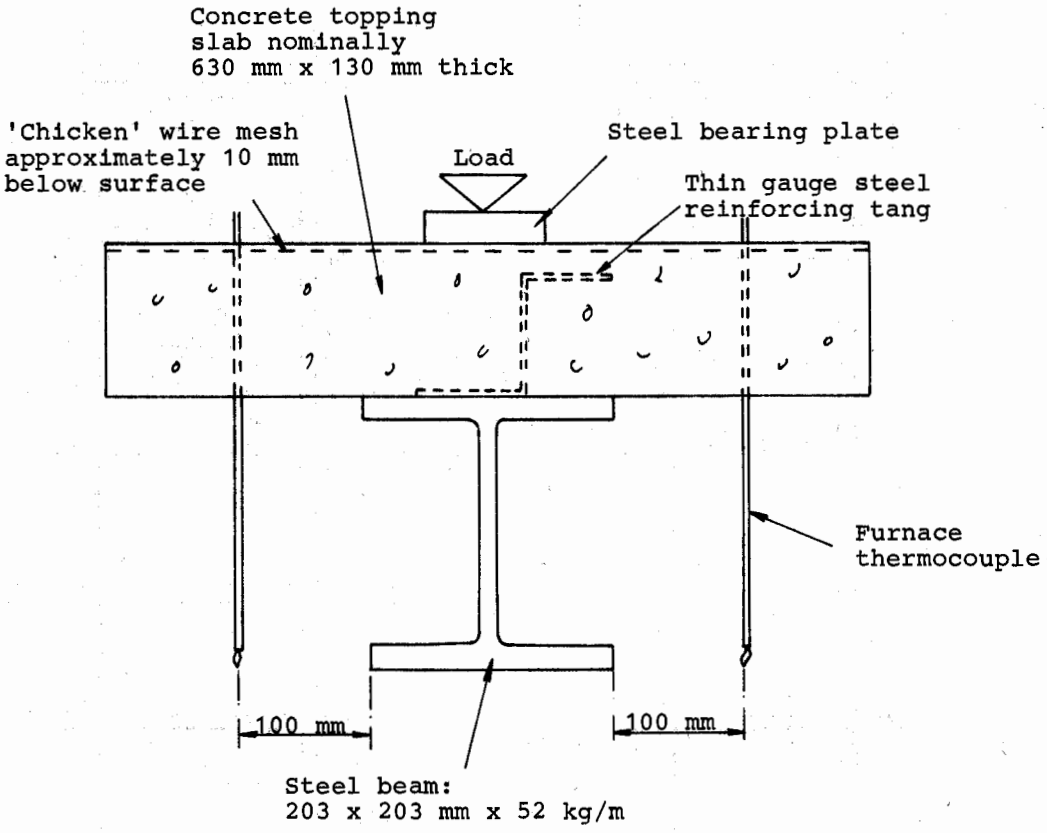
SECTION X-X

FIG. 5(c)
(R2/7091)



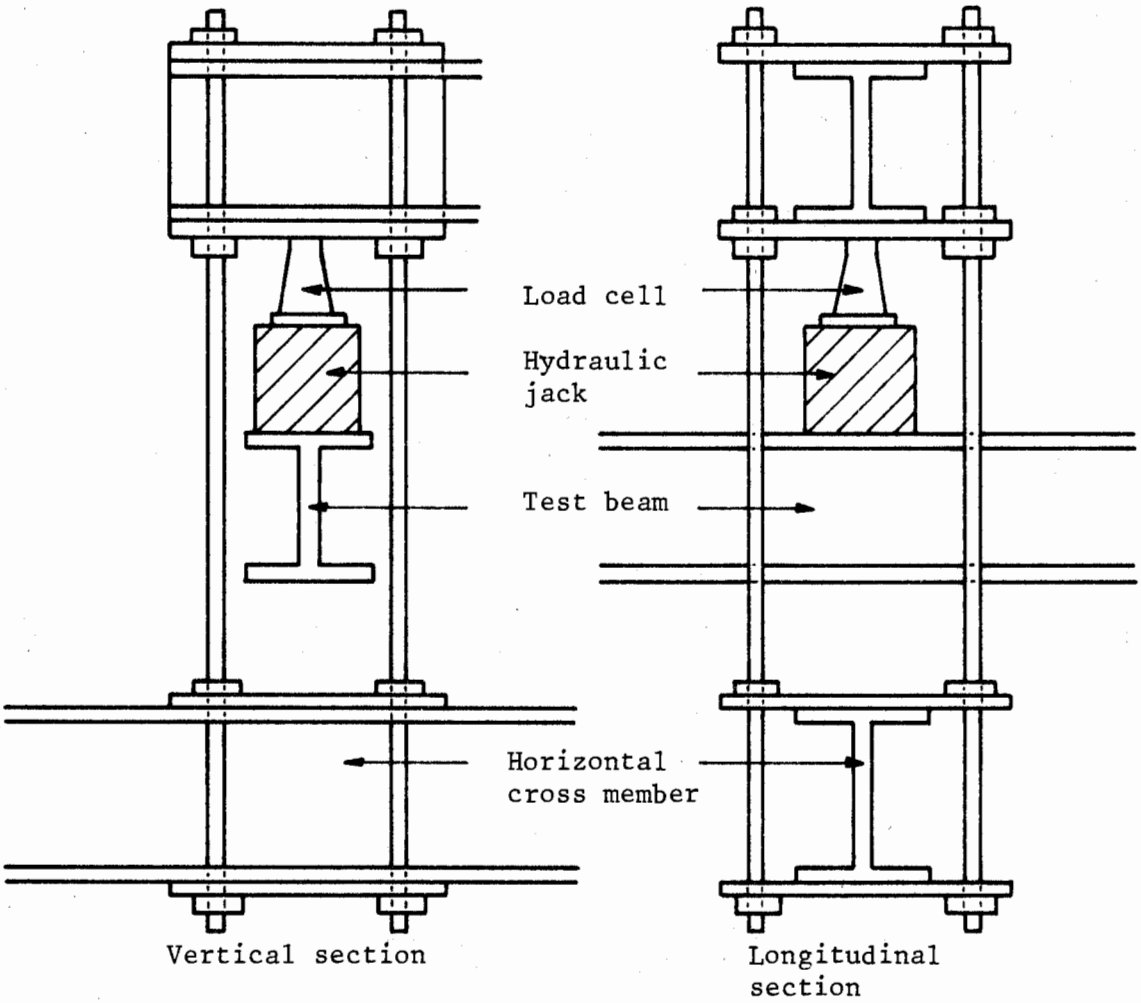
LONGITUDINAL SECTION SHOWING THE GENERAL ARRANGEMENT FOR A FLOOR BEAM WITH CONSTANT ROTATIONAL END RESTRAINT

FIG. 6(a)
(R2/7092)



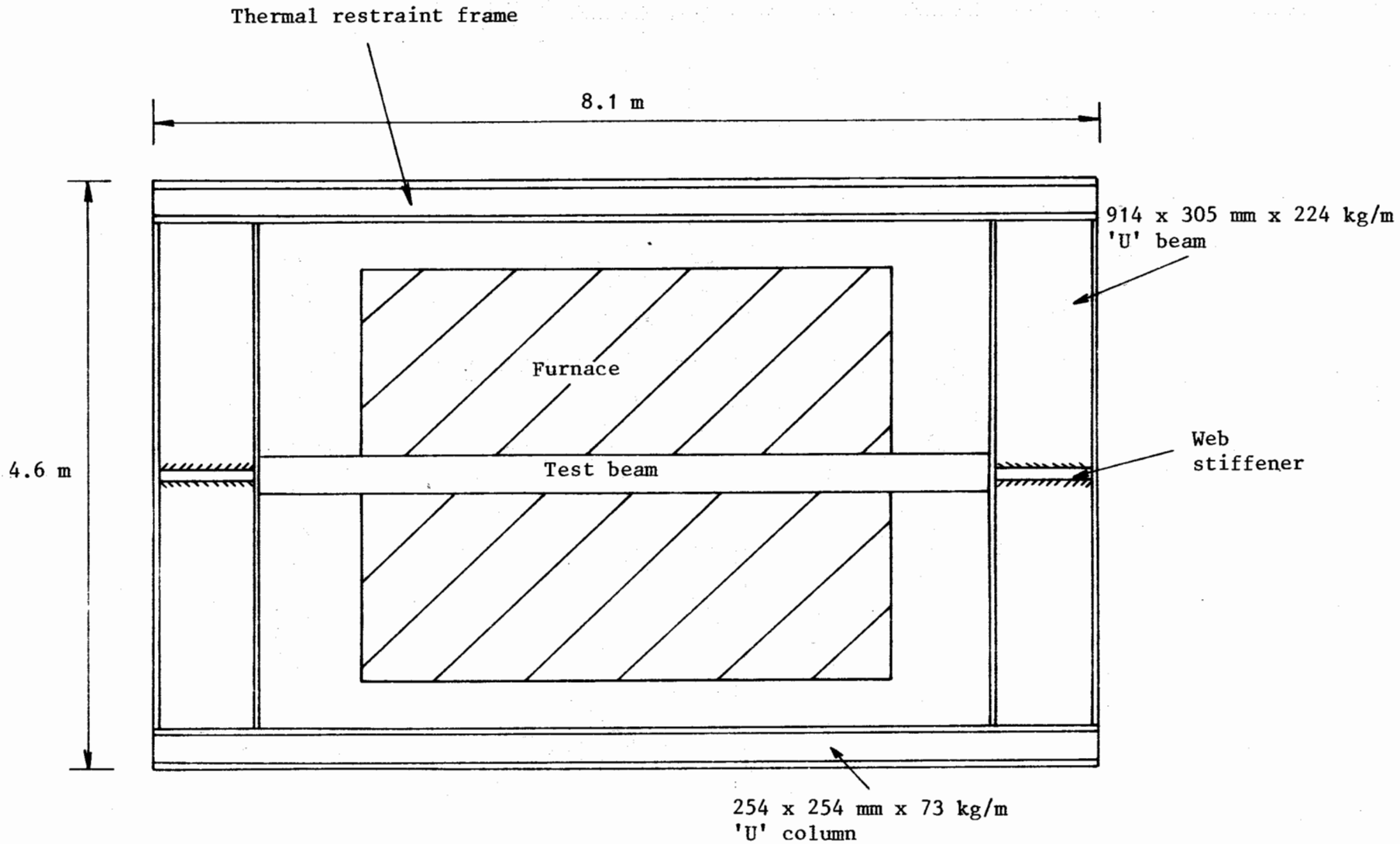
VERTICAL SECTION THROUGH A FLOOR BEAM TEST ASSEMBLY WITH ROTATIONAL END RESTRAINT

FIG. 6(b)
(R2/7093)



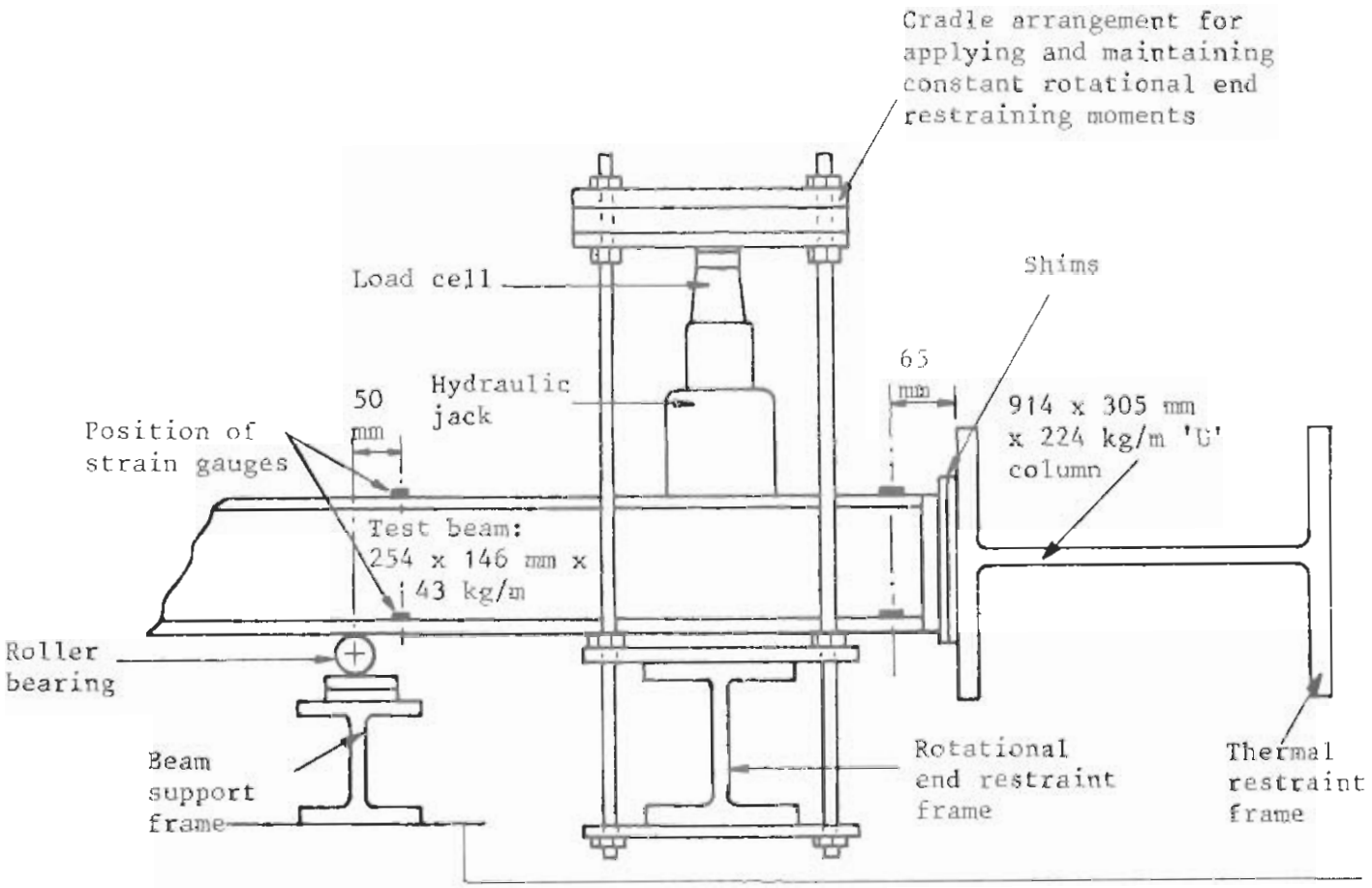
SCHEMATIC ILLUSTRATION OF THE 'CRADLE' ARRANGEMENT USED FOR APPLYING AND MAINTAINING CONSTANT ROTATIONAL END RESTRAINING MOMENTS

FIG. 6(c)
(R2/7094)



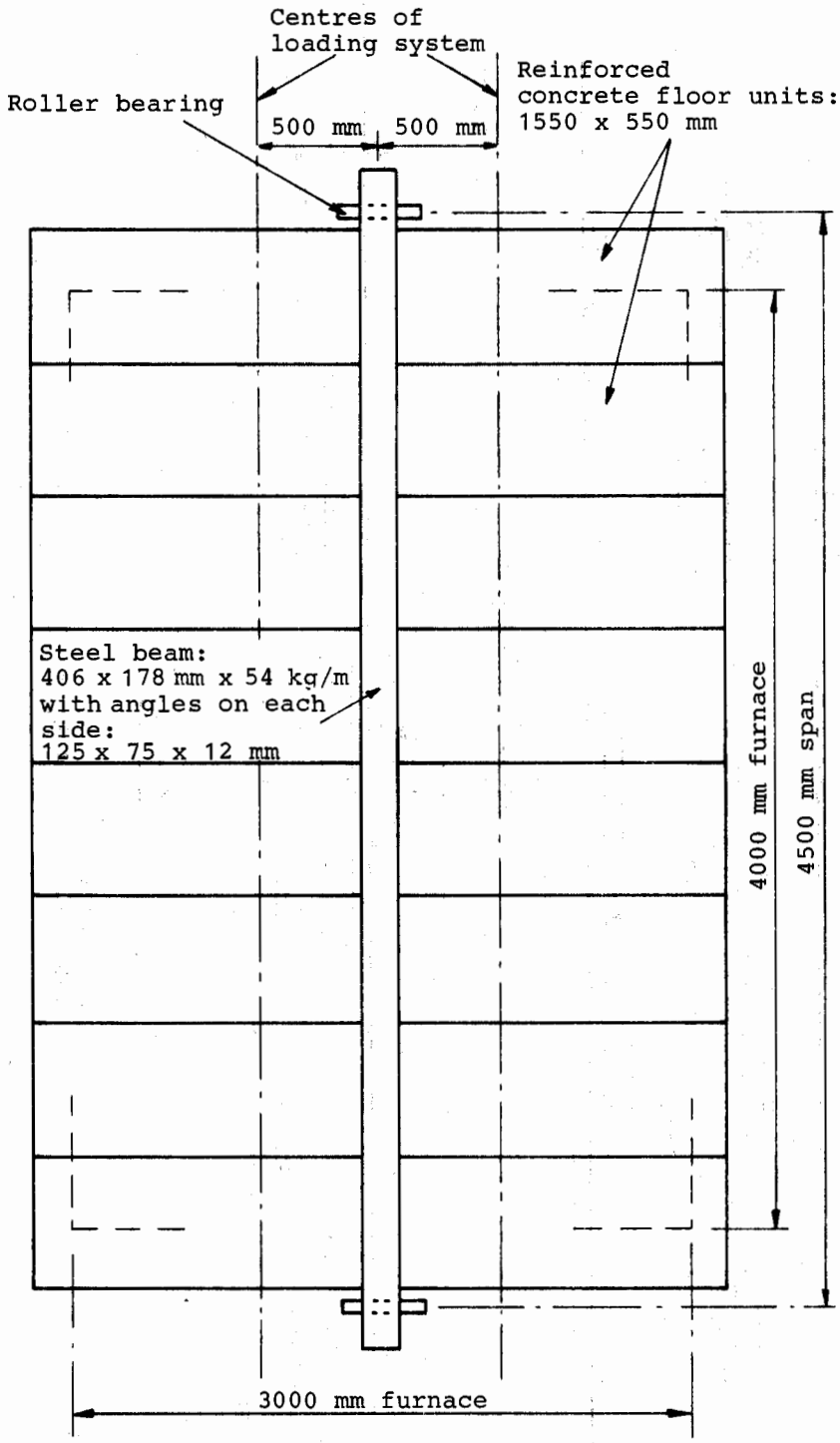
SCHEMATIC ILLUSTRATION SHOWING A PLAN VIEW OF THE THERMAL RESTRAINT FRAME SURROUNDING THE FLOOR BEAM FURNACE

FIG. 7(a)
(R2/7095)



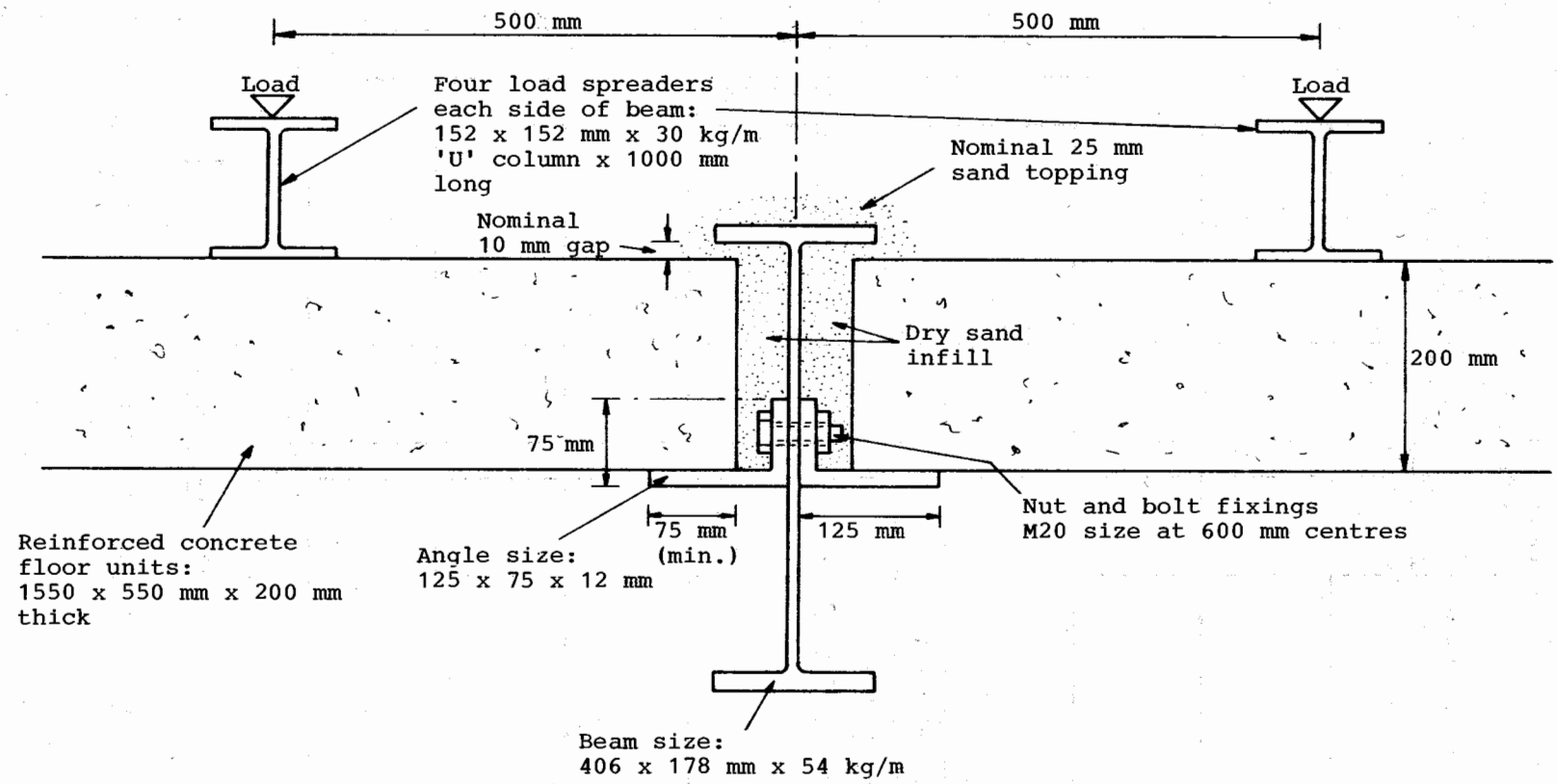
SCHEMATIC ILLUSTRATION SHOWING THE END CONDITIONS OF A FIRE TEST BEAM WITH BOTH THERMAL AND APPLIED ROTATIONAL END RESTRAINT

FIG. 7(b)
(R2/7096)



GENERAL PLAN VIEW OF A SHELF ANGLE FLOOR BEAM TEST ASSEMBLY

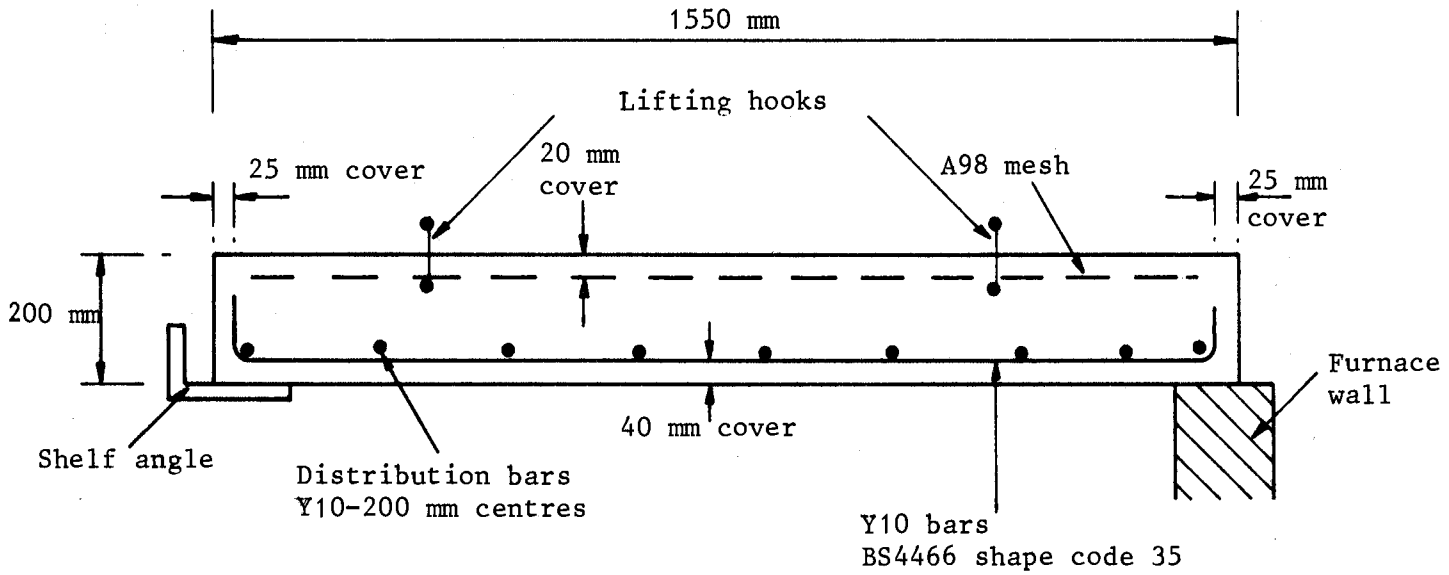
FIG. 8(a)
(R2/7097)



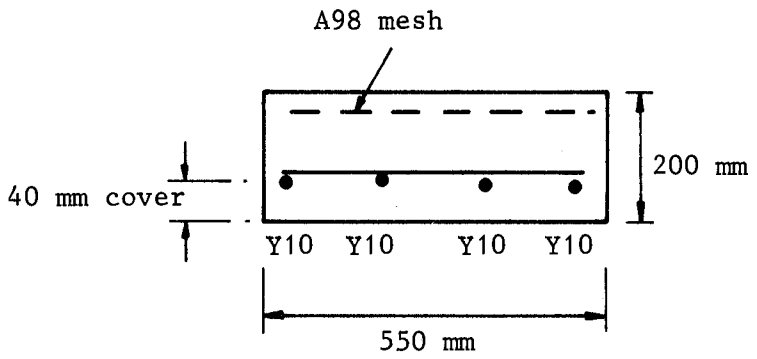
VERTICAL SECTION THROUGH A SHELF ANGLE FLOOR BEAM

FIG. 8(b)
(R2/7098)

Longitudinal Section



Transverse Section



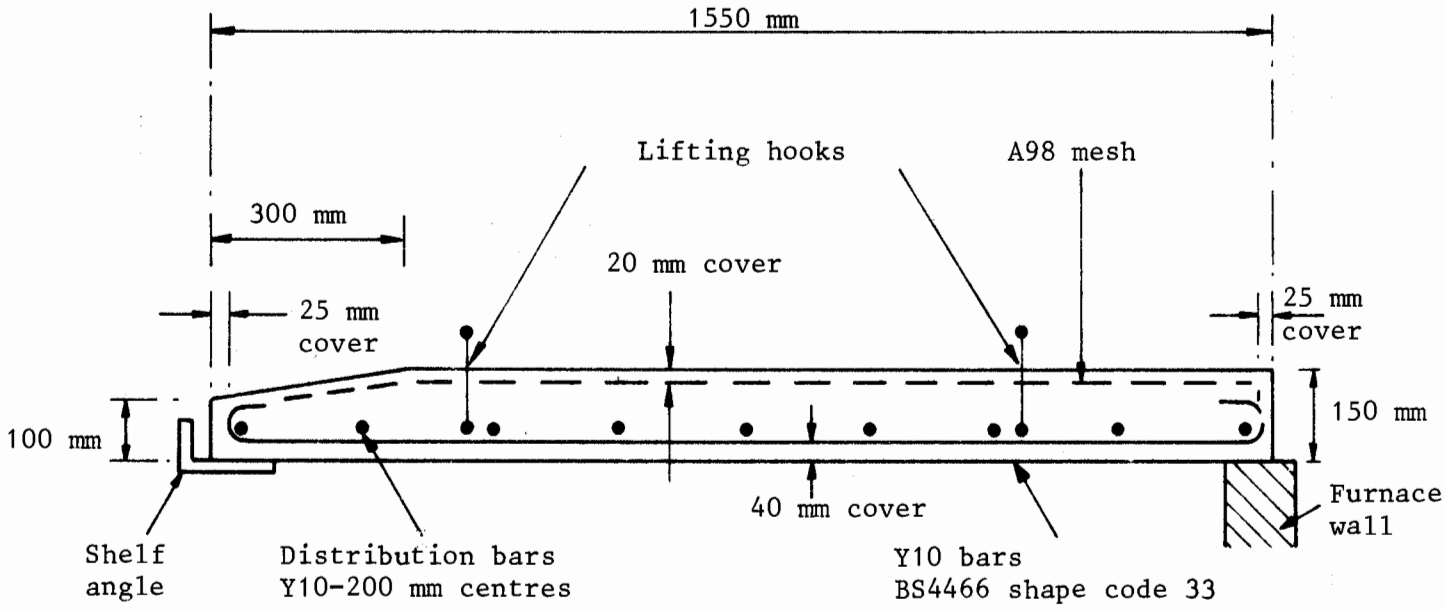
Concrete crushing strength: 25 N/mm² at 28 days

Reinforcement: cold worked high yield bar to BS4461

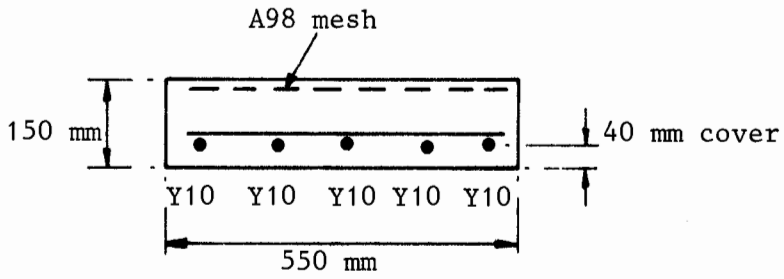
DESIGN DETAILS OF THE REINFORCED CONCRETE FLOOR UNITS

FIG. 9(a)
(R2/7099)

Longitudinal Section



Transverse Section

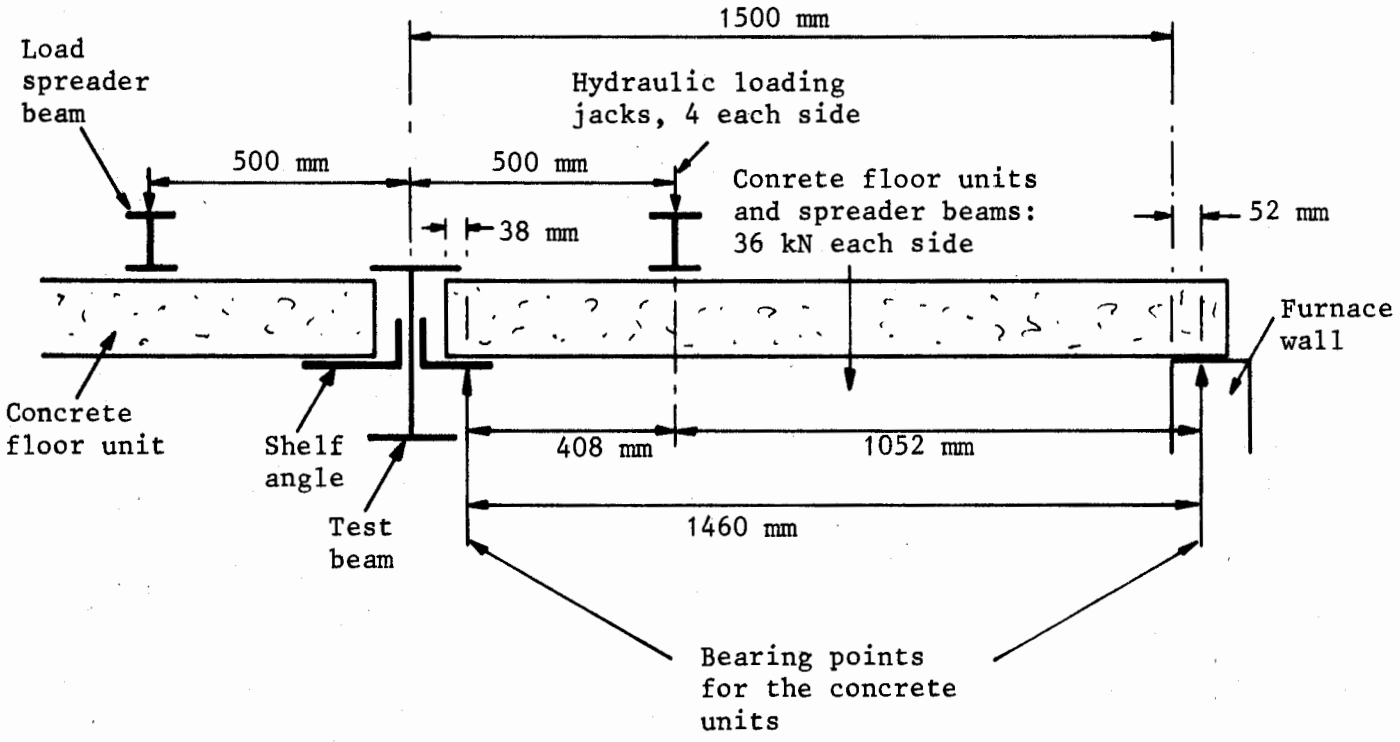


Concrete crushing strength: 25 N/mm² at 28 days

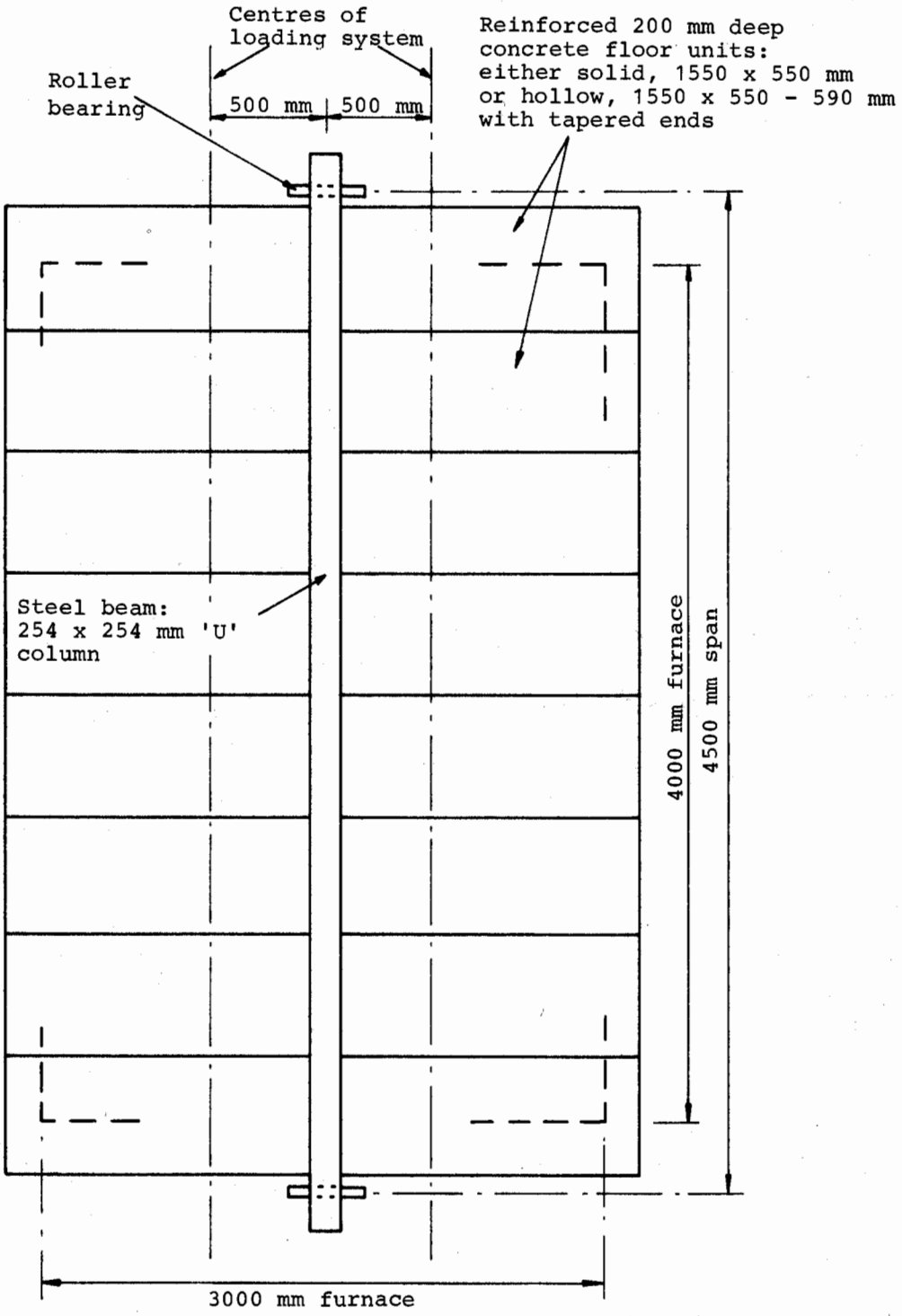
Reinforcement: cold worked high yield bar to BS4461

DESIGN DETAILS OF THE REINFORCED CONCRETE FLOOR UNITS WITH TAPERED ENDS

FIG. 9(b) (R2/7100)

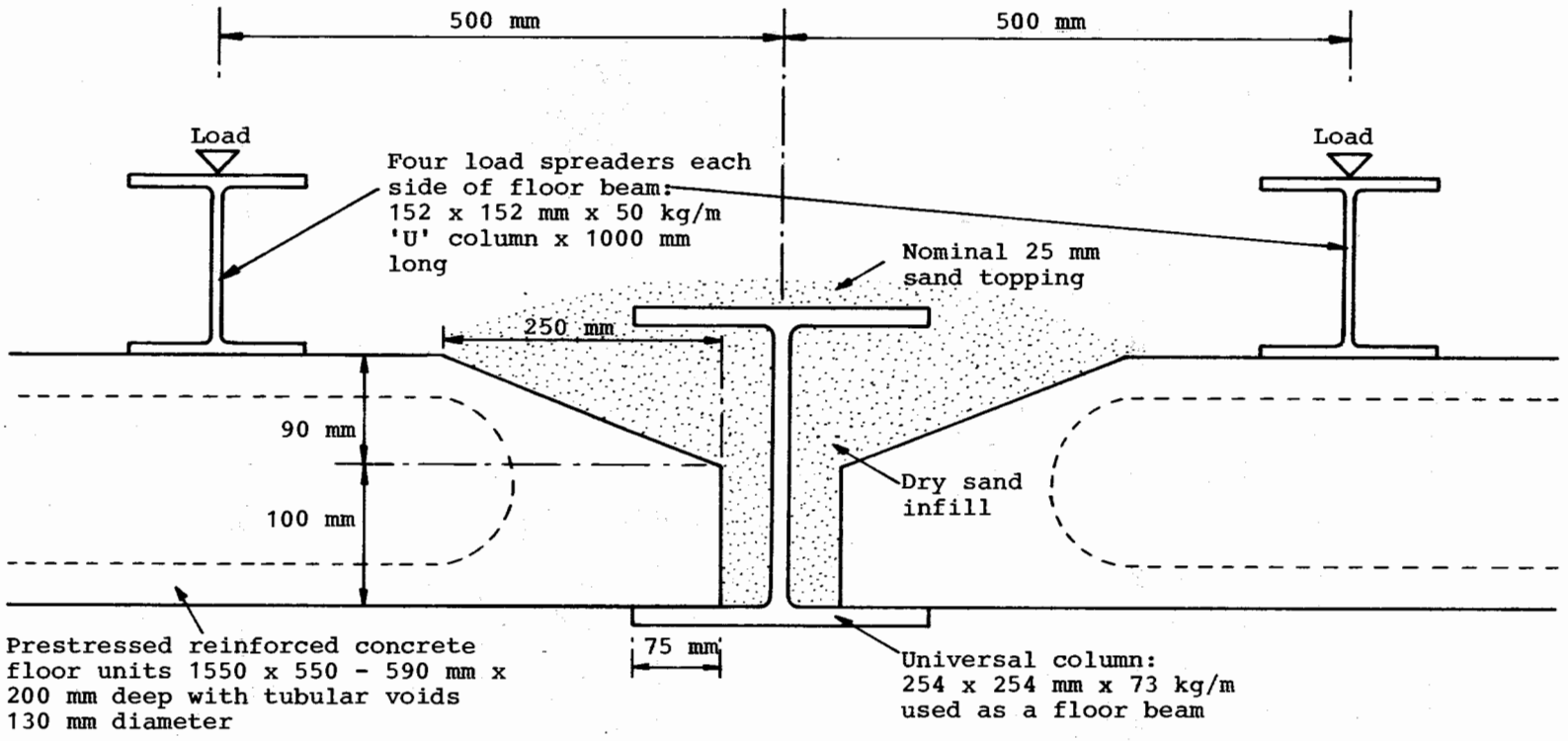


DESIGN DETAILS FOR LOADING A SHELF ANGLE FLOOR BEAM ASSEMBLY FIG. 10 (R2/7101)



GENERAL PLAN VIEW OF A 'SLIM' FLOOR BEAM TEST ASSEMBLY

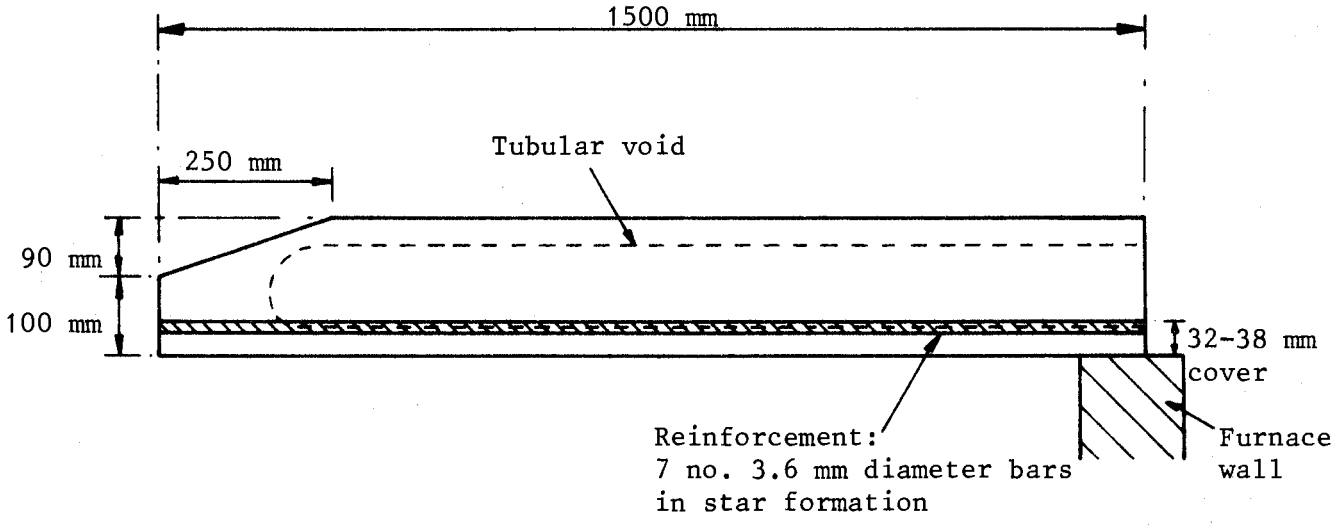
FIG. 11(a)
(R2/7102)



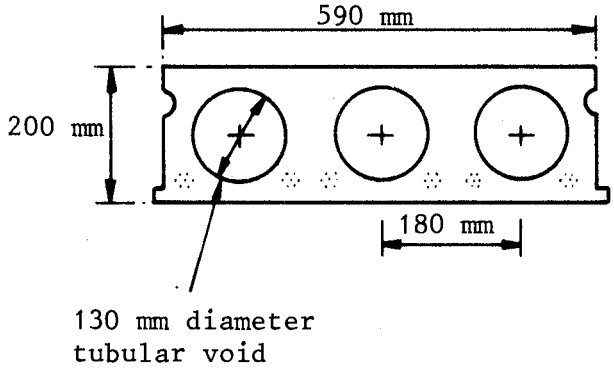
VERTICAL SECTION THROUGH A 'SLIM' FLOOR BEAM WITH HOLLOW CONCRETE FLOOR UNITS

FIG. 11(b)
(R2/7103)

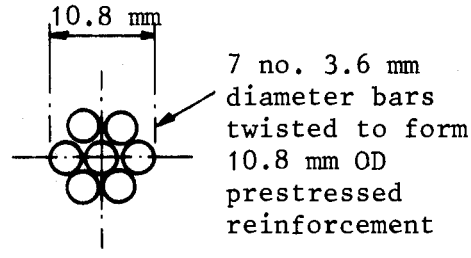
Longitudinal Section



Transverse Section



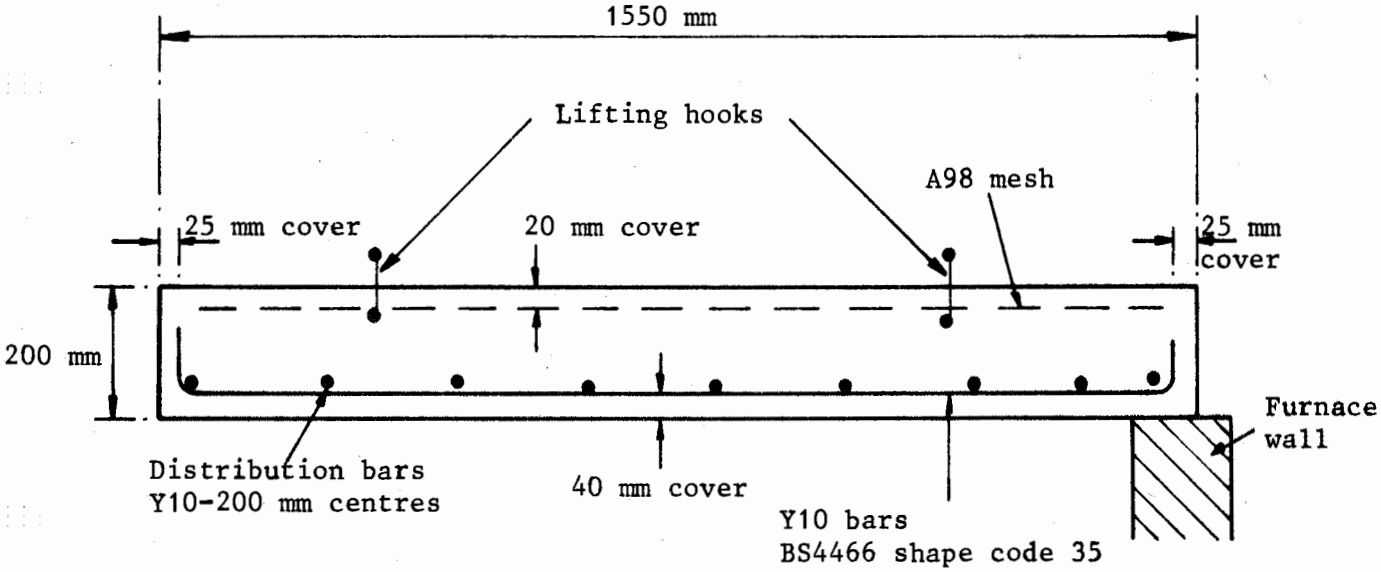
Reinforcement Detail



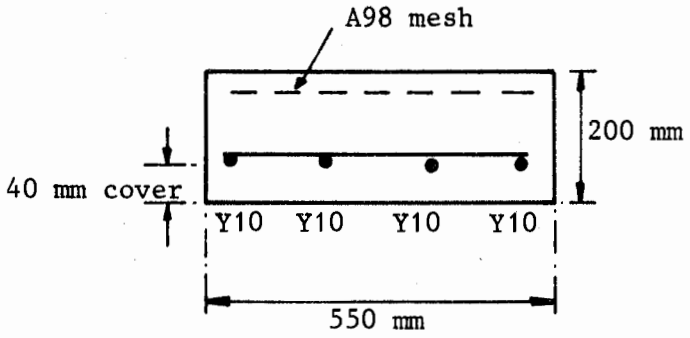
DESIGN DETAILS OF THE 'SPIROLL' FLOOR UNITS

FIG. 12(a)
(R2/7104)

Longitudinal Section



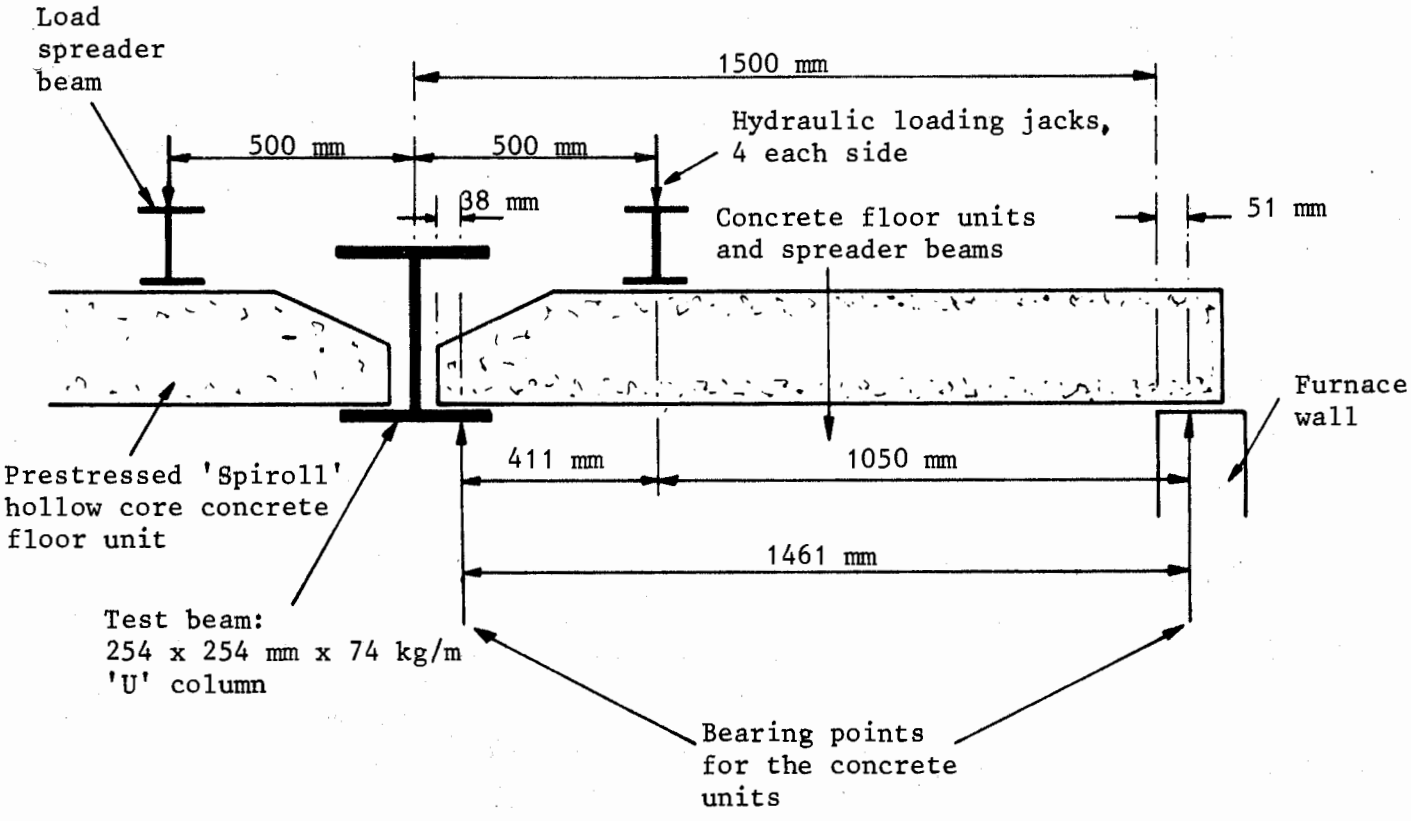
Transverse Section



Concrete crushing strength: 25 N/mm² at 28 days

Reinforcement: cold worked high yield bar to BS4461

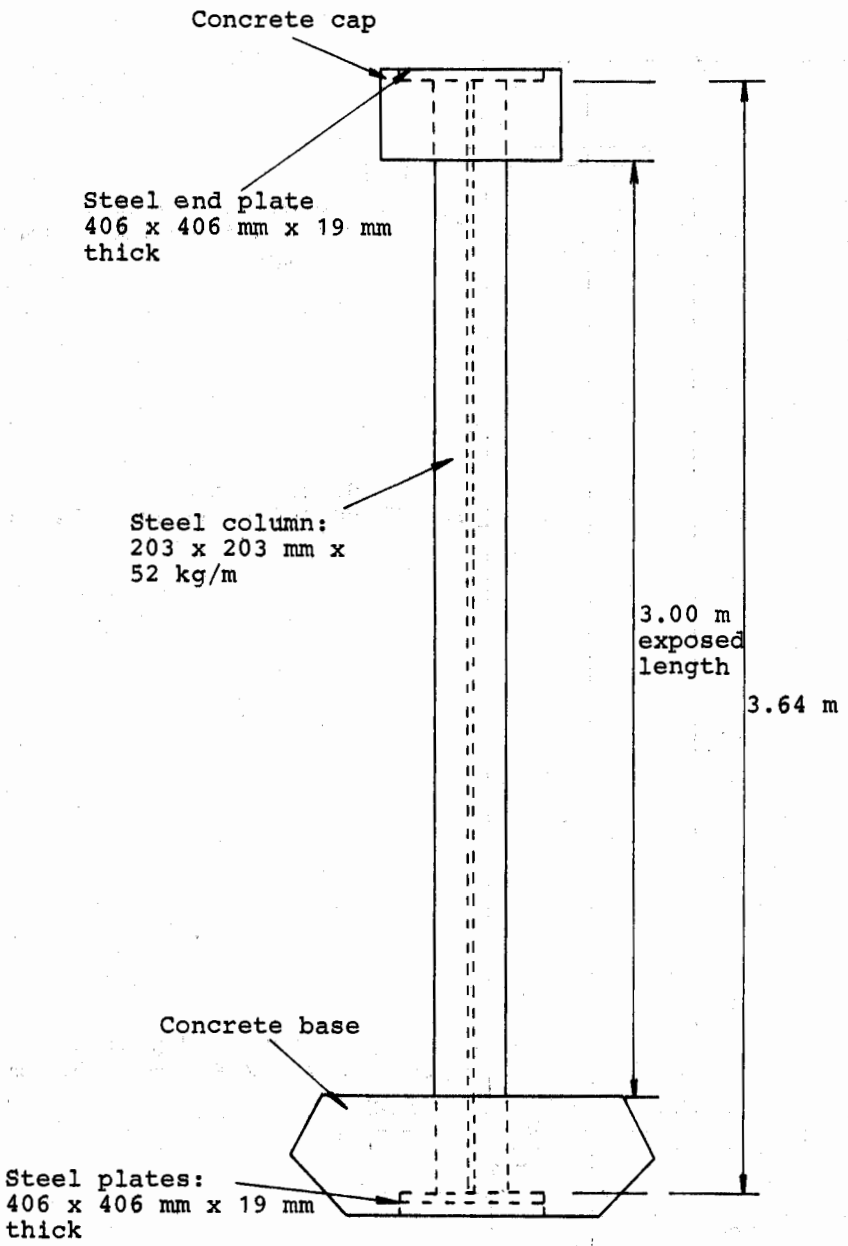
DESIGN DETAILS OF THE SOLID REINFORCED CONCRETE FLOOR UNITS FIG. 12(b) (R2/7105)



DESIGN DETAILS FOR LOADING A 'SLIM' FLOOR BEAM ASSEMBLY FIG. 13
(R2/7106)

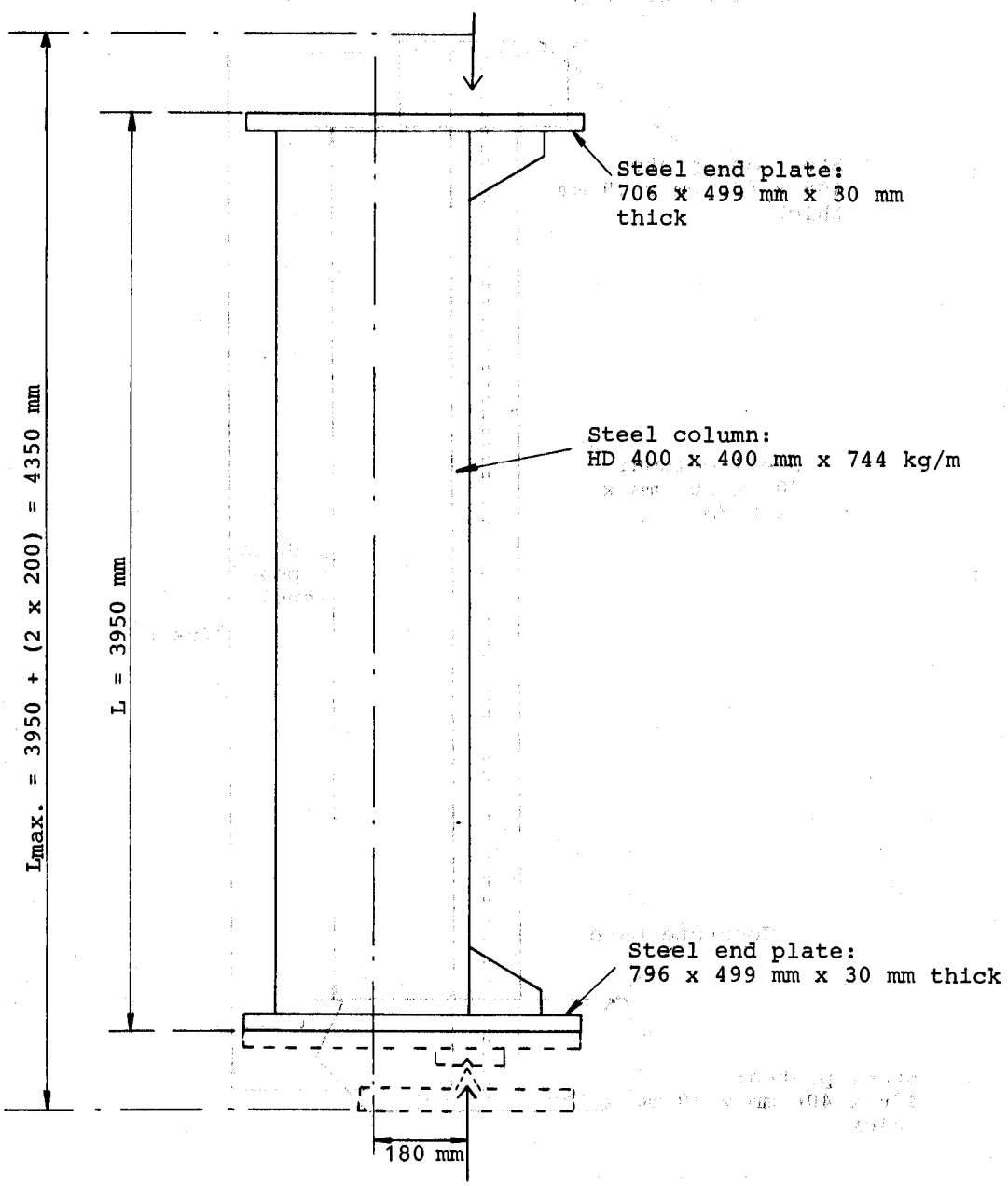
THE COLUMN FURNACE FIRE TEST FACILITY AT FIRTO, BOREHAMWOOD
FIG. 14(a)

A STEEL COLUMN WITH A BLOCKED IN WEB FOLLOWING A FIRE TEST
FIG. 14(b)



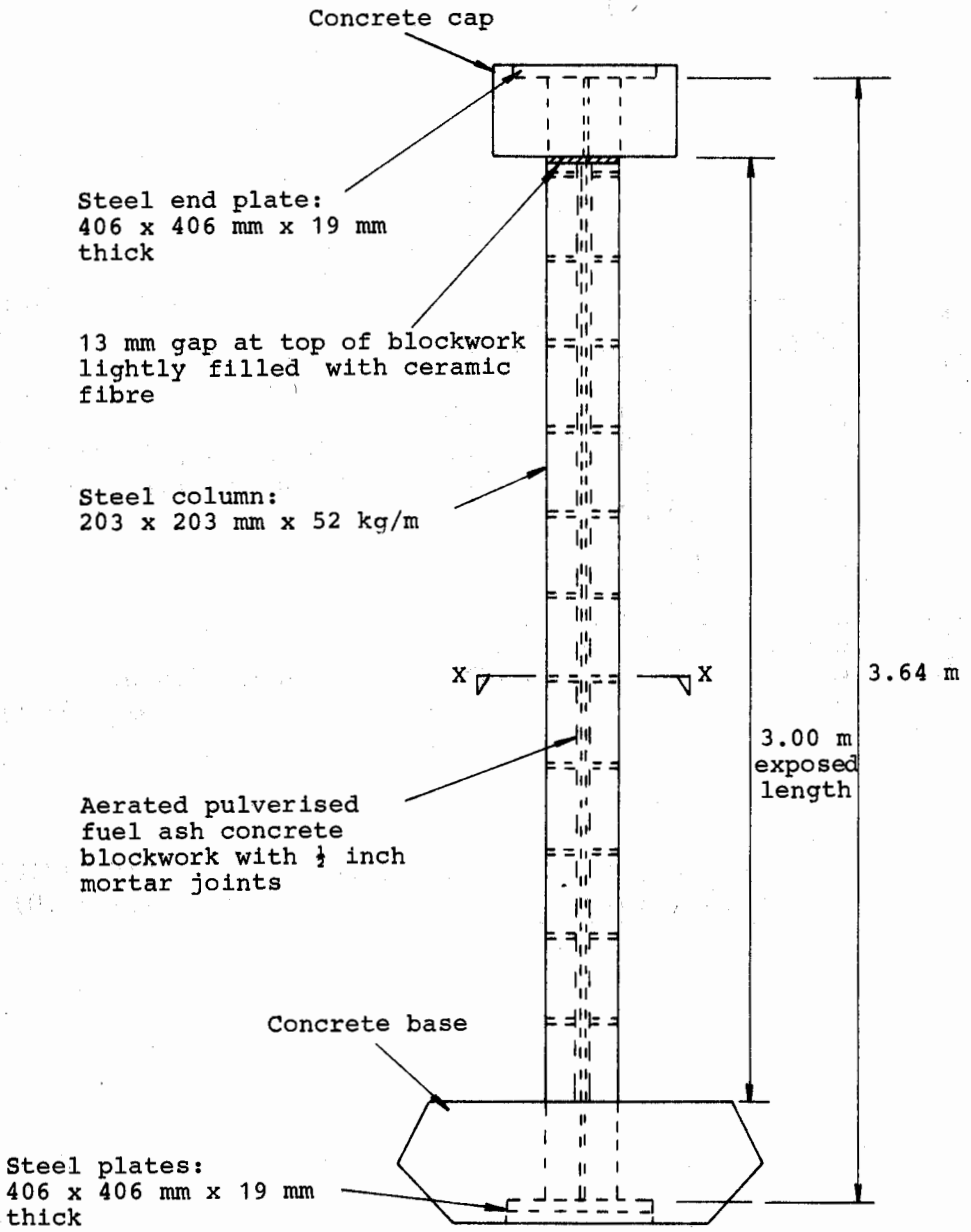
VERTICAL SECTION OF AN UNPROTECTED COLUMN TEST ASSEMBLY (UK)

FIG. 15
(R2/7107)



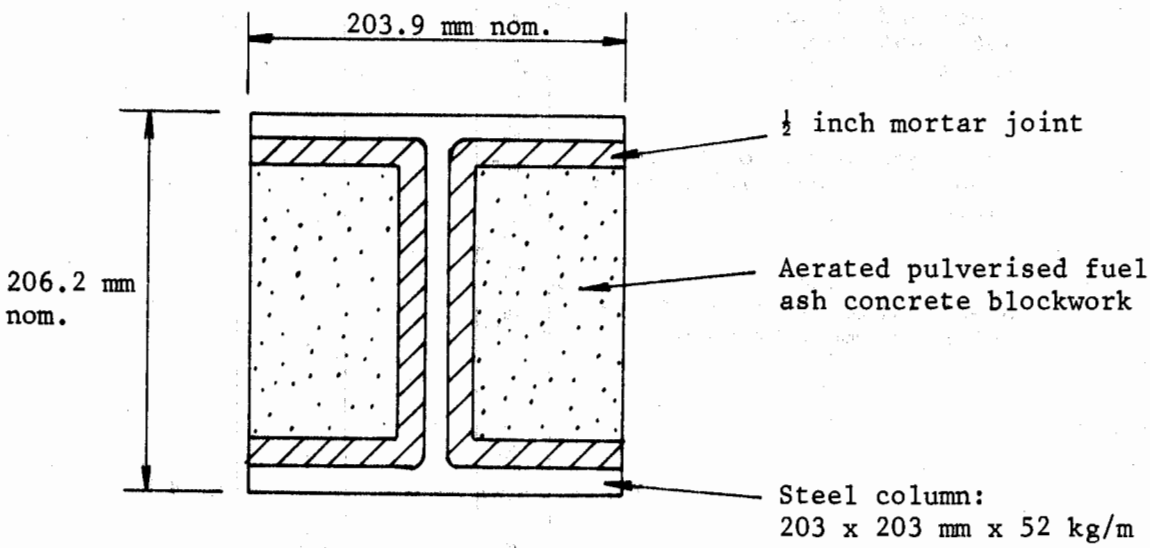
VERTICAL SECTION OF AN UNPROTECTED COLUMN TEST ASSEMBLY SPONSORED BY ARBED SA

FIG. 16
(R2/7108)



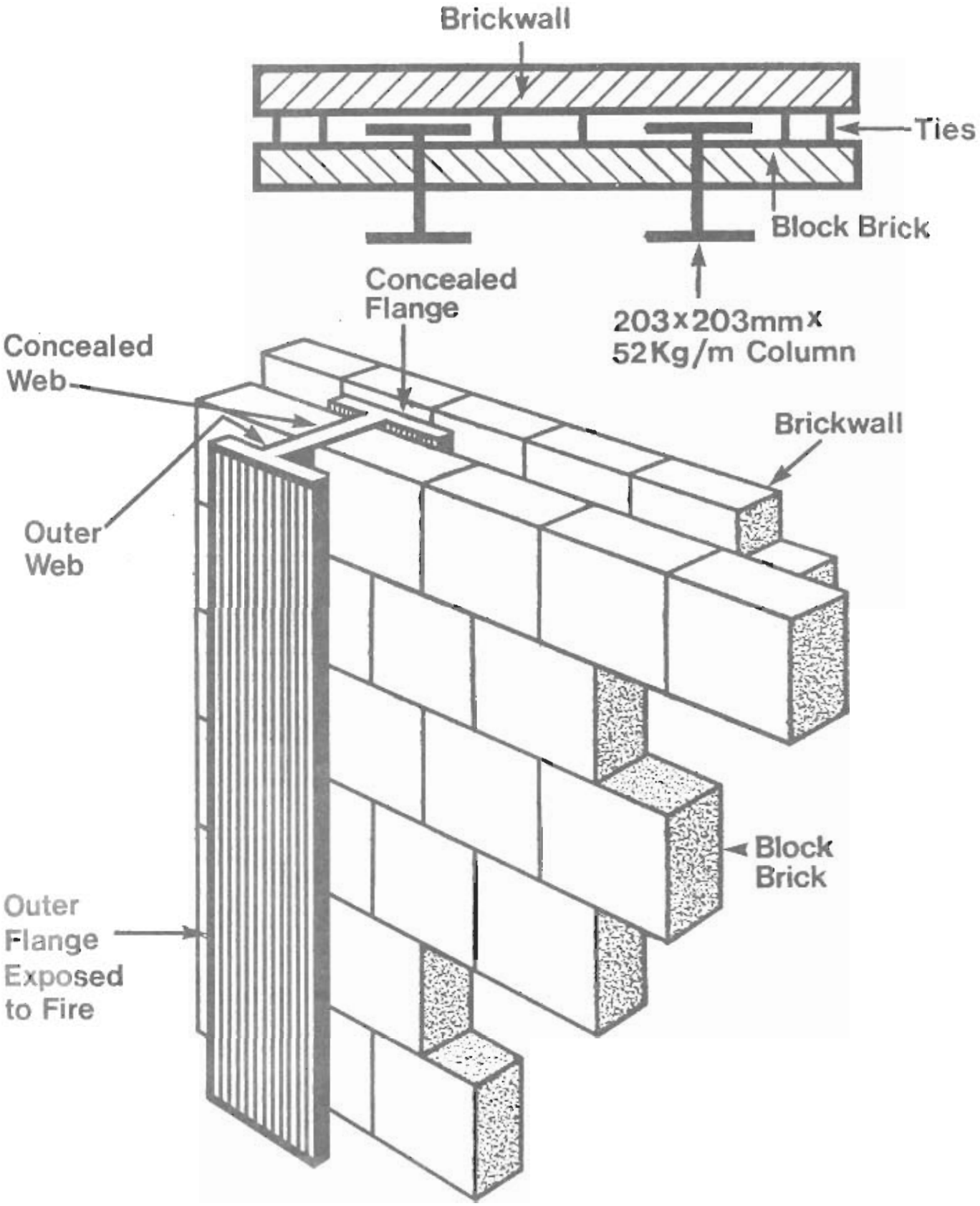
VERTICAL SECTION OF A COLUMN TEST ASSEMBLY
WITH THE WEB PROTECTED BY LIGHTWEIGHT BLOCKWORK

FIG. 17(a)
(R2/7109)

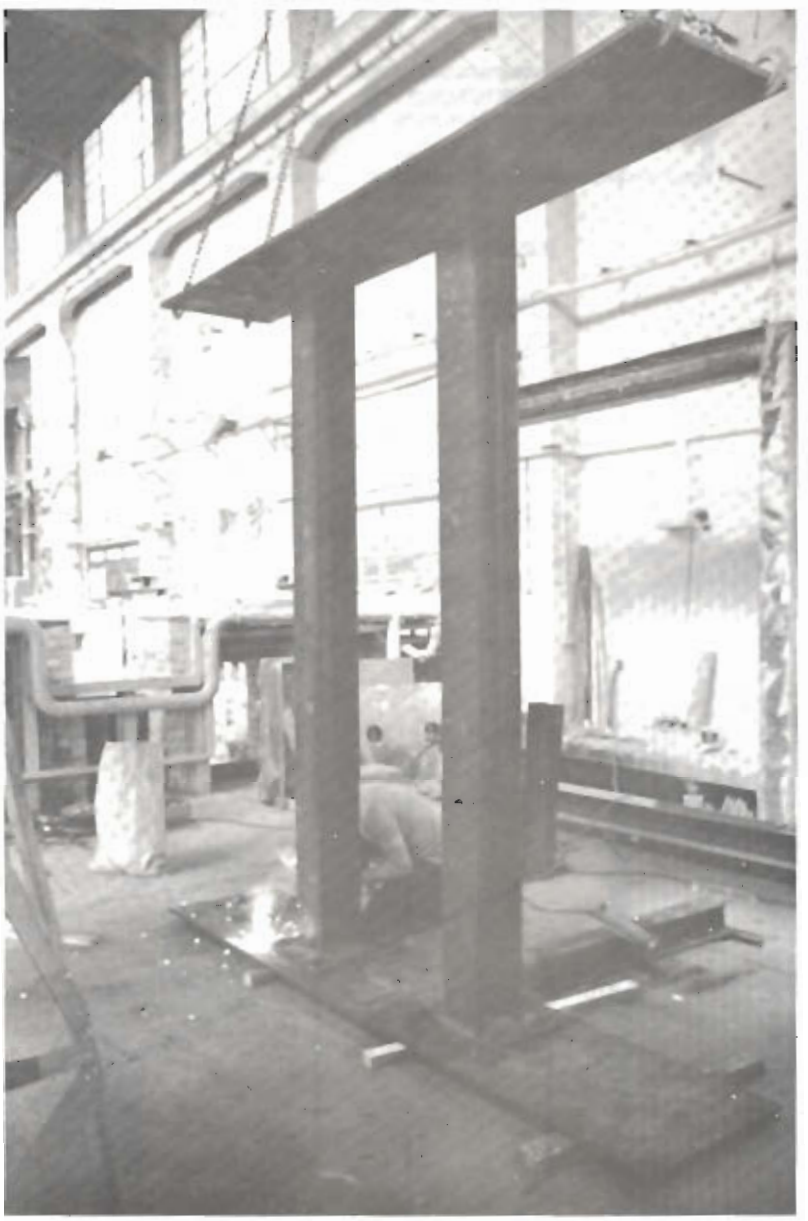


SECTION X-X THROUGH A STEEL COLUMN WITH A BLOCKED IN WEB

FIG. 17(b)
(r2/7110)



CONFIGURATION OF A STEEL COLUMN BUILT INTO WALL FIG. 18

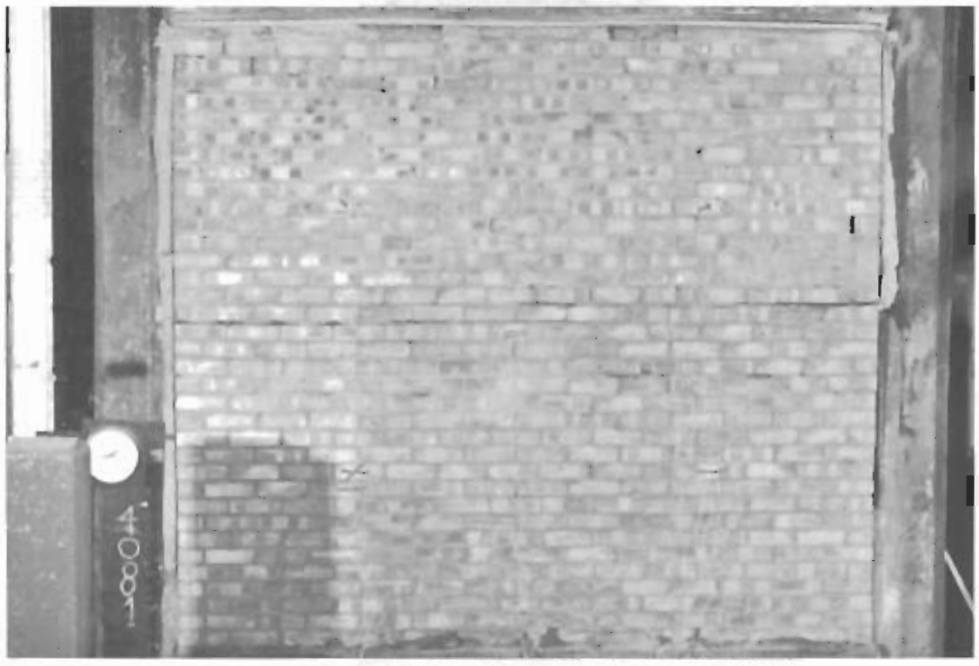


FABRICATION OF THE WALL TEST ASSEMBLY
FIG. 19(a)

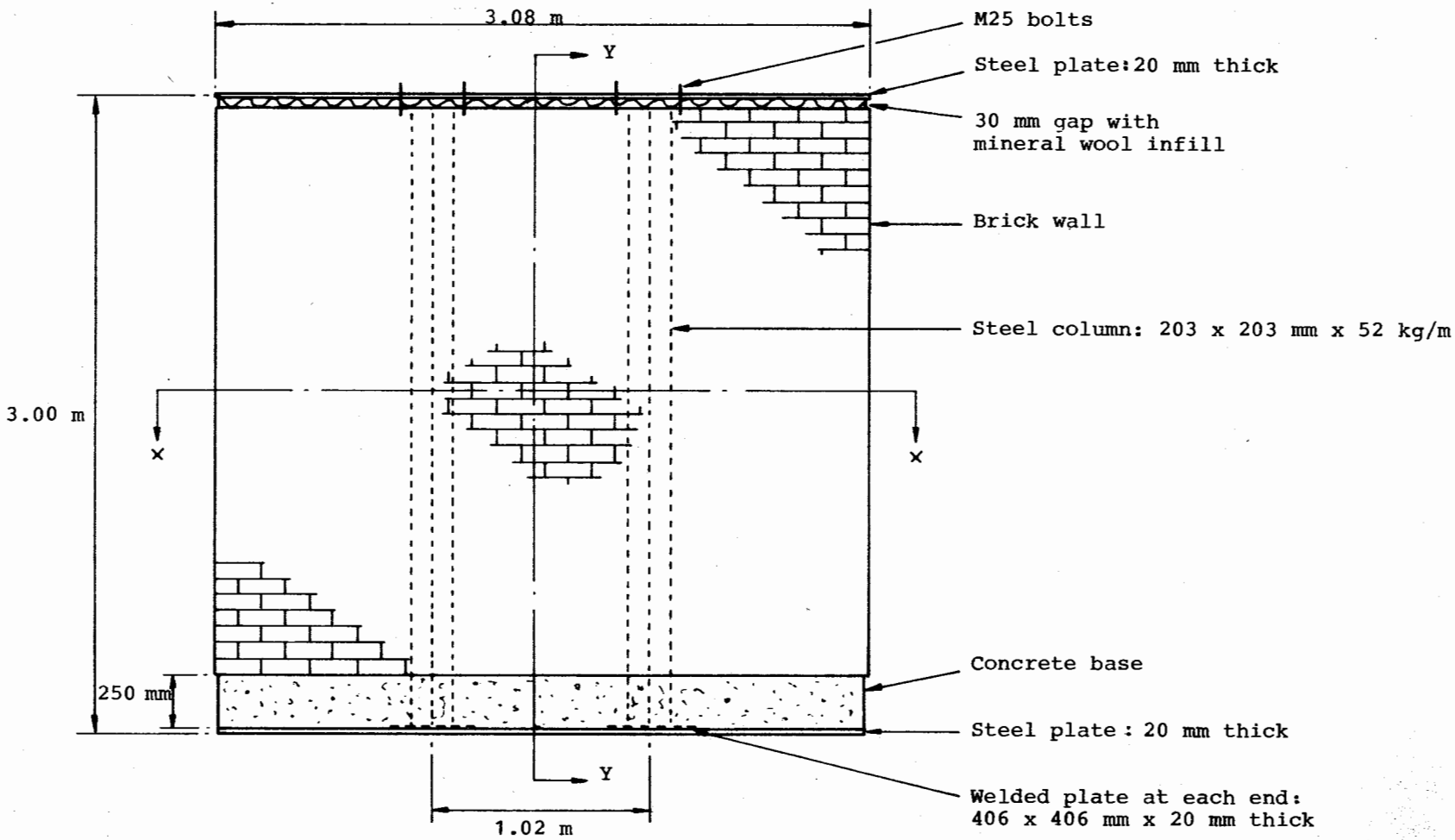
THE EXPOSED WALL SURFACE
BEFORE TESTING
FIG. 19(b)

THE UNEXPOSED WALL SURFACE
BEFORE TESTING
FIG. 19(c)

THE EXPOSED WALL SURFACE AFTER TESTING
FIG. 19(d)

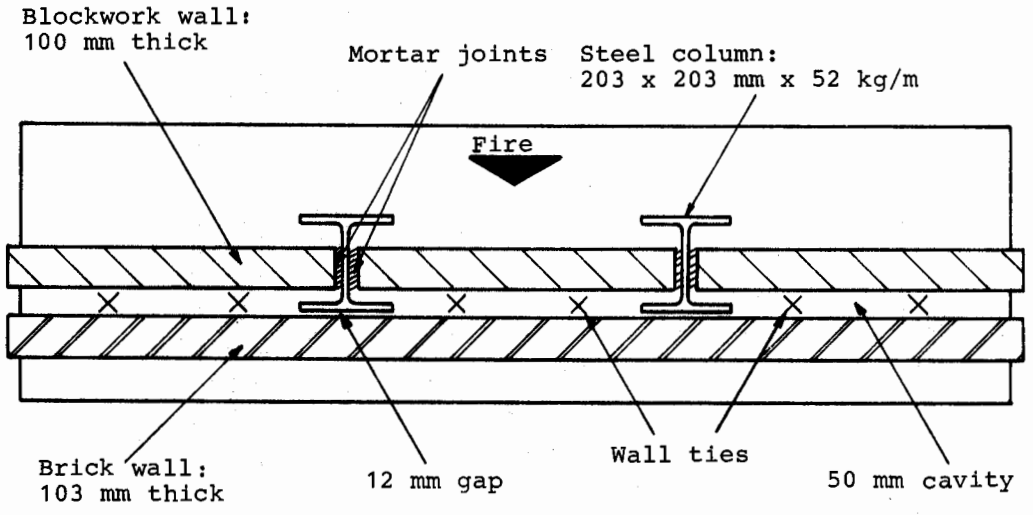


THE UNEXPOSED WALL SURFACE AFTER TESTING
FIG. 19(e)



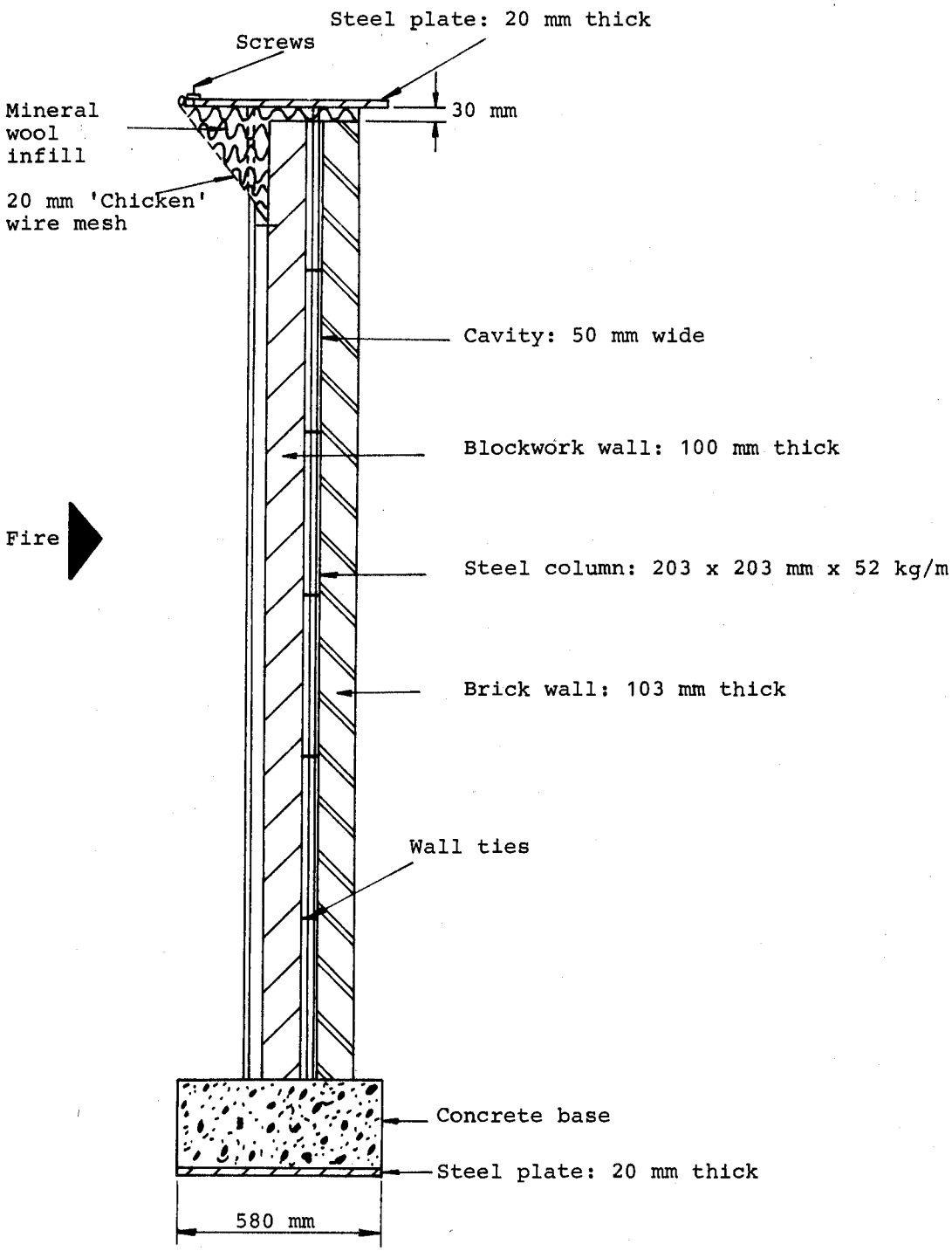
GENERAL ARRANGEMENT OF A WALL ASSEMBLY WHEN VIEWED FROM THE UNEXPOSED FACE

FIG. 20(a)
(R2/7111)



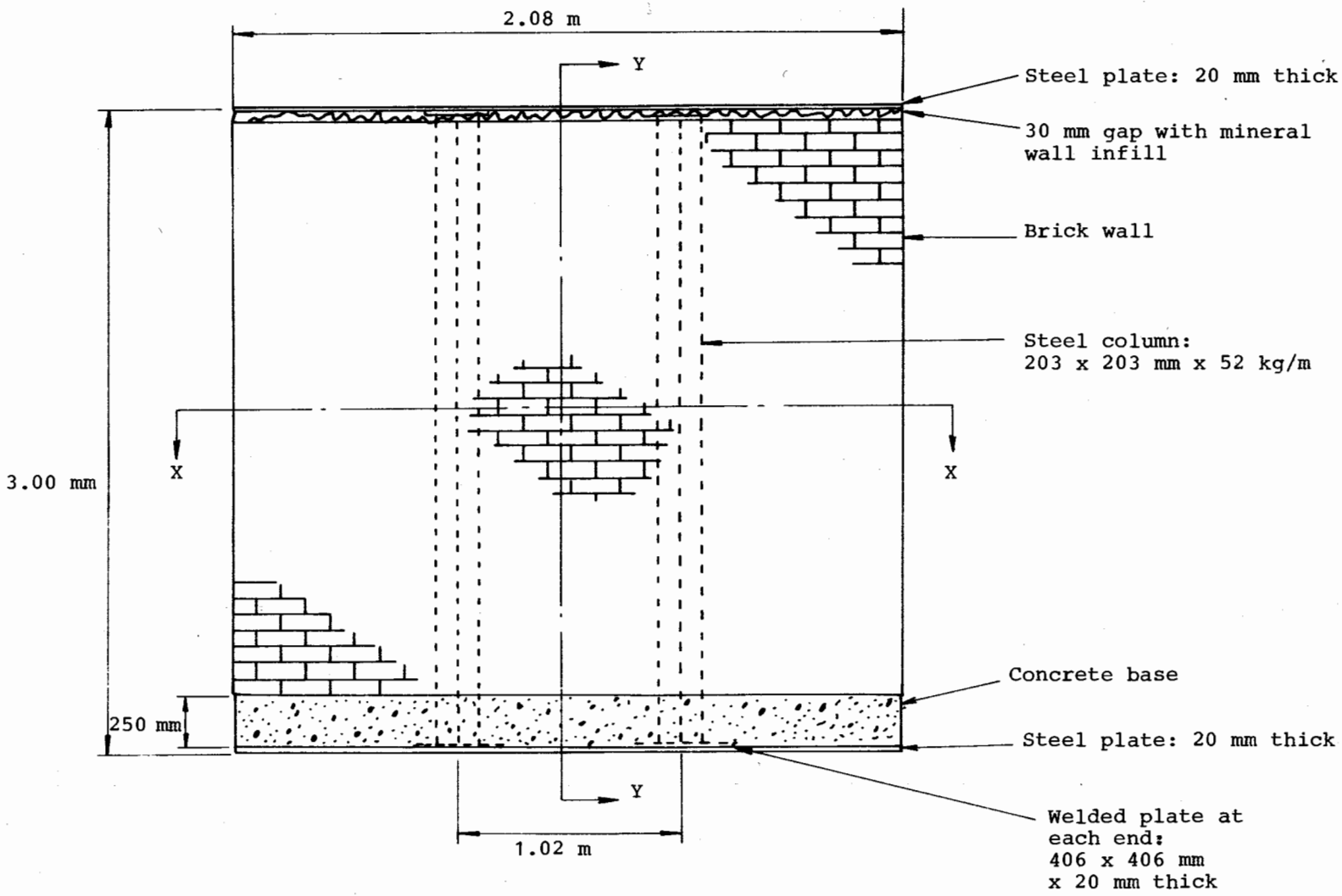
SECTION X-X THROUGH WALL ASSEMBLY

FIG. 20(b)
(R2/7112)



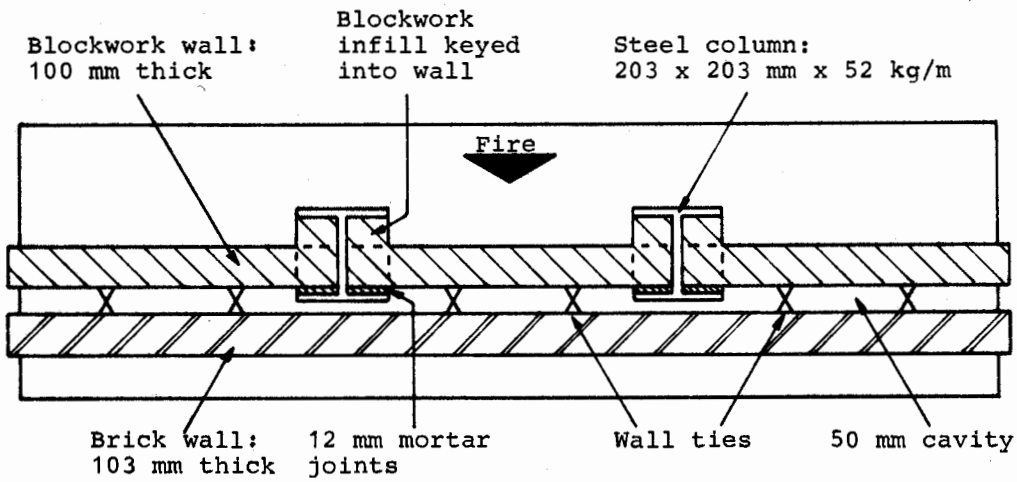
SECTION Y-Y THROUGH WALL ASSEMBLY

FIG. 20(c)
(R2/7113)



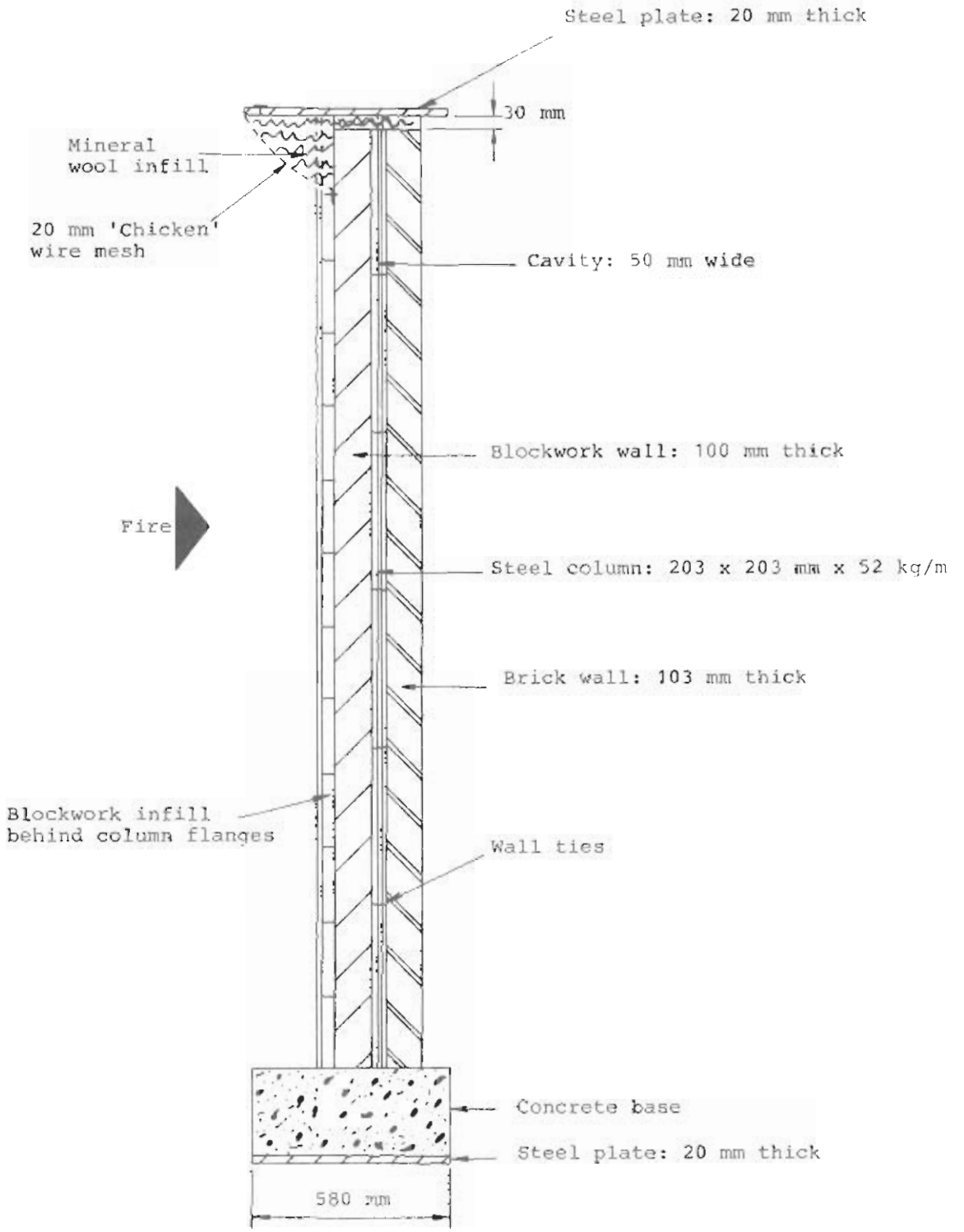
GENERAL ARRANGEMENT OF A WALL ASSEMBLY WHEN VIEWED FROM THE UNEXPOSED FACE

FIG. 21(a)
(R2/7114)



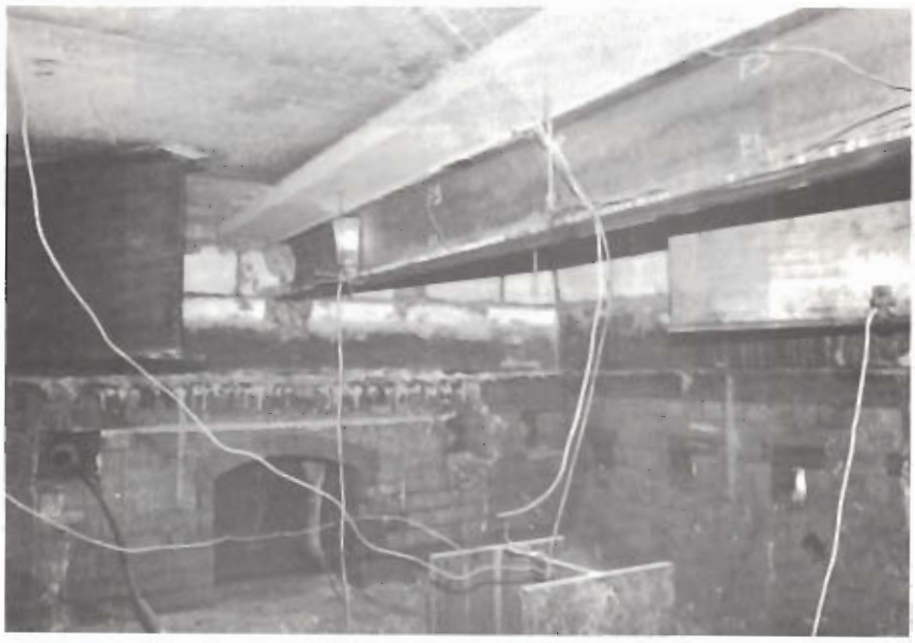
SECTION X-X THROUGH WALL ASSEMBLY

FIG. 21(b)
(R2/7115)



SECTION Y-Y THROUGH WALL ASSEMBLY

FIG. 21(c)
(R2/7116)

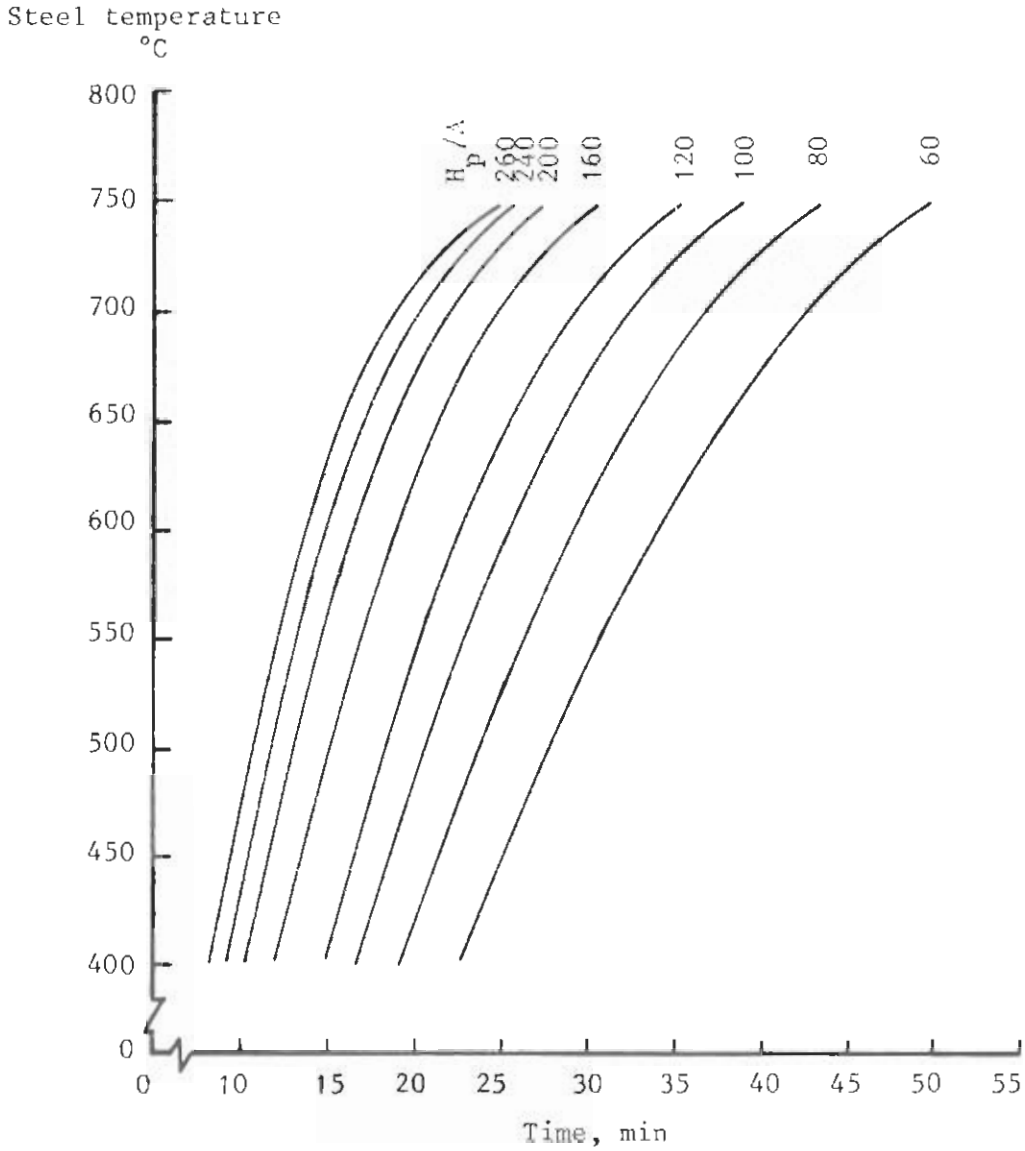


FLOOR BEAM WITH INDICATIVE BEAMS
BOLTED TO THE UNDERSIDE OF THE FURNACE ROOF
FIG. 22

INDICATIVE COLUMNS PLACED ON PLINTHS
ON THE FLOOR OF THE BEAM FURNACE
FIG. 23

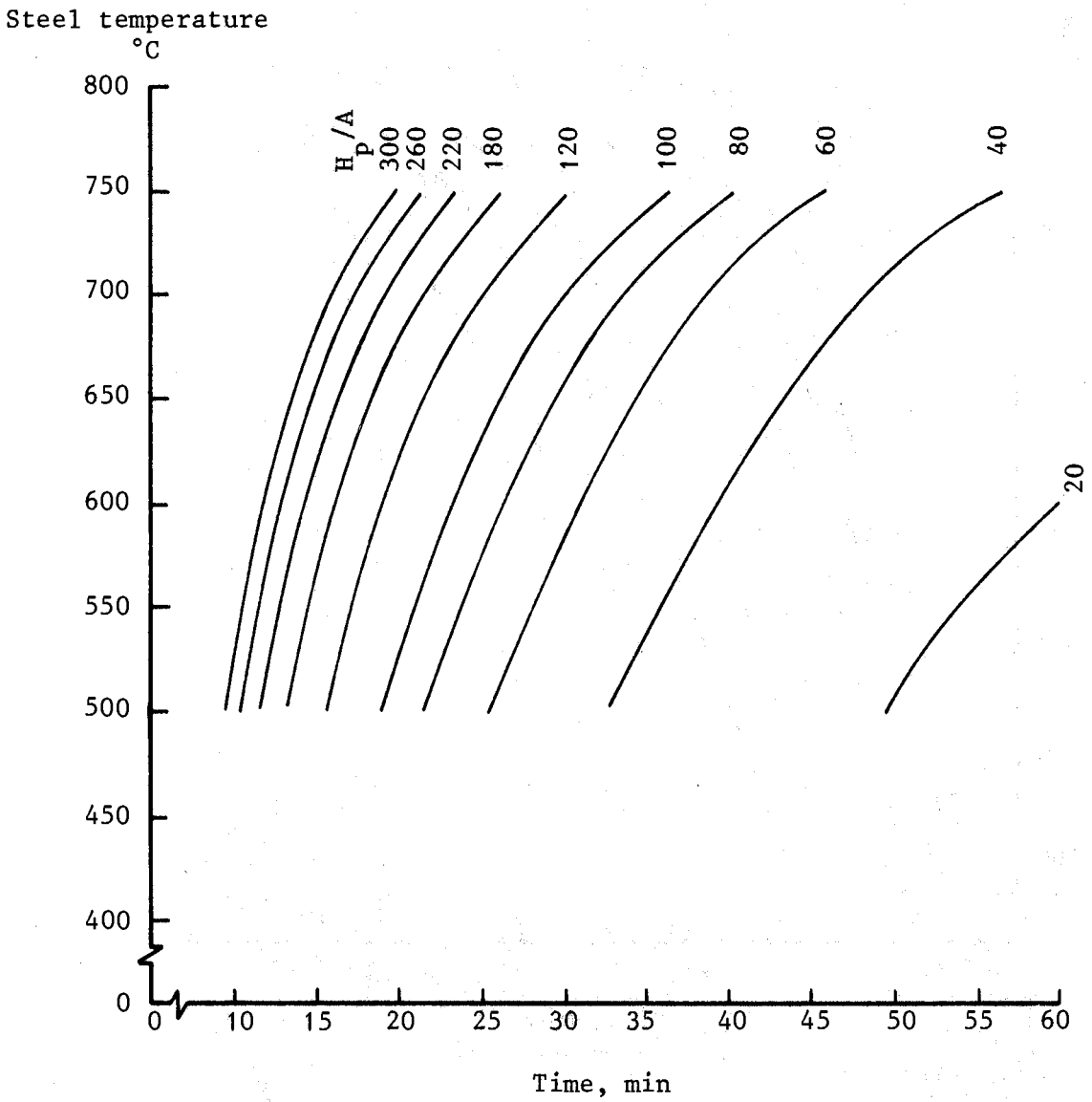
THE 1 m CUBE FURNACE AT WARRINGTON RESEARCH CENTRE
SHOWING THE UNEXPOSED SURFACE
OF A PERIMETER BEAM SET IN THE WALL
FIG. 24(a)

THE EXPOSED SIDE OF A PERIMETER BEAM
SET IN THE WALL OF THE 1 m CUBE FURNACE (AFTER TESTING)
FIG. 24(b)



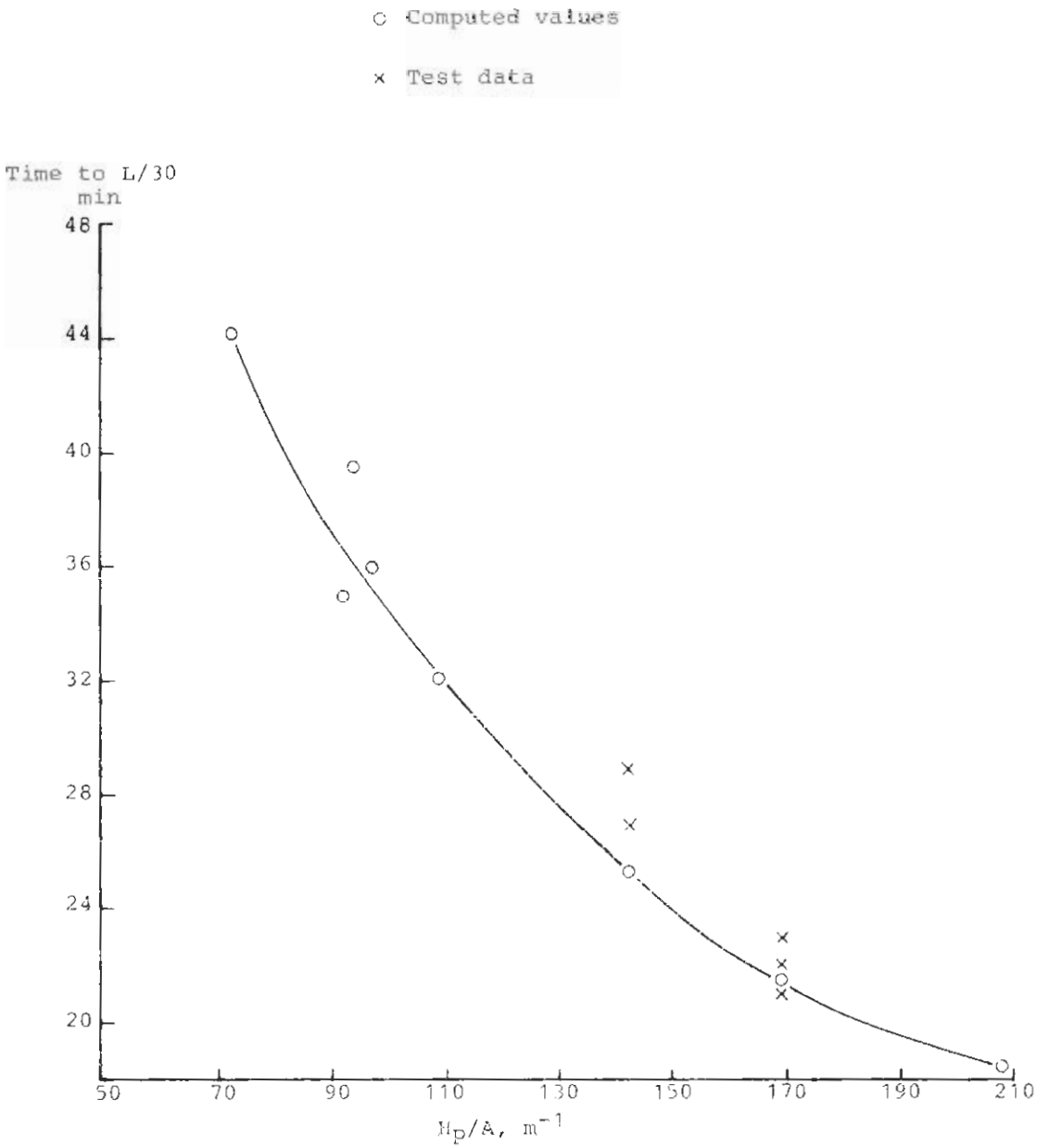
HEATING CURVES FOR BARE STEEL FLOOR BEAMS IN THE BS476:PART 8:1972 FIRE TEST (LOWER FLANGE TEMPERATURES)

FIG. 25
(R2/7117)



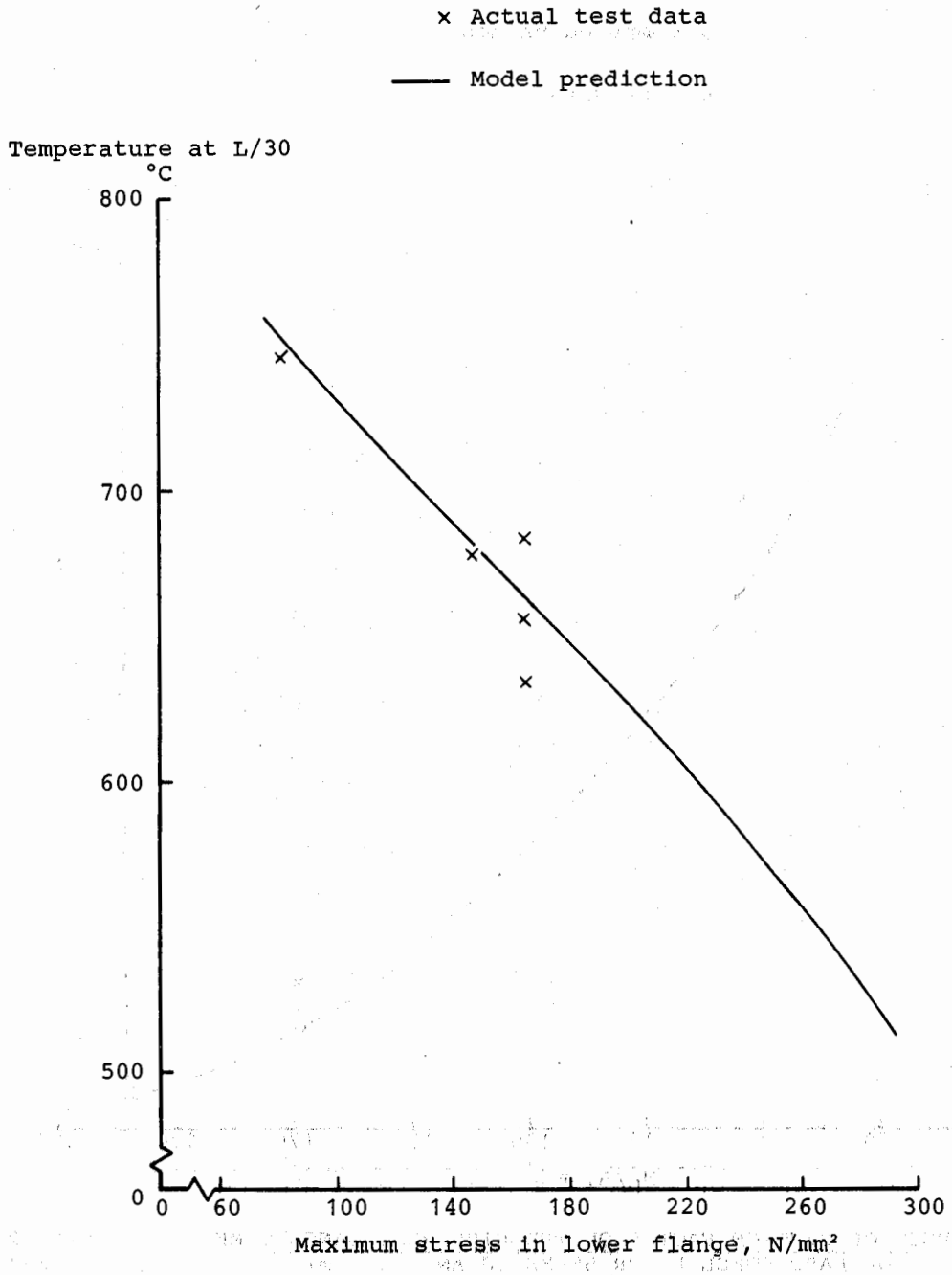
HEATING CURVES FOR BARE STEEL COLUMNS IN THE BS476:PART 8:1972 FIRE TEST (AVERAGE TEMPERATURES WEB AND BOTH FLANGES)

FIG. 26 (R2/7118)



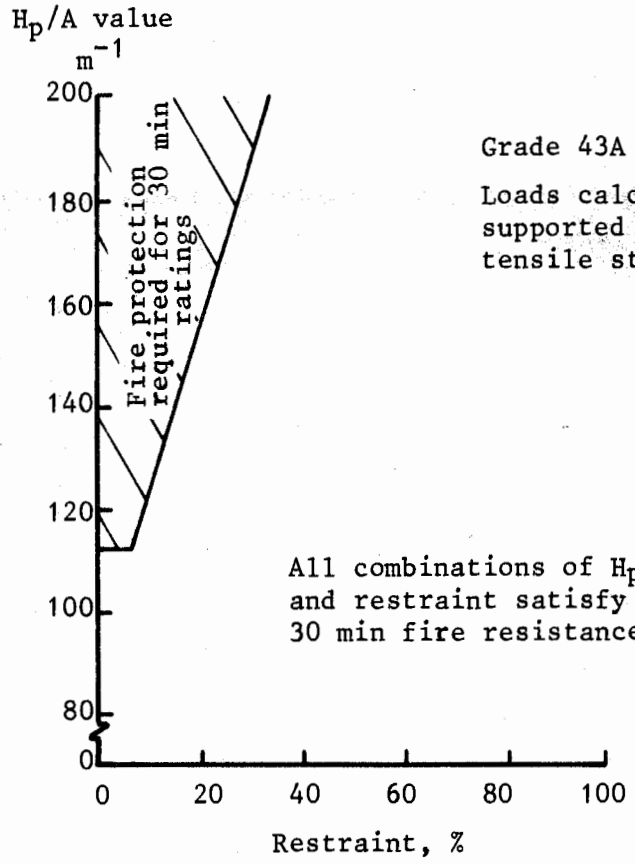
EFFECT OF SECTION FACTOR ON THE FIRE RESISTANCE TIME OF BARE STEEL FLOOR BEAMS (SPAN = 4.5 m)

FIG. 27
(R2/7119)



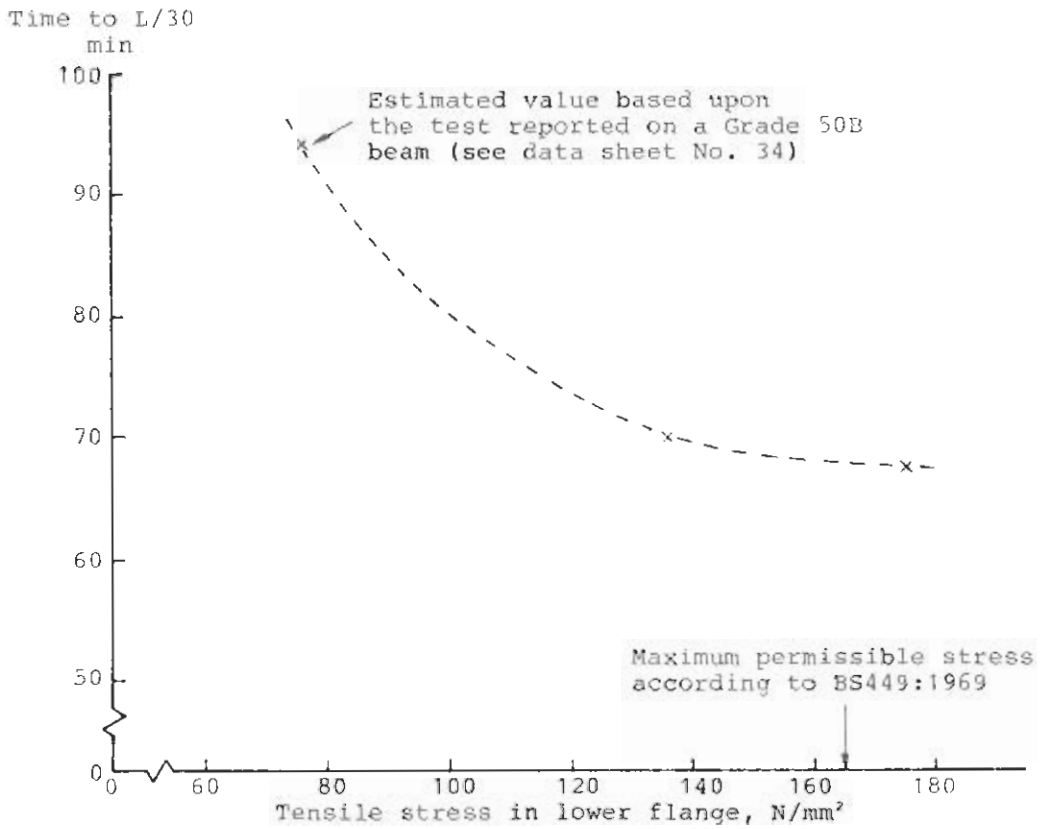
EFFECT OF DESIGN STRESS ON THE LIMITING TEMPERATURE IN THE LOWER FLANGE OF UNPROTECTED SIMPLY SUPPORTED 254 x 146 mm x 43 kg/m FLOOR BEAMS IN THE BS476:PART 8:1972 FIRE TEST (SPAN = 4.5 m)

FIG. 28
(R2/7120)



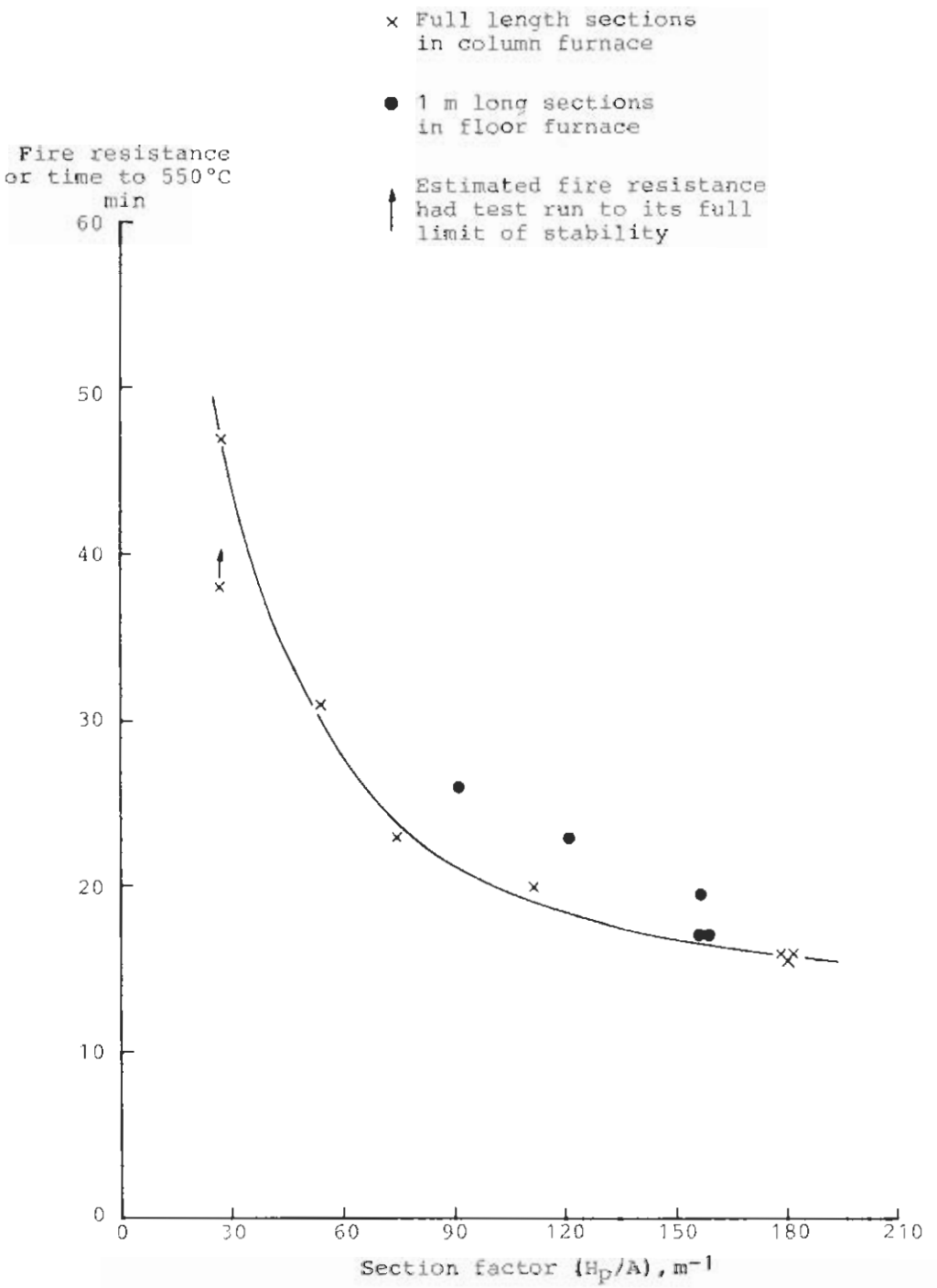
APPROXIMATE ANALYSIS FOR COMBINATIONS OF RESTRAINT AND H_p/A VALUES REQUIRED TO PROVIDE 30 min FIRE RESISTANCE FOR UNPROTECTED STEEL BEAMS (SPAN = 4.5 m)

FIG. 29
(R2/7121)



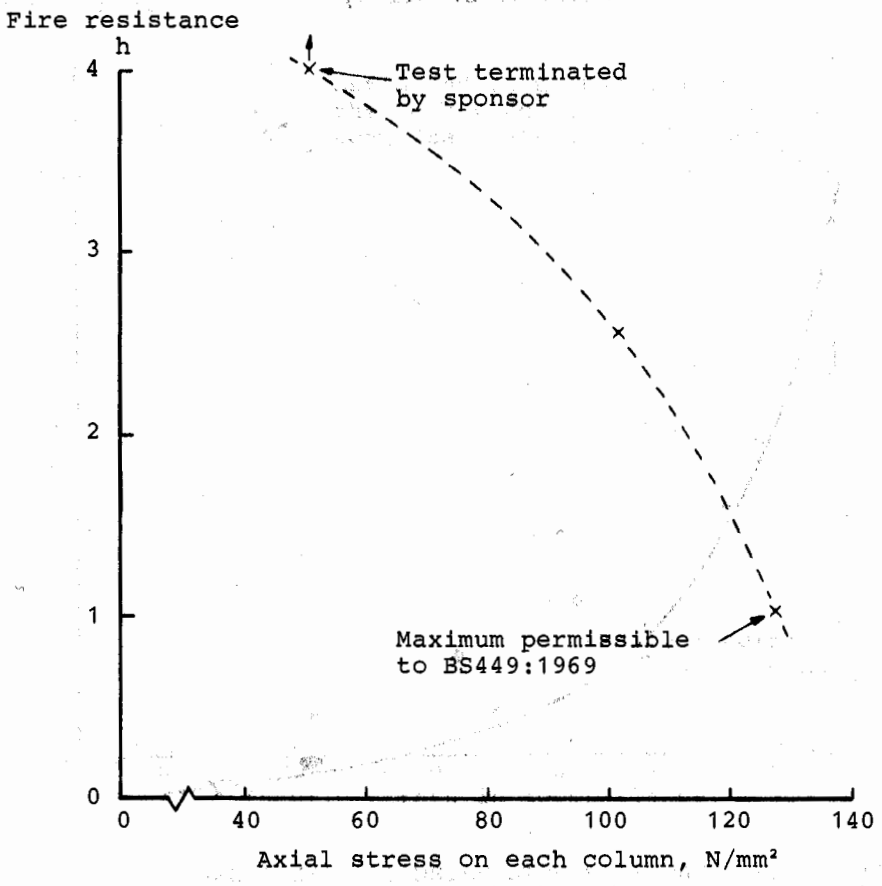
THE INFLUENCE OF TENSILE STRESS ON THE FIRE RESISTANCE OF BS4360:GRADE 43A 406 x 178 mm x 54 kg/m SHELF ANGLE FLOOR BEAMS WITH 200 mm DEEP PRECAST CONCRETE UNITS

FIG. 30
(R2/7122)



THE INFLUENCE OF SECTION FACTOR ON THE FIRE RESISTANCE OF BARE STEEL COLUMNS

FIG. 31
(R2/7123)



THE INFLUENCE OF AXIAL STRESS ON THE FIRE RESISTANCE OF 203 x 203 mm x 52 kg/m COLUMNS BUILT INTO A CAVITY WALL WITH THE EXPOSED WEBS BLOCKED IN

FIG. 32 (R2/7124)

APPENDIX A BS476:PART 8:1972 FIRE TESTS

	Test Configuration	Data Sheet No.
I	Simply supported floor beam	1-14
II	Simply supported floor beam with composite action between the steel and concrete	15-16
III	Floor beam with applied rotational end restraining moments	17-28
IV	Floor beam with applied rotational and longitudinal thermal restraint	29-31
V	Shelf angle floor beam	32-37
VI	'Slim' floor beam	38-39
VII	Column	40-43
VIII	Column with blocked in web	44-47
IX	Columns in wall	48-49
X	Columns and beams in wall with blocked in webs	50-53
XI	Indicative	54-83

DATA SHEET NUMBER **1a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.4	262	147	*	*					6479.0	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.29	0.02	0.96	0.017	0.044	0.013	0.005	0.031	0.005	0.018	0.005	0.005	0.0107

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	284	484	29.0
WEB	306	504	27.0

TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN	:	4.500 m
DEAD LOAD	:	2.272 kN/m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	145.5 N/mm2 (b)
CENTRAL BENDING MOMENT	:	71.970 kN.m (c)
CENTRAL BENDING MOMENT FROM DEAD LOAD	:	5.751 kN.m
CENTRAL BENDING MOMENT REQUIRED FROM IMPOSED LOAD	:	66.219 kN.m
LOADS APPLIED (d)	:	44.15 kN

NOTES

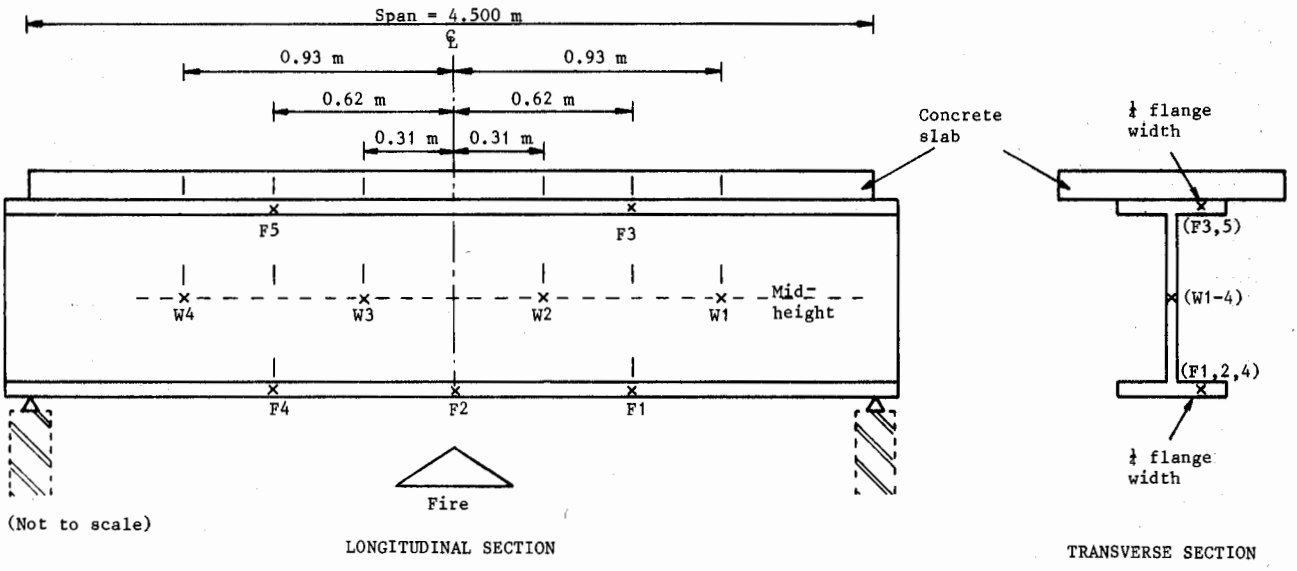
(a) Slab size = 130 mm thick x 650 mm wide
Slab mass per metre = 1.857 kN
(b) Equals 88.2% of the maximum allowable bending stress to BS 449 : Part 2 : 1969 for a Grade 43A steel section
(c) Calculation based upon deriving the required loads at two loading points only
(d) Two loading points each located 1.5 m from supports
(e) Initial ambient temperature = 21 deg. C
(*) Not measured

ALTHOUGH THIS TEST WAS CARRIED OUT FULLY IN ACCORDANCE WITH BS476: PART 8, THE RESULTS ARE SIGNIFICANTLY AT VARIANCE WITH ALL OTHER BEAM TESTS

This was possibly due to the following :-

1 The test beam was subject to 2 point loading (all other beam tests in this publication were loaded at 4 points)
2 Despite the combustion gas furnace temperature following the ISO 834 heating curve, the heating rate of the steel was uncharacteristically slow for this size of beam

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

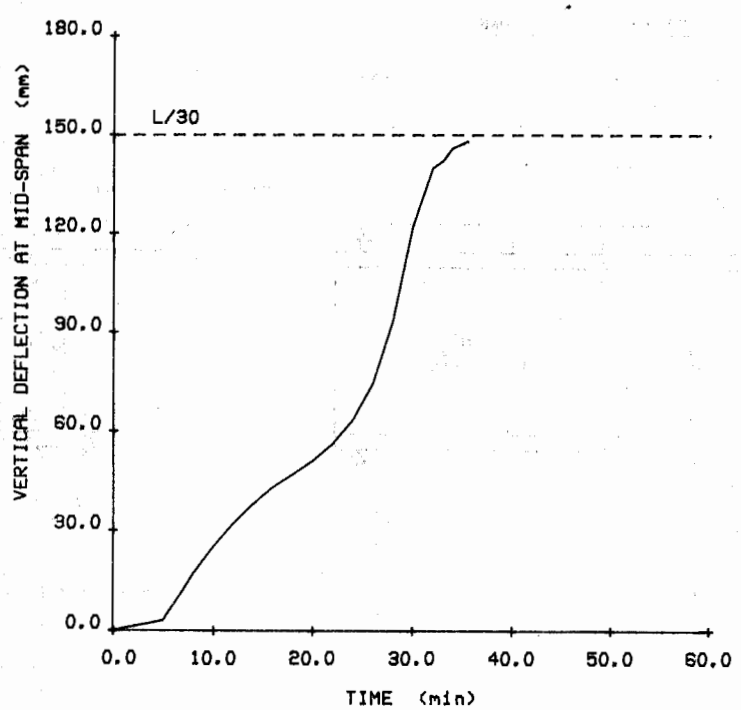
(R2/7124A)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 28th. AUGUST 1979
TEST NUMBER	: W.R.C.S.I. 24826

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 35.5 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 35.5 MINUTES
FIRE RESISTANCE	: 35.5 MINUTES

DATA SHEET NUMBER **1b**

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	35.5
UPPER FLANGE	F3	41	82	114	149	179	211	240	270	300	329	360	387	418	448	481	512	539	561
	F5	30	59	88	123	162	195	222	252	280	306	333	360	386	412	440	470	493	509
	MEAN	36	71	101	136	171	203	231	261	290	318	347	374	402	430	461	491	516	535
WEB	W1	65	148	219	295	373	432	474	510	538	559	581	602	622	637	651	670	681	696
	W2	60	139	207	277	341	397	442	477	505	527	550	571	593	609	625	645	658	672
	W3	70	170	253	326	393	446	487	519	541	560	579	599	614	626	641	659	673	681
	W4	88	184	269	346	420	472	512	543	568	586	608	629	647	662	677	693	702	715
	MEAN	71	160	237	311	382	437	479	512	538	558	580	600	619	633	649	667	679	691
LOWER FLANGE	F1	43	108	172	241	313	375	429	475	509	535	559	581	600	617	632	649	662	673
	F2	41	101	166	238	311	376	431	476	509	533	555	575	593	609	626	641	656	666
	F4	47	119	190	266	344	415	472	518	551	577	600	619	639	654	669	684	697	707
	MEAN	44	109	176	248	323	389	444	490	523	548	571	592	611	627	642	658	672	682
MEAN FURNACE GAS		459	569	609	645	687	699	715	729	760	788	793	797	829	844	851	857	865	870
STANDARD CURVE (e)		446	545	604	646	679	706	729	749	767	782	797	810	821	833	843	852	861	868
DEFLECTION (mm)		1	2	8	17	25	32	38	43	47	51	56	63	74	93	122	140	146	148



DATA SHEET NUMBER **2a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.7	258.5	148	7.6	12.3					6359.8	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.19	0.01	1.58	0.023	0.033	0.026	0.005	0.030	0.080	0.030	0.005	0.003	0.0032

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	411	574	24.0
WEB	399	546	23.5

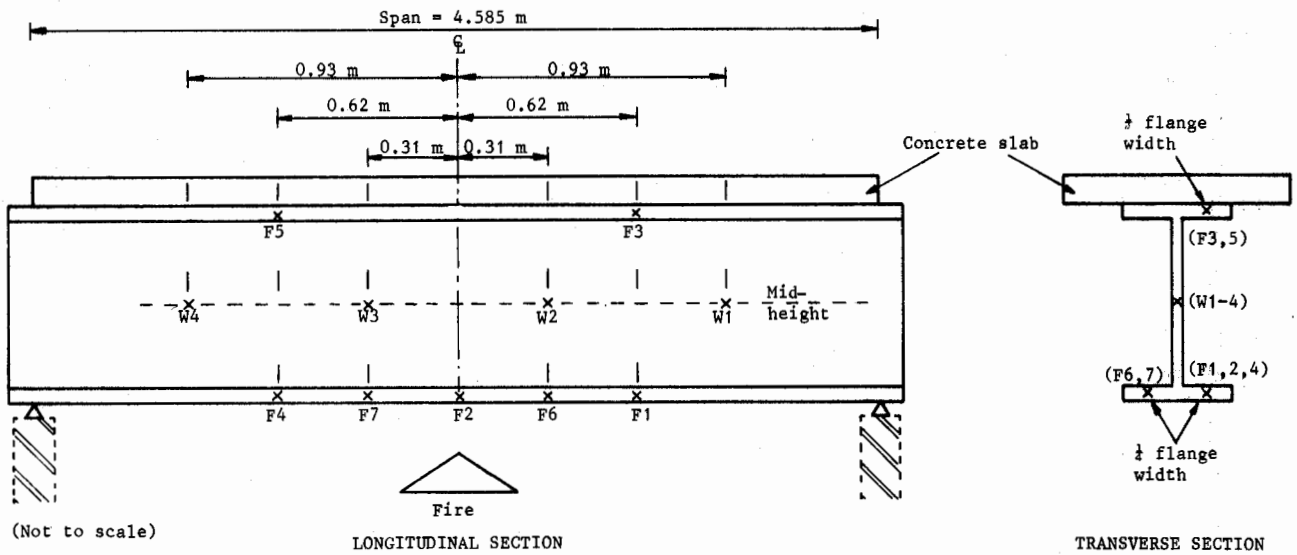
NOTES

(a) Slab size = 125 mm thick x 650 mm wide
Slab mass per metre = 1.785 kN
(b) Initial ambient temperature = 13 deg. C

TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN	:	4.585 m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	230 N/mm2
TOTAL LOAD	:	42.985 kN/m
DEAD LOAD	:	2.204 kN/m
IMPOSED LOAD REQUIRED	:	40.781 kN/m
LOADS APPLIED	:	46.73 kN

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

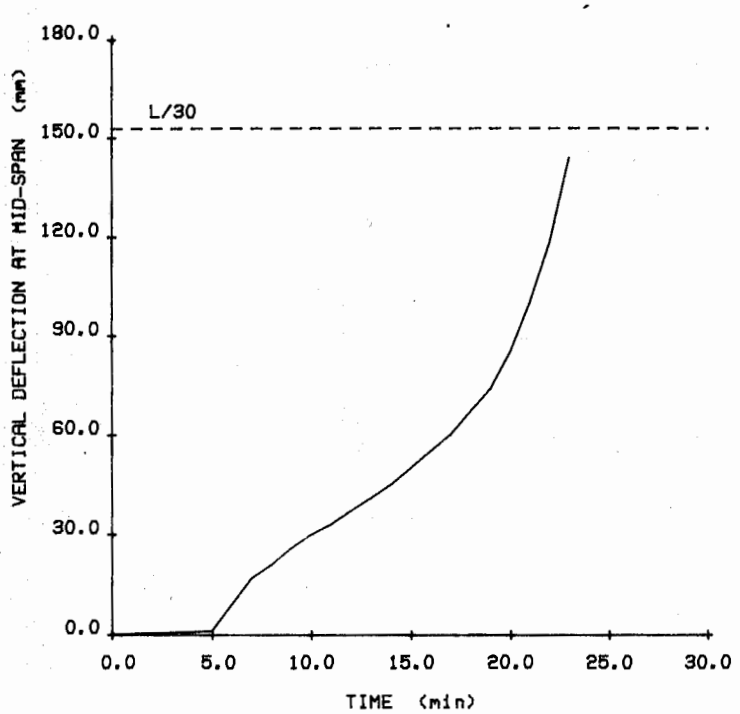
(R2/7124A)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 3rd. DECEMBER 1979
TEST NUMBER	: W.R.C.S.I. 24672

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 23 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 23 MINUTES
FIRE RESISTANCE	: 23 MINUTES

DATA SHEET NUMBER **2b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		3	6	9	12	15	18	21	23
UPPER FLANGE	F3	57	105	161	211	266	322	378	414
	F5	49	99	161	213	268	325	385	432
	MEAN	53	102	161	212	267	323	381	423
WEB	W1	109	217	335	431	505	565	609	634
	W2	118	229	352	449	523	582	628	653
	W3	127	250	375	470	541	592	636	661
	W4	114	229	354	445	513	567	615	640
	MEAN	117	231	354	449	520	576	622	647
LOWER FLANGE	F1	98	209	329	429	516	583	633	661
	F2	83	190	315	428	518	587	638	665
	F4	113	227	344	440	520	581	630	658
	F6	85	181	299	411	502	573	625	652
	F7	114	221	337	441	526	589	638	663
	MEAN	99	206	325	430	516	583	633	660
MEAN FURNACE GAS		433	589	658	705	744	775	793	808
STANDARD CURVE (b)		495	596	656	698	732	759	782	795
DEFLECTION (mm)		1	9	26	37	50	67	100	144



DATA SHEET NUMBER **3a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	43.4	260	147	*	*					6464.0	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.21	0.06	0.89	0.007	0.025	0.005	0.005	0.022	0.005	0.016	0.005	0.003	0.0048

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	250	436	30.0
WEB	277	439	31.0

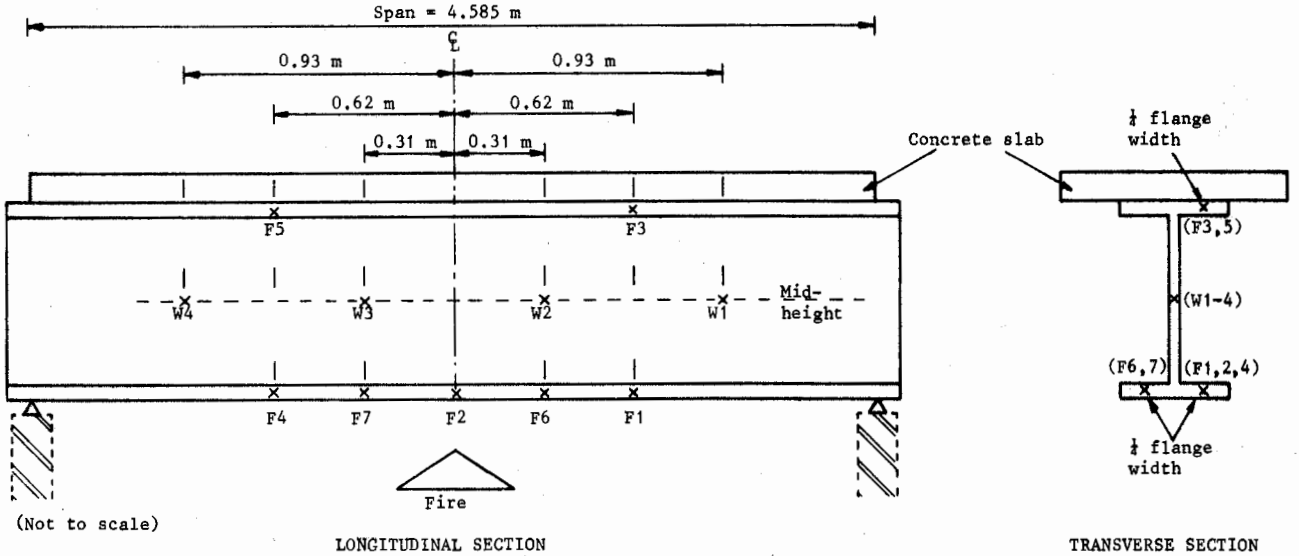
NOTES

(a) Slab size = 125 mm thick x 650 mm wide
Slab mass per metre = 1.785 kN
(b) Initial ambient temperature = 16 deg. C
(*) Not measured

TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN	:	4.585 m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	165 N/mm2
TOTAL LOAD	:	30.597 kN/m
DEAD LOAD	:	2.210 kN/m
IMPOSED LOAD REQUIRED	:	28.387 kN/m
LOADS APPLIED	:	32.54 kN

THERMOCOUPLE POSITIONS



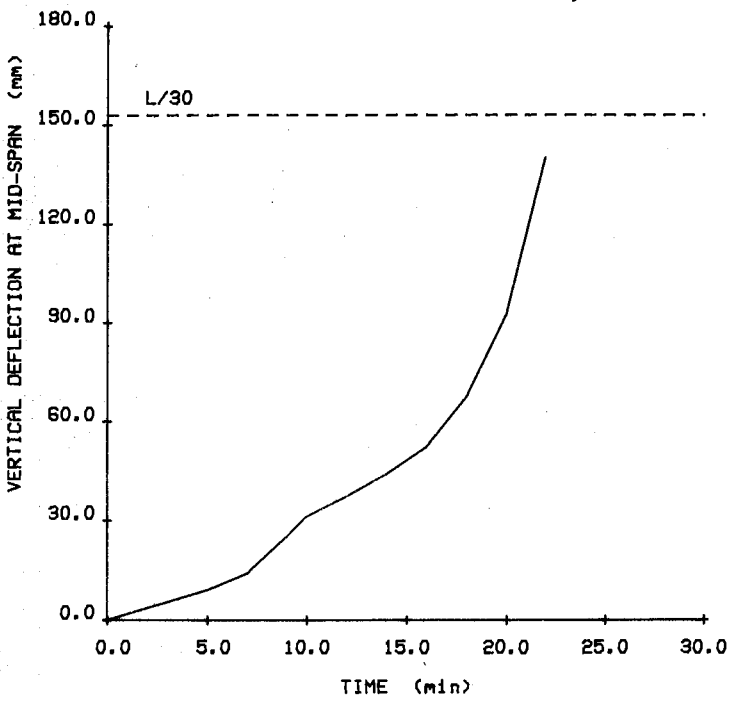
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	5th. DECEMBER 1979
TEST NUMBER	:	W.R.C.S.I. 24673

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	22 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	22 MINUTES
FIRE RESISTANCE	:	22 MINUTES

DATA SHEET NUMBER **3b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		3	6	9	12	15	18	21	22
UPPER FLANGE	F3	82	134	192	252	307	358	403	421
	F5	45	97	166	232	287	344	402	426
	MEAN	63	115	179	242	297	351	402	423
WEB	W1	110	226	337	430	502	558	597	609
	W2	89	194	309	416	505	569	612	626
	W3	121	250	373	475	542	590	628	641
	W4	118	235	356	456	520	568	605	618
	MEAN	109	226	344	444	517	571	610	623
LOWER FLANGE	F1	97	202	320	431	517	580	621	634
	F2	86	194	317	433	522	583	627	639
	F4	75	181	308	426	513	575	619	632
	F6	129	249	362	457	526	577	617	628
	F7	96	205	321	432	520	581	625	638
	MEAN	97	206	326	436	520	579	622	634
MEAN FURNACE GAS		496	586	672	721	741	760	777	780
STANDARD CURVE (b)		498	599	659	701	735	762	785	792
DEFLECTION (mm)		4	11	25	37	47	67	116	140



DATA SHEET NUMBER **4a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.7	259	148	7.51	12.37					6377.1	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.18	0.01	1.60	0.023	0.033	0.026	0.005	0.028	0.082	0.030	0.005	0.002	0.0035

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	408	582	23.0
WEB	409	552	23.5

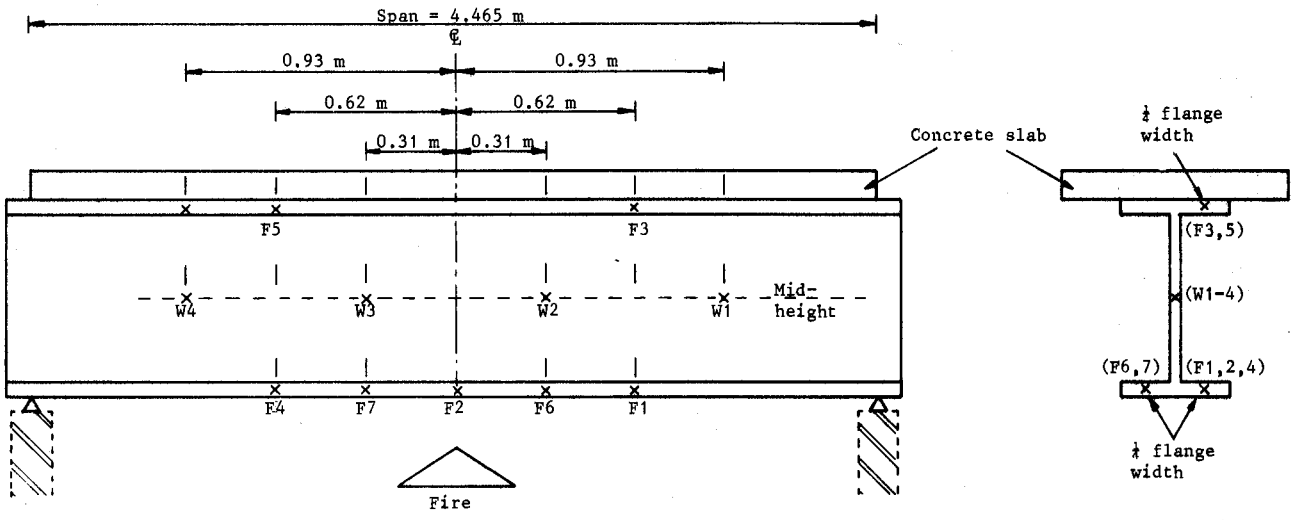
NOTES

(a) Slab size = 125 mm thick x 650 mm wide
Slab mass per metre = 1.785 kN
(b) Equals 71.7% of the maximum allowable bending stress to BS 449 : Part 2 : 1969 for a Grade 50 steel section
(c) Initial ambient temperature = 15 deg. C

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.465 m
MAXIMUM BENDING STRESS
IN LOWER FLANGE : 165 N/mm2 (b)
TOTAL LOAD : 32.605 kN/m
DEAD LOAD : 2.204 kN/m
IMPOSED LOAD REQUIRED : 30.401 kN/m
LOADS APPLIED : 33.92 kN

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

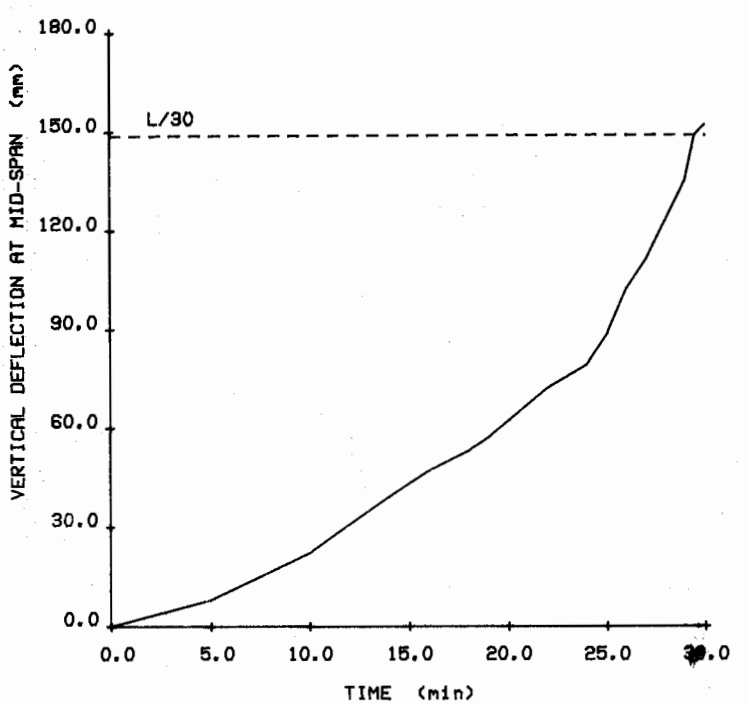
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	7th. DECEMBER 1979
TEST NUMBER	:	W.R.C.S.I. 25452

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	30 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	30 MINUTES
FIRE RESISTANCE	:	30 MINUTES

DATA SHEET NUMBER **4b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)									
		3	6	9	12	15	18	21	24	27	30
UPPER FLANGE	F3	60	96	155	215	258	310	357	399	441	485
	F5	99	149	209	266	307	356	407	458	511	554
	MEAN	79	122	182	240	282	333	382	428	476	519
WEB	W1	157	248	368	468	524	573	607	636	662	685
	W2	159	255	382	490	546	594	629	657	682	704
	W3	162	260	376	478	537	585	620	651	677	698
	W4	167	259	371	468	523	570	607	636	661	682
	MEAN	161	255	374	476	532	580	616	645	670	692
LOWER FLANGE	F1	106	187	315	444	519	582	624	656	682	703
	F2	113	196	310	435	514	581	626	661	688	709
	F4	134	221	332	447	514	570	614	646	675	696
	F6	124	206	321	442	517	582	628	661	687	708
	F7	121	207	315	427	497	559	606	640	667	689
	MEAN	120	203	319	439	512	575	620	653	680	701
MEAN FURNACE GAS		501	575	649	700	747	761	780	804	804	830
STANDARD CURVE (c)		497	598	658	700	734	761	784	804	821	837
DEFLECTION (mm)		3	9	14	33	43	53	67	79	111	152



DATA SHEET NUMBER **5a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
356 x 171	NOMINAL	67	364.0	173.2	9.1	15.7	1073	157.3	1212	243.0	19522	1362
BEAM	ACTUAL	65.6	363	172	9.22	15.3					18740	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.23	0.03	0.74	0.01	0.023	0.005	0.005	0.026	0.005	0.019	0.005	0.002	0.0062

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	240	443	21.0
WEB	280	463	18.0

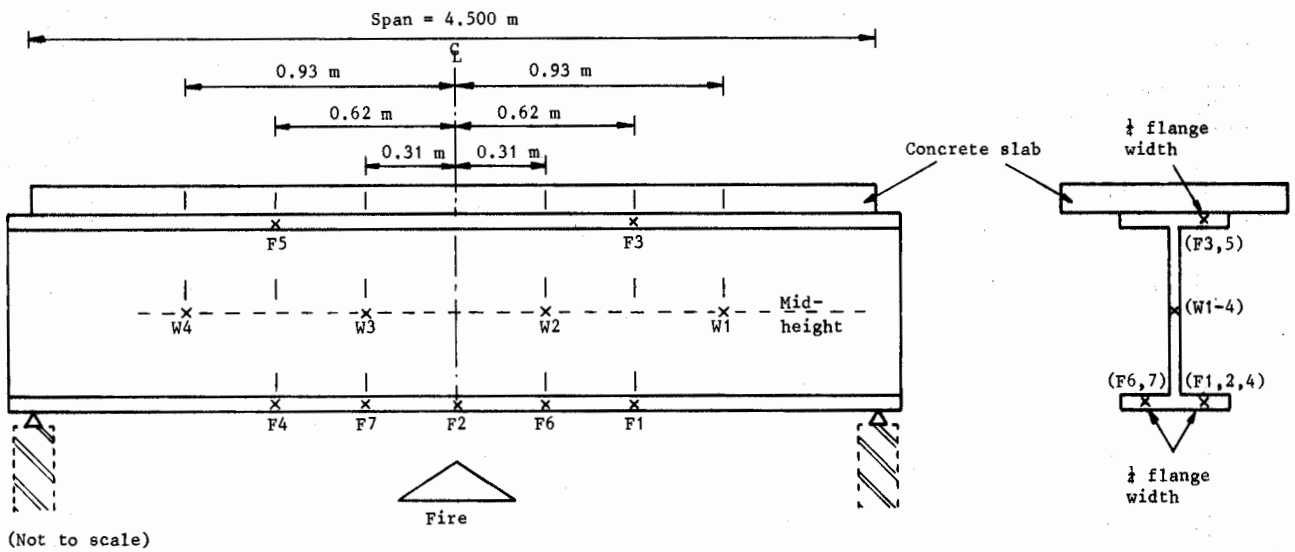
NOTES

(a) Slab size = 125 mm thick x 670 mm wide
Slab mass per metre = 1.840 kN
(b) Initial ambient temperature = 14 deg. C

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m
MAXIMUM BENDING STRESS
IN LOWER FLANGE : 165 N/mm2
TOTAL LOAD : 67.302 kN/m
DEAD LOAD : 2.483 kN/m
IMPOSED LOAD REQUIRED : 64.819 kN/m
LOADS APPLIED : 72.90 kN

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

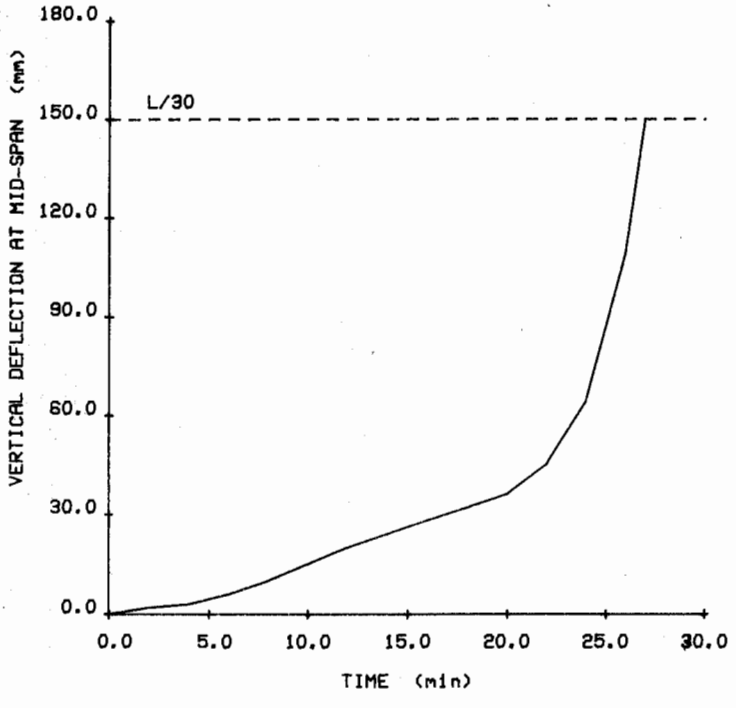
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	27th. FEBRUARY 1980
TEST NUMBER	:	W.R.C.S.I. 25786

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	27 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	27 MINUTES
FIRE RESISTANCE	:	27 MINUTES

DATA SHEET NUMBER **5b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)								
		3	6	9	12	15	18	21	24	27
UPPER FLANGE	F3	76	91	137	173	214	259	303	354	399
	F5	77	90	137	179	226	277	328	380	436
	MEAN	76	90	137	176	220	268	315	367	417
WEB	W1	114	205	295	384	460	520	567	604	630
	W2	122	214	319	417	494	549	595	633	658
	W3	127	228	337	429	502	556	600	636	663
	W4	128	216	312	397	470	527	574	611	640
	MEAN	123	216	316	407	481	538	584	621	648
LOWER FLANGE	F1	81	156	248	340	425	496	553	602	637
	F2	76	157	256	352	438	510	569	618	653
	F4	77	157	252	343	432	509	569	618	652
	F6	72	147	235	327	418	494	553	604	639
	F7	79	157	257	355	445	517	575	623	655
	MEAN	77	155	250	343	432	505	564	613	647
MEAN FURNACE GAS		493	587	642	694	727	747	779	788	798
STANDARD CURVE (b)		496	597	657	699	733	760	783	803	820
DEFLECTION (mm)		3	6	12	20	26	32	40	64	150



DATA SHEET NUMBER **6a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
406 x 178	NOMINAL	60	406.4	177.8	7.8	12.8	1058	134.8	1194	208.3	21508	1199
BEAM	ACTUAL	59.8	403	173	8.28	12.83					20706	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50D	0.12	0.34	1.34	0.016	0.024	0.016	0.005	0.031	0.069	0.022	0.005	0.009	0.0077

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	391	521	25.0
WEB	401	521	26.0

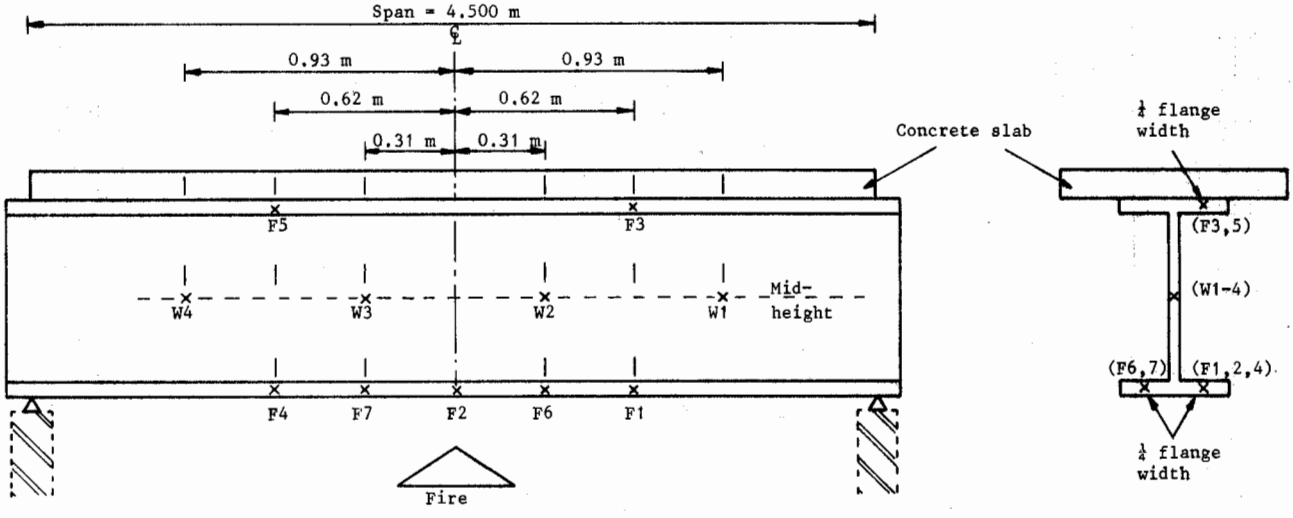
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN	:	4.500 m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	165 N/mm2 (b)
TOTAL LOAD	:	66.984 kN/m
DEAD LOAD	:	2.413 kN/m
IMPOSED LOAD REQUIRED	:	64.571 kN/m
LOADS APPLIED	:	72.62 kN

NOTES

(a) Slab size = 125 mm thick x 665 mm wide
Slab mass per metre = 1.827 kN
(b) Equals 71.7% of the maximum allowable bending stress to BS 449 : Part 2 : 1969 for a Grade 50 steel section
(c) Initial ambient temperature = 20 deg. C
(*) No data recorded due to thermocouple malfunction

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

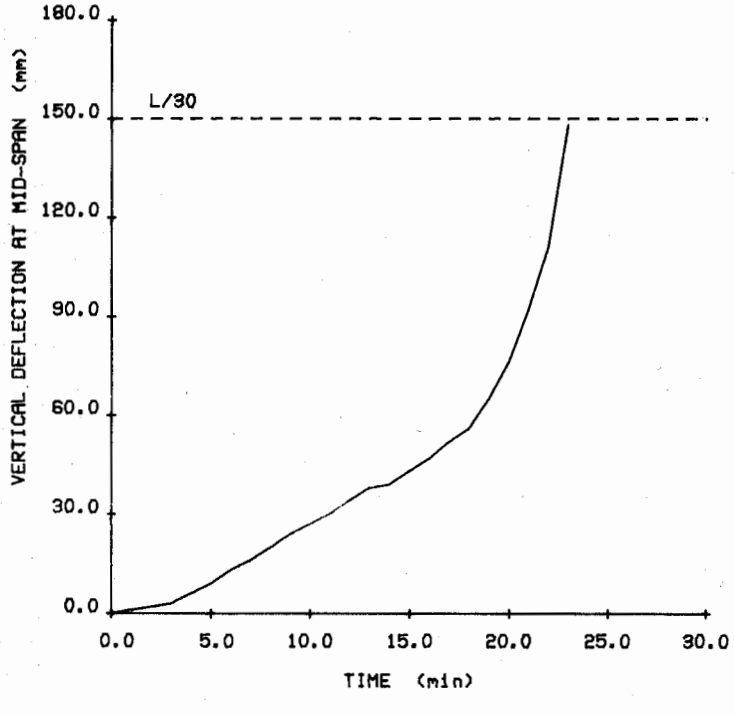
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	30th. JUNE 1980
TEST NUMBER	:	W.R.C.S.I. 25787

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	23 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	23 MINUTES
FIRE RESISTANCE	:	23 MINUTES

DATA SHEET NUMBER **6b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		3	6	9	12	15	18	21	23
UPPER FLANGE	F3	86	137	192	252	313	370	427	467
	F5	73	138	201	266	331	394	454	503
	MEAN	79	137	196	259	322	382	440	485
WEB	W1	137	299	438	542	609	654	690	709
	W2	141	316	*	*	*	675	712	730
	W3	144	334	484	578	636	677	709	728
	W4	162	330	466	560	619	662	694	715
	MEAN	146	320	463	560	621	667	701	720
LOWER FLANGE	F1	115	254	394	516	601	660	703	725
	F2	112	262	413	536	620	676	716	737
	F4	100	247	402	526	612	670	711	733
	F6	186	348	474	573	644	690	727	746
	F7	121	293	442	558	636	689	726	746
	MEAN	127	281	425	542	623	677	717	737
MEAN FURNACE GAS		509	637	663	723	752	794	787	803
STANDARD CURVE (c)		502	603	663	705	739	766	789	802
DEFLECTION (mm)		3	13	24	34	43	56	92	148



DATA SHEET NUMBER **7a**

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
305 x 165	NOMINAL	54	310.9	166.8	7.7	13.7	753.3	127.3	844.8	195.3	11710	1061
BEAM	ACTUAL	53.2	314	166	7.87	13.53					11695	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50D	0.13	0.34	1.43	0.019	0.019	0.017	0.005	0.034	0.071	0.021	0.005	0.035	0.0068

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	406	545	24.0
WEB	429	556	22.0

TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN	:	4.530 m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	165 N/mm2 (b)
TOTAL LOAD	:	47.915 kN/m
DEAD LOAD	:	2.334 kN/m
IMPOSED LOAD REQUIRED	:	45.581 kN/m
LOADS APPLIED	:	51.60 kN

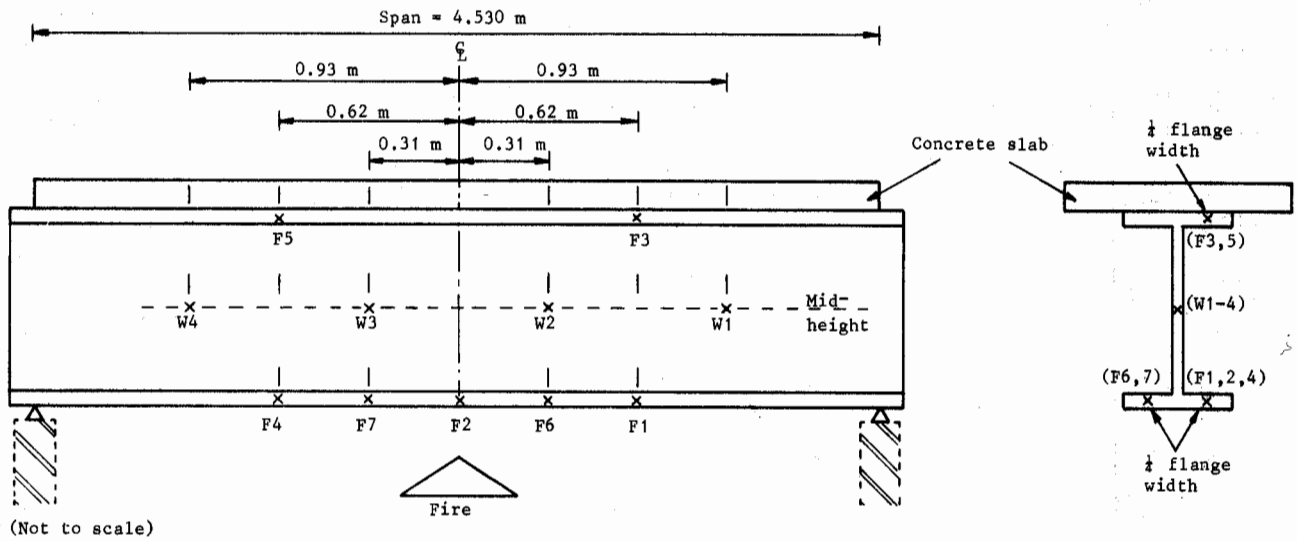
NOTES

(a) Slab size = 125 mm thick x 660 mm wide
Slab mass per metre = 1.813 kN

(b) Equals 71.7% of the maximum allowable bending stress to BS 449 : Part 2 : 1969 for a Grade 50 steel section

(c) Initial ambient temperature = 26 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

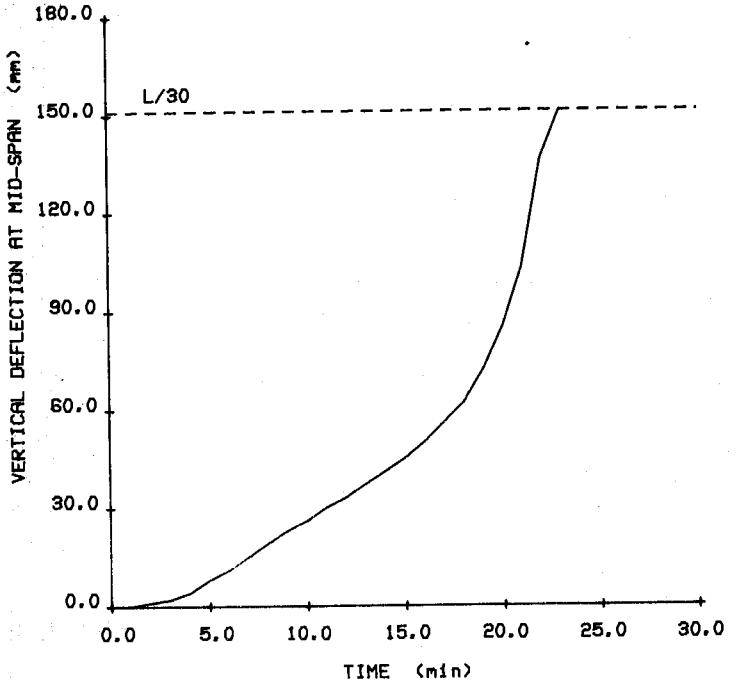
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	2nd. JULY 1980
TEST NUMBER	:	W.R.C.S.I. 25788

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	22.5 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	22.5 MINUTES
FIRE RESISTANCE	:	22.5 MINUTES

DATA SHEET NUMBER **7b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		3	6	9	12	15	18	21	22.5
UPPER FLANGE	F3	87	157	211	268	328	390	450	479
	F5	90	156	213	279	349	419	489	523
	MEAN	88	156	212	273	338	404	469	501
WEB	W1	128	287	413	509	590	646	690	708
	W2	177	347	471	560	631	684	726	743
	W3	156	321	456	556	632	687	731	748
	W4	135	287	421	525	606	664	709	727
	MEAN	149	310	440	537	615	670	714	731
LOWER FLANGE	F1	136	272	385	491	580	644	696	719
	F2	91	224	360	483	584	657	710	731
	F4	105	236	368	485	583	655	709	728
	F6	123	270	395	504	596	664	715	733
	F7	133	278	404	514	606	673	725	743
	MEAN	118	256	382	495	590	659	711	731
MEAN FURNACE GAS		519	651	703	747	786	814	835	847
STANDARD CURVE (c)		508	609	669	711	745	772	795	815
DEFLECTION (mm)		2	11	23	33	45	62	103	144



DATA SHEET NUMBER **8a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
305 x 165	NOMINAL	46	307.1	165.7	6.7	11.8	647.9	108.3	722.7	165.8	9948	897
BEAM	ACTUAL	47.2	311	164	7.71	11.48					9984.7	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50D	0.09	0.35	1.34	0.019	0.026	0.019	0.005	0.034	0.088	0.026	0.005	0.045	0.0072

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	402	529	27.0
WEB	414	532	23.0

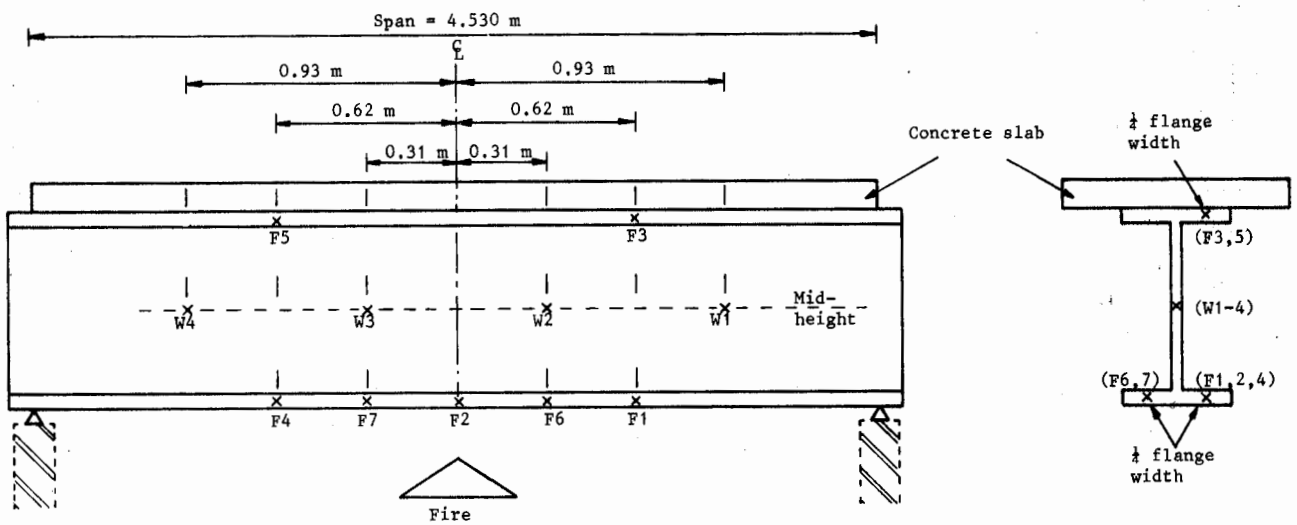
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN	:	4.530 m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	165 N/mm2 (b)
TOTAL LOAD	:	41.303 kN/m
DEAD LOAD	:	2.303 kN/m
IMPOSED LOAD REQUIRED	:	39.000 kN/m
LOADS APPLIED	:	44.15 kN

NOTES

(a) Slab size = 125 mm thick x 670 mm wide
Slab mass per metre = 1.840 kN
(b) Equals 71.7% of the maximum allowable bending stress to BS 449 : Part 2 : 1969 for a Grade 50 steel section
(c) Initial ambient temperature = 25 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

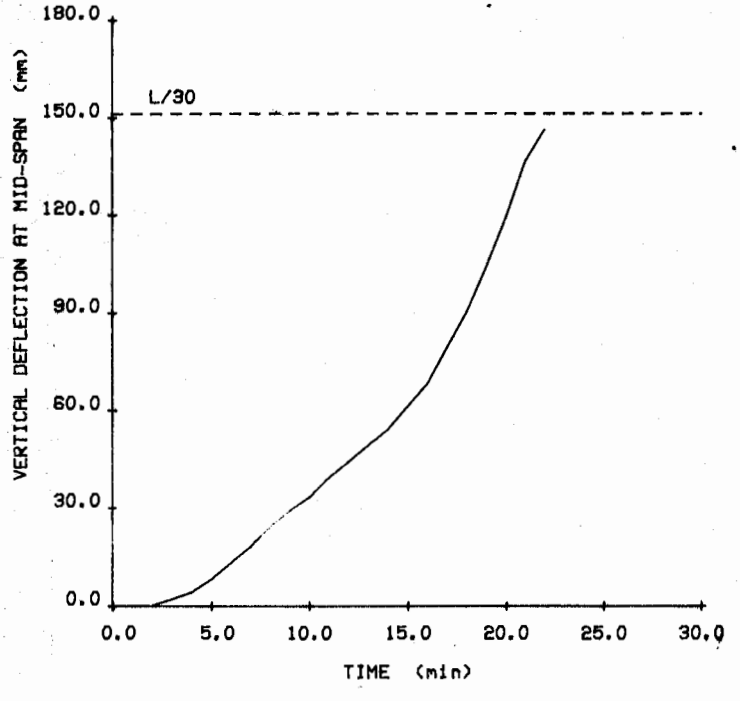
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	4th. JULY 1980
TEST NUMBER	:	W.R.C.S.I. 25789

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	22 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	22 MINUTES
FIRE RESISTANCE	:	22 MINUTES

DATA SHEET NUMBER **8b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		3	6	9	12	15	18	21	22
UPPER FLANGE	F3	89	145	198	263	330	391	443	459
	F5	87	154	214	289	368	440	503	519
	MEAN	88	149	206	276	349	415	473	489
WEB	W1	127	298	439	546	616	653	667	672
	W2	137	313	456	565	637	676	692	696
	W3	136	332	488	591	656	687	703	708
	W4	143	322	477	573	636	671	685	690
	MEAN	136	316	465	569	636	672	687	691
LOWER FLANGE	F1	116	251	393	521	612	663	685	690
	F2	112	253	399	533	625	677	703	709
	F4	120	265	416	540	628	678	702	707
	F6	120	279	419	540	628	679	700	705
	F7	107	277	432	553	639	686	708	712
	MEAN	115	265	412	537	626	677	700	705
MEAN FURNACE GAS		498	713	721	766	798	792	800	798
STANDARD CURVE (c)		507	608	668	710	744	771	794	801
DEFLECTION (mm)		2	13	29	44	61	90	136	146



DATA SHEET NUMBER **9a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
356 x 171	NOMINAL	67	364.0	173.2	9.1	15.7	1073	157.3	1212	243.0	19522	1362
BEAM	ACTUAL	67.1	363	169	9.3	16.11					19198	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.17	0.020	1.42	0.012	0.050	0.016	0.005	0.014	0.072	0.008	0.005	0.006	0.0068

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	392	488	*
WEB	395	498	*

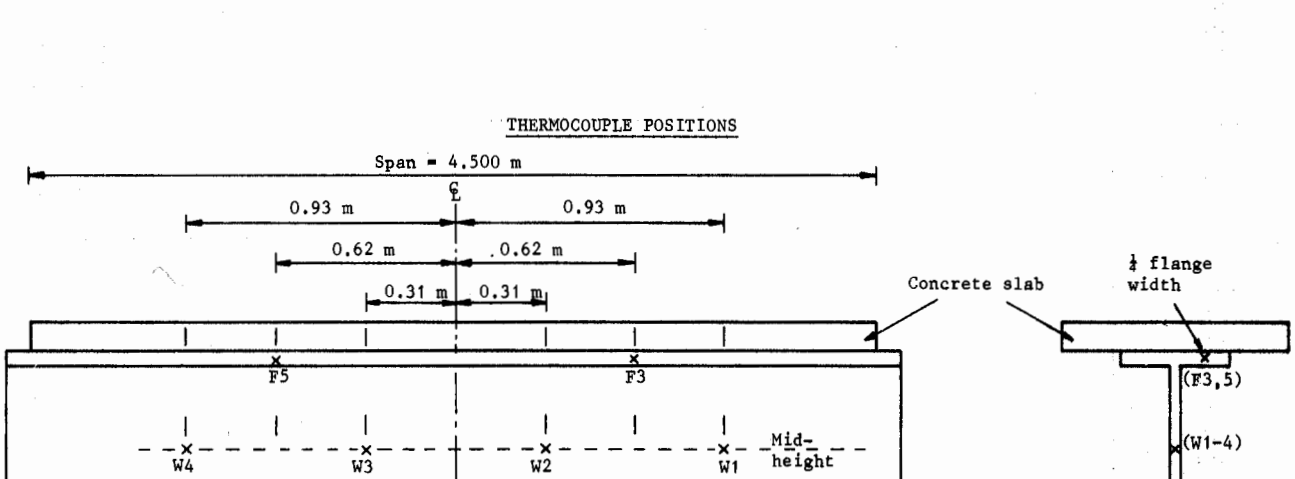
NOTES

(a) Slab size = 130 mm thick x 655 mm wide
Slab mass per metre = 1.871 kN
(b) Equals 71.7% of the maximum allowable bending stress to BS 449 : Part 2 : 1969 for a Grade 50 steel section
(c) Initial ambient temperature = 23 deg. C
(*) Not measured

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m
MAXIMUM BENDING STRESS
IN LOWER FLANGE : 165 N/mm2 (b)
TOTAL LOAD : 68.947 kN/m
DEAD LOAD : 2.529 kN/m
IMPOSED LOAD REQUIRED : 66.418 kN/m
LOADS APPLIED : 74.70 kN

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

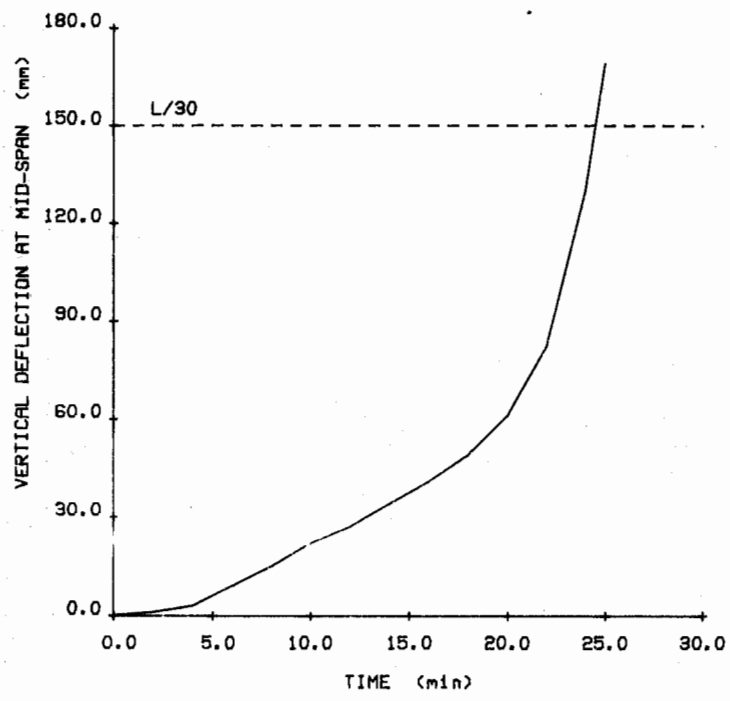
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	15th. JULY 1980
TEST NUMBER	:	W.R.C.S.I. 26069

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	24.5 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	24.5 MINUTES
FIRE RESISTANCE	:	24.5 MINUTES

DATA SHEET NUMBER **9b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)								
		3	6	9	12	15	18	21	24	24.5
UPPER FLANGE	F3	76	120	167	218	275	334	387	438	447
	F5	79	129	188	255	318	380	437	496	507
	MEAN	77	124	177	236	296	357	412	467	477
WEB	W1	124	246	377	483	563	623	665	696	701
	W2	142	273	410	517	596	652	690	721	724
	W3	151	290	436	542	612	657	692	721	725
	W4	136	258	392	501	578	630	666	698	703
	MEAN	138	267	404	511	587	640	678	709	713
LOWER FLANGE	F1	110	211	324	436	531	606	658	698	702
	F2	120	221	342	458	553	624	673	711	717
	F4	97	199	325	449	548	619	668	705	711
	F6	132	244	363	468	558	626	675	712	718
	F7	106	220	353	469	564	632	680	716	721
	MEAN	113	219	341	456	551	621	671	708	714
MEAN FURNACE GAS		527	630	715	752	778	804	820	836	838
STANDARD CURVE (c)		505	606	666	708	742	769	792	812	815
DEFLECTION (mm)		3	9	20	27	38	49	71	130	152



DATA SHEET NUMBER **10a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	43.0	257	145	7.65	12.7					6292.2	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.28	0.045	0.88	0.020	0.036	0.013	0.005	0.029	0.005	0.028	0.005	0.002	0.0075

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	300	484	25.0
WEB	304	494	24.0

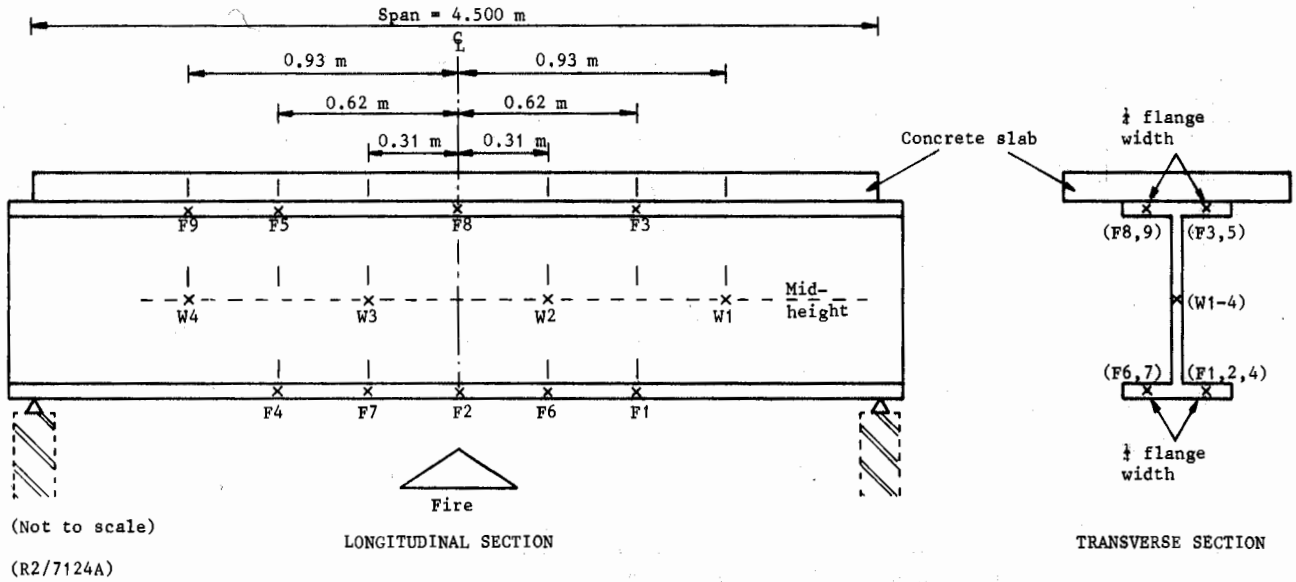
TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m
MAXIMUM BENDING STRESS
IN LOWER FLANGE : 165 N/mm2
TOTAL LOAD : 31.919 kN/m
DEAD LOAD : 2.235 kN/m
IMPOSED LOAD REQUIRED : 29.684 kN/m
LOADS APPLIED : 33.38 kN

NOTES

(a) Slab size = 130 mm thick x 635 mm wide
Slab mass per metre = 1.814 kN
(b) Initial ambient temperature = 12 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

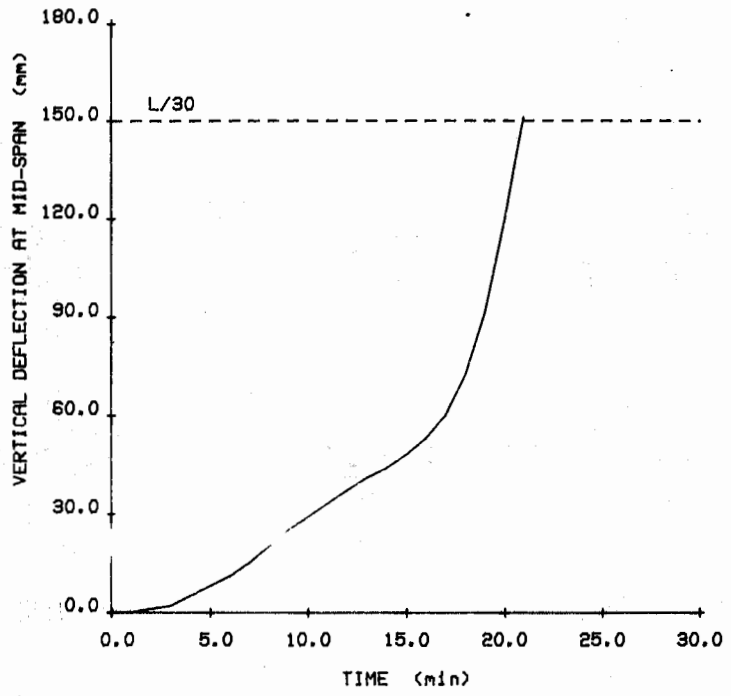
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	27th. JANUARY 1981
TEST NUMBER	:	W.R.C.S.I. 27601

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	21 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	21 MINUTES
FIRE RESISTANCE	:	21 MINUTES

DATA SHEET NUMBER **10b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)						
		3	6	9	12	15	18	21
UPPER FLANGE	F3	73	136	185	246	303	362	426
	F5	63	115	175	241	307	371	434
	F8	72	124	177	240	300	369	433
	F9	64	115	169	242	301	365	430
	MEAN	68	122	176	242	303	367	431
WEB	W1	114	223	340	457	533	594	640
	W2	113	228	349	467	541	605	649
	W3	130	244	368	490	560	621	661
	W4	144	251	367	488	558	619	659
	MEAN	125	236	356	475	548	610	652
LOWER FLANGE	F1	84	186	308	431	526	598	653
	F2	126	220	329	442	529	604	654
	F4	109	216	333	448	536	606	651
	F6	110	213	330	456	535	605	653
	F7	125	220	338	468	550	619	665
	MEAN	111	211	328	449	535	606	655
MEAN FURNACE GAS		477	606	666	745	751	784	793
STANDARD CURVE (b)		494	595	655	697	731	758	781
DEFLECTION (mm)		2	11	25	37	48	72	151



DATA SHEET NUMBER **11a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.8	256	145	7.47	12.79					6251.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.26	0.043	0.87	0.018	0.033	0.006	0.005	0.022	0.005	0.019	0.005	0.002	0.0080

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	293	483	24.5
WEB	311	497	26.5

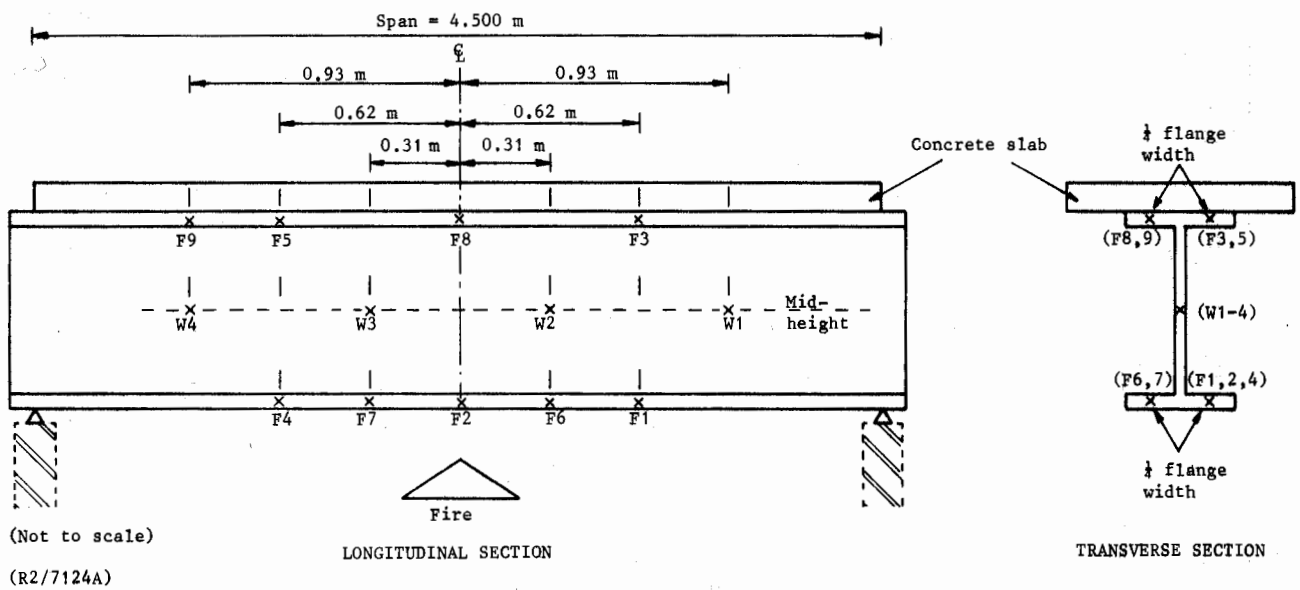
NOTES

(a) Slab size = 130 mm thick x 625 mm wide
Slab mass per metre = 1.785 kN
(b) Initial ambient temperature = 13 deg. C

TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
COVER SLAB (a)	:	DENSE CONCRETE, CONTINUOUS
EFFECTIVE SPAN	:	4.500 m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	165 N/mm2
TOTAL LOAD	:	31.837 kN/m
DEAD LOAD	:	2.205 kN/m
IMPOSED LOAD REQUIRED	:	29.632 kN/m
LOADS APPLIED	:	33.32 kN

THERMOCOUPLE POSITIONS



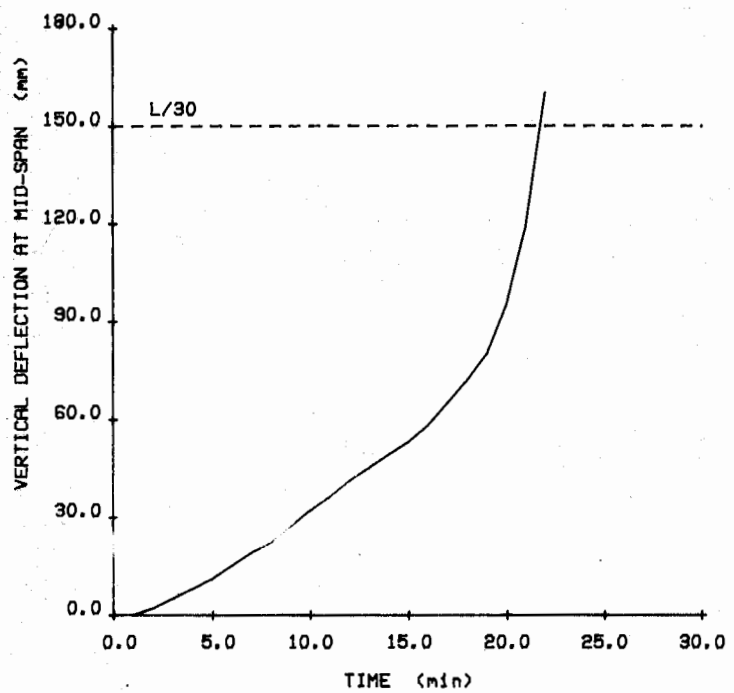
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	30th. JANUARY 1981
TEST NUMBER	:	W.R.C.S.I. 27603

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	22 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	22 MINUTES
FIRE RESISTANCE	:	22 MINUTES

DATA SHEET NUMBER **11b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		3	6	9	12	15	18	21	22
UPPER FLANGE	F3	48	98	148	209	279	345	414	440
	F5	93	149	199	264	327	394	465	488
	F8	84	129	183	250	322	391	460	477
	F9	53	92	144	200	262	327	397	420
	MEAN	69	117	168	231	297	364	434	456
WEB	W1	109	227	348	458	540	601	648	660
	W2	102	227	348	463	548	611	659	672
	W3	131	255	371	476	556	620	666	680
	W4	110	232	349	449	531	595	644	657
	MEAN	113	235	354	461	544	607	654	667
LOWER FLANGE	F1	86	197	320	449	543	614	665	679
	F2	95	199	322	449	546	618	671	683
	F4	149	259	364	469	554	622	673	687
	F6	88	199	319	443	543	615	666	682
	F7	95	210	331	449	545	618	668	682
	MEAN	103	213	331	452	546	617	669	683
MEAN FURNACE GAS		509	597	668	731	756	786	797	798
STANDARD CURVE (b)		495	596	656	698	732	759	782	789
DEFLECTION (mm)		5	15	27	41	53	72	119	160



DATA SHEET NUMBER **12a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
356 x 171	NOMINAL	67	364.0	173.2	9.1	15.7	1073	157.3	1212	243.0	19522	1362
BEAM	ACTUAL	67.1	367	172	9.47	15.5					19474	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.24	0.032	0.96	0.022	0.039	0.013	0.005	0.017	0.005	0.019	0.005	0.002	0.0040

ROOM TEMPERATURE TENSILE PROPERTIES (a)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	273	476	28.0
WEB	291	479	27.0

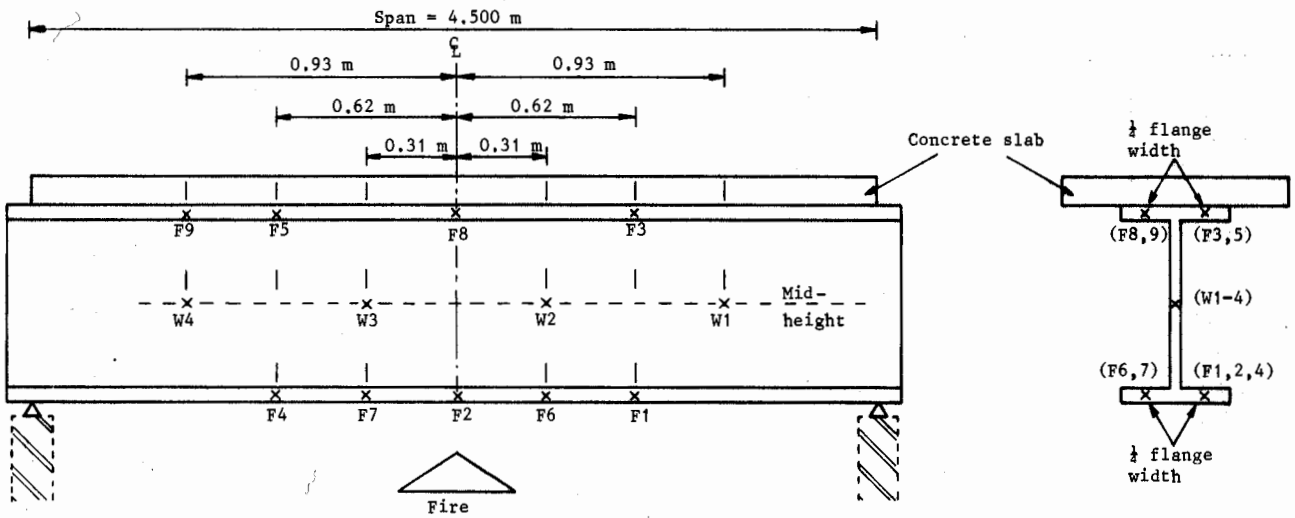
NOTES

(a) For elevated temperature anisothermal tensile properties see Data Sheet No. 84
(b) Slab size = 135 mm thick x 660 mm wide
Slab mass per metre = 1.958 kN
(c) Initial ambient temperature = 20 deg. C

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (b) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m
MAXIMUM BENDING STRESS
IN LOWER FLANGE : 165 N/mm2
TOTAL LOAD : 69.177 kN/m
DEAD LOAD : 2.616 kN/m
IMPOSED LOAD REQUIRED : 66.561 kN/m
LOADS APPLIED : 74.86 kN

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

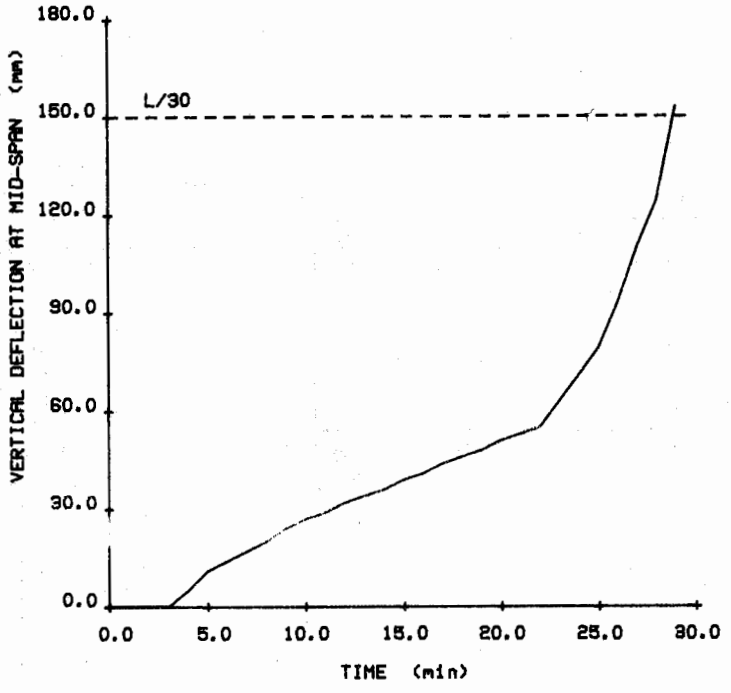
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	13th. JULY 1981
TEST NUMBER	:	W.R.C.S.I. 28055

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	29 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	29 MINUTES
FIRE RESISTANCE	:	29 MINUTES

DATA SHEET NUMBER **12b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)									
		3	6	9	12	15	18	21	24	27	29
UPPER FLANGE	F3	107	176	240	293	330	349	383	424	473	504
	F5	100	138	181	218	250	317	377	422	469	509
	F8	81	137	190	239	271	347	391	432	477	509
	F9	140	196	235	275	287	303	349	389	433	460
	MEAN	107	162	211	256	284	329	375	417	463	495
WEB	W1	175	334	461	541	588	603	614	639	659	679
	W2	172	331	459	535	574	598	615	641	666	685
	W3	213	339	444	509	551	567	604	637	668	689
	W4	182	295	380	443	487	518	569	611	645	666
	MEAN	185	325	436	507	550	571	600	632	659	680
LOWER FLANGE	F1	128	266	385	477	537	566	600	633	662	683
	F2	93	205	303	390	458	529	582	625	660	681
	F4	113	214	308	391	454	511	572	620	657	680
	F6	110	223	330	419	484	551	594	630	661	682
	F7	144	262	372	459	517	537	582	621	656	678
	MEAN	118	234	340	427	490	539	586	626	659	681
MEAN FURNACE GAS		602	579	616	632	651	688	715	739	752	775
STANDARD CURVE (c)		502	603	663	705	739	766	789	809	826	837
DEFLECTION (mm)		0	14	24	32	39	46	53	71	110	153



DATA SHEET NUMBER **13a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.0	260	146	7.34	12.36					6334.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.15	0.26	1.31	0.017	0.010	0.020	0.005	0.020	0.068	0.011	0.005	0.002	0.0062

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	370	519	25.0
WEB	388	525	25.0

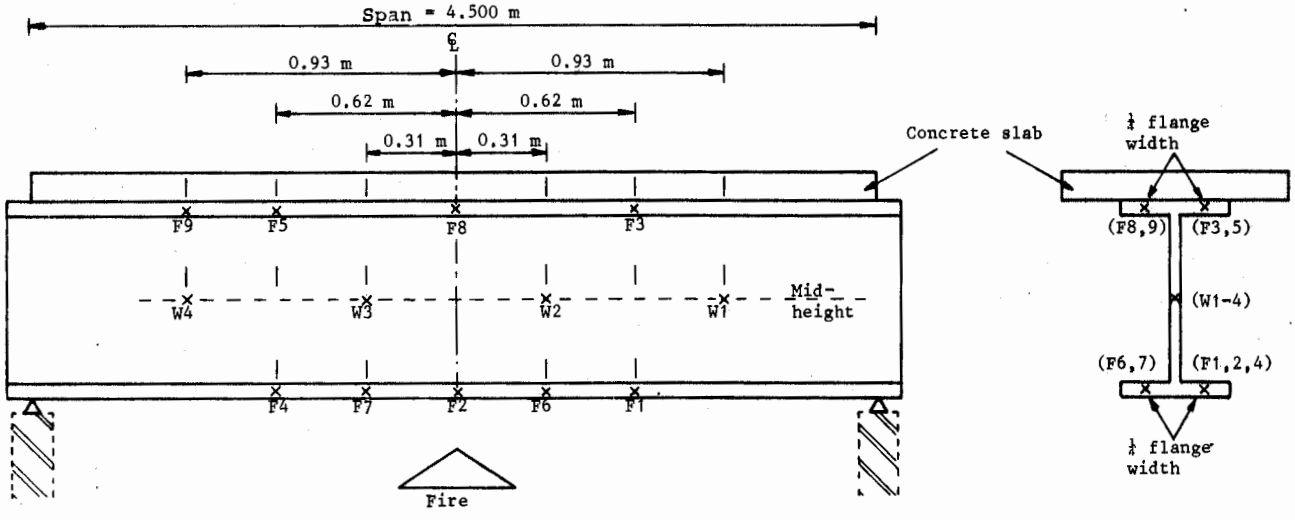
NOTES

(a) Slab size = 130 mm thick x 630 mm wide
Slab mass per metre = 1.800 kN
(b) Equals 71.7% of the maximum allowable bending stress to BS 449 : Part 2 : 1969 for a Grade 50 steel section
(c) Initial ambient temperature = 17 deg. C

TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN : 4.500 m
MAXIMUM BENDING STRESS
IN LOWER FLANGE : 165 N/mm2 (b)
TOTAL LOAD : 31.763 kN/m
DEAD LOAD : 2.212 kN/m
IMPOSED LOAD REQUIRED : 29.551 kN/m
LOADS APPLIED : 33.23 kN

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

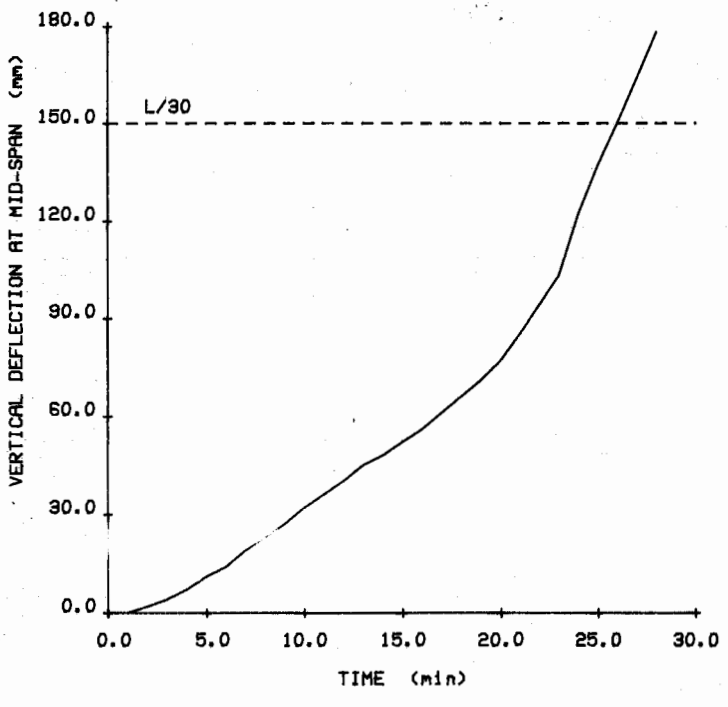
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	17th. JULY 1981
TEST NUMBER	:	W.R.C.S.I. 28057

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	26 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	26 MINUTES
FIRE RESISTANCE	:	26 MINUTES

DATA SHEET NUMBER **13b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)									
		3	6	9	12	15	18	21	24	26	27
UPPER FLANGE	F3	86	155	211	273	326	384	431	479	516	535
	F5	122	185	246	305	358	418	464	510	545	563
	F8	88	144	203	267	329	392	446	499	533	551
	F9	68	114	171	229	288	340	390	436	469	488
	MEAN	91	149	208	268	325	383	433	481	516	534
WEB	W1	146	276	393	485	552	603	640	671	693	702
	W2	174	303	414	506	572	623	659	690	711	720
	W3	155	284	417	509	576	623	660	689	712	722
	W4	162	286	408	496	563	607	645	674	697	707
	MEAN	159	287	408	499	566	614	651	681	703	713
LOWER FLANGE	F1	127	239	364	475	558	619	660	692	711	721
	F2	104	218	355	471	561	624	669	702	722	733
	F4	144	272	401	501	576	633	672	703	723	733
	F6	131	249	371	478	560	619	660	692	713	722
	F7	144	246	370	474	557	616	659	691	713	724
	MEAN	130	245	372	480	562	622	664	696	716	727
MEAN FURNACE GAS		515	649	680	730	749	775	793	800	835	832
STANDARD CURVE (c)		499	600	660	702	736	763	786	806	817	823
DEFLECTION (mm)		4	14	27	40	52	66	85	122	150	164



DATA SHEET NUMBER **14a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	43.2	262	148	7.65	12.39					6568.2	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.23	0.030	1.00	0.018	0.035	0.02	0.005	0.04	0.004	0.03	0.001	0.003	0.006

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	297	517	34.0

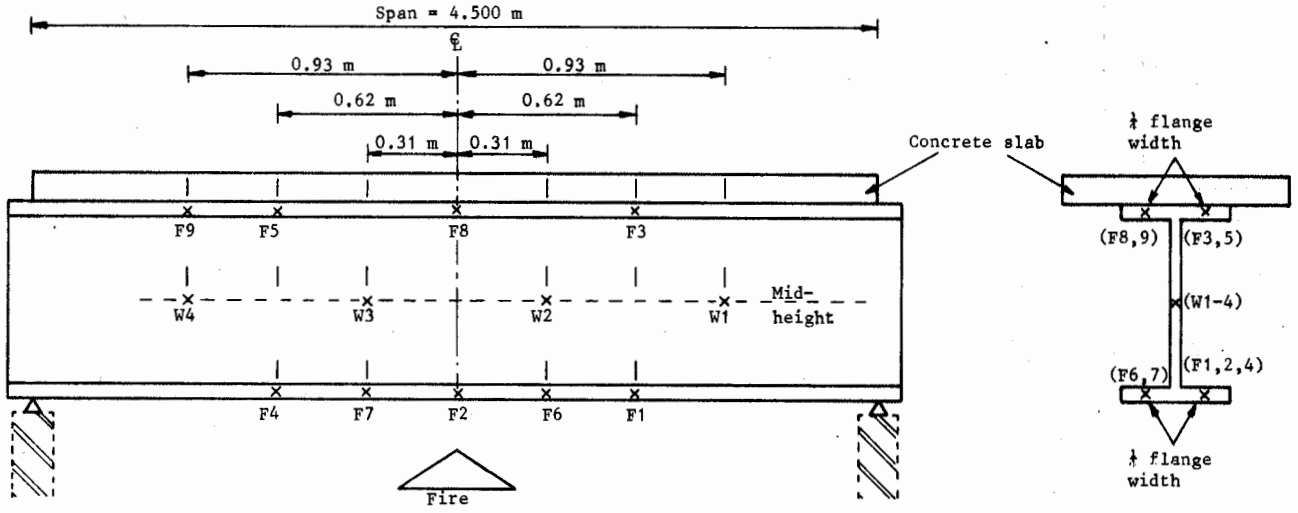
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN	:	4.500 m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	82.5 N/mm2 (b)
TOTAL LOAD	:	16.342 kN/m
DEAD LOAD	:	2.266 kN/m
IMPOSED LOAD REQUIRED	:	14.076 kN/m
LOADS APPLIED	:	15.83 kN

NOTES

(a) Slab size = 130 mm thick x 645 mm wide
Slab mass per metre = 1.843 kN
(b) Equals 50% of the maximum allowable bending stress to BS 449 : Part 2 : 1969
(c) Initial ambient temperature = 20 deg.C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

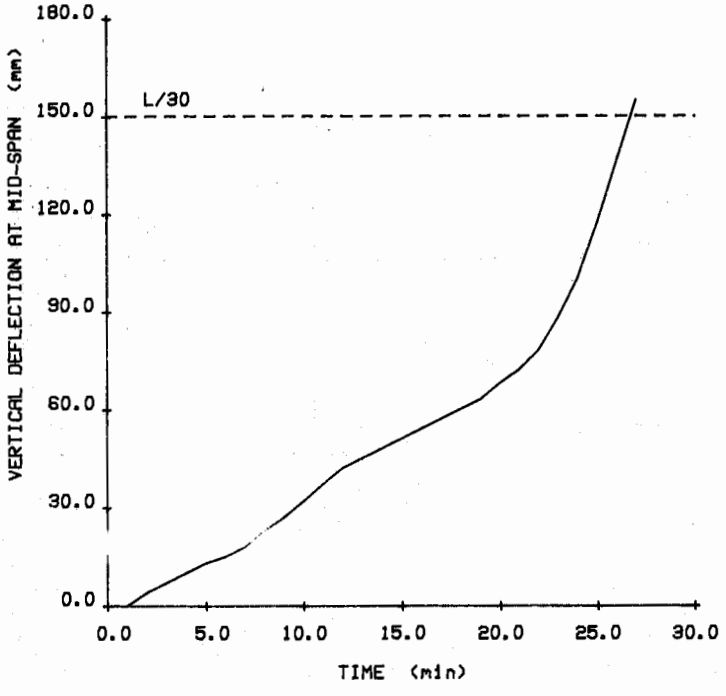
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	20th. JUNE 1984
TEST NUMBER	:	W.R.C.S.I. 34141

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	27 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	27 MINUTES
FIRE RESISTANCE	:	27 MINUTES

DATA SHEET NUMBER **14b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)								
		3	6	9	12	15	18	21	24	27
UPPER FLANGE	F3	69	112	156	224	282	341	398	457	525
	F5	80	129	174	249	311	370	425	482	546
	F8	81	133	183	270	344	415	477	532	581
	F9	74	115	155	214	267	320	375	431	490
	MEAN	76	122	167	239	301	362	419	476	536
WEB	W1	145	255	357	475	561	612	653	697	731
	W2	150	267	380	508	594	642	681	720	741
	W3	152	277	387	512	598	646	683	725	746
	W4	142	250	350	464	547	597	638	682	719
	MEAN	147	262	369	490	575	624	664	706	734
LOWER FLANGE	F1	116	221	335	467	560	625	671	714	742
	F2	119	228	342	483	579	645	691	731	756
	F4	117	223	333	468	567	632	679	722	742
	F6	124	228	337	472	567	633	680	722	743
	F7	124	234	343	470	565	631	679	721	741
	MEAN	120	227	338	472	568	633	680	722	745
MEAN FURNACE GAS		495	549	639	713	739	756	774	814	834
STANDARD CURVE (c)		502	603	663	705	739	766	789	809	826
DEFLECTION (mm)		7	15	27	42	51	60	72	100	155



DATA SHEET NUMBER **15a**

SIMPLY SUPPORTED FLOOR BEAM WITH COMPOSITE ACTION

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	41.6	257	146	7.08	12.45					6177.7	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.26	0.041	0.88	0.019	0.034	0.006	0.005	0.022	0.005	0.020	0.005	0.002	0.0082

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	283	469	26.5
WEB	280	475	25.0

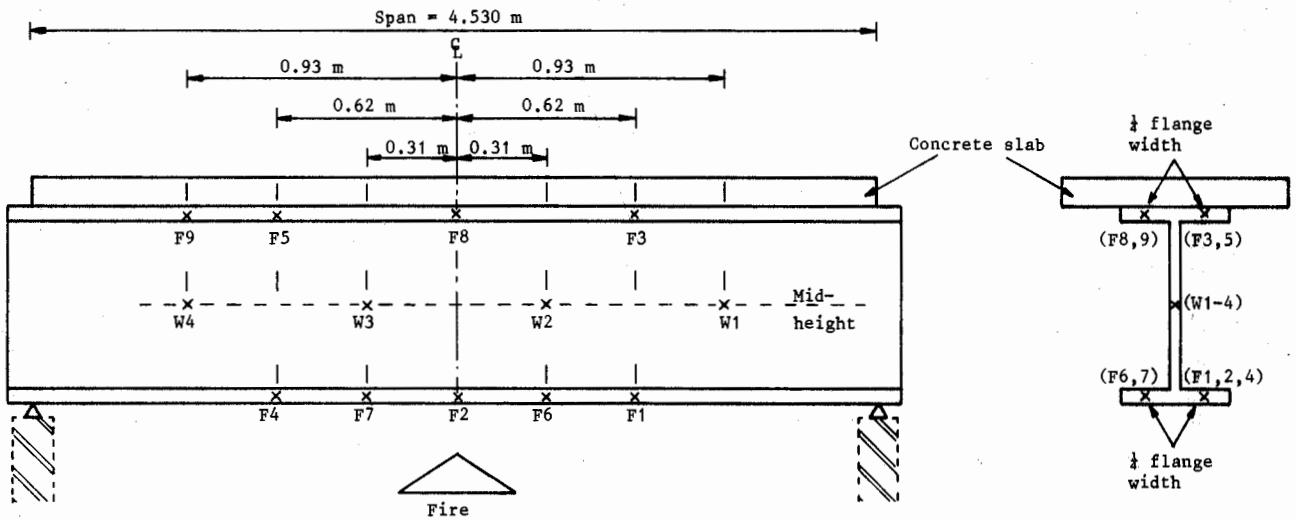
TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : REINFORCED CONCRETE TO CP110 : PART 1 : GRADE 30 : 1972, CONTINUOUS
EFFECTIVE SPAN : 4.530 m
MAXIMUM BENDING STRESS IN LOWER FLANGE (b) : 165 N/mm2
TOTAL LOAD : 30.925 kN/m
DEAD LOAD : 2.242 kN/m
IMPOSED LOAD REQUIRED : 28.683 kN/m
LOADS APPLIED : 32.47 kN
APPLIED MOMENT : 79.33 kN.m
ACTUAL MAXIMUM STEEL STRESS AT APPLIED MOMENT (c) : 105 N/mm2

NOTES

(a) Slab size = 130 mm thick x 642 mm wide
Slab mass per metre = 1.834 kN
(b) Equals the maximum allowable to BS 449 : Part 2 : 1969 based on a simply supported Grade 43A beam section in which the composite action between steel and concrete is ignored
(c) Determined from "Design Tables For Composite Steel and Concrete Beams", published by CONSTRADO, in accordance with CP 117 : Part 1 : 1965
(d) Initial ambient temperature = 11 deg. C
(*) No data collected during the first 12 minutes of the test due to instrumentation malfunction

THERMOCOUPLE POSITIONS



LONGITUDINAL SECTION

TRANSVERSE SECTION

(Not to scale)

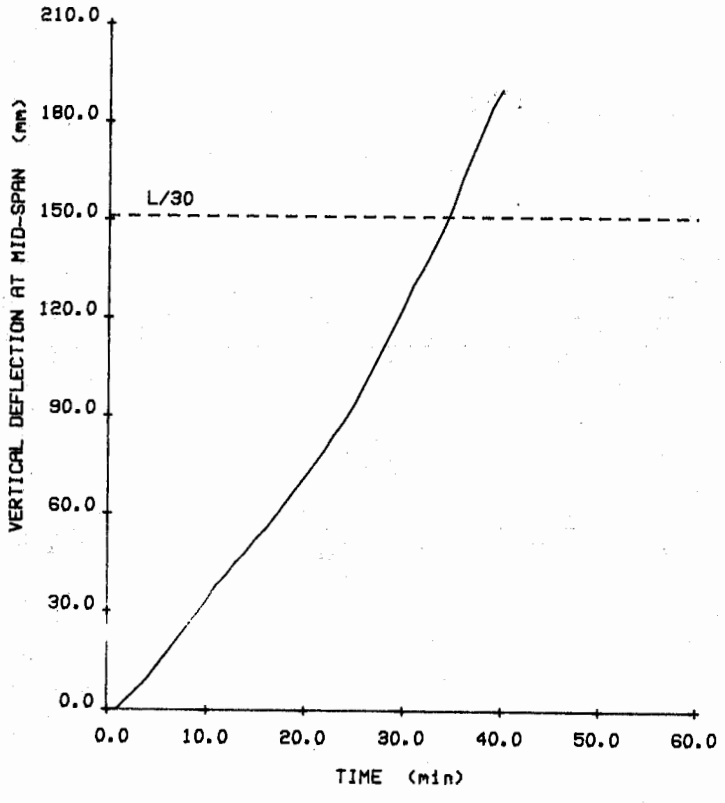
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	2nd. MARCH 1981
TEST NUMBER	:	W.R.C.S.I. 27825

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	35 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	35 MINUTES
FIRE RESISTANCE	:	35 MINUTES

DATA SHEET NUMBER **15b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
		3	6	9	12	15	18	21	24	27	30	33	35	36	39	40
UPPER FLANGE	F3	*	*	*	203	249	296	338	376	413	460	500	523	537	568	583
	F5	*	*	*	221	273	318	368	413	462	504	544	569	578	608	615
	F8	*	*	*	223	277	322	365	415	455	496	533	556	567	593	609
	F9	*	*	*	236	288	338	384	425	467	508	544	566	578	607	616
	MEAN	*	*	*	221	272	318	364	407	449	492	530	533	565	594	606
WEB	W1	*	*	*	448	514	569	609	634	656	678	696	709	714	730	733
	W2	*	*	*	497	563	612	651	674	696	717	733	740	743	762	764
	W3	*	*	*	466	536	592	632	661	683	704	722	732	734	746	752
	W4	*	*	*	480	548	597	638	660	683	702	720	730	734	744	749
	MEAN	*	*	*	473	540	592	632	657	679	700	718	728	731	745	749
LOWER FLANGE	F1	*	*	*	447	520	583	629	659	679	701	719	728	731	739	747
	F2	*	*	*	444	529	594	641	673	696	716	728	734	738	755	763
	F4	*	*	*	449	530	593	640	669	694	712	727	732	735	751	757
	F6	*	*	*	457	539	604	650	680	703	721	734	741	745	762	767
	F7	*	*	*	478	558	617	661	690	711	730	739	750	755	773	776
	MEAN	*	*	*	455	535	598	644	674	697	716	729	737	741	756	762
MEAN FURNACE GAS		*	*	*	689	723	747	761	768	779	801	806	819	819	834	838
STANDARD CURVE (d)		493	594	654	696	730	757	780	800	817	833	847	856	860	872	876
DEFLECTION (mm)		6	17	29	41	52	63	75	88	105	123	141	154	163	185	190



DATA SHEET NUMBER **16a**

SIMPLY SUPPORTED FLOOR BEAM WITH COMPOSITE ACTION

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	41.6	257	146	7.57	12.6					6284.7	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.28	0.044	0.87	0.020	0.039	0.013	0.005	0.030	0.005	0.027	0.005	0.002	0.0053

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	273	481	25.0
WEB	299	483	19.0

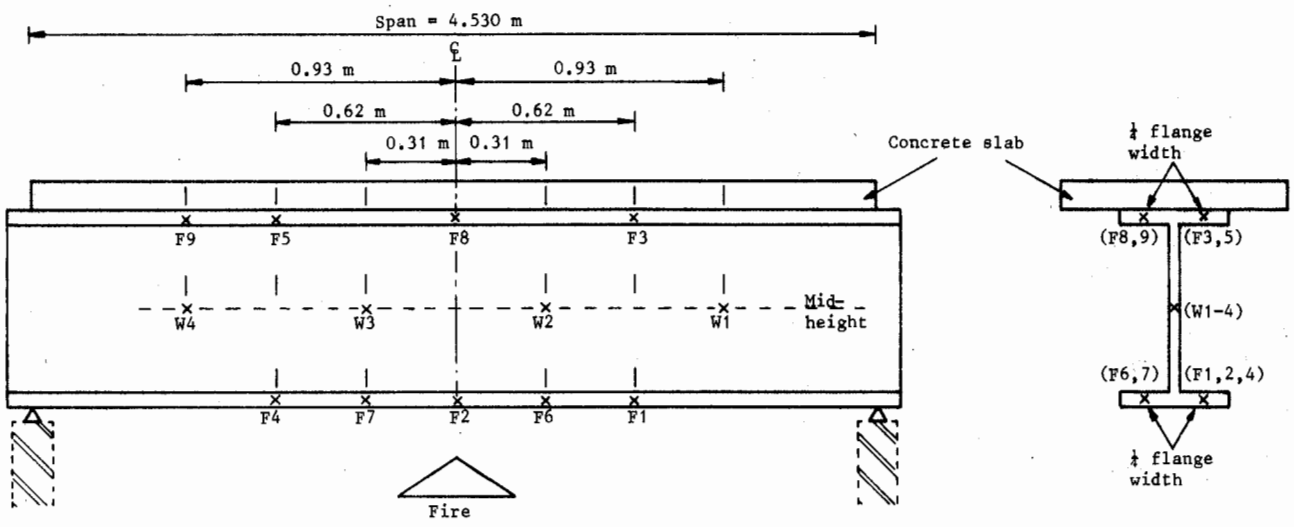
TEST CONDITIONS

END CONDITIONS : SIMPLY SUPPORTED
COVER SLAB (a) : REINFORCED CONCRETE TO CP110 : PART 1 : GRADE 30 : 1972, CONTINUOUS
EFFECTIVE SPAN : 4.530 m
MOMENT CAPACITY (b) : 257.2 kN (c)
REQUIRED BENDING
MOMENT : 146.97 kN.m
TOTAL LOAD : 57.296 kN/m
DEAD LOAD : 2.242 kN/m
IMPOSED LOAD : 55.054 kN/m
LOADS APPLIED : 62.36 kN

NOTES

(a) Slab size = 130 mm thick x 642 mm wide
Slab mass per metre = 1.834 kN
(b) Determined from "Design Tables For Composite Steel and Concrete Beams", published by CONSTRADO, in accordance with CP 117 : Part 1 : 1965
(c) Factored
(d) Initial ambient temperature = 15 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

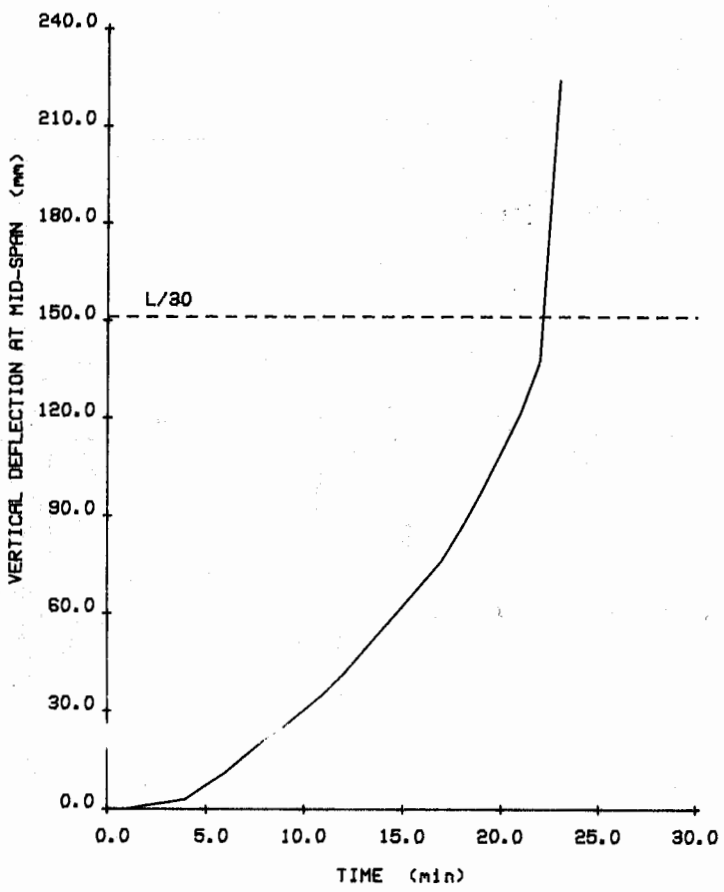
(R2/7124A)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	6th. MARCH 1981
TEST NUMBER	:	W.R.C.S.I. 27827

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	22 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	22 MINUTES
FIRE RESISTANCE	:	22 MINUTES

DATA SHEET NUMBER **16b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)								
		3	6	9	12	15	18	21	22	23
UPPER FLANGE	F3	221	278	336	398	441	474	520	546	556
	F5	88	137	190	243	300	356	406	424	447
	F8	103	155	207	269	330	373	420	438	451
	F9	137	170	225	290	343	396	446	470	500
	MEAN	137	185	239	300	353	400	448	469	488
WEB	W1	157	262	375	459	527	576	613	623	632
	W2	217	311	404	492	554	600	633	645	657
	W3	198	295	395	483	553	600	635	645	653
	W4	161	272	380	469	536	585	620	632	646
	MEAN	183	285	388	476	542	590	625	636	647
LOWER FLANGE	F1	145	238	353	461	543	597	640	653	662
	F2	122	232	347	458	545	606	646	658	672
	F4	183	269	376	468	543	600	639	651	664
	F6	168	254	363	465	548	607	648	657	669
	F7	146	247	356	459	540	598	639	651	664
	MEAN	153	248	359	462	544	602	642	654	666
MEAN FURNACE GAS		546	586	640	678	717	736	762	780	785
STANDARD CURVE (d)		497	598	658	700	734	761	784	791	797
DEFLECTION (mm)		2	11	25	41	62	86	121	137	224



DATA SHEET NUMBER **17a**

FLOOR BEAM WITH VARIABLE ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.4	254	145	7.57	12.61					6087.3	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.25	0.040	0.88	0.019	0.032	0.007	0.005	0.023	0.005	0.020	0.005	0.002	0.0072

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	295	487	25.5
WEB	329	493	17.0

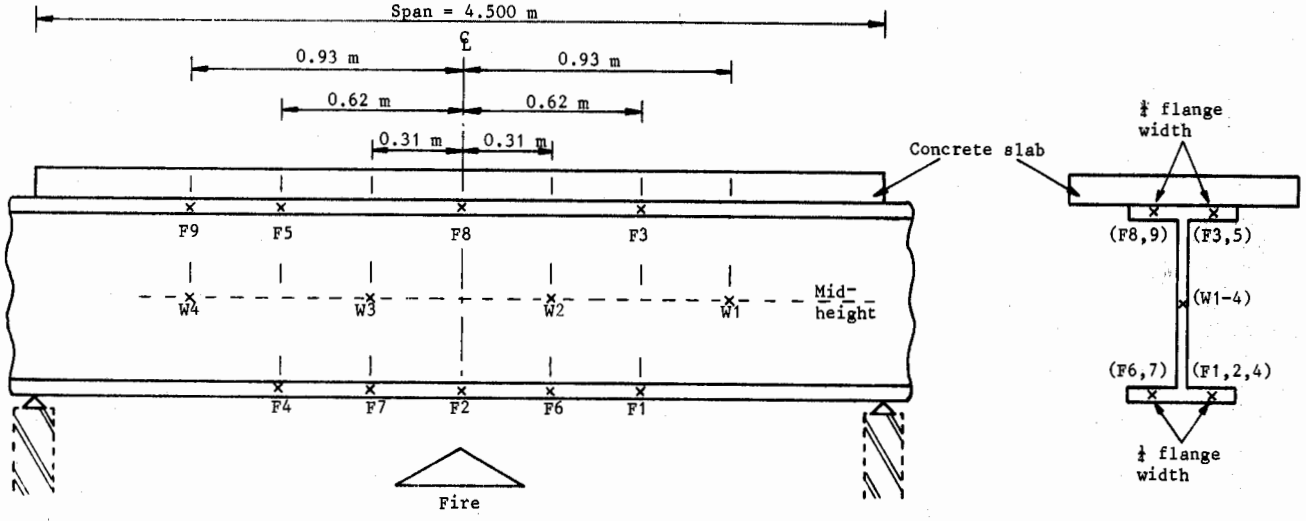
TEST CONDITIONS

END CONDITIONS	:	VARIABLE ROTATIONAL END RESTRAINT
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED
EFFECTIVE SPAN	:	4.500 m
MAXIMUM BENDING STRESS IN LOWER FLANGE	:	165 N/mm2 (b)
TOTAL LOAD	:	31.244 kN/m
DEAD LOAD	:	2.230 kN/m
IMPOSED LOAD REQUIRED	:	29.014 kN/m
INITIAL ROTATIONAL END RESTRAINT GENERATED	:	15 %
NEW TOTAL LOAD (c)	:	35.934 kN/m
IMPOSED LOAD REQUIRED	:	33.704 kN/m
LOADS APPLIED	:	37.9 kN (d)

NOTES

(a) Slab size = 130 mm thick x 635 mm wide
Slab mass per metre = 1.814 kN
(b) Equals the maximum allowable bending stress to BS 449 : Part 2 : 1969 for a Grade 43A steel section
(c) Load increased to maintain a maximum working stress of 165 N/mm2 at the mid-span position
(d) Between supports
(e) Loads reduced after 33 minutes to those for a simply supported beam with a maximum bending stress of 165 N/mm2 at the mid-span position. Had the test continued with the original applied loads held constant, it is estimated that failure would have occured after 37.5 minutes
(f) Initial ambient temperature = 11 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

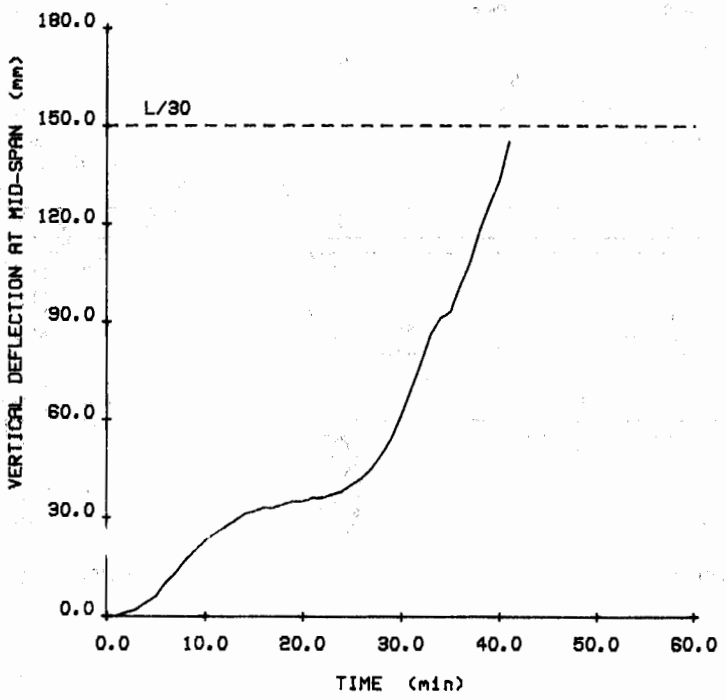
(R2/7124B)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	28th. JANUARY 1981
TEST NUMBER	:	W.R.C.S.I. 27602

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	41 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	41 MINUTES
FIRE RESISTANCE	:	41 MINUTES

DATA SHEET NUMBER **17b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES) (e)														
		3	6	9	12	15	18	21	24	27	30	33	36	37.5	39	41
UPPER FLANGE	F3	101	153	204	260	331	388	448	501	549	594	627	658	671	682	697
	F5	74	131	183	245	309	376	433	490	541	579	619	653	668	683	701
	F8	85	137	199	273	351	420	488	542	589	621	643	665	676	687	702
	F9	69	125	188	250	316	381	441	494	537	565	591	618	631	642	657
	MEAN	82	136	193	257	327	391	452	507	554	590	620	648	661	673	689
WEB	W1	113	242	373	475	556	614	659	693	717	734	750	771	781	790	799
	W2	116	247	382	483	567	623	671	703	728	741	761	784	793	803	814
	W3	137	269	396	497	577	633	677	709	733	744	766	790	799	810	823
	W4	137	272	398	496	569	623	665	697	723	737	755	776	786	795	807
	MEAN	126	257	387	488	567	623	668	700	725	739	758	780	790	799	811
LOWER FLANGE	F1	123	236	358	465	558	621	672	705	732	748	765	788	796	805	817
	F2	143	242	359	469	561	622	672	705	730	743	764	787	797	807	819
	F4	107	223	348	465	556	622	670	705	729	740	763	786	796	807	821
	F6	93	219	348	456	552	619	671	707	730	745	766	790	799	809	820
	F7	97	221	354	470	567	634	684	720	737	756	778	802	812	822	837
	MEAN	113	228	353	465	559	624	674	708	732	746	767	791	800	810	823
MEAN FURNACE GAS		513	612	679	720	751	768	796	812	826	846	848	865	867	872	881
STANDARD CURVE (f)		493	594	654	696	730	757	780	800	817	833	847	860	866	872	879
DEFLECTION (mm)		2	10	20	27	32	34	36	38	45	61	86	101	112	126	145



DATA SHEET NUMBER **18a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	41.7	256	147	7.05	12.47					6165.2	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.26	0.041	0.87	0.019	0.033	0.006	0.005	0.022	0.005	0.019	0.005	0.002	0.0083

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	275	483	25.0
WEB	298	484	23.5

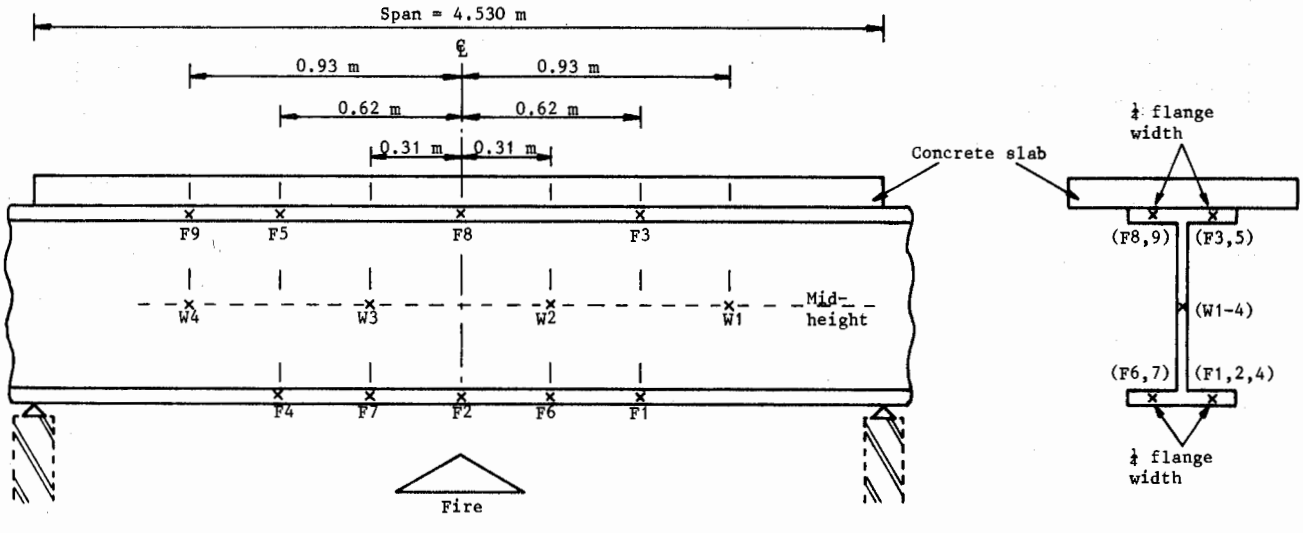
TEST CONDITIONS

END CONDITIONS	:	30% ROTATIONAL END RESTRAINT	
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	:	4.530 m	
TOTAL LOAD (b)	:	30.983 kN/m	
DEAD LOAD	:	2.209 kN/m	
IMPOSED LOAD REQUIRED	:	28.774 kN/m	
LOADS APPLIED (c)	:	32.58 kN	
CENTRAL BENDING MOMENT	:	79.48 kN.m	(b)
END MOMENTS	:	23.84 kN.m	
APPLIED END LOADS	:	33.34 kN	(d)

NOTES

(a) Slab size = 130 mm thick x 630 mm wide
Slab mass per metre = 1.800 kN
(b) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(c) Between supports
(d) Applied at a distance of 0.715 m from each support
(e) Initial ambient temperature = 5 deg. C
(f) After 22 minutes the applied end loads were allowed to increase naturally and reached an average value of 90.56 kN (equivalent to 81.5% rotational end restraint) after 40 minutes, at which time the beam had attained a deflection of approximately L/30. The test was extended from 40 to 45 minutes with increased applied end loads of 96.067 kN (equivalent to 86.4% rotational end restraint)

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

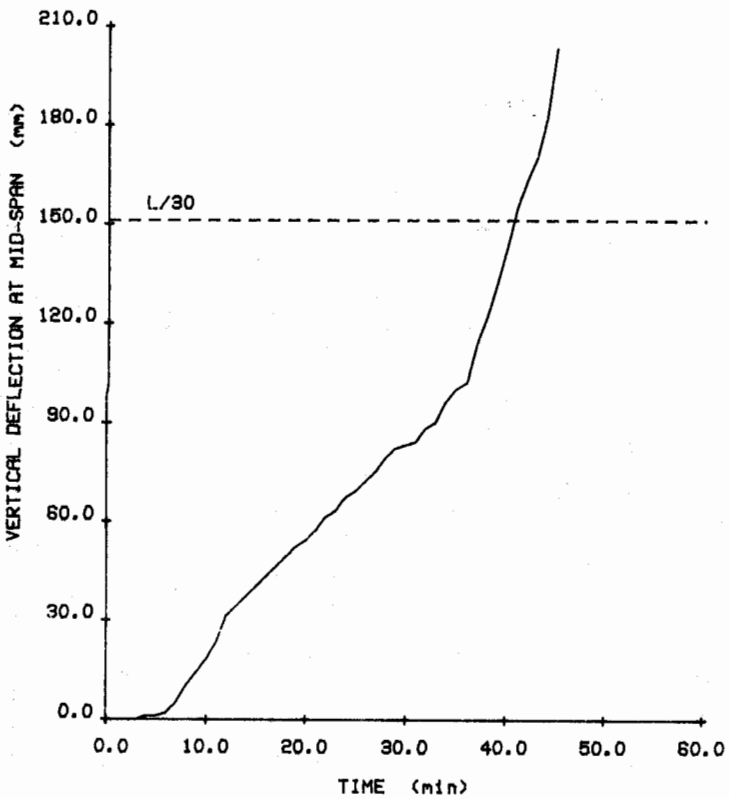
(R2/7124B)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 4th. MARCH 1981
TEST NUMBER	: W.R.C.S.I. 27826

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 40 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 40 MINUTES
FIRE RESISTANCE	: 40 MINUTES

DATA SHEET NUMBER **18b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)															
		3	6	9	12	15	18	21	24	27	30	33	36	39	40	42	45
UPPER FLANGE	F3	112	166	229	276	325	383	418	463	506	544	577	610	641	647	669	695
	F5	91	160	225	283	334	402	441	481	522	564	597	629	654	663	683	705
	F8	116	184	259	317	373	440	471	514	552	589	622	646	672	681	700	722
	F9	62	102	167	220	288	350	393	440	483	523	561	594	624	635	655	682
	MEAN	95	153	220	274	330	394	431	474	516	555	589	620	648	656	677	701
WEB	W1	77	176	306	411	486	552	588	624	654	680	706	726	738	743	754	773
	W2	122	252	388	491	557	619	640	667	695	714	733	746	763	770	781	801
	W3	81	186	331	441	518	577	612	644	674	698	720	736	747	754	767	788
	W4	106	215	350	453	526	584	616	648	674	697	718	734	745	753	766	785
	MEAN	96	207	344	449	522	583	614	646	674	697	719	735	748	755	767	787
LOWER FLANGE	F1	102	189	308	411	491	565	602	640	670	696	718	734	747	752	766	787
	F2	138	231	347	446	525	598	630	662	690	714	732	741	759	766	781	800
	F4	100	199	326	441	525	595	629	662	690	713	730	742	759	765	779	798
	F6	83	192	323	432	516	583	624	657	687	711	731	743	761	767	780	800
	F7	65	169	303	429	524	597	636	671	700	722	734	750	769	776	789	809
	MEAN	98	196	321	432	516	588	624	658	687	711	729	742	759	765	779	799
MEAN FURNACE GAS		366	558	651	671	689	713	733	752	770	793	804	817	830	836	844	855
STANDARD CURVE (e)		487	588	648	690	724	751	774	794	811	827	841	854	866	870	877	887
DEFLECTION (mm)		0	2	14	31	40	49	57	67	75	83	90	102	132	143	163	203



DATA SHEET NUMBER **19a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.0	260	146	7.34	12.36					6334.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.15	0.27	1.34	0.017	0.011	0.019	0.005	0.020	0.065	0.011	0.005	0.002	0.0062

ROOM TEMPERATURE TENSILE PROPERTIES (a)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	373	521	25.0
WEB	390	526	23.0

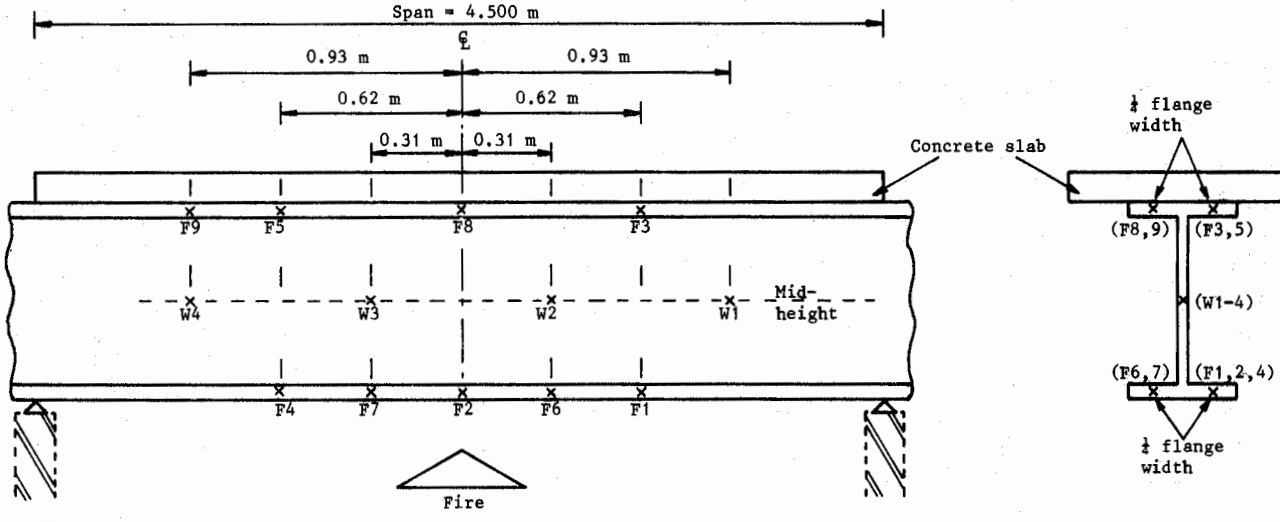
TEST CONDITIONS

END CONDITIONS	:	70% ROTATIONAL END RESTRAINT	
COVER SLAB (b)	:	DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	:	4.500 m	
TOTAL LOAD (c)	:	31.763 kN/m	
DEAD LOAD	:	2.212 kN/m	
IMPOSED LOAD REQUIRED	:	29.551 kN/m	
LOADS APPLIED (d)	:	33.23 kN	
CENTRAL BENDING MOMENT	:	80.39 kN.m	(c)
END MOMENTS	:	58.42 kN.m	(e)
APPLIED END LOADS	:	81.70 kN	(f)

NOTES

(a) For elevated temperature anisothermal tensile properties see Data Sheet No. 85
(b) Slab size = 130 mm thick x 630 mm wide
Slab mass per metre = 1.800 kN
(c) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(d) Between supports
(e) Actual end restraining moments = 72.7% of central bending moment
(f) Applied at a distance of 0.715 m from each support
(g) Initial ambient temperature = 28 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

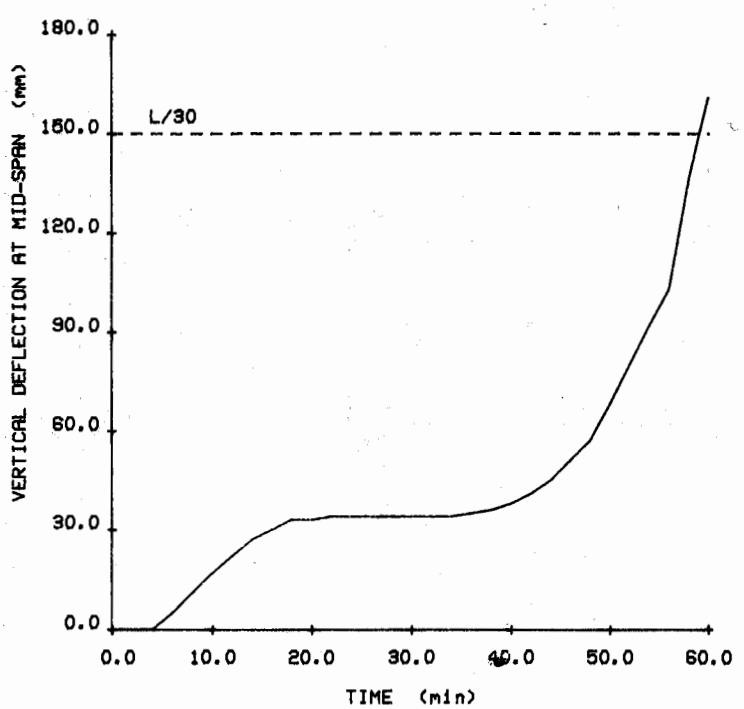
(R2/7124B)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	15th. JULY 1981
TEST NUMBER	:	W.R.C.S.I. 28056

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	59 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	59 MINUTES
FIRE RESISTANCE	:	59 MINUTES

DATA SHEET NUMBER **19b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	59	60
UPPER FLANGE	F3	118	167	207	256	315	364	415	464	503	545	580	612	643	665	692	713	735	753	773	780	785
	F5	113	182	254	302	370	418	469	516	560	597	627	658	684	708	731	750	770	788	799	810	815
	F8	91	136	193	255	318	384	441	495	541	578	612	641	667	691	712	731	747	759	770	779	785
	F9	78	119	168	220	280	340	398	448	492	531	566	596	622	648	671	693	714	734	753	765	769
	MEAN	100	151	205	258	321	376	431	481	524	563	596	627	654	678	701	722	741	758	774	783	788
WEB	W1	137	255	363	446	519	574	613	647	675	699	721	741	755	772	792	809	823	838	851	860	865
	W2	120	250	362	453	531	587	629	662	689	714	734	750	767	786	805	820	834	848	862	870	875
	W3	136	252	364	456	538	594	636	669	695	720	739	753	771	791	809	824	837	851	865	873	878
	W4	130	235	346	442	527	585	629	661	687	709	732	747	760	780	798	815	828	843	856	867	871
	MEAN	131	248	359	449	529	585	627	660	686	710	731	748	763	782	801	817	830	845	858	867	872
LOWER FLANGE	F1	120	215	325	429	520	586	634	672	700	725	744	757	777	795	814	829	844	858	872	881	885
	F2	109	204	314	423	518	589	639	677	706	730	746	762	783	802	819	834	850	864	877	884	888
	F4	86	195	322	431	531	599	648	684	712	734	748	764	783	802	819	834	849	863	875	883	887
	F6	99	215	330	433	521	587	635	670	699	723	741	754	774	792	810	825	840	855	868	877	882
	F7	107	204	313	418	513	583	634	669	698	723	741	753	772	792	810	826	840	854	869	876	880
	MEAN	104	207	321	427	521	589	638	674	703	727	744	758	778	797	814	830	845	859	872	880	884
MEAN FURNACE GAS		474	604	659	676	722	752	763	780	801	816	824	836	850	858	873	882	892	917	914	931	930
STANDARD CURVE (g)		510	611	671	713	747	774	797	817	834	850	864	877	889	900	910	920	929	938	946	951	953
DEFLECTION (mm)		0	5	14	22	30	33	33	34	34	34	34	35	37	41	48	57	75	94	122	149	161



DATA SHEET NUMBER **20a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

DIMENSIONS AND PROPERTIES

SECTION SERIAL SIZE AND TYPE	DIMENSIONS AND PROPERTIES	MASS PER METRE	DEPTH OF SECTION	WIDTH OF SECTION	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB	FLANGE	AXIS XX	AXIS YY	AXIS XX	AXIS YY	AXIS XX	AXIS YY
mm		kg	mm	mm	mm	mm	cm3	cm3	cm3	cm3	cm4	cm4
203 x 133	NOMINAL	30	206.8	133.8	6.3	9.6	279.3	57.4	313.3	88.05	2887	384
BEAM	ACTUAL	30.2	207	132	6.9	9.6					2851.7	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.15	0.01	1.20	0.019	0.024	0.021	0.005	0.015	0.005	0.012	0.012	0.01	0.0036

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	344	478	28.5
WEB	356	488	25.5

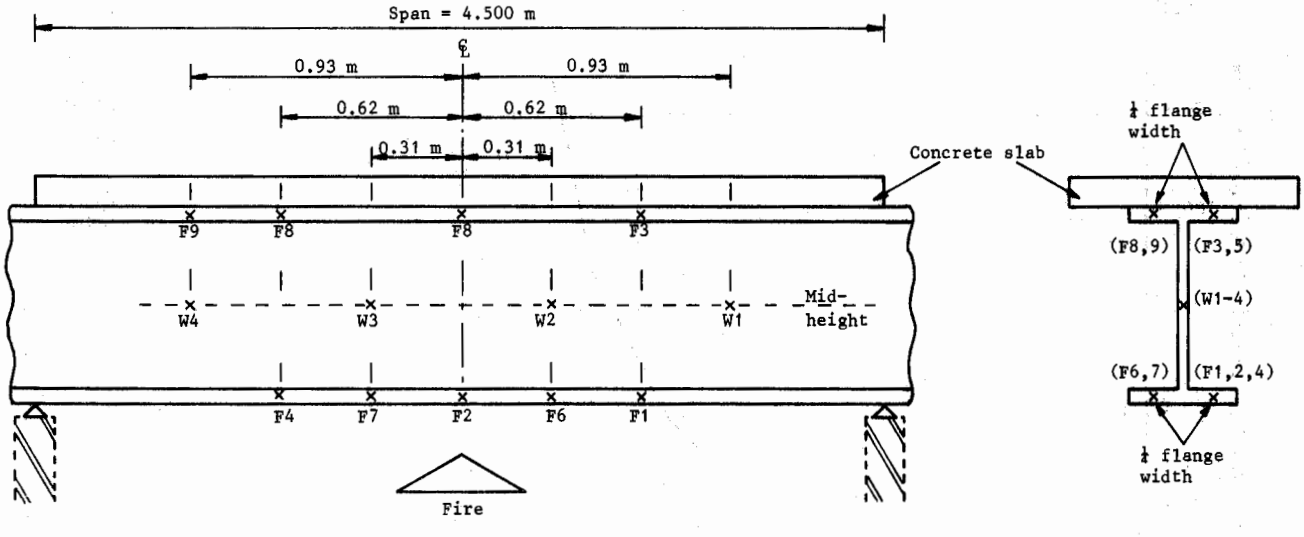
TEST CONDITIONS

END CONDITIONS		: 100% ROTATIONAL END RESTRAINT	
COVER SLAB	(a)	: DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN		: 4.500 m	
TOTAL LOAD	(b)	: 17.960 kN/m	
DEAD LOAD		: 2.134 kN/m	
IMPOSED LOAD REQUIRED		: 15.826 kN/m	
LOADS APPLIED	(c)	: 17.80 kN	
CENTRAL BENDING MOMENT		: 45.46 kN.m	(b)
END MOMENTS		: 44.87 kN.m	(d)
APPLIED END LOADS		: 62.76 kN	(e)

NOTES

(a) Slab size = 132 mm thick x 634 mm wide
Slab mass per metre = 1.839 kN
(b) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(c) Between supports
(d) Actual end restraining moments = 98.7% of central bending moment
(e) Applied at a distance of 0.715 m from each support
(f) Initial ambient temperature = 13 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

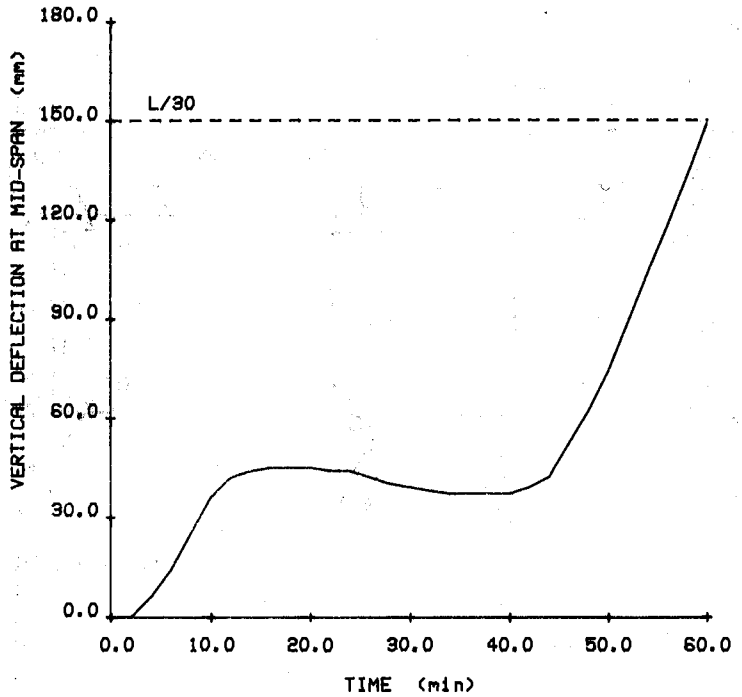
(R2/7124B)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 13th. OCTOBER 1981
TEST NUMBER	: W.R.C.S.I. 28058

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 60 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 60 MINUTES
FIRE RESISTANCE	: 60 MINUTES

DATA SHEET NUMBER **20b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
UPPER FLANGE	F3	140	234	325	391	436	479	520	567	605	639	656	691	715	736	757	774	789	805	819	837
	F5	63	125	189	260	324	382	436	481	526	572	588	633	660	686	709	730	746	766	787	807
	F8	72	146	236	333	421	490	547	590	622	655	665	696	714	732	794	754	770	787	804	819
	F9	58	120	184	251	311	363	413	459	501	547	565	609	639	666	690	714	735	750	774	798
	MEAN	83	156	233	309	373	428	479	524	563	603	618	657	682	705	737	743	760	777	796	815
WEB	W1	148	303	439	536	594	635	669	696	719	739	747	773	791	808	823	838	852	864	876	886
	W2	172	335	473	564	622	659	689	716	735	753	762	788	805	821	835	848	864	875	887	898
	W3	141	301	446	543	603	645	676	703	725	743	753	779	798	814	828	845	857	871	882	893
	W4	164	307	433	527	585	625	660	687	710	735	740	764	783	801	815	832	847	859	872	884
	MEAN	156	311	448	542	601	641	673	700	722	742	750	776	794	811	825	841	855	867	879	890
LOWER FLANGE	F1	118	285	443	557	627	668	698	725	739	760	769	795	812	827	842	856	868	880	890	900
	F2	131	293	448	563	635	676	708	732	746	768	777	803	819	834	847	861	873	884	895	905
	F4	118	268	411	526	600	649	683	709	730	747	757	783	801	817	831	847	861	873	883	894
	F6	101	270	433	553	626	671	702	726	740	762	772	798	815	830	846	860	873	884	895	904
	F7	107	264	422	540	613	660	692	717	733	753	763	789	806	822	837	853	865	877	888	899
	MEAN	115	276	431	548	620	665	697	722	738	758	768	794	811	826	841	855	868	880	890	900
MEAN FURNACE GAS		554	628	705	732	749	768	787	802	819	831	839	856	867	878	886	899	907	917	923	937
STANDARD CURVE (f)		495	596	656	698	732	759	782	802	819	835	849	862	874	885	895	905	914	923	931	938
DEFLECTION (mm)		1	14	30	42	45	45	45	44	41	39	37	37	37	39	44	62	80	104	125	149



DATA SHEET NUMBER **21a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 133	NOMINAL	30	206.8	133.8	6.3	9.6	279.3	57.4	313.3	88.05	2887	384
BEAM	ACTUAL	33.2	209	133	7.56	10.55					3180.2	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.14	0.01	1.20	0.019	0.020	0.021	0.005	0.015	0.005	0.012	0.012	0.01	0.0039

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	335(a)	475	25.0
WEB	341	469	28.5

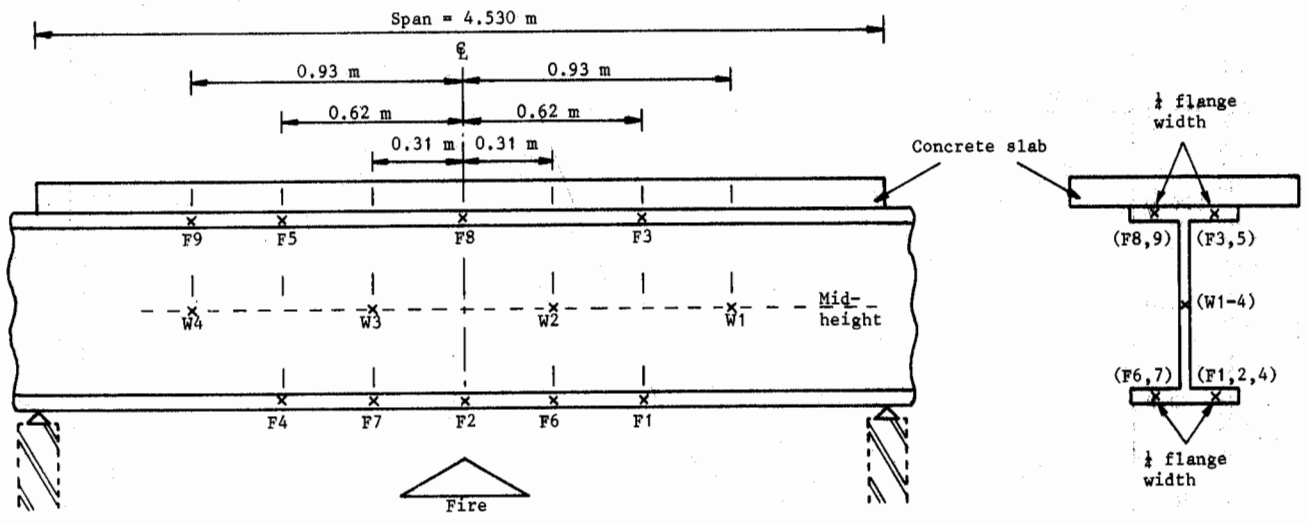
TEST CONDITIONS

END CONDITIONS	:	70% ROTATIONAL END RESTRAINT	
COVER SLAB (b)	:	DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	:	4.530 m	
TOTAL LOAD (c)	:	19.576 kN/m	
DEAD LOAD	:	2.137 kN/m	
IMPOSED LOAD REQUIRED	:	17.439 kN/m	
LOADS APPLIED (d)	:	19.74 kN	
CENTRAL BENDING MOMENT	:	50.22 kN.m	(c)
END MOMENTS	:	35.15 kN.m	(e)
APPLIED END LOADS	:	49.0 kN	(f)

NOTES

(a) 0.2% proof stress
(b) Slab size = 132 mm thick x 634 mm wide
Slab mass per metre = 1.811 kN
(c) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(d) Between supports
(e) Actual end restraining moments = 69.8% of central bending moment
(f) Applied at a distance of 0.715 m from each support
(g) Initial ambient temperature = 14 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

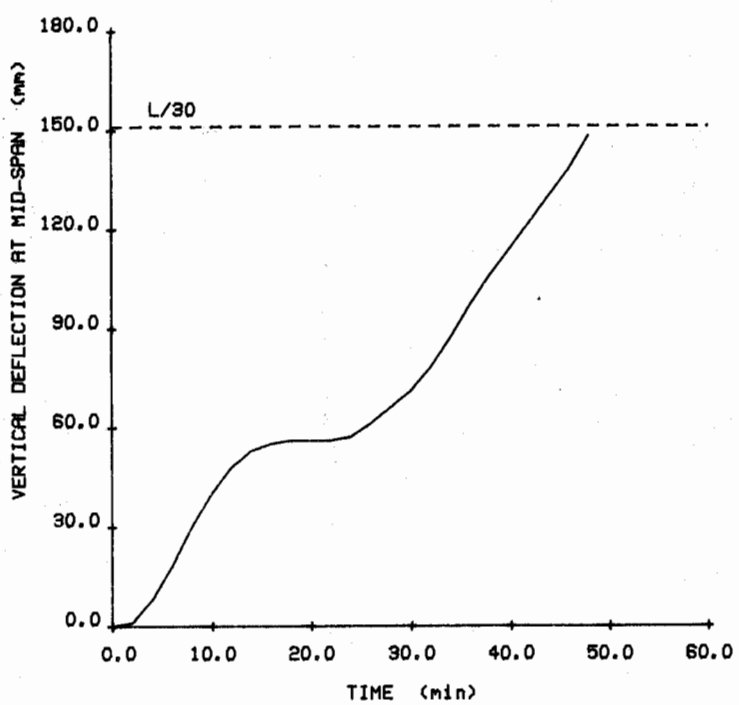
(R2/7124B)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	14th. OCTOBER 1981
TEST NUMBER	:	W.R.C.S.I. 29300

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	48 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	48 MINUTES
FIRE RESISTANCE	:	48 MINUTES

DATA SHEET NUMBER **21b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)															
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
UPPER FLANGE	F3	89	160	225	302	366	432	485	534	577	617	652	685	711	736	751	773
	F5	119	172	234	304	367	428	485	536	579	619	652	683	710	733	751	767
	F8	99	171	248	337	418	491	547	592	625	654	678	700	720	740	754	774
	F9	90	147	203	269	333	392	448	500	546	588	624	655	684	710	733	751
	MEAN	99	162	227	303	371	436	491	540	582	619	651	681	706	730	747	766
WEB	W1	185	323	451	555	620	663	696	721	739	761	781	802	819	836	852	870
	W2	148	312	453	563	627	672	704	729	746	770	790	810	827	844	861	878
	W3	162	318	454	560	624	671	703	729	746	767	789	810	825	843	858	876
	W4	164	299	424	532	601	647	683	711	733	750	772	793	811	828	844	864
	MEAN	165	313	445	552	618	663	696	722	741	762	783	804	820	838	854	872
LOWER FLANGE	F1	121	281	436	564	641	690	721	739	760	783	803	822	839	856	870	885
	F2	125	277	438	568	646	696	728	747	770	792	812	831	847	863	875	891
	F4	155	291	432	552	630	679	713	736	754	777	798	817	834	852	866	882
	F6	120	275	429	558	638	687	719	737	760	790	805	824	842	860	875	890
	F7	112	264	418	545	627	679	713	734	756	785	802	821	839	857	871	887
	MEAN	127	278	431	557	636	686	719	739	760	785	804	823	840	858	871	887
MEAN FURNACE GAS		562	661	709	754	776	798	814	829	842	860	874	882	897	909	916	933
STANDARD CURVE (g)		496	597	657	699	733	760	783	803	820	836	850	863	875	886	896	906
DEFLECTION (mm)		2	18	36	48	55	56	56	57	64	71	82	97	110	122	134	148



DATA SHEET NUMBER **22a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 133	NOMINAL	30	206.8	133.8	6.3	9.6	279.3	57.4	313.3	88.05	2887	384
BEAM	ACTUAL	29.7	210	133	6.5	9.5					2919.0	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.17	0.01	1.21	0.019	0.023	0.021	0.005	0.016	0.005	0.012	0.012	0.01	0.0038

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	335	477	26.0
WEB	343	473	28.0

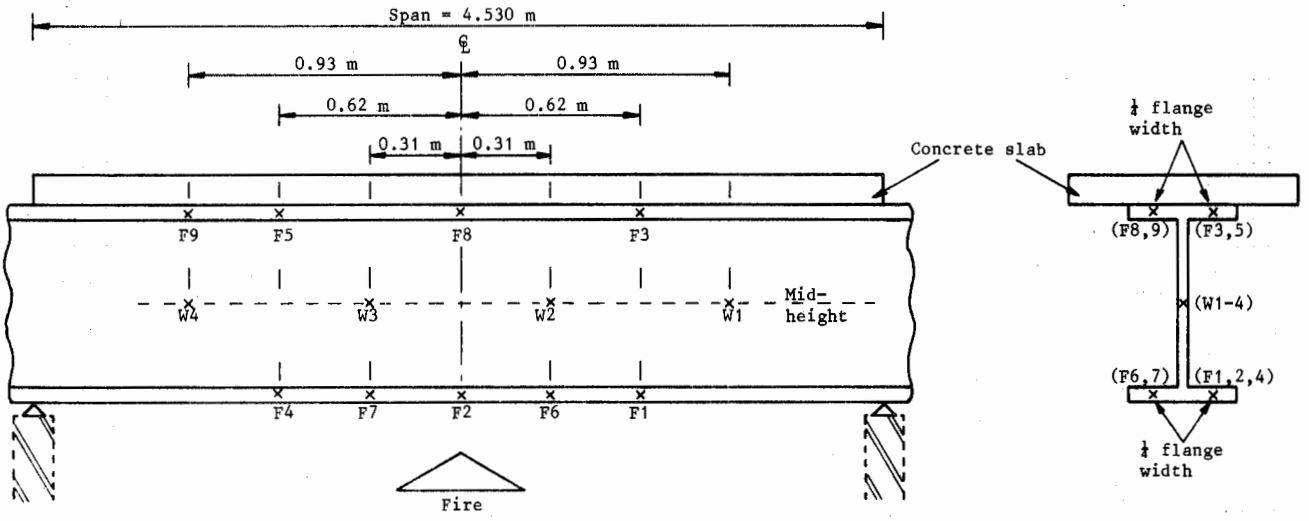
TEST CONDITIONS

END CONDITIONS		: 30% ROTATIONAL END RESTRAINT	
COVER SLAB	(a)	: DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN		: 4.530 m	
TOTAL LOAD	(b)	: 17.882 kN/m	
DEAD LOAD		: 2.091 kN/m	
IMPOSED LOAD REQUIRED		: 15.791 kN/m	
LOADS APPLIED	(c)	: 17.88 kN	
CENTRAL BENDING MOMENT		: 45.87 kN.m	(b)
END MOMENTS		: 13.46 kN.m	(d)
APPLIED END LOADS		: 18.83 kN	(e)

NOTES

(a) Slab size = 130 mm thick x 630 mm wide
Slab mass per metre = 1.800 kN
(b) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(c) Between supports
(d) Actual end restraining moments = 29.3% of central bending moment
(e) Applied at a distance of 0.715 m from each support
(f) Initial ambient temperature = 7 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

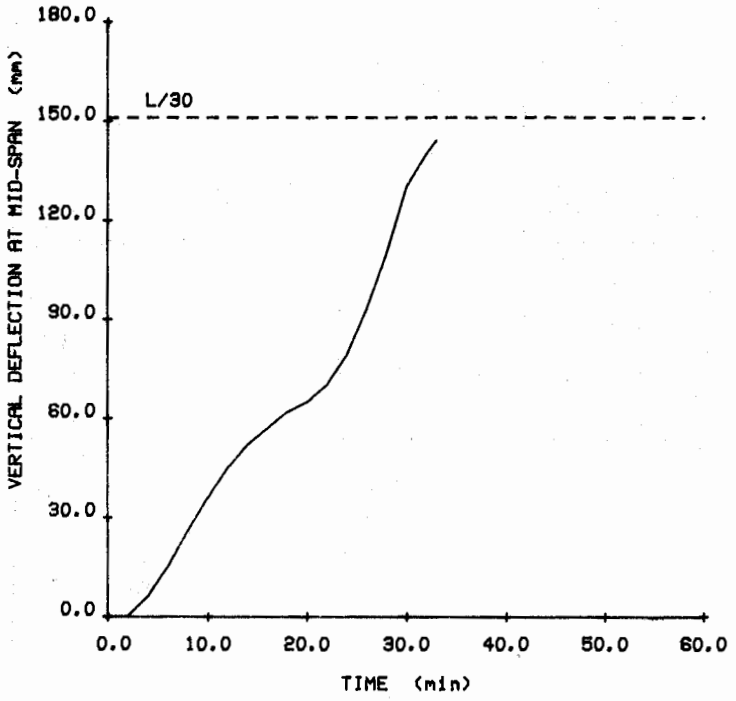
(R2/7124B)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 16th. OCTOBER 1981
TEST NUMBER	: W.R.C.S.I. 29301

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	33 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	33 MINUTES
FIRE RESISTANCE	:	33 MINUTES

DATA SHEET NUMBER **22b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)										
		3	6	9	12	15	18	21	24	27	30	33
UPPER FLANGE	F3	61	114	170	236	302	367	424	475	520	562	598
	F5	68	130	190	263	330	395	452	502	545	586	622
	F8	63	119	176	250	336	415	477	523	544	580	616
	F9	62	120	176	242	312	383	442	495	539	574	607
	MEAN	63	121	178	248	320	390	449	499	537	575	611
WEB	W1	149	287	393	488	556	607	647	677	697	720	737
	W2	109	257	382	490	570	624	661	692	715	734	750
	W3	116	262	387	496	576	629	666	696	720	738	754
	W4	126	264	382	487	565	619	655	685	710	730	742
	MEAN	125	267	386	490	567	620	657	687	710	730	746
LOWER FLANGE	F1	91	235	371	490	577	633	672	700	722	734	750
	F2	116	250	392	503	590	645	681	710	732	744	763
	F4	91	231	365	486	575	634	673	702	724	736	754
	F6	92	235	373	494	582	641	680	709	729	745	764
	F7	97	244	375	491	582	641	679	708	730	745	764
	MEAN	97	239	375	493	581	639	677	706	727	741	759
MEAN FURNACE GAS		515	626	663	727	757	775	794	810	816	829	840
STANDARD CURVE (f)		489	590	650	692	726	753	776	796	813	829	843
DEFLECTION (mm)		3	15	31	45	55	62	67	79	100	130	144



DATA SHEET NUMBER **23a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.4	260	146	7.42	12.45					6377.7	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.11	0.32	1.39	0.015	0.011	0.01	0.005	0.013	0.054	0.032	0.005	0.026	0.0062

ROOM TEMPERATURE TENSILE PROPERTIES (a)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	382	563	29.0
WEB	397	574	25.0

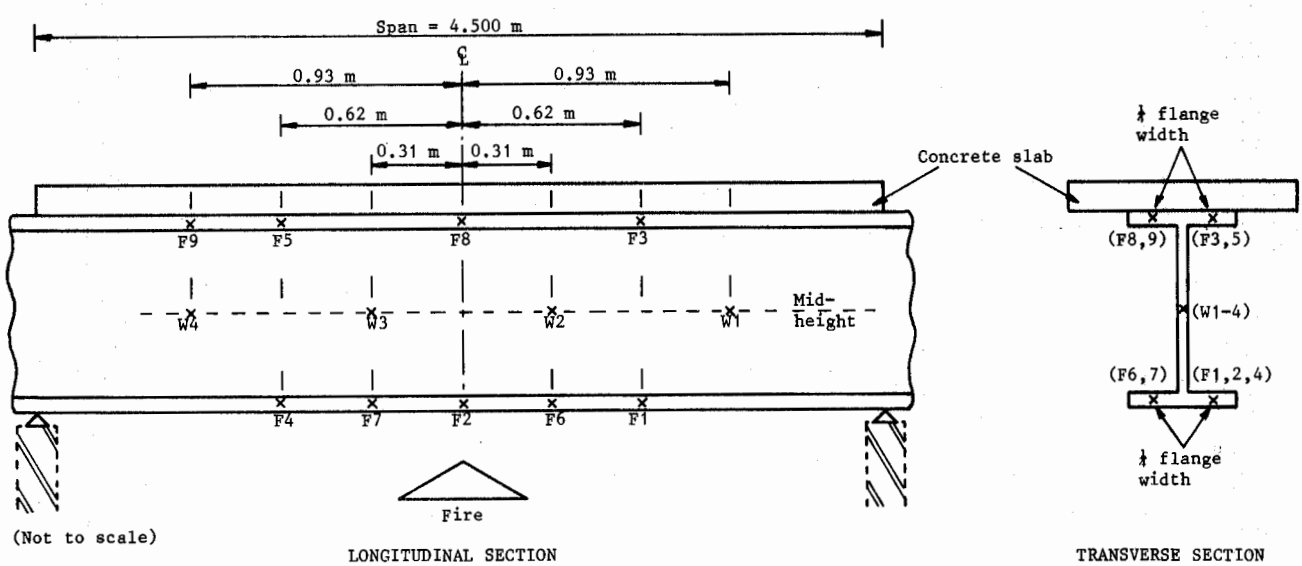
TEST CONDITIONS

END CONDITIONS	:	100% ROTATIONAL END RESTRAINT	
COVER SLAB (b)	:	DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	:	4.500 m	
TOTAL LOAD (c)	:	31.979 kN/m	
DEAD LOAD	:	2.329 kN/m	
IMPOSED LOAD REQUIRED	:	29.650 kN/m	
LOADS APPLIED (d)	:	33.35 kN	
CENTRAL BENDING MOMENT	:	80.95 kN.m	(c)
END MOMENTS	:	81.34 kN.m	(e)
APPLIED END LOADS	:	113.76 kN	(f)

NOTES

(a) For elevated temperature anisothermal tensile properties see Data Sheet No. 86
(b) Slab size = 135 mm thick x 645 mm wide
Slab mass per metre = 1.913 kN
(c) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(d) Between supports
(e) Actual end restraining moments = 100.5% of central bending moment
(f) Applied at a distance of 0.715 m from each support
(g) Initial ambient temperature = 10 deg. C
(*) No data collected at these times due to instrumentation malfunction

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

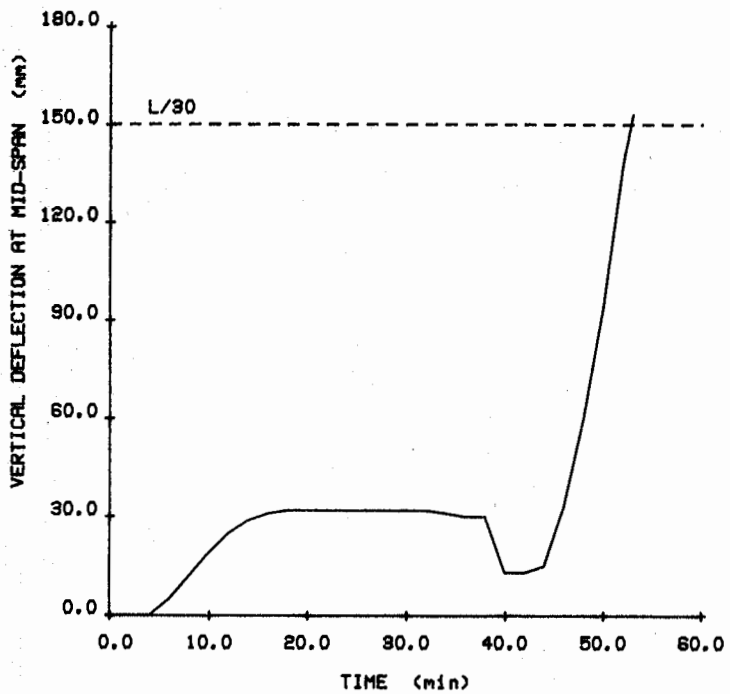
(R2/7124B)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	18th. NOVEMBER 1981
TEST NUMBER	:	W.R.C.S.I. 29467

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	53 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	53 MINUTES
FIRE RESISTANCE	:	53 MINUTES

DATA SHEET NUMBER **23b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																	
		3	5	8	9	12	15	18	21	24	27	30	33	37	40	43	46	48	50	53
UPPER FLANGE	F3	*	124	183	*	*	*	*	*	*	*	*	619	673	*	*	*	771	786	807
	F5	*	104	149	*	*	*	*	*	*	*	*	593	647	*	*	*	744	760	783
	F8	*	116	184	215	298	378	456	519	569	607	633	667	711	739	756	769	775	782	806
	F9	*	112	167	*	*	*	*	*	*	*	*	597	646	*	*	*	726	739	758
	MEAN		114	171									619	669				754	767	788
WEB	W1	150	225	328	367	477	557	613	652	683	710	730	746	781	803	821	837	844	856	871
	W2	*	233	361	*	*	*	*	*	*	*	*	768	804	*	*	*	865	875	889
	W3	*	226	356	*	*	*	*	*	*	*	*	770	806	*	*	*	864	873	888
	W4	156	227	336	371	479	553	609	648	678	706	727	745	776	799	815	832	839	850	866
	MEAN		228	345									757	792				853	863	878
LOWER FLANGE	F1	*	167	290	*	*	*	*	*	*	*	*	759	798	*	*	*	864	874	890
	F2	113	190	312	358	487	582	650	696	727	744	764	791	826	848	861	878	885	895	910
	F4	84	152	266	307	435	537	612	662	698	725	740	764	802	825	841	858	866	877	892
	F6	*	179	306	*	*	*	*	*	*	*	*	782	818	*	*	*	880	889	901
	F7	*	160	286	*	*	*	*	*	*	*	*	783	820	*	*	*	881	890	904
	MEAN		170	292									776	813				875	885	899
MEAN FURNACE GAS		*	533	610	*	*	*	*	*	*	*	*	830	853	*	*	*	901	911	924
STANDARD CURVE (g)		492	566	635	653	695	729	756	779	799	816	832	846	863	875	886	896	902	908	917
DEFLECTION (mm)		0	2	12	15	25	31	32	32	32	32	32	32	30	13	13	33	60	94	153



DATA SHEET NUMBER **24a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL	51.5	205	204	8.0	12.5					5120.1	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.26	0.034	0.89	0.026	0.044	0.023	0.005	0.027	0.005	0.046	0.005	0.01	0.0037

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	274	495	26.0
WEB	338(a)	558	22.5

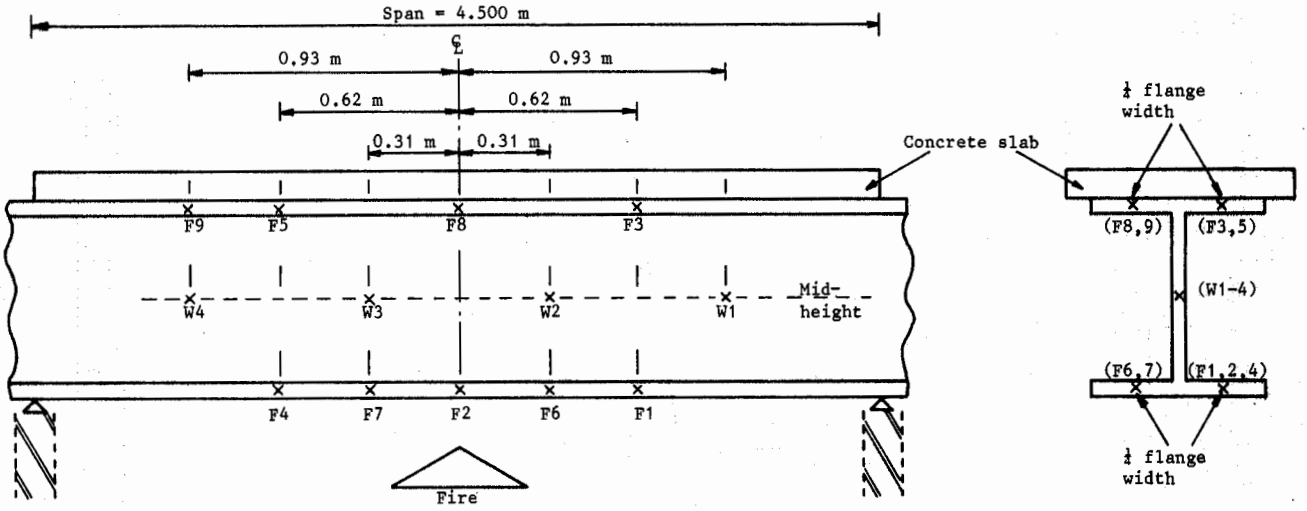
TEST CONDITIONS

END CONDITIONS	: 100% ROTATIONAL END RESTRAINT		
COVER SLAB (b)	: DENSE CONCRETE, SEGMENTED		
EFFECTIVE SPAN	: 4.500 m		
TOTAL LOAD (c)	: 32.562 kN/m		
DEAD LOAD	: 2.582 kN/m		
IMPOSED LOAD REQUIRED	: 29.980 kN/m		
LOADS APPLIED (d)	: 33.72 kN		
CENTRAL BENDING MOMENT	: 82.42 kN.m	(c)	
END MOMENTS	: 82.04 kN.m	(e)	
APPLIED END LOADS	: 114.74 kN	(f)	

NOTES

(a) 0.2% proof stress
(b) Slab size = 135 mm thick x 700 mm wide
Slab mass per metre = 2.077 kN
(c) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(d) Between supports
(e) Actual end restraining moments = 99.5% of central bending moment
(f) Applied at a distance of 0.715 m from each support
(g) Initial ambient temperature = 9 deg. C

THERMOCOUPLE POSITIONS



LONGITUDINAL SECTION

TRANSVERSE SECTION

(Not to scale)

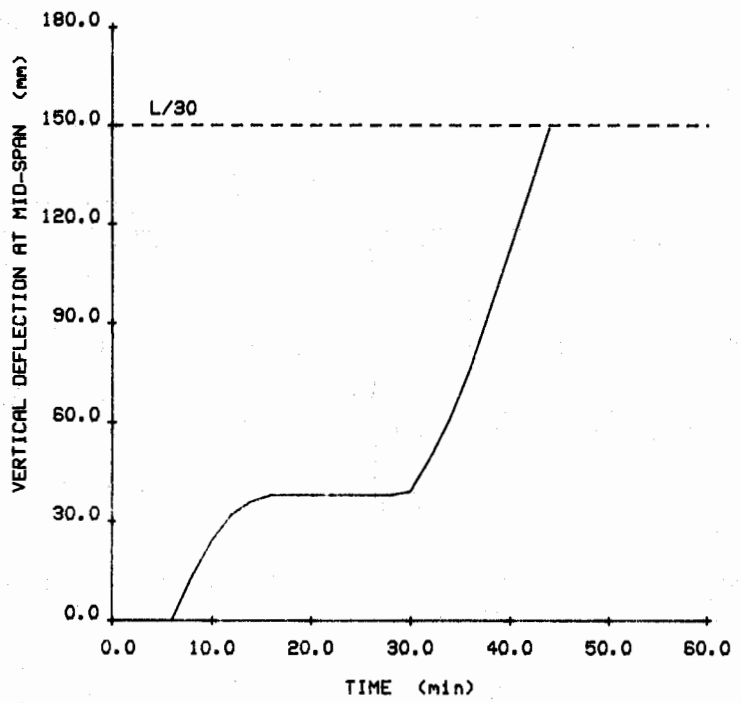
(R2/7124C)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 20th. NOVEMBER 1981
TEST NUMBER	: W.R.C.S.I. 29468

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 44 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 44 MINUTES
FIRE RESISTANCE	: 44 MINUTES

DATA SHEET NUMBER **24b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)													
		3	6	9	12	15	18	21	24	27	30	33	37	40	44
UPPER FLANGE	F3	88	160	235	293	360	424	474	519	563	605	640	685	717	751
	F5	100	173	234	283	354	414	479	537	580	625	660	703	733	761
	F8	81	152	249	330	418	493	558	610	650	683	708	736	754	775
	F9	61	127	202	260	334	403	469	525	573	614	648	691	721	749
	MEAN	82	153	230	291	366	433	495	548	591	632	664	704	731	759
WEB	W1	122	260	384	490	576	629	674	708	733	744	767	804	826	849
	W2	98	256	396	515	605	659	697	729	741	767	794	827	847	867
	W3	114	272	413	532	615	665	703	731	747	772	796	827	847	867
	W4	121	260	382	486	569	624	669	705	732	743	767	804	820	851
	MEAN	114	262	394	506	591	644	686	718	738	756	781	815	835	858
LOWER FLANGE	F1	74	218	374	508	607	665	703	727	742	767	790	821	844	866
	F2	70	217	380	524	626	682	722	737	765	793	817	848	866	886
	F4	71	217	368	495	595	653	696	727	741	767	792	823	846	867
	F6	85	252	400	520	614	669	709	732	753	781	805	828	856	875
	F7	72	222	380	515	613	671	711	732	754	780	804	837	857	877
	MEAN	74	225	380	512	611	668	708	731	751	778	802	831	854	874
MEAN FURNACE GAS		457	634	694	744	770	788	809	829	845	858	869	886	898	914
STANDARD CURVE (g)		491	592	652	694	728	755	778	798	815	831	845	862	874	888
DEFLECTION (mm)		0	0	18	32	37	38	38	38	38	39	54	83	112	149



DATA SHEET NUMBER **25a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL	51.0	208	202	8.06	12.37					5201.2	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 50B	0.11	0.34	1.36	0.011	0.020	0.014	0.005	0.025	0.057	0.052	0.005	0.032	0.0076

ROOM TEMPERATURE TENSILE PROPERTIES (a)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	413	541	25.0
WEB	394	526	26.0

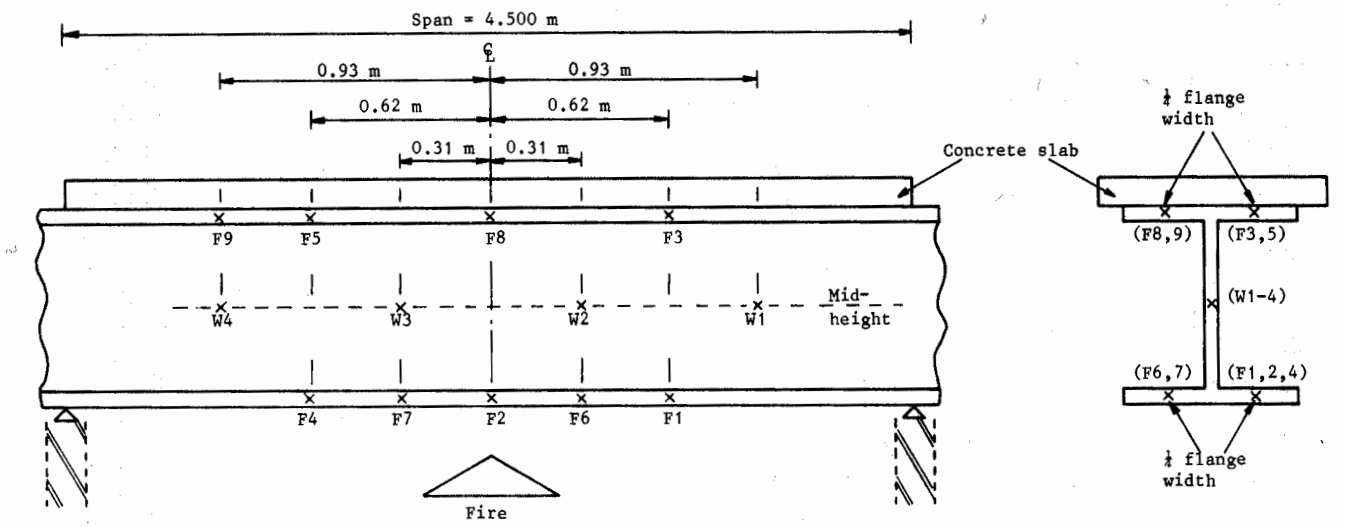
TEST CONDITIONS

END CONDITIONS	:	10% ROTATIONAL END RESTRAINT	
COVER SLAB (b)	:	DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	:	4.500 m	
TOTAL LOAD (c)	:	32.600 kN/m	
DEAD LOAD	:	2.714 kN/m	
IMPOSED LOAD REQUIRED	:	29.886 kN/m	
LOADS APPLIED (d)	:	33.61 kN	
CENTRAL BENDING MOMENT	:	82.52 kN.m	(c)
END MOMENTS	:	8.20 kN.m	(e)
APPLIED END LOADS	:	11.47 kN	(f)

NOTES

(a) For elevated temperature anisothermal tensile properties see Data Sheet No. 87
(b) Slab size = 145 mm thick x 695 mm wide
Slab mass per metre = 2.214 kN
(c) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(d) Between supports
(e) Actual end restraining moments = 9.9% of central bending moment
(f) Applied at a distance of 0.715 m from each support
(g) Initial ambient temperature = 8 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

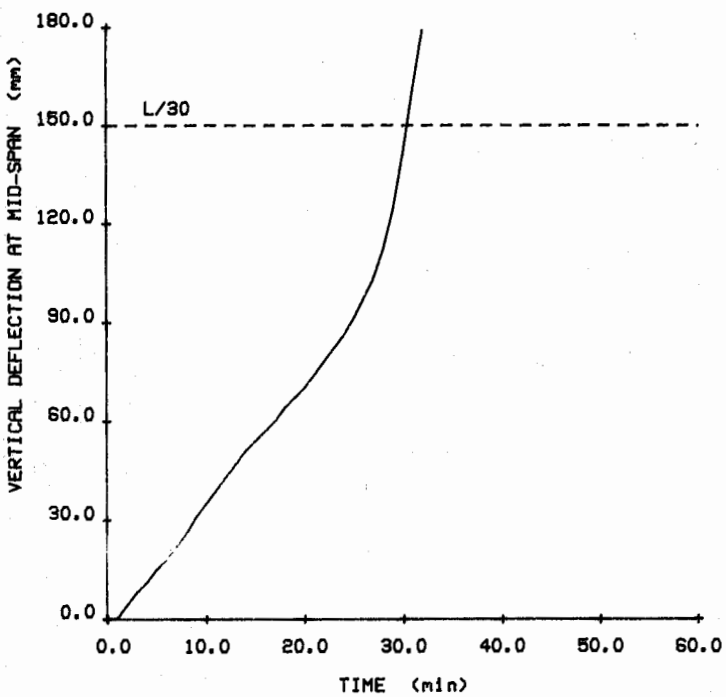
(R2/7124C)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 14th. DECEMBER 1981
TEST NUMBER	: W.R.C.S.I. 29471

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 30 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 30 MINUTES
FIRE RESISTANCE	: 30 MINUTES

DATA SHEET NUMBER **25b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)										
		3	6	9	12	15	18	21	24	27	30	32
UPPER FLANGE	F3	60	88	144	198	252	308	361	412	459	504	538
	F5	71	116	169	218	266	314	363	411	457	511	549
	F8	103	133	187	243	303	365	423	473	520	571	605
	F9	59	94	143	193	243	294	343	390	437	482	512
	MEAN	73	108	161	213	266	320	372	421	468	517	551
WEB	W1	137	225	323	413	487	548	597	634	666	694	709
	W2	167	249	356	446	517	580	626	660	692	717	733
	W3	151	237	338	437	513	574	621	657	687	713	731
	W4	153	236	330	415	485	544	591	628	662	693	711
	MEAN	152	237	337	428	500	561	609	645	677	704	721
LOWER FLANGE	F1	104	198	312	421	509	580	632	671	703	728	740
	F2	129	224	333	440	525	594	644	682	712	738	750
	F4	137	227	331	430	509	574	624	662	693	721	737
	F6	179	259	364	453	527	588	635	668	698	723	737
	F7	97	195	304	415	507	579	632	672	702	727	742
	MEAN	129	221	329	432	515	583	633	671	702	727	741
MEAN FURNACE GAS		571	577	652	683	719	749	765	785	802	819	828
STANDARD CURVE (g)		490	591	651	693	727	754	777	797	814	830	839
DEFLECTION (mm)		8	18	31	43	54	64	74	86	103	141	179



DATA SHEET NUMBER **26a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL	51.3	206	202	8.05	12.5					5131.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 50B	0.11	0.34	1.36	0.012	0.020	0.014	0.005	0.025	0.058	0.052	0.005	0.032	0.008

ROOM TEMPERATURE TENSILE PROPERTIES (a)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	410	537	28.0
WEB	387(b)	519	26.0

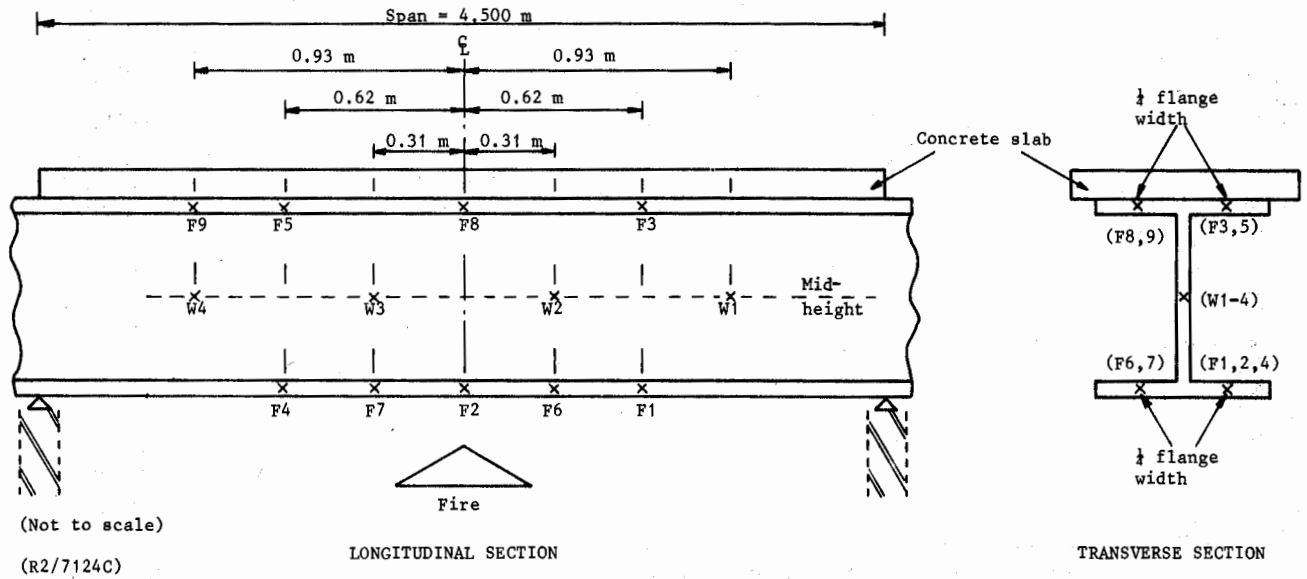
TEST CONDITIONS

END CONDITIONS	:	100% ROTATIONAL END RESTRAINT	
COVER SLAB (c)	:	DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	:	4.500 m	
TOTAL LOAD (d)	:	32.475 kN/m	
DEAD LOAD	:	2.502 kN/m	
IMPOSED LOAD REQUIRED	:	29.973 kN/m	
LOADS APPLIED (e)	:	33.71 kN	
CENTRAL BENDING MOMENT	:	82.20 kN.m	(d)
END MOMENTS	:	82.04 kN m	(f)
APPLIED END LOADS	:	114.74 kN	(g)

NOTES

(a) For elevated temperature anisothermal tensile properties see Data Sheet No. 87
(b) 0.2% proof stress
(c) Slab size = 130 mm thick x 700 mm wide
Slab mass per metre = 2.000 kN
(d) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(e) Between supports
(f) Actual end restraining moments = 99.8% of central bending moment
(g) Applied at a distance of 0.715 m from each support
(h) Initial ambient temperature = 4 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

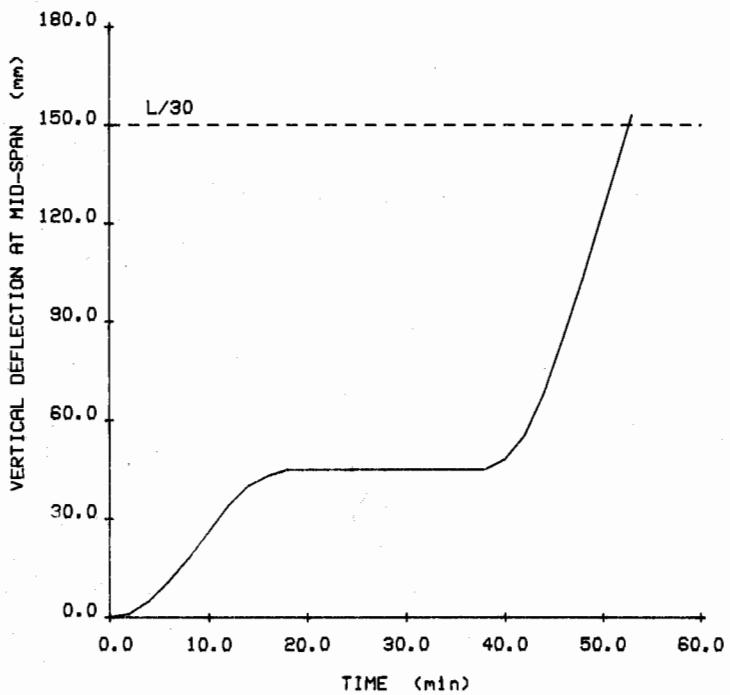
(R2/7124C)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	16th. DECEMBER 1981
TEST NUMBER	:	W.R.C.S.I. 29472

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	53 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	53 MINUTES
FIRE RESISTANCE	:	53 MINUTES

DATA SHEET NUMBER **26b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	53
UPPER FLANGE	F3	54	107	153	206	264	326	389	450	505	555	598	636	670	700	727	752	767	779
	F5	123	171	209	255	323	374	431	488	535	579	617	649	681	710	739	762	781	791
	F8	141	219	283	356	416	484	549	603	646	681	712	739	763	782	798	811	826	839
	F9	58	102	150	194	248	303	359	414	463	506	549	589	625	657	685	711	735	750
	MEAN	94	150	199	253	313	372	432	489	537	580	619	653	685	712	737	759	777	790
WEB	W1	104	209	309	405	496	562	618	661	696	725	746	765	791	812	831	847	859	871
	W2	107	233	340	444	529	591	645	688	721	745	764	790	811	831	849	864	876	884
	W3	127	251	359	454	524	582	632	677	711	738	757	783	806	826	843	859	871	880
	W4	142	245	335	413	488	549	601	647	684	711	735	755	777	799	818	836	849	858
	MEAN	120	234	336	429	509	571	624	668	703	730	750	773	796	817	835	851	864	873
LOWER FLANGE	F1	106	230	345	461	550	614	667	704	737	756	779	803	823	841	857	873	881	890
	F2	91	220	342	465	561	630	685	725	751	778	802	823	842	859	876	890	900	906
	F4	116	228	329	427	523	592	648	691	723	746	764	786	809	827	844	860	873	881
	F6	87	210	326	437	531	601	657	699	731	750	776	801	822	841	858	874	885	893
	F7	88	206	325	438	526	594	647	690	725	746	770	797	819	837	854	870	882	890
	MEAN	98	219	333	446	538	606	661	702	733	755	778	802	823	841	858	873	884	892
MEAN FURNACE GAS		470	598	644	684	722	740	774	798	813	831	843	857	874	888	898	912	915	924
STANDARD CURVE (h)		486	587	647	689	723	750	773	793	810	826	840	853	865	876	886	896	905	911
DEFLECTION (mm)		2	11	21	34	43	45	45	45	45	45	45	45	45	55	75	103	133	153



DATA SHEET NUMBER **27a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL	51.3	206	202	8.05	12.5					5131.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 50B	0.11	0.33	1.34	0.011	0.020	0.014	0.005	0.025	0.057	0.050	0.005	0.033	0.0071

ROOM TEMPERATURE TENSILE PROPERTIES (a)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	400	539	31.0
WEB	410	531	26.0

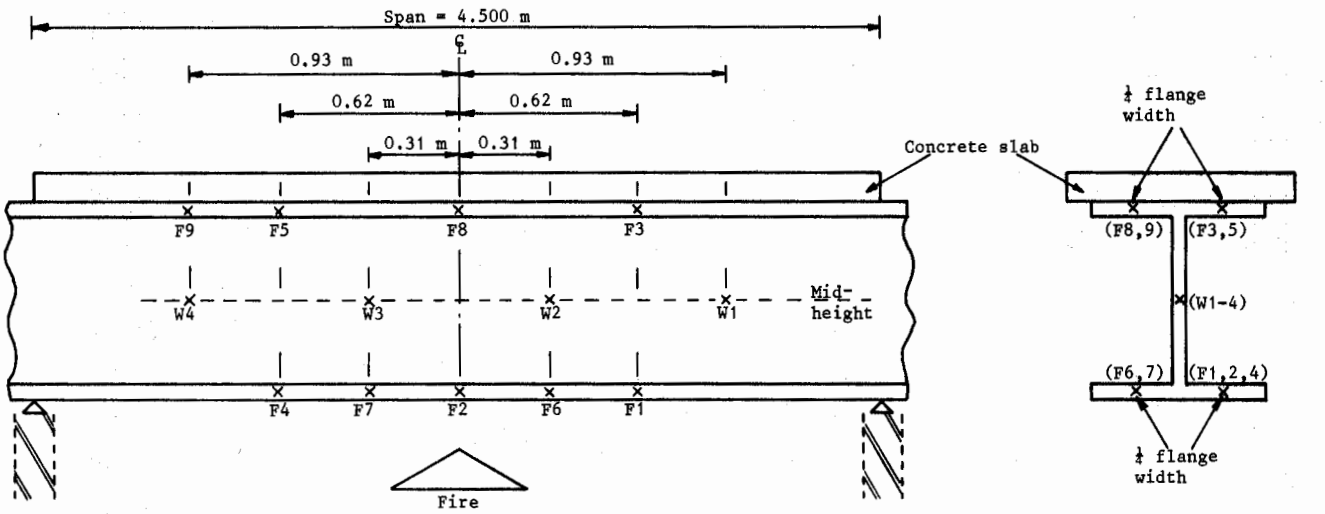
TEST CONDITIONS

END CONDITIONS		: 70% ROTATIONAL END RESTRAINT	
COVER SLAB	(b)	: DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN		: 4.500 m	
TOTAL LOAD	(c)	: 32.475 kN/m	
DEAD LOAD		: 2.474 kN/m	
IMPOSED LOAD REQUIRED		: 30.001 kN/m	
LOADS APPLIED	(d)	: 33.74 kN	
CENTRAL BENDING MOMENT		: 82.20 kN.m	(c)
END MOMENTS		: 56.79 kN.m	(e)
APPLIED END LOADS		: 79.43 kN	(f)

NOTES

(a) For elevated temperature anisothermal tensile properties see Data Sheet No. 87
(b) Slab size = 130 mm thick x 690 mm wide
Slab mass per metre = 1.971 kN
(c) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(d) Between supports
(e) Actual end restraining moments = 69.1% of central bending moments
(f) Applied at a distance of 0.715 m from each support
(g) Initial ambient temperature = 6 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

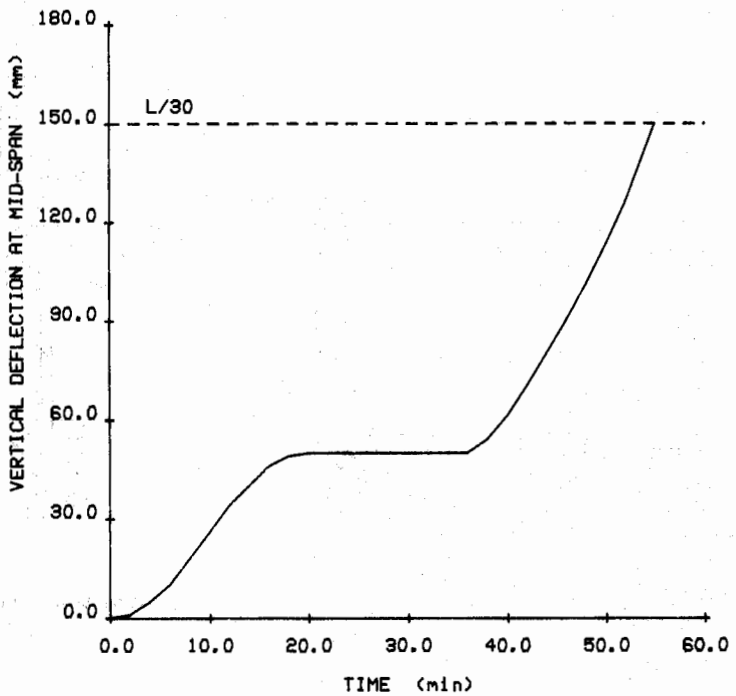
(R2/7124C)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	17th. DECEMBER 1981
TEST NUMBER	:	W.R.C.S.I. 29680

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	55 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	55 MINUTES
FIRE RESISTANCE	:	55 MINUTES

DATA SHEET NUMBER **27b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																	
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	55
UPPER FLANGE	F3	62	99	154	206	268	328	381	430	479	527	570	609	643	679	703	726	750	772
	F5	51	87	133	177	231	292	350	405	458	507	556	596	631	668	691	716	739	759
	F8	82	130	170	223	295	366	435	495	544	594	637	671	699	723	738	755	770	787
	F9	63	105	155	206	268	333	397	455	507	553	590	623	653	685	702	723	744	765
	MEAN	64	105	153	203	265	330	391	446	497	545	588	625	656	689	708	730	751	771
WEB	W1	117	209	319	419	509	574	618	650	677	706	734	752	773	796	815	830	846	865
	W2	104	200	314	412	501	568	617	652	680	711	740	759	783	803	821	836	853	873
	W3	124	216	319	417	511	580	624	660	686	719	743	761	786	805	823	840	855	873
	W4	117	208	308	401	489	557	606	642	673	706	732	749	772	794	811	828	843	862
	MEAN	115	208	315	412	502	570	616	651	679	710	737	755	778	799	817	833	849	868
LOWER FLANGE	F1	98	191	315	429	530	601	648	680	706	731	749	773	797	817	833	848	864	883
	F2	93	191	300	410	514	594	647	684	711	739	760	787	811	828	845	861	877	894
	F4	108	200	311	415	513	589	640	676	704	732	752	777	801	821	837	853	869	886
	F6	77	166	284	397	500	579	632	670	698	725	745	770	795	815	832	848	865	884
	F7	90	180	294	407	511	588	639	676	703	730	747	772	796	817	834	851	867	884
	MEAN	93	186	301	412	514	590	641	677	704	731	751	776	800	820	836	852	868	886
MEAN FURNACE GAS		431	531	618	673	726	741	759	777	791	820	835	848	866	878	888	900	910	923
STANDARD CURVE (g)		488	589	649	691	725	752	775	795	812	828	842	855	867	878	888	898	907	918
DEFLECTION (mm)		2	10	22	34	43	49	50	50	50	50	50	50	57	70	85	101	119	150



DATA SHEET NUMBER **28a**

FLOOR BEAM WITH ROTATIONAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.0	260	146	7.34	12.36					6334.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.24	0.03	0.91	0.013	0.031	0.03	0.007	0.03	0.005	0.05	0.005	0.005	0.005

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	267	485	29.0

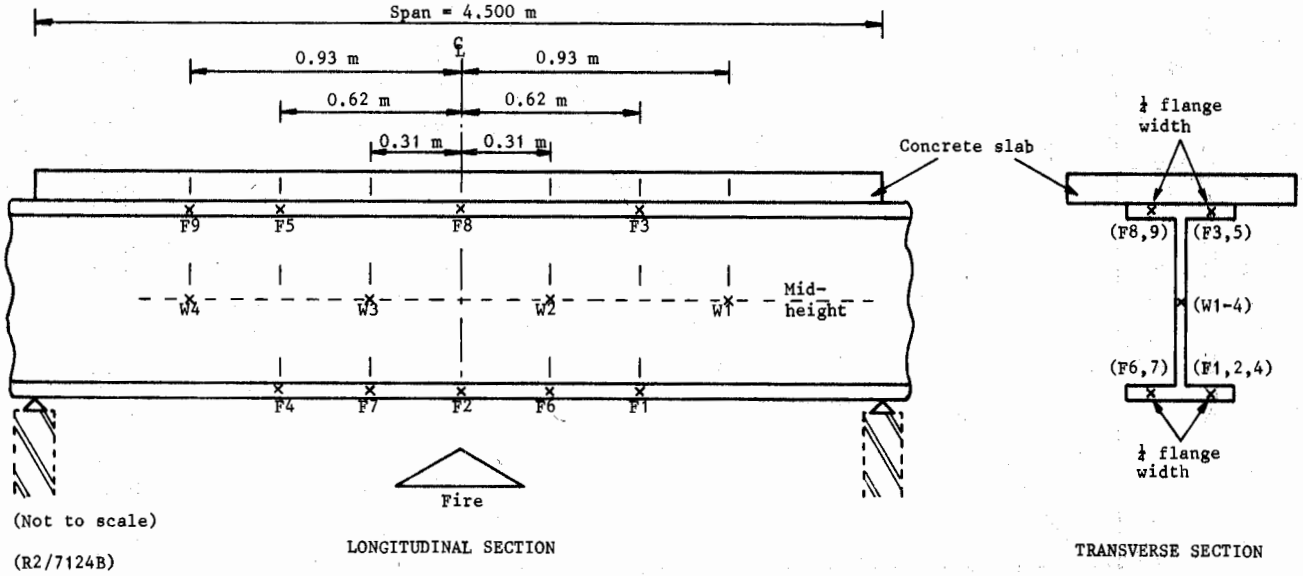
TEST CONDITIONS

END CONDITIONS		: 30% ROTATIONAL END RESTRAINT	
COVER SLAB	(a)	: DENSE CONCRETE, CONTINUOUS	
EFFECTIVE SPAN		: 4.500 m	
TOTAL LOAD	(b)	: 31.763 kN/m	
DEAD LOAD		: 2.212 kN/m	
IMPOSED LOAD REQUIRED		: 29.551 kN/m	
LOADS APPLIED	(c)	: 33.23 kN	
CENTRAL BENDING MOMENT		: 80.40 kN.m	(b)
END MOMENTS		: 24.10 kN.m	
APPLIED END LOADS		: 33.70 kN	(d)

NOTES

(a) Slab size = 130 mm thick x 630 mm wide
Slab mass per metre = 1.800 kN
(b) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(c) Between supports
(d) Applied at a distance of 0.715 m from each support
(e) Initial ambient temperature = 17 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

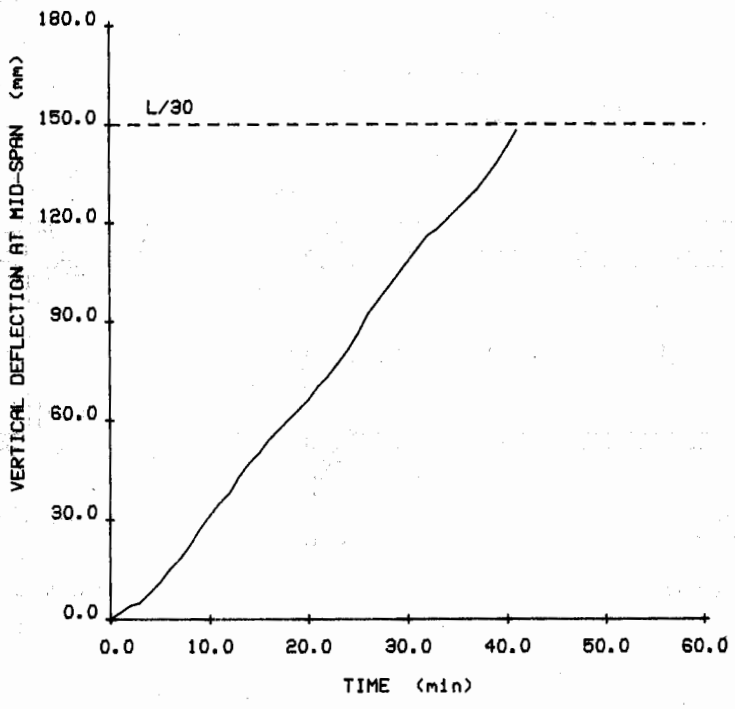
(R2/7124B)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	7th. FEBRUARY 1983
TEST NUMBER	:	W.R.C.S.I. 31764

BS 476 PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	41 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	41 MINUTES
FIRE RESISTANCE	:	41 MINUTES

DATA SHEET NUMBER **28b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)													
		3	6	9	12	15	18	21	24	27	30	33	36	39	41
UPPER FLANGE	F3	70	120	170	222	279	335	382	430	477	526	573	614	652	675
	F5	47	83	131	181	237	291	342	393	444	496	543	587	625	649
	F8	58	108	161	215	275	333	377	385	433	488	538	583	622	646
	F9	52	94	145	201	263	319	375	424	469	519	567	608	643	666
	MEAN	57	101	152	205	263	319	369	408	456	507	555	598	635	659
WEB	W1	128	237	355	454	537	591	629	660	686	720	738	757	784	804
	W2	141	264	383	482	564	615	652	682	705	738	750	780	809	827
	W3	124	246	367	470	551	606	642	672	699	733	745	771	801	822
	W4	104	209	326	431	525	583	628	662	689	724	739	760	789	808
	MEAN	124	239	358	459	544	599	638	669	695	729	743	767	796	815
LOWER FLANGE	F1	92	204	329	443	540	606	650	684	710	734	755	785	810	830
	F2	124	238	351	455	544	609	651	683	712	739	759	789	816	834
	F4	90	186	299	413	514	585	635	671	701	733	745	774	801	819
	F6	100	211	335	449	545	608	652	683	707	726	744	769	775	751
	F7	105	217	337	453	549	615	659	691	718	739	764	792	817	836
	MEAN	102	211	330	443	538	605	649	682	710	734	753	782	804	814
MEAN FURNACE GAS		434	564	636	692	728	750	766	784	806	840	857	874	888	896
STANDARD CURVE (e)		499	600	660	702	736	763	786	806	823	839	853	866	878	885
DEFLECTION (mm)		5	15	27	38	50	60	70	81	96	108	118	127	138	148



DATA SHEET NUMBER **29a**

FLOOR BEAM WITH ROTATIONAL AND THERMAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.0	260	146	7.34	12.36					6334.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.20	0.02	0.88	0.007	0.022	0.02	0.01	0.03	0.01	0.05	0.005	0.005	0.004

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	286	480	31.0

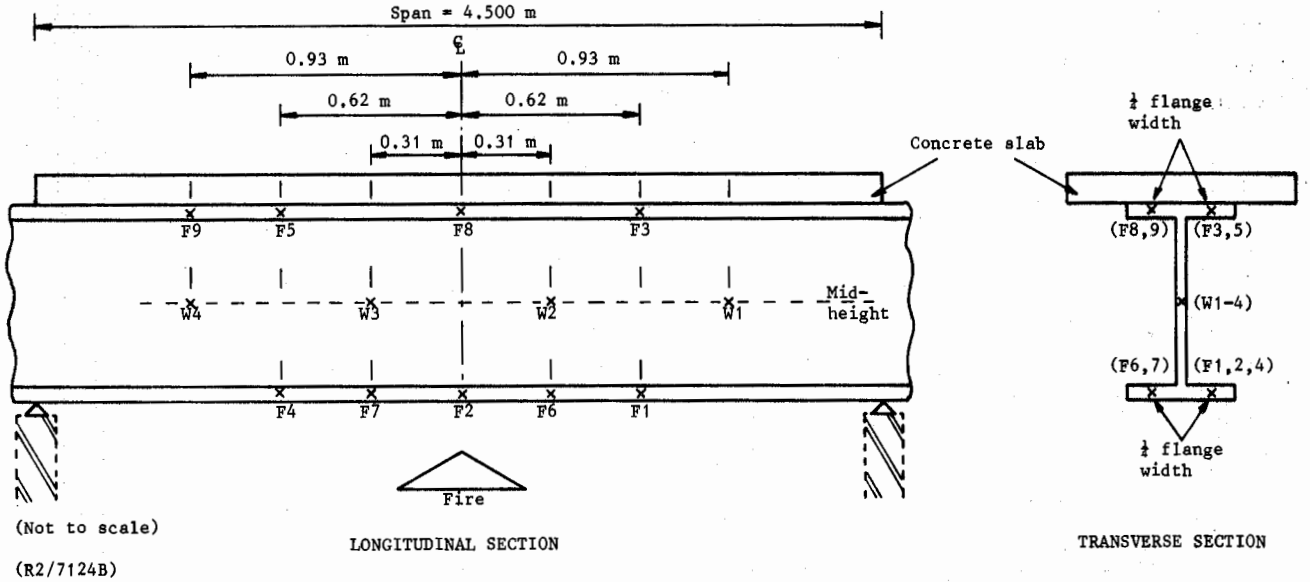
TEST CONDITIONS

END CONDITIONS	:	70% ROTATIONAL AND THERMAL END RESTRAINT	
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	:	4.500 m	
TOTAL LOAD (b)	:	31.763 kN/m	
DEAD LOAD	:	2.212 kN/m	
IMPOSED LOAD REQUIRED	:	29.551 kN/m	
LOADS APPLIED (c)	:	33.23 kN	
CENTRAL BENDING MOMENT	:	80.40 kN.m	(b)
END MOMENTS	:	55.84 kN.m	(d)
APPLIED END LOADS	:	78.1 kN	(e)

NOTES

(a) Slab size = 130 mm thick x 630 mm wide
Slab mass per metre = 1.800 kN
(b) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(c) Between supports
(d) Actual end restraining moments = 69.5% of central bending moment
(e) Applied at a distance of 0.715 m from each support
(f) Initial ambient temperature = 12 deg. C
(g) Rotational end restraint increased to 82% during the test due to movement in the thermal restraining frame
(h) Test extended beyond a central deflection of 150 mm (L/30)

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

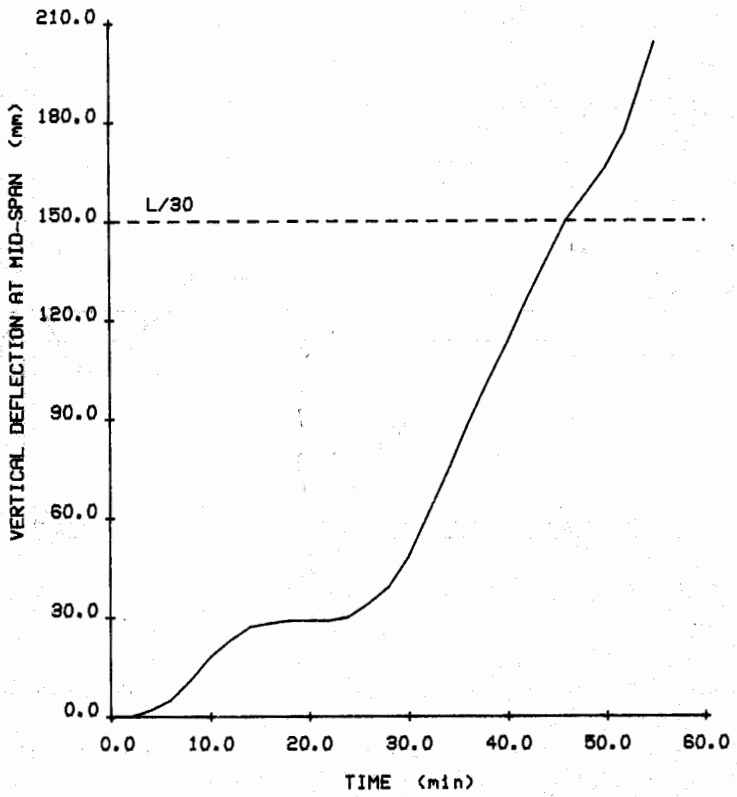
(R2/7124B)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 22nd. MARCH 1983
TEST NUMBER	: W.R.C.S.I. 31695

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 46 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 46 MINUTES
FIRE RESISTANCE	: 46 MINUTES

DATA SHEET NUMBER **29b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		5	8	10	12	15	18	21	24	27	30	33	36	39	42	45	46	49	52	55	
UPPER FLANGE	F3	57	94	134	178	225	285	347	401	450	495	535	572	604	635	662	669	692	713	732	
	F5	67	111	150	194	224	280	334	389	439	487	530	568	600	630	657	665	689	710	732	
	F8	69	125	169	213	289	353	423	478	523	557	587	614	639	664	688	695	715	733	743	
	F9	68	117	158	202	248	308	367	420	467	509	544	574	602	626	648	655	674	694	713	
	MEAN	65	112	153	197	246	306	368	422	470	512	549	582	611	639	664	671	692	712	730	
WEB	W1	157	263	350	446	521	579	624	659	688	711	729	737	752	771	792	798	816	834	852	
	W2	146	264	358	454	540	598	643	677	703	723	735	746	765	788	809	815	834	851	866	
	W3	152	261	354	450	523	582	632	668	696	717	732	739	757	778	800	805	824	843	859	
	W4	145	246	336	432	497	557	607	645	675	700	719	734	742	760	780	786	804	822	841	
	MEAN	150	258	349	445	520	579	626	662	690	713	729	739	754	774	795	801	819	837	854	
LOWER FLANGE	F1	118	224	324	432	525	591	646	685	713	734	744	763	783	803	822	828	847	863	878	
	F2	136	245	343	451	525	590	646	685	713	732	745	764	784	805	825	831	849	865	878	
	F4	163	272	364	472	511	575	628	666	695	719	737	745	762	781	799	805	824	842	858	
	F6	117	227	327	435	532	597	651	689	717	736	749	768	790	809	828	834	852	868	882	
	F7	138	238	334	442	513	580	637	676	705	729	740	760	779	797	817	823	840	856	871	
	MEAN	134	241	338	446	521	587	642	680	709	730	743	760	780	799	818	824	842	859	873	
MEAN FURNACE GAS		468	601	634	671	713	728	756	772	786	803	813	774	841	853	867	869	879	893	902	
STANDARD CURVE (f)		568	637	670	697	731	758	781	801	818	834	848	861	873	884	894	898	907	916	924	
DEFLECTION (mm)		4	11	18	23	28	29	29	30	36	48	67	88	107	126	144	150	161	177	204	(g)(h)



DATA SHEET NUMBER **30a**

FLOOR BEAM WITH ROTATIONAL AND THERMAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.0	260	146	7.34	12.36					6334.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.23	0.02	0.91	0.012	0.029	0.02	0.01	0.03	0.01	0.05	0.005	0.005	0.005

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	285	481	28.0

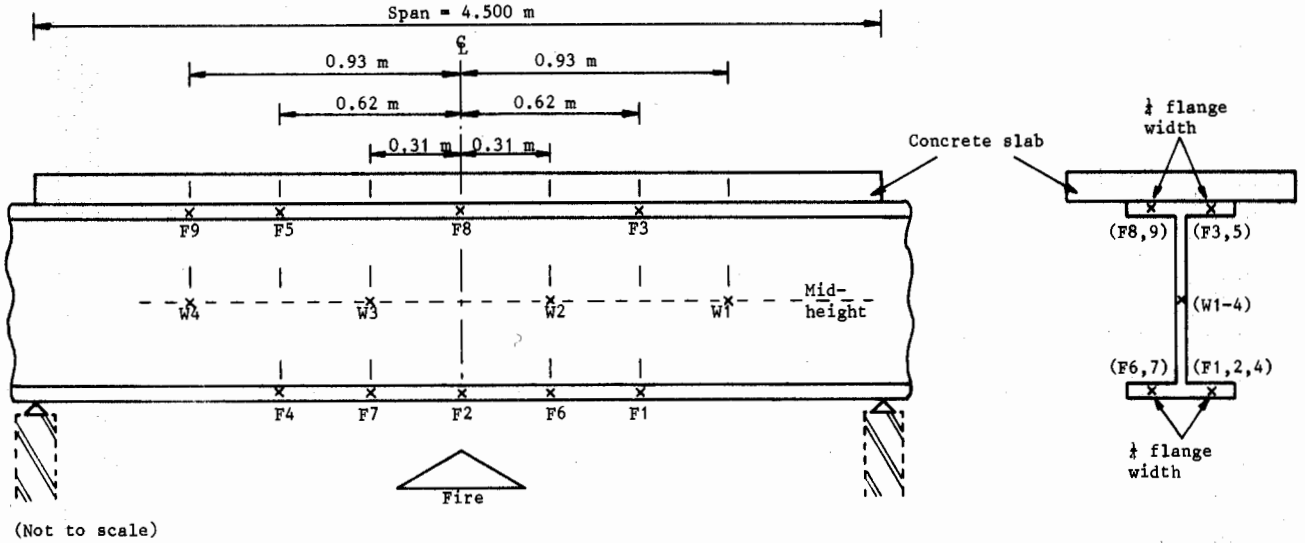
TEST CONDITIONS

END CONDITIONS	:	30% ROTATIONAL AND THERMAL END RESTRAINT
COVER SLAB (a)	:	DENSE CONCRETE, CONTINUOUS
EFFECTIVE SPAN	:	4.500 m
TOTAL LOAD (b)	:	31.763 kN/m
DEAD LOAD	:	2.212 kN/m
IMPOSED LOAD REQUIRED	:	29.551 kN/m
LOADS APPLIED (c)	:	33.23 kN
CENTRAL BENDING MOMENT	:	80.40 kN.m (b)
END MOMENTS	:	24.10 kN.m
APPLIED END LOADS	:	33.70 kN (d)

NOTES

(a) Slab size = 130 mm thick x 630 mm wide
Slab mass per metre = 1.800 kN
(b) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(c) Between supports
(d) Applied at a distance of 0.715 m from each support
(e) Initial ambient temperature = 14 deg. C
(f) Rotational end restraint increased to 43% during the test due to movement in the thermal restraining frame

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

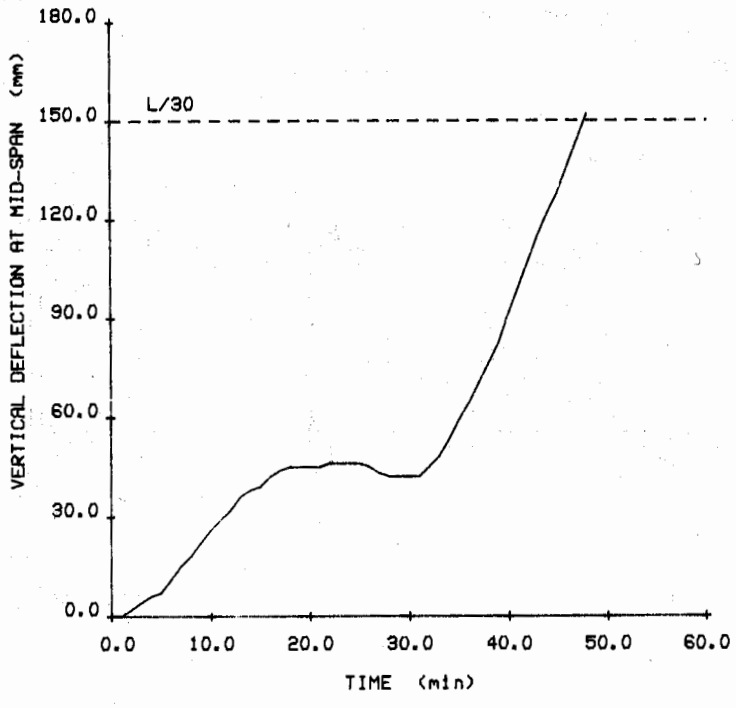
(R2/7124B)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	22nd. FEBRUARY 1983
TEST NUMBER	:	W.R.C.S.I. 31765

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	48 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	48 MINUTES
FIRE RESISTANCE	:	48 MINUTES

DATA SHEET NUMBER **30b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)															
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
UPPER FLANGE	F3	48	94	146	201	258	316	375	431	485	525	565	605	646	674	701	724
	F5	49	90	143	194	253	309	368	423	478	546	567	604	642	674	703	726
	F8	50	96	151	211	276	341	402	453	504	543	584	617	652	682	710	732
	F9	53	106	165	217	274	327	376	425	472	511	551	590	630	659	685	711
	MEAN	50	96	151	206	265	323	380	433	485	531	567	604	642	672	700	723
WEB	W1	149	252	370	466	544	600	643	678	713	728	743	760	781	806	829	849
	W2	128	244	375	484	568	623	666	700	729	745	762	778	796	821	847	866
	W3	136	257	382	484	567	620	662	696	725	741	758	774	792	822	847	865
	W4	109	227	348	452	532	588	632	667	700	718	732	744	769	797	822	841
	MEAN	130	245	369	471	553	608	651	685	717	733	749	764	784	811	836	855
LOWER FLANGE	F1	92	207	333	452	544	608	658	693	725	746	767	788	809	832	853	868
	F2	83	194	320	444	546	615	667	703	732	750	767	788	812	837	858	874
	F4	101	209	330	440	534	601	652	689	721	739	759	780	804	827	850	866
	F6	95	205	335	456	552	619	669	705	733	754	775	796	820	844	865	881
	F7	87	200	326	447	544	612	662	700	731	752	773	794	811	838	860	877
	MEAN	92	203	329	448	544	611	662	698	728	748	768	789	811	836	857	873
MEAN FURNACE GAS		477	567	642	671	713	745	761	788	808	822	837	851	867	880	896	906
STANDARD CURVE (e)		496	597	657	699	733	760	783	803	820	836	850	863	875	886	896	906
DEFLECTION (mm)		4	11	22	32	39	45	45	46	43	42	48	64	82	107	128	152 (f)



DATA SHEET NUMBER **31a**

FLOOR BEAM WITH ROTATIONAL AND THERMAL END RESTRAINT

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 146	NOMINAL	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677
BEAM	ACTUAL	42.0	260	146	7.34	12.36					6334.5	

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.23	0.02	0.92	0.010	0.029	0.02	0.01	0.03	0.01	0.05	0.005	0.005	0.005

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	294	484	31.0

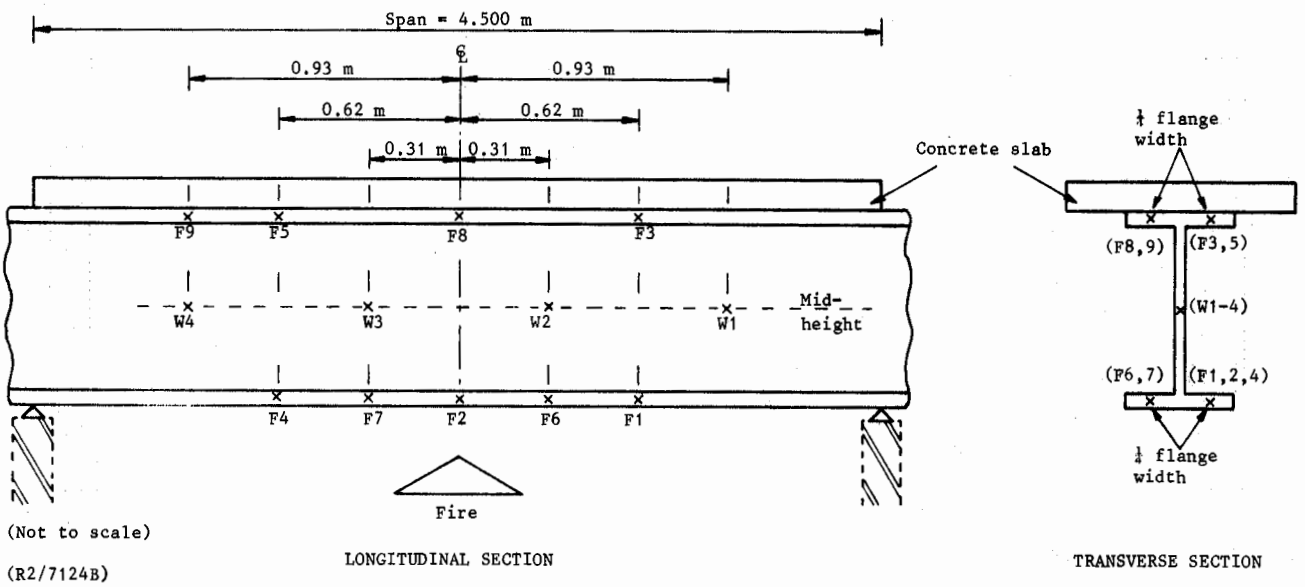
TEST CONDITIONS

END CONDITIONS	:	30% ROTATIONAL AND THERMAL END RESTRAINT	
COVER SLAB (a)	:	DENSE CONCRETE, SEGMENTED	
EFFECTIVE SPAN	:	4.500 m	
TOTAL LOAD (b)	:	31.763 kN/m	
DEAD LOAD	:	2.212 kN/m	
IMPOSED LOAD REQUIRED	:	29.551 kN/m	
LOADS APPLIED (c)	:	33.23 kN	
CENTRAL BENDING MOMENT	:	80.40 kN.m	(b)
END MOMENTS	:	24.10 kN.m	
APPLIED END LOADS	:	33.70 kN	(d)

NOTES

(a) Slab size = 130 mm thick x 630 mm wide
Slab mass per metre = 1.800 kN
(b) Calculated for a simply supported beam subject to a maximum bending stress of 165 N/mm2 in the lower flange
(c) Between supports
(d) Applied at a distance of 0.715 m from each support
(e) Initial ambient temperature = 12 deg. C
(f) Rotational end restraint increased to 43% during the test due to movement in the thermal restraining frame

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

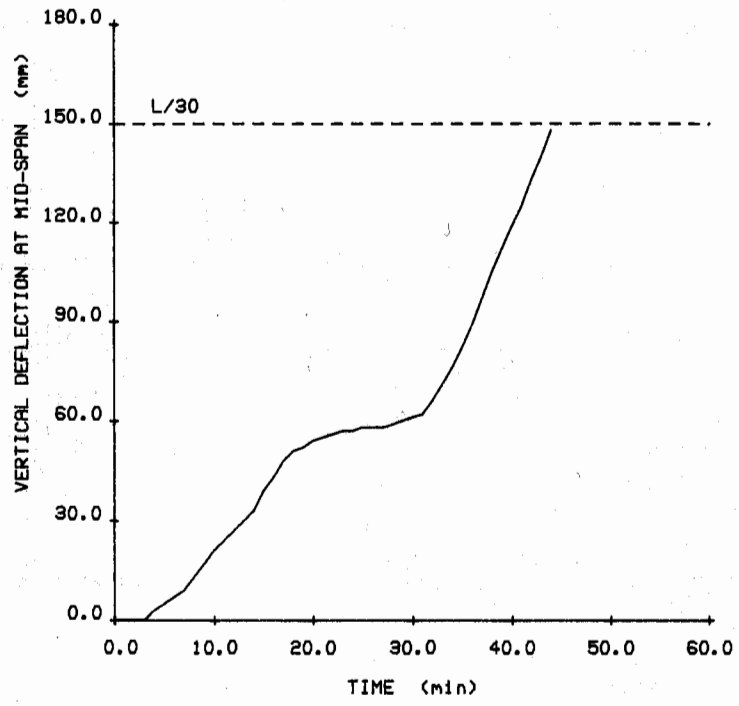
(R2/7124B)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	25th. FEBRUARY 1983
TEST NUMBER	:	W.R.C.S.I. 31766

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	44 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	44 MINUTES
FIRE RESISTANCE	:	44 MINUTES

DATA SHEET NUMBER **31b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
		2	6	9	12	15	18	21	24	27	30	33	36	39	42	44
UPPER FLANGE	F3	78	121	170	220	276	335	386	435	486	532	571	606	637	669	693
	F5	71	111	157	200	250	302	357	404	443	481	521	562	607	641	665
	F8	70	110	161	215	280	342	403	461	500	532	569	603	636	667	690
	F9	105	135	189	241	294	345	397	447	479	511	549	590	632	667	693
	MEAN	81	119	169	219	275	331	386	437	477	514	552	590	628	661	685
WEB	W1	202	298	394	478	543	592	633	673	705	726	735	750	774	797	815
	W2	189	292	401	496	566	617	659	697	724	736	751	771	796	821	839
	W3	209	297	403	492	561	612	652	690	717	737	746	766	792	815	836
	W4	195	288	382	467	534	584	626	666	696	718	735	745	769	791	810
	MEAN	199	294	395	483	551	601	642	681	710	729	742	758	783	806	825
LOWER FLANGE	F1	149	265	372	470	551	608	653	693	724	738	757	779	801	822	840
	F2	138	249	364	467	553	613	661	701	730	741	763	785	809	833	851
	F4	148	257	360	454	534	592	639	680	711	732	743	762	787	807	825
	F6	173	266	382	480	558	616	661	700	731	743	763	784	807	828	846
	F7	160	261	363	460	542	602	651	692	724	738	757	777	801	823	843
	MEAN	154	260	368	466	548	606	653	693	724	738	757	777	801	823	841
MEAN FURNACE GAS		607	507	637	687	707	746	761	798	813	824	833	848	870	877	890
STANDARD CURVE (e)		437	595	655	697	731	758	781	801	818	834	848	861	873	884	891
DEFLECTION (mm)		0	7	17	27	39	51	55	57	58	61	71	89	112	133	148 (f)



DATA SHEET NUMBER **32a**

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
406 x 178	NOMINAL	54	402.6	177.6	7.6	10.9	925.3	114.5	1048	177.5	18626	1017
BEAM	ACTUAL	58	402	178.5	7.7	12.7						
125 x 75 x 12	NOMINAL	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5
ANGLE	ACTUAL	18.0	125	76	12.1	12.1						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

PRODUCT	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.24	0.085	0.93	0.013	0.029	0.010	0.005	0.018	0.005	0.017	0.005	0.01	0.0044
ANGLE	GRADE 50B	0.15	0.24	1.30	0.018	0.018	0.016	0.005	0.017	0.054	0.019	0.005	0.01	0.0058

ROOM TEMPERATURE TENSILE PROPERTIES

PRODUCT	LYS N/mm2	TS N/mm2	ELONG %
BEAM	274	439	25.0
ANGLE	384	518	22.0

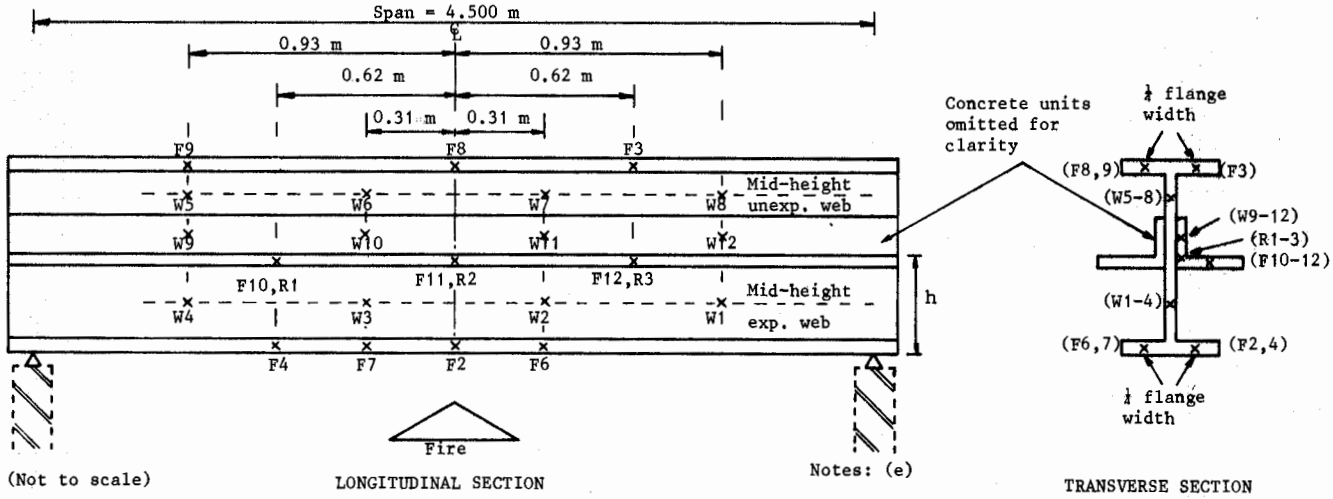
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
EFFECTIVE SPAN	:	4.500 m
CONCRETE FLOOR UNITS	:	SOLID, 200 mm DEEP (a)
SAFE WORKING LOAD	:	271.4 kN (b)(c)
OPERATING LOAD REQUIRED	:	271.4 kN
DEAD LOAD (BEAM + SAND)	:	5.5 kN
TOTAL FORCE REQUIRED	:	265.9 kN
DEAD LOAD (CONCRETE + LOAD SPREADERS)	:	72 kN
REACTION ON EACH ANGLE	:	18 kN
IMPOSED FORCE REQUIRED	:	114.95 kN (ON EACH ANGLE)
LOADS REQUIRED	:	39.88 kN (BY EACH JACK)
LOADS APPLIED	:	42.75 kN (d)(e)

NOTES

(a) Height of exposed steel, h, = 181.1 mm
(b) Based upon nominal dimensions and properties
(c) Assuming a maximum bending stress of 165 N/mm2 in the lower flange
(d) 0.5 m from the centre-line of the beam
(e) 106% of safe working load applied
(f) M20 Grade 4.6 bolts used, one of which sheared during the test
(g) Initial ambient temperature = 23 deg. C

THERMOCOUPLE POSITIONS



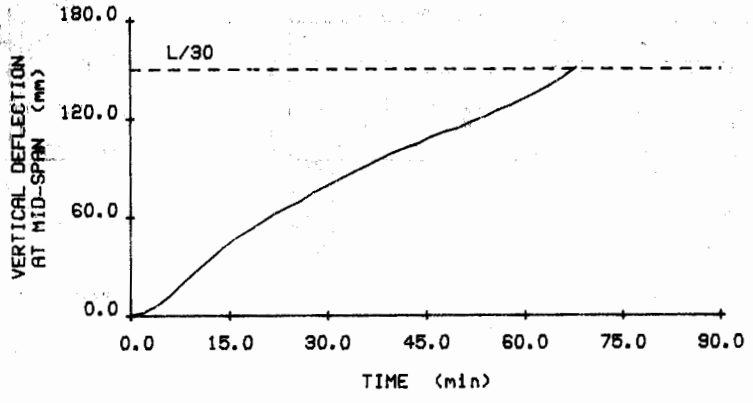
(R2/7124D)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 3rd. NOVEMBER 1982
TEST NUMBER	: W.R.C.S.I. 30238

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 67.5 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 67.5 MINUTES
FIRE RESISTANCE	: 68 MINUTES

DATA SHEET NUMBER **32b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)															
		3	6	9	12	15	20	25	30	35	40	45	50	55	60	65	67.5
UPPER FLANGE	F3	23	23	23	24	24	25	27	30	35	41	49	58	68	77	85	89
	F8	25	25	25	25	33	27	29	33	37	44	52	60	70	81	93	98
	F9	25	25	25	26	26	27	29	32	36	40	46	55	67	77	89	94
	MEAN	24	24	24	25	28	26	28	32	36	42	49	58	68	78	89	94
UNEXPOSED WEB	W5	25	27	30	36	44	58	72	94	109	113	121	130	141	153	164	170
	W6	26	27	31	37	45	60	74	98	112	119	127	137	148	162	175	182
	W7	25	27	31	36	45	60	76	104	112	115	117	120	124	130	143	155
	W8	26	27	30	35	43	57	70	93	107	109	109	110	112	116	121	127
	MEAN	25	27	30	36	44	59	73	97	110	114	118	124	131	140	151	158
EXPOSED WEB	W1	122	220	325	414	492	581	633	689	724	749	780	810	839	863	884	894
	W2	131	229	337	433	515	602	655	708	742	767	798	827	855	878	898	907
	W3	117	216	321	416	495	583	633	688	722	747	781	810	838	862	883	893
	W4	145	231	326	400	471	553	603	655	691	722	749	776	803	830	851	864
	MEAN	129	224	327	416	493	580	631	685	720	746	777	806	834	858	879	889
LOWER FLANGE	F2	88	194	323	442	538	638	690	738	760	792	823	850	875	896	914	922
	F4	87	188	308	415	503	602	656	708	737	759	790	817	843	867	885	894
	F6	86	187	314	434	532	592	690	740	762	794	824	853	878	899	918	927
	F7	90	189	310	424	516	610	674	727	748	778	810	838	865	888	916	916
	MEAN	88	189	314	429	522	610	677	728	752	781	812	839	865	887	908	915
EXPOSED FLANGE ANGLE	F10	115	175	233	284	343	430	492	564	613	653	692	718	746	773	792	805
	F11	71	121	182	243	308	403	468	547	601	646	689	722	753	779	807	822
	F12	93	150	208	266	338	429	496	575	624	666	709	744	776	801	830	845
	MEAN	93	149	208	264	330	421	485	562	613	655	697	728	758	784	810	824
UNEXPOSED FLANGE ANGLE	W9	32	47	72	101	135	195	246	316	367	410	449	484	517	547	576	590
	W10	32	50	80	115	155	227	282	356	409	453	492	528	560	591	618	631
	W11	31	46	71	102	139	212	269	340	380	422	468	508	544	577	607	621
	W12	31	48	74	108	148	216	268	339	389	431	467	501	532	562	590	602
	MEAN	32	48	74	106	144	212	266	338	386	429	469	505	538	569	598	611
ANGLE ROOT	R1	38	64	101	142	187	269	331	413	470	519	561	597	631	662	690	702
	R2	39	66	107	156	208	296	359	442	500	551	594	632	666	697	723	736
	R3	39	65	104	146	198	284	349	432	490	539	582	620	656	686	714	727
	MEAN	39	65	104	148	198	283	346	429	487	536	579	616	651	682	709	722
MEAN FURNACE GAS		488	618	681	704	743	772	796	817	836	855	878	894	909	930	940	950
STANDARD CURVE (g)		505	606	666	708	742	784	818	845	868	888	905	921	935	948	960	966
DEFLECTION (mm)		4	12	24	34	45	57	68	79	89	99	106	114	123	132	142	149



DATA SHEET NUMBER **33a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
305 x 165	NOMINAL	40	303.8	165.1	6.1	10.2	561.2	92.4	624.5	141.5	8523	763
BEAM	ACTUAL	40	304	165	6.5	10.0						
125 x 75 x 12	NOMINAL	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5
ANGLE	ACTUAL	18.1	125	75	12.2	12.2						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

PRODUCT	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.23	0.02	0.88	0.024	0.017	0.02	0.01	0.03	0.02	0.04	0.005	0.008	0.005
ANGLE	GRADE 50B	0.15	0.24	1.41	0.02	0.011	0.02	0.01	0.02	0.07	0.28	0.005	0.005	0.0062

ROOM TEMPERATURE TENSILE PROPERTIES

PRODUCT	LYS N/mm2	TS N/mm2	ELONG %
BEAM	*	*	*
ANGLE	*	*	*

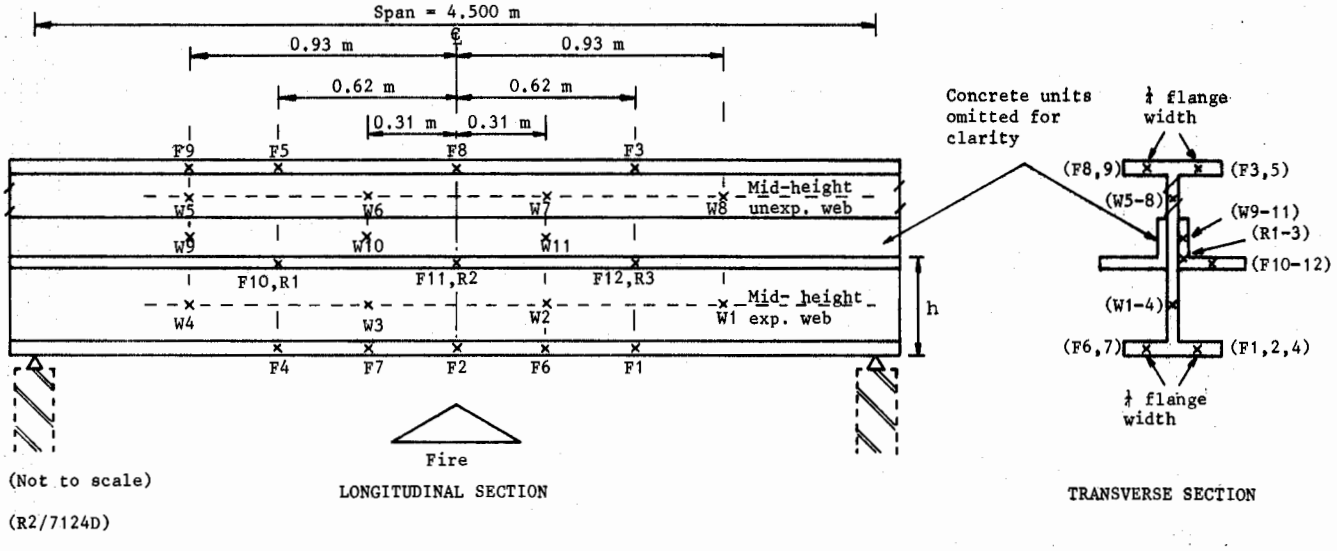
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
EFFECTIVE SPAN	:	4.500 m
CONCRETE FLOOR UNITS	:	SOLID, 200 mm DEEP (a)
SAFE WORKING LOAD	:	164.6 kN (b)(c)
OPERATING LOAD REQUIRED	:	164.6 kN
DEAD LOAD (BEAM + SAND)	:	~ 5 kN
TOTAL FORCE REQUIRED	:	159.6 kN
DEAD LOAD (CONCRETE + LOAD SPREADERS)	:	~72 kN
REACTION ON EACH ANGLE	:	18 kN
IMPOSED FORCE REQUIRED	:	61.80 kN (ON EACH ANGLE)
LOADS REQUIRED	:	21.44 kN (BY EACH JACK)
LOADS APPLIED	:	23.45 kN (d)(e)

NOTES

(a) Height of exposed steel, h, = 84 mm
(b) Based upon nominal dimensions and properties
(c) Assuming a maximum bending stress of 165 N/mm2 in the lower flange
(d) 0.5 m from the centre-line of the beam
(e) 107% of safe working load applied
(f) Initial ambient temperature = 15 deg. C
(*) Not measured

THERMOCOUPLE POSITIONS



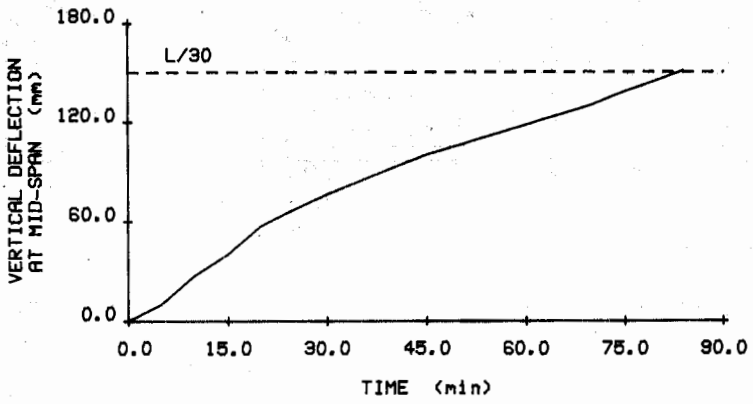
(R2/7124D)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 30th. NOVEMBER 1983
TEST NUMBER	: W.R.C.S.I. 33721

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 83 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 83 MINUTES
FIRE RESISTANCE	: 83 MINUTES

DATA SHEET NUMBER **33b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
		3	6	9	12	15	18	21	24	27	30	35	40	45	50	55	60	65	70	75	80	83
UPPER FLANGE	F3	11	10	12	12	12	11	12	15	14	16	24	31	39	44	57	61	71	79	82	86	88
	F5	9	9	11	12	12	11	12	15	14	16	22	27	34	39	52	58	72	83	89	95	99
	F8	9	9	11	11	11	10	11	14	14	18	27	35	43	46	57	60	71	79	83	89	92
	F9	9	9	11	11	12	11	12	15	14	16	21	25	31	33	44	48	60	71	77	83	88
	MEAN	9	9	11	11	12	11	12	15	14	16	23	29	37	40	52	57	68	78	83	88	92
UNEXPOSED WEB	W5	12	12	16	20	24	28	35	45	52	62	81	97	106	110	121	126	139	151	160	170	176
	W6	11	12	15	19	23	27	34	44	51	60	77	88	97	100	107	105	116	126	130	134	135
	W7	12	12	15	18	21	24	30	39	45	53	70	82	92	96	106	103	110	116	120	126	130
	W8	12	12	16	19	23	26	33	45	55	66	83	94	102	102	107	108	119	129	134	140	143
	MEAN	12	12	15	19	23	26	33	43	51	60	78	90	99	102	110	110	121	130	136	142	146
EXPOSED WEB	W1	65	132	197	247	296	363	422	474	507	537	581	621	655	682	719	746	780	812	834	856	869
	W2	63	126	181	232	280	340	398	448	484	518	566	608	644	674	713	742	777	807	831	855	868
	W3	58	123	187	241	290	356	417	468	504	536	579	614	647	673	708	735	771	804	830	854	868
	W4	54	116	180	232	278	339	396	443	477	509	557	596	632	661	692	718	752	784	812	838	852
	MEAN	60	124	186	238	286	349	408	458	493	525	571	610	644	672	708	735	770	802	827	851	864
LOWER FLANGE	F1	71	166	268	343	409	500	569	613	641	665	698	727	747	774	807	831	860	883	899	917	927
	F2	64	160	267	345	412	506	577	621	650	674	708	734	757	784	816	841	869	891	908	926	935
	F4	74	169	261	332	393	473	540	587	617	644	681	709	732	752	786	810	841	867	886	905	916
	F6	104	222	307	379	446	527	586	625	650	674	704	729	752	777	810	834	860	880	896	912	925
	F7	66	163	263	340	404	492	563	609	638	663	696	722	740	762	794	816	847	871	889	906	918
	MEAN	76	176	273	348	413	500	567	611	639	664	697	724	746	770	803	826	855	878	896	913	924
EXPOSED FLANGE ANGLE	F10	50	103	147	183	220	276	329	385	429	470	532	582	630	669	712	740	774	807	837	866	882
	F11	37	74	120	146	166	230	299	339	390	443	512	571	620	661	705	735	770	808	836	864	880
	F12	44	87	133	165	187	230	296	341	388	431	509	573	626	666	707	736	769	803	830	858	873
	MEAN	44	88	133	165	191	245	308	355	402	448	518	575	625	665	708	737	771	806	834	863	878
UNEXPOSED FLANGE ANGLE	W9	15	27	45	65	88	115	150	189	223	258	313	359	400	433	470	498	532	563	588	614	628
	W10	14	26	45	66	90	116	152	191	214	231	264	299	336	368	409	443	483	520	550	579	594
	W11	14	27	47	72	99	128	165	205	238	272	324	367	406	437	475	504	538	569	592	616	630
	MEAN	14	27	46	68	92	120	156	195	225	254	300	342	381	413	451	482	518	551	577	603	617
ANGLE ROOT	R1	22	42	66	94	122	156	198	240	279	318	380	434	482	521	564	597	634	668	693	719	734
	R2	21	41	67	95	112	151	201	248	288	327	390	447	498	538	583	617	655	687	713	738	753
	R3	20	30	63	88	104	129	170	212	248	289	358	418	471	513	558	591	629	662	688	713	727
	MEAN	21	38	65	92	113	145	190	233	272	311	376	433	484	524	568	602	639	672	698	723	738
MEAN FURNACE GAS		462	623	630	653	694	767	786	797	803	811	828	847	866	880	901	913	934	944	959	969	979
STANDARD CURVE (f)		497	598	658	700	734	761	784	804	821	837	860	880	897	913	927	940	952	963	974	983	989
DEFLECTION (mm)		6	13	23	32	40	51	60	66	71	76	84	92	100	106	112	118	124	130	138	145	149



DATA SHEET NUMBER **34a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
406 x 178	NOMINAL	54	402.6	177.6	7.6	10.9	925.3	114.5	1048	177.5	18626	1017
BEAM	ACTUAL	54	403	178	7.5	11.0						
125 x 75 x 12	NOMINAL	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5
ANGLE	ACTUAL	17.8	125	75	12.0	12.0						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

PRODUCT	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.18	0.015	1.50	0.018	0.015	0.03	0.005	0.03	0.088	0.03	0.001	0.004	0.003
ANGLE	GRADE 50B	0.16	0.25	1.39	0.026	0.021	0.06	0.002	0.02	0.057	0.04	0.001	0.003	0.006

ROOM TEMPERATURE TENSILE PROPERTIES

PRODUCT	LYS N/mm2	TS N/mm2	ELONG %
BEAM	407	564	29.0
ANGLE	397	575	30.0

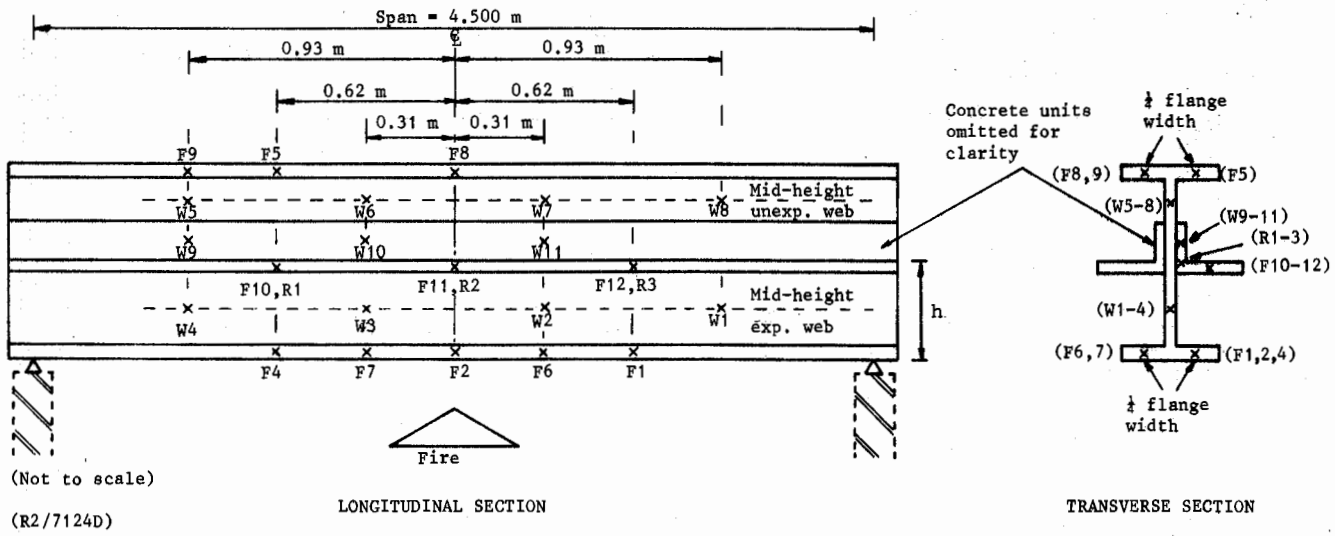
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
EFFECTIVE SPAN	:	4.500 m
CONCRETE FLOOR UNITS	:	SOLID, 200 mm DEEP (a)
SAFE WORKING LOAD	:	378.3 kN (b)(c)
OPERATING LOAD REQUIRED	:	151.3 kN (NOM. 40% OF SWL)
DEAD LOAD (BEAM + SAND)	:	~ 5.5 kN
TOTAL FORCE REQUIRED	:	145.8 kN
DEAD LOAD (CONCRETE + LOAD SPREADERS)	:	~72 kN
REACTION ON EACH ANGLE	:	18 kN
IMPOSED FORCE REQUIRED	:	54.90 kN (ON EACH ANGLE)
LOADS REQUIRED	:	19.05 kN (BY EACH JACK)
LOADS APPLIED	:	23.1 kN (d)(e)

NOTES

(a) Height of exposed steel, h, = 182.0 mm
(b) Based upon nominal dimensions and properties
(c) Assuming a maximum bending stress of 230 N/mm2 in the lower flange
(d) 0.5 m from the centre-line of the beam
(e) 46.2% of safe working load utilised (for BS 4360 : Grade 50 steel)
(f) Initial ambient temperature = 20 deg. C

THERMOCOUPLE POSITIONS



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LONGITUDINAL SECTION

TRANSVERSE SECTION

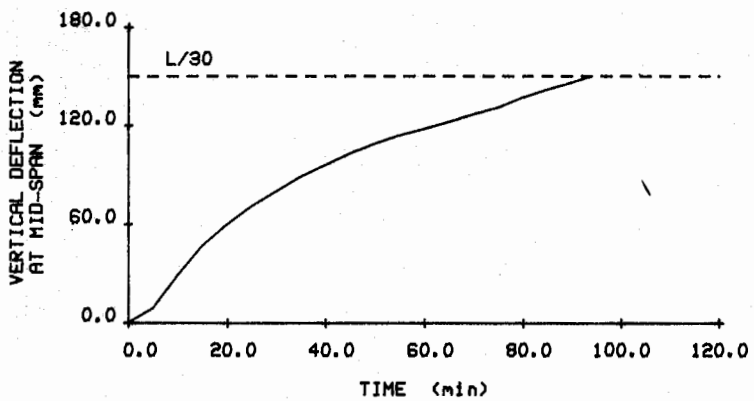
(R2/7124D)

TEST CENTRE	: WARRINGTON RESEARCH
TEST DATE	: 24th. MAY 1984
TEST NUMBER	: W.R.C.S.I. 34140

BS 476 : PART 8 : 1972 ASSESSMENT	
TIME TO L/30	: 94 MINUTES
RE-LOAD TEST	: SATISFIED
STABILITY	: 94 MINUTES
FIRE RESISTANCE	: 94 MINUTES

DATA SHEET NUMBER **34b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		3	6	9	12	15	18	21	24	27	30	35	40	45	50	55	60	70	80	90	94
UPPER FLANGE	F5	18	19	22	23	20	24	21	23	26	29	34	41	45	59	68	87	93	101	103	103
	F8	19	20	22	22	20	24	21	22	27	29	35	41	41	53	61	77	82	101	102	102
	F9	20	20	23	22	20	24	21	22	27	28	32	36	37	47	55	73	89	104	105	105
	MEAN	19	20	22	22	20	24	21	22	27	29	34	39	41	53	61	79	88	102	103	103
UNEXPOSED WEB	W5	20	21	26	30	36	43	50	58	68	78	97	108	120	131	142	153	173	195	220	229
	W6	20	21	26	31	37	46	54	64	75	88	110	127	141	153	165	177	202	226	249	257
	W7	19	21	27	32	37	45	54	63	75	88	106	118	128	139	150	163	188	210	232	246
	W8	19	21	26	31	37	45	53	62	71	84	104	121	134	141	143	148	162	193	228	240
	MEAN	19	21	26	31	37	45	53	62	72	84	104	118	131	141	150	160	181	206	232	243
EXPOSED WEB	W1	76	167	261	360	442	502	557	606	642	672	712	740	768	799	827	854	894	930	960	971
	W2	75	159	266	372	456	515	571	620	656	686	723	749	780	812	840	865	905	941	970	980
	W3	81	170	283	383	463	522	578	625	662	692	729	754	786	816	844	867	907	942	971	981
	W4	90	180	279	375	453	509	563	609	645	673	711	739	765	796	824	850	890	924	955	964
	MEAN	80	169	272	372	453	512	567	615	651	681	719	745	775	806	834	859	899	934	964	974
LOWER FLANGE	F1	61	153	270	391	488	558	612	660	696	723	750	783	815	843	868	888	925	957	984	994
	F2	57	146	267	389	487	558	614	662	700	726	752	786	817	846	871	892	929	962	984	999
	F4	65	166	298	412	500	567	615	660	696	722	749	781	813	841	866	889	924	956	982	992
	F6	58	150	270	393	490	560	611	659	696	721	747	780	811	836	863	883	921	953	960	989
	F7	95	187	312	425	507	568	619	661	694	720	746	779	807	834	858	878	911	948	970	985
	MEAN	67	160	283	402	494	562	614	660	696	722	749	782	813	840	865	886	922	955	976	992
EXPOSED FLANGE ANGLE	F10	43	86	156	217	271	329	381	442	488	526	581	631	676	714	749	772	833	884	925	938
	F11	47	85	146	207	263	322	382	442	496	541	601	651	696	734	766	794	854	908	946	959
	F12	50	87	140	199	257	316	373	433	485	528	593	640	684	721	753	778	839	891	927	939
	MEAN	47	86	147	208	264	322	379	439	490	532	592	641	685	723	756	781	842	894	933	945
UNEXPOSED FLANGE ANGLE	W9	22	41	83	92	127	165	204	242	278	312	363	407	447	482	516	548	605	652	693	708
	W10	22	38	60	91	125	165	204	245	284	321	372	413	448	484	519	550	605	654	698	714
	W11	23	39	62	93	129	171	211	252	291	326	374	415	455	493	528	561	617	667	711	726
	MEAN	22	39	68	92	127	167	206	246	284	320	370	412	450	486	521	553	609	658	701	716
ANGLE ROOT	R1	27	53	91	133	178	225	271	318	363	404	464	515	561	602	638	671	724	775	824	841
	R2	27	50	83	121	165	211	258	308	356	400	464	518	566	606	642	674	728	779	828	844
	R3	27	49	87	113	156	202	248	296	343	386	451	502	549	588	621	653	704	751	798	816
	MEAN	27	51	87	122	166	213	259	307	354	397	460	512	559	599	634	666	719	768	817	834
MEAN FURNACE GAS		429	516	627	687	714	734	776	792	800	827	846	863	883	901	920	934	966	990	1014	1020
STANDARD CURVE (f)		502	603	663	705	739	766	789	809	826	842	865	885	902	918	932	945	968	988	1006	1012
DEFLECTION (mm)		5	12	26	36	47	55	63	69	75	80	89	96	103	109	114	118	127	137	146	150



DATA SHEET NUMBER **35a**

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
406 x 178	NOMINAL	54	402.6	177.6	7.6	10.9	925.3	114.5	1048	177.5	18626	1017
BEAM	ACTUAL	54	403	178	7.5	11.0						
125 x 75 x 12	NOMINAL	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5
ANGLE	ACTUAL	17.5	125	75	11.8	11.8						

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	0.89	0.026	0.025	0.04	0.004	0.03	0.001	0.04	0.001	0.004	0.005
ANGLE	GRADE 50B	0.12	0.33	1.35	0.019	0.011	0.02	0.003	0.02	0.051	0.02	0.001	0.043	0.007

ROOM TEMPERATURE TENSILE PROPERTIES

PRODUCT	LYS N/mm2	TS N/mm2	ELONG %
BEAM	280	478	32.0
ANGLE	381	518	32.0

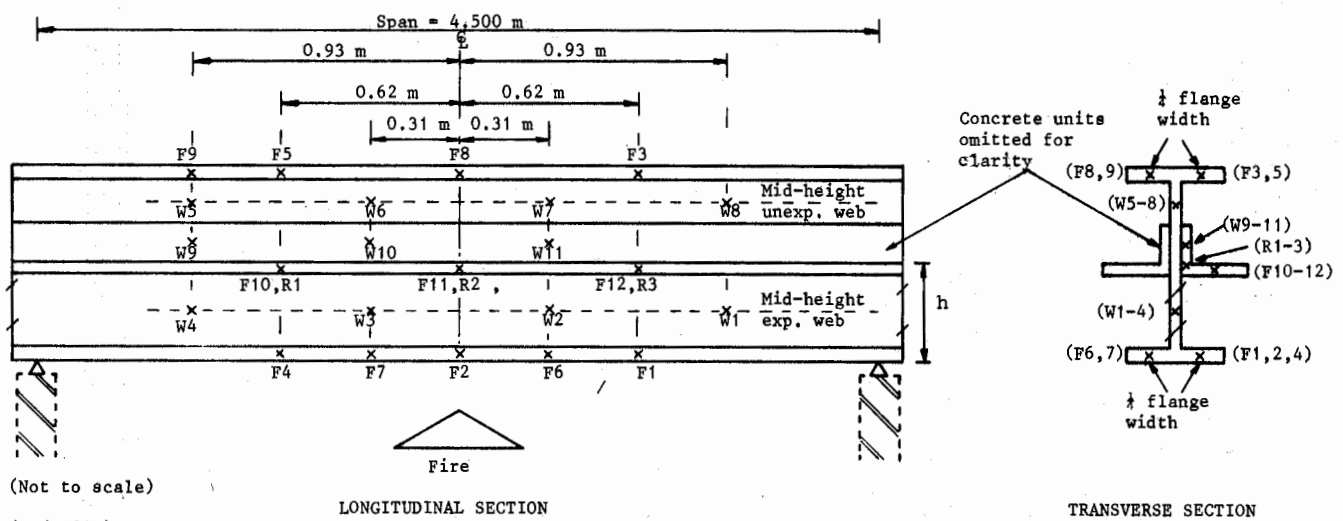
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
EFFECTIVE SPAN	:	4.500 m
CONCRETE FLOOR UNITS	:	SOLID, 150 mm DEEP (a)(b)
SAFE WORKING LOAD	:	271.4 kN (c)(d)
OPERATING LOAD REQUIRED	:	271.4 kN
DEAD LOAD (BEAM + SAND)	:	~ 5.5 kN
TOTAL FORCE REQUIRED	:	265.9 kN
DEAD LOAD (CONCRETE + LOAD SPREADERS)	:	~53 kN
REACTION ON EACH ANGLE	:	13.25 kN
IMPOSED FORCE REQUIRED	:	119.70 kN (ON EACH ANGLE)
LOADS REQUIRED	:	41.53 kN (BY EACH JACK)
LOADS APPLIED	:	44.0 kN (e)(f)

NOTES

(a) 50 mm deep x 300 mm long taper at one end
(b) Height of exposed steel, h, = 282.0 mm
(c) Based upon nominal dimensions and properties
(d) Assuming a maximum bending stress of 165 N/mm2 in the lower flange
(e) 0.5 m from the centre-line of the beam
(f) 105.2% of safe working load applied
(g) Initial ambient temperature = 24 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

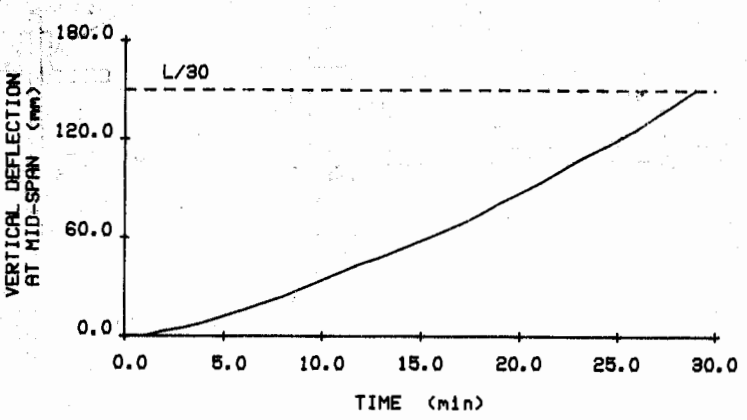
(R2/7124D)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	11th. JULY 1984
TEST NUMBER	:	W.R.C S.I. 34142

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	29 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	29 MINUTES
FIRE RESISTANCE	:	29 MINUTES

DATA SHEET NUMBER **35b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)								
		3	6	9	12	15	18	21	24	29
UPPER FLANGE	F3	22	23	24	28	35	44	56	69	99
	F5	22	22	24	28	34	45	58	74	95
	F8	23	23	25	28	34	43	54	69	98
	F9	23	23	25	29	35	44	54	67	96
	MEAN	22	23	24	28	34	44	55	70	97
UNEXPOSED WEB	W5	23	28	38	52	68	86	105	126	161
	W6	23	28	39	53	71	92	113	135	174
	W7	23	29	41	56	75	96	119	141	180
	W8	23	28	37	49	64	81	98	120	152
	MEAN	23	28	39	52	69	89	109	130	167
EXPOSED WEB	W1	88	235	343	466	545	596	635	669	709
	W2	89	247	361	492	572	617	656	686	724
	W3	85	230	345	479	561	613	653	683	719
	W4	89	234	341	464	543	596	636	667	707
	MEAN	88	236	347	475	555	605	645	676	715
LOWER FLANGE	F1	74	219	339	480	571	627	668	697	724
	F2	97	241	355	492	579	634	675	705	735
	F4	74	217	339	479	570	627	669	700	733
	F6	93	243	363	498	587	637	678	709	738
	F7	75	213	337	479	572	631	674	705	734
	MEAN	83	227	347	486	576	631	673	703	733
EXPOSED FLANGE ANGLE	F10	90	161	217	292	355	411	465	513	578
	F11	75	157	211	290	352	409	458	501	561
	F12	79	164	226	300	366	429	472	514	573
	MEAN	81	161	218	294	358	416	465	509	571
UNEXPOSED FLANGE ANGLE	W9	27	47	78	121	168	215	260	303	368
	W10	27	45	74	116	165	213	260	303	367
	W11	27	48	80	123	172	220	264	305	368
	MEAN	27	47	77	120	168	216	261	304	368
ANGLE ROOT	R1	34	67	106	159	214	267	318	366	437
	R2	33	69	110	167	223	277	328	375	443
	R3	33	68	108	163	221	275	324	370	440
	MEAN	33	68	108	163	219	273	323	370	440
MEAN FURNACE GAS		466	611	679	722	741	759	783	799	818
STANDARD CURVE (g)		506	607	667	709	743	770	793	813	841
DEFLECTION (mm)		5	16	29	44	58	74	93	113	150



DATA SHEET NUMBER **36a**

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
406 x 178	NOMINAL	54	402.6	177.6	7.6	10.9	925.3	114.5	1048	177.5	18626	1017
BEAM	ACTUAL	54	403	178	8.0	11.0						
125 x 75 x 12	NOMINAL	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5
ANGLE	ACTUAL	17.8	125	75	12.0	12.0						

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	0.027	0.92	0.014	0.028	0.02	0.004	0.01	0.001	0.02	0.001	0.006	0.005
ANGLE	GRADE 50B	0.14	0.22	1.43	0.031	0.021	0.03	0.006	0.02	0.067	0.02	0.001	0.005	0.005

ROOM TEMPERATURE TENSILE PROPERTIES

PRODUCT	LYS N/mm2	TS N/mm2	ELONG %
BEAM	300	467	36.0
ANGLE	380	539	32.0

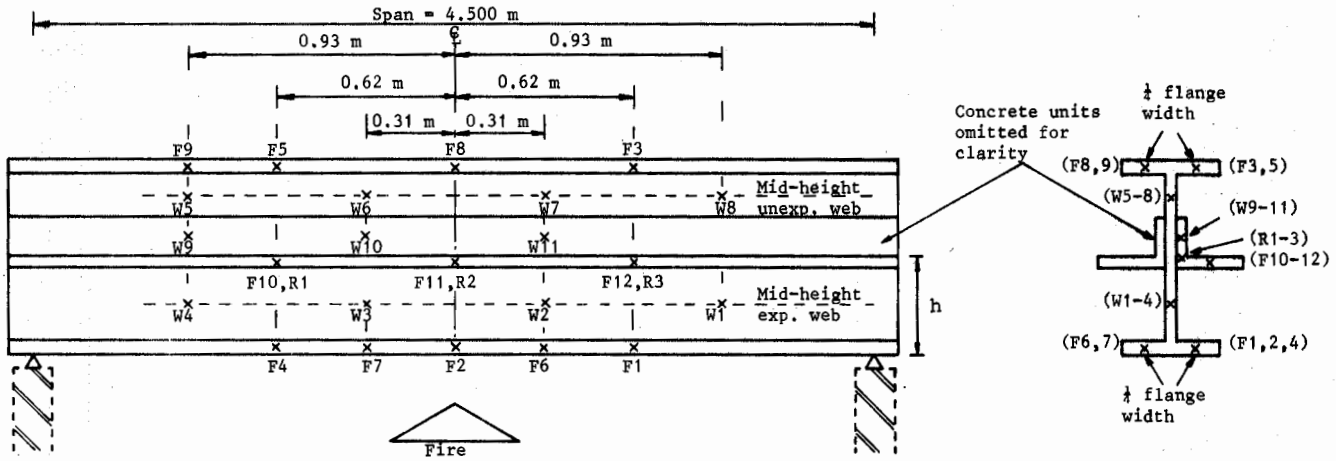
NOTES

(a) Height of exposed steel, h, = 182.0 mm
(b) Based upon nominal dimensions and properties
(c) Assuming a maximum bending stress of 165 N/mm2 in the lower flange
(d) 0.5 m from the centre-line of the beam
(e) 85.2% of safe working load utilised
(f) Initial ambient temperature = 22 deg. C

TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
EFFECTIVE SPAN	:	4.500 m
CONCRETE FLOOR UNITS	:	SOLID, 200 mm DEEP (a)
SAFE WORKING LOAD	:	271.4 kN (b)(c)
OPERATING LOAD REQUIRED	:	217.1 kN (NOM. 80% OF SWL)
DEAD LOAD (BEAM + SAND)	:	~ 5.5 kN
TOTAL FORCE REQUIRED	:	211.6 kN
DEAD LOAD (CONCRETE + LOAD SPREADERS)	:	~72 kN
REACTION ON EACH ANGLE	:	18 kN
IMPOSED FORCE REQUIRED	:	87.80 kN (ON EACH ANGLE)
LOADS REQUIRED	:	30.46 kN (BY EACH JACK)
LOADS APPLIED	:	32.9 kN (d)(e)

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

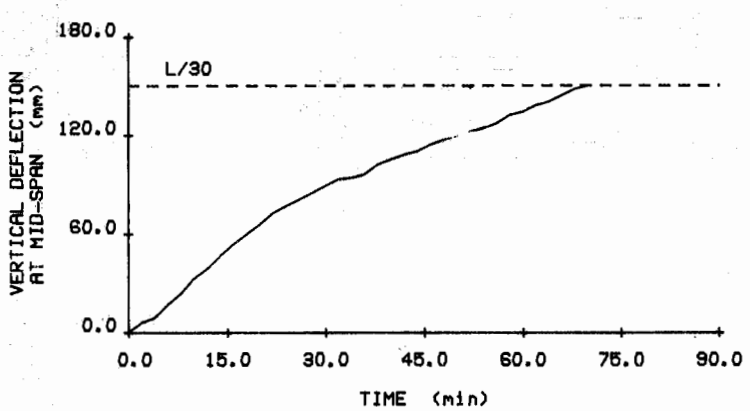
(R2/1724D)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	26th. JUNE 1984
TEST NUMBER	:	W.R.C.S.I. 34478

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	70 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	70 MINUTES
FIRE RESISTANCE	:	70 MINUTES

DATA SHEET NUMBER **36b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																	
		3	6	9	12	15	18	21	24	27	30	35	40	45	50	55	60	65	70
UPPER FLANGE	F3	17	17	17	18	19	19	21	22	24	26	30	37	46	55	63	71	79	87
	F5	18	19	18	18	19	20	21	23	24	27	33	40	49	59	69	77	85	92
	F8	18	18	19	19	20	21	23	35	48	67	88	96	96	97	97	98	98	99
	F9	17	17	17	18	19	20	22	23	26	29	34	40	48	55	64	74	84	97
	MEAN	17	18	18	18	19	20	22	26	30	37	46	53	60	66	73	80	86	94
UNEXPOSED WEB	W5	17	20	25	32	40	50	62	74	87	100	121	140	156	168	180	192	204	219
	W6	18	20	23	29	35	43	53	63	74	85	100	108	114	122	132	143	155	173
	W7	18	20	24	30	38	47	57	67	79	93	109	124	136	141	147	155	162	177
	W8	18	20	23	29	37	45	55	66	77	89	109	126	140	151	162	172	182	194
	MEAN	18	20	24	30	37	46	57	67	79	92	110	124	136	145	155	165	176	191
EXPOSED WEB	W1	107	192	295	377	469	537	585	620	648	669	700	727	745	775	803	833	856	878
	W2	96	184	299	389	490	556	605	639	663	685	715	736	765	796	826	853	873	894
	W3	103	195	304	384	482	550	600	635	662	685	716	737	767	800	830	857	878	898
	W4	133	217	319	394	483	547	594	628	655	677	708	734	757	789	819	847	869	889
	MEAN	110	197	304	386	481	547	596	630	657	679	710	733	758	790	819	847	869	890
LOWER FLANGE	F1	91	185	317	425	535	607	654	685	707	724	742	770	798	824	851	874	894	914
	F2	85	178	310	415	533	606	655	687	709	728	747	776	806	835	862	885	903	922
	F4	91	204	341	440	538	606	652	683	705	722	738	765	794	822	852	877	896	914
	F6	86	180	313	419	531	603	651	683	704	723	740	767	796	822	850	874	892	910
	F7	104	205	333	431	534	602	649	680	702	719	738	766	795	822	851	874	893	911
	MEAN	91	190	323	426	534	605	652	684	705	723	741	769	798	825	853	877	896	914
EXPOSED FLANGE ANGLE	F10	67	133	202	257	326	391	447	482	504	515	539	596	648	708	752	781	811	839
	F11	66	112	176	233	309	373	423	446	490	547	612	660	704	738	768	794	823	851
	F12	67	116	178	241	321	391	450	495	531	561	607	651	689	722	748	772	798	826
	MEAN	67	120	185	244	319	385	440	474	508	541	586	636	680	723	756	782	811	839
UNEXPOSED FLANGE ANGLE	W9	25	41	67	99	138	181	225	268	308	343	393	434	469	501	531	560	588	613
	W10	26	43	69	103	142	185	229	271	308	342	391	432	467	500	530	560	588	614
	W11	24	40	66	100	143	189	234	276	313	346	394	433	468	500	531	561	588	613
	MEAN	25	41	67	101	141	185	229	272	310	344	393	433	468	500	531	560	588	613
ANGLE ROOT	R1	33	57	96	135	183	235	285	330	367	402	452	500	545	587	626	661	690	716
	R2	32	54	89	130	180	233	286	334	375	415	474	524	567	604	639	669	696	722
	R3	36	59	97	139	191	245	297	345	387	424	476	516	551	584	614	644	674	703
	MEAN	34	57	94	135	185	238	289	336	376	414	467	513	554	592	626	658	687	714
MEAN FURNACE GAS		426	601	649	697	742	767	781	791	803	815	835	856	875	905	909	927	940	957
STANDARD CURVE (f)		504	605	665	707	741	768	791	811	828	844	867	887	904	920	934	947	959	970
DEFLECTION (mm)		7	17	28	39	50	60	69	77	83	89	95	105	112	119	125	134	142	150



DATA SHEET NUMBER **37a**

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
406 x 178	NOMINAL	54	402.6	177.6	7.6	10.9	925.3	114.5	1048	177.5	18626	1017
BEAM	ACTUAL	54	403	178	7.5	11.0						
125 x 75 x 12	NOMINAL	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5
ANGLE	ACTUAL	17.5	125	75	11.8	11.8						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

PRODUCT	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 43A	0.21	0.038	0.96	0.024	0.012	0.02	0.005	0.02	0.002	0.02	0.001	0.008	0.004
ANGLE	GRADE 50B	0.16	0.21	1.41	0.031	0.024	0.03	0.004	0.02	0.067	0.02	0.002	0.005	0.006

ROOM TEMPERATURE TENSILE PROPERTIES

PRODUCT	LYS N/mm2	TS N/mm2	ELONG %
BEAM	335	499	30.0
ANGLE	404	562	32.0

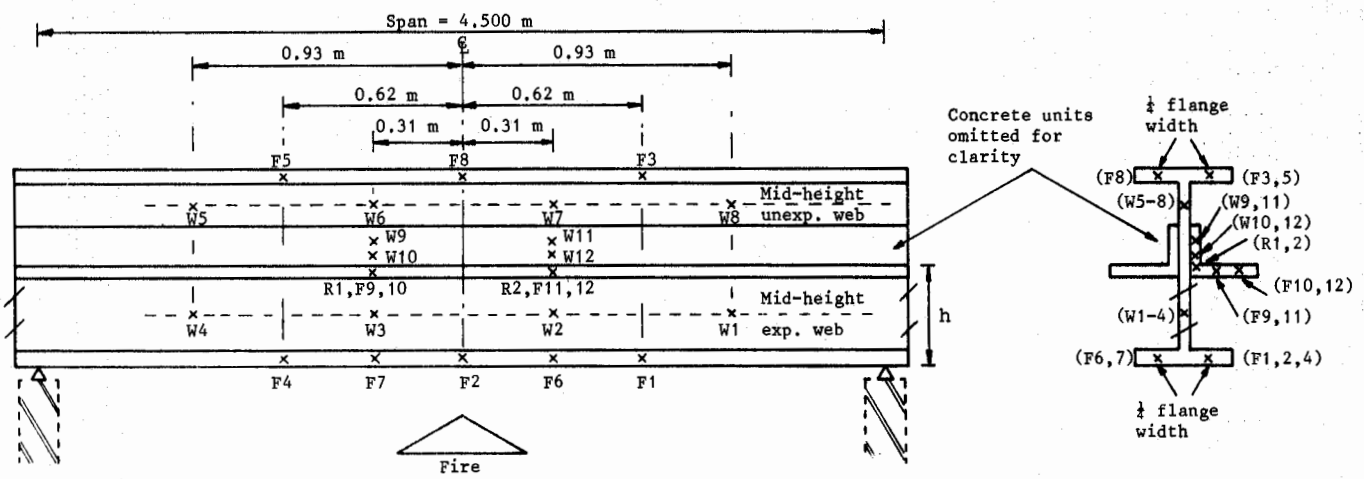
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
EFFECTIVE SPAN	:	4.500 m
CONCRETE FLOOR UNITS	:	SOLID, 150 mm DEEP (a)(b)
SAFE WORKING LOAD	:	271.4 kN (c)(d)
OPERATING LOAD REQUIRED	:	162.8 kN (NOM. 60% OF SWL)
DEAD LOAD (BEAM + SAND)	:	~ 5.5 kN
TOTAL FORCE REQUIRED	:	157.3 kN
DEAD LOAD (CONCRETE + LOAD SPREADERS)	:	~53 kN
REACTION ON EACH ANGLE	:	13.25 kN
IMPOSED FORCE REQUIRED	:	65.40 kN (ON EACH ANGLE)
LOADS REQUIRED	:	22.69 kN (BY EACH JACK)
LOADS APPLIED	:	23.1 kN (e)(f)

NOTES

(a) 50 mm deep x 300 mm long taper at one end
(b) Height of exposed steel, h, = 182.0 mm
(c) Based upon nominal dimensions and properties
(d) Assuming a maximum bending stress of 165 N/mm2 in the lower flange
(e) 0.5 m from the centre-line of the beam
(f) 60.9% of safe working load utilised
(g) Initial ambient temperature = 13 deg. C
(h) Test continued to L/20

THERMOCOUPLE POSITIONS



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LONGITUDINAL SECTION

TRANSVERSE SECTION

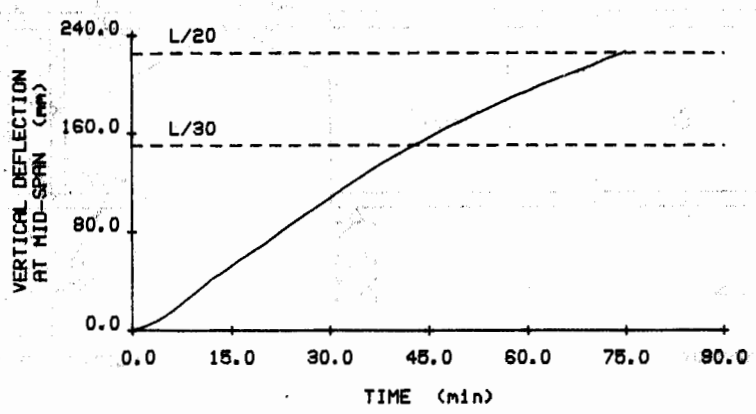
(R2/7124E)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	19th. DECEMBER 1984
TEST NUMBER	:	W.R.C.S.I. 35217

BS 476 : PART 8 : 1972 ASSESSMENT		
TIME TO L/30	:	43 MINUTES
RE-LOAD TEST	:	SATISFIED
STABILITY	:	43 MINUTES
FIRE RESISTANCE	:	43 MINUTES

DATA SHEET NUMBER **37b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
		3	6	9	12	15	18	21	24	27	30	33	36	39	43	45	48	54	60	66	72	74
UPPER FLANGE	F3	11	11	13	16	21	28	39	55	72	92	98	100	101	106	109	113	122	135	150	166	175
	F5	11	12	14	21	33	51	67	80	90	94	96	101	108	117	121	127	135	145	161	189	206
	F8	9	10	13	19	32	55	78	86	94	102	116	124	135	150	157	167	186	209	231	267	286
	MEAN	10	11	13	19	29	45	61	74	85	96	103	108	115	124	129	136	148	163	181	207	222
UNEXPOSED WEB	W5	12	18	28	41	56	71	88	103	121	134	148	156	165	178	185	194	213	232	252	276	287
	W6	13	20	31	47	64	81	100	114	141	154	170	181	194	210	218	230	252	277	302	328	340
	W7	14	20	32	47	66	84	100	112	130	145	161	172	188	208	217	231	258	284	306	328	338
	W8	12	18	28	40	58	73	88	100	105	112	127	139	154	173	182	195	220	244	268	293	304
	MEAN	13	19	30	44	61	77	94	107	124	136	151	162	175	192	200	212	236	259	282	306	317
EXPOSED WEB	W1	130	252	364	464	542	593	628	655	675	694	714	726	735	755	766	782	809	836	860	883	889
	W2	145	280	397	502	577	626	656	684	704	722	739	746	761	785	795	810	834	859	881	901	908
	W3	120	254	379	486	567	620	655	680	700	719	736	743	757	780	791	807	834	859	881	901	909
	W4	134	257	369	469	547	598	632	659	680	693	716	728	738	755	766	784	814	841	865	886	895
	MEAN	132	261	377	480	558	609	643	669	690	707	726	736	748	769	779	796	823	849	872	893	900
LOWER FLANGE	F1	100	224	354	472	563	626	667	695	718	734	746	760	775	797	806	820	847	871	892	913	919
	F2	83	199	328	453	553	623	668	699	722	733	751	765	781	802	811	825	852	875	895	914	921
	F4	100	227	356	471	563	623	664	693	715	731	743	756	771	791	802	817	846	870	890	910	918
	F6	92	215	347	471	567	631	671	702	723	736	751	765	780	802	811	825	846	861	882	901	910
	F7	97	218	343	460	556	621	664	694	717	733	744	758	773	795	805	820	842	860	881	898	907
	MEAN	94	217	346	465	560	625	667	697	719	733	747	761	776	797	807	821	847	867	888	907	915
EXPOSED FLANGE ANGLE	F9	54	108	159	219	274	323	369	416	454	491	528	553	579	613	630	654	690	724	753	778	790
	F10	78	154	216	290	353	404	445	486	520	552	589	615	638	670	685	707	739	766	794	823	834
	F11	64	105	150	202	252	299	352	400	442	477	512	534	557	592	607	633	678	716	750	775	788
	F12	59	113	167	225	286	337	386	432	471	503	535	555	576	609	625	651	694	731	758	789	803
	MEAN	64	120	173	234	291	341	388	434	472	506	541	564	588	621	637	661	700	734	764	791	804
UNEXPOSED FLANGE ANGLE	W9	16	31	55	86	114	150	186	223	257	288	321	344	371	403	419	441	482	519	552	582	594
	W10	19	38	67	102	135	175	216	255	293	328	365	388	416	451	467	491	533	571	605	635	647
	W11	15	28	48	75	104	137	173	210	243	274	308	331	357	389	404	427	469	508	543	576	589
	W12	18	35	59	91	121	156	194	233	270	304	340	364	390	424	440	465	510	551	587	620	633
ANGLE ROOT	R1	30	57	97	143	191	238	283	327	366	403	441	466	494	530	546	569	611	647	680	708	719
	R2	29	55	88	129	173	216	262	308	349	386	423	447	473	508	525	551	597	637	673	704	715
	MEAN	29	56	92	136	182	227	272	317	357	394	432	456	483	519	535	560	604	642	676	706	717
MEAN FURNACE GAS		517	616	649	711	739	755	770	783	794	804	816	825	831	847	853	863	882	900	917	935	939
STANDARD CURVE (g)		495	596	656	698	732	759	782	802	819	835	849	862	874	889	895	905	923	938	953	966	970
DEFLECTION (mm)(h)		5	15	28	41	52	63	74	86	96	107	118	129	139	150	156	165	180	194	207	220	224



DATA SHEET NUMBER **38a**

SLIM 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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 254	NOMINAL	73	254.0	254.0	8.6	14.2	894.5	305.0	988.6	462.4	11360	3873
COLUMN	ACTUAL	68.7	257	251	9.11	13.2						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.20	0.03	0.97	0.022	0.028	0.02	0.005	0.03	0.005	*	0.005	0.005	0.0055

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	287	478	34.0

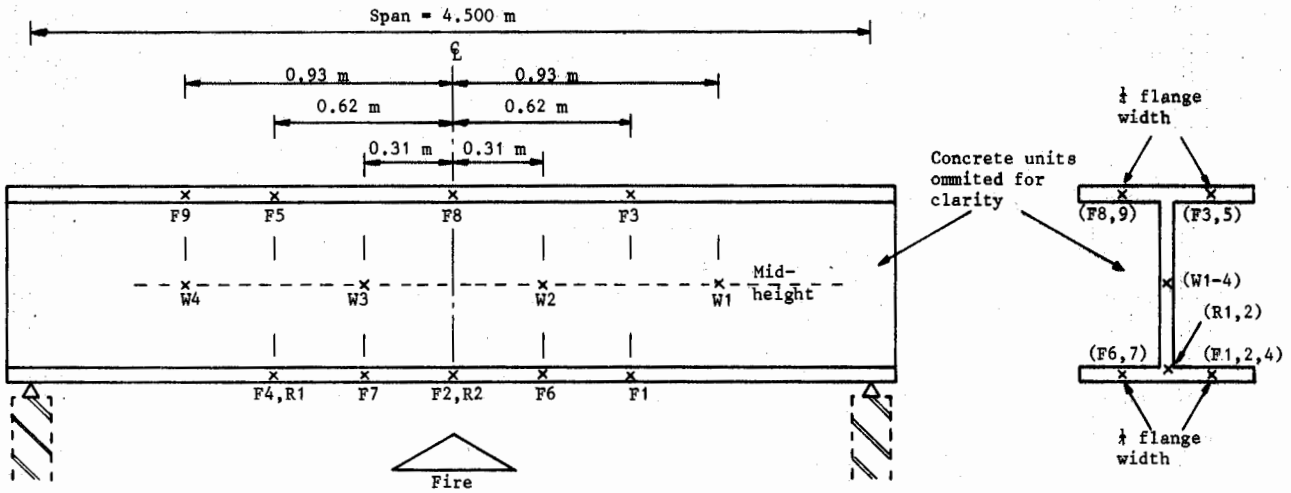
TEST CONDITIONS

END CONDITIONS	:	SIMPLY SUPPORTED
EFFECTIVE SPAN	:	4.500 m
CONCRETE FLOOR UNITS	:	HOLLOW, 200 mm DEEP "SPIROLL"
SAFE WORKING LOAD	:	262.5 kN (a)(b)
OPERATING LOAD REQUIRED	:	262.5 kN
DEAD LOAD (BEAM + SAND)	:	~ 5.5 kN
TOTAL FORCE REQUIRED	:	257 kN
DEAD LOAD (CONCRETE + LOAD SPREADERS)	:	~43.6 kN
REACTION ON EACH FLANGE	:	10.9 kN
IMPOSED FORCE REQUIRED	:	117.6 kN (PER FLANGE) (c)(d)
LOADS APPLIED	:	41.08 kN (BY EACH JACK)
COMBINED STRESS ON LOWER FLANGE - U.D.L.	:	200.1 N/mm2 (e)
COMBINED STRESS ON LOWER FLANGE - POINT LOADING	:	178.4 N/mm2 (f)

NOTES

(a) Based upon nominal dimensions and properties
(b) Assuming a maximum bending stress of 165 N/mm2 in the lower flange
(c) Estimated load taking into account local bending and shear stresses
(d) Applied 0.5m from the centre line of the column
(e) Equivalent to 121.3% of the maximum permissible load according to BS 449 : Part 2 : 1969
(f) Equivalent to 108.1% of the maximum permissible load according to BS 449 : Part 2 : 1969
(g) Ammendment No. 4822 (May 1985) incorporated into BS 476 : Part 8 : 1972 for determination of fire resistance
(h) The limiting rate of deflection, (R), was exceeded before a deflection of L/30 was achieved. Therefore stability is assessed on the time taken to achieve L/30
(i) Initial ambient temperature = 22 deg. C
(*) Not measured

THERMOCOUPLE POSITIONS



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LONGITUDINAL SECTION

TRANSVERSE SECTION

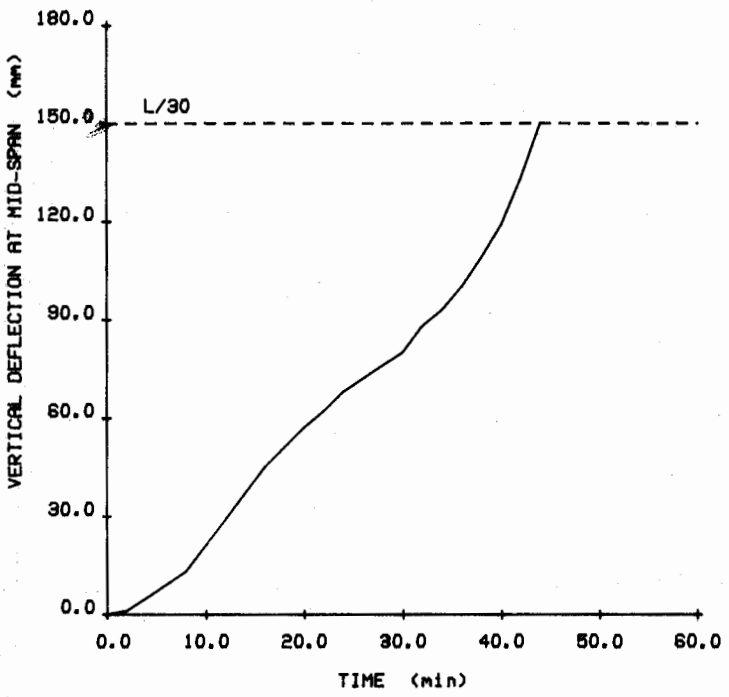
(R2/7124F)

TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	11th. JULY 1985
TEST NUMBER	:	W.R.C.S.I. 36438

BS 476 : PART 8 : 1972 ASSESSMENT			
TIME TO L/30	:	44 MINUTES	(g)
RE-LOAD TEST	:	SATISFIED	
STABILITY	:	44 MINUTES	(h)
FIRE RESISTANCE	:	44 MINUTES	

DATA SHEET NUMBER **38b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	44
UPPER FLANGE	F3	19	20	20	20	20	20	21	22	24	25	27	30	32	35	37
	F5	20	20	20	20	20	21	21	22	24	25	27	29	31	33	35
	F8	20	20	20	20	21	21	22	23	25	27	29	31	34	37	39
	F9	20	20	20	20	20	21	21	22	24	26	28	30	32	35	37
	MEAN	20	20	20	20	20	21	21	22	24	26	28	30	32	35	37
WEB	W1	20	22	28	36	48	62	78	94	113	128	143	156	168	179	186
	W2	20	23	29	39	54	71	89	109	130	146	161	174	187	199	207
	W3	21	23	29	38	51	67	83	100	121	134	146	159	171	183	190
	W4	20	23	28	36	49	63	79	95	117	129	141	153	164	175	182
	MEAN	20	23	29	37	51	66	82	100	120	134	148	161	173	184	191
FLANGE/WEB JUNCTION	R1	45	84	137	216	289	352	408	459	504	543	577	607	633	656	670
	R2	44	83	133	205	272	329	381	430	473	510	545	576	605	631	647
	MEAN	45	84	135	211	281	341	395	445	489	527	561	592	619	644	659
LOWER FLANGE	F1	84	142	230	326	402	463	521	567	605	641	671	699	723	746	758
	F2	79	138	224	317	395	456	513	561	602	638	671	700	726	748	759
	F4	111	169	253	336	405	456	507	551	586	620	651	680	705	729	744
	F6	111	176	269	363	433	493	548	592	632	664	693	719	744	765	774
	F7	60	115	186	286	370	439	501	556	599	636	668	697	722	741	751
	MEAN	89	148	232	326	401	461	518	565	605	640	671	699	724	746	757
MEAN FURNACE GAS		496	562	711	734	751	769	802	819	833	849	863	876	891	902	909
STANDARD CURVE (i)		504	605	665	707	741	768	791	811	828	844	858	871	883	894	901
DEFLECTION (mm)		3	9	17	29	41	51	60	68	74	80	91	100	114	133	150
DEF. RATE (mm/min)		2	2	3	4	4	3	3	3	2	2	4	3	5	8	9



DATA SHEET NUMBER **39a**

SLIM 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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 254	NOMINAL	89	260.4	255.9	10.5	17.3	1099	378.9	1228	575.4	14307	4849
COLUMN	ACTUAL	90.6	264	255	11.5	17.4						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.15	0.19	0.95	0.009	0.014	0.02	0.01	0.02	0.005	0.04	0.005	0.032	0.0048

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	299	465	36.0

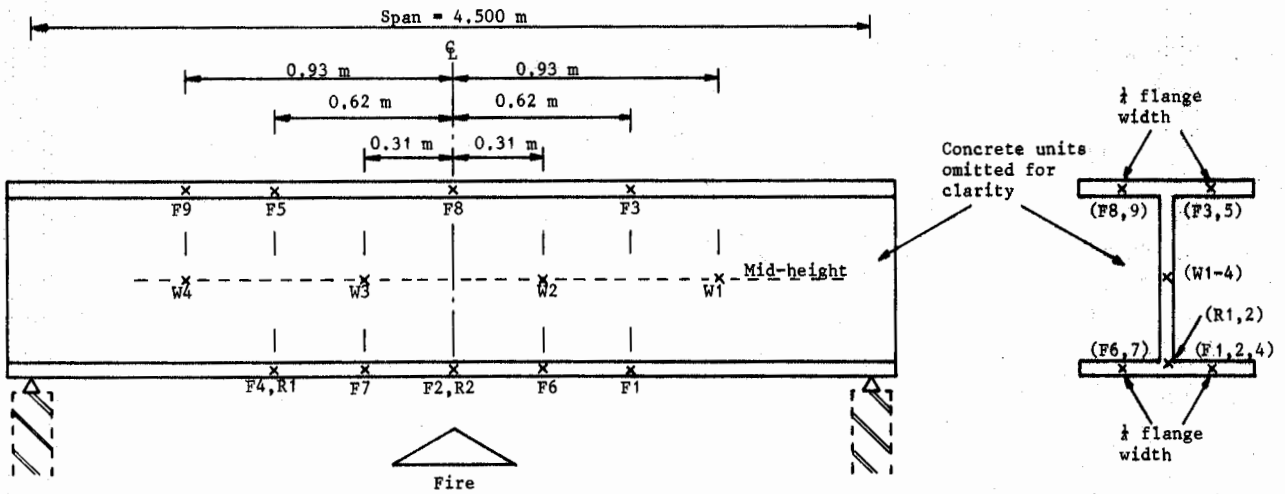
TEST CONDITIONS

END CONDITIONS	: SIMPLY SUPPORTED	
EFFECTIVE SPAN	: 4.500	m
CONCRETE FLOOR UNITS	: SOLID, 200 mm DEEP	
SAFE WORKING LOAD	: 322.3	kN (a)(b)
OPERATING LOAD REQUIRED	: 322.3	kN
DEAD LOAD (BEAM + SAND)	: ~ 5.5	kN
TOTAL FORCE REQUIRED	: 316.8	kN
DEAD LOAD (CONCRETE + LOAD SPREADERS)	: ~72	kN
REACTION ON EACH FLANGE	: 18	kN
IMPOSED FORCE REQUIRED	: 140.4	kN (PER FLANGE) (c)(d)
LOADS APPLIED	: 42.8	kN (BY EACH JACK)
COMBINED STRESS ON LOWER FLANGE - U.D.L.	: 174.1	N/mm2 (e)
COMBINED STRESS ON LOWER FLANGE - POINT LOADING	: 158.8	N/mm2 (f)

NOTES

(a) Based upon nominal dimensions and properties
(b) Assuming a maximum bending stress of 165 N/mm2 in the lower flange
(c) Estimated load taking into account local bending and shear stresses
(d) Applied 0.5m from the centre line of the column
(e) Equivalent to 105.5% of the maximum permissible load according to BS 449 : Part 2 : 1969
(f) Equivalent to 96.2% of the maximum permissible load according to BS 449 : Part 2 : 1969
(g) Ammendment No. 4822 (May 1985) incorporated into BS 476 : Part 8 : 1972 for determination of fire resistance
(h) The limit of deflection, (L/20), was achieved before the limiting rate of deflection, (R). Therefore stability is assessed on the time taken to achieve L/20
(i) Initial ambient temperature = 17 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

(R2/7124F)

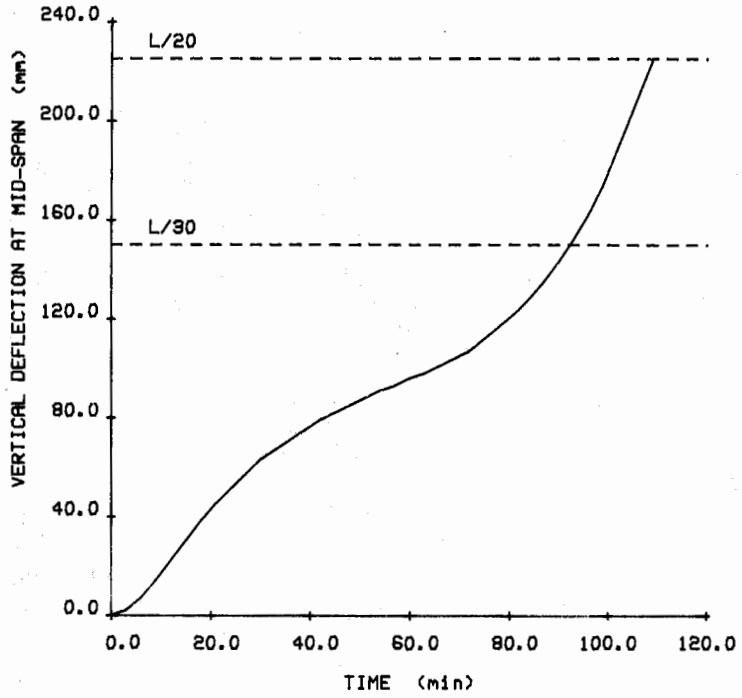
TEST CENTRE	:	WARRINGTON RESEARCH
TEST DATE	:	29th. APRIL 1986
TEST NUMBER	:	W.R.C.S.I. 38185

BS 476 : PART 8 : 1972 ASSESSMENT (g)

TIME TO L/20	:	109 MINUTES (h)
RE-LOAD TEST	:	SATISFIED
STABILITY	:	109 MINUTES
FIRE RESISTANCE	:	109 MINUTES

DATA SHEET NUMBER **39b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
		3	6	9	12	15	18	21	24	27	30	36	42	48	54	60	70	80	90	93	100	109
UPPER FLANGE	F3	10	10	10	10	10	11	13	13	14	17	23	31	41	52	64	80	90	93	94	95	97
	F5	10	10	10	10	10	11	12	12	14	15	20	28	40	50	60	75	88	94	96	96	98
	F8	11	12	11	12	12	12	14	15	17	20	28	39	61	80	88	94	95	96	96	97	99
	F9	12	12	12	12	12	13	13	14	15	16	19	23	28	35	43	57	73	87	90	96	99
	MEAN	11	11	11	11	11	12	13	14	15	17	23	30	43	54	64	77	87	93	94	96	98
WEB	W1	11	13	17	24	33	45	59	70	83	95	106	115	127	143	158	183	206	229	237	257	284
	W2	11	13	19	28	40	54	72	87	98	100	100	101	102	103	109	132	177	225	237	265	301
	W3	10	12	18	27	37	51	68	82	95	101	109	119	136	152	168	194	226	259	269	292	321
	W4	12	13	16	22	29	39	51	60	71	81	95	101	114	130	147	172	194	217	224	241	265
	MEAN	11	13	18	25	35	47	63	75	87	94	103	109	120	132	146	170	201	233	242	264	293
FLANGE/WEB JUNCTION	R1	30	66	115	169	222	272	328	364	404	442	507	565	615	657	690	731	781	832	846	877	911
	R2	29	65	117	175	231	283	339	375	413	448	512	565	611	649	679	726	783	838	852	882	913
	MEAN	30	66	116	172	227	278	334	370	409	445	510	565	613	653	685	729	782	835	849	880	912
LOWER FLANGE	F1	60	126	192	271	337	399	459	496	535	571	637	691	735	766	799	851	900	938	947	971	997
	F2	76	163	226	302	358	414	469	504	544	579	639	693	736	771	804	863	919	957	967	989	1014
	F4	52	109	165	231	294	353	404	441	484	522	588	649	700	740	769	828	883	926	937	961	986
	F6	65	130	192	265	326	385	447	485	526	560	614	662	708	746	773	832	887	932	943	968	994
	F7	52	127	185	259	317	376	433	471	511	546	605	657	703	743	772	832	889	935	947	972	999
	MEAN	61	131	192	266	326	385	442	479	520	556	617	670	716	753	783	841	896	938	948	972	998
MEAN FURNACE GAS		505	638	664	720	733	760	775	774	802	820	845	873	893	916	933	964	991	1015	1024	1037	1055
STANDARD CURVE (i)		499	600	660	702	736	763	786	806	823	839	866	889	909	927	942	965	985	1003	1008	1019	1032
DEFLECTION (mm)		2	7	14	22	30	38	45	51	57	63	71	79	85	91	96	105	120	143	150	179	224
DEF. RATE (mm/min)		2	2	2	2	2	3	2	2	2	2	1	1	1	1	1	1	2	3	4	5	5



DATA SHEET NUMBER **40a**

COLUMN

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
305 x 305	NOMINAL	198	339.9	314.1	19.2	31.4	2991	1034	3436	1576	50832	16230
COLUMN	ACTUAL		341	314	*	*						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%) (*)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A													

ROOM TEMPERATURE TENSILE PROPERTIES (*)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE			

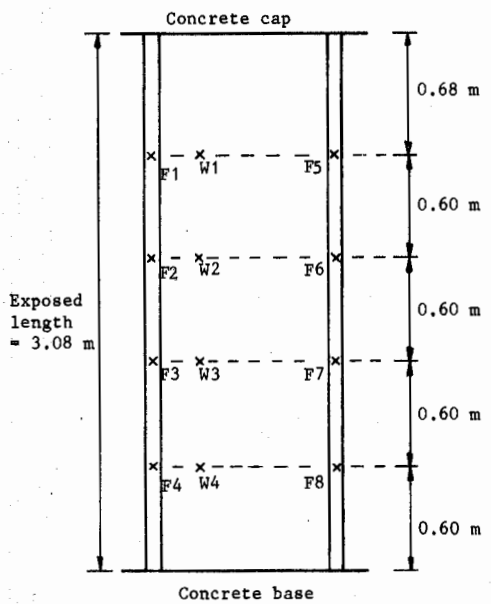
NOTES

(a) After 20 minutes the loading frame collapsed, thereby prematurely terminating the loaded fire test. At that time the section had bowed approximately 10 mm. However the heating cycle was continued until 33 minutes
(b) Temperatures accurate to the nearest 5 deg. C
(c) Initial ambient temperature = 10 deg. C
(*) Data not available

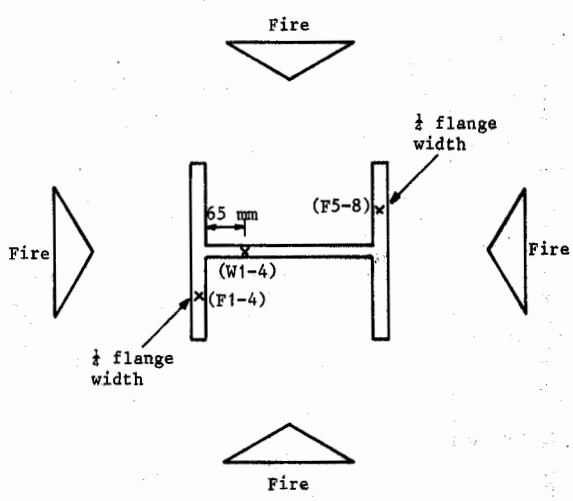
TEST CONDITIONS

EXPOSED LENGTH	:	308	cm
EFFECTIVE LENGTH	:	215.6	cm
RADIUS OF GYRATION (y-y)	:	8.02	cm
SLENDERNESS RATIO	:	26.88	
MAXIMUM AXIAL STRESS	:	144	N/mm2
AREA OF CROSS SECTION	:	252	cm2
MAXIMUM LOAD	:	3629	kN
LOAD APPLIED	:	3630	kN

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124G)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	17th. MARCH 1980
TEST NUMBER	:	TE 3646

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	20 MINUTES
FIRE RESISTANCE	:	20 MINUTES

(a)

DATA SHEET NUMBER **40b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES) (b)										
		3	6	9	12	15	18	21	24	27	30	33
EXPOSED FLANGES	F1	50	85	140	215	300	380	465	530	585	625	665
	F2	40	70	140	210	300	395	485	560	620	660	700
	F3	30	75	145	240	320	445	540	610	660	695	725
	F4	30	85	150	230	345	405	490	565	620	665	700
	F5	35	75	130	200	280	360	435	495	560	610	650
	F6	30	60	120	200	285	375	455	520	590	635	670
	F7	40	75	150	235	305	410	495	570	640	680	715
	F8	35	90	155	240	330	405	475	535	600	635	670
	MEAN	35	75	140	220	310	395	480	550	610	650	685
EXPOSED WEB	W1	50	95	160	255	360	445	525	590	645	690	725
	W2	45	80	145	245	345	445	535	605	650	685	715
	W3	40	80	145	250	365	470	555	630	685	720	740
	W4	45	115	185	280	390	475	560	630	685	715	740
	MEAN	45	95	160	260	365	460	545	615	665	705	730
MEAN FURNACE GAS		435	500	620	730	740	765	795	810	835	830	845
STANDARD CURVE (c)		492	593	653	695	729	756	779	799	816	832	846
EXTENSION (mm)		(*)										

DATA SHEET NUMBER **41a**

COLUMN

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL		204.5	204	8.0	12.5						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.15	0.05	1.24	0.024	0.018	0.03	0.005	0.07	0.005	*	0.005	0.005	0.0095

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	349	500	30.0

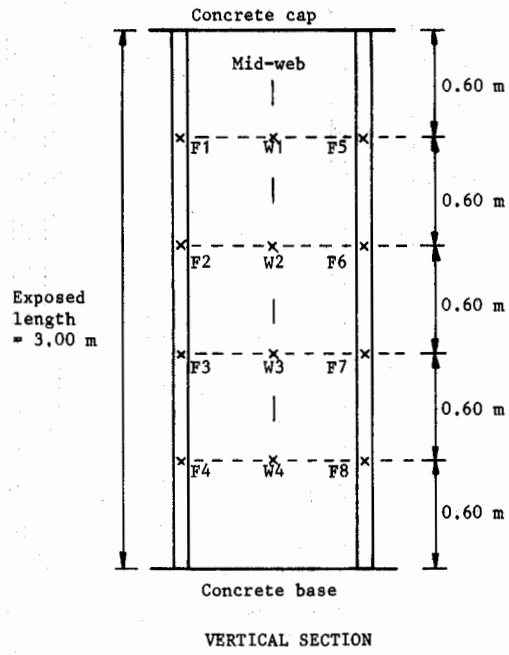
NOTES

(a) Equals 60% of the maximum permissible load according to BS 449 : Part 2 : 1969
(b) Initial ambient temperature = 15 deg. C
(*) Not measured

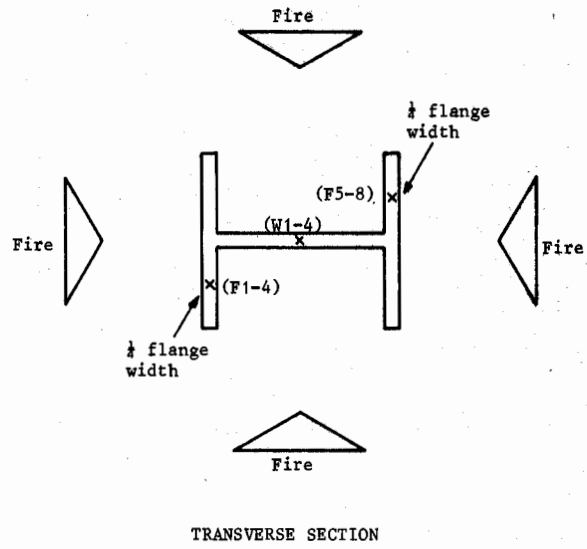
TEST CONDITIONS

EXPOSED LENGTH	: 300	cm	
EFFECTIVE LENGTH	: 210	cm	
RADIUS OF GYRATION (y-y)	: 5.16	cm	
SLENDERNESS RATIO	: 40.69		
MAXIMUM AXIAL STRESS	: 138	N/mm2	
AREA OF CROSS SECTION	: 66.4	cm2	
MAXIMUM LOAD	: 916	kN	
LOAD APPLIED	: 550	kN	(a)

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

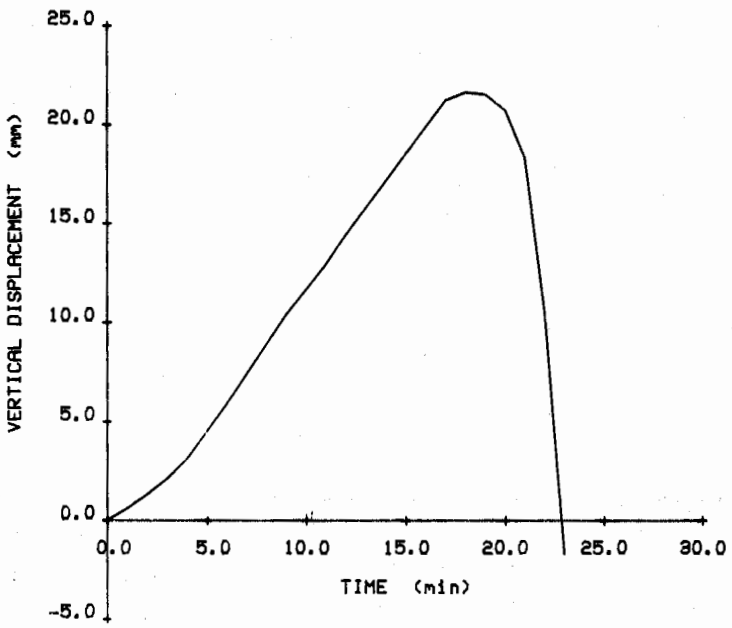
(R2/7124H)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	7th. JUNE 1984
TEST NUMBER	:	TE 4883

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	23 MINUTES
FIRE RESISTANCE	:	23 MINUTES

DATA SHEET NUMBER **41b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		3	6	9	12	15	18	21	23
EXPOSED FLANGES	F1	101	181	283	390	482	568	633	667
	F2	100	185	295	403	506	592	654	687
	F3	101	190	306	419	525	607	665	696
	F4	121	238	370	485	590	654	701	723
	F5	88	166	267	382	475	561	625	658
	F6	90	173	277	397	497	580	642	674
	F7	87	175	282	391	501	589	652	685
	F8	92	189	314	437	542	619	673	699
	MEAN	98	187	299	413	515	596	656	686
EXPOSED WEB	W1	101	185	285	401	490	579	643	674
	W2	104	190	295	421	514	596	654	684
	W3	104	196	305	417	527	610	668	698
	W4	88	188	332	461	566	639	688	713
	MEAN	99	190	304	425	524	606	663	692
MEAN FURNACE GAS		429	532	616	662	708	739	764	774
STANDARD CURVE (b)		497	598	658	700	734	761	784	797
EXTENSION (mm)		2.1	5.9	10.4	14.4	18.5	21.6	18.3	-1.7



DATA SHEET NUMBER **42a**

COLUMN (a)

DIMENSIONS AND PROPERTIES

SECTION SERIAL SIZE AND TYPE inches	DIMENSIONS AND PROPERTIES	MASS PER FOOT lb	DEPTH OF SECTION inches	WIDTH OF SECTION inches	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB inches	FLANGE inches	AXIS XX in3	AXIS YY in3	AXIS XX in3	AXIS YY in3	AXIS XX in4	AXIS YY in4
6 x 6	NOMINAL	122.4	6	6	N/A	N/A						
SOLID SQUARE	ACTUAL	*	*	*								

CHEMICAL COMPOSITION (LADLE ANALYSIS - Wt.%) (b)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
SQUARE	GRADE 3	0.25	-	-	0.060	0.060	-	-	-	-	0.35/0.50	-	-	-

ROOM TEMPERATURE TENSILE PROPERTIES (b)(c)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
(d)	227 min	432/510	20 min

TEST CONDITIONS

TOTAL LENGTH		:	11' 6"
EXPOSED LENGTH		:	9' 9"
MAXIMUM LOAD	(e)	:	300 tons
LOAD APPLIED		:	300 tons

NOTES

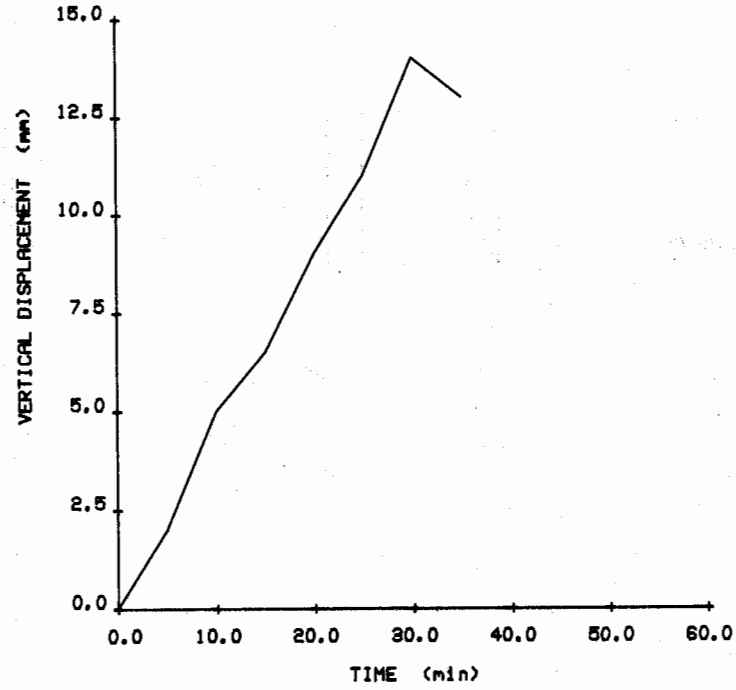
(a) Test carried out on behalf of Pell Frischmann and Partners
(b) Maximum values assuming steel was supplied to BS 15 : Grade 3 : 1961 (mild steel)
(c) Specified values for material over 1.5 inches thick
(d) Test position unknown
(e) In accordance with BS 449 : 1959
(f) Initial ambient temperature = 20 deg. C (estimated)
(g) Approximate values
(*) Not recorded
(+) Not known

TEST CENTRE	:	J.F.R.O. BOREHAMWOOD
TEST DATE	:	SEPTEMBER 1965
TEST NUMBER	:	F.R.O.S.I. 3698

BS 476 : PART 1 : 1953 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	37 MINUTES
FIRE RESISTANCE	:	37 MINUTES

DATA SHEET NUMBER **42b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		5	10	15	20	25	30	35	37
EXPOSED FACES	F1	*	*	*	*	*	*	*	*
	F2	*	*	*	*	*	*	*	*
	F3	*	*	*	*	*	*	*	*
	F4	*	*	*	*	*	*	*	*
MEAN									
MEAN FURNACE GAS		+	+	+	+	+	+	+	+
STANDARD CURVE (f)		576	678	739	781	815	842	865	873
EXTENSION (mm)(g)		2.0	5.0	6.5	9.0	11.0	14.0	13.0	*



DATA SHEET NUMBER **43a**

COLUMN (a)

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
400 x 400	NOMINAL	744	499	431	54.5	89.5	13780	5563	17220	8556	343900	119900
HD - COLUMN	ACTUAL	*	499	431	54	89	*	*	*	*	*	*

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%) (b)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE St 37	0.25	-	-	0.065	0.065	-	-	-	-	-	-	-	0.010

ROOM TEMPERATURE TENSILE PROPERTIES (c)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	238	*	*

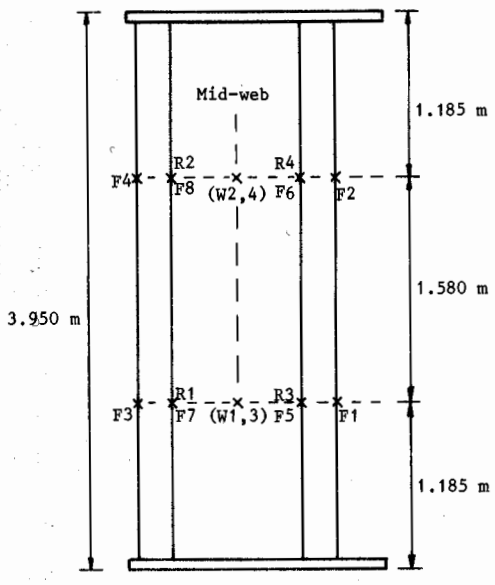
TEST CONDITIONS

LENGTH OF COLUMN		: 389	cm	
EXPOSED LENGTH		: 414	cm	(d)
RADIUS OF GYRATION	(x-x)	: 19.0	cm	
RADIUS OF GYRATION	(y-y)	: 11.2	cm	
END FIXITY	(z-z)	: PINNED		
END FIXITY	(y-y)	: FIXED		
ECCENTRICITY	(z-z)	: 180	mm	
ECCENTRICITY	(y-y)	: AXIAL		
AREA OF CROSS SECTION		: 948	cm2	(e)
APPLIED LOAD		: 3400	kN	(f)

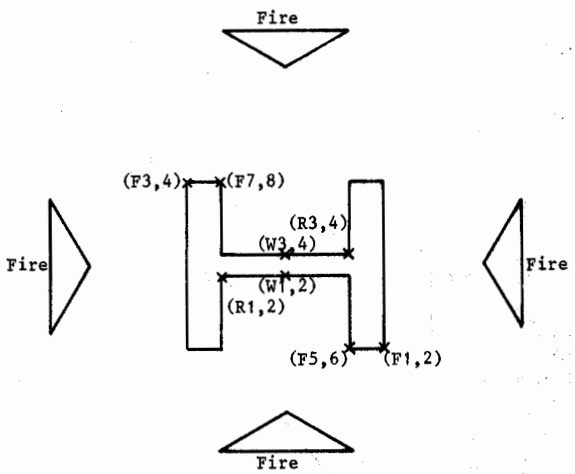
NOTES

(a) Test carried out on behalf of ARBED SA (Belgium)
(b) Maximum values as specified in DIN 171000 : St 37 : 1980
(c) For flange thicknesses in the range 80 to 100 mm (incl.) St 37-2 specifies :-
LYS = 195 N/mm2
TS = 340 - 470 N/mm2
ELONG = 24% (Lo = 5Do, Longitudinal specimen)
(d) Including end plates and loading frame
(e) Nominal
(f) Maximum design load in accordance with DIN 18800
(g) Thermocouples placed at steel surface
(h) Temperatures estimated to within 10 deg. C
(i) Initial ambient temperature unknown, therefore ISO-834 temperature rise is given
(j) Estimated to within 0.2 mm
(k) Estimated to within 1 mm
(*) Not known
(+) Data considered to be unreliable

THERMOCOUPLE POSITIONS (g)



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

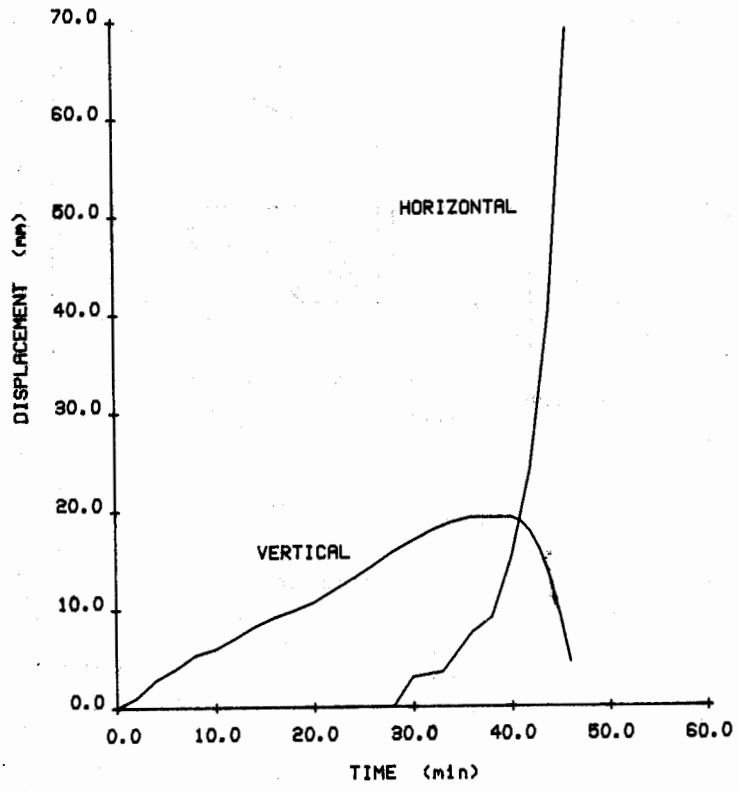
(R2/7124I)

TEST CENTRE	:	GHENT UNIV. BELGIUM
TEST DATE	:	2nd. OCTOBER 1984
TEST NUMBER	:	*

ISO : 834 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	46 MINUTES
FIRE RESISTANCE	:	46 MINUTES

DATA SHEET NUMBER **43b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES) (h)				
		10	20	30	40	46
FLANGES	F1	170	+	500	630	690
	F2	170	+	+	620	670
	F3	180	330	480	620	680
	F4	150	280	400	530	590
	F5	150	+	+	620	660
	F6	160	+	+	580	640
	F7	130	270	420	560	610
	F8	150	260	400	520	570
	MEAN					
WEB	W1	110	+	+	510	540
	W2	+	+	+	530	580
	W3	100	200	+	480	530
	W4	+	280	400	510	570
	MEAN					
FLANGE/WEB JUNCTIONS (RADIUS)	R1	+	+	370	500	550
	R2	100	+	+	470	520
	R3	+	250	+	500	520
	R4	80	190	320	450	500
	MEAN					
MEAN FURNACE GAS		*	*	*	*	*
STANDARD CURVE (i)		658	761	822	865	886
EXTENSION (mm)(j)		5.8	10.6	16.8	19.2	4.4
DEFLECTION (mm)(k)		<1	1	3	15	69



DATA SHEET NUMBER **44a**

COLUMN WITH BLOCKED-IN WEB

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL		*	*	*	*						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.27	0.04	0.94	0.012	0.020	0.02	0.005	0.02	0.005	0.02	0.005	0.005	0.0042

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	266	506	29.0

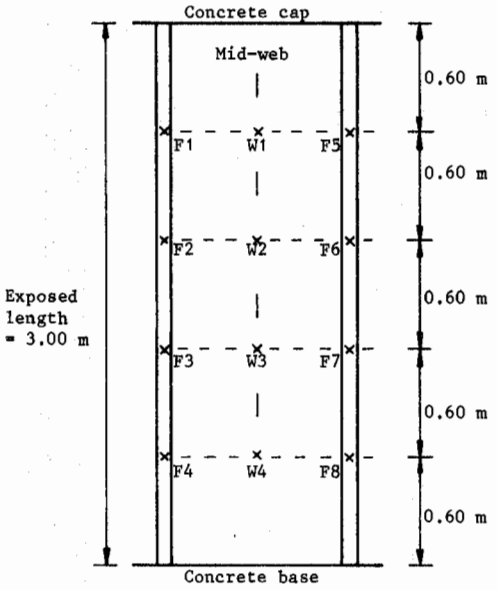
NOTES

(a) Not oven dry density
(b) Initial ambient temperature = 15 deg. C
(c) Accurate to the nearest 0.25 mm
(*) Not measured

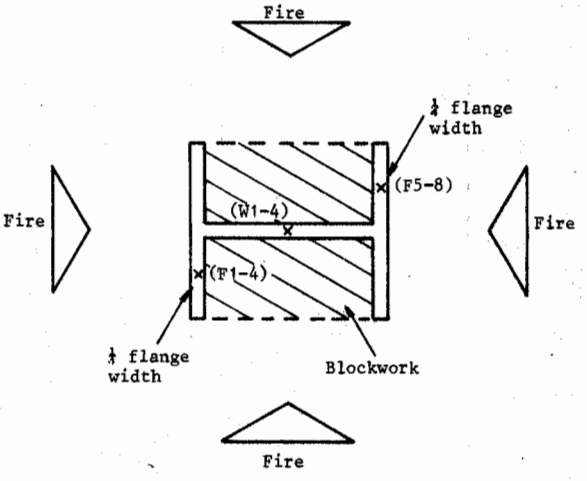
TEST CONDITIONS

DENSITY OF BLOCKWORK	:	865 kg/m3	(a)
MOISTURE CONTENT	:	* %	
EXPOSED LENGTH	:	300 cm	
EFFECTIVE LENGTH	:	210 cm	
RADIUS OF GYRATION (y-y)	:	5.16 cm	
SLENDERNESS RATIO	:	40.69	
MAXIMUM AXIAL STRESS	:	138 N/mm2	
AREA OF CROSS SECTION	:	66.4 cm2	
MAXIMUM LOAD	:	916 kN	
LOAD APPLIED	:	916 kN	

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

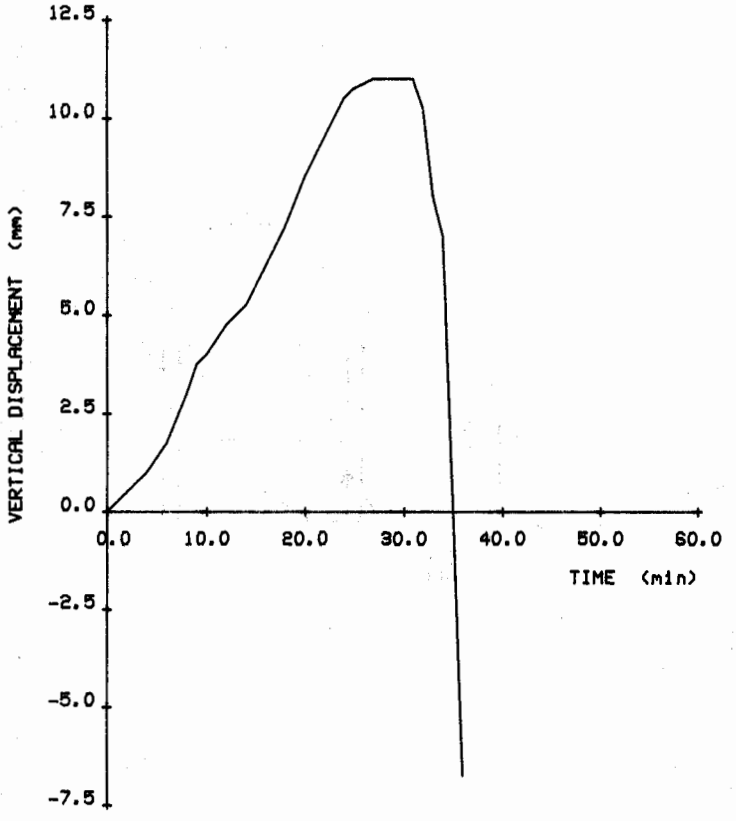
(R2/7124J)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	21st. OCTOBER 1983
TEST NUMBER	:	TE 4747

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	36 MINUTES
FIRE RESISTANCE	:	36 MINUTES

DATA SHEET NUMBER **44b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)											
		3	6	9	12	15	18	21	24	27	30	33	36
EXPOSED FLANGES	F1	54	98	148	195	252	311	376	431	480	524	567	608
	F2	47	91	143	192	247	308	368	422	470	513	556	601
	F3	49	91	143	193	253	319	383	437	485	531	576	619
	F4	63	110	181	252	332	405	470	526	572	614	655	690
	F5	53	95	147	198	260	327	403	464	516	562	603	639
	F6	58	111	167	221	276	338	404	456	503	545	588	622
	F7	64	113	168	220	278	338	393	447	493	533	573	609
	F8	67	114	180	235	307	380	439	481	516	552	589	623
	MEAN	57	103	160	213	276	341	405	458	504	547	588	626
UNEXPOSED WEB	W1	17	24	38	58	83	114	145	175	203	231	258	286
	W2	17	25	42	66	92	122	155	184	211	238	264	303
	W3	17	26	43	66	94	127	160	188	215	242	268	305
	W4	16	25	42	67	100	133	169	198	226	254	284	316
	MEAN	17	25	41	64	92	124	157	186	214	241	269	303
MEAN FURNACE GAS		469	583	649	669	744	768	790	799	815	835	855	864
STANDARD CURVE (b)		497	598	658	700	734	761	784	804	821	837	851	864
EXTENSION (mm)(c)		0.75	1.75	3.75	4.75	5.75	7.25	9.0	10.5	11.0	11.0	8.0	-6.75



DATA SHEET NUMBER **45a**

COLUMN WITH BLOCKED-IN WEB

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL		204.5	204	8.0	12.5						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.21	0.057	0.86	0.020	0.023	0.03	0.005	0.03	0.001	0.03	0.001	0.004	0.005

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	276	477	35.0

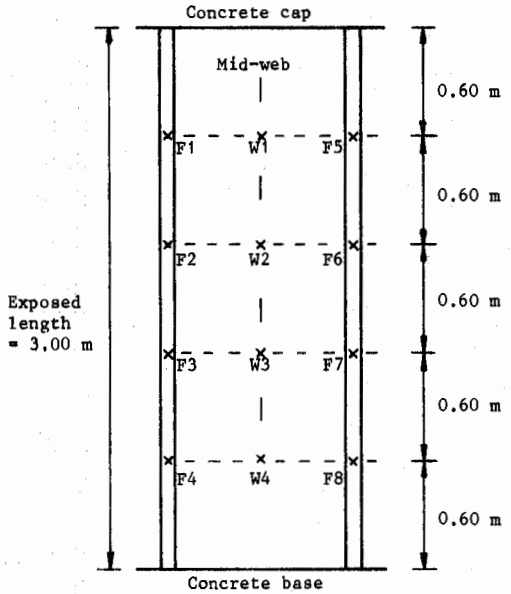
TEST CONDITIONS

DENSITY OF BLOCKWORK	: 582	kg/m3	
MOISTURE CONTENT	: 8.4	%	
EXPOSED LENGTH	: 300	cm	
EFFECTIVE LENGTH	: 210	cm	
RADIUS OF GYRATION (y-y)	: 5.16	cm	
SLENDERNESS RATIO	: 40.69		
MAXIMUM AXIAL STRESS	: 138	N/mm2	
AREA OF CROSS SECTION	: 66.4	cm2	
MAXIMUM LOAD	: 916	kN	
LOAD APPLIED	: 550	kN	(a)

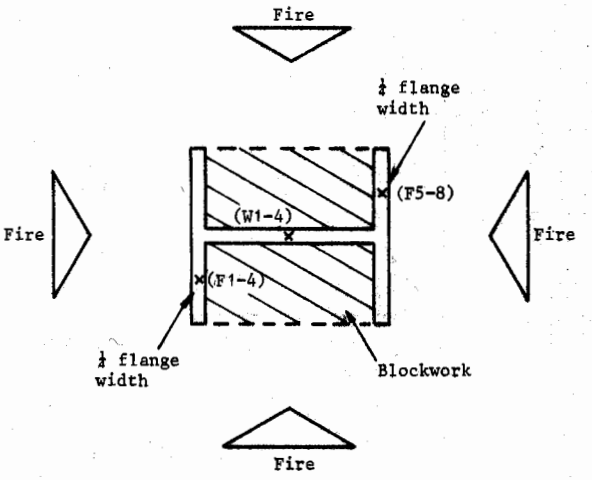
NOTES

(a) Equals 60% of the maximum permissible load according to BS 449 : Part 2 : 1969
(b) Initial ambient temperature = 14 deg. C

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

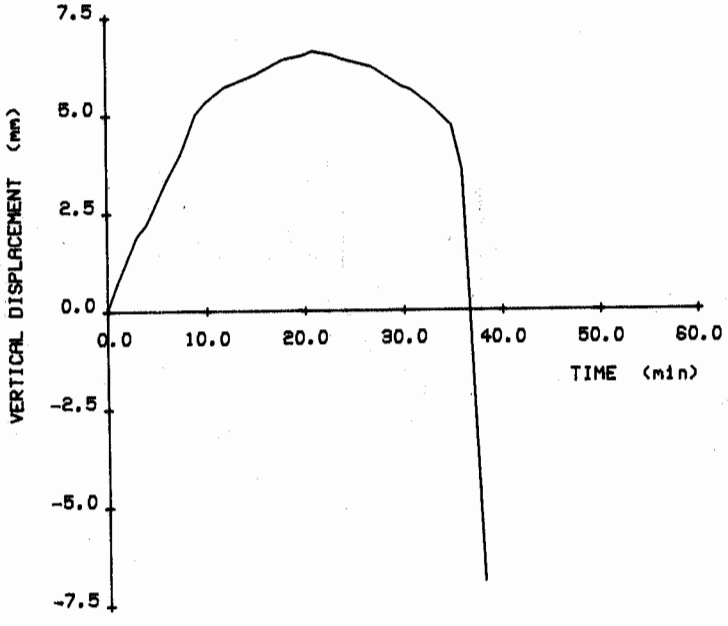
(R2/7124J)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	5th. JUNE 1984
TEST NUMBER	:	TE 4884

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	38 MINUTES
FIRE RESISTANCE	:	38 MINUTES

DATA SHEET NUMBER **45b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)												
		3	6	9	12	15	18	21	24	27	30	33	36	38
EXPOSED FLANGES	F1	90	128	184	257	328	409	465	524	596	622	657	685	707
	F2	69	111	177	255	338	427	481	542	591	634	669	697	716
	F3	65	117	179	234	300	371	439	509	566	613	647	677	698
	F4	70	146	223	290	370	444	505	560	597	642	680	706	723
	F5	65	110	167	227	296	377	441	509	565	614	649	677	701
	F6	70	118	193	273	334	412	461	526	585	626	655	680	699
	F7	58	100	174	219	280	347	414	483	541	592	629	662	681
	F8	70	151	199	254	314	389	448	509	558	599	637	660	683
	MEAN	70	123	187	251	320	397	457	520	575	618	653	681	701
UNEXPOSED WEB	W1	21	34	57	87	132	176	216	251	283	313	341	367	385
	W2	19	31	54	90	134	179	220	255	287	314	344	373	392
	W3	20	33	59	93	134	177	217	253	290	320	350	378	397
	W4	19	34	65	104	148	190	229	265	300	332	362	389	407
	MEAN	20	33	59	94	137	181	221	256	290	320	349	377	395
MEAN FURNACE GAS		455	572	628	660	695	751	787	805	815	835	849	863	866
STANDARD CURVE (b)		496	597	657	699	733	760	783	803	820	836	850	863	871
EXTENSION (mm)		1.9	3.3	5.0	5.7	6.0	6.4	6.6	6.4	6.2	5.7	5.2	3.6	-6.9



DATA SHEET NUMBER **46a**

COLUMN WITH BLOCKED-IN WEB

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
152 x 152	NOMINAL	23	152.4	152.4	6.1	6.8	165.7	52.95	184.3	80.87	1263	403
COLUMN	ACTUAL		156.0	151.5	6.0	7.0						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.18	0.25	0.74	0.017	0.018	0.01	0.004	0.02	0.004	*	0.001	0.005	0.0043

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	280	459	37.0

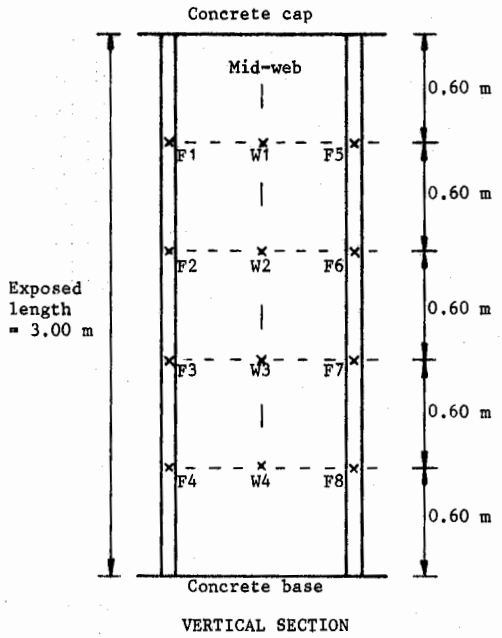
NOTES

(a) Initial ambient temperature = 15 deg. C
(*) Not measured

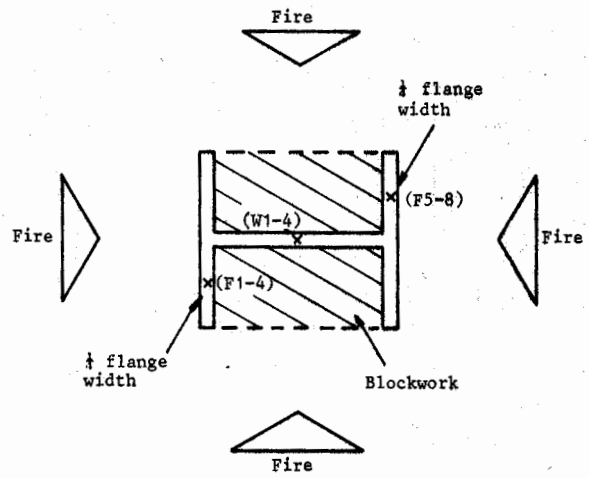
TEST CONDITIONS

DENSITY OF BLOCKWORK	:	615	kg/m3
MOISTURE CONTENT	:	8.9	%
EXPOSED LENGTH	:	300	cm
EFFECTIVE LENGTH	:	210	cm
RADIUS OF GYRATION (y-y)	:	3.68	cm
SLENDERNESS RATIO	:	57.07	
MAXIMUM AXIAL STRESS	:	128	N/mm2
AREA OF CROSS SECTION	:	29.8	cm2
MAXIMUM LOAD	:	381	kN
LOAD APPLIED	:	381	kN

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

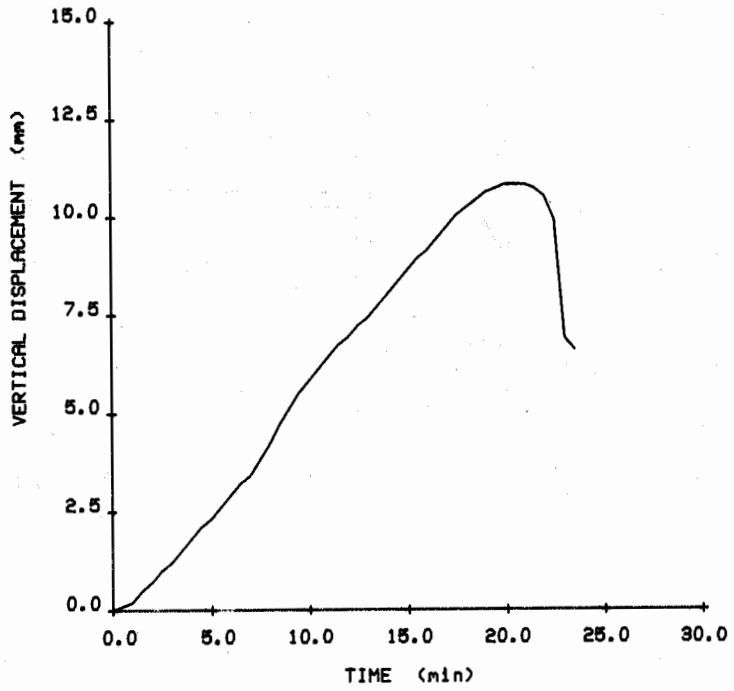
(R2/7124J)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	29th. OCTOBER 1984
TEST NUMBER	:	TE 5154

BS 476 : PART 8 : 1972 ASSESSMENT		
RE- LOAD TEST	:	SATISFIED
STABILITY	:	23 MINUTES
FIRE RESISTANCE	:	23 MINUTES

DATA SHEET NUMBER **46b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)							
		3	6	9	12	15	18	21	23
EXPOSED FLANGES	F1	106	156	245	324	404	479	535	572
	F2	116	169	243	320	387	467	515	548
	F3	81	139	201	286	382	462	521	557
	F4	67	170	239	327	401	467	524	559
	F5	99	148	244	328	407	479	546	582
	F6	85	142	220	302	385	462	520	558
	F7	97	165	238	323	405	487	547	581
	F8	73	192	262	352	426	489	537	563
	MEAN	91	160	237	320	400	474	531	565
UNEXPOSED WEB	W1	24	50	93	141	183	228	267	295
	W2	24	51	93	136	174	215	251	280
	W3	22	49	92	135	180	227	263	287
	W4	18	34	68	117	148	184	214	248
	MEAN	22	46	87	132	171	214	249	278
MEAN FURNACE GAS		542	598	702	716	750	772	779	784
STANDARD CURVE (a)		497	598	658	700	734	761	784	797
EXTENSION (mm)		1.2	2.9	5.1	6.9	8.6	10.2	10.8	6.9



DATA SHEET NUMBER **47a**

COLUMN WITH BLOCKED-IN WEB

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
203 x 203	NOMINAL	46	203.2	203.2	7.3	11.0	449.2	151.5	497.4	230.0	4564	1539
COLUMN	ACTUAL		203	202	7.0	10.5						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.19	0.22	0.72	0.019	0.013	0.02	0.004	0.02	0.003	*	0.001	0.002	0.003

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	284	474	34.0

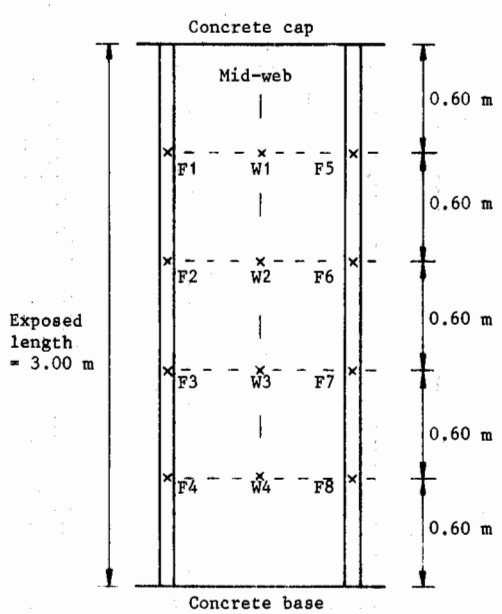
TEST CONDITIONS

DENSITY OF BLOCKWORK	: 795	kg/m3	
MOISTURE CONTENT	: 5.0	%	
EXPOSED LENGTH	: 300	cm	(a)
EFFECTIVE LENGTH	: 210	cm	
RADIUS OF GYRATION (y-y)	: 5.11	cm	
SLENDERNESS RATIO	: 41.10		
MAXIMUM AXIAL STRESS	: 138	N/mm2	
AREA OF CROSS SECTION	: 58.8	cm2	
MAXIMUM LOAD	: 811	kN	
LOAD APPLIED	: 811	kN	

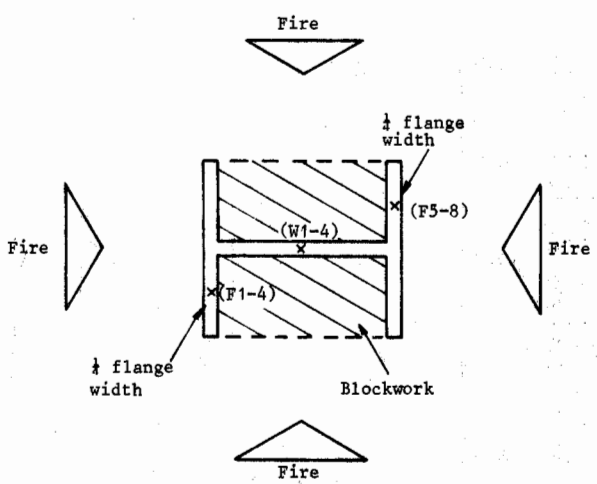
NOTES

(a) Exposed flanges were painted with two coats of a high build alkyd primer applied at nominally 100 g/m2
(b) 80% of 30 minutes
(c) Initial ambient temperature = 16 deg. C
(*) Not measured

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124J)

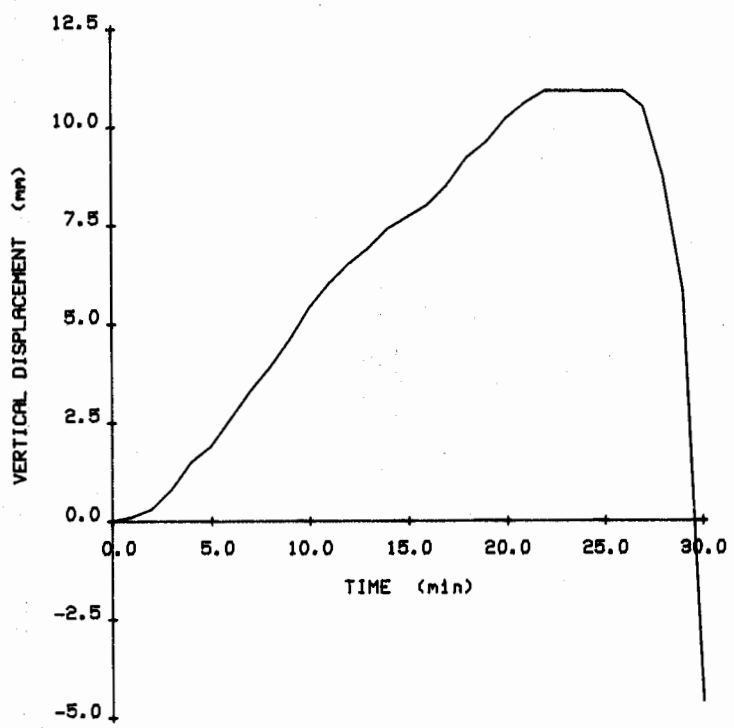
TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	16th. APRIL 1985
TEST NUMBER	:	TE 5236

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	NOT SATISFIED
STABILITY	:	24 MINUTES
FIRE RESISTANCE	:	24 MINUTES

(b)

DATA SHEET NUMBER **47b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)									
		3	6	9	12	15	18	21	24	27	30
EXPOSED FLANGES	F1	60	115	171	234	306	387	460	526	573	615
	F2	60	121	183	252	320	393	464	534	580	619
	F3	60	123	193	266	333	404	479	544	587	623
	F4	60	127	187	265	331	392	461	519	561	603
	F5	50	99	153	214	283	353	422	489	548	602
	F6	52	104	160	222	288	357	427	489	543	593
	F7	51	106	172	239	307	374	444	509	554	614
	F8	60	115	180	248	314	378	441	502	544	583
	MEAN	57	114	175	243	310	380	450	514	561	607
UNEXPOSED WEB	W1	20	35	59	92	131	170	206	240	272	307
	W2	18	31	52	83	121	153	185	217	252	290
	W3	18	31	56	90	131	168	202	234	266	299
	W4	18	35	63	102	143	178	210	243	275	305
	MEAN	19	33	58	92	132	167	201	234	266	300
MEAN FURNACE GAS		535	557	622	667	707	744	779	797	817	835
STANDARD CURVE (c)		498	599	659	701	735	762	785	805	822	838
EXTENSION (mm)		0.8	2.6	4.6	6.5	7.7	9.2	10.6	10.9	10.5	-4.6



DATA SHEET NUMBER **48a**

COLUMNS IN WALL

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL		206	204	8.0	12.5						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.27	0.041	0.94	0.010	0.022	0.01	0.005	0.026	0.005	0.018	0.005	0.01	0.0033

ROOM TEMPERATURE TENSILE PROPERTIES (a)

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	285	492	25.5
WEB	287	472	28.0

TEST CONDITIONS

HEIGHT OF COLUMNS	: 300	cm	
EFFECTIVE LENGTH	: 255	cm	
RADIUS OF GYRATION (x-x)	: 8.90	cm	
RADIUS OF GYRATION (y-y)	: 5.16	cm	
SLENDERNESS RATIO (x-x)	: 28.65		
MAXIMUM AXIAL STRESS	: 143.5	N/mm2	
AREA OF CROSS SECTION	: 66.4	cm2	
MAXIMUM LOAD PER COLUMN	: 953	kN	
LOAD APPLIED PER COLUMN	: 476.5	kN	(b)(c)

NOTES

(a) For elevated temperature anisothermal tensile properties see Data Sheet No. 88

(b) Equals 50% of the maximum permissible load according to BS 449 : Part 2 : 1969

(c) Examination of the test behaviour by the British Steel Corporation suggests that for the x-x axis the effective length factor = 1.0 - 1.2 (estimate) and for the y-y axis the effective length factor = 1.0

Effective length (x-x) = 300 - 360 cm
Effective length (y-y) = 300 cm
Slenderness ratio (x-x) = 33.71 - 40.45
Slenderness ratio (y-y) = 58.14

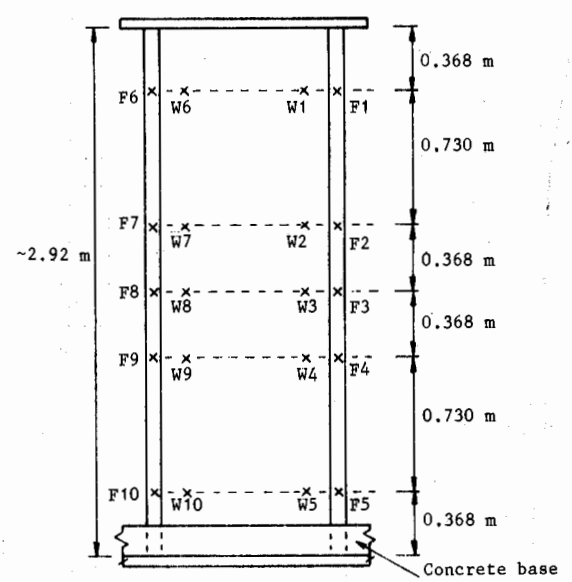
Hence the y-y axis governs collapse and the maximum allowable axial stress on the gross section = 127 N/mm2
Maximum permissible load per column = 843.3 kN
Therefore the load applied per column (476.5 kN) equals 56.5% of the maximum permissible load according to BS 449 : Part 2 : 1969

(d) Initial ambient temperature = 19 deg. C

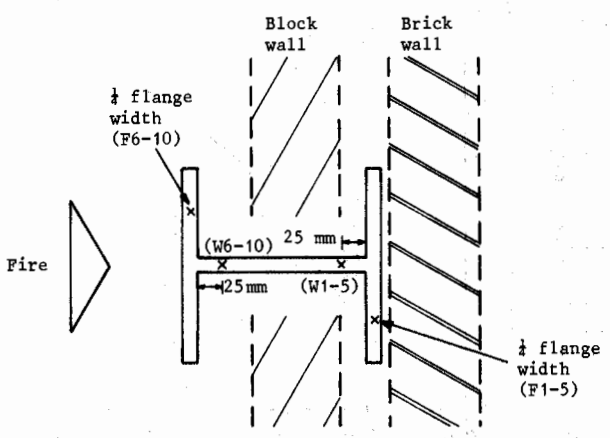
(e) Accurate to the nearest 0.5 mm

(*) Not measured

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

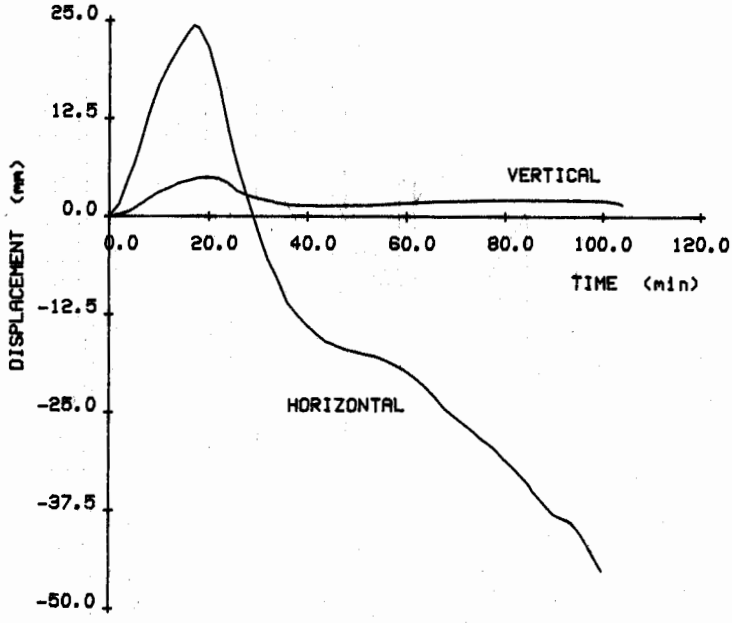
(R2/7124K)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	3rd. NOVEMBER 1981
TEST NUMBER	:	TE 4081

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	104 MINUTES
INTEGRITY	:	104 MINUTES
INSULATION	:	104 MINUTES
FIRE RESISTANCE	:	104 MINUTES

DATA SHEET NUMBER **48b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		5	10	20	25	30	40	45	50	55	60	65	70	75	80	85	90	95	100	103	104
UNEXPOSED FLANGE	F1	33	56	92	112	129	161	176	190	202	213	228	241	254	267	279	290	300	313	322	*
	F2	19	34	60	75	95	136	155	172	186	199	217	234	246	258	269	279	288	298	304	*
	F3	18	21	41	53	69	105	122	138	151	163	174	186	195	204	213	220	226	232	234	*
	F4	17	19	34	46	60	92	108	123	137	148	162	176	187	197	207	215	223	230	233	*
	F5	16	17	23	28	36	54	63	71	78	86	95	104	112	120	127	134	140	146	149	*
	MEAN	21	29	50	63	78	110	125	139	151	162	175	188	199	209	219	228	235	244	248	
UNEXPOSED WEB	W1	37	66	125	150	174	220	241	259	276	292	309	326	340	354	367	379	391	403	411	*
	W2	27	54	118	154	190	250	274	295	314	332	358	378	393	409	424	437	450	464	474	*
	W3	20	33	82	115	144	190	210	228	244	259	277	295	307	320	331	341	350	358	364	*
	W4	20	32	76	106	132	178	199	220	236	251	278	300	315	330	343	355	366	376	382	*
	W5	18	23	43	61	80	112	125	137	148	158	169	181	191	200	209	218	226	234	238	*
	MEAN	24	42	89	117	144	190	210	228	244	258	278	296	309	323	335	346	357	367	374	
EXPOSED WEB	W6	121	217	400	478	542	639	670	700	733	765	797	824	843	861	881	899	915	931	940	*
	W7	101	210	431	535	615	707	747	786	818	845	874	892	906	920	937	952	964	977	983	*
	W8	94	213	437	537	607	687	722	758	792	821	853	870	883	899	919	935	948	960	966	*
	W9	74	170	385	486	559	653	694	731	762	791	831	853	867	886	909	926	939	952	958	*
	W10	51	100	250	365	454	550	584	615	642	671	713	748	768	790	816	840	860	887	882	*
	MEAN	88	182	381	480	555	647	683	718	749	779	814	837	853	871	892	910	925	941	946	
EXPOSED FLANGE	F6	155	283	513	604	668	743	772	804	836	862	887	902	914	928	944	957	970	983	989	*
	F7	133	284	559	665	727	801	838	866	889	908	933	944	953	966	981	993	1004	1014	1018	*
	F8	158	319	570	660	716	777	812	847	873	894	918	927	936	950	968	982	994	1005	1010	*
	F9	148	290	563	664	723	787	821	852	875	896	922	931	939	954	974	989	999	1010	1013	*
	F10	90	172	415	584	677	739	764	790	815	838	874	893	904	919	939	957	969	981	980	*
	MEAN	137	270	524	635	702	769	801	832	858	880	907	919	929	943	961	976	987	999	1002	
MEAN FURNACE GAS		589	657	808	825	856	882	896	913	927	940	955	963	970	988	1001	1014	1024	1035	1033	*
STANDARD CURVE (d)		575	677	780	814	841	884	901	917	931	944	956	967	978	987	996	1005	1013	1021	1025	1027
DEFLECTION (mm)		6.5	16.7	21.5	8.4	-1.9	-13.9	-16.2	-17.3	-18.1	-19.7	-22.4	-25.5	-28.1	-30.9	-34.0	-37.8	-39.6	-45.0	*	*
EXTENSION (mm)(e)		1.0	3.1	5.0	3.7	2.3	1.4	1.3	1.4	1.5	1.7	1.9	2.0	2.0	2.1	2.1	2.1	2.0	2.0	1.8	1.5



DATA SHEET NUMBER **49a**

COLUMNS IN WALL

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL		*	*	*	*						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.27	0.04	0.94	0.012	0.020	0.02	0.005	0.02	0.005	0.02	0.005	0.005	0.0042

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	266	506	29.0

TEST CONDITIONS

HEIGHT OF COLUMNS	: 270	cm	
EFFECTIVE LENGTH	: 189	cm	(a)
RADIUS OF GYRATION (x-x)	: 8.90	cm	
RADIUS OF GYRATION (y-y)	: 5.16	cm	
SLENDERNESS RATIO (x-x)	: 21.23		
MAXIMUM AXIAL STRESS	: 146	N/mm2	
AREA OF CROSS SECTION	: 66.4	cm2	
MAXIMUM LOAD PER COLUMN	: 969.4	kN	
LOAD APPLIED PER COLUMN	: 969.5	kN	(b)

NOTES

(a) An effective length factor of 0.7 has been assumed

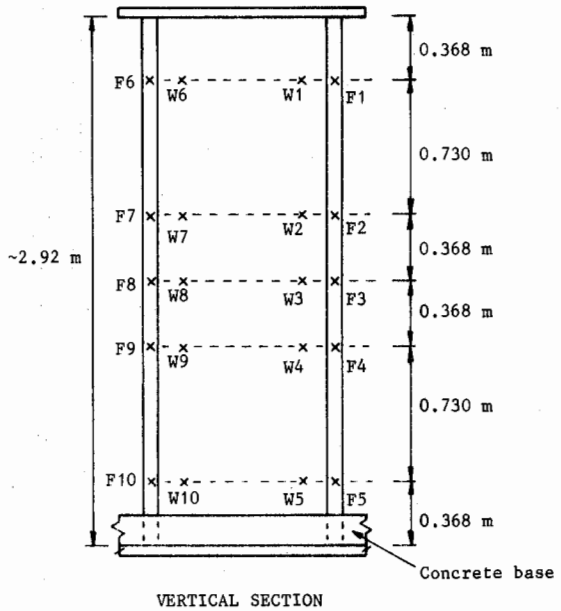
(b) Examination of the test behaviour by the British Steel Corporation suggests that for the x-x axis the effective length factor = 1.0 - 1.2 (estimate) and for the y-y axis the effective length factor = 1.0 The height of the columns should also be taken as 300 cm.
Effective length (x-x) = 300 - 360 cm
Effective length (y-y) = 300 cm
Slenderness ratio (x-x) = 33.71 - 40.45
Slenderness ratio (y-y) = 58.14
Hence the y-y axis governs collapse and the maximum allowable axial stress on the gross section = 127 N/mm2
Maximum permissible load per column = 843.3 kN
Therefore the load applied per column (969.5 kN) equals 115% of the maximum permissible load according to BS 449 : Part 2 : 1969

(c) 80% of 31 minutes

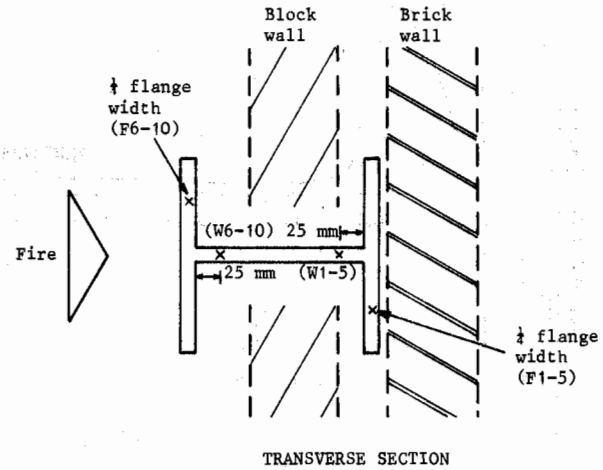
(d) Initial ambient temperature = 13 deg. C

(*) Not measured

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124K)

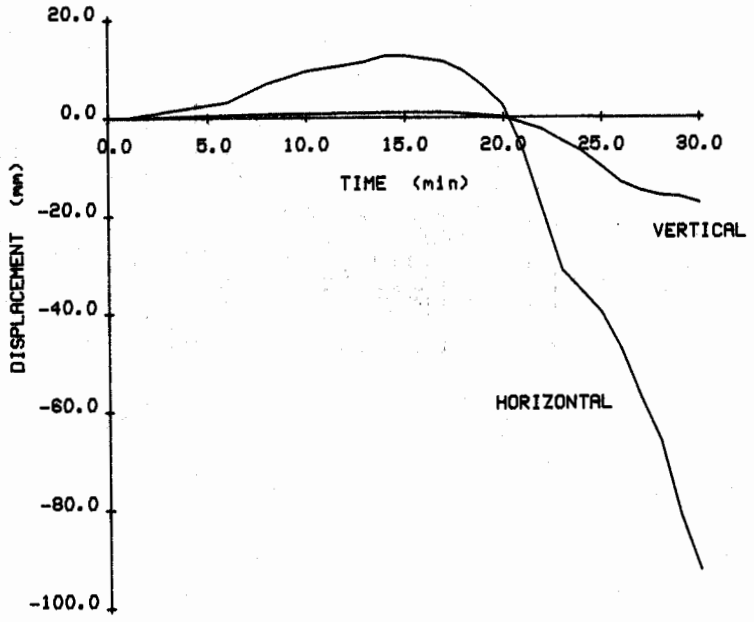
TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	7th. DECEMBER 1982
TEST NUMBER	:	TE 4413

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	NOT SATISFIED
STABILITY	:	25 MINUTES
INTEGRITY	:	31 MINUTES
INSULATION	:	31 MINUTES
FIRE RESISTANCE	:	25 MINUTES

(c)

DATA SHEET NUMBER **49b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)										
		3	6	9	12	15	18	21	24	27	30	31
UNEXPOSED FLANGE	F1	18	27	38	49	60	69	82	97	118	140	*
	F2	12	13	16	20	26	35	46	70	81	101	*
	F3	11	13	16	20	28	38	52	71	80	91	*
	F4	11	12	15	19	25	33	42	52	69	83	*
	F5	11	11	12	14	17	21	26	32	39	46	*
	MEAN	13	15	19	24	31	39	50	64	77	92	
UNEXPOSED WEB	W1	35	52	69	86	105	127	152	190	223	253	*
	W2	16	24	35	49	68	87	101	118	161	189	*
	W3	16	24	34	48	64	82	104	127	148	168	*
	W4	14	21	33	46	61	76	82	102	125	150	*
	W5	13	16	22	32	46	60	77	87	101	114	*
	MEAN	19	27	39	52	69	86	103	125	152	175	
EXPOSED WEB	W6	110	179	248	317	385	455	524	579	622	668	*
	W7	73	137	206	284	365	451	528	576	621	670	*
	W8	76	130	203	280	360	446	524	560	605	648	*
	W9	70	132	202	271	345	426	493	530	594	648	*
	W10	52	79	148	248	340	426	473	464	547	584	*
	MEAN	76	131	201	280	359	441	508	542	598	644	
EXPOSED FLANGE	F6	125	215	304	390	475	558	626	664	700	740	*
	F7	114	197	294	392	487	582	654	684	719	745	*
	F8	114	194	291	388	480	568	644	667	714	746	*
	F9	120	210	290	379	461	547	614	637	707	749	*
	F10	74	137	228	334	438	534	586	572	666	702	*
	MEAN	109	191	281	377	468	558	625	645	701	736	
MEAN FURNACE GAS		468	572	621	668	734	777	795	700	891	852	*
STANDARD CURVE (d)		495	596	656	698	732	759	782	802	819	835	840
DEFLECTION (mm)		1.3	3.1	8.1	10.6	12.5	9.4	-6.3	-35.6	-57.5	-92.5	*
EXTENSION (mm)		0.2	0.5	0.75	0.85	1.0	0.7	-1.2	-6.9	-15.0	-17.5	*



DATA SHEET NUMBER **50a**

BEAMS IN WALL WITH BLOCKED-IN WEBS

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
356 x 171	NOMINAL	67	364.0	173.2	9.1	15.7	1073	157.3	1212	243.0	19522	1362
BEAM	ACTUAL		*	*	*	*						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
BEAM	GRADE 50B	0.17	0.02	1.24	0.011	0.018	0.01	0.005	0.02	0.075	0.04	0.005	0.008	0.006

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	379	526	28.0

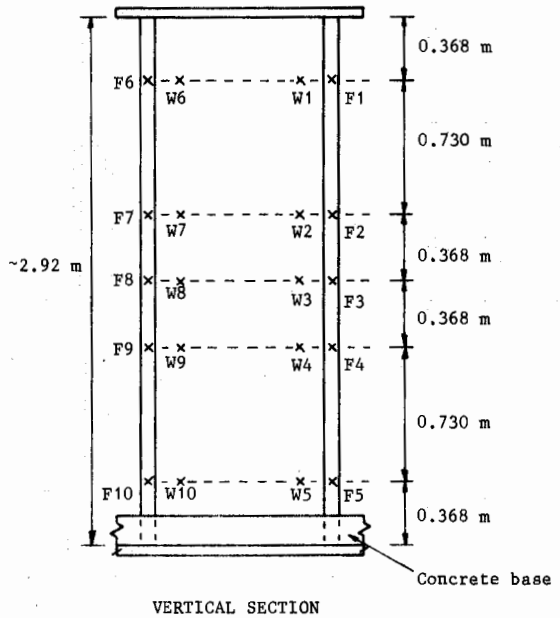
NOTES

(a) The y-y axis governs collapse
(b) Equals 39.3% of the maximum permissible load according to BS 449 : Part 2 : 1969 for a Grade 50 steel section
(c) Initial ambient temperature = 13 deg. C
(*) Not measured

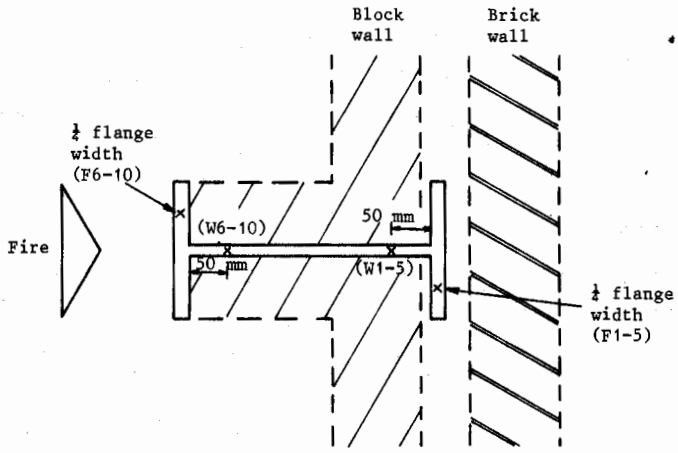
TEST CONDITIONS

DENSITY OF BLOCKWORK	: *	kg/m3	
HEIGHT OF BEAMS	: 300	cm	
EFFECTIVE LENGTH (y-y)	: 300	cm	(a)
RADIUS OF GYRATION (y-y)	: 3.99	cm	
SLENDERNESS RATIO (y-y)	: 75.19		
MAXIMUM AXIAL STRESS	: 140	N/mm2	
AREA OF CROSS SECTION	: 85.4	cm2	
MAXIMUM LOAD PER COLUMN	: 1196	kN	
LOAD APPLIED PER COLUMN	: 469.5	kN	(b)

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

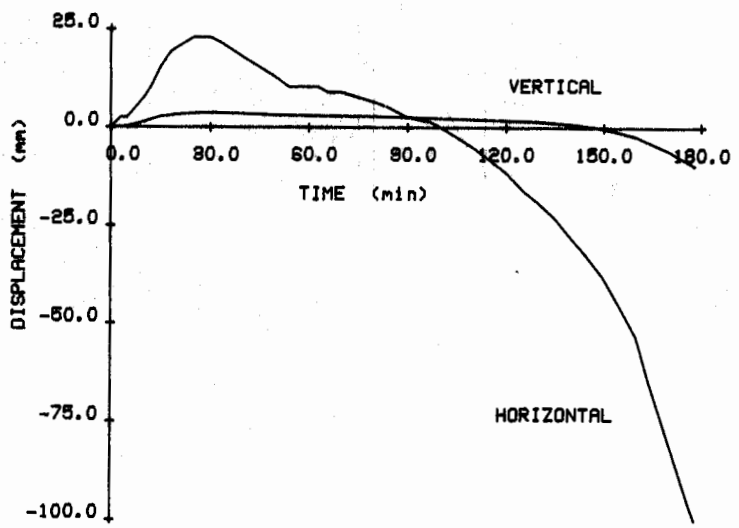
(R2/7124L)

TEST CENTRE	: FIRTO -- BOREHAMWOOD
TEST DATE	: 15th. DECEMBER 1983
TEST NUMBER	: TE 4414

BS 476 : PART 8 : 1972 ASSESSMENT	
RE-LOAD TEST	: SATISFIED
STABILITY	: 180 MINUTES
INTEGRITY	: 180 MINUTES
INSULATION	: 180 MINUTES
FIRE RESISTANCE	: 180 MINUTES

DATA SHEET NUMBER **50b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
		5	10	15	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
UNEXPOSED FLANGE	F1	10	13	15	18	22	27	44	65	79	87	97	106	112	120	128	138	152	169	189	205	225
	F2	9	8	9	9	12	15	29	52	72	83	94	100	105	110	114	119	126	135	146	159	177
	F3	8	8	8	8	10	12	21	39	71	94	99	101	103	107	110	113	117	122	128	135	143
	F4	8	8	8	8	10	14	25	54	80	90	97	101	105	108	111	115	120	126	133	143	156
	F5	7	7	7	8	9	10	16	40	83	90	93	96	98	99	100	100	101	102	103	105	107
	MEAN	8	9	9	10	13	16	27	50	77	89	96	101	105	109	113	117	123	131	140	149	162
WEB IN WALL	W1	9	10	12	17	24	35	59	90	100	107	116	127	138	148	159	171	186	205	225	249	277
	W2	8	8	10	18	31	43	80	97	101	110	118	131	144	156	166	177	191	208	230	257	291
	W3	8	8	9	14	21	29	51	97	103	113	120	127	135	142	149	156	164	175	187	202	219
	W4	7	8	9	13	19	27	55	91	101	102	110	122	129	137	144	152	162	174	189	209	234
	W5	7	8	9	13	19	26	51	97	102	104	108	113	117	121	125	128	132	137	142	147	152
	MEAN	8	8	10	15	23	32	59	94	101	107	114	124	133	141	149	157	167	180	195	213	235
WEB IN BLOCKWORK	W6	24	58	106	157	204	249	325	388	434	476	517	552	582	614	648	685	725	764	800	843	874
	W7	23	61	117	172	226	280	365	417	462	506	546	577	604	638	675	716	760	813	872	937	979
	W8	24	63	115	187	250	307	392	447	495	543	581	606	627	657	686	713	739	764	802	835	855
	W9	24	67	135	198	256	308	393	449	494	540	578	605	627	652	679	710	743	778	810	833	854
	W10	21	62	112	163	210	254	329	378	414	446	479	507	532	557	582	603	620	636	662	685	690
	MEAN	23	62	117	175	229	280	361	416	460	502	540	569	594	624	654	685	717	751	789	827	850
EXPOSED FLANGE	F6	111	198	289	384	473	552	677	758	820	884	930	948	972	996	1014	1029	1038	1044	1068	1072	1064
	F7	91	205	319	437	543	628	745	816	886	936	972	979	1001	1024	1040	1053	1060	1066	1093	1097	1087
	F8	83	194	321	445	533	640	754	829	903	951	984	980	1002	1026	1042	1051	1052	1055	1092	1090	1075
	F9	88	206	327	449	552	636	748	818	890	940	974	976	995	1016	1030	1039	1042	1046	1079	1069	1054
	F10	105	222	323	412	493	563	665	709	751	798	844	869	899	924	942	952	949	959	1008	984	960
	MEAN	96	205	316	425	519	604	718	786	850	902	941	950	974	997	1014	1025	1028	1034	1068	1062	1048
MEAN FURNACE GAS		525	657	720	762	799	837	884	907	949	977	999	984	1012	1026	1046	1053	1049	1049	1097	1073	1051
STANDARD CURVE (c)		569	671	732	774	808	835	878	911	938	961	981	999	1015	1029	1042	1054	1065	1075	1085	1094	1103
DEFLECTION (mm)		2.5	7.6	15.2	20.3	22.9	22.9	17.8	12.7	10.2	8.9	6.4	2.5	0.0	-5.1	-11.4	-19.1	-27.9	-38.1	-53.3	-80.0	-105.4
EXTENSION (mm)		0.3	1.5	2.8	3.3	3.6	3.7	3.5	3.1	3.0	2.9	2.7	2.5	2.3	2.0	1.8	1.5	0.8	-0.3	-2.4	-6.0	-9.8



DATA SHEET NUMBER **51a**

COLUMNS IN WALL WITH BLOCKED-IN WEBS

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL		*	*	*	*						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.27	0.04	0.94	0.012	0.020	0.02	0.005	0.02	0.005	0.02	0.005	0.005	0.0042

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	266	506	29.0

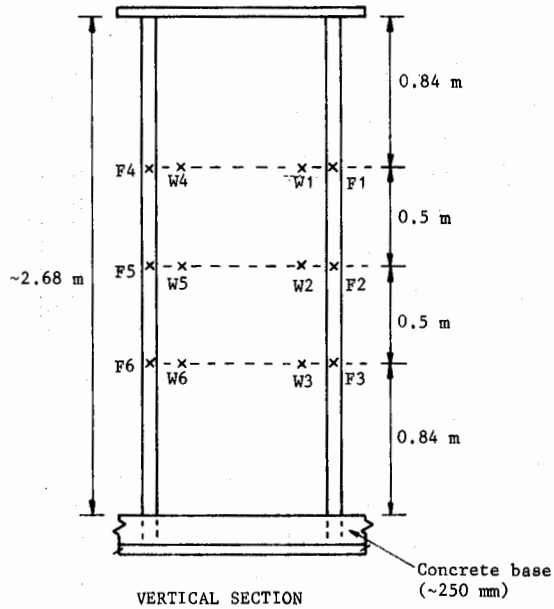
NOTES

(a) The y-y axis therefore governs collapse
(b) Initial ambient temperature = 17 deg. C
(c) Accurate to the nearest 0.5 mm
(*) Not measured

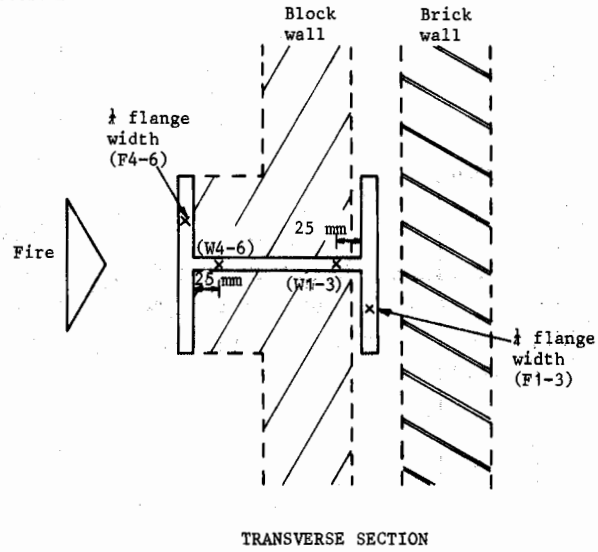
TEST CONDITIONS

DENSITY OF BLOCKWORK	: *	kg/m3
HEIGHT OF COLUMNS	: 300	cm
EFFECTIVE LENGTH (x-x)	: 300-360	cm (estimate)
EFFECTIVE LENGTH (y-y)	: 300	cm
RADIUS OF GYRATION (x-x)	: 8.90	cm
RADIUS OF GYRATION (y-y)	: 5.16	cm
SLENDERNESS RATIO (x-x)	: 33.71 - 40.45	
SLENDERNESS RATIO (y-y)	: 58.14	(a)
MAXIMUM AXIAL STRESS	: 127	N/mm2
AREA OF CROSS SECTION	: 66.4	cm2
MAXIMUM LOAD PER COLUMN	: 843.3	kN
LOAD APPLIED PER COLUMN	: 843.3	kN

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

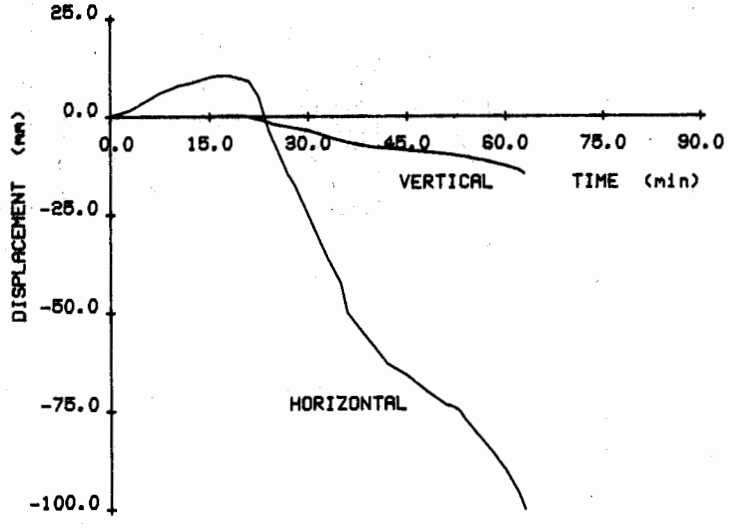
(R2/7124M)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	18th. OCTOBER 1983
TEST NUMBER	:	TE 4415

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	63 MINUTES
INTEGRITY	:	63 MINUTES
INSULATION	:	63 MINUTES
FIRE RESISTANCE	:	63 MINUTES

DATA SHEET NUMBER **51b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
UNEXPOSED FLANGE	F1	14	15	18	23	33	45	56	69	80	87	94	100	107	115	122	129	133	138	142	146	149
	F2	14	14	17	25	43	63	78	84	87	87	97	116	133	148	160	172	182	192	199	204	208
	F3	14	14	15	25	53	66	73	77	82	94	109	125	140	152	164	176	186	196	205	214	222
	MEAN	14	14	17	24	43	58	69	77	83	89	100	114	127	138	149	159	167	175	182	188	193
WEB IN WALL	W1	14	20	34	50	70	93	111	127	140	155	170	186	198	208	217	226	233	240	246	252	258
	W2	14	19	33	57	80	90	97	109	138	155	170	188	206	222	237	250	263	276	286	295	301
	W3	14	18	23	64	80	89	117	148	164	185	200	221	238	251	266	279	293	306	319	330	343
	MEAN	14	19	30	57	77	91	108	128	147	165	180	198	214	227	240	252	263	274	284	292	301
WEB IN BLOCKWORK	W4	22	47	82	117	152	192	227	258	286	312	337	359	380	397	412	426	437	450	462	474	484
	W5	28	72	117	168	224	270	312	353	387	423	457	493	520	543	564	584	606	628	649	665	675
	W6	28	72	110	206	282	343	397	442	474	508	536	568	588	606	627	646	669	691	711	725	736
	MEAN	26	64	103	164	219	268	312	351	382	414	443	473	496	515	534	552	571	590	607	621	632
EXPOSED FLANGE	F4	61	155	212	302	389	459	524	580	620	674	713	744	773	794	813	832	856	879	896	906	915
	F5	59	174	229	337	434	506	569	617	648	694	729	759	791	819	844	866	892	915	930	937	943
	F6	56	170	217	364	483	557	628	660	679	712	736	768	794	822	848	870	899	922	935	940	944
	MEAN	59	166	219	334	435	507	574	619	649	693	726	757	786	812	835	856	882	905	920	928	934
MEAN FURNACE GAS		424	593	623	787	778	806	811	803	812	847	872	890	892	900	909	937	950	948	948	954	959
STANDARD CURVE (b)		499	600	660	702	736	763	786	806	823	839	853	866	878	889	899	909	918	927	935	942	950
DEFLECTION (mm)(c)		1.5	4.5	7.0	8.5	10.0	10.5	9.0	-3.5	-15.0	-25.0	-36.0	-50.0	-56.5	-63.0	-66.0	-70.0	-73.5	-77.5	-83.5	-90.0	-100.5
EXTENSION (mm)		0.0	0.0	0.0	0.0	0.0	0.2	-0.1	-1.6	-2.8	-3.6	-5.3	-6.8	-7.7	-8.3	-8.8	-9.3	-9.7	-10.5	-11.5	-12.7	-14.7



DATA SHEET NUMBER **52a**

COLUMNS IN WALL WITH BLOCKED-IN WEBS

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL		*	*	*	*						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.20	0.23	0.80	0.016	0.021	0.02	0.003	0.01	0.002	0.03	0.001	0.005	0.006

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	292	489	31.5

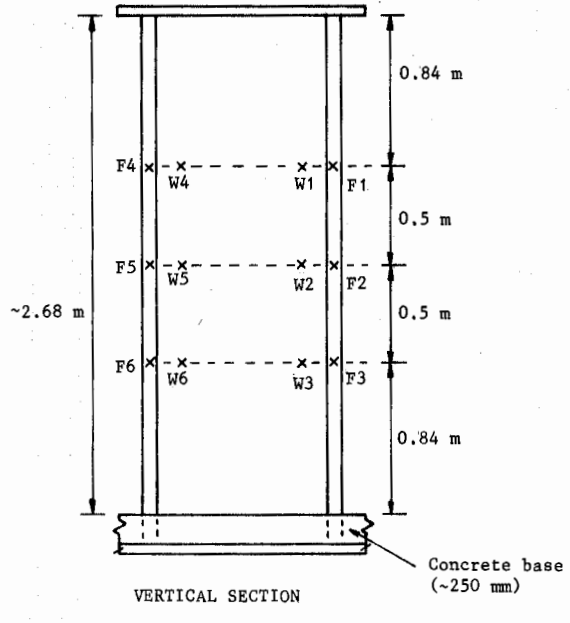
TEST CONDITIONS

DENSITY OF BLOCKWORK	: 621	kg/m3	(a)
HEIGHT OF COLUMNS	: 300	cm	
EFFECTIVE LENGTH (x-x)	: 300-360	cm	(estimate)
EFFECTIVE LENGTH (y-y)	: 300	cm	
RADIUS OF GYRATION (x-x)	: 8.90	cm	
RADIUS OF GYRATION (y-y)	: 5.16	cm	
SLENDERNESS RATIO (x-x)	: 33.71 - 40.45		
SLENDERNESS RATIO (y-y)	: 58.14		(b)
MAXIMUM AXIAL STRESS	: 127	N/mm2	
AREA OF CROSS SECTION	: 66.4	cm2	
MAXIMUM LOAD PER COLUMN	: 843.3	kN	
LOAD APPLIED PER COLUMN	: 337	kN	(c)

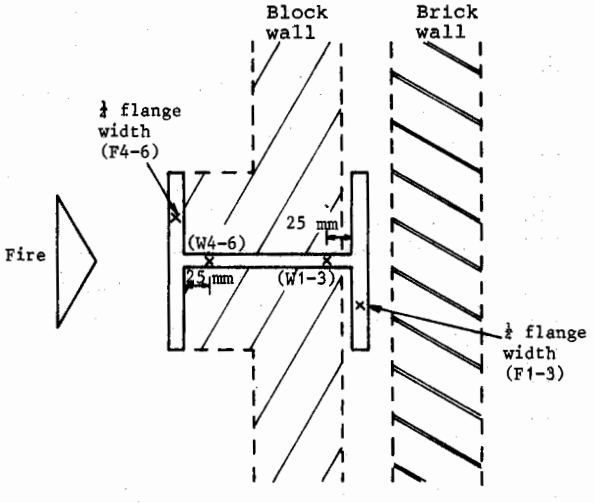
NOTES

(a) Oven dry density
(b) The y-y axis therefore governs collapse
(c) Equals 40% of the maximum permissible load according to BS 449 : Part 2 : 1969
(d) Initial ambient temperature = 13 deg. C
(*) Not measured

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

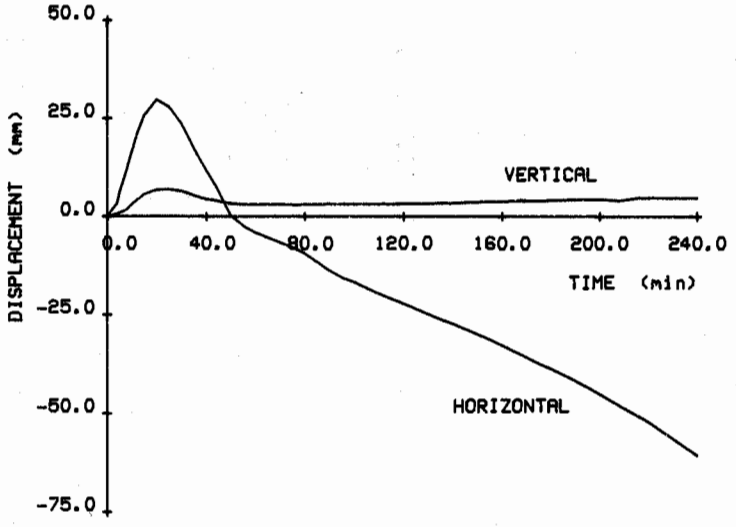
(R2/7124M)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	25th. FEBRUARY 1985
TEST NUMBER	:	TE 5208

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	240 MINUTES
INTEGRITY	:	240 MINUTES
INSULATION	:	240 MINUTES
FIRE RESISTANCE	:	240 MINUTES

DATA SHEET NUMBER **52b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
		5	10	15	20	25	30	40	50	60	70	80	90	100	110	120	140	160	180	200	220	240
UNEXPOSED FLANGE	F1	14	14	17	21	30	40	67	93	107	117	125	136	144	155	166	189	209	229	250	272	293
	F2	13	13	15	18	24	33	55	83	103	113	123	133	143	153	164	184	205	224	242	262	283
	F3	13	13	16	21	37	56	89	102	113	122	130	140	148	158	168	188	207	225	245	268	293
	MEAN	13	13	16	20	30	43	70	93	108	117	126	136	145	155	166	187	207	226	246	267	290
WEB IN WALL	W1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	W2	14	18	27	39	53	69	101	129	153	172	189	205	220	235	252	281	307	333	359	385	411
	W3	9	4	29	52	91	107	126	147	165	181	195	210	224	238	254	282	311	337	364	392	421
	MEAN	12	11	28	46	72	88	114	138	159	177	192	208	222	237	253	282	309	335	362	389	416
WEB IN BLOCKWORK	W4	50	118	203	281	346	398	488	545	591	632	617	705	733	760	787	832	869	901	933	960	983
	W5	43	107	178	250	313	367	453	511	558	600	639	673	701	726	751	796	835	869	901	927	952
	W6	41	109	186	262	327	380	463	518	564	602	639	671	699	724	749	794	834	869	902	928	953
	MEAN	45	111	189	264	329	382	468	525	571	611	632	683	711	737	762	807	846	880	912	938	963
EXPOSED FLANGE	F4	126	247	387	509	601	666	757	821	871	908	940	965	982	999	1015	1040	1060	1079	1096	1111	1122
	F5	125	246	384	505	597	660	752	817	868	907	941	965	982	999	1016	1042	1063	1082	1099	1114	1125
	F6	145	274	406	526	612	676	766	832	880	917	950	972	988	1005	1021	1046	1068	1088	1105	1120	1132
	MEAN	132	256	392	513	603	667	758	823	873	911	944	967	984	1001	1017	1043	1064	1083	1100	1115	1126
MEAN FURNACE GAS		569	694	765	790	820	850	908	940	955	983	1001	1017	1027	1043	1053	1074	1091	1107	1120	1131	1140
STANDARD CURVE (d)		569	671	732	774	808	835	878	911	938	961	981	999	1015	1029	1042	1065	1085	1103	1119	1133	1146
DEFLECTION (mm)		6.1	16.6	25.7	29.8	27.9	23.6	11.8	0.1	-4.2	-6.7	-9.5	-13.7	-16.8	-19.7	-22.3	-27.4	-32.9	-38.7	-45.1	-52.1	-60.6
EXTENSION (mm)		1.0	3.3	5.7	6.9	7.0	6.5	4.4	3.2	3.0	3.0	3.0	3.1	3.1	3.1	3.2	3.4	3.8	4.1	4.4	4.8	4.8



DATA SHEET NUMBER **53a**

COLUMNS IN WALL WITH BLOCKED-IN WEBS

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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
203 x 203	NOMINAL	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770
COLUMN	ACTUAL		*	*	*	*						

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
COLUMN	GRADE 43A	0.18	0.22	0.81	0.016	0.020	0.02	0.003	0.01	0.002	0.03	0.001	0.004	0.005

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE	277	480	37.0

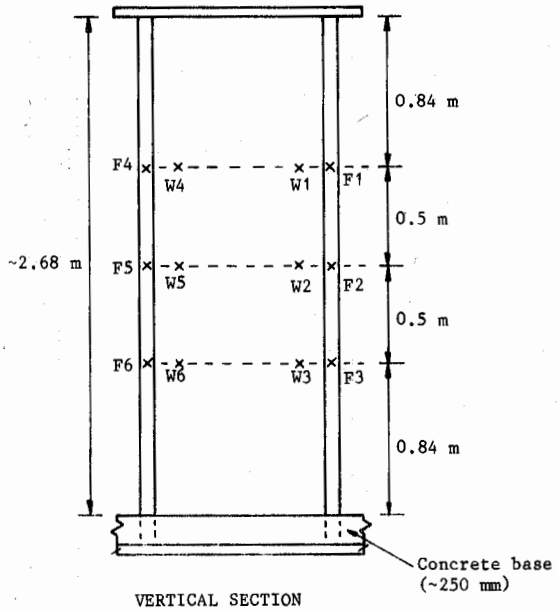
NOTES

(a) Oven dry density
(b) The y-y axis therefore governs collapse
(c) Equals 79.9% of the maximum permissible load according to BS 449 : Part 2 : 1969
(d) Initial ambient temperature = 13 deg. C
(*) Not measured

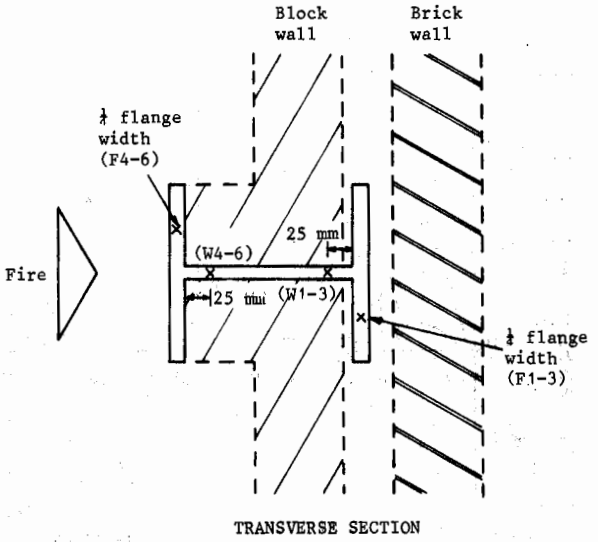
TEST CONDITIONS

DENSITY OF BLOCKWORK	:	621 kg/m3	(a)
HEIGHT OF COLUMNS	:	300 cm	
EFFECTIVE LENGTH (x-x)	:	300-360cm (estimate)	
EFFECTIVE LENGTH (y-y)	:	300 cm	
RADIUS OF GYRATION (x-x)	:	8.90 cm	
RADIUS OF GYRATION (y-y)	:	5.16 cm	
SLENDERNESS RATIO (x-x)	:	33.71 - 40.45	
SLENDERNESS RATIO (y-y)	:	58.14	(b)
MAXIMUM AXIAL STRESS	:	127 N/mm2	
AREA OF CROSS SECTION	:	66.4 cm2	
MAXIMUM LOAD PER COLUMN	:	843.3 kN	
LOAD APPLIED PER COLUMN	:	674 kN	(c)

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

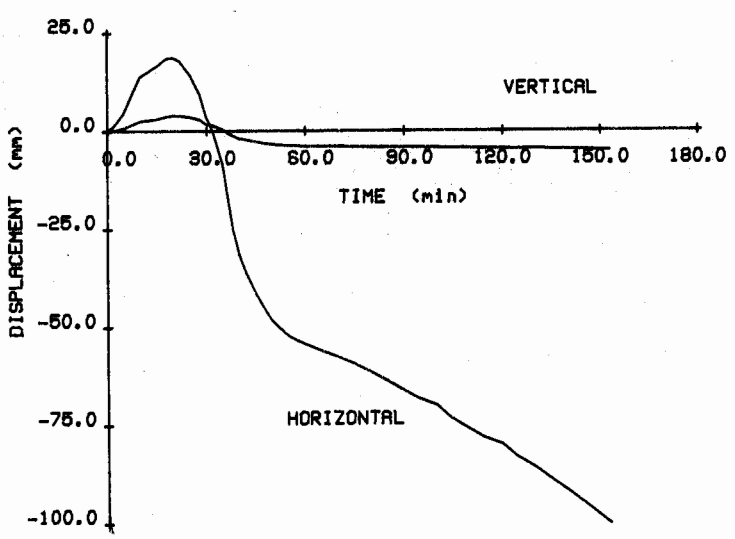
(R2/7124M)

TEST CENTRE	:	FIRTO -- BOREHAMWOOD
TEST DATE	:	27th. FEBRUARY 1985
TEST NUMBER	:	TE 5209

BS 476 : PART 8 : 1972 ASSESSMENT		
RE-LOAD TEST	:	SATISFIED
STABILITY	:	153 MINUTES
INTEGRITY	:	153 MINUTES
INSULATION	:	153 MINUTES
FIRE RESISTANCE	:	153 MINUTES

DATA SHEET NUMBER **53b**

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		5	10	15	20	25	30	35	40	45	50	55	60	70	80	90	100	110	120	130	140	153
UNEXPOSED FLANGE	F1	14	15	18	24	41	67	88	98	99	103	108	113	123	133	143	154	165	176	187	198	214
	F2	14	15	18	24	37	53	67	90	99	105	110	115	125	134	143	152	163	174	186	197	213
	F3	13	14	17	22	35	72	93	96	98	102	106	111	120	128	137	146	155	166	176	186	201
	MEAN	14	15	18	23	38	64	83	95	99	103	108	113	123	132	141	151	161	172	183	194	209
WEB IN WALL	W1	15	20	32	61	92	99	108	131	141	151	160	170	188	205	222	239	254	271	286	301	323
	W2	14	20	35	56	79	102	117	133	145	154	162	171	187	202	217	232	246	262	278	293	314
	W3	14	19	30	46	74	101	117	132	143	153	162	170	186	201	216	230	244	258	272	286	306
	MEAN	14	20	32	54	82	101	114	132	143	153	161	170	187	203	218	234	248	264	279	293	314
WEB IN BLOCKWORK	W4	44	109	189	264	325	380	427	466	495	520	544	567	612	653	686	715	741	767	791	816	844
	W5	43	112	190	264	326	381	429	469	497	522	546	569	612	650	682	709	733	757	781	805	832
	W6	40	101	174	240	302	357	405	445	475	502	526	550	594	633	665	692	716	740	763	788	817
	MEAN	42	107	184	256	318	373	420	460	489	515	539	562	606	645	678	705	730	755	778	803	831
EXPOSED FLANGE	F4	127	257	400	522	612	680	732	764	800	832	857	879	919	951	968	985	1001	1016	1030	1043	1040
	F5	122	260	401	521	610	677	730	763	797	830	860	883	922	955	972	989	1005	1021	1035	1049	1051
	F6	107	237	379	501	591	666	722	755	789	824	853	876	916	949	968	986	1002	1017	1033	1047	1052
	MEAN	119	251	393	515	604	674	728	761	795	829	857	879	919	952	969	987	1003	1018	1033	1046	1048
MEAN FURNACE GAS		553	672	742	784	811	850	875	892	915	927	934	945	972	974	1004	1019	1031	1043	1059	1065	899
STANDARD CURVE (d)		569	671	732	774	808	835	858	878	895	911	925	938	961	981	999	1015	1029	1042	1054	1065	1078
DEFLECTION (mm)		4.2	13.6	16.2	18.5	14.2	3.6	-8.5	-31.6	-41.3	-48.2	-52.1	-54.3	-57.5	-61.4	-66.1	-69.9	-76.0	-79.9	-85.8	-91.6	-100.0
EXTENSION (mm)		0.7	2.5	3.0	3.9	3.5	1.7	0.4	-2.0	-2.8	-3.4	-3.8	-4.0	-4.0	-4.2	-4.3	-4.4	-4.5	-4.6	-4.6	-4.9	-5.1



DATA SHEET NUMBER **54**

INDICATIVE FLOOR BEAM

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

DIMENSIONS AND PROPERTIES (NOMINAL)

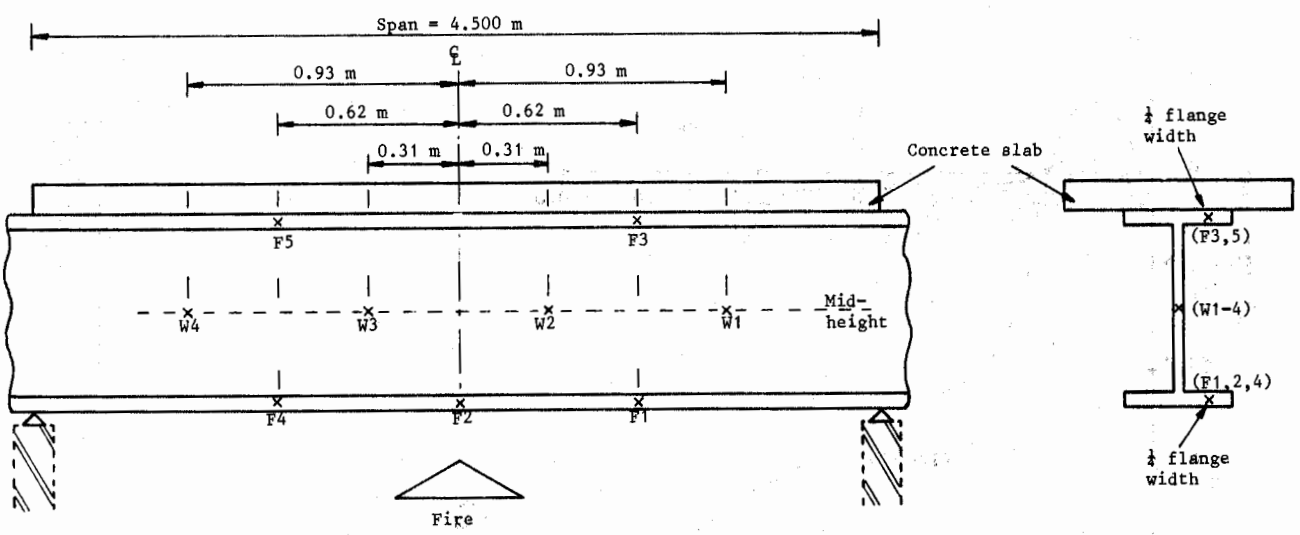
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
BEAM	254 x 146	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677

TEMPERATURE DATA

THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
UPPER FLANGE F3	50	88	125	161	213	264	318	362	407	454	494	531	565	592	611	632	651	672	691	707
F5	58	92	129	164	216	273	319	356	394	435	484	523	561	594	620	643	659	678	694	708
MEAN	54	90	127	163	215	269	319	359	401	445	489	527	563	593	616	638	655	675	693	708
WEB W1	104	201	287	368	456	523	566	595	624	650	672	693	711	726	734	743	763	774	787	797
W2	103	214	311	392	479	550	590	617	643	668	688	705	723	734	746	766	777	797	812	822
W3	114	218	318	402	480	547	580	607	631	654	677	697	717	734	741	756	773	786	799	807
W4	89	176	269	362	452	521	563	595	622	647	667	684	703	718	731	739	753	771	785	795
MEAN	103	202	296	381	467	535	575	604	630	655	676	695	714	728	738	751	767	782	796	805
LOWER FLANGE F1	102	186	265	348	446	520	577	610	644	673	685	709	731	737	747	760	776	794	810	819
F2	79	173	268	355	447	521	577	610	642	666	684	705	723	733	742	756	778	790	805	819
F4	75	149	234	326	420	500	558	596	628	653	673	694	713	729	736	749	767	782	796	809
MEAN	85	169	256	343	438	514	571	605	638	664	681	703	722	733	742	755	774	789	804	816
MEAN FURNACE GAS	440	574	634	692	697	749	709	736	752	749	776	808	828	834	843	852	871	862	871	809
STANDARD CURVE (a)	509	610	670	712	746	773	796	816	833	849	863	876	888	899	909	919	928	937	945	952

NOTES:- (a) Initial ambient temperature = 27 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

(R2/6124B)

DATA SHEET NUMBER **55**

INDICATIVE FLOOR BEAM

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

DIMENSIONS AND PROPERTIES (NOMINAL)

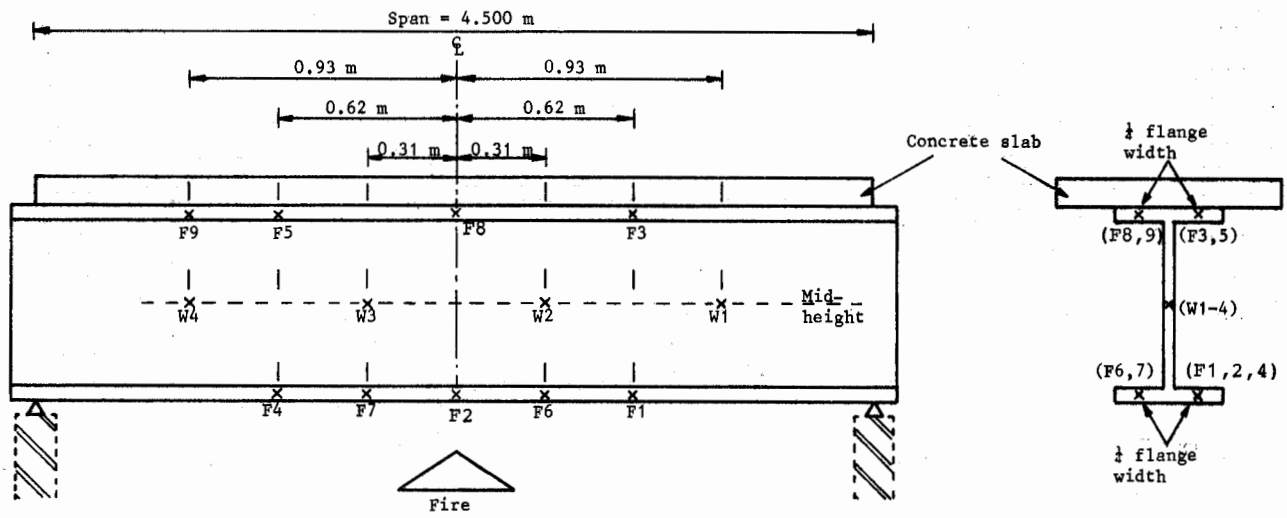
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
BEAM	254 x 146	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)									
		3	6	9	12	15	18	21	24	27	28
UPPER FLANGE	F3	56	104	164	218	282	350	413	467	517	535
	F5	124	182	239	293	342	415	467	523	575	587
	F8	87	147	220	291	357	428	492	540	587	608
	F9	88	137	192	250	306	362	419	468	513	529
	MEAN	89	143	204	263	322	389	448	500	548	565
WEB	W1	149	267	382	473	544	606	651	687	714	722
	W2	169	300	419	512	580	639	682	716	740	747
	W3	117	247	386	489	562	626	671	707	735	743
	W4	164	273	380	467	537	599	645	681	711	719
	MEAN	150	272	392	485	556	618	662	698	725	733
LOWER FLANGE	F1	90	210	346	461	550	621	672	708	735	743
	F2	93	210	353	472	561	634	685	722	747	754
	F4	77	188	319	434	527	605	659	699	729	737
	F6	104	232	362	471	556	625	676	713	738	744
	F7	98	209	342	456	546	619	671	709	737	744
	MEAN	92	210	344	459	548	621	673	710	737	744
MEAN FURNACE GAS		464	572	638	690	715	754	778	793	808	815
STANDARD CURVE (a)		490	591	651	693	727	754	777	797	814	820

NOTES:- (a) Initial ambient temperature = 8 deg. C

THERMOCOUPLE POSITIONS



LONGITUDINAL SECTION

TRANSVERSE SECTION

(Not to scale)

(R2/7124A)

DATA SHEET NUMBER **56**

INDICATIVE FLOOR BEAM

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

DIMENSIONS AND PROPERTIES (NOMINAL)

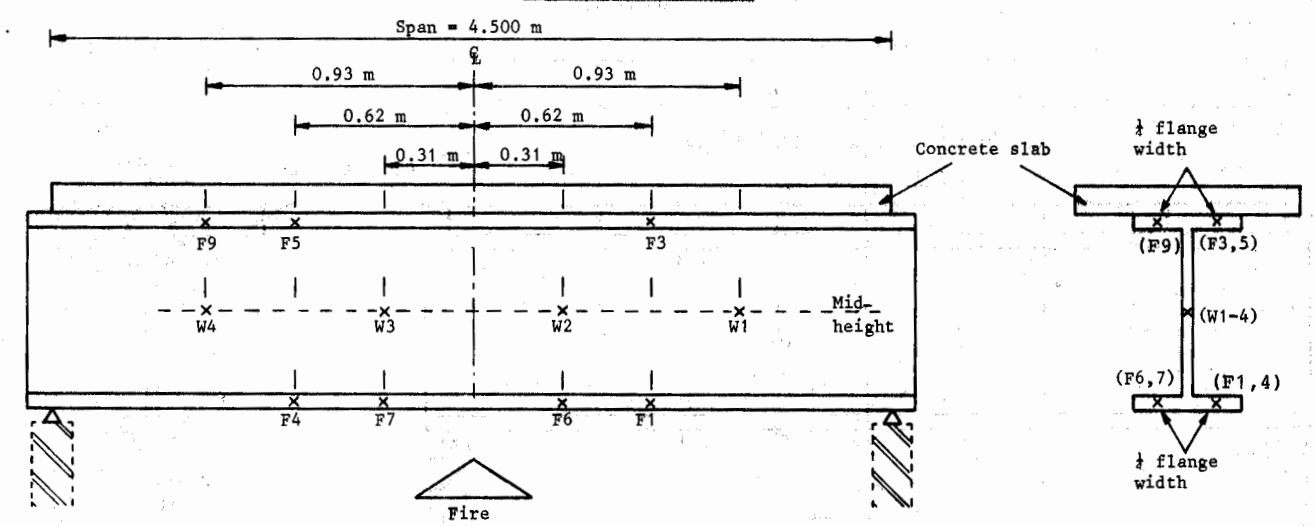
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
BEAM	254 x 146	43	259.6	147.3	7.3	12.7	505.3	92.0	568.2	141.2	6558	677

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES) 3	6	9	12	15	18	21	24
UPPER FLANGE	F3	67	122	186	251	305	359	413	465
	F5	93	146	203	254	299	354	402	457
	F9	84	137	197	252	305	359	408	452
	MEAN	81	135	195	252	303	357	408	458
WEB	W1	134	252	370	462	535	595	638	679
	W2	146	255	363	452	522	583	633	675
	W3	131	235	338	432	504	569	622	665
	W4	126	236	350	445	516	575	624	663
	MEAN	134	245	355	448	519	581	629	671
LOWER FLANGE	F1	105	215	337	447	537	605	656	699
	F4	108	211	325	429	512	582	634	678
	F6	87	182	293	398	486	558	616	664
	F7	90	181	285	390	478	552	611	660
	MEAN	98	197	310	416	503	574	629	675
MEAN FURNACE GAS		445	545	615	668	699	734	759	785
STANDARD CURVE (a)		490	591	651	693	727	754	777	797

NOTES:- (a) Initial ambient temperature = 8 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

(R2/7124A)

DATA SHEET NUMBER **57**

INDICATIVE FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : UNDERSIDE OF ROOF

DIMENSIONS AND PROPERTIES (NOMINAL)

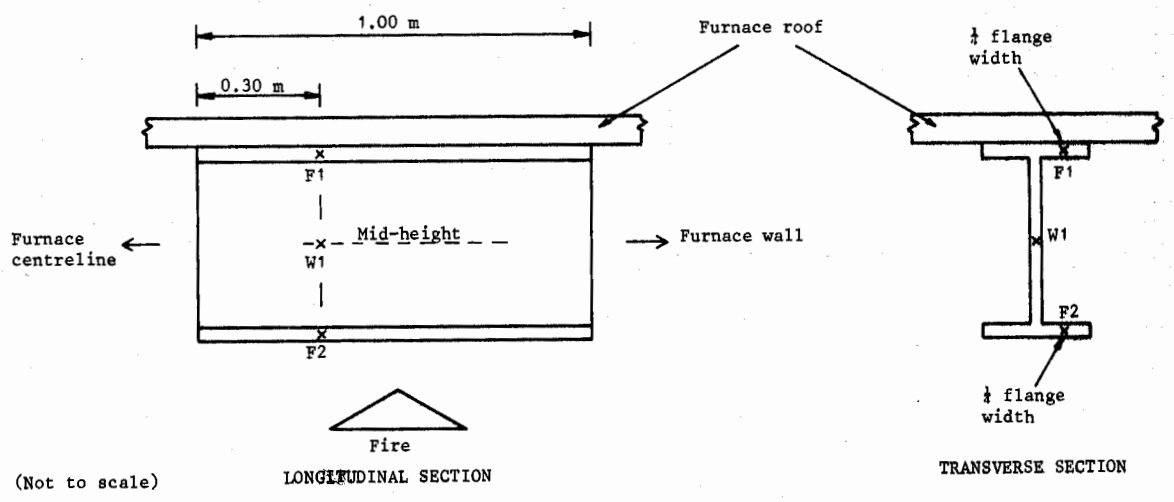
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
BEAM	533 x 210	101	536.7	210.1	10.9	17.4	2298	256.6	2620	400.0	61659	2694

TEMPERATURE DATA

THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
UPPER FLANGE F1	60	99	147	198	253	308	364	419	470	516	557	594	626	654	682	702	723	743	752	764
WEB W1	118	199	294	382	466	531	581	623	657	684	708	730	739	756	779	796	813	830	843	854
LOWER FLANGE F2	72	138	217	298	383	459	524	578	623	658	687	713	733	741	761	778	798	816	833	847
LOCAL GAS	445	543	592	625	663	692	712	729	754	766	780	804	809	827	835	852	862	875	878	886
MEAN FURNACE GAS	474	604	659	676	722	752	763	780	801	816	824	836	850	858	873	882	892	917	914	930
STANDARD CURVE (a)	510	611	671	713	747	774	797	817	834	850	864	877	889	900	910	920	929	938	946	953

NOTES:- (a) Initial ambient temperature = 28 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

(R2/7124N)

DATA SHEET NUMBER **58**

INDICATIVE FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : UNDERSIDE OF ROOF

DIMENSIONS AND PROPERTIES (NOMINAL)

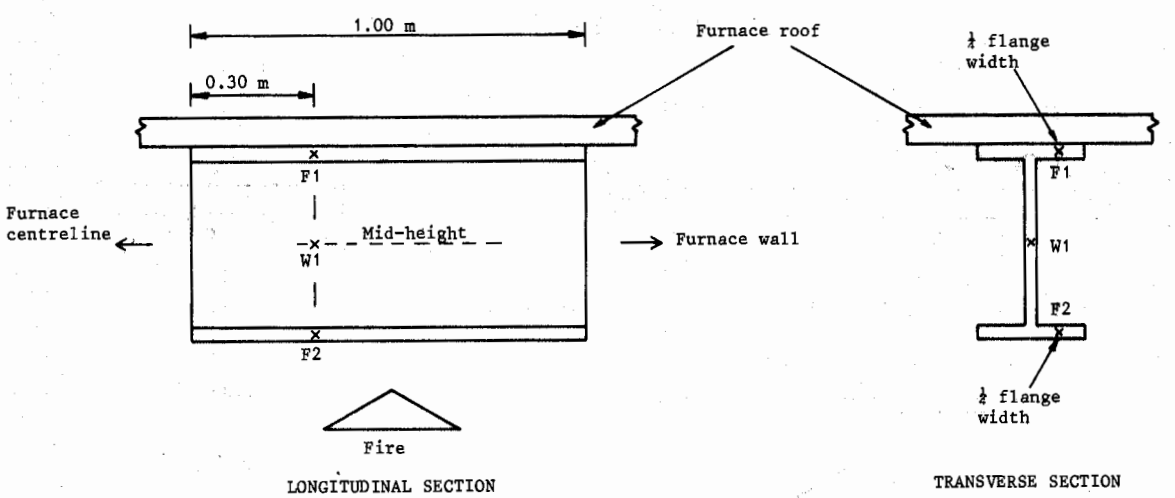
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
BEAM	610 x 229	113	607.3	228.2	11.2	17.3	2879	301.4	3288	470.2	87431	3439

TEMPERATURE DATA

THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
UPPER FLANGE F1	81	130	178	232	292	348	407	459	506	549	585	617	646	670	695	711	729	743	747	757
WEB W1	106	199	299	395	484	550	599	637	666	691	713	730	741	755	776	790	805	818	834	849
LOWER FLANGE F2	76	146	230	314	405	482	547	598	639	672	699	721	739	747	766	781	799	815	832	849
LOCAL GAS	433	541	589	617	662	684	706	726	743	756	773	781	796	805	821	826	838	849	867	875
MEAN FURNACE GAS	474	604	659	676	722	752	763	780	801	816	824	836	850	858	873	882	892	917	914	930
STANDARD CURVE (a)	510	611	671	713	747	774	797	817	834	850	864	877	889	900	910	920	929	938	946	953

NOTES:- (a) Initial ambient temperature = 28 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

(R2/7124N)

DATA SHEET NUMBER **59**

INDICATIVE FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : UNDERSIDE OF ROOF

DIMENSIONS AND PROPERTIES (NOMINAL)

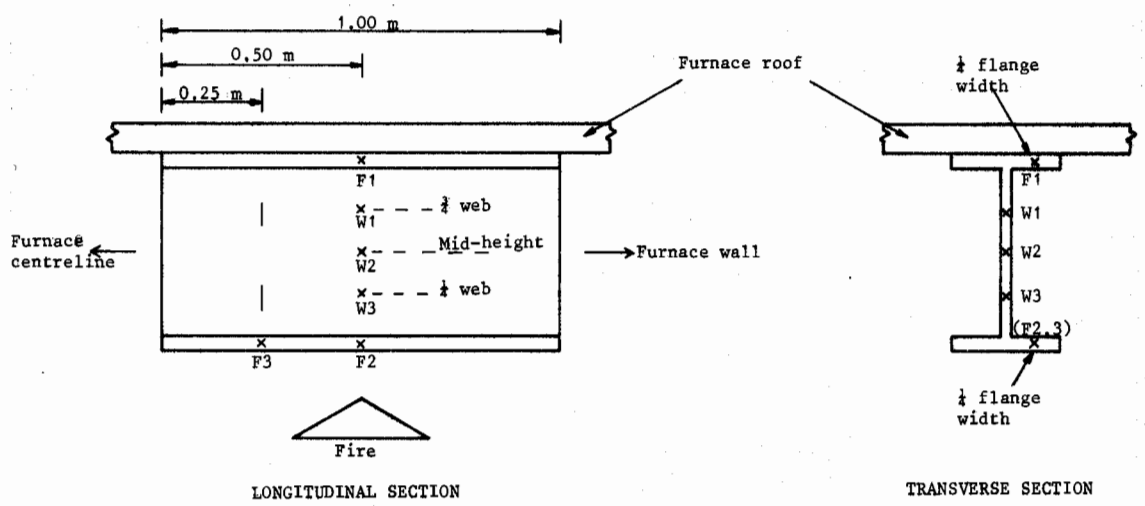
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
BEAM	914 x 305	201	903.0	303.4	15.2	20.2	7210	621.4	8362	982.5	325529	9427

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	33	36	39	42	45
UPPER FLANGE	F1	50	73	93	117	163	204	244	288	329	374	419	463	507	545	581	628	661	691	717	738
3/4 WEB	W1	62	103	142	182	251	319	382	443	495	541	582	620	653	679	703	730	742	754	773	793
1/2 WEB	W2	57	102	146	189	260	336	405	469	524	572	612	649	680	706	727	745	756	774	794	814
1/4 WEB	W3	46	97	143	185	254	329	399	461	516	563	605	642	673	699	721	743	752	768	788	807
LOWER FLANGE	F2	44	83	123	161	219	290	356	419	476	528	574	616	653	683	706	733	745	763	784	804
	F3	44	91	135	175	237	312	380	443	501	553	597	638	672	700	722	738	758	779	799	819
MEAN		44	87	129	168	228	301	368	431	489	541	586	627	663	692	714	736	752	771	792	812
MEAN FURNACE GAS		493	542	564	585	722	739	751	768	779	791	810	827	840	849	864	872	877	887	897	909
STANDARD CURVE (a)		442	541	600	642	675	702	725	745	763	778	793	806	817	829	839	853	866	878	889	899

NOTES:- (a) Initial ambient temperature = 17 deg. C

THERMOCOUPLE POSITIONS



LONGITUDINAL SECTION

TRANSVERSE SECTION

(Not to scale)

(R2/71240)

DATA SHEET NUMBER **60**

INDICATIVE FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : UNDERSIDE OF ROOF

DIMENSIONS AND PROPERTIES (NOMINAL)

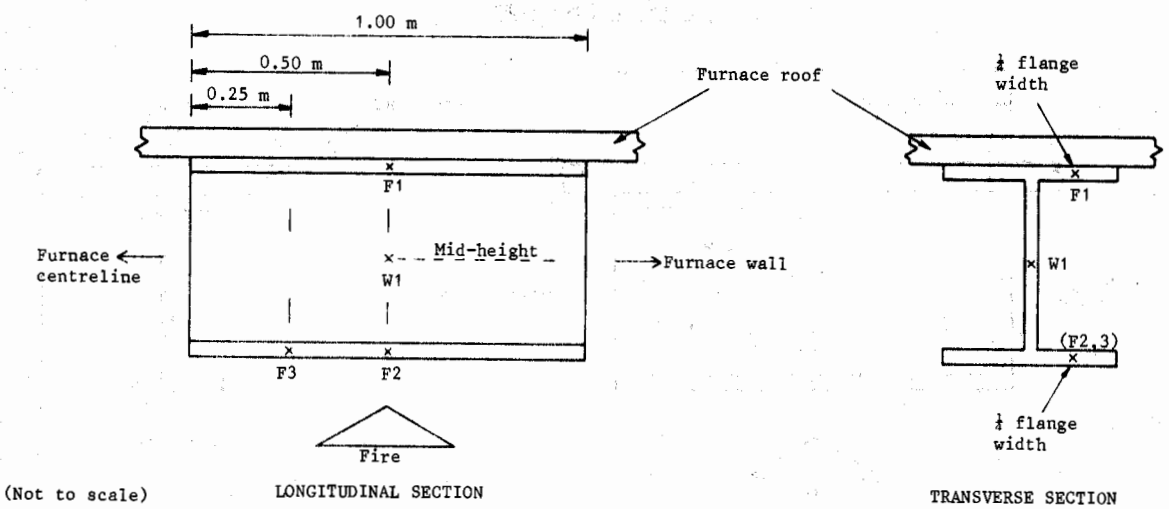
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
BEAM	610 x 305	149	609.6	304.8	11.9	19.7	4090	610.3	4572	936.8	124660	9300

TEMPERATURE DATA

THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	33	36	39	42	45
UPPER FLANGE F1	36	57	78	107	148	189	230	273	317	363	407	455	497	537	572	619	655	688	715	738
WEB W1	55	111	167	219	296	376	446	505	554	594	627	659	685	708	728	741	761	781	801	819
LOWER FLANGE F2	42	83	124	163	222	289	357	421	480	533	579	621	657	687	711	737	750	771	792	813
F3	49	94	138	180	245	320	393	460	519	570	614	653	686	714	735	750	773	796	816	836
MEAN	46	89	131	172	234	305	375	441	500	552	597	637	672	701	723	744	762	784	804	825
MEAN FURNACE GAS	493	542	564	585	722	739	751	768	779	791	810	827	840	849	864	872	877	887	897	909
STANDARD CURVE (a)	442	541	600	642	675	702	725	745	763	778	793	806	817	829	839	853	866	878	889	899

NOTES:- (a) Initial ambient temperature = 17 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

(R2/71240)

DATA SHEET NUMBER **61**

INDICATIVE FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : UNDERSIDE OF ROOF

DIMENSIONS AND PROPERTIES (NOMINAL)

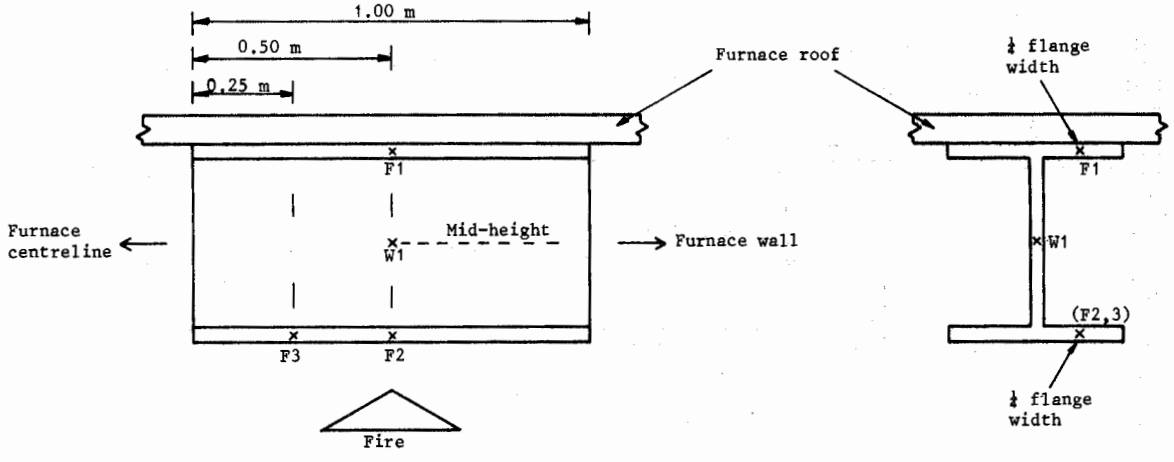
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
COLUMN	305 x 305	118	314.5	306.8	11.9	18.7	1755	587.0	1953	891.7	27601	9006

TEMPERATURE DATA

THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	33	36	39	42	45
UPPER FLANGE F1	70	94	116	141	184	226	267	310	356	402	448	493	537	576	610	654	689	718	741	754
WEB W1	62	114	161	205	274	346	409	466	517	560	600	635	666	693	714	737	750	771	790	809
LOWER FLANGE F2	47	87	128	166	228	301	371	436	495	548	594	634	670	700	722	738	754	774	793	811
F3	44	89	136	181	250	333	409	477	538	588	630	668	700	727	737	757	779	799	817	835
MEAN	46	88	132	174	239	317	390	457	517	568	612	651	685	714	730	748	767	787	805	823
MEAN FURNACE GAS	493	542	564	585	722	739	751	768	779	791	810	827	840	849	864	872	877	887	897	909
STANDARD CURVE (a)	442	541	600	642	675	702	725	745	763	778	793	806	817	829	839	853	866	878	889	899

NOTES:- (a) Initial ambient temperature = 17 deg. C

THERMOCOUPLE POSITIONS



LONGITUDINAL SECTION

TRANSVERSE SECTION

(Not to scale)

(R2/7124P)

DATA SHEET NUMBER **62**

INDICATIVE FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : UNDERSIDE OF ROOF

DIMENSIONS AND PROPERTIES (NOMINAL)

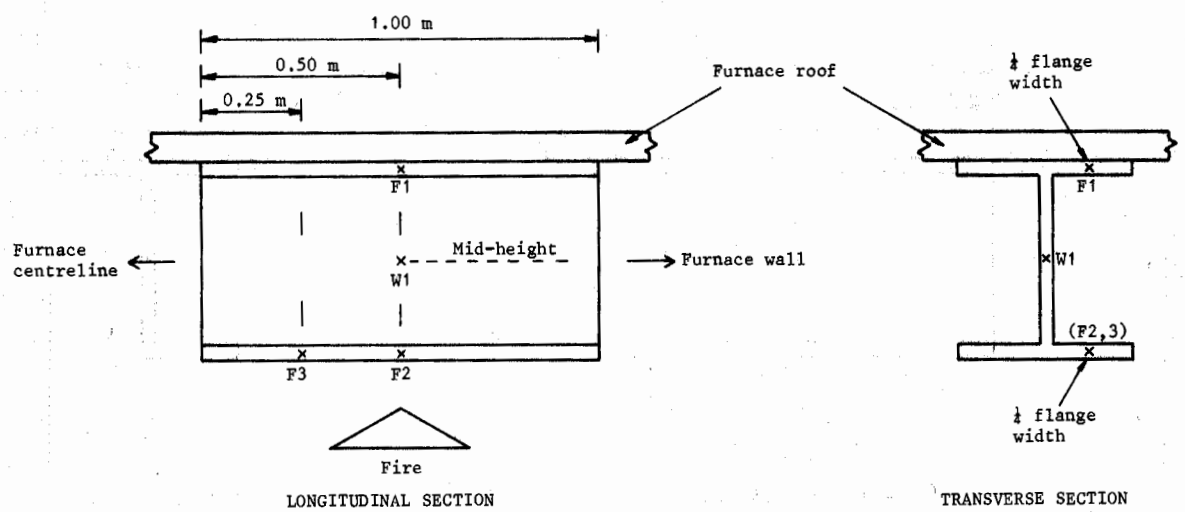
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	254 x 254	89	260.4	255.9	10.5	17.3	1099	378.9	1228	575.4	14307	4849

TEMPERATURE DATA

THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	33	36	39	42	45
UPPER FLANGE F1	34	59	82	111	153	195	237	280	323	368	412	456	500	541	578	625	664	696	723	743
WEB W1	58	112	159	201	264	323	379	429	475	517	555	592	625	656	681	712	737	750	770	790
LOWER FLANGE F2	49	94	138	180	244	307	365	420	469	515	556	594	627	658	683	713	737	749	770	790
F3	51	102	152	198	263	325	385	441	491	535	574	609	641	671	697	726	741	760	780	801
MEAN	50	98	145	189	254	316	375	431	480	525	565	602	634	665	690	720	739	755	775	796
MEAN FURNACE GAS	493	542	564	585	722	739	751	768	779	791	810	827	840	849	864	872	877	887	897	909
STANDARD CURVE (a)	442	541	600	642	675	702	725	745	763	778	793	806	817	829	839	853	866	878	889	899

NOTES:- (a) Initial ambient temperature = 17 deg. C

THERMOCOUPLE POSITIONS



LONGITUDINAL SECTION

TRANSVERSE SECTION

(Not to scale)

(R2/7124P)

DATA SHEET NUMBER **63**

INDICATIVE FLOOR BEAM

FURNACE TYPE	:	FLOOR FURNACE
POSITION IN FURNACE	:	UNDERSIDE OF ROOF

DIMENSIONS AND PROPERTIES (NOMINAL)

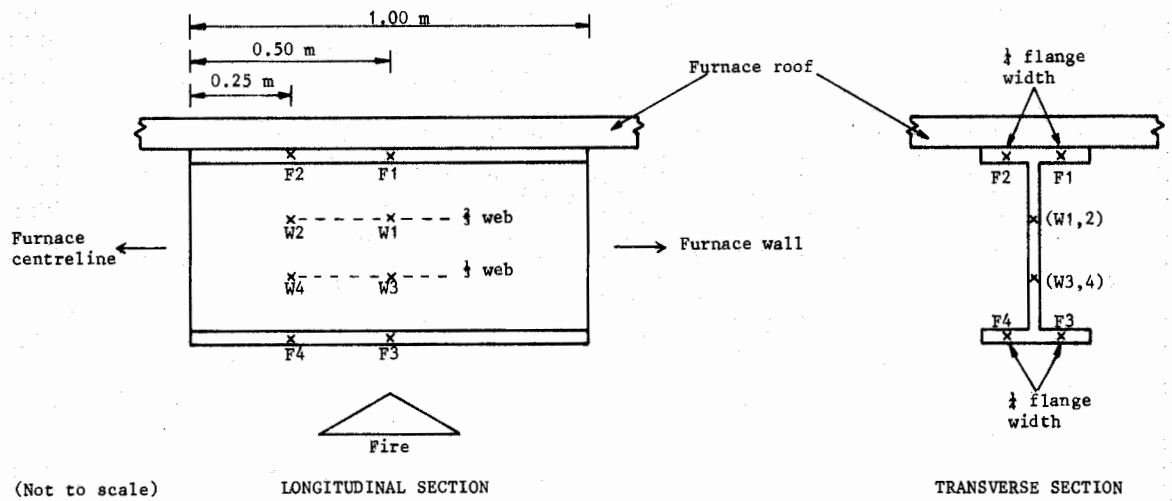
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
BEAM	838 x 292	194	840.7	292.4	14.7	21.7	6648	620.4	7648	974.4	279450	9069

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
UPPER FLANGE	F1	66	113	157	201	245	294	350	404	456	505	550	590	629	664	694	720	742	754	769	787
	F2	48	88	134	184	231	282	341	397	452	502	548	590	629	664	693	719	739	750	768	788
	MEAN	57	101	146	193	238	288	346	401	454	504	549	590	629	664	694	720	741	752	769	788
2/3 WEB	W1	70	150	238	325	400	465	534	587	628	659	684	708	732	743	762	782	803	823	843	864
	W2	70	147	232	317	389	454	524	577	618	650	675	699	722	737	752	772	793	812	831	852
	MEAN	70	149	235	321	395	460	529	582	623	655	680	704	727	740	757	777	798	818	837	858
1/3 WEB	W3	74	158	251	342	418	483	551	603	643	672	697	719	739	751	773	795	815	835	855	873
	W4	73	152	240	328	402	468	538	591	632	662	687	710	732	743	763	783	803	822	842	861
	MEAN	74	155	246	335	410	476	545	597	638	667	692	715	736	747	768	789	809	829	849	867
LOWER FLANGE	F3	58	125	204	284	358	422	493	554	604	644	677	706	732	742	763	787	809	831	856	877
	F4	66	130	201	275	343	408	479	541	592	633	667	696	724	739	756	777	799	819	843	866
	MEAN	62	128	203	280	351	415	486	548	598	639	672	701	728	741	760	782	804	825	850	872
MEAN FURNACE GAS		451	570	616	637	651	703	742	756	770	782	797	818	835	853	866	879	893	902	915	926
STANDARD CURVE (a)		489	590	650	692	726	753	776	796	813	829	843	856	868	879	889	899	908	917	925	932

NOTES:- (a) Initial ambient temperature = 7 deg. C

THERMOCOUPLE POSITIONS



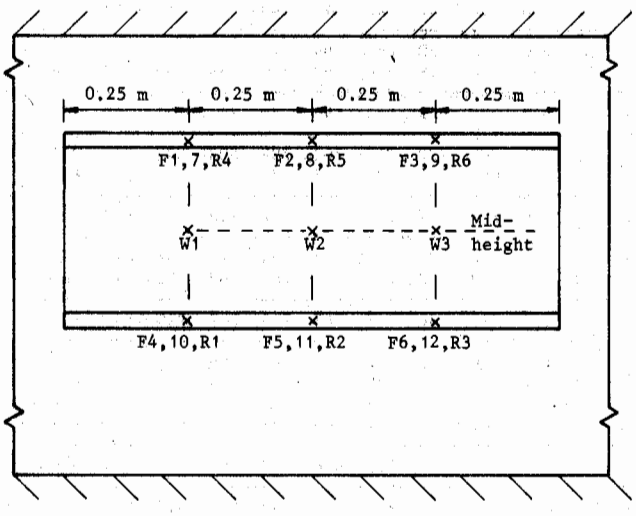
(Not to scale) LONGITUDINAL SECTION TRANSVERSE SECTION

(R2/71240)

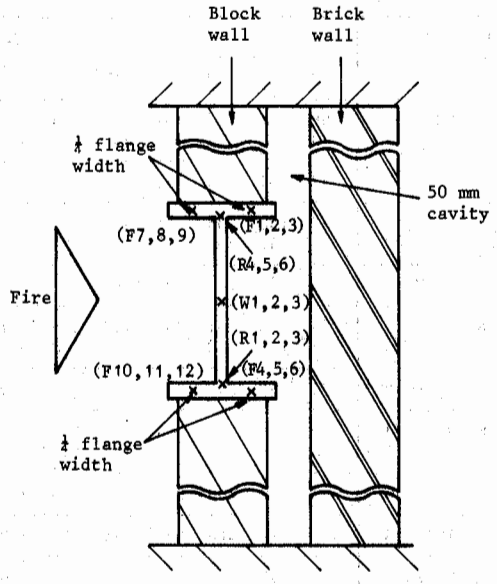
DATA SHEET NUMBER **64a**

INDICATIVE PERIMETER BEAM

THERMOCOUPLE POSITIONS



LONGITUDINAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124R)

DATA SHEET NUMBER **64b**

INDICATIVE PERIMETER BEAM

FURNACE TYPE : 1m CUBE FURNACE
POSITION IN FURNACE : SET IN FRONT WALL

DIMENSIONS AND PROPERTIES (NOMINAL)

SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
BEAM	305 x 127	37	303.8	123.5	7.2	10.7	471.5	54.6	540.5	85.66	7162	337

TEMPERATURE DATA

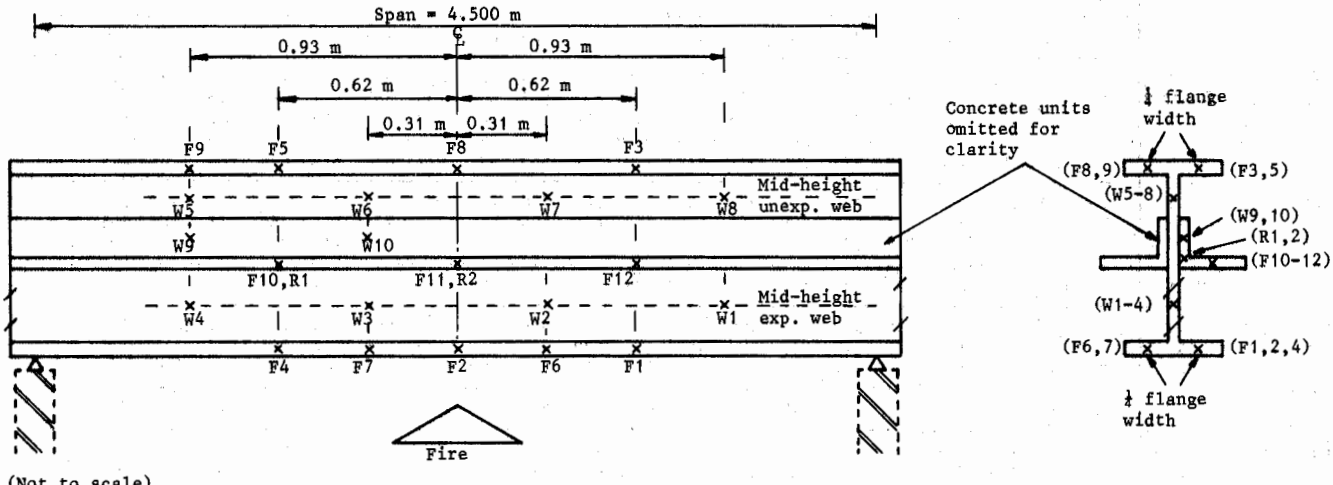
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
EXPOSED SIDE																					
UPPER FLANGE	F7	45	73	112	167	234	317	401	477	541	592	636	674	706	730	753	777	799	820	839	857
	F8	43	71	105	152	212	286	361	433	497	549	593	634	669	698	722	744	768	791	812	831
	F9	43	70	103	141	193	259	329	395	458	513	562	605	643	677	705	728	752	776	798	819
	MEAN	44	71	107	153	213	287	364	435	499	551	597	638	673	702	727	750	773	796	816	836
U/F - WEB JUNCTION	R4	34	58	92	140	195	264	338	407	467	516	558	595	626	652	674	693	711	728	745	763
	R5	33	56	86	127	177	238	306	372	431	482	527	567	601	630	655	677	697	715	732	749
	R6	32	54	82	117	161	213	273	333	389	440	486	528	565	598	627	652	674	676	713	731
	MEAN	33	56	87	128	178	238	306	371	429	479	524	563	597	627	652	674	694	706	730	748
WEB	W1	61	110	168	261	357	458	538	594	634	662	687	708	724	737	746	765	782	794	806	814
	W2	59	107	158	237	325	425	508	568	612	643	670	695	710	725	736	748	763	778	792	803
	W3	58	103	155	230	312	396	473	533	579	613	643	671	694	713	732	741	760	779	795	810
	MEAN	59	107	160	243	331	426	506	565	608	639	667	691	709	725	738	751	768	784	798	809
L/F - WEB JUNCTION	R1	31	54	87	141	199	269	342	408	465	512	553	589	618	643	665	684	701	717	732	748
	R2	31	53	82	126	177	242	315	383	444	495	539	578	611	639	662	682	701	717	732	748
	R3	32	53	83	129	180	237	301	363	421	471	515	555	589	619	644	666	686	704	720	734
	MEAN	31	53	84	132	185	249	319	385	443	493	536	574	606	634	657	677	696	713	728	743
LOWER FLANGE	F10	*	*	153	233	319	410	506	567	633	669	714	745	762	795	809	829	857	875	891	904
	F11	67	97	139	201	268	375	460	534	594	643	684	720	752	773	797	819	840	859	876	890
	F12	55	82	126	188	251	324	402	473	535	589	635	675	713	735	757	780	802	822	841	857
	MEAN			139	207	279	370	456	525	587	634	678	713	742	768	788	809	833	852	869	884
UNEXPOSED SIDE																					
UPPER FLANGE	F1	22	41	66	102	144	196	258	321	379	428	470	508	544	566	588	608	625	643	659	674
	F2	21	39	63	95	131	178	235	295	352	401	445	484	524	548	573	594	613	631	648	664
	F3	21	38	60	89	124	164	213	267	320	368	412	453	495	522	551	575	596	616	635	653
	MEAN	21	39	63	95	133	179	235	294	350	399	442	482	521	545	571	592	611	630	647	664
LOWER FLANGE	F4	20	37	60	98	144	197	257	318	371	417	459	494	529	550	571	590	607	624	640	654
	F5	20	37	58	89	129	176	236	297	354	406	449	489	528	551	574	594	612	628	643	658
	F6	19	35	55	87	126	168	218	272	324	371	414	452	491	516	542	563	582	599	615	630
	MEAN	20	36	58	91	133	180	237	296	350	398	441	478	516	539	562	582	600	617	633	647
CAVITY GAS		14	20	30	50	82	122	177	234	293	343	380	417	455	477	497	514	532	555	573	591
MEAN FURNACE GAS		432	619	695	735	753	777	787	803	818	832	*	*	*	*	903	*	*	*	*	922
STANDARD CURVE (a)		495	596	656	698	732	759	782	802	819	835	849	862	874	885	895	905	914	923	931	938

NOTES:- (a) Initial ambient temperature = 13 deg. C
(*) Data not available

DATA SHEET NUMBER **65a**

INDICATIVE SHELF-ANGLE FLOOR BEAM

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

(R2/7124D)

DATA SHEET NUMBER **65b**

INDICATIVE SHELF-ANGLE FLOOR BEAM

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
BEAM	406 x 178	54	402.6	177.6	7.6	10.9	925.3	114.5	1048	177.5	18626	1017
ANGLE	125 x 75 x 12	17.8	125	75	12	12	43.2	16.9	77.36	31.42	354	95.5

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
UPPER FLANGE	F3	20	20	20	21	23	26	31	36	42	47	53	60	68	77	87
	F5	20	20	21	22	23	27	31	36	43	49	56	63	72	82	92
	F8	20	20	20	21	23	27	31	36	42	47	53	60	69	78	88
	F9	20	20	21	22	24	28	33	38	47	58	63	69	90	98	101
	MEAN	20	20	20	21	23	27	31	36	43	50	56	63	75	84	92
UNEXPOSED WEB	W5	21	25	32	43	57	79	96	112	131	144	157	170	184	198	212
	W6	21	25	33	45	59	82	100	117	135	148	162	176	191	203	217
	W7	20	24	31	42	55	74	91	108	128	142	154	167	181	193	207
	W8	21	25	33	44	58	76	92	107	129	141	157	172	186	201	216
	MEAN	21	25	32	43	57	78	95	111	131	144	157	171	185	199	213
EXPOSED WEB	W1	118	250	371	470	539	575	596	620	670	706	730	744	769	792	812
	W2	116	256	392	502	571	600	618	640	690	726	741	765	792	813	832
	W3	105	230	364	481	562	600	615	640	696	731	745	767	794	813	832
	W4	113	227	346	455	535	564	570	595	674	715	736	747	772	796	818
	MEAN	113	241	368	477	552	585	600	624	682	719	738	756	782	803	823
LOWER FLANGE	F1	110	247	384	500	583	627	648	670	715	738	762	788	811	833	855
	F2	110	229	371	501	591	639	659	682	727	748	775	800	825	849	867
	F4	93	213	364	496	589	641	661	681	730	751	779	802	826	846	864
	F6	108	254	403	525	603	636	654	676	720	741	765	789	810	830	848
	F7	110	248	386	507	592	635	652	677	720	740	765	787	810	827	844
	MEAN	106	238	382	506	592	636	655	677	722	744	769	793	816	837	856
EXPOSED FLANGE ANGLE	F10	57	109	187	226	337	391	429	469	535	585	625	659	691	717	740
	F11	61	118	183	258	328	377	411	450	515	564	603	637	670	701	725
	F12	65	125	185	249	315	368	406	443	508	558	595	628	662	690	717
	MEAN	61	117	185	244	327	379	415	454	519	569	608	641	674	703	727
UNEXPOSED FLANGE ANGLE	W9	28	52	92	134	181	229	267	302	343	379	412	443	471	497	521
	W10	27	46	77	113	154	198	234	263	307	347	385	419	450	479	506
	MEAN	27	49	84	123	167	213	250	282	325	363	398	431	460	488	513
ANGLE ROOT	R1	36	63	111	166	222	273	314	352	408	453	494	529	561	590	617
	R2	38	70	117	171	226	277	318	357	413	458	498	532	565	595	621
	MEAN	37	66	114	168	224	275	316	354	410	455	496	530	563	592	619
MEAN FURNACE GAS		516	633	668	721	754	734	739	782	825	842	853	871	890	898	910
STANDARD CURVE (a)		504	605	665	707	741	768	791	811	828	844	858	871	883	894	904

NOTES:- (a) Initial ambient temperature = 22 deg. C

(b) Standard 'TEMBO' pre-stressed hollow concrete units supplied by Richard Lees Ltd. were used. Their dimensions were:- Length 1550 mm, Width 590 mm, Thickness 155 mm. The ends were solid with a 50 mm deep x 100 mm wide rebate. The angles were bolted to the web of the beam section so as to leave a clearance gap of 160 mm between the angle and the underside of the upper flange of the beam. Sand was used to cover the upper flange and also to fill the gap between the ends of the concrete units and the web of the beam.

DATA SHEET NUMBER **66**

INDICATIVE SLIM-FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FULL LENGTH MEMBER (a)

DIMENSIONS AND PROPERTIES (NOMINAL)

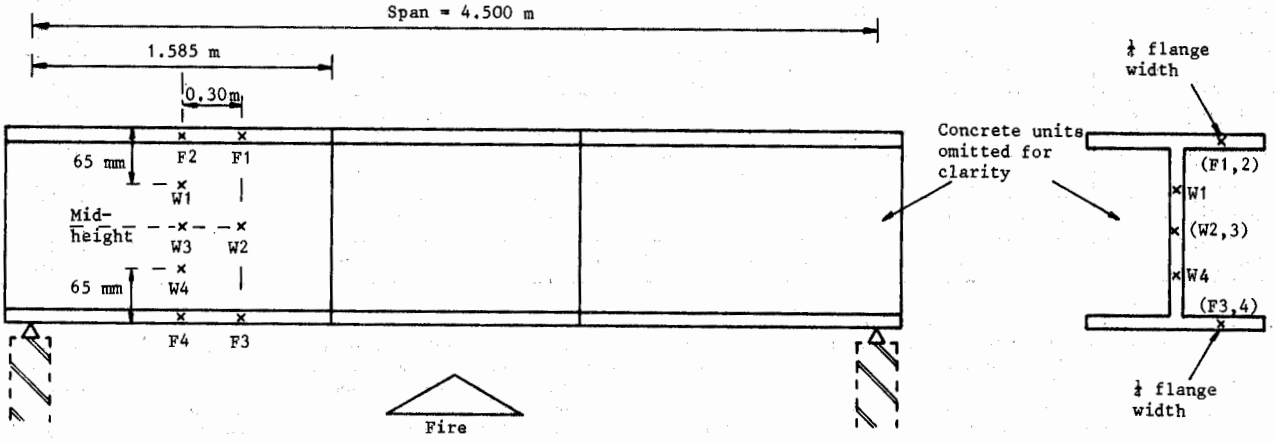
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
COLUMN	254 x 254	107	266.7	258.3	13.0	20.5	1313	456.9	1485	695.5	17510	5901

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	50	55	59	73	75
UPPER FLANGE	F1	11	9	12	10	13	12	17	20	26	30	39	47	53	58	66	80	88	90	96	97
	F2	11	10	11	10	11	11	14	16	19	22	28	36	46	55	66	81	87	88	92	94
	MEAN	11	10	12	10	12	12	16	18	23	26	34	42	50	57	66	81	88	89	94	96
UPPER WEB	W1	11	10	13	13	22	28	35	44	57	67	77	87	96	100	103	104	106	107	126	131
MID-WEB	W2	12	13	19	30	72	82	91	100	103	103	105	108	113	116	119	127	139	151	197	206
	W3	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	MEAN																				
LOWER WEB	W4	16	29	50	98	104	106	117	131	147	162	177	196	212	226	242	271	303	329	414	431
LOWER FLANGE	F3	92	164	208	249	296	332	379	423	461	478	499	533	*	571	597	*	*	704	781	795
	F4	66	122	168	197	217	256	309	355	394	427	461	490	519	548	575	610	646	680	755	767
	MEAN	79	143	188	223	257	294	344	389	428	453	480	512		560	586			692	768	781
MEAN FURNACE GAS		506	603	649	713	727	738	764	777	785	797	809	821	833	843	854	872	890	902	944	952
STANDARD CURVE (b)		495	596	656	698	732	759	782	802	819	835	849	862	874	885	895	911	925	936	968	972

NOTES:- (a) Constitutes approximately one third of a composite slim-floor beam. See also Data Sheets Numbers 67 and 68
(b) Initial ambient temperature = 13 deg. C
(*) Data not available

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

(R2/7124S)

DATA SHEET NUMBER **67**

INDICATIVE SLIM-FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FULL LENGTH MEMBER (a)

DIMENSIONS AND PROPERTIES (NOMINAL)

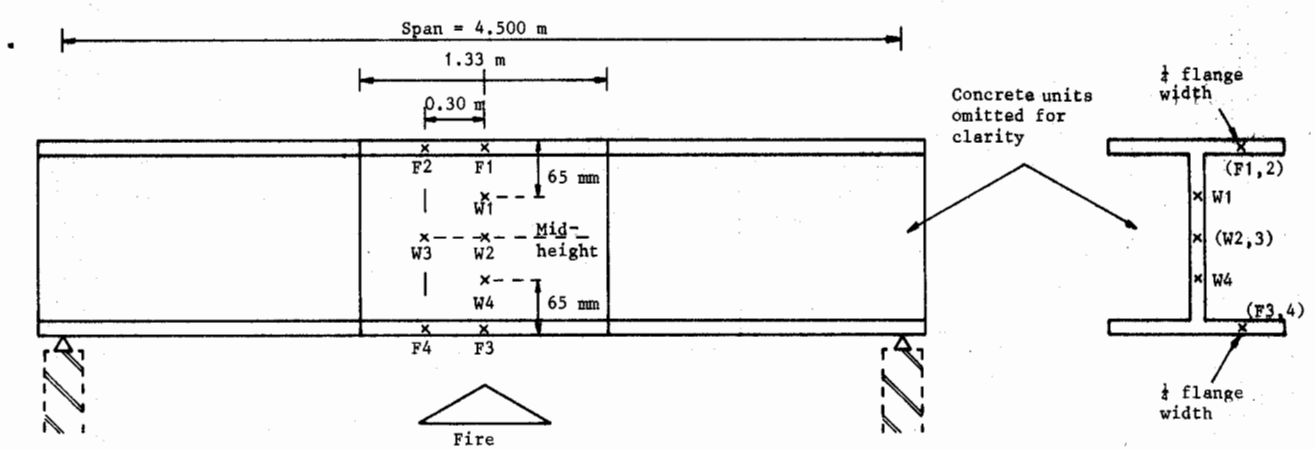
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	254 x 254	167	289.1	264.5	19.2	31.7	2070	740.6	2417	1132	29914	9796

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	50	55	59	73	75
UPPER FLANGE	F1	9	8	10	8	10	9	12	13	17	21	27	35	45	54	62	75	85	90	97	98
	F2	10	10	11	10	11	10	12	13	14	15	17	20	25	32	40	57	73	85	97	99
	MEAN	10	9	11	9	11	10	12	13	16	18	22	28	35	43	51	66	79	88	97	99
UPPER WEB	W1	10	10	12	13	17	21	28	40	59	78	91	97	101	101	102	104	104	104	126	133
MID-WEB	W2	11	12	18	24	35	45	63	85	97	102	106	108	111	112	115	124	136	147	203	217
	W3	11	13	18	23	34	47	75	86	94	98	103	105	108	108	110	119	130	138	186	197
	MEAN	11	13	18	24	35	46	69	86	96	100	105	107	110	110	113	122	133	143	195	207
LOWER WEB	W4	16	26	43	62	98	109	122	139	158	176	195	214	232	248	265	296	327	352	431	446
LOWER FLANGE	F3	47	82	130	169	210	245	285	332	374	410	444	478	514	535	561	604	644	680	752	763
	F4	52	88	135	179	224	264	310	354	394	430	469	501	530	555	581	618	650	692	757	768
	MEAN	50	85	133	174	217	255	298	343	384	420	457	490	522	545	571	611	647	686	755	766
MEAN FURNACE GAS		506	603	649	713	727	738	764	777	785	797	809	821	833	843	854	872	890	902	944	952
STANDARD CURVE (b)		495	596	656	698	732	759	782	802	819	835	849	862	874	885	895	911	925	936	968	972

NOTES:- (a) Constitutes approximately one third of a composite slim-floor beam. See also Data Sheets Numbers 66 and 68
(b) Initial ambient temperature = 13 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

(R2/7124T)

DATA SHEET NUMBER **68**

INDICATIVE SLIM-FLOOR BEAM

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FULL LENGTH MEMBER (a)

DIMENSIONS AND PROPERTIES (NOMINAL)

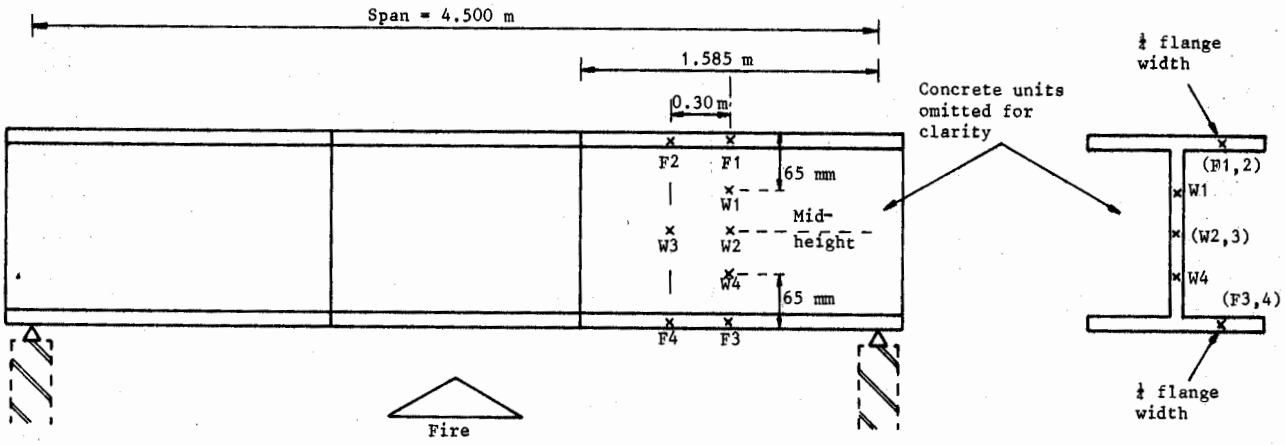
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
COLUMN	254 x 254	132	276.4	261.0	15.6	25.3	1634	576.2	1875	878.6	22575	7519

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	50	55	59	73	75
UPPER FLANGE	F1	10	9	11	8	11	9	11	12	13	14	17	19	22	22	24	31	38	45	85	93
	F2	9	8	9	8	9	9	11	11	12	13	15	17	20	22	26	33	40	45	68	75
	MEAN	10	9	10	8	10	9	11	12	13	14	16	18	21	22	25	32	39	45	77	84
UPPER WEB	W1	10	9	11	11	14	18	26	31	37	41	46	50	55	59	64	87	97	100	114	117
MID-WEB	W2	11	12	17	22	35	72	84	92	97	98	100	102	104	106	111	127	143	155	198	206
	W3	10	11	16	20	29	35	45	54	64	74	87	97	103	107	113	124	134	141	174	181
	MEAN	11	12	17	21	32	54	65	73	81	86	94	100	104	107	112	126	139	148	186	194
LOWER WEB	W4	16	26	43	62	101	105	111	122	139	156	176	196	218	237	258	293	324	345	417	430
LOWER FLANGE	F3	43	78	120	155	183	216	261	303	344	383	421	457	491	519	547	592	630	661	737	746
	F4	49	88	148	185	219	259	303	343	380	417	453	487	518	546	573	616	655	686	762	772
	MEAN	46	83	134	170	201	238	282	323	362	400	437	472	505	533	560	604	643	674	750	759
MEAN FURNACE GAS		506	603	649	713	727	738	764	777	785	797	809	821	833	843	854	872	890	902	944	952
STANDARD CURVE (b)		495	596	656	698	732	759	782	802	819	835	849	862	874	885	895	911	925	936	968	972

NOTES:- (a) Constitutes approximately one third of a composite slim-floor beam. See also Data Sheets Numbers 66 and 67
(b) Initial ambient temperature = 13 deg. C

THERMOCOUPLE POSITIONS



(Not to scale)

LONGITUDINAL SECTION

TRANSVERSE SECTION

(R2/7124U)

DATA SHEET NUMBER **69**

INDICATIVE COLUMN

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES (NOMINAL)

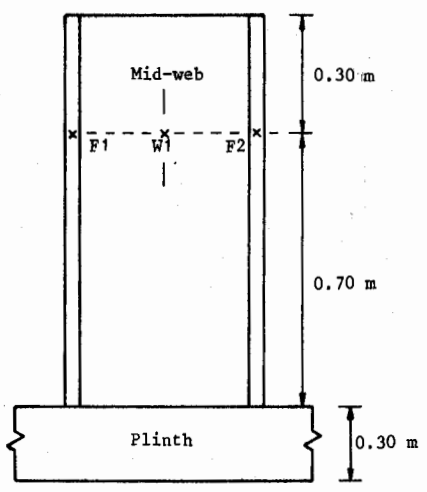
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	254 x 254	132	276.4	261.0	15.6	25.3	1634	576.2	1875	878.6	22575	7519

TEMPERATURE DATA

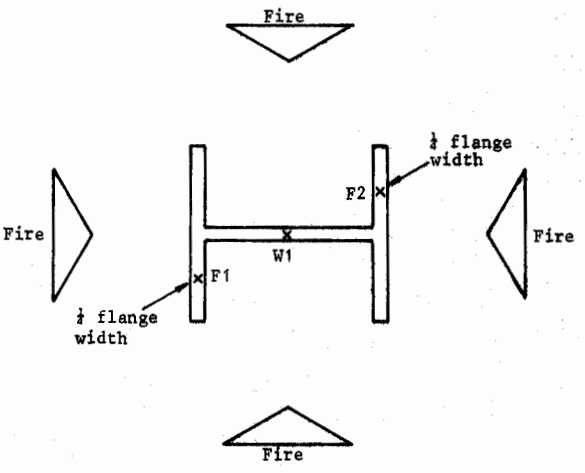
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES) 2	4	6	8	10	12	14	16	18	20	22
FLANGES	F1	35	66	100	140	184	236	294	351	398	449	494
	F2	29	56	88	130	177	229	287	335	389	441	488
	MEAN	32	61	94	135	181	233	291	343	394	445	491
WEB	W1	38	76	*	*	*	*	*	*	*	*	*
MEAN FURNACE GAS		403	545	586	665	689	721	737	755	760	770	780
STANDARD CURVE (a)		441	540	599	641	674	701	724	744	762	777	792

NOTES:- (a) Initial ambient temperature = 16 deg. C
(*) No data recorded due to instrumentation malfunction

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124V)

DATA SHEET NUMBER **70**

INDICATIVE COLUMN

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES (NOMINAL)

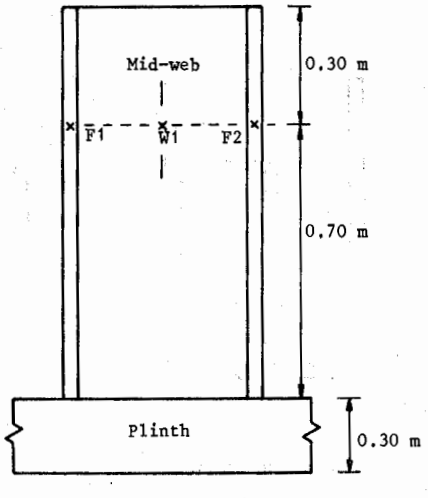
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	254 x 254	132	276.4	261.0	15.6	25.3	1634	576.2	1875	878.6	22575	7519

TEMPERATURE DATA

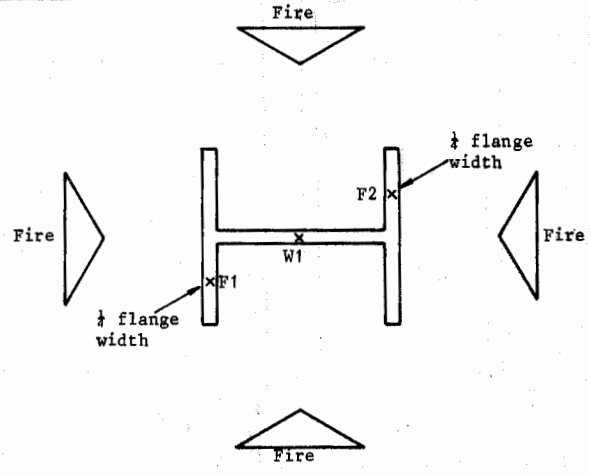
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES) 2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
FLANGES	F1	39	62	92	134	175	220	271	323	374	422	470	514	554	589	619
	F2	37	62	93	132	173	217	268	320	373	422	470	515	556	591	621
	MEAN	38	62	93	133	174	219	270	322	374	422	470	515	555	590	620
WEB	W1	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
MEAN FURNACE GAS		500	529	575	655	645	700	743	746	761	780	789	804	812	823	830
STANDARD CURVE (a)		440	539	598	640	673	700	723	743	761	776	791	804	815	827	837

NOTES:- (a) Initial ambient temperature = 15 deg. C
(*) No data recorded due to instrumentation malfunction

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124V)

INDICATIVE COLUMN

DATA SHEET NUMBER **71**

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES (NOMINAL)

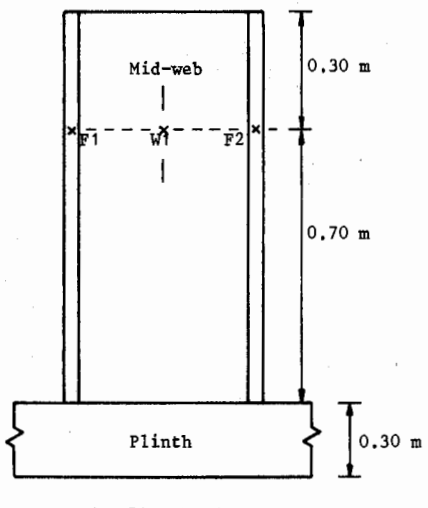
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
COLUMN	305 x 305	118	314.5	306.8	11.9	18.7	1755	587.0	1953	891.7	27601	9006

TEMPERATURE DATA

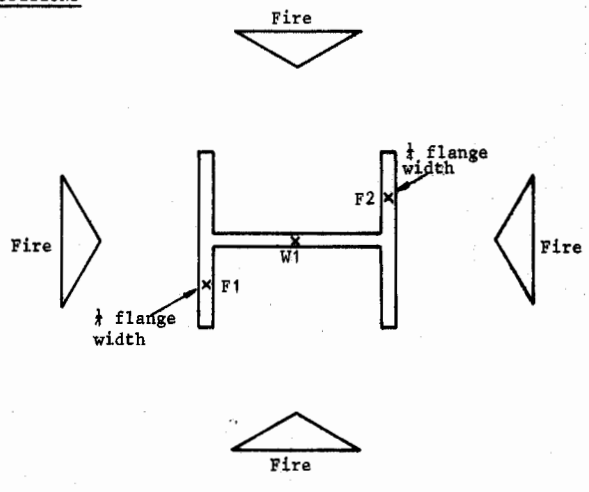
THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	29
FLANGES F1	81	110	120	141	164	187	214	246	373	463	530	589	637	676	693
F2	72	98	111	135	157	180	206	235	345	443	519	582	633	674	690
MEAN	77	104	116	138	161	184	210	241	359	453	525	586	635	675	692
WEB W1	67	106	127	152	178	205	235	266	364	474	554	613	659	694	707
LOCAL GAS	310	369	314	344	366	377	414	449	757	787	789	808	815	834	837
MEAN FURNACE GAS	403	562	579	603	621	632	660	706	688	706	725	739	752	768	775
STANDARD CURVE (a)	445	544	603	645	678	705	728	748	766	781	796	809	820	832	837

NOTES:- (a) Initial ambient temperature = 20 deg. C

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(R2/7124V)

(Not to scale)

DATA SHEET NUMBER **72**

INDICATIVE COLUMN

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES

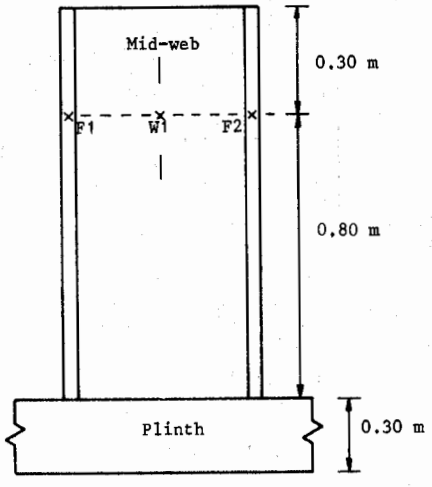
SECTION SERIAL SIZE AND TYPE mm	DIMENSIONS AND PROPERTIES	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 254	NOMINAL	71	249.9	257.5	12.1	12.1	813	268	911	411	10153	3451
BEARING PILE	ACTUAL	76.3	250	257	13	13						

TEMPERATURE DATA

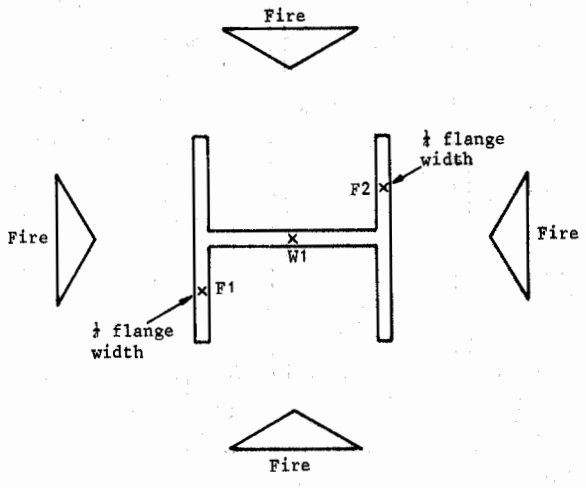
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)										
		2	4	6	8	10	12	14	16	18	20	22
FLANGES	F1	40	84	135	202	276	355	436	503	558	600	636
	F2	44	96	148	226	299	377	459	523	571	608	642
	MEAN	42	90	142	214	288	366	448	513	565	604	639
WEB	W1	40	86	137	208	285	368	452	521	573	613	647
MEAN FURNACE GAS		403	545	586	665	689	721	737	755	760	770	780
STANDARD CURVE (a)		441	540	599	641	674	701	724	744	762	777	792

NOTES:- (a) Initial ambient temperature = 16 deg. C

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(R2/7124W)

(Not to scale)

DATA SHEET NUMBER **73**

INDICATIVE COLUMN

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON FLOOR

DIMENSIONS AND PROPERTIES

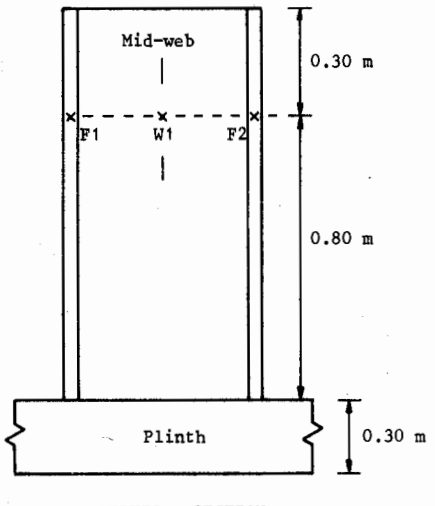
SECTION SERIAL SIZE AND TYPE mm	DIMENSIONS AND PROPERTIES	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 254	NOMINAL	71	249.9	257.5	12.1	12.1	813	268	911	411	10153	3451
BEARING PILE	ACTUAL	76.3	250	257	13	13						

TEMPERATURE DATA

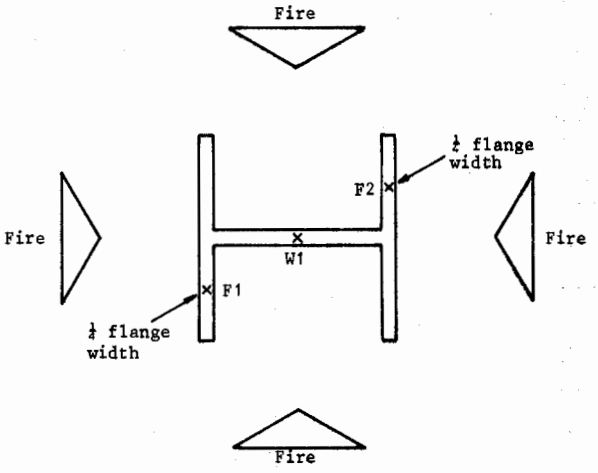
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
FLANGES	F1	55	93	130	186	239	301	377	445	506	558	604	643	675	699	720
	F2	63	102	140	197	252	321	393	459	515	566	612	648	678	702	723
	MEAN	59	98	135	192	246	311	385	452	511	562	608	646	677	701	722
WEB	W1	61	96	132	188	242	307	384	452	512	566	614	653	684	708	730
MEAN FURNACE GAS		500	529	575	655	645	700	743	746	761	780	789	804	812	823	830
STANDARD CURVE (a)		440	539	598	640	673	700	723	743	761	776	791	804	815	827	837

NOTES:- (a) Initial ambient temperature = 15 deg. C

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(R2/7124W)

(Not to scale)

DATA SHEET NUMBER **74**

INDICATIVE COLUMN

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON FLOOR

DIMENSIONS AND PROPERTIES

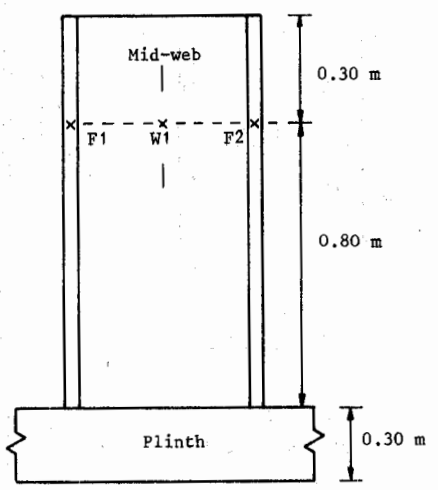
SECTION SERIAL SIZE AND TYPE mm	DIMENSIONS AND PROPERTIES	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
254 x 254	NOMINAL	71	249.9	257.5	12.1	12.1	813	268			10153	3451
BEARING PILE	ACTUAL	76.3	250	257	13	13						

TEMPERATURE DATA

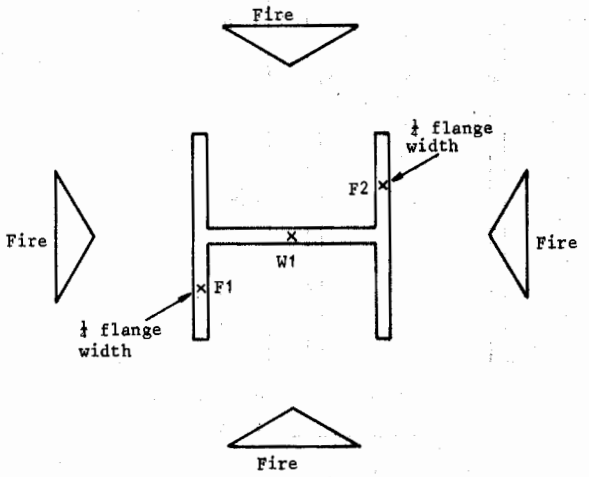
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
FLANGES	F1	38	71	133	209	281	359	431	504	567	619	661	696	712	746	745
	F2	69	118	183	262	334	414	487	558	615	662	698	729	741	762	765
	MEAN	54	95	158	236	308	387	459	531	591	641	680	713	727	754	755
WEB	W1	41	76	140	211	280	358	432	507	569	622	665	700	717	750	748
LOCAL GAS		407	487	578	645	684	734	777	807	836	855	866	879	875	891	888
MEAN FURNACE GAS		467	518	588	630	665	690	714	730	742	754	761	774	791	796	813
STANDARD CURVE (a)		433	532	591	633	666	693	716	736	754	769	784	797	808	820	830

NOTES:- (a) Initial ambient temperature = 8 deg. C

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124W)

DATA SHEET NUMBER **76**

INDICATIVE COLUMN

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES (NOMINAL)

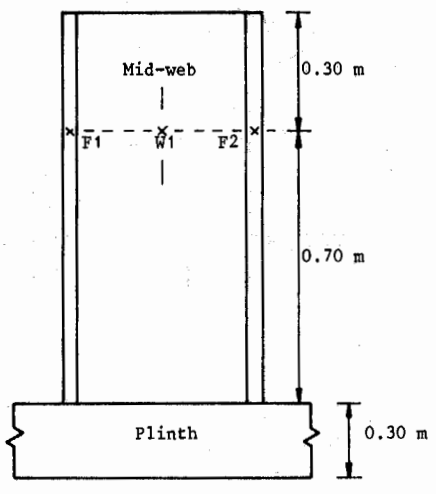
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
BEAM	533 x 210	101	536.7	210.1	10.9	17.4	2298	256.6	2620	400.0	61659	2694

TEMPERATURE DATA

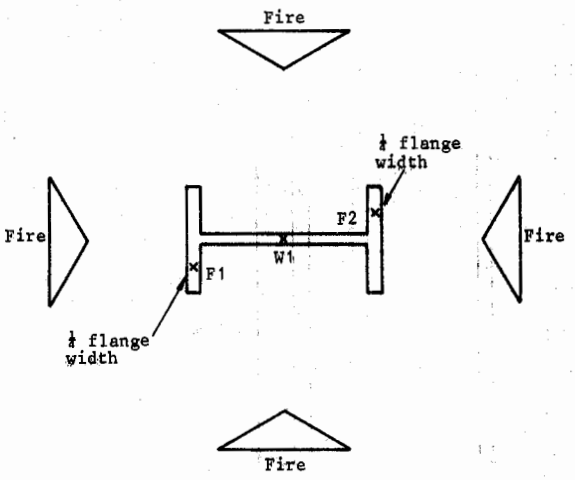
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	29
FLANGES	F1	67	96	113	138	163	187	214	239	291	377	453	519	576	618	637
	F2	68	101	117	144	171	197	229	257	317	413	486	550	600	642	660
	MEAN	68	99	115	141	167	192	222	248	304	395	470	535	588	630	649
WEB	W1	92	132	146	175	204	232	266	296	373	474	540	596	638	669	683
LOCAL GAS		311	346	296	326	344	356	395	399	586	700	720	736	757	770	782
MEAN FURNACE GAS		403	562	579	603	621	632	660	706	688	706	725	739	752	768	775
STANDARD CURVE (a)		445	544	603	645	678	705	728	748	766	781	796	809	820	832	837

NOTES:- (a) Initial ambient temperature = 20 deg. C

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124X)

DATA SHEET NUMBER **76**

INDICATIVE COLUMN

FURNACE TYPE	:	FLOOR FURNACE
POSITION IN FURNACE	:	FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES (NOMINAL)

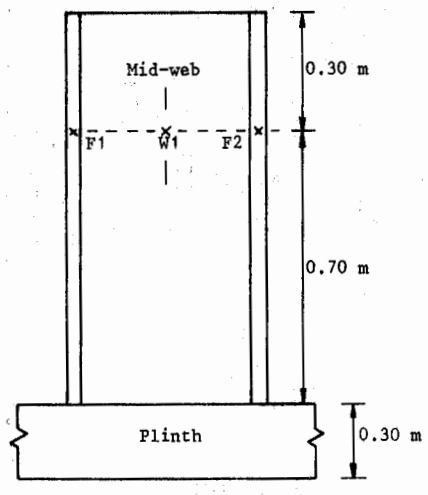
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
BEAM	610 x 229	113	607.3	228.2	11.2	17.3	2879	301.4	3288	470.2	87431	3439

TEMPERATURE DATA

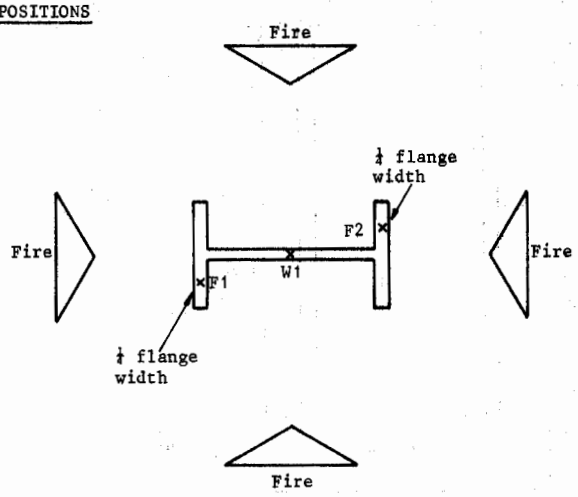
THERMOCOUPLE LOCATION	TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)														
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	29
FLANGES F1	97	125	140	170	199	227	257	309	416	492	552	606	643	678	692
F2	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
MEAN															
WEB W1	96	135	156	190	221	252	285	334	452	546	606	650	677	703	713
LOCAL GAS	313	340	296	327	342	357	387	444	696	727	750	771	774	793	801
MEAN FURNACE GAS	403	562	579	603	621	632	660	706	688	706	725	739	752	768	775
STANDARD CURVE (a)	445	544	603	645	678	705	728	748	766	781	796	809	820	832	837

NOTES:- (a) Initial ambient temperature = 20 dec. C
(*) No data recorded due to instrumentation malfunction

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124X)

DATA SHEET NUMBER **77**

INDICATIVE COLUMN WITH BLOCKED-IN WEB

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES (NOMINAL)

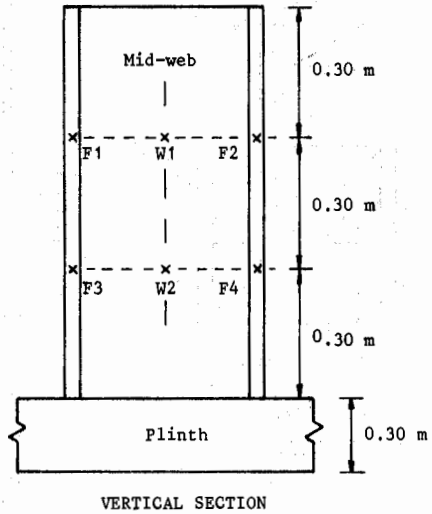
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	203 x 203	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770

TEMPERATURE DATA

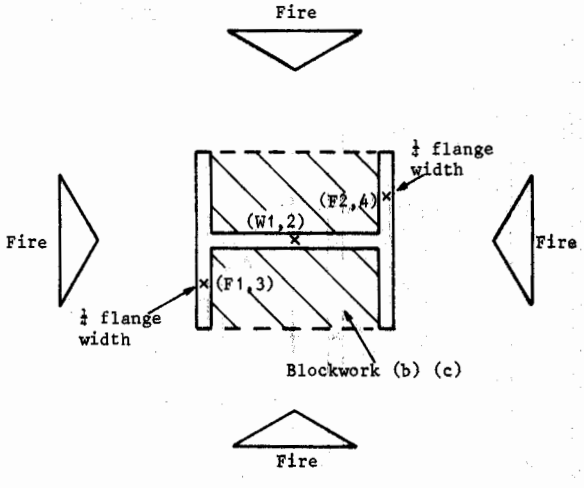
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
FLANGES	F1	117	211	288	378	444	505	564	597	630	659	683	706	727	746	760	776	793	811	828	846
	F2	65	143	216	299	366	430	494	533	573	607	639	667	693	717	739	754	771	792	811	831
	F3	90	176	238	311	371	428	487	524	561	594	626	653	680	704	728	748	761	778	796	815
	F4	56	129	198	274	337	403	469	509	551	588	622	652	680	706	729	747	762	783	804	824
	MEAN	82	165	235	316	380	442	504	541	579	612	643	670	695	718	739	756	772	791	810	829
WEB	W1	14	31	69	116	158	196	235	261	293	324	355	383	411	437	462	485	507	526	544	561
	W2	13	26	53	93	131	168	209	237	270	301	332	361	388	414	439	463	486	506	526	543
	MEAN	14	29	61	105	145	182	222	249	282	313	344	372	400	426	451	474	497	516	535	552
LOCAL GAS		481	601	639	718	732	769	788	793	813	829	845	854	874	889	895	910	921	934	940	951
MEAN FURNACE GAS		505	638	664	720	733	760	775	774	802	820	832	845	861	873	881	893	905	916	922	933
STANDARD CURVE (a)		499	600	660	702	736	763	786	806	823	839	853	866	878	889	899	909	918	927	935	942

NOTES:- (a) Initial ambient temperature = 17 deg. C
(b) Thermalite 'TURBO' blocks used with an oven-dry density of 480 kg/m3
(c) Gap between blockwork and steel filled with a standard mortar mix suitable for blockwork

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124Y)

DATA SHEET NUMBER **78**

INDICATIVE COLUMN WITH BLOCKED-IN WEB

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES (NOMINAL)

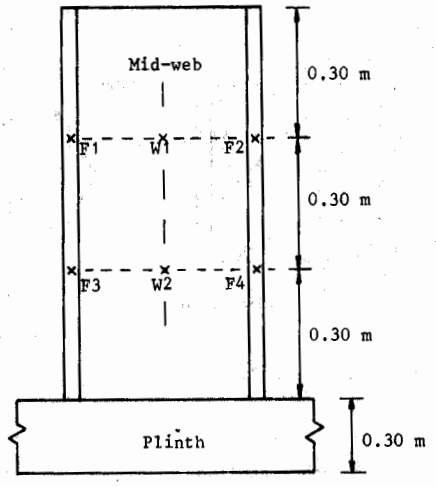
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	203 x 203	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770

TEMPERATURE DATA

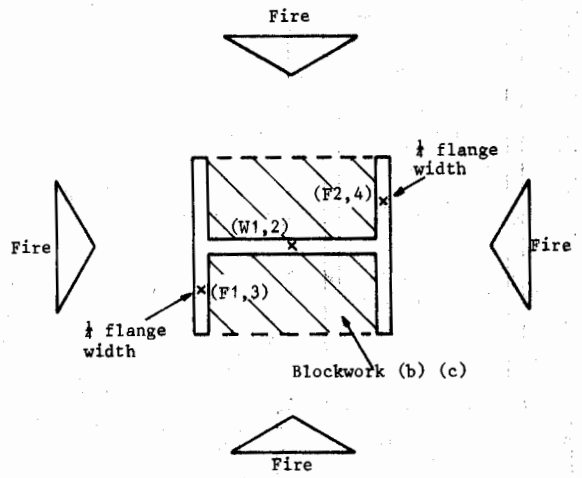
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
FLANGES	F1	68	151	242	347	431	513	587	627	667	699	726	744	764	789	814	839	860	879	895	908
	F2	108	196	276	363	432	495	556	594	631	665	694	720	744	760	780	805	828	850	871	890
	F3	62	136	213	306	377	457	527	570	611	646	678	706	731	751	770	794	817	739	860	879
	F4	74	151	216	291	355	419	483	524	566	603	638	667	696	723	746	762	784	807	829	853
	MEAN	78	159	237	327	399	471	538	579	619	653	684	709	734	756	778	800	822	844	864	883
WEB	W1	14	28	58	101	140	175	217	245	279	313	346	376	405	431	456	479	500	520	541	560
	W2	12	25	52	97	137	173	214	241	274	305	335	363	391	417	442	465	487	507	526	545
	MEAN	13	27	55	99	139	174	216	243	277	309	341	370	398	424	449	472	494	514	534	553
LOCAL GAS		517	656	688	705	700	741	759	765	784	801	815	830	849	860	873	886	902	912	919	932
MEAN FURNACE GAS		505	638	664	720	733	760	775	774	802	820	832	845	861	873	881	893	905	916	922	933
STANDARD CURVE (a)		499	600	660	702	736	763	786	806	823	839	853	866	878	889	899	909	918	927	935	942

NOTES:- (a) Initial ambient temperature = 17 deg. C
(b) Thermalite 'SHIELD' blocks used with an oven-dry density of 650 kg/m3
(c) Gap between blockwork and steel filled with a standard mortar mix suitable for blockwork

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124Y)

DATA SHEET NUMBER **79**

INDICATIVE COLUMN WITH BLOCKED-IN WEB

FURNACE TYPE : FLOOR FURNACE
POSITION IN FURNACE : FREE-STANDING ON PLINTH

DIMENSIONS AND PROPERTIES (NOMINAL)

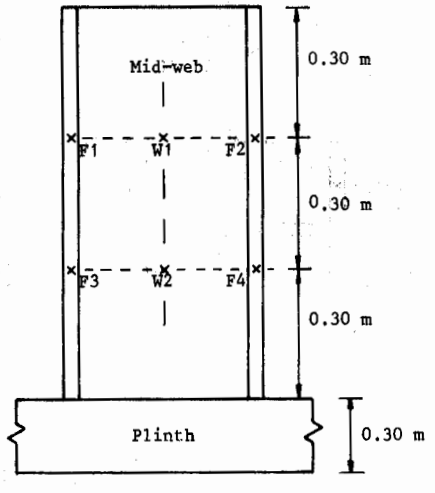
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
COLUMN	203 x 203	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770

TEMPERATURE DATA

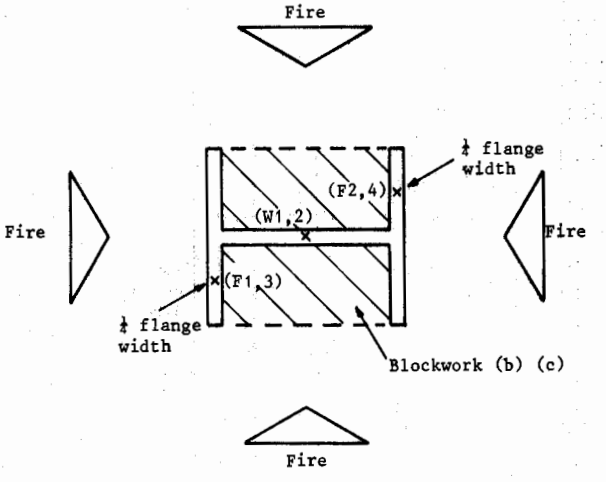
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
FLANGES	F1	91	181	260	352	419	483	544	580	618	650	678	704	727	744	760	781	801	822	842	862
	F2	55	137	221	312	385	459	532	575	616	650	681	706	727	742	763	785	807	828	850	868
	F3	57	132	210	292	362	431	501	542	587	623	655	684	710	730	746	769	791	813	835	855
	F4	43	98	164	238	304	375	449	495	541	581	616	646	675	702	726	741	759	781	803	825
	MEAN	62	137	214	299	368	437	507	548	591	626	658	685	710	730	749	769	790	811	833	853
WEB	W1	15	34	73	121	172	212	253	278	307	335	361	386	410	433	455	475	494	512	529	546
	W2	12	26	54	98	137	174	215	242	273	304	333	359	385	410	433	456	476	495	512	529
	MEAN	14	30	64	110	155	193	234	260	290	320	347	373	398	422	444	466	485	504	521	538
LOCAL GAS		478	643	683	753	774	818	836	848	863	871	886	899	914	927	937	950	957	969	974	984
MEAN FURNACE GAS		505	638	664	720	733	760	775	774	802	820	832	845	861	873	881	893	905	916	922	933
STANDARD CURVE (a)		499	600	660	702	736	763	786	806	823	839	853	866	878	889	899	909	918	927	935	942

NOTES:- (a) Initial ambient temperature = 17 deg. C
(b) Thermalite 'HI-STRENGTH' blocks used with an oven-dry density of 760 kg/m3
(c) Gap between blockwork and steel filled with a standard mortar mix suitable for blockwork

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124Y)

DATA SHEET NUMBER **80**

INDICATIVE COLUMN (a)

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

DIMENSIONS AND PROPERTIES (NOMINAL)

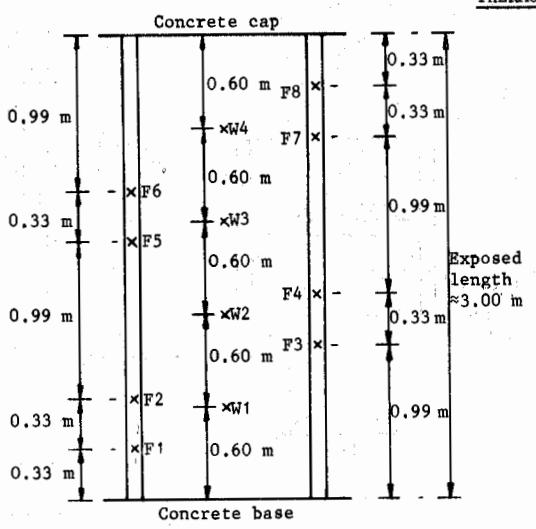
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS		ELASTIC MODULUS		PLASTIC MODULUS		MOMENT OF INERTIA	
					WEB mm	FLANGE mm	AXIS XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
COLUMN	203 x 203	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770

TEMPERATURE DATA

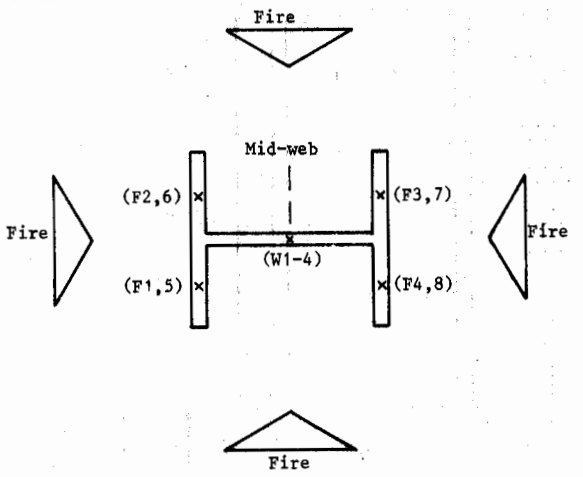
THERMOCOUPLE LOCATION		TEMPERATURE RISE Deg. C AFTER VARIOUS TIMES (MINUTES)											
		5	10	15	20	25	30	35	40	45	50	55	60
FLANGES	F1	215	360	520	625	680	715	730	760	780	800	820	835
	F2	265	420	565	655	705	725	760	790	815	840	860	885
	F3	270	420	565	650	705	735	770	805	835	865	890	910
	F4	260	420	545	630	680	715	735	765	790	810	835	855
	F5	275	435	545	625	680	715	730	755	780	800	820	835
	F6	250	400	520	605	665	710	725	755	785	805	830	855
	F7	230	380	480	580	650	695	725	750	775	805	830	855
	F8	235	365	465	550	605	650	680	705	715	740	775	810
	MEAN	250	400	526	615	671	708	732	761	784	808	833	855
WEB	W1	280	435	585	690	720	755	785	810	830	845	860	875
	W2	270	440	565	650	695	715	745	775	795	815	835	855
	W3	265	415	525	615	670	705	725	750	775	795	815	830
	W4	240	390	495	585	650	685	710	725	745	770	790	805
	MEAN	264	420	543	635	684	715	741	765	786	806	825	841
MEAN FURNACE GAS		*	*	*	*	*	*	*	*	*	*	*	*
STANDARD CURVE (b)		556	658	719	761	795	822	845	865	882	898	912	925

NOTES:-
(a) Test carried out on behalf of Fire Research Station
(b) Initial ambient temperature = 0 deg. C
(c) Actual flange position and depth of thermocouples into the steelwork not known
(*) Data not available

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124Z)

DATA SHEET NUMBER **81**

INDICATIVE COLUMN (a)

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

DIMENSIONS AND PROPERTIES (NOMINAL)

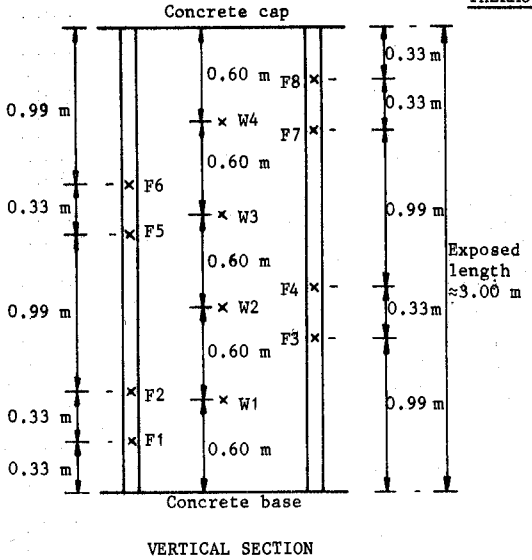
SECTION TYPE	SERIAL SIZE mm	MASS PER METRE kg	DEPTH OF SECTION mm	WIDTH OF SECTION mm	THICKNESS WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	254 x 254	107	266.7	258.3	13.0	20.5	1313	456.9	1485	695.5	17510	5901

TEMPERATURE DATA

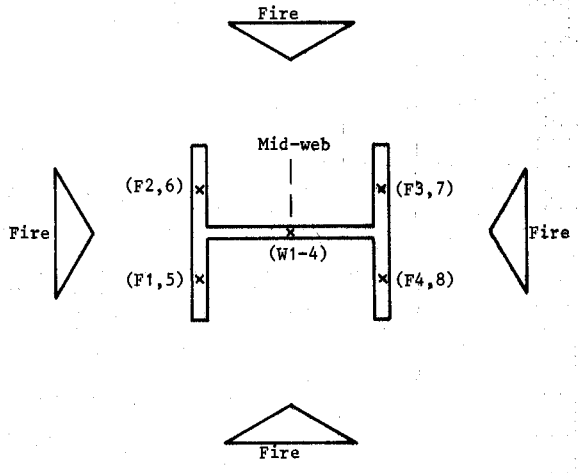
THERMOCOUPLE LOCATION		TEMPERATURE RISE Deg. C AFTER VARIOUS TIMES (MINUTES) 5	10	15	20	25	30	35	40	45	50	55	60	75	90	105
FLANGES	F1	150	300	410	510	595	650	*	*	750	*	*	825	865	875	900
	F2	255	415	530	625	680	725	770	810	835	855	870	880	920	925	940
	F3	240	400	525	620	685	725	770	810	840	860	875	880	920	925	945
	F4	195	350	460	550	625	675	705	745	775	810	835	850	885	905	925
	F5	185	330	435	530	605	655	685	715	750	785	815	830	870	890	910
	F6	190	340	450	545	615	665	695	720	755	785	810	830	870	890	910
	F7	160	305	425	515	590	645	680	705	735	765	795	815	860	880	900
	F8	160	290	390	485	570	630	*	*	720	*	*	795	840	865	885
	MEAN	192	341	453	548	621	671			770			838	879	894	914
WEB	W1	200	375	495	590	670	705	*	*	820	*	*	870	905	915	935
	W2	205	355	480	580	655	695	*	*	810	*	*	865	900	915	930
	W3	180	335	450	545	615	670	*	*	765	*	*	835	875	895	915
	W4	155	315	400	495	570	630	*	*	720	*	*	800	845	865	885
	MEAN	185	345	456	553	628	650			779			843	881	898	916
MEAN FURNACE GAS		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
STANDARD CURVE (b)		556	658	719	761	795	822	845	865	882	898	912	925	959	986	1009

NOTES:-
(a) Test carried out on behalf of Fire Research Station
(b) Initial ambient temperature = 0 deg. C
(c) Actual flange position and depth of thermocouples into the steelwork not known
(*) Data not available

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

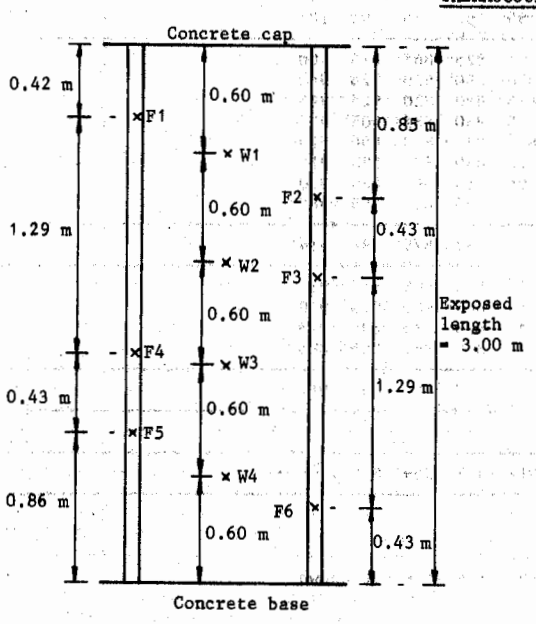
(R2/7124Z)

(Not to scale)

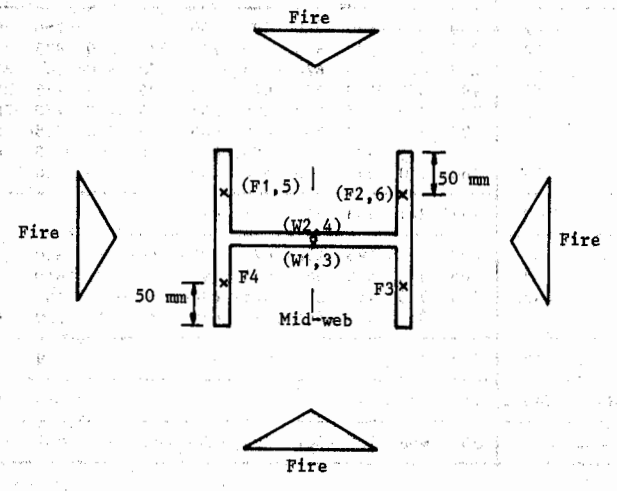
DATA SHEET NUMBER **82a**

INDICATIVE COLUMN

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124ZAA)

DATA SHEET NUMBER **82b**

INDICATIVE COLUMN (a)

FURNACE TYPE : COLUMN 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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	203 x 203	52	206.2	203.9	8.0	12.5	510.4	173.6	568.1	263.7	5263	1770

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																				
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	35	40	45	50	55	60	65
FLANGES	F1	72	137	203	272	352	424	484	539	585	624	656	684	709	726	734	775	816	854	877	894	905	916
	F2	72	132	196	266	354	427	491	545	590	629	661	687	713	727	741	785	831	866	887	904	915	926
	F3	73	135	203	274	364	436	492	546	591	631	666	695	720	731	748	793	837	870	892	908	924	937
	F4	81	146	208	274	358	430	489	542	587	623	658	688	715	731	743	784	827	860	884	903	923	936
	F5	65	128	198	275	371	449	515	572	615	649	676	701	722	731	746	788	829	856	879	898	914	928
	F6	78	141	205	274	358	431	491	550	598	637	662	687	712	729	740	776	812	841	865	884	901	916
	MEAN	74	137	202	273	360	433	494	549	594	632	663	690	715	729	742	784	825	858	881	899	914	927
WEB	W1	78	144	216	289	375	443	504	558	604	643	674	698	721	729	745	790	832	865	886	903	914	925
	W2	91	160	229	301	399	462	512	562	603	639	668	696	723	732	750	795	839	870	888	905	919	932
	W3	74	141	207	273	362	440	506	562	605	642	671	697	721	729	745	790	832	861	885	904	921	934
	W4	67	128	203	288	393	473	535	595	634	672	694	717	731	743	766	804	839	861	883	901	918	930
	MEAN	78	143	214	288	382	455	514	569	612	649	677	702	724	733	752	795	836	764	886	903	918	930
MEAN FURNACE GAS		391	563	578	621	687	693	721	751	753	771	*	*	*	*	844	864	886	905	918	934	941	950
STANDARD CURVE (b)		452	551	610	652	685	712	735	755	773	788	803	816	827	839	849	872	892	909	925	939	952	964

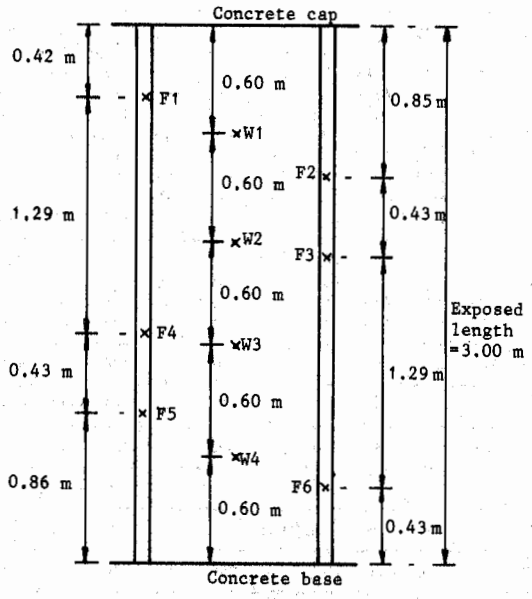
THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		70	75	80	85	90	95	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240
FLANGES	F1	931	945	956	966	977	988	995	1011	1027	1040	1054	1065	1074	1082	1089	1098	1105	1111	1118	1125	1134
	F2	941	954	965	974	985	995	1002	1018	1033	1046	1059	1069	1079	1086	1093	1101	1108	1115	1121	1129	1137
	F3	951	964	974	983	994	1003	1011	1025	1039	1052	1064	1075	1083	1090	1097	1105	1112	1118	1125	1133	1141
	F4	950	964	974	983	993	1002	1010	1024	1038	1050	1062	1073	1082	1089	1096	1103	1110	1117	1124	1132	1142
	F5	943	952	962	971	982	991	999	1014	1029	1041	1054	1065	1074	1081	1088	1096	1103	1109	1117	1126	1139
	F6	933	941	951	962	973	983	991	1007	1021	1034	1048	1058	1068	1075	1083	1091	1099	1105	1115	1124	1139
	MEAN	942	953	964	973	984	994	1001	1017	1031	1044	1057	1068	1077	1084	1091	1099	1106	1113	1120	1128	1139
WEB	W1	940	954	965	975	986	996	1004	1019	1034	1047	1060	1071	1080	1086	1094	1102	1109	1115	1122	1130	1138
	W2	948	960	971	980	991	1000	1008	1023	1037	1050	1063	1073	1082	1089	1096	1104	1111	1117	1124	1132	1141
	W3	948	960	972	980	991	1000	1008	1023	1037	1049	1062	1073	1082	1089	1096	1104	1111	1117	1124	1132	1144
	W4	946	953	962	973	984	993	1001	1017	1031	1044	1057	1068	1077	1084	1092	1099	1107	1113	1123	1131	1146
	MEAN	946	957	968	977	988	997	1005	1021	1035	1048	1061	1071	1080	1087	1095	1102	1110	1116	1123	1131	1142
MEAN FURNACE GAS		971	977	988	997	1007	*	1021	1034	1047	1061	1073	1084	1090	1099	1104	1113	1121	1127	1136	1142	1150
STANDARD CURVE (b)		975	986	995	1004	1013	1021	1029	1043	1056	1068	1079	1089	1099	1108	1117	1125	1133	1140	1147	1153	1160

NOTES:
(a) Test carried out on behalf of Fire Research Station
(b) Initial ambient temperature = 27 deg. C
(c) Thermocouples embedded approximately 5 mm below the steel surface
(*) Data not available

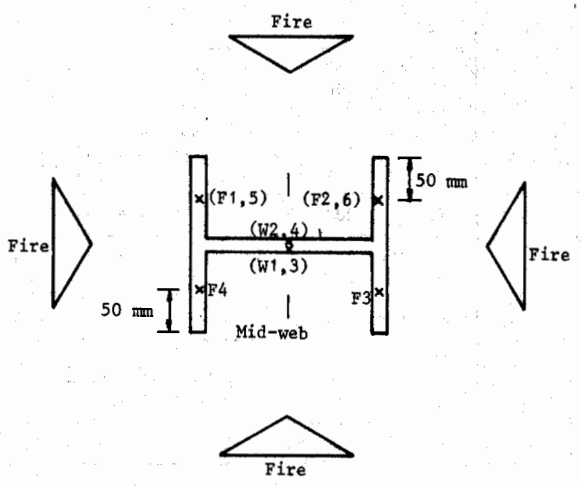
DATA SHEET NUMBER 83a

INDICATIVE COLUMN

THERMOCOUPLE POSITIONS



VERTICAL SECTION



TRANSVERSE SECTION

(Not to scale)

(R2/7124ZAA)

INDICATIVE COLUMN (a)

DATA SHEET NUMBER **83b**

FURNACE TYPE : COLUMN 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 WEB mm	THICKNESS FLANGE mm	ELASTIC MODULUS AXIS XX cm3	ELASTIC MODULUS AXIS YY cm3	PLASTIC MODULUS AXIS XX cm3	PLASTIC MODULUS AXIS YY cm3	MOMENT OF INERTIA AXIS XX cm4	MOMENT OF INERTIA AXIS YY cm4
COLUMN	305 x 305	283	365.3	321.8	26.9	44.1	4314	1525	5101	2337	78777	24545

TEMPERATURE DATA

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		2	4	6	8	10	12	14	16	18	20	24	28	32	36	40	44	48	52	56	60	64
FLANGES	F1	34	52	71	98	134	165	199	236	271	305	383	457	523	581	631	674	710	736	753	778	804
	F2	37	58	80	114	147	178	220	264	307	343	416	483	545	602	651	693	727	747	776	804	830
	F3	38	60	84	115	150	187	228	270	311	350	431	501	565	621	665	705	735	754	784	813	840
	F4	35	60	87	114	148	185	230	274	319	363	453	525	586	640	684	722	744	771	801	827	854
	F5	29	48	69	96	124	160	202	248	301	348	441	530	603	661	708	735	754	776	799	821	842
	F6	31	53	79	112	149	188	229	267	307	349	423	493	555	610	657	694	725	740	763	788	814
	MEAN	34	55	78	108	142	177	218	260	303	343	425	498	563	619	666	704	733	754	779	805	831
WEB	W1	37	58	79	112	146	179	219	259	298	336	418	505	574	632	679	717	740	764	792	814	834
	W2	39	62	84	118	149	185	226	266	306	343	426	503	569	629	675	710	738	755	781	807	831
	W3	40	64	90	118	150	188	229	276	331	381	473	548	613	669	714	741	766	792	817	839	863
	W4	32	55	80	113	147	188	228	271	320	369	454	529	593	648	697	732	751	776	801	823	845
	MEAN	37	60	83	115	148	185	226	268	314	357	443	521	587	645	691	725	749	772	798	821	843
MEAN FURNACE GAS		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
STANDARD CURVE (b)		442	541	600	642	675	702	725	745	763	778	806	829	848	866	882	896	909	929	932	942	952

THERMOCOUPLE LOCATION		TEMPERATURE Deg. C AFTER VARIOUS TIMES (MINUTES)																			
		68	72	76	80	84	88	92	96	100	110	120	130	140	150	160	170	180	190	200	210	214
FLANGES	F1	828	852	879	901	920	935	945	954	962	983	1001	1015	1029	1044	1057	1074	1084	1092	1104	1114	1117
	F2	856	884	908	929	945	959	965	973	980	1000	1015	1027	1039	1052	1064	1078	1087	1093	1103	1110	1113
	F3	870	898	922	940	954	968	978	987	994	1012	1026	1037	1049	1061	1071	1083	1090	1099	1111	1118	1121
	F4	880	904	926	943	957	970	980	990	998	1016	1027	1038	1050	1061	1070	1083	1087	1098	1111	1118	1120
	F5	865	890	912	930	944	957	967	976	985	1005	1022	1038	1050	1065	1076	1092	1098	1101	1112	1117	1119
	F6	835	859	884	903	919	934	944	953	963	985	1004	1017	1031	1045	1053	1069	1075	1079	1097	1105	1107
	MEAN	856	881	905	924	940	954	963	972	980	1000	1016	1029	1041	1055	1065	1080	1087	1094	1106	1114	1116
WEB	W1	855	880	902	922	939	954	959	966	973	994	1011	1024	1037	1050	1063	1077	1086	1093	1104	1112	1115
	W2	855	884	910	929	945	959	969	979	987	1006	1022	1034	1046	1060	1071	1085	1093	1100	1111	1117	1120
	W3	888	912	932	948	961	974	984	993	1001	1021	1031	1043	1055	1068	1078	1094	1097	1106	1116	1123	1125
	W4	866	888	909	925	939	952	962	972	981	1002	1017	1030	1044	1059	1068	1085	1090	1094	1111	1119	1122
	MEAN	866	891	913	931	946	960	969	978	986	1006	1020	1033	1046	1059	1070	1085	1092	1098	1111	1118	1121
MEAN FURNACE GAS		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
STANDARD CURVE (b)		961	970	978	985	993	1000	1006	1013	1019	1033	1046	1058	1069	1079	1089	1098	1107	1115	1123	1130	1133

NOTES:- (a) Test carried out on behalf of Fire Research Station
(b) Initial ambient temperature = 17 deg. C
(c) Thermocouples embedded approximately 5 mm below the steel surface
(*) Data not available

APPENDIX B

	Data Sheet No.
Elevated Temperature Anisothermal Tensile Properties	84-88

MATERIAL TEST DATA (a)

DATA SHEET NUMBER **84**

SECTION SERIAL SIZE :- 356 x 171 mm x 67 kg/m UNIVERSAL BEAM

STEEL QUALITY :- BS 4360 : GRADE 43A : 1979

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
0.24	0.032	0.96	0.038	0.022	0.013	0.005	0.017	0.005	0.019	0.005	0.002	0.004

ROOM TEMPERATURE TENSILE PROPERTIES

LOWER YIELD STRESS	=	267 N/mm2
TENSILE STRENGTH	=	460 N/mm2
ELONGATION	=	38 %
REDUCTION OF AREA	=	66 %

ELEVATED TEMPERATURE ANISOTHERMAL TENSILE PROPERTIES

HEATING RATE Deg. C per Minute	APPLIED STRESS N/mm2	APPLIED STRESS / YIELD STRESS	TEMPERATURES (Deg. C) ATTAINED FOR VARIOUS STRAINS (%) (ELASTIC + PLASTIC)																		
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	4.0	5.0
20	250	0.94	-	219	240	295	384	419	443	458	470	479	493	500	507	513	518	525	529	534	536
	200	0.75	116	269	286	440	470	488	502	510	518	524	533	538	543	547	551	558	562	568	570
	150	0.56	395	491	520	536	550	558	565	570	574	576	582	587	592	596	600	609	616	621	624
	100	0.38	440	545	584	602	614	620	625	628	631	634	640	645	648	651	654	659	664	670	675
10	250	0.94	-	205	214	216	224	283	348	391	421	440	468	480	491	500	504	515	522	530	535
	200	0.75	98	283	298	414	461	484	496	506	514	520	528	534	539	543	545	554	559	566	572
	150	0.56	288	434	508	530	541	549	557	561	565	570	575	580	583	586	588	594	599	602	-
	100	0.38	391	541	574	588	598	605	610	614	618	622	626	630	634	636	638	644	648	655	-
	50	0.19	563	636	665	678	687	695	702	707	710	713	718	721	723	724	724	-	-	-	-
	25	0.094	673	722	725	733	743	758	778	789	801	813	837	859	871	881	888	902	912	927	936
5	250	0.94	-	202	222	225	227	247	317	374	407	428	456	473	483	490	495	505	511	522	529
	200	0.75	83	266	282	407	453	474	488	498	505	511	519	526	530	534	538	544	550	556	561
	150	0.56	245	435	499	521	532	540	545	550	554	558	563	567	572	574	577	583	587	594	598
	100	0.38	393	541	568	581	590	597	602	607	611	614	618	622	626	628	632	637	641	649	654
	50	0.19	567	629	651	661	669	675	680	685	688	692	697	701	703	705	708	714	718	723	727
	25	0.094	642	702	722	726	731	738	746	755	763	772	789	803	814	826	837	862	873	893	906
	15	0.056	667	719	726	738	748	762	775	788	798	808	826	851	866	876	883	899	909	925	938

NOTES:- (a) See data sheet number 12 for BS 476 : Part 8 fire test on structural element.

DATA SHEET NUMBER **85**

MATERIAL TEST DATA (a)

SECTION SERIAL SIZE :- 254 x 146 mm x 43 kg/m UNIVERSAL BEAM

STEEL QUALITY :- BS 4360 : GRADE 50B : 1979

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
0.15	0.27	1.34	0.017	0.011	0.019	0.005	0.020	0.065	0.011	0.005	0.002	0.0062

ROOM TEMPERATURE TENSILE PROPERTIES

LOWER YIELD STRESS	=	357 N/mm2
TENSILE STRENGTH	=	519 N/mm2
ELONGATION	=	33 %
REDUCTION OF AREA	=	75 %

ELEVATED TEMPERATURE ANISOTHERMAL TENSILE PROPERTIES

HEATING RATE Deg. C per Minute	APPLIED STRESS N/mm2	APPLIED STRESS / YIELD STRESS	TEMPERATURES (Deg. C) ATTAINED FOR VARIOUS STRAINS (%) (ELASTIC + PLASTIC)																	
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	4.0	5.0
20	350	0.98	-	84	122	129	133	136	222	374	395	406	424	436	447	455	461	472	479	489	493
	300	0.84	-	161	383	426	444	457	465	473	479	484	490	496	501	505	509	519	527	534	-
	250	0.70	-	419	471	491	504	514	519	525	529	532	537	541	545	549	552	557	561	567	572
	200	0.56	145	450	501	524	539	550	557	563	568	571	576	581	586	590	594	599	603	610	614
	150	0.42	405	506	549	576	592	603	609	614	618	620	625	630	634	637	640	645	651	657	662
10	350	0.98	-	31	74	95	102	105	107	280	365	388	409	427	439	445	451	463	471	481	487
	300	0.84	-	225	383	423	444	455	461	467	471	478	483	488	492	495	497	502	507	514	520
	250	0.70	-	374	446	472	486	496	503	508	513	517	522	527	531	533	536	541	546	552	557
	200	0.56	185	453	497	521	536	542	548	553	558	562	567	571	575	577	579	584	588	595	600
	150	0.42	390	520	553	573	584	591	597	601	604	607	613	616	620	623	627	634	638	646	652
	100	0.28	492	580	613	640	648	656	662	667	671	673	679	683	685	688	690	695	699	705	710
	50	0.14	650	705	725	730	734	738	742	746	750	753	760	764	768	771	775	781	787	796	801
	25	0.070	735	763	785	798	808	813	820	829	837	845	863	876	886	893	899	910	920	-	-
5	350	0.98	-	63	102	104	107	110	113	116	305	356	393	410	423	433	441	455	462	473	480
	300	0.84	-	197	315	392	417	433	443	451	457	461	468	474	478	482	485	493	498	506	513
	250	0.70	-	295	430	461	475	483	490	497	501	505	513	518	520	523	526	533	537	544	549
	200	0.56	205	448	488	510	522	527	533	538	542	546	552	556	559	563	565	570	576	582	586
	150	0.42	312	513	550	568	578	584	590	594	597	601	607	611	613	615	618	623	626	633	636
	100	0.28	445	567	609	631	644	652	658	662	665	668	673	676	679	682	685	689	692	697	701
	50	0.14	565	680	710	724	729	733	737	741	744	748	752	756	759	763	767	774	779	788	793
	25	0.070	721	740	758	771	780	788	796	801	805	810	818	826	834	842	849	868	879	899	912
	15	0.042	724	758	784	798	812	829	847	865	879	891	903	923	936	948	962	-	-	-	-

NOTES:- (a) See data sheet number 19 for BS 476 : Part 8 fire test on structural element.

MATERIAL TEST DATA (a)

DATA SHEET NUMBER **86**

SECTION SERIAL SIZE :- 254 x 146 mm x 43 kg/m UNIVERSAL BEAM

STEEL QUALITY :- BS 4360 : GRADE 50B : 1979

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
0.11	0.32	1.39	0.015	0.011	0.010	0.005	0.013	0.054	0.032	0.005	0.026	0.0062

ROOM TEMPERATURE TENSILE PROPERTIES

LOWER YIELD STRESS	=	401 N/mm2
TENSILE STRENGTH	=	538 N/mm2
ELONGATION	=	30 %
REDUCTION OF AREA	=	78 %

ELEVATED TEMPERATURE ANISOTHERMAL TENSILE PROPERTIES

HEATING RATE Deg. C per Minute	APPLIED STRESS N/mm2	APPLIED STRESS / YIELD STRESS	TEMPERATURES (Deg. C) ATTAINED FOR VARIOUS STRAINS (%) (ELASTIC + PLASTIC)																	
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	4.0	5.0
20	350	0.87	-	119	126	141	147	152	153	154	155	156	318	395	417	430	442	459	473	485	495
	300	0.75	-	230	253	315	382	415	433	447	455	461	473	486	492	497	501	510	517	526	531
	250	0.62	-	312	432	467	487	497	504	510	515	520	529	534	538	542	545	551	556	564	569
	200	0.50	115	487	525	543	553	560	565	569	573	576	581	586	590	594	596	601	605	611	616
	150	0.37	420	552	584	601	609	615	620	625	629	633	638	641	644	647	649	653	657	663	668
10	350	0.87	-	58	105	124	126	127	128	130	131	133	365	400	417	430	440	457	466	478	485
	250	0.62	-	347	440	467	483	494	501	508	514	517	522	527	532	536	539	545	549	556	561
	150	0.37	438	535	564	580	589	596	601	605	608	611	616	620	624	627	629	634	638	644	649
	50	0.12	641	726	735	743	750	755	761	764	768	771	774	777	780	783	786	792	795	801	805
	25	0.062	726	759	777	787	797	805	813	820	827	833	845	855	865	874	883	904	-	-	-

NOTES:- (a) See data sheet number 23 for BS 476 : Part 8 fire test on structural element.

DATA SHEET NUMBER **87**

MATERIAL TEST DATA (a)

SECTION SERIAL SIZE :- 203 x 203 mm x 52 kg/m UNIVERSAL COLUMN

STEEL QUALITY :- BS 4360 : GRADE 50B : 1979

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
0.11	0.34	1.36	0.011	0.020	0.014	0.005	0.025	0.057	0.052	0.005	0.032	0.0031

ROOM TEMPERATURE TENSILE PROPERTIES

LOWER YIELD STRESS	=	385 N/mm2
TENSILE STRENGTH	=	528 N/mm2
ELONGATION	=	35 %
REDUCTION OF AREA	=	76 %

ELEVATED TEMPERATURE ANISOTHERMAL TENSILE PROPERTIES

HEATING RATE Deg. C per Minute	APPLIED STRESS N/mm2	APPLIED STRESS / YIELD STRESS	TEMPERATURES (Deg. C) ATTAINED FOR VARIOUS STRAINS (%) (ELASTIC + PLASTIC)																	
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	4.0	5.0
20	350	0.91	-	149	151	162	166	167	168	169	170	171	377	403	420	433	443	457	469	481	489
	300	0.78	-	236	268	334	383	408	427	445	449	456	470	478	484	489	494	504	511	520	527
	250	0.65	-	321	405	449	470	484	495	501	506	512	521	528	533	536	539	548	554	562	567
	200	0.52	98	405	476	515	533	543	551	556	561	565	572	577	580	584	588	594	599	606	612
	150	0.39	360	540	565	583	597	603	608	612	616	620	625	629	633	636	640	645	648	654	658
10	350	0.91	-	134	145	148	151	154	156	158	160	161	365	395	412	424	434	452	463	480	489
	300	0.78	-	198	238	253	330	378	401	418	431	440	454	464	471	477	483	494	501	510	518
	250	0.65	-	314	403	447	465	477	486	493	499	504	512	517	521	525	528	535	540	549	556
	200	0.52	98	422	486	510	520	532	539	544	548	552	557	562	566	570	573	579	584	591	596
	150	0.39	354	516	552	570	581	589	594	598	602	605	611	616	619	621	624	630	635	641	646
	100	0.26	492	586	625	643	651	659	665	669	672	674	680	685	688	690	692	696	699	702	706
	50	0.13	675	728	735	742	748	753	758	762	765	767	771	774	777	779	781	786	789	794	798
	25	0.065	724	755	776	789	798	805	811	817	822	827	836	845	854	863	872	893	908	927	937
5	350	0.91	-	108	138	146	147	148	149	150	151	152	283	371	391	403	421	440	453	466	473
	300	0.78	-	220	235	296	356	390	409	422	433	441	453	462	469	474	478	485	492	502	509
	250	0.65	-	292	382	428	451	464	473	480	486	491	499	504	508	512	515	522	527	535	541
	200	0.52	138	438	485	503	513	520	528	533	537	541	547	551	555	558	560	-	-	-	-
	150	0.39	356	499	541	562	570	577	583	588	591	594	600	603	606	609	612	617	621	627	631
	100	0.26	519	593	616	628	638	645	649	653	656	659	663	667	671	674	676	680	684	689	692
	50	0.13	650	715	732	737	741	745	749	752	755	757	760	763	766	769	771	774	777	782	784
	25	0.065	732	754	767	774	780	786	791	796	800	805	813	822	829	836	843	862	877	898	910
	15	0.039	745	777	790	801	812	822	832	841	849	857	875	893	908	923	935	957	-	-	-
2.5	350	0.91	-	112	135	137	140	143	145	146	147	147	337	382	401	410	419	437	447	458	466
	300	0.78	-	224	236	282	347	381	406	419	426	432	445	455	461	466	471	478	485	493	499
	250	0.65	-	316	408	440	456	468	475	480	484	488	495	502	506	509	512	519	523	531	536
	200	0.52	132	442	478	492	502	509	515	520	525	529	534	538	541	544	547	553	558	565	570

NOTES:- (a) See data sheets numbers 25, 26 & 27 for BS 476 : Part 8 fire test on structural element.

MATERIAL TEST DATA (a)

DATA SHEET NUMBER **88**

SECTION SERIAL SIZE :- 203 x 203 mm x 52 kg/m UNIVERSAL COLUMN

STEEL QUALITY :- BS 4360 : GRADE 43A : 1979

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
0.27	0.041	0.93	0.010	0.022	0.01	0.005	0.026	0.005	0.018	0.005	0.01	0.0039

ROOM TEMPERATURE TENSILE PROPERTIES

LOWER YIELD STRESS	=	286 N/mm2
TENSILE STRENGTH	=	509 N/mm2
ELONGATION	=	29 %
REDUCTION OF AREA	=	65 %

ELEVATED TEMPERATURE ANISOTHERMAL TENSILE PROPERTIES

HEATING RATE Deg. C per Minute	APPLIED STRESS N/mm2	APPLIED STRESS / YIELD STRESS	TEMPERATURES (Deg. C) ATTAINED FOR VARIOUS STRAINS (%) (ELASTIC + PLASTIC)																	
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	4.0	5.0
20	250	0.87	-	232	333	393	431	452	465	474	480	488	499	505	510	515	518	525	529	537	543
	200	0.70	98	382	460	493	509	518	525	531	536	541	545	549	553	558	561	566	570	576	582
	150	0.52	326	414	500	530	545	553	560	567	571	574	580	585	589	592	595	602	607	614	620
	100	0.35	435	567	591	603	610	617	624	628	632	635	639	642	644	646	647	656	661	668	673
10	250	0.87	-	203	233	337	395	429	450	462	471	478	488	496	502	507	512	518	523	531	537
	200	0.70	98	258	325	433	468	486	497	505	511	516	524	531	536	540	543	549	555	562	567
	150	0.52	313	489	525	539	548	555	561	566	570	573	578	583	585	587	589	594	598	605	609
	100	0.35	470	548	573	585	596	602	606	609	612	620	-	-	-	-	-	-	-	-	-
	50	0.18	591	643	664	675	684	692	697	700	703	706	712	716	718	720	721	724	729	737	744
	25	0.087	668	707	719	723	730	740	753	767	780	790	806	828	843	852	862	875	887	905	917
5	250	0.87	-	198	212	214	225	277	337	381	407	424	449	465	476	484	490	501	508	515	521
	200	0.70	98	331	440	474	492	501	508	513	517	521	527	532	535	538	541	546	551	556	560
	150	0.52	255	410	478	506	520	527	533	538	543	546	552	557	561	565	568	573	578	586	591
	100	0.35	437	530	539	574	582	589	593	597	601	604	608	612	615	618	621	627	631	636	641
	50	0.18	567	616	638	652	661	667	673	677	681	685	690	695	699	702	704	710	715	719	723
	25	0.087	645	697	713	722	727	732	743	756	767	777	796	813	829	843	852	868	882	902	914
	15	0.052	693	717	727	744	757	773	791	810	825	835	850	860	869	876	882	895	910	927	940

NOTES:- (a) See data sheet number 48 for BS 476 : Part 8 fire test on structural element.

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 XX cm3	AXIS YY cm3	AXIS XX cm3	AXIS YY cm3	AXIS XX cm4	AXIS YY cm4
	NOMINAL											
	ACTUAL											

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt.%)

SECTION	STEEL QUALITY	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N

ROOM TEMPERATURE TENSILE PROPERTIES

POSITION	LYS N/mm2	TS N/mm2	ELONG %
FLANGE			
WEB			

NOTES

(a)

TEST CONDITIONS

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) EXTENSION (mm)	