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STAND TESTING FOR PREFABRICATED BEAMS USED IN THE EXECUTION OF THE SUPRASTRUCTURE OF ROAD BRIDGES

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Rezumat. *Lucrarea prezintă încercarea pe stand a unei grinzi de beton precomprimat utilizată la execuția suprastructurii pasajelor rutiere. Încărcarea a fost realizată cu ajutorul unei instalații hidraulice prin aplicarea în trepte a două forțe concentrate verticale. Deformațiile verticale ale grinzii s-au măsurat cu comparatoare cu fir şi rolă, iar deformațiile specifice prin tensometrie electro-rezistivă. Sunt prezentate rezultatele obținute şi comportarea acesteia la încărcarea cu sarcini verticale a grinzii din beton precomprimat.*

Abstract. *The paper presents the test on the stand of a pre-pressed concrete beam used for the execution of the overpass of roadways. The loading was carried out by means of a hydraulic installation by stepwise application of two vertical concentrate forces. Vertical beam deformations were measured with wire and roller comparators, and specific deformations by electrically resistive tensometry. Are presented the obtained results and their behaviour in loading with vertical loads of pre-compacted concrete beams.*

Keywords: test beams, deformation beams, concrete precast, road bridges.

1. Introduction

The continuous growth of road traffic leads to the development of new communication routes, namely highways, national roads, as well as the rehabilitation of the existing ones. Achieving efficient transport infrastructure favours economic development and contributes to European integration.

In this context, bridges and viaducts that ensure the crossing of natural obstacles are of great importance. The main objective to be met by new bridges and those in operation is to ensure traffic safety [4]. The resistance structure represents the portable construction of bridges and is generally composed of two main parts: the superstructure and the infrastructure. The resistance structure at the level of the bridge superstructure has the role of directly supporting the roadway and taking over the loads from the road and / or railway traffic. The structure of the infrastructure of the bridge infrastructure supports the superstructure, usually by means of the bearings and transfers the loads to the foundation ground. [5]

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The beams are part of the superstructure of the bridge, whose role is to take over traffic loads. In order to ensure the safety of the bridges, it is necessary for the beams to be tested in order to confirm their capacity to cope with the exploitation demands. The paper presents the results of the measurements made on the test of a pre-compressed concrete beam G03-VI01-T25 with a length of 34.89 m and a height of 2.08 m. The beam has a 2.40 m top plate with asymmetrical consoles (marginal beam). The beam was used for the execution of a passage on the Bucharest-Ploiesti highway, Sector 1. The tests were carried out in the framework of the contract concluded between SC INCERTRANS SA as executor and the association AKTOR S.A.- EURO CONSTRUCT TRADING as beneficiary. [1]

The test was carried out on the site test bench in the area of the beams' site on 13.07.2017 and consisted of the application of two concentrated forces in stages, according to STAS 12313-85 [3] and the test design elaborated by VIADESIGN [2]. The beam was placed on two foundation blocks and reinforced concrete, and the supports were made using neoprene material. The load carrying facility consists of a metal frame anchored by the reinforced concrete foundation with bolts; an assembly made of a hydraulic pump for increasing and controlling the pressure in the hydraulic installation and a hydraulic press having a maximum capacity of 2000 kN.

Fig. 1. Detailed frame location, press, intermediate metal beam, tensometric marks, comparators.

The loading was done by means of the hydraulic press located on an intermediate metal beam, supported on two supports (hard wood chips) on the test beam (Fig. 1).

The forces were applied at 3.00 m from the beam shaft on one side and the other side, and the distance between the two forces so applied is of 6.00 m.

The test steps were performed according to the test design. The arrows were measured with roller and yarn type MF with the accuracy of 0.05 mm, and the specific deformations by the electro - resistive tensometric method (Hottinger 1 - LY41-50 / 120 tensometric mark, Huggenberger measuring bridge).

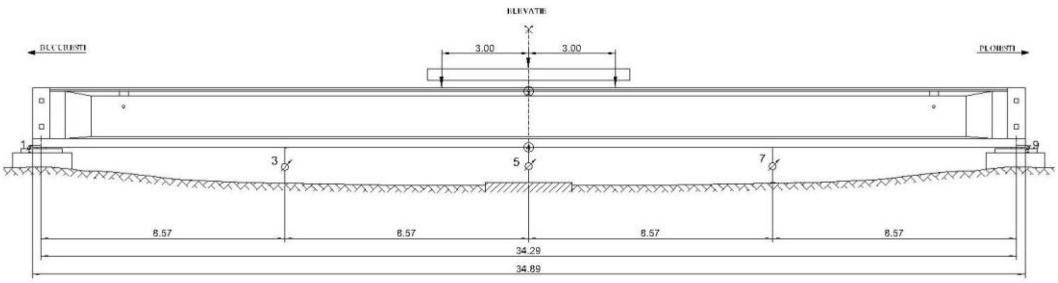

Fig.2. Overview of the location of the comparators.

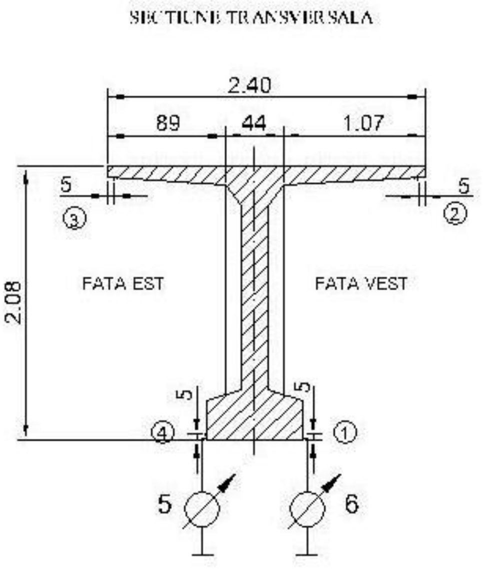

Fig. 3. Cross beam section.

At the same time, some cracks were observed, and a cracked magnifying glass was prepared to measure them.

To measure the arrows, comparators were placed on the supports, at the quarter and in the middle of the beam (Fig. 2, Fig. 3 and Fig. 4). For measuring the specific deformations, the tensometric marks were placed in the middle of the beam, the upper fibre and the lower fibre.

Fig. 4. Detailed positioning on the support.

Two loading cycles were performed according to the test design.

The loading steps are presented in the Table 1.

Table 1. Test program

The test step	Total force P (kN)	Pressure (bar)	Remarks
I	125	25	
II	250	50	discharge
III	380	76	
IV	520	104	discharge
V	600	120	
VI	685	137	discharge
VII	765	153	
VIII	850	170	↑

2. Obtained results

2.1. Deformations

After the bead was placed in position, by levelling, the counter beam was measured. The measured values are shown in Table 2.

Table 2. Counter - arrow of the beam (cm)

Support SUD	Quarter SUD	Middle	Quarter NORD	Support NORD
0.00	7.72	8.24	5.82	0.00

The deformations were measured at each loading stage, on the supports, in the middle and on the two quarters of the beam, on both sides, respectively: East and West. Table 3 shows the values of the deformations measured at each loading stage with the comparators placed on the floor 1 for the Load Cycle I and Table 4 for the Load Cycle II. Tables 5 and 6 show the actual arrows of the beam (the requirements of the neoprene bearings have been removed).

Table 3. I Cycle (cm)

	Support SUD		Quarter SUD		Middle		Quarter NORD		Support NORD	
Landmark	1	2	3	4	5	6	7	8	9	10
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000		0.000		0.000		0.000		0.000	
125	0.025	0.000	0.290	0.270	0.410	0.390	0.280	0.280	0.020	0.000
	0.013		0.280		0.400		0.280		0.010	
250	0.050	0.000	0.640	0.580	0.910	0.850	0.620	0.590	0.040	0.000
	0.025		0.610		0.880		0.605		0.020	
380	0.080	0.000	1.030	0.940	1.470	1.390	1.010	0.940	0.070	0.000
	0.040		0.985		1.430		0.975		0.035	
520	0.120	0.000	1.460	1.340	2.050	1.930	1.420	1.340	0.100	0.000
	0.060		1.400		1.990		1.380		0.050	
600	0.130	0.000	1.670	1.540	2.370	2.240	1.630	1.540	0.110	0.000
	0.065		1.605		2.305		1.585		0.055	
685	0.150	0.000	1.920	1.770	2.710	2.570	1.880	1.830	0.130	0.000
	0.075		1.845		2.640		1.855		0.065	
765	0.170	0.000	2.180	2.010	3.070	2.905	2.130	2.010	0.150	0.000
	0.085		2.095		2.988		2.070		0.075	
850	0.190	0.010	2.430	2.250	3.440	3.280	2.385	2.270	0.160	0.000
	0.100		2.340		3.360		2.328		0.080	
Discharge										
685	0.180	0.010	2.060	1.890	2.910	2.750	2.020	1.890	0.150	0.000
	0.095		1.975		2.830		1.955		0.075	
520	0.170	0.010	1.560	1.420	2.210	2.300	2.020	1.425	0.140	0.000
	0.090		1.490		2.255		1.723		0.070	
250	0.130	0.010	0.710	0.630	1.020	0.930	0.690	0.635	0.100	0.000
	0.070		0.670		0.975		0.663		0.050	
0	0.100	0.000	-0.080	-0.180	-0.130	-0.220	-0.090	-0.180	0.080	-0.010
	0.050		-0.130		-0.175		-0.135		0.035	

Table 4. II Cycle (cm)

	Support SUD		Quarter SUD		Middle		Quarter NORD		Support NORD	
Landmark	1	2	3	4	5	6	7	8	9	10
0	0.100	0.000	-0.080	-0.180	-0.130	-0.220	-0.090	-0.180	0.080	-0.010
	0.050		-0.130		-0.175		-0.135		0.035	
125	0.120	-0.010	0.200	0.080	0.290	0.170	0.190	0.100	0.090	-0.015
	0.055		0.140		0.230		0.145		0.038	
250	0.125	-0.010	0.530	0.390	0.760	0.625	0.510	0.410	0.100	-0.015
	0.058		0.460		0.693		0.460		0.043	
380	0.150	-0.010	0.900	0.730	1.300	1.140	0.880	0.740	0.130	-0.015
	0.070		0.815		1.220		0.810		0.058	
520	0.170	-0.010	1.300	1.095	1.860	1.670	1.270	1.120	0.150	-0.015
	0.080		1.198		1.765		1.195		0.068	
600	0.180	-0.010	1.515	1.310	2.170	1.960	1.480	1.325	0.140	-0.015
	0.085		1.413		2.065		1.403		0.063	
685	0.200	-0.010	1.765	1.545	2.530	2.310	1.720	1.555	0.160	-0.015
	0.095		1.655		2.420		1.638		0.073	
765	0.210	-0.010	1.990	1.750	2.835	2.700	1.940	1.760	0.185	-0.015
	0.100		1.870		2.768		1.850		0.085	
850	0.225	-0.010	2.240	1.980	3.190	2.940	2.190	1.990	0.200	-0.015
	0.108		2.110		3.065		2.090		0.093	

Discharge										
685	0.220	-0.010	1.840		1.600	2.630	2.610	1.790	1.610	0.190
	0.105		1.720	2.620	1.700		0.088		-0.015	
520	0.210	-0.010	1.350		1.130	1.940	1.740	1.320	1.160	0.180
	0.100		1.240	1.840	1.240		0.083		-0.015	
250	0.165	-0.010	0.540		0.330	0.720	0.580	0.480	0.350	0.140
	0.078		0.435	0.650	0.415		0.063		-0.015	
0	0.110	-0.010	-0.350		-0.460	-0.460	-0.350	-0.550	-0.450	0.090
	0.050		-0.405	-0.405	-0.500		0.038			-0.015

Table 5. Cycle I measured arrows (cm)

Step	Support SUD	Quarter SUD	Middle	Quarter NORD	Support NORD
0	0.000	0.000	0.000	0.000	0.000
125	0.000	0.268	0.389	0.269	0.000
250	0.000	0.586	0.858	0.584	0.000
380	0.000	0.946	1.393	0.939	0.000
520	0.000	1.343	1.935	1.328	0.000
600	0.000	1.543	2.245	1.528	0.000
685	0.000	1.773	2.570	1.788	0.000
765	0.000	2.013	2.908	1.993	0.000
850	0.000	2.245	3.270	2.243	0.000
Discharge					
685	0.000	1.885	2.745	1.875	0.000
520	0.000	1.405	2.175	1.648	0.000
250	0.000	0.605	0.915	0.608	0.000
0	0.000	-0.176	-0.218	-0.174	0.000

Table 6. Cycle II measured arrows (cm)

Step	Support SUD	Quarter SUD	Middle	Quarter NORD	Support NORD
0	0.000	-0.176	-0.218	-0.174	0.000
125	0.000	0.089	0.184	0.103	0.000
250	0.000	0.406	0.643	0.414	0.000
380	0.000	0.748	1.156	0.749	0.000
520	0.000	1.121	1.691	1.124	0.000
600	0.000	1.333	1.991	1.334	0.000
685	0.000	1.566	2.336	1.559	0.000
765	0.000	1.774	2.675	1.761	0.000
850	0.000	2.006	2.965	1.994	0.000
Discharge					
685	0.000	1.619	2.524	1.608	0.000
520	0.000	1.144	1.749	1.153	0.000
250	0.000	0.361	0.580	0.349	0.000
0	0.000	-0.452	-0.449	-0.541	0.000

At the total load of P = 520 kN, corresponding to the permanent loads, an average arrow of 1.935 cm was measured in the middle section. At the total load of P = 850 kN, corresponding to the frequent traffic loads, an average arrow of 3.27 cm was measured in the middle section, while the unloading remained a 0.218 cm counter-arrow.

Figure 5 shows the diagram: load - deformation - time.

In the load test at P = 850 kN, no cracks appeared on the beam surface. The repaired cracks did not open.

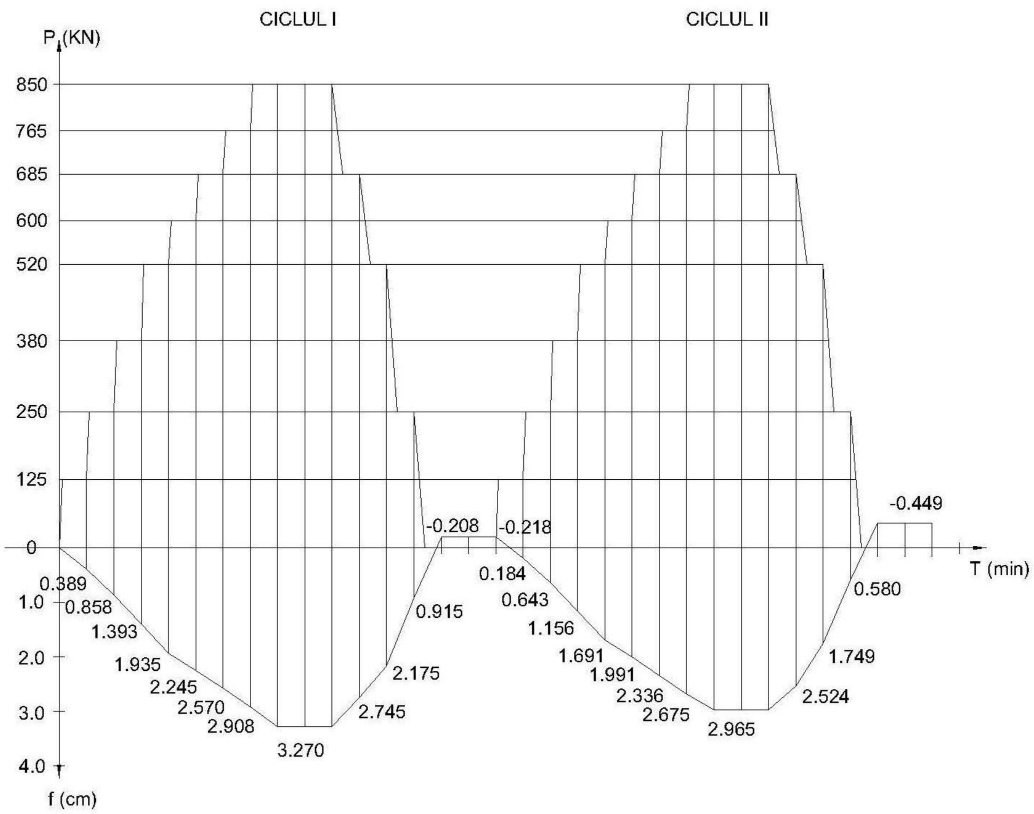

Fig. 5. Diagram: load - deformation - time.

2.2. Specific deformations

Diagrams of specific measured deformations are presented in the paper. The specific deformations were determined by the electro-resistive tensometric method, using the Hottinger 1-LY41-50 / 120 strain gauge and the Huggenberger measuring bridge. In Table 7 are presented the values of the specific deformations measured for each loading stage. The values determined in the beam shaft were obtained by interpolating the measured values on the East and West faces for the upper plate and as the average for the lower bulb values.

Table 7. Specific deformations measured - ε (μm) – I Cycle

Step (kN)	Reading	Lower bulb		Upper plate	
		1	4	2	3
125	individual	25	25	-35	-35
	beam axis	25		-35.0	
250	cumulated	60	60	-75	-80
	beam axis	60		-77.7	
380	cumulated	95	95	-115	-130
	beam axis	95		-123.1	
520	cumulated	135	135	-170	-185
	beam axis	135		-178.1	
600	cumulated	160	160	-195	-215
	beam axis	160		-205.8	
685	cumulated	185	185	-225	-250
	beam axis	185		-238.5	
765	cumulated	210	210	-255	-280
	beam axis	210		-268.5	
850	cumulated	235	240	-280	-310
	beam axis	237.5		-296.2	
Discharge					
685	cumulated	190	195	-255	-275
	beam axis	192.5		-265.8	
520	cumulated	140	140	-220	-220
	beam axis	140		-220.0	
250	cumulated	55	55	-150	-135
	beam axis	55		-141.9	
0	cumulated	-35	-20	-100	-35
	beam axis	-27.5		-65.0	

The values from the lower fibre and the upper fibre were determined by extrapolating the measured values (Table 8).

Table 8. Specific deformations calculated - ε (μm) – I Cycle

Step (kN)	Lower fibre	Upper fibre
125	26.5	-37.6
250	63.5	-83.6
380	100.6	-132.4
520	143.0	-191.4

600	169.4	-221.4
685	195.9	-256.5
765	222.3	-288.9
850	251.2	-318.9
Discharge		
685	204.2	-285.3
520	149.2	-235.3
250	60.1	-150.3
0	-26.5	-66.6

The values of the specific deformations at load P = 850 kN are ε = 251.2 μm in the lower fibre and ε = -285.3 μm in the upper fibre (see Tables 8 and 9).

Table 9. Specific deformations measured - ε (μm) – II Cycle

Step (kN)	Reading	Lower bulb		Upper plate	
		1	4	2	3
125	individual	35	35	-30	-50
	beam axis	35		-40.8	
250	cumulated	70	65	-65	-90
	beam axis	67.5		-78.5	
380	cumulated	110	95	-105	-145
	beam axis	102.5		-126.6	
520	cumulated	150	135	-145	-195
	beam axis	142.5		-172.0	
600	cumulated	170	155	-170	-220
	beam axis	162.5		-197.0	
685	cumulated	195	180	-200	-255
	beam axis	187.5		-229.7	
765	cumulated	220	210	-220	-280
	beam axis	215		-252.3	
850	cumulated	245	240	-245	-305
	beam axis	242.5		-277.3	
Discharge					
685	cumulated	200	195	-215	-270
	beam axis	197.5		-244.7	
520	cumulated	145	145	-185	-230
	beam axis	145		-209.3	
250	cumulated	55	60	-120	-130
	beam axis	57.5		-125.4	
0	cumulated	-30	-20	-65	-50
	beam axis	-25		-56.9	

The values from the lower fibre and the upper fibre were determined by extrapolating the measured values (Table 10).

Table 10. Specific deformations calculated - ε (μm) – II Cycle

Step (kN)	Lower fibre	Upper fibre
125	36.9	-44.0
250	71.2	-84.7
380	108.3	-136.3
520	150.5	-185.4
600	171.7	-212.3
685	198.2	-247.4
765	226.9	-272.3
850	255.8	-299.5
Discharge		
685	208.8	-263.5
520	154.1	-224.4
250	62.2	-133.2
0	-23.5	-58.3

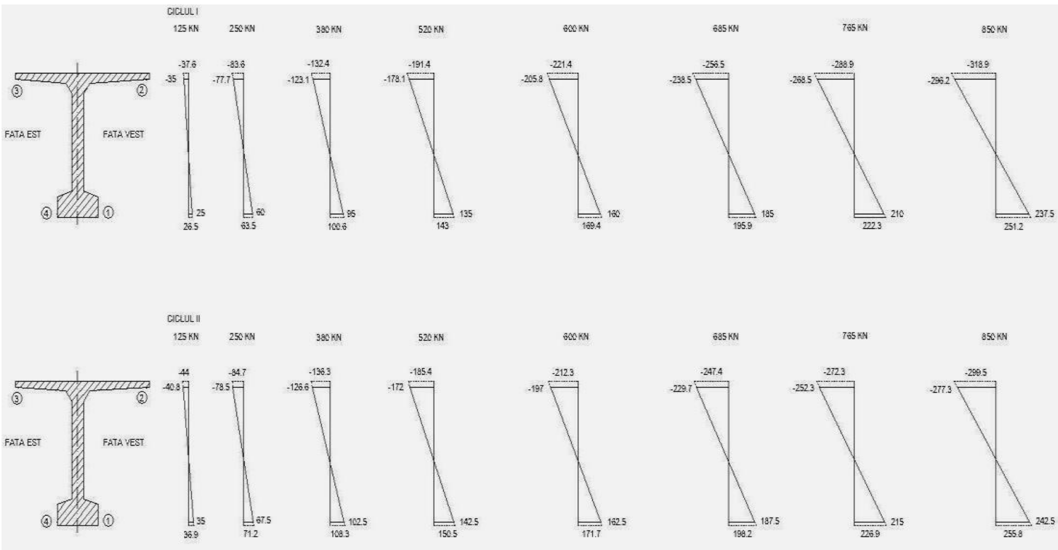

Fig 5. Specific deformations.

3. Conclusions

From the analysis and interpretation of the data we observed that the beam did not show signs of failure or loss of stability and that there were no defects that would affect its functionality; no cracks have occurred at the 850 kN test load.

The deformations measured for the beam with dimensions of L = 34.89 m, h = 2.08 m were compared with the calculations and it was observed that the specific deformations measured had a linear variation on the beam height.

The measured arrows correspond to the admissibility criterion from STAS 12313-85 point 2.6.2.4 a) up to a total load of 850 kN, resp. F_{ex} '= 1.274 cm versus 4.29 cm (L_0 / 800).

R E F E R E N C E S

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