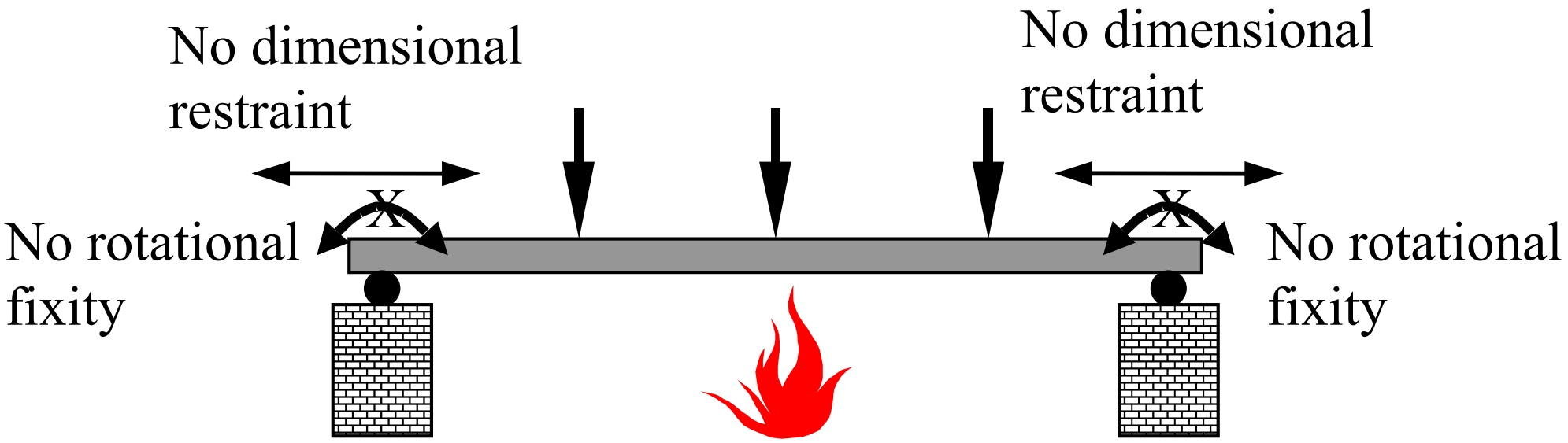
Route 1: Standard fire resistance tests

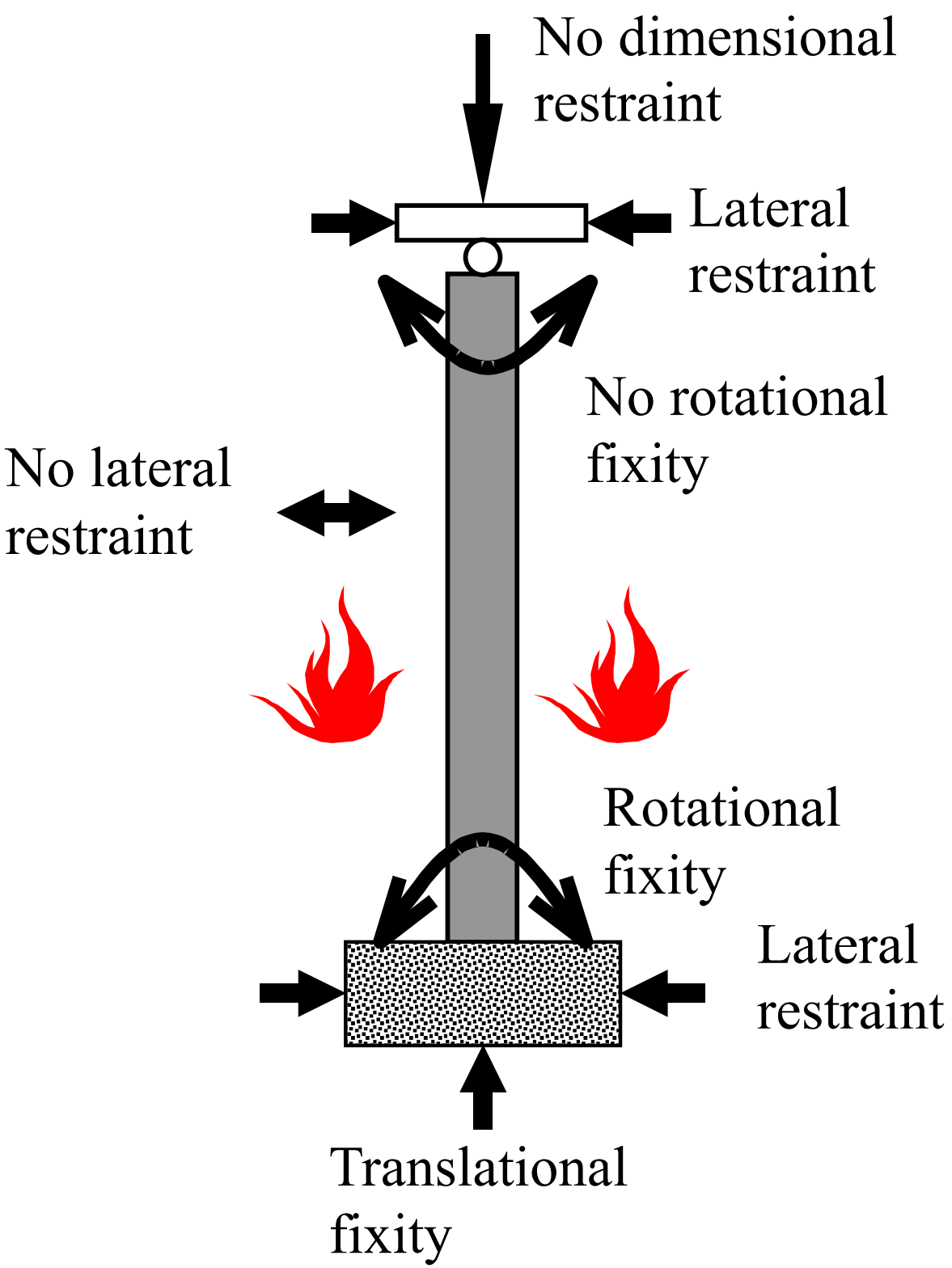
Standard Fire Resistance Tests: the tabulated

method has been developed based on standard fire resistance tests which still dominate the development of fire protection methods. In this type of test, an isolated structural member with idealised loading and boundary conditions and limited dimensions, which may have no relation to the design situation, is exposed to fire in a furnace that is regulated to follow the standard fire exposure temperature-time relationship. A typical horizontal test (beam/floor slab) is shown below.



Standard fire resistance test:

a typical vertical (column/wall) test arrangement is sketched.



Applied loads

Table NA.A1.1 — Values of Ψ factors for buildings

Action	Ψ_0	Ψ_1	Ψ_2
Imposed loads in buildings, category (see EN 1991-1.1)			
Category A: domestic, residential areas	0,7	0,5	0,3
Category B: office areas	0,7	0,5	0,3
Category C: congregation areas	0,7	0,7	0,6
Category D: shopping areas	0,7	0,7	0,6
Category E: storage areas	1,0	0,9	0,8
Category F: traffic area, vehicle weight $\leq$ 30 kN	0,7	0,7	0,6
Category G: traffic area, 30 kN < vehicle weight $\leq$ 160 kN	0,7	0,5	0,3
Category H: roofs[a]	0,7	0	0
Snow loads on buildings (see EN 1991-3)			
— for sites located at altitude H > 1 000 m a.s.l.	0,70	0,50	0,20
— for sites located at altitude H $\leq$ 1 000 m a.s.l.	0,50	0,20	0
Wind loads on buildings (see EN 1991-1-4)	0,5	0,2	0
Temperature (non-fire) in buildings (see EN 1991-1-5)	0,6	0,5	0

[a] See also EN 1991-1-1: Clause 3.3.2 (1)

Table 5 — Load factors fo

Load	
Dead load	
Imposed loads:	
a) permanent:	
1) those specifically allowed for in design, e.g. plant, machinery and fixed partitions	1.00
2) in storage buildings or areas used for storage in other buildings (including libraries and designated filing areas)	1.00
b) non-permanent:	
1) in escape stairs and lobbies	1.00
2) in offices for general use	0.50
3) all other areas (imposed snow loads on roofs may be ignored)	0.80
Wind loads:	
a) design for boundary conditions to control external fire spread	0.00
b) all other cases	0.33

Thermocouples:

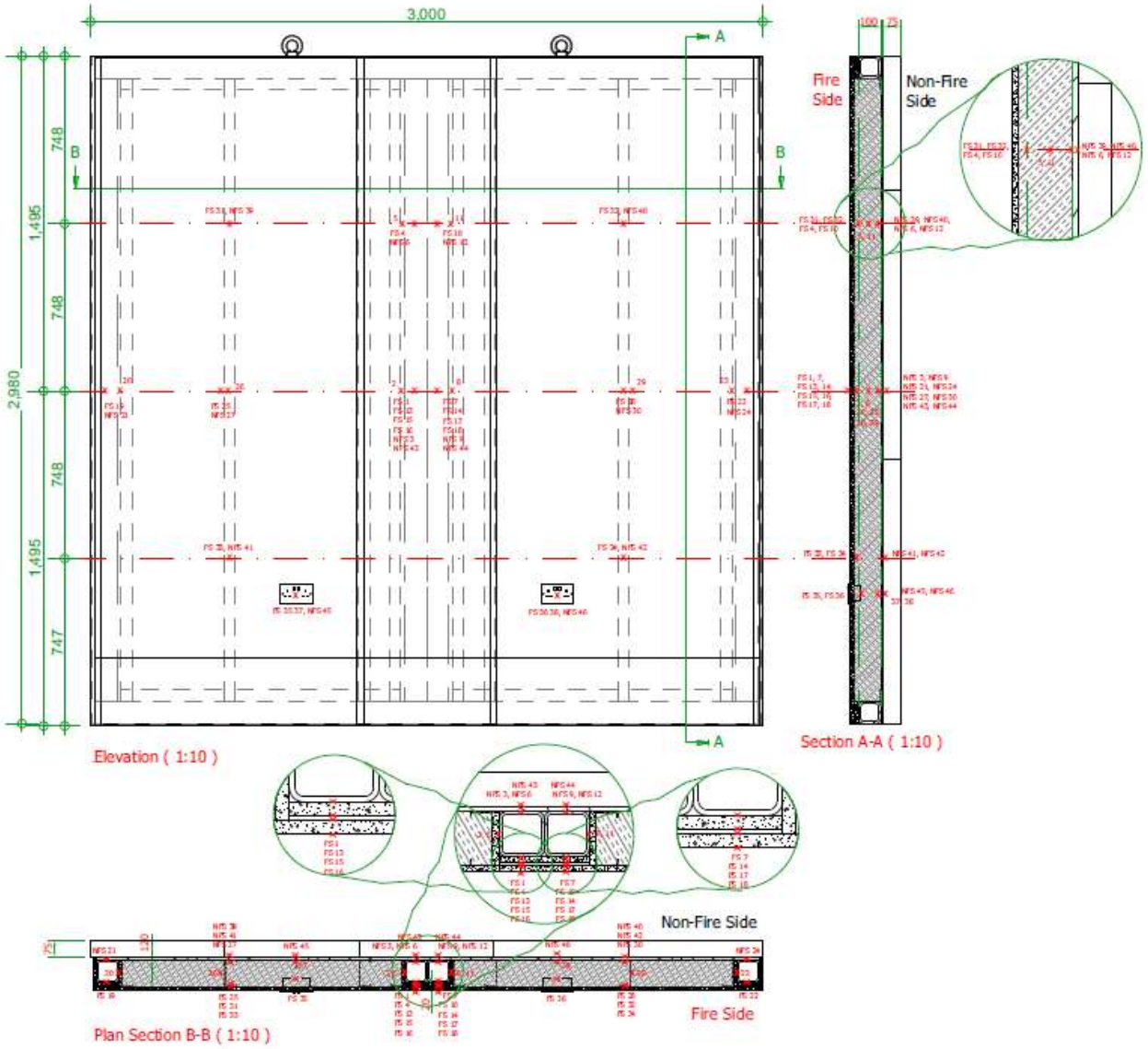
unless additional TCs are specified, the fire test lab will only install the minimum number of TCs to monitor temperatures on the unexposed surface

GENERAL PLAN VIEW OF TEST SPECIMEN SHOWING THERMOCOUPLE POSITIONS - UNEXPOSED FACE

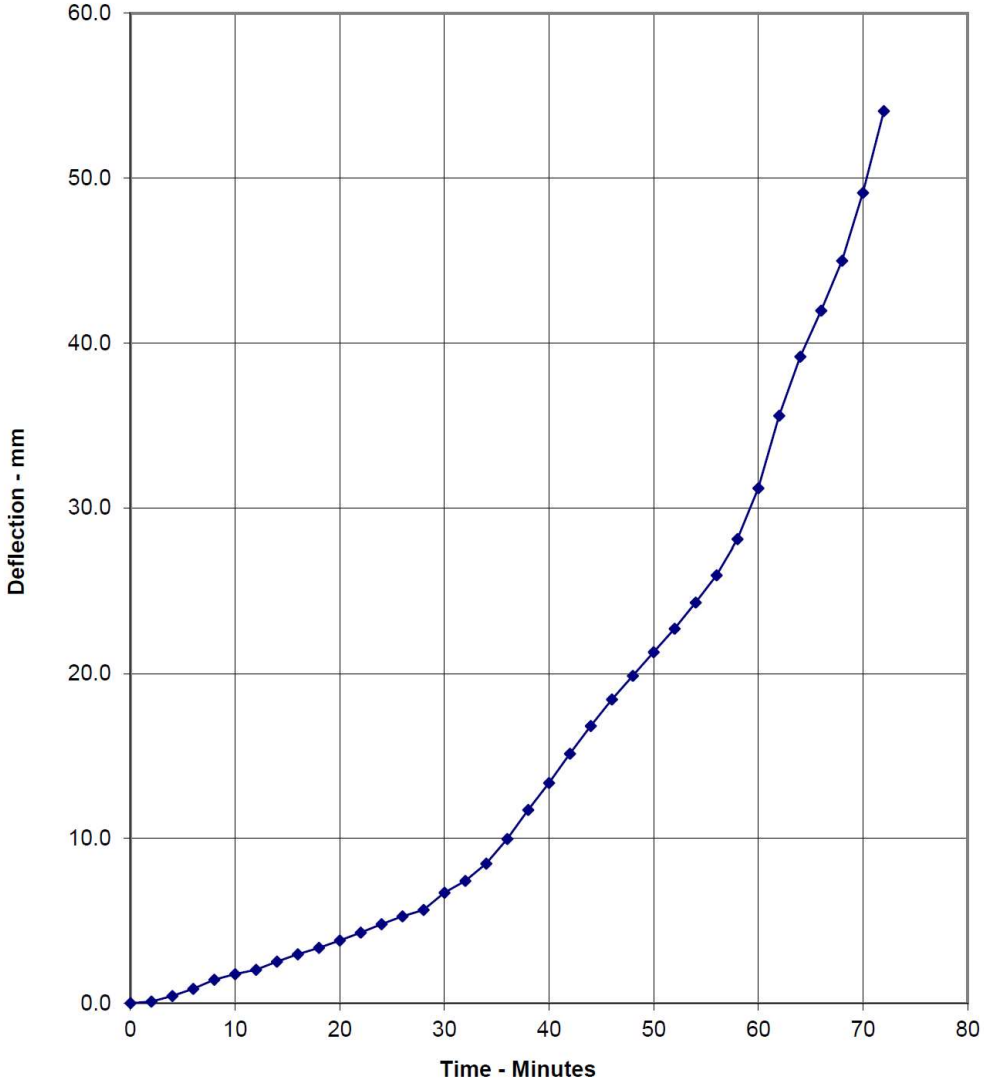
■ Positions of thermocouples

See also figures 4, 5, 6, & 7 for internal thermocouple positions

More thermocouples please!



Fire test duration until failure



Route 2: manufacturer certified solution: Tabulated method

Example:

Determine the necessary fire protection to a structural steel member in a non-sprinklered office building of 28m tall.

Step 1: determine the required standard fire resistance rating.

Table A2 **Minimum periods of fire resistance**

Purpose group of building	Minimum periods (minutes) for elements of structure in a:					
	Basement storey ($) including floor over		Ground or upper storey			
	Depth (m) of a lowest basement		Height (m) of top floor above ground, in a building or separated part of a building			
	more than 10	not more than 10	not more than 5	not more than 18	not more than 30	more than 30
1. Residential (domestic):						
a. flats and maisonettes	90	60	30*	60**†	90**	120**
b. and c. dwellinghouses	not relevant	30*	30*	60@	not relevant	not relevant
2. Residential:						
a. Institutional æ	90	60	30*	60	90	120#
b. Other residential	90	60	30*	60	90	120#
3. Office:						
– not sprinklered	90	60	30*	60	90	not permitted
– sprinklered (2)	60	60	30*	30*	60	120#
4. Shop and commercial:						
– not sprinklered	90	60	60	60	90	not permitted
– sprinklered (2)	60	60	30*	60	60	120#
5. Assembly and recreation:						
– not sprinklered	90	60	60	60	90	not permitted
– sprinklered (2)	60	60	30*	60	60	120#
6. Industrial:						
– not sprinklered	120	90	60	90	120	not permitted
– sprinklered (2)	90	60	30*	60	90	120#
7. Storage and other non-residential:						
a. any building or part not described elsewhere:						
– not sprinklered	120	90	60	90	120	not permitted
– sprinklered (2)	90	60	30*	60	90	120#
b. car park for light vehicles:						
i. open sided car park (3)	not applicable	not applicable	15*+	15*+	15*+	60
ii. any other car park	90	60	30*	60	90	120#

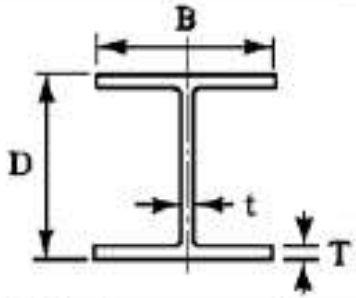
Tabular Method: Determination of Fire Protection Thickness, Yellow Book

Step 2: Based on the steel section size (UKC254x73) from cold design and the assumed fire protection type (board), determine the Section Factor Hp/A. Such information is provided in an industrial guide referred to as the "Yellow Book".

Table 4: October 2006

Columns (UKC)

Dimensions to BS4 Part 1:2005

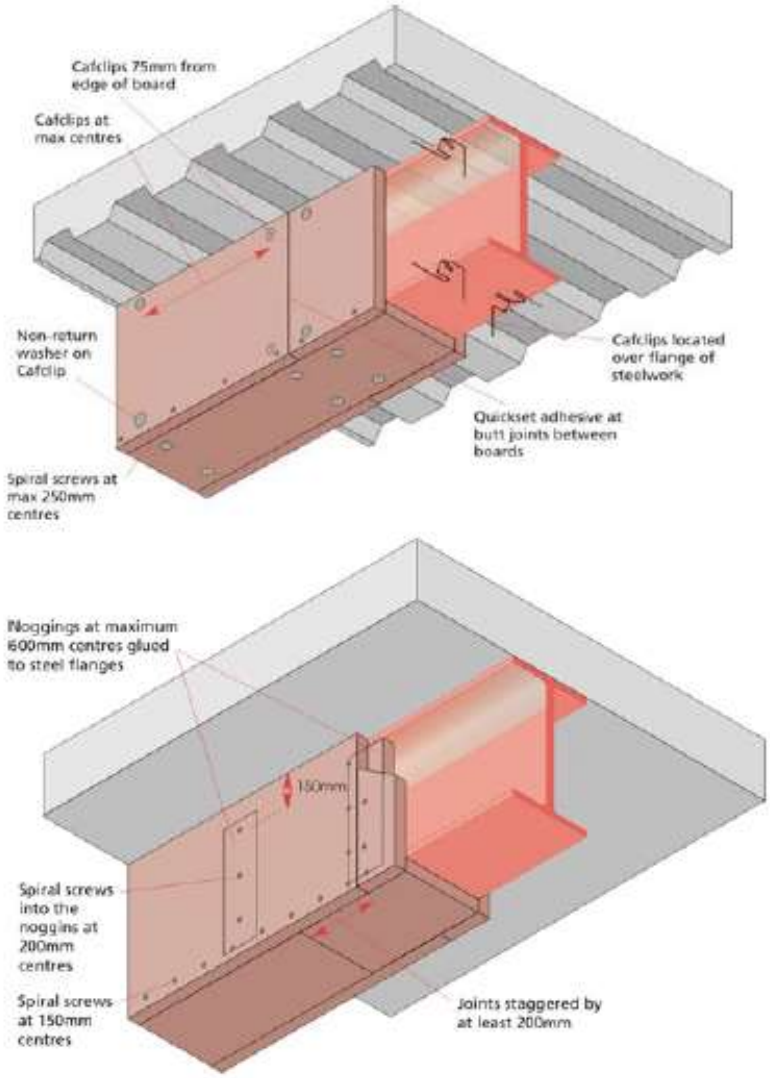


Designation		Depth of section D	Width of section B	Thickness		Area of section	Section factorA/V(Hp/A)			
							Profile		Box	
							3 sides	4 sides	3 sides	4sides
Serial size	Mass per metre			Web t	Flange T					
mm	kg	mm	mm	mm	mm	cm²	m⁻¹	m⁻¹	m⁻¹	m⁻¹
254 x 254	167	289.1	265.2	19.2	31.7	212.855	60	75	40	50
	132	276.3	261.3	15.3	25.3	168.134	75	90	50	65
	107	266.7	258.8	12.8	20.5	136.381	95	110	60	75
	89	260.3	256.3	10.3	17.3	113.311	110	135	70	90
	73	254.1	254.6	8.6	14.2	93.100	130	160	80	110

Example: UKC254x254x73, 4 sided box,
Hp/A=110m^{-1}

Step 3: Given FR=90 min, Hp/A=110 m^{-1}, based on the fire protection product to be used, the fire protection thickness can be decided. For example, here, 30mm thickness is good for section factors up to 119m^{-1} at FR=90minutes if the assessment temperature is 550°C under the standard fire exposure.

COLUMNS						
Critical Temperature 550°C						
Stud welded pins and adhesive fixing system or Noggings and adhesive fixing system						
Section factor Hp/A (m^{-1})	Fire resistance period (minutes)					Product thickness
	30	60	90	120	180	240	
	260	185	74	46			20mm
		250	95	59			25mm
		260	119	73	41		30mm
			143	86	48		35mm
			169	101	56	38	40mm
			196	116	63	43	45mm
			226	131	71	49	50mm
			260	164	87	59	60mm
				200	104	70	70mm
				239	122	82	80mm
				260	141	94	90mm
					160	106	100mm
					181	118	110mm



Thickness = 30mm

Assessment Temperature: this is the temperature that the steelwork should not exceed in fire. In the tabulated method, it is typically fixed (550C for columns and 620C for beams). However, this value can change depending on the loading condition on the structure.

FIREPRO BEAMCLAD SYSTEMS

	Clips or Stud welded pins, Dry joint system								Glued noggins. Dry joint system								
	BEAMS 3 sided protection In contact with, and fixed to, concrete floor decks **Critical temperature: 620°C**				**BEAMS AND COLUMNS** 4 sided protection and other configurations **Critical temperature: 550°C**				**BEAMS** 3 sided protection In contact with, and fixed to, concrete floor decks **Critical temperature: 620°C**				**BEAMS AND COLUMNS** 4 sided protection and other configurations **Critical temperature: 550°C**				Product thickness
	Fire resistance period (minutes)								Fire resistance period (minutes)								
Section factor Hp/A (m-1)	**30**	**60**	**90**	**120**	**30**	**60**	**90**	**120**	**30**	**60**	**90**	**120**	**30**	**60**	**90**	**120**	
	260	260	260	95	260	260	148	65	260	260	196	73	260	260	146	65	25mm
				124			206	84			260	93			202	83	30mm
				159			260	104				116			260	103	35mm
				200				128				143				126	40mm
				251				155				173				153	45mm
				260				187				209				184	50mm
								225				252				221	55mm
								260				260				260	60mm
Tested and assessed to BS 476:Part 21																	