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BS476:Part 21 Fire Resistance Tests

Summary of Data Obtained During a Test on an Arched Metal Deck Floor Beam

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SUMMARY

BS476:PART 21 FIRE RESISTANCE TESTS

SUMMARY OF DATA OBTAINED DURING A TEST ON AN ARCHED METAL DECK FLOOR BEAM

D.E. Wainman

During the five years 1989-1993 British Steel Technical carried out more than thirty standard fire resistance tests on hot rolled structural steel sections. Data arising from the tests are being summarised in a series of reports, each one dealing with either a different form of construction or a generic group of test assemblies.

This is the fourth report issued as part of that series. It contains a detailed description of the design, instrumentation and construction for a single test assembly, usually referred to as an 'arched metal deck floor beam', together with the data arising from it. The test was carried out at the Warrington Fire Research Centre.

The serial size for the steel section used was 406 x 178 mm x 54 kg/m UB. The steel grade was BS4360:Grade 43A (now BS EN 10025 S275). The section was loaded so as to develop a bending stress of 165 N/mm^2, (the maximum likely service stress for such a section), in the lower flange. The performance of the test assembly was judged against the load bearing capacity criterion outlined in Section 5 of BS476:Part 21:1987. The fire resistance rating for the assembly was found to be 190 minutes.

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BS476:PART 21 FIRE RESISTANCE TESTS

SUMMARY OF DATA OBTAINED DURING A TEST ON AN ARCHED METAL DECK FLOOR BEAM

1. INTRODUCTION

Between 1989 and 1993 more than 30 full scale fire resistance tests were carried out on a wide range of structural assemblies. The major features of all the tests were summarised in an earlier Technical Note[1]. Data obtained during the tests are being presented in a series of reports, each of which is concerned with either a different form of construction or a generically similar group of test assemblies. The first report in the series was issued in 1993[2] and included material relating to eight flange plated slim floor beams. The second report[3] gave details relating to five web encased column assemblies. In the most recent report[4] material concerning tests on connections between beams and columns was presented.

This is therefore the fourth report issued as part of that ongoing series. It contains a detailed description of the design, instrumentation and construction for a single test assembly, together with the data arising from it which are included in Appendix 1. The test assembly was a steel and concrete composite floor slab construction which is usually referred to as an 'arched metal deck floor'. The data are presented in a format which is generally consistent with that of the earlier publications. As before, no analysis of the data is included since this has already been incorporated into other publications dealing with design aspects of this form of construction. The numerical sequence of the data sheets has been maintained, the one in this document being numbered 125. As in the previous compendia and reports the thermal data are reduced to summary values at various times throughout the duration of the test. It should be noted, however, that all the thermal data, usually recorded at one minute intervals, can be made available on a PC disk. This may be obtained, on request, from British Steel, Swinden Technology Centre.

The work reported here forms part of an ongoing research programme concerned with the evaluation and prediction of the performance of constructional steelwork in fire. Readers are therefore reminded to exercise caution when using any single test result and not to take it out of context with data for other tests of a similar nature.

2. TEST ASSEMBLY WFRC 50427

The test assembly consisted of a 5 metre length of 406 x 178 mm x 54 kg/m universal beam which was encased within Grade 30 lightweight aggregate concrete. The concrete was supported on QUIKSPAN Q51 galvanised mild steel profiled decking having a gauge thickness of 1.2 mm. The decking sheets were positioned so that they rested on the lower flange of the steel section and were inclined upwards at approximately 30° with respect to that flange. The sheets were overlapped and fixed together using steel rivets.

The lightweight concrete contained LYTAG aggregate at a nominal 12 mm sieve size. It was poured in-situ around the beam filling the cavity created by the Q51 decking and the beam. The concrete was cast in accordance with a specification given by BORAL / LYTAG and to BS8110:Parts 1 and 2:1985, 'The Structural Use of Concrete'. The formwork was arranged so as to produce a composite steel / concrete assembly which was 1000 mm wide across the top surface, 150 mm deep at the edges, with a 50 mm thickness of concrete cover to the upper flange of the beam. A layer of A142 steel reinforcing mesh was also incorporated into the concrete slab.

Dimensional details for the QUIKSPAN Q51 decking are given in Fig. 1. A transverse section through the assembly showing the arrangement of the various components is given in Fig. 2. The steel section used in the construction of the test assembly was manufactured by British Steel and supplied to the requirements of BS4360:Grade 43A. Details of its chemical composition and mechanical properties are included in Data Sheet No. 125A in Appendix 1.

The concrete was cast during April 1990 and was allowed to cure naturally until four weeks prior to the test. The assembly was then placed in an atmosphere controlled by a de-humidifier until the test date. Samples of the concrete were taken at the time of casting. The density and moisture content, measured on the day of the test, were reported as being:-

Density	:	1860 kg/m^3
Moisture Content	:	5.0% w/w

The compressive, (crushing), strength measured 28 days after casting was reported to be 30 N/mm^2.

3. DIMENSIONS AND SECTION PROPERTIES

The nominal dimensions and section properties, as specified in BS4:Part 1:1980 for the steel beam used in the construction of the test assembly are included in Data Sheet No. 125A. The actual dimensions of the section are also given, together with the calculated section properties.

4. INSTRUMENTATION

The test assembly was instrumented such that the temperature attained by the steel section could be recorded throughout the duration of the heating period. For this purpose seventeen 3 mm diameter mineral insulated 'K' type thermocouples, (Ni-Cr / Ni-Al), with insulated hot junctions and Inconel 600 sheaths were used. The thermocouples were embedded to the mid-thickness position in the steel section. The thermocouple positions were as shown in Fig. 3, (longitudinal arrangement), and Fig. 4, (transverse arrangement).

Thermocouples of the same type were installed by WFRC for monitoring the temperature of the furnace atmosphere. These were situated at eight positions within the furnace, being evenly distributed on each side of the assembly, level with the soffit of the beam and 100 mm away from it.

Provision was also made for monitoring the vertical deflection of the assembly throughout the test. These measurements were made at the geometric centre of the upper, (concrete), surface using a displacement transducer connected to the WFRC data logging facility. The deflection values recorded are included in Data Sheet No. 125B in Appendix 1.

5. ASSEMBLY

The test assembly was positioned so as to form part of the roof of the floor furnace at WFRC. It was simply supported on a refractory lined steel loading frame so as to give a total effective span between the roller supports of 4500 mm. This frame was supported on the outer walls of the gas fired furnace so that the length of beam actually exposed to the heating conditions of the test was 4000 mm.

6. LOADING

A total imposed load of 24.34 tonnes was applied to the steel section by means of four hydraulic rams positioned along the centre line of the web and at points corresponding to $^1/_8$, $^3/_8$, $^5/_8$, and $^7/_8$, of the supported span. The applied load, together with the self weight of the system, was intended to develop a bending stress of 165 N/mm^2 in the lower flange of the steel section. This is the maximum allowable bending stress for a BS4360:Grade 43A steel section according to the design rules in BS449:Part 2:1969. The applied load was kept constant for the total test duration of 190 minutes.

The load to be applied to the test assembly was initially calculated on the basis of the nominal dimensions and section properties for the steel member concerned. These calculations were subsequently repeated to take account of the actual dimensions and mechanical properties of the section. Calculations relating to the applied load level are given in Appendix 2. A comparison of the calculation data to BS5950:Part 1:1985 is also included.

7. FAILURE CRITERIA

The performance of the test assembly was judged against the load bearing capacity criterion outlined in Section 5 of BS476:Part 21:1987. The maximum allowable deflection and the maximum allowable rate of deflection for the test assembly, as specified by the standard, were calculated to be 225 mm, (span / 20), and 5.5 mm/min, (span^2/ 9000 x D), respectively, where D = 405 mm, the measured depth of the section. The allowable rate of deflection criterion is not applicable until the deflection exceeds span / 30, i.e. 150 mm. At the termination of the test after 190 minutes the maximum deflection of the assembly was recorded as being only 67 mm.

8. CONCLUSIONS

1. Data arising from a standard fire resistance test carried out on an arched metal deck floor system have been collected and reported. Details of the test assembly are given, together with a summary of the material properties, structural calculations and the thermal data recorded.

2. The performance of the test assembly was judged against the load bearing capacity criterion outlined in Section 5 of BS 476:Part 21:1987. The fire resistance rating for the assembly was found to be 190 minutes which was the time at which the test was terminated. The measured central vertical displacement of the assembly at this time was only 67 mm.

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4. D.E. Wainman: 'BS476:Part 21 Fire Resistance Tests - Summary of Data Obtained During Tests on Bolted Beam/Column and Beam/Beam Connections', Report SL/HED/R/S2442/2/95/C, British Steel plc, Swinden Technology Centre, 1995.

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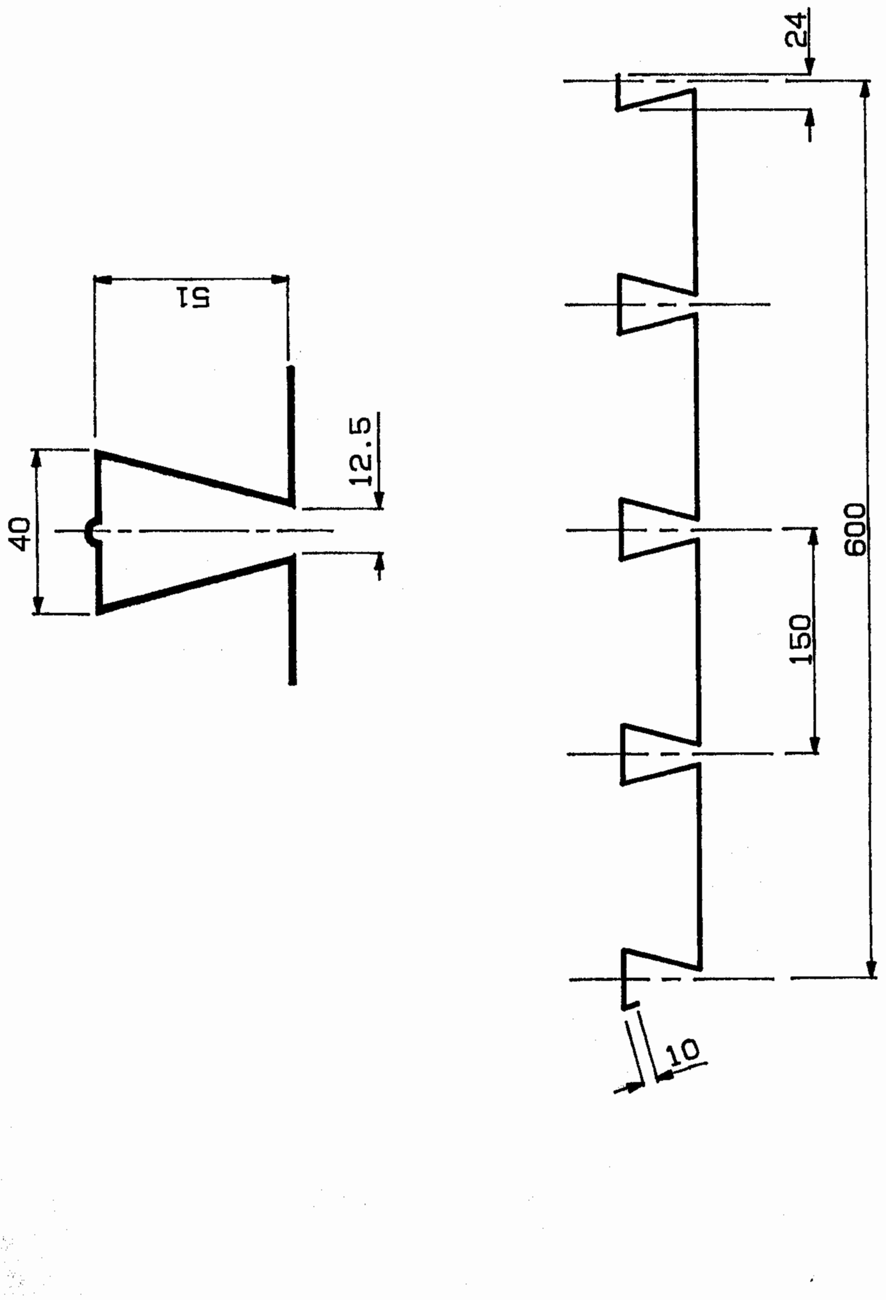
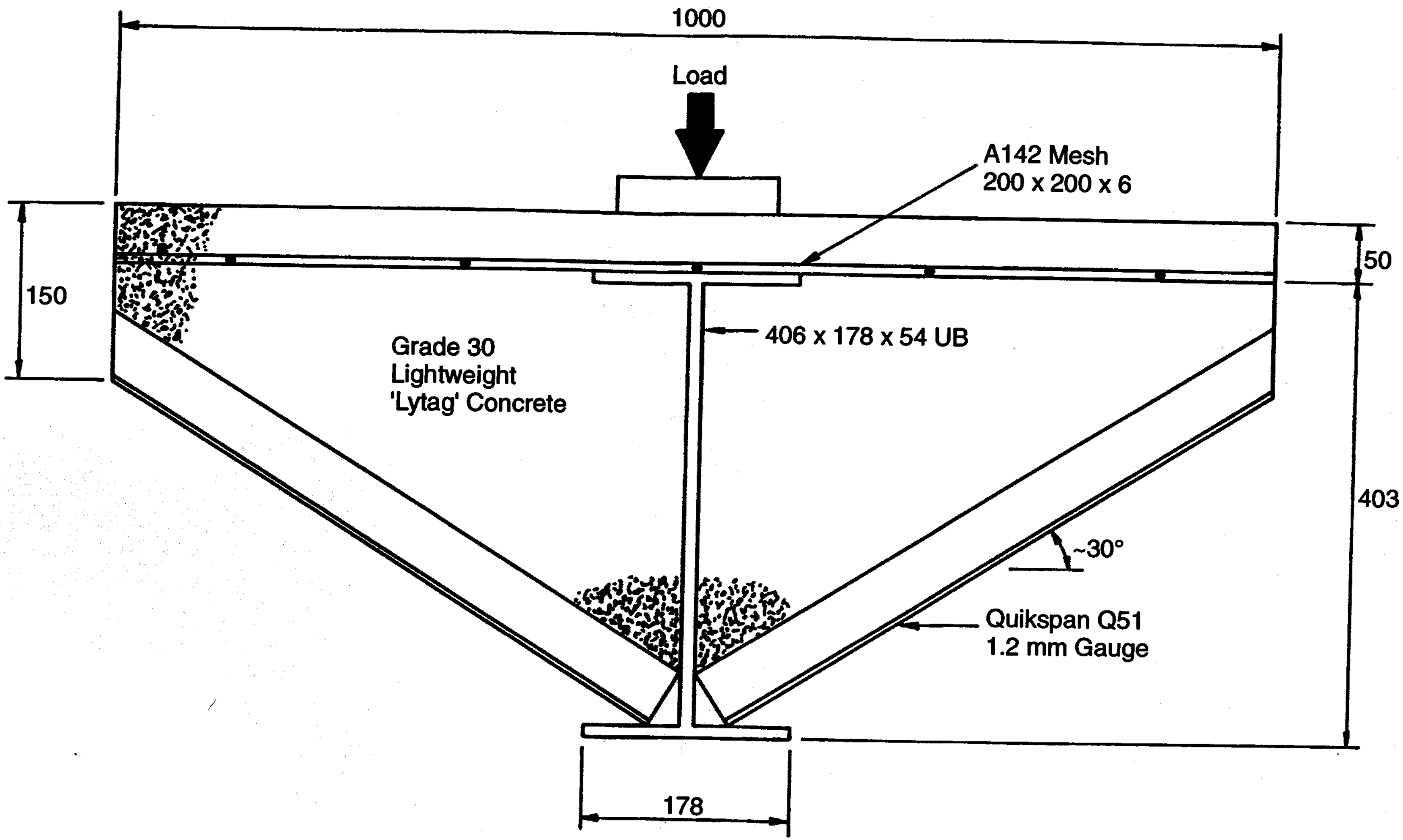


FIG. 1 DIMENSIONAL DETAILS FOR THE QUIKSPAN Q51 PROFILED STEEL DECKING

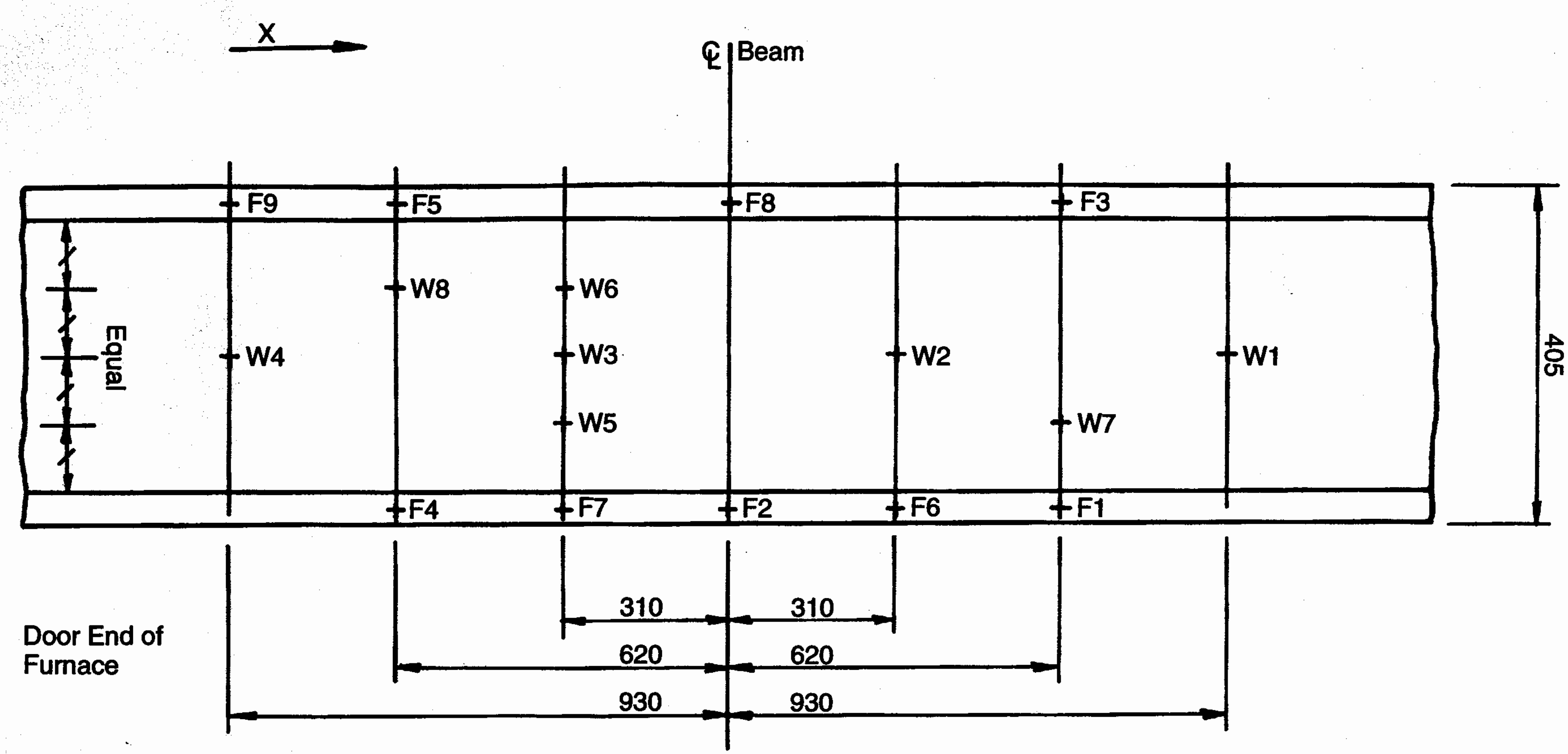


(All dimensions in mm)

FIG. 2

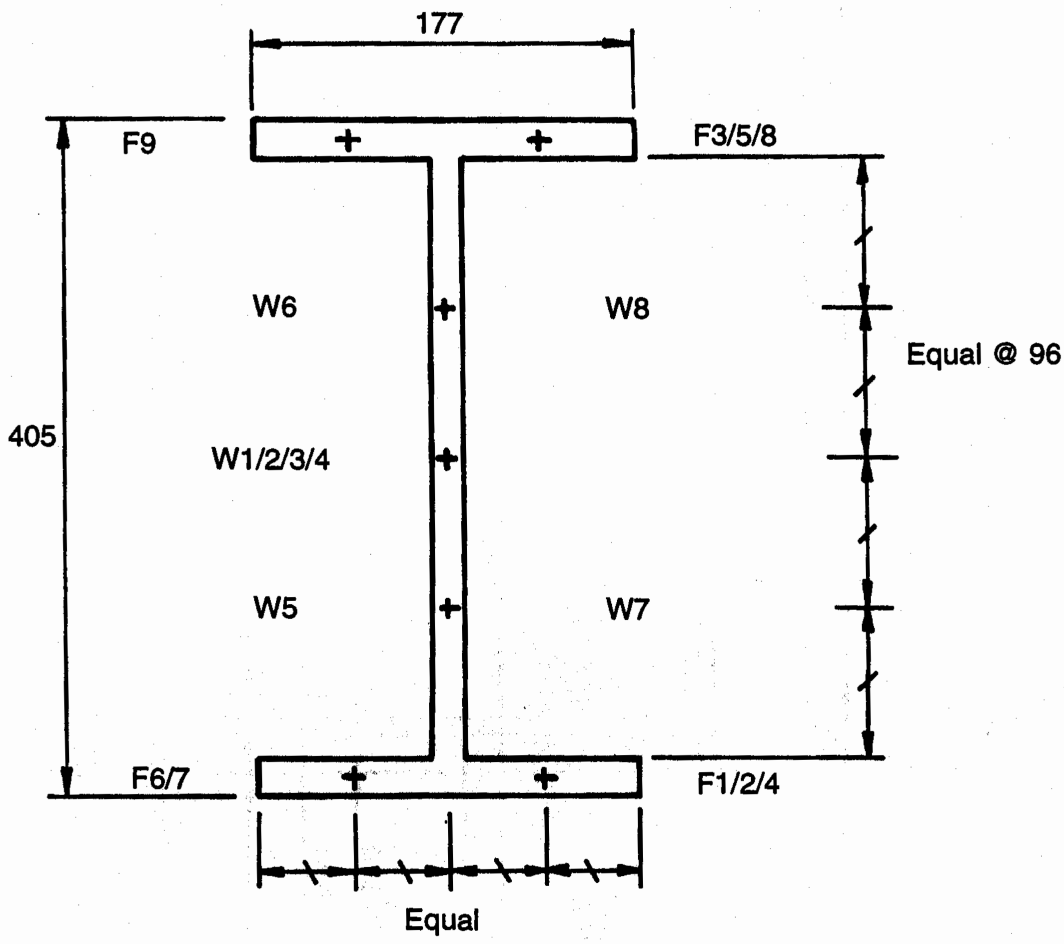
**SCHEMATIC ARRANGEMENT OF COMPONENTS
TEST NO. WFRC 50427 (TRANSVERSE SECTION)
(BASED ON NOMINAL DIMENSIONS)**

(G1066B01)



(All dimensions in mm)

FIG. 3 THERMOCOUPLE POSITIONS IN THE STEELWORK - LONGITUDINAL ARRANGEMENT (G1066B01)



(All dimensions in mm)

FIG. 4 **THERMOCOUPLE POSITIONS IN THE STEELWORK - TRANSVERSE ARRANGEMENT IN DIRECTION OF ARROW 'X' IN FIG. 3** (G1066B02)

APPENDIX 1

DATA SHEET NO. 125

DATA SHEET NUMBER	125A

ARCHED METAL DECK FLOOR BEAM

DIMENSIONS AND PROPERTIES

Section Serial Size and Type (mm)	Dimensions and Properties	Mass per Metre (kg)	Depth of Section (mm)	Width of Section (mm)	Thickness		Elastic Modulus		Plastic Modulus		Moment of Inertia	
					Web (mm)	Flange (mm)	Axis x-x (cm^3)	Axis y-y (cm^3)	Axis x-x (cm^3)	Axis y-y (cm^3)	Axis x-x (cm^4)	Axis y-y (cm^4)
406 x 178 Beam	Nominal Actual	54 54.4	402.6 405	177.6 177	7.6 8.08	10.9 10.57	925.3 922.8	114.5 110.6	1048 1053	177.5 172.4	18 626 18 686	1017 979

CHEMICAL COMPOSITION (PRODUCT ANALYSIS - Wt. %)

Section	Steel Quality	C	Si	Mn	P	S	Cr	Mo	Ni	V	Cu	Nb	Al	N
Beam	Grade 43A	0.11	0.31	1.30	0.020	0.012	<0.02	<0.005	0.02	<0.005	0.03	<0.005	<0.005	0.0048

ROOM TEMPERATURE TENSILE PROPERTIES

Position	LYS (N/mm^2)	UTS (N/mm^2)	Elongation (%)
Flange	335	484	36

NOTES

(a) Initial ambient temperature = 24°C.

(b) Based on an initial ambient temperature of 20°C.

TEST CONDITIONS

TEST CENTRE : Warrington Research
TEST DATE : 7th August 1990
TEST NUMBER : WFRC 50427

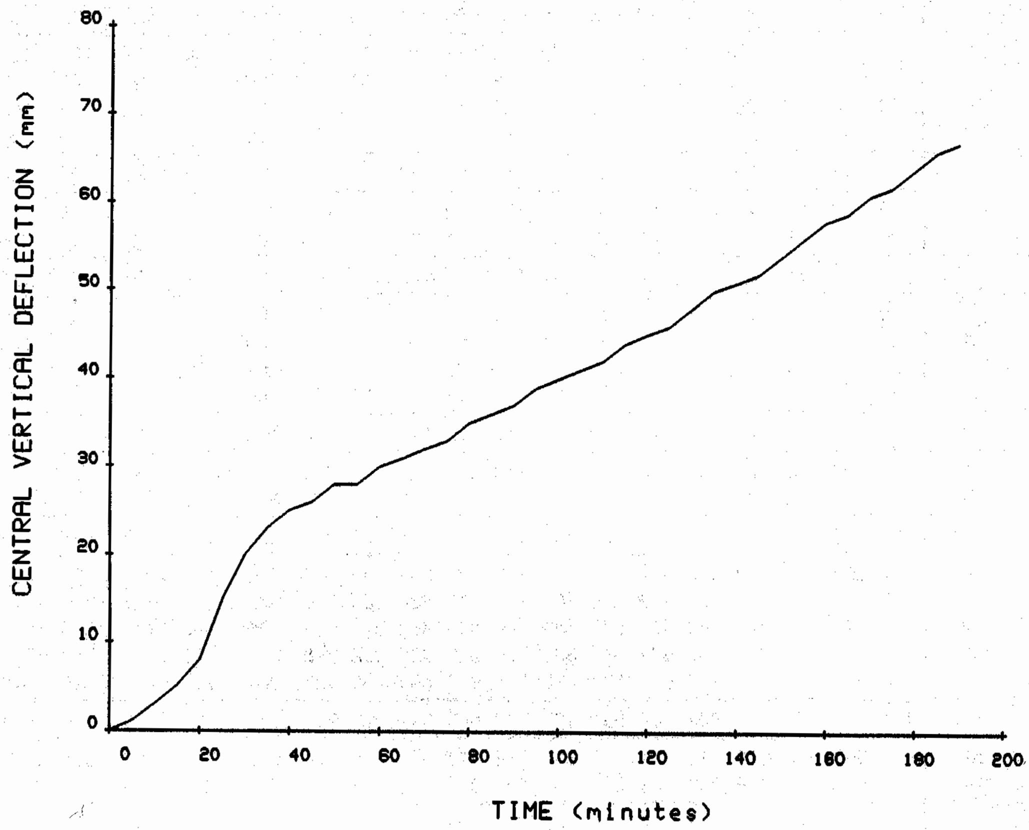
BS476:PARTS 20 & 21: 1987
RESULTS

Time to L/30	:	Not attained
Time to $L^2/9000$ D	:	Not attained
Reload Test	:	Not carried out
Load Bearing Capacity	:	190 minutes
Fire Resistance	:	190 minutes

DATA SHEET NUMBER **125B**

THERMOCOUPLE LOCATION		TEMPERATURE Dev. C AFTER VARIOUS TIMES (MINUTES)																		
		3	6	9	12	15	20	25	30	40	50	60	70	80	90	100	120	140	160	190
Upper Flange	F3	19	19	19	20	20	20	20	22	39	56	64	70	76	82	86	98	100	101	101
	F5	19	19	19	19	20	20	20	21	35	52	67	83	89	92	94	96	97	98	99
	F8	19	19	19	20	20	20	20	23	39	57	73	84	95	96	101	102	103	103	104
	F9	20	19	20	20	20	20	21	22	34	50	62	72	80	83	87	92	95	97	101
	Mean	19	19	19	20	20	20	20	22	37	54	67	77	85	88	92	97	99	100	101
Upper Web	W6	20	20	20	20	21	26	94	101	102	102	102	102	102	102	102	103	103	106	122
	W8	20	19	20	20	20	21	33	93	97	98	99	99	100	100	100	101	101	103	114
	Mean	20	20	20	20	21	24	64	97	100	100	101	101	101	101	101	102	102	105	118
Centre Web	W1	20	20	21	22	32	101	101	100	101	101	102	103	104	108	124	156	180	200	227
	W2	20	20	21	23	30	42	93	101	101	101	100	100	100	100	101	119	140	163	198
	W3	20	20	21	22	42	101	102	102	103	103	103	103	104	107	120	149	173	196	227
	W4	20	20	21	22	26	44	101	102	102	102	102	103	103	106	111	126	154	174	201
	Mean	20	20	21	22	33	72	99	101	102	102	102	102	103	105	114	138	162	183	213
Lower Web	W5	21	26	35	53	90	98	101	101	140	191	228	256	284	310	337	387	438	480	529
	W7	21	25	34	47	67	101	102	102	106	147	172	208	246	278	310	368	417	461	517
	Mean	21	26	35	50	79	100	102	102	123	169	200	232	265	294	324	378	428	471	523
Lower Flange	F1	134	204	297	348	383	457	576	685	797	865	905	943	967	990	1008	1043	1054	1080	1109
	F2	100	161	240	314	391	489	590	666	767	842	888	926	955	978	997	1033	1046	1074	1103
	F4	128	190	264	327	360	427	548	649	764	838	883	923	951	976	994	1033	1042	1072	1102
	F6	95	159	243	326	407	507	612	688	779	843	885	922	948	970	990	1027	1040	1069	1100
	F7	148	219	302	375	440	532	628	695	786	851	893	931	959	981	997	1037	1046	1074	1105
	Mean	121	187	269	338	396	482	591	677	779	848	891	929	956	979	997	1035	1046	1074	1104
Mean Furnace Gas	(a)	468	558	640	670	711	754	808	840	888	917	944	970	991	1009	1022	1059	1066	1089	1122
Standard Curve	(b)	502	603	663	705	739	781	815	842	885	918	945	968	988	1006	1022	1049	1072	1092	1118
Deflection (mm)		-	-	-	-	5	8	15	20	25	28	30	32	35	37	40	45	51	58	67

DATA SHEET NUMBER	**125C**



APPENDIX 2

LOAD CALCULATION SUMMARY SHEETS

A2.1 **TEST NO. WFRC 50427 ON 7 AUG 1990**

A2.2 **CALCULATIONS BASED ON BS449:PART 2:1969**

A2.3 **CALCULATIONS BASED ON BS5950:PART 1:1985**

A2.4 **COMPARISON OF LOADINGS**

A2.1 TEST NO. WFRC 50427 ON 7 AUG 1990

A2.1.1 Geometry

Figure 2 gives the relevant details

A2.1.2 Material Properties

(a) Steel

Universal Beam - 406 x 178 mm x 54 kg/m
Steel Grade - BS4360 Grade 43A

(b) Summary of Nominal and Actual Dimensions and Properties

		Nominal	Actual
Depth of Section	h (mm)	402.6	405
Breadth of Section	b (mm)	177.6	177
Thickness of Flange	t (mm)	10.9	10.57
Thickness of Web	s (mm)	7.6	8.08
Area of Section	A (mm^2)	6 840	6 933
Mass	m (kg/m)	54	54.42
Weight	m (N/m)	530	534
Distance of Neutral Axis from Base of Beam	y (mm)	201.3	202.5
Effective Span of Beam	L (mm)	4 500	4 500
Moment of Inertia (x-x)	I (cm^4)	18 626	18 686
Elastic Modulus (x-x)	Z (cm^3)	925.3	922.8
Plastic Modulus (x-x)	S (cm^3)	1 048	1 053
Modulus of Elasticity	E (kN/mm^2)	205	205
Design Strength	p_y (N/mm^2)	275	335
Classification	Class 1, Plastic (Table 7, BS5950)		

(c) Concrete

The maximum moisture content of the concrete, measured on the day of the test, was found to be 5.0%. The characteristic strength of the concrete was accepted as being 30 N/mm^2 based on the results from the 28 day cube strength tests. The density was reported to be 1860 kg/m^3 which is approximately 77.5% of typical normal weight concrete density of 2400 kg/m^3.

A2.2 CALCULATIONS BASED ON BS449:PART 2:1969

A2.2.1 Calculations Using Nominal Dimensions and Properties

Maximum allowable bending stress, Table 2, (for steel with a minimum yield stress of 275 N/mm^2):

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

Percentage of allowable bending stress required during the test is 100%.

Therefore, bending stress required is 165 N/mm^2

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

The required bending moment is given by (f I) / y.

$$\frac{f\,I}{y} = \frac{wL^2}{8}$$

Therefore, w, the load per metre run, (in N/m), is given by:

$$w = \frac{8\,f\,I}{y\,L^2}$$

$$= \frac{8 \times 165 \times 18\,626 \times 10^7}{201.3 \times 4500 \times 4500} \text{ N/m}$$

$$= \underline{60\,315 \text{ N/m}}$$

For the Light-Weight Concrete Slab.

Based on the dimensional data given in Fig. 2 the area of cross section is 0.3035 m^2.

Density of concrete is 1860 kg/m^3.

Therefore the concrete load per metre run is given by:

$$w_{conc} = 0.3035 \times 1860 \text{ kg/m}$$

$$= 564.51 \text{ kg/m}$$

$$= \underline{5538 \text{ N/m}}$$

Total Self Weight of Beam and Concrete Slab, (Dead Load).

$$w_1 = 530 + 5538 \text{ N/m}$$

$$= \underline{6068 \text{ N/m}}$$

Total load to produce required bending stress

$$w_2 = 60\,315 - 6068 \text{ N/m}$$

$$= \underline{54\,247 \text{ N/m}}$$

Therefore total imposed load

$$W = 54\,247 \times 4.5 \text{ N}$$

$$= 244\,112 \text{ N}$$

$$= \underline{244.11 \text{ kN}}$$

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

Point Loads Required are:-

$$P = 244.11 / 4 \text{ kN} \quad \text{(i.e. 24 884 / 4 kg)}$$

$$= \underline{61.03 \text{ kN}} \quad \text{(i.e. 6221 kg)}$$

$$\underline{6.22 \text{ tonnes}}$$

The total load actually applied was 24.34 tonnes.

A2.2.2 Retrospective Calculations Using Actual Dimensions and Properties

The required bending moment is given by (f I) / y

$$\frac{f\,I}{y} = \frac{w\,L^2}{8}$$

Therefore, w, the load per metre run, (in N/m), is given by

$$w = \frac{8\,f\,I}{y\,L^2}$$

$$= \frac{8 \times f \times 18\,686 \times 10^7}{202.5 \times 4500 \times 4500} \text{ N/m} \qquad \text{... (A2/1)}$$

Since the load actually applied was 24.34 tonnes

$$W = 24\,340 \text{ kg}$$

$$= \underline{238\,775 \text{ N}}$$

and therefore the total load generating the bending stress is

$$w_2 = 238\,775 / 4.5 \text{ N/m}$$

$$= \underline{53\,061.2 \text{ N/m}}$$

But the total self-weight of the Beam and Concrete Slab is given by

$$w_1 = 534 + 5538 \text{ N/m}$$

$$= \underline{6072 \text{ N/m}}$$

Therefore the load available to generate a bending moment is

$$w = 53\,061.2 + 6072 \text{ N/m}$$

$$= \underline{59\,133.2 \text{ N/m}}$$

Substituting w in the earlier expression (A2/1) we have:

$$59\ 133.2 = \frac{8 \times f \times 18\ 686 \times 10^7}{202.5 \times 4500 \times 4500} \text{ N/mm}^2$$

$$\therefore \quad f = \frac{59\ 133.2 \times 202.5 \times 4500 \times 4500}{8 \times 18\ 686 \times 10^7}$$

$$= \underline{162.2 \text{ N/mm}^2}$$

The retrospective calculation, based on actual dimensions and properties, suggests that the steel section was loaded to 98.3% of the maximum allowable bending stress (BS449 Design Rules).

A2.3 CALCULATIONS BASED ON BS5950:PART 1:1985

A2.3.1 Initial Calculations Using Nominal Dimensions and Properties

(a) Moment Capacity of beam for a plastic or compact section, with assumed low shear load.

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

$$= 275 \times 1048 \times 10^{-3} \text{ kN m}$$

$$= \underline{288.2 \text{ kN m}}$$

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

$$1.2\, p_y Z = 1.2 \times 275 \times 925.3 \times 10^{-3} \text{ kN m}$$

$$= \underline{305.3 \text{ kN m}}$$

So $p_y S$ is less than $1.2\, p_y Z$

(b) From A2.2.1, Self Weight of beam and Concrete Slab, (dead load), is 6068 N/m

So $w_1 = \underline{6.068 \text{ kN/m}}$

Moment produced by dead load is given by

$$\text{Moment}_1 = (w_1 L^2) / 8 \text{ kN m}$$

$$= \frac{6.068 \times 4.5 \times 4.5}{8} \text{ kN m}$$

$$= \underline{15.360 \text{ kN m}}$$

From A2.2.1, Total Imposed Load is 244 112 N.

So $W = \underline{244.112 \text{ kN}}$

Assuming a uniformly distributed load, the moment produced by the imposed load is given by

$$\text{Moment}_2 = (WL) / 8 \ \text{kN m}$$

$$= \frac{244.112 \times 4.5}{8} \ \text{kN m}$$

$$= \underline{137.313 \ \text{kN m}}$$

Total Moment Applied, (dead + imposed loads)

$$M_x = 15.36 + 137.313 \ \text{kN m}$$

$$= \underline{152.673 \ \text{kN m}}$$

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

$$LR = M_f / M_c$$

$$= 152.673 / 288.2$$

$$= \underline{0.530}$$

(c) Check Shear Force, (F_V), does not exceed shear capacity, (P_V)

Maximum Shear Force at the ends

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

$$= (60.315 \times 4.5) / 2 \ \text{kN}$$

$$= \underline{135.71 \ \text{kN}}$$

Shear Capacity

$$P_V = 0.6 \ p_y A_v$$

where A_v is the shear area.

For an I section $A_v = h \times s$

$$\therefore \quad P_V = 0.6 \times 275 \times 402.6 \times 7.6 \times 10^{-3} \ \text{kN}$$

$$= \underline{504.86 \ \text{kN}}$$

Therefore since $F_V < P_V$ the low shear load calculation, (a), is acceptable.

A2.3.2 Calculations Using Actual Dimensions and Properties

(a) Moment Capacity of Beam for a plastic or compact section, with assumed low shear load.

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

$$= 335 \times 1053 \times 10^{-3} \text{ kN m}$$

$$= \underline{352.76 \text{ kN m}}$$

Check whether $p_y S \le 1.2\, p_y Z$

$$1.2\, p_y Z = 1.2 \times 335 \times 922.8 \times 10^{-3} \text{ kN m}$$

$$= \underline{370.97 \text{ kN m}}$$

So $p_y S$ is less than $1.2\, p_y Z$.

(b) From A2.2.2, Self Weight of beam and concrete slab, (dead load), is 6072 N/m.

So $w_1 = \underline{6.072 \text{ kN/m}}$

Moment produced by dead load is given by

$$\text{Moment}_1 = (w_1 L^2) / 8 \text{ kN m}$$

$$= \frac{6.072 \times 4.5 \times 4.5}{8} \text{ kN m}$$

$$= \underline{15.370 \text{ kN m}}$$

From A2.2.2 Total imposed load is 238 775 N.

So $W = 238.775$ kN

Assuming a uniformly distributed load, the moment produced by the imposed load is given by

$$\text{Moment}_2 = (WL) / 8 \text{ kN m}$$

$$= \frac{238.775 \times 4.5}{8} \text{ kN m}$$

$$= \underline{134.311 \text{ kN m}}$$

Total Moment Applied, (dead + imposed loads)

$$M_x = 15.37 + 134.311 \text{ kN m}$$

$$= \underline{149.681 \text{ kN m}}$$

and therefore the load ratio given by

$$LR = M_f / M_c$$

$$= 149.681 / 352.76$$

$$= \underline{0.424}$$

A2.4 COMPARISON OF LOADINGS

A2.4.1 BS449:Part 2:1969

Based on nominal dimensions and section properties it was calculated that in order to develop the maximum permissible bending stress of 165 N/mm^2 in the lower flange of the steel section an imposed load of 24.88 tonnes was required. However, in the test the load actually applied was 24.34 tonnes. Retrospective calculations using this load in conjunction with the actual section properties data indicates that the bending stress in the lower flange was slightly lower than intended at 162.2 N/mm^2, or 98.3% of the maximum permitted value.

A2.4.2 BS5950:Part 1:1985

Based on nominal values and the application of the previously calculated imposed loading of 24.88 tonnes the load ratio for the test assembly was found to be 0.53. When the lower actual loading value was used in conjunction with the actual section properties data the load ratio value reduced to 0.42. The single most effective factor in bringing about such a reduction is the design strength which at 335 N/mm^2 is much higher than the nominal value of 275 N/mm^2.

APPENDIX 3

PC DISK VERSION OF DATA

As mentioned in the Introduction to this report the data recorded during the test are available on a PC disk. The following section gives a brief outline of the material available and its format. The reader may find it useful to additionally consult Reference 1.

The data are held on the disk in the form of ASCII text files. This format has been chosen since the majority of commercial software packages can import files of this type. The format allows the data to be referenced either via the screen, (or printer), or read directly by PC based software. The data are initially being made available on 3½ inch DSDD, 720 KB, floppy disks, but other disk sizes and formats can be supplied on request. The data files have been designated 'read only' in order to safeguard the user from accidentally corrupting or erasing them.

The data file is identified by reference to the DATA SHEET NUMBER sequence, i.e. 125.DAT. This numbering system is consistent with that introduced in Reference 1. The thermal data recorded during the fire test have been divided into 'SETS' which reflect the positions of the thermocouples in the steel section. Mean temperature values are included in the sets where it is considered valid to do so. In order that the columns of data in any particular 'SET' can be related to the corresponding thermocouple positions a 'README' file is associated with the data file. README.125 which relates to data in file 125.DAT is shown in Table A3.1.

REFERENCE

1. D.E. Wainman: 'Compendia of UK Standard Fire Test Data - Unprotected Structural Steel Nos. 1 and 2, PC Disk Version', Report SL/HED/R/S2298/1/92/C, British Steel Technical, Swinden Laboratories, 1992.

TABLE A3.1
README FILE ASSOCIATED WITH DATA FILE 125.DAT

Data file 125.DAT contains data recorded during the standard fire resistance test number WFRC 50427 which is described in report number SL/HED/R/S2442/3/95/C - 'Summary of Data Obtained During a Test on an Arched Metal Deck Floor Beam' and should be read in conjunction with that document.

There are 28 items of data which, together with their mean values, are grouped in sets as shown below.

Set Number	Items in Columns
SET001.DAT	TIME, F3, F5, F8, F9, MEAN
SET002.DAT	TIME, W6, W8, MEAN
SET003.DAT	TIME, W1, W2, W3, W4, MEAN
SET004.DAT	TIME, W5, W7, MEAN
SET005.DAT	TIME, F1, F2, F4, F6, F7, MEAN
SET006.DAT	TIME, ISO, AT1, AT2, AT3, AT4, AT5, AT6, AT7, AT8, MEAN ATM
SET007.DAT	TIME, DEFLECTION