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EFFECTIS ERA AVRASYA TEST VE BELGELENDİRME A.Ş.

Dilovası OSB, 5. Kısım, Fırat Caddesi No:18, Dilovası, KOCAELİ/TÜRKİYE

DENEY RAPORU

TEST REPORT

AB-0556-T

20.05.2019

RFTR19114

Müşterinin adı/adresi : ISONEM BOYA VE YALITIM TEKNOLOJİLERİ İNŞ. SAN. TİC. A.Ş.
Customer name/address İTOB OSB, 10001 Sk. No:20, Tekeli, Menderes, İZMİR, TURKEY

İstek numarası : EEA-18-000393
Order No.

Numunenin adı ve tarifi : Fire Resistance Intumescent Paint For Structural Steels "ISONEM Anti-Fire
Name and identity of test sample Paint Plus" – (Loaded beam-7500 µm)

Numunenin kabul tarihi : 13.11.2018
The date of receipt of sample

Açıklamalar :
Remarks

Deneyin yapıldığı tarih : 18.04.2019
Date of test

Raporun sayfa sayısı : 10 (21 pages including appendixes)
Number of pages of the Report

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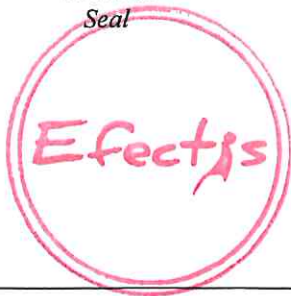
The test and/or measurement results, the uncertainties (if applicable) with confidence probability and test methods are given on the following pages which are part of this report

Mühür
Seal

Tarih
Date

Deney Sorumlusu
Person in charge of test

Laboratuvar Müdürü
Head of Testing Laboratory



20.05.2019

Mustafa Emre ÖZBEY

Ali BAYRAKTAR

Bu rapor, laboratuvarın yazılı izni olmadan kısmen kopyalanıp çoğaltılamaz.

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1. SCOPE

Fire resistance test, in conformity with the general requirements of standards EN 1363-1:2012, with substitute or additional methods of standard EN 1363-2:1999 and with the particular requirements of standard EN 13381-8:2013 "Test methods for determining the contribution to the fire resistance of structural members - Part 8: Applied reactive protection to steel members".

2. TEST LABORATORY

Name : Efectis Era Avrasya Test ve Belgelendirme A.Ş.

Address : Dilovası OSB, 5. Kısım, Fırat Caddesi No:18, Dilovası, KOCAELİ/TURKEY

3. DESCRIPTION OF THE TEST SPECIMEN**3.1. General**

Product identification: Fire Resistance Intumescent Paint For Structural Steels "**ISONEM Anti-Fire Paint Plus**" – (Loaded beam 7500 µm)

Manufacturer of paint : ISONEM BOYA VE YALITIM TEKNOLOJİLERİ İNŞ. SAN. TİC. A.Ş.
İTOSB OSB, 10001 Sk. No:20, Tekeli, Menderes, İZMİR, TÜRKİYE

Sponsor of test : ISONEM BOYA VE YALITIM TEKNOLOJİLERİ İNŞ. SAN. TİC. A.Ş.
İTOSB OSB, 10001 Sk. No:20, Tekeli, Menderes, İZMİR, TÜRKİYE



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3.2. Preparation of Test Specimens

3.2.1. Steel Profiles

The steel profiles were supplied by the test laboratory include IPE 400 profiles. The specimens were described below in the Table 1.

Table 1: Test specimens

Test specimen	Steel Symbol	Type of steel section	Length (mm)	Protection thickness (μm)
Reference beam	RB-2	IPE 400	1000	7500
Loaded beam	LB-2	IPE 400	5200	7500

Table 2: Details of profiles

No.	Symbol	Section type	Heating	Profile	Measured values						
					h [mm]	b [mm]	t_f [mm]	t_w [mm]	P [mm]	A [mm ²]	Section factor [m ⁻¹]
1	RB-2	open	3 side	IPE 400	402	182	13	9,5	1330	8444	157
2	LB-2	open	3 side	IPE 400	402	181	13	9,5	1329	8364	159

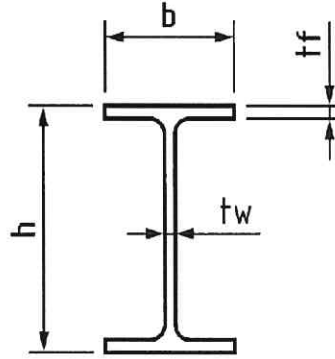


Figure 1: Profile details



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3.2.2. The fire protection system

The fire protection system consists of Fire Resistance Intumescent Paint For Structural Steels "ISONEM Anti-Fire Paint Plus"

Table 3: Measured points of the IPE 400 (7500 µm)

Results	MEAN	MIN	MAX	MEAN -20%	MEAN +20%	MEAN -30%	MEAN +30%	MEAN -45%	MEAN +45%	% of readings within limit			Result
	8059	7596	8540	6447	9671	5641	10477	4432	11686	±20%	±30%	±45%	
	Deviation = 6,0 %			Requirements						68%	95%	100%	PASS

Measurement no.:		1	2	3	4	5	6	7	8	% of readings within limit		
										±20%	±30%	±45%
Measuring points	1. Position 1 temperature measurement station	7833	8023	8323	8175	8373	8092	8029	8044	100%	100%	100%
	2. Position 2 temperature measurement station	8065	8134	8113	8470	8525	8540	8506	8498	100%	100%	100%
	3. Position 3 temperature measurement station	8230	8321	8106	8072	8106	8536	8505	8440	100%	100%	100%
	4. Position A temperature measurement station	7940	7978	8050	8044	8056	8102	7860	7765	100%	100%	100%
	5. Position B temperature measurement station	7850	7834	8020	8088	8091	8125	8061	8115	100%	100%	100%
	6. Halfway between Position 1 and Position A	8123	8040	8079	8061	8137	8133	7999	7966	100%	100%	100%
	7. Halfway between Position A and Position 2	7847	7874	7894	7936	7947	7978	7814	7843	100%	100%	100%
	8. Halfway between Position 2 and Position B	7700	7654	7758	7760	8012	8112	8074	8040	100%	100%	100%
	9. Halfway between Position B and Position 3	7921	7622	7930	7973	8020	8171	8115	8179	100%	100%	100%
	10. Halfway between Position 1 and beam's end	7934	7935	8005	7877	8025	8303	8254	8295	100%	100%	100%
	11. Halfway between Position 3 and beam's end	7687	7596	8105	7960	8220	8122	8082	8040	100%	100%	100%
		Requirements								68%	95%	100%

All measurements in [µm]



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Table 4: Measured points of the IPE 400 (7500 µm)

Results	MEAN	MIN	MAX	MEAN -20%	MEAN +20%	MEAN -30%	MEAN +30%	MEAN -45%	MEAN +45%	% of readings within limit			Result
	8160	7700	8585	6528	9792	5712	10608	4488	11832	±20%	±30%	±45%	
Deviation = 5,6 %										Requirements	68%	95%	100%

Measurement no.:										% of readings within limit		
										±20%	±30%	±45%
Measuring points	1. Position 1 temperature measurement station	7970	8343	8550	7936	8536	7950	7840	7700	100%	100%	100%
	2. Position 2 temperature measurement station	8080	8141	8246	8340	8122	8225	8453	8384	100%	100%	100%
	3. Position 3 temperature measurement station	7970	7964	7950	8360	8585	7960	7925	8308	100%	100%	100%
Requirements										68%	95%	100%

All measurements in [µm]

- Type: Steel Fire Protection Paint is a water base acrylic coating fire retardant. This coat is specially designed as passive fire protection for steel constructions. Coat can be applied for structural steel exposed and internal environments.
- Thickness: Thickness measurements were reached by applying 400 µm per a day. 24 hours drying internal is waited between application of each layer.
- Paint : Water based fire retardant intumescent paint
 - Nominal density : 1150±0.05 kg/m³
 - Measured density: 1288.32 kg/m³
 - Nominal thickness: 1.5-7.5 µm

3.2.2. Application

"ISONEM Anti-Fire Paint Plus" paint was applied on the surface with the air injection spray machine. The paint was applied by brush for strips and small areas. The epoxy based prime paint that has 50 µm thicknesses was applied on the beams before the test to protect from corrosion

*Brand, type, quantity and dimension information of the components, when it is not possible to be verified by the laboratory, are given according to the sponsor's declaration.



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4. PRE-TEST PROCESSES

4.1. Verification of specimen

Efectis Era Avrasya A.S. verified the used materials and parts against the supplied data and drawings during installation of the test specimen and not involved in the selection of test specimen.

The test specimen was assembled by sub-contractor of the test sponsor with the witness of manufacturer.

4.2. Thickness measurement

Thickness measurement was checked and documented on the test specimens by the laboratory.

4.3 Conditioning

The construction was stored in the laboratory of Efectis Era Avrasya A.S. under the following conditions:

- Ambient temperature : $13,2 \pm 2,1$ °C.
- Relative humidity : 55 ± 5 %.
- Conditioning time : 33 days

5. TEST PROCESS

5.1. Method

The fire test was conducted according to the EN 13381-8:2013.

The heating of the furnace followed the standard fire curve, as specified in the EN 1363-1:2012

The target overpressure in the furnace was 20 Pa 100 mm below the furnace ceiling

5.2. Measurements

Following test data were measured during the test:

- During the heating, the following data was measured and registered:
- Gas temperatures inside the furnace with ten plate thermocouples (TC1 to TC4 and TC8 to TC9, TC 11 and TC 12), evenly distributed over the directly heated surface (see figure A1).
- The pressure in the furnace, measured at a height of 2,9 meter above the furnace floor level (see figure A3).
- Ambient temperature in the laboratory (see figure A4).
- The steel temperatures (TC 1 to TC 17 (loaded beam) and TC 1 to TC 9 (reference beam)) (see figure B3-B4).
- There is no need to use roving thermocouple.
- Deflection and rate of deflection of loaded beam (see figure B5).
- Load applied on the long beam (see figure B6)
- The positions of the thermocouples measurement are given in figure B1 – B2.



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6. OBSERVATIONS

Table 5: Observations during the test.

-15	Load was started to be applied by hydraulic jacks to the test specimen.
0	Heating started.
5	Smoke release from the gaps of the beam.
102	Reference beam temperature increased; $\Delta T \geq 750$ °C.
170	LB-2 (IPE 400) temperature increased at Thermocouple Avr., $\Delta T \geq 575$ °C. The load was started to increase gradually
172	Rate of deflection exceeded $\geq 6,94$ mm/min
180	Max. deflection occurred $L/30 \geq 166,6$ mm
183	Test was terminated due to reach to desing temperature

7. TEST RESULTS**7.1 Results**

The results are given in table 6 and appendixes B and C.

During the heating the temperature in the laboratory complied with the standard EN 1363-1:2012.

7.2 Uncertainty of measurements

Due to the nature of fire resistance testing, in which several non-linear effects are present in both the test configuration and the test specimen, which influence each other, it is at this moment not yet possible to give a stated degree of uncertainty of measurement.

8. SUMMARY

The most important results of the examination are given in table 6.

Table 6: Summary of test results of the loaded beam

Load; – Maximum deformation ($L_{sup}/30$) – Deformation ratio	180. minute. 172. minute.
Insulation: [I] – average temperature (loaded beam bottom side)	170. minute (575°C).
Test was terminated at 183. minute due to reach to design temperature.	

This report provides the constructional details, the test conditions, the results obtained and the interpolated data obtained when the specified fire protection system described herein was tested following the procedures of EN 13381-8. Any deviation with respect to thickness and density of fire protection material and constructional details, loads, stresses, edge or end conditions other than those allowed under the field of application could invalidate the test result.

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9. DRAWINGS

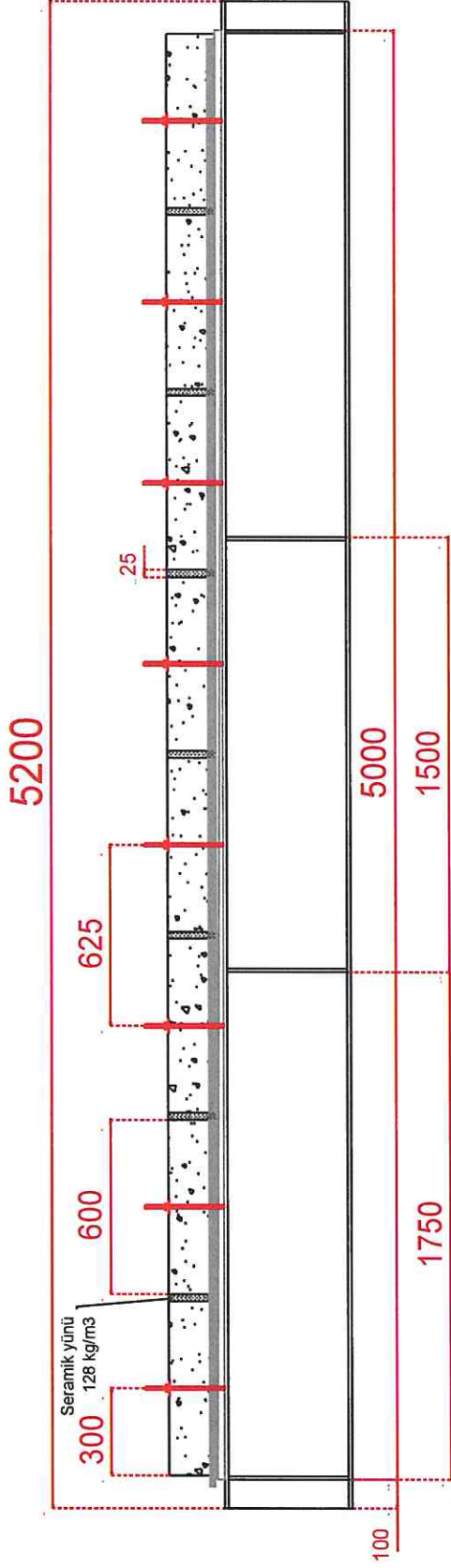


Figure 2: Section view of the beam

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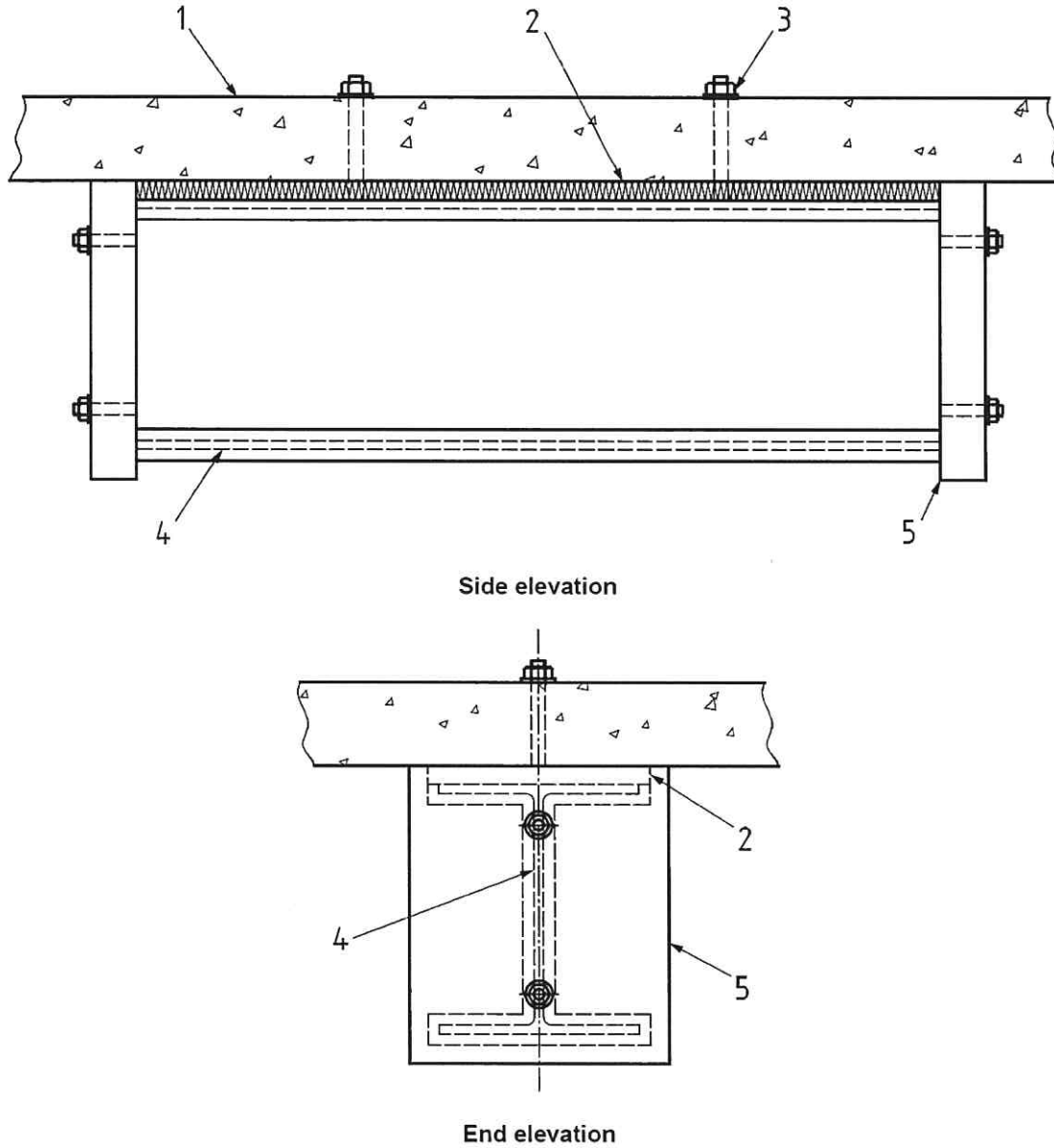


Figure 2: Cross section details of the reference beam



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APPENDIXES:

Appendix A: Furnace and laboratory conditions

Appendix B: Test results

Appendix C: Photos

Appendix D: Load calculation



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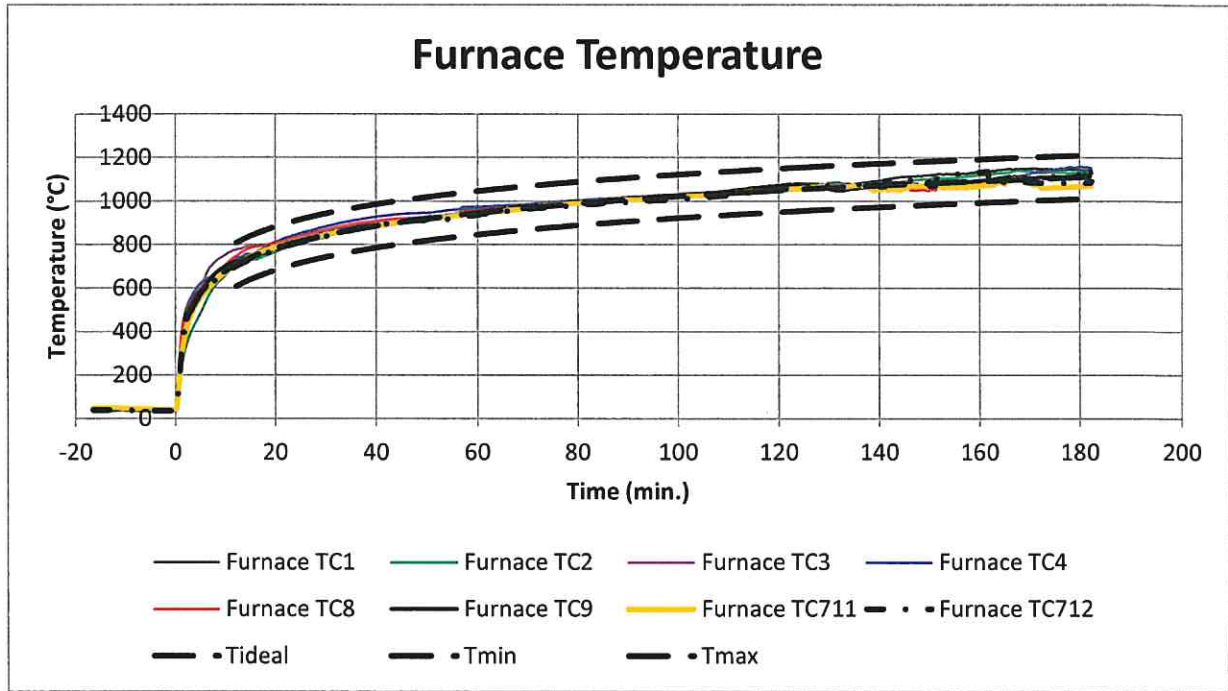


Figure A1: Furnace Temperatures

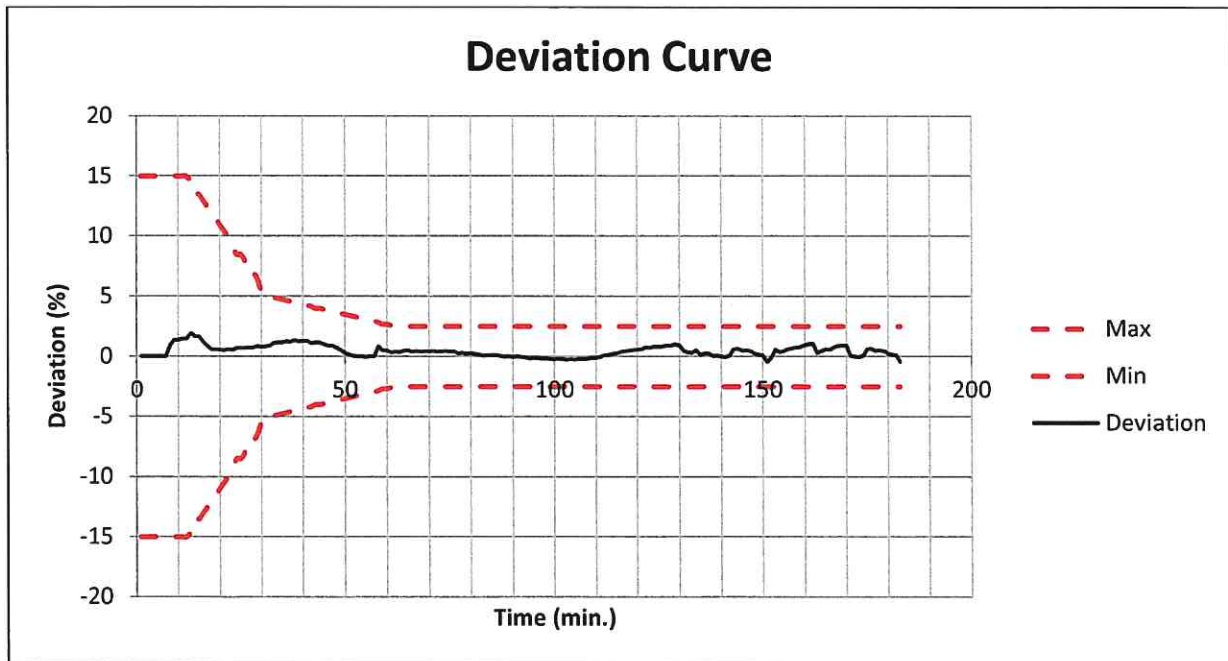


Figure A2: Deviation of furnace temperature

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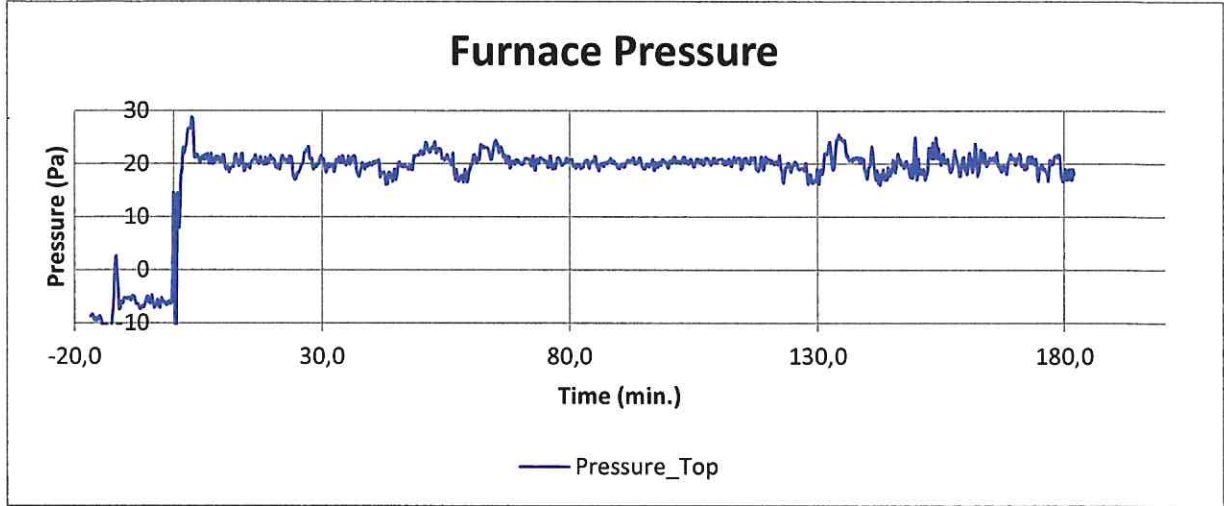


Figure A3: Pressure in the furnace

- The sudden peaks caused by the parts of the specimen fallen inside to the furnace.

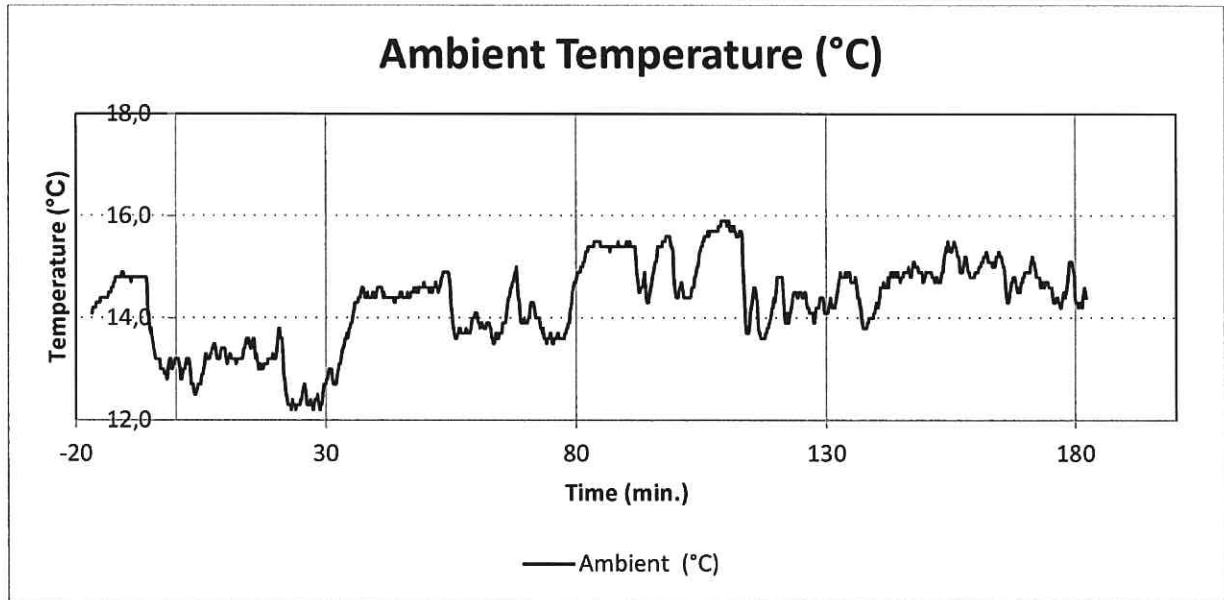


Figure A4: Ambient temperature at laboratory

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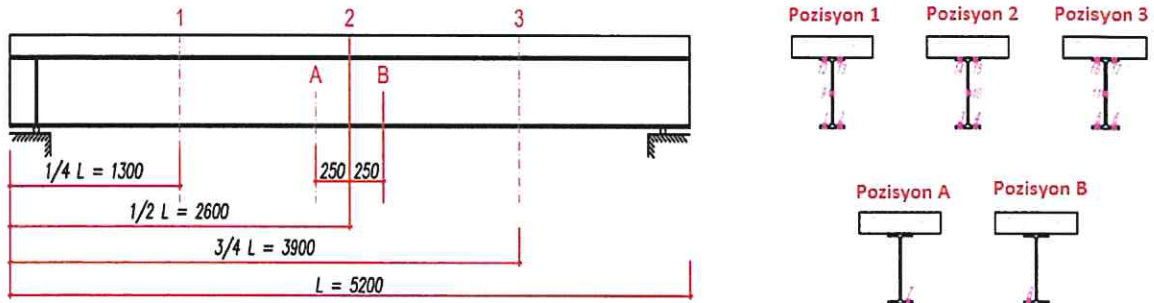


Figure B1: Locations of thermocouples of the loaded beam

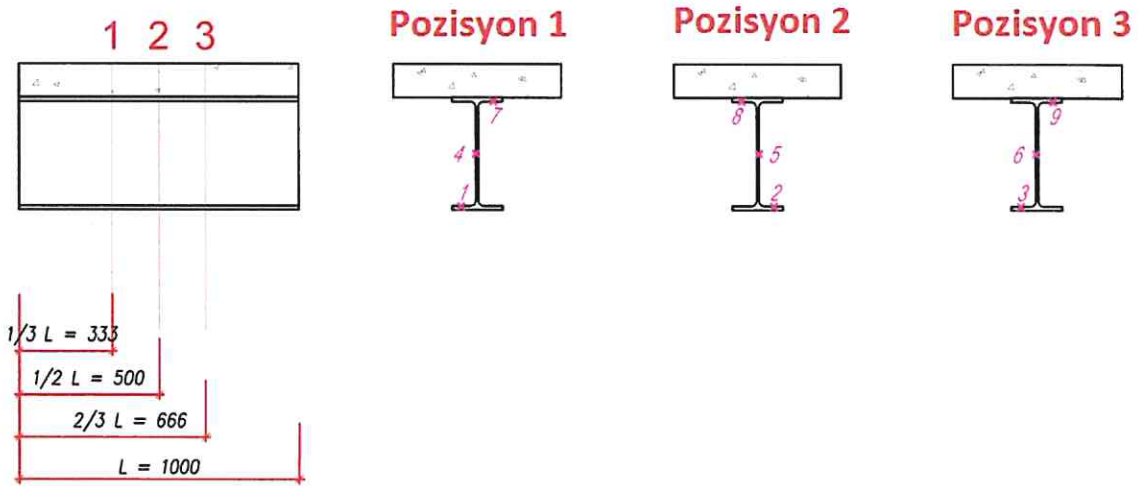


Figure B2: Locations of thermocouples of the reference beam

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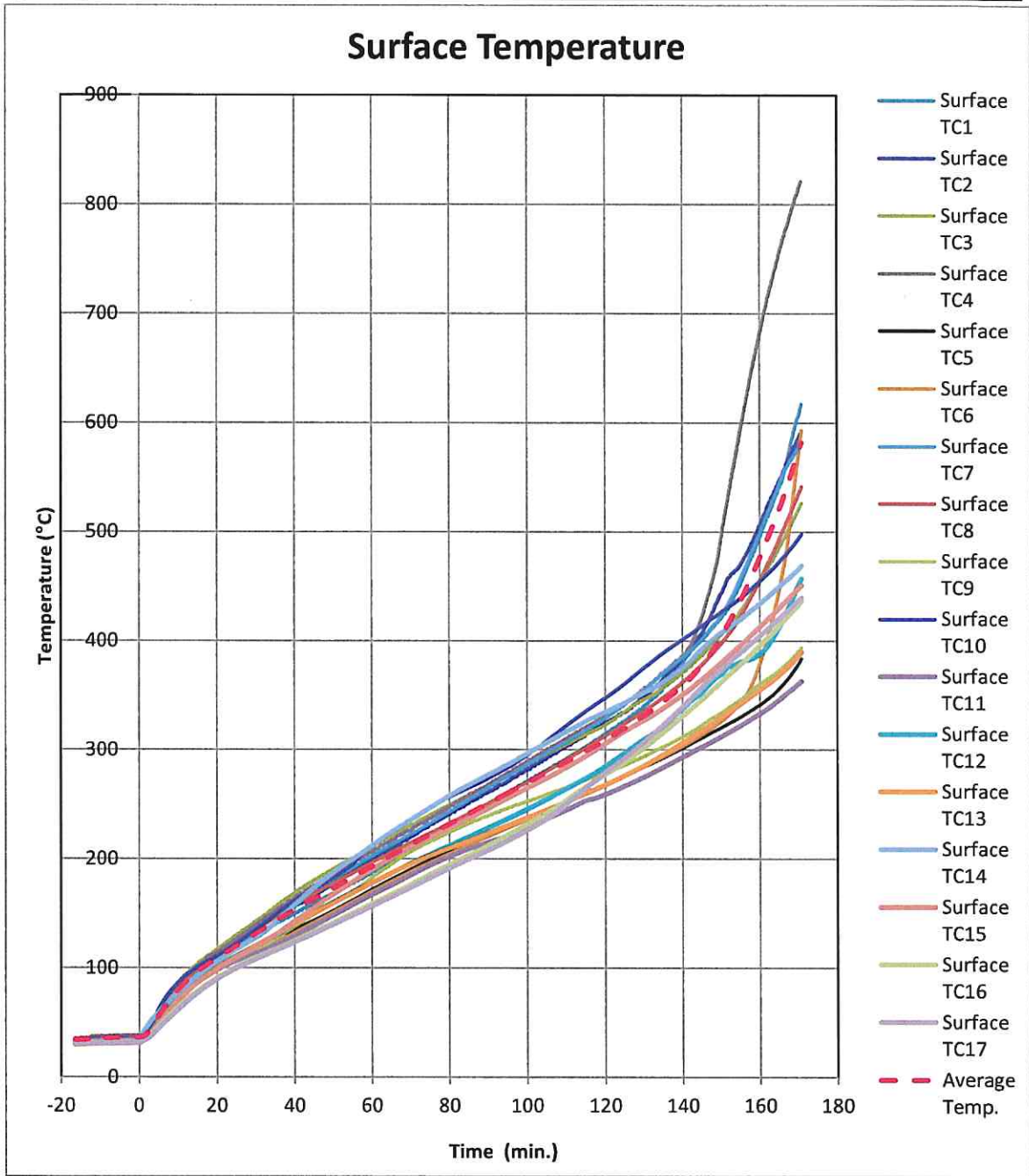


Figure B3: Surface temperatures of loaded beam (TC1 –TC17 and Web Avr. Temp)

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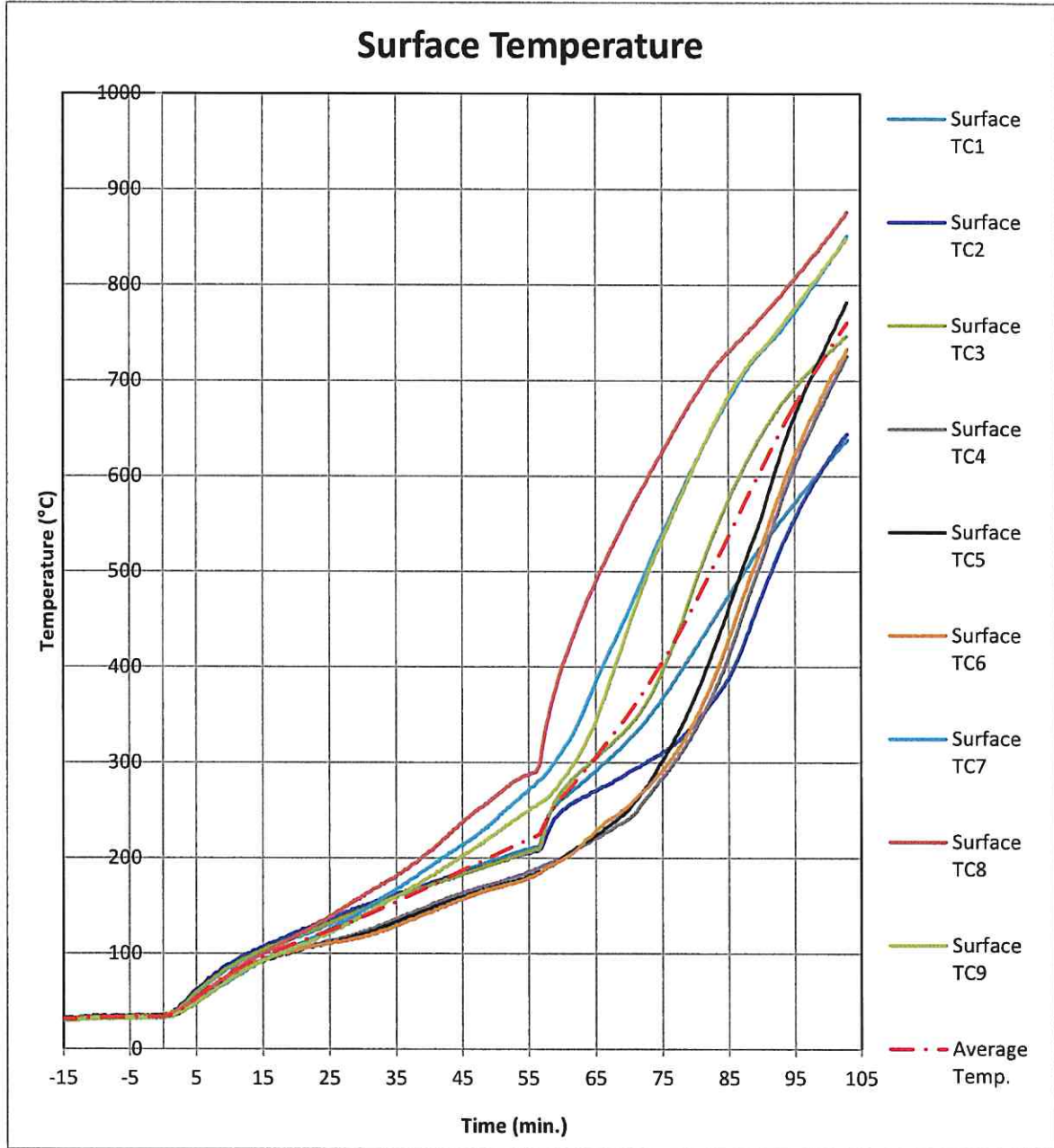


Figure B4: Surface temperatures of reference beam (TC1 –TC9 and Web Avr. Temp)

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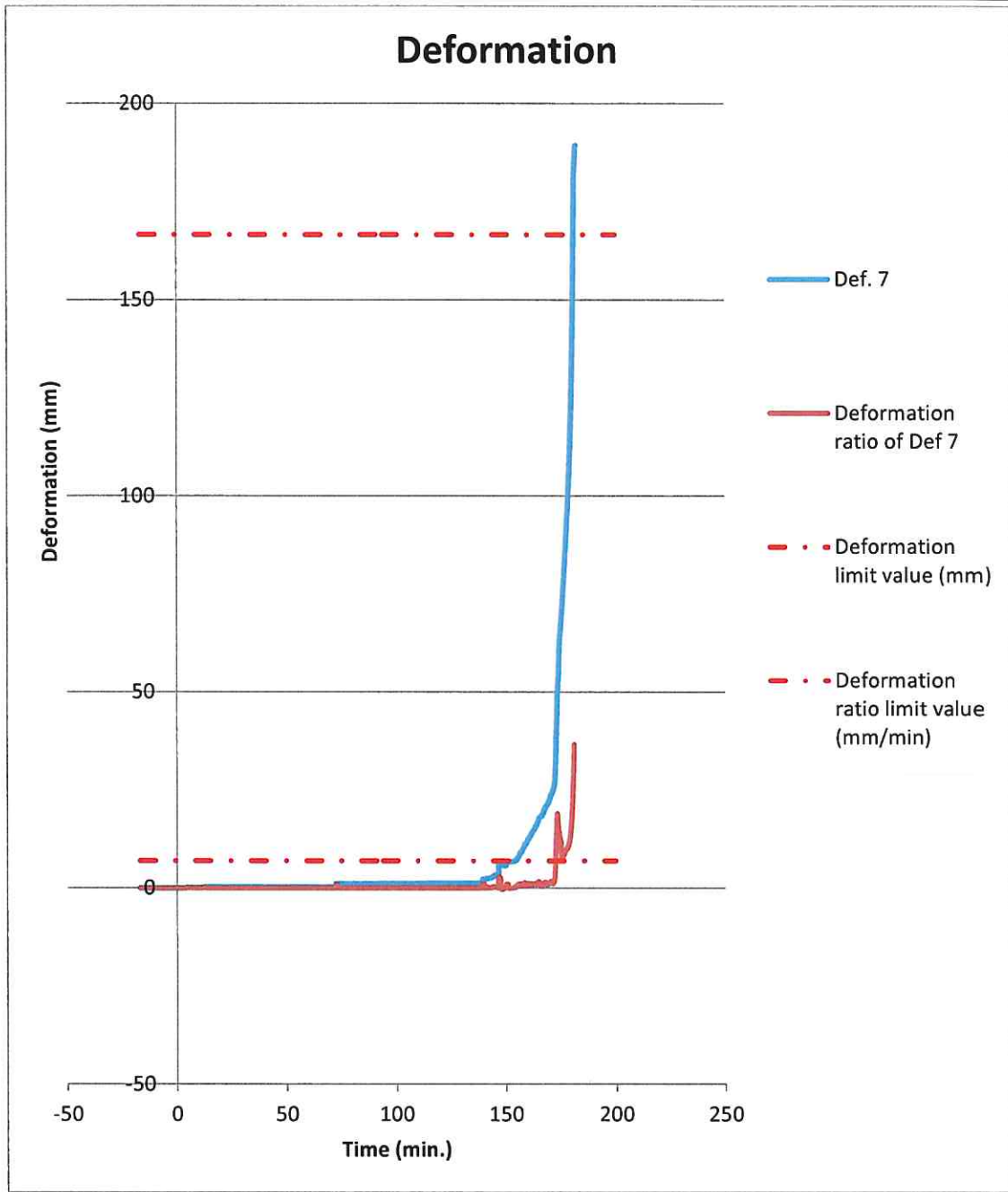


Figure B5: Loaded beam deformation and deformation ratio

*Load was removed after reaching maximum deflection

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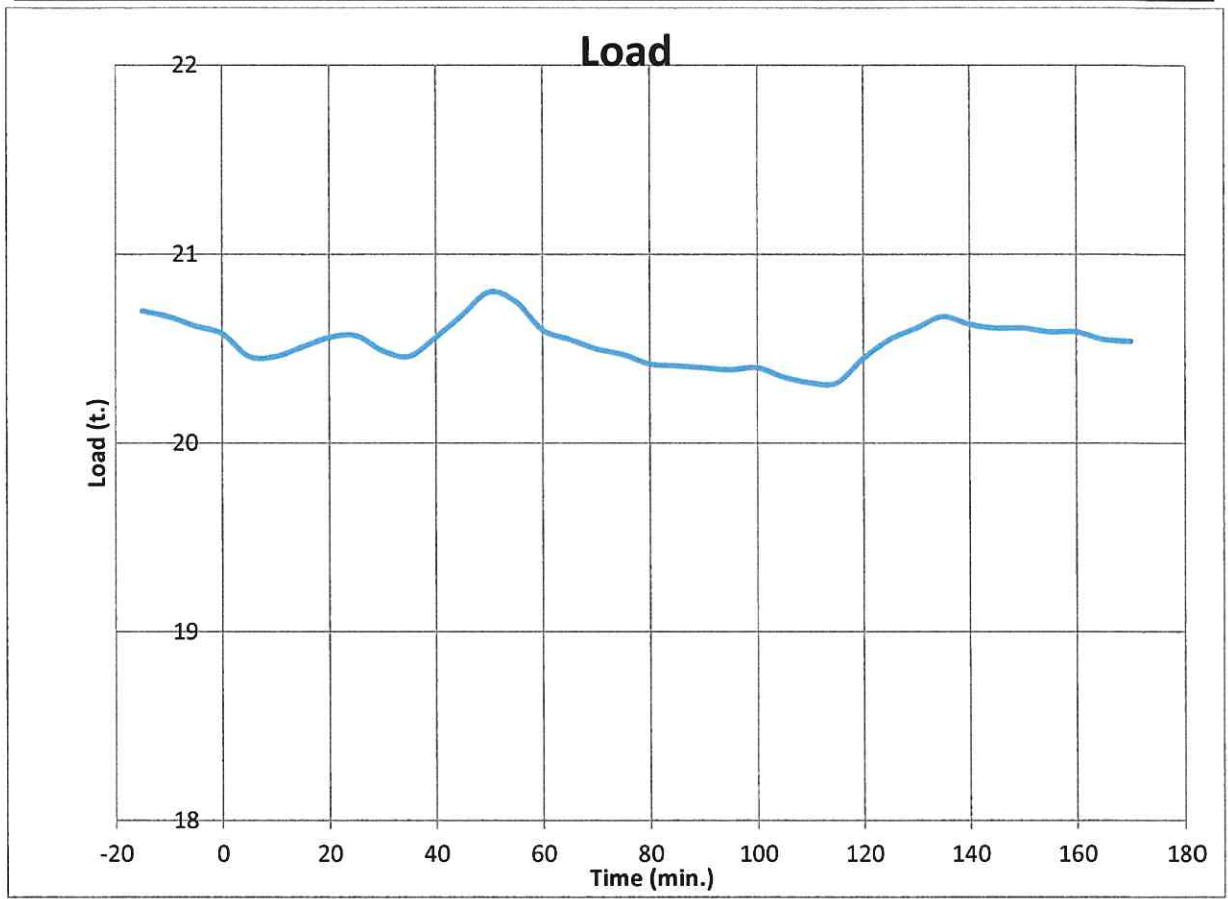


Figure B6: Applied load for beam

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Photo C1: The aspect of the reference and the loaded beam before the test

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Photo C2: The aspect of the loaded beam after the test



Photo C3: The aspect of the reference beam after the test

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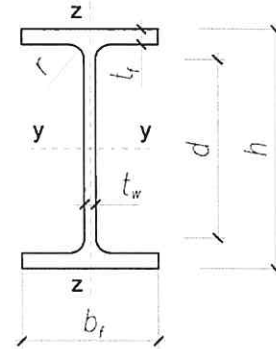
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BEAM (open section) - LOAD CALCULATION (in accord. EN 1991-1-1)**1. Static**

L_{sup}	5000	[mm]
$P/2_{dist}$	1500	[mm]
$P/2_{sup}$	1750	[mm]
P/2 distance is OK		

2. Cross-section parameters and steel grade

IPE 400		Actual steel yield strength		235	[MPa]
h	400,0	[mm]	$I_{y,c}$	23130	[cm ⁴]
b	180,0	[mm]	$I_{z,c}$	1318	[cm ⁴]
t_w	8,6	[mm]	$I_{w,c}$	490000	[cm ⁶]
t_f	13,5	[mm]	$I_{T,c}$	51,1	[cm ⁴]
r	21,0	[mm]	i_y	16,6	[cm]
d	331,0	[mm]	i_z	3,95	[cm]

**3. Dead load calculation**

Fire protection material parameters	- shape*	c	
	- density	1288	[kg/m ³]
	- thickness	7,5	[mm]

* type: "b" for box, "c" for contour

Concrete topping parameters	- density	600	[kg/m ³]
	- width	60	[cm]
	- thickness	17	[cm]

Beam self-weight	66,3	[kg/m]
Concrete topping	54,0	[kg/m]

Fire protection material	12,8	[kg/m]
Additional linear load	0,0	[kg/m]

4. Moment resistance

Cross section class
1

t_{max}	13,5	[mm]
ϵ	1,000	[-]

web c/t	38,5	$\leq 72\epsilon$ = 72,0
flange c/t	4,8	$\leq 9\epsilon$ = 9,0

$M_{c,y,Rd}$	307,1	[kNm]	- plastic
--------------	-------	-------	-----------

E	210000	N/mm ²
G	80770	N/mm ²

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5. Critical moment for lateral torsional buckling

k	1,0	[-]	- since the compression flange is free to rotate about the weak axis of the cross-section
k_w	1,0	[-]	- since there is no device to prevent the warping at the ends of the beam

C_1	1,127	[-]
C_2	0,454	[-]

z_g	200	[mm]
-------	-----	------

$$M_{cr} = C_1 \frac{\pi^2 EI_z}{(kL)^2} \left\{ \sqrt{\left(\frac{k}{k_w} \right)^2 \frac{I_\omega}{I_z} + \frac{(kL)^2 GI_T}{\pi^2 EI_z} + (C_2 z_g)^2} - C_2 z_g \right\}$$

M_{cr}	243,4	[kNm]
----------	-------	-------

6. Non-dimensional slenderness and reduction factor

λ_{LT}	1,123	[-]
$\lambda_{LT,0}$	0,4	[-]
β	0,75	[-]
λ_{LT}	>	$\lambda_{LT,0}$

h/b	2,222	[-]
h/b_{limit}	2,0	[-]

h/b	>	h/b_{limit}
-------	---	---------------

k_c	0,94	[-]
-------	------	-----

f	0,976	[-]
-----	-------	-----

curve c		
α_{LT}	0,49	[-]
Φ_{LT}	1,150	[-]
χ_{LT}	0,567	[-]
χ_{LT}	0,567	[-]
$\chi_{LT,mod}$	0,580	[-]

before checks

after checks

7. Design buckling resistance moment

$M_{c,y,Rd}$	178,3	[kNm]
$V_{c,z,Rd}$	579,8	[kN]

No M-V interaction has to be considered since the maximum moment is obtained at mid-span and the maximum shear force is obtained at supports

8. Force in the test

60% $M_{c,y,Rd}$	184,3	[kNm]	=	"P" force momentum	180,3	[kNm]
—						
Dead load momentum	4,5	[kNm]				

Load required to be applied in the fire test (in addition to the dead load)	P	205,5	[kN]
Note: One hydraulic ram applies half of the value P !!!			

Bu rapor, laboratuvarın yazılı izni olmadan kısmen kopyalanıp çoğaltılamaz.

İmzasız ve mühürsüz raporlar geçersizdir.

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