

Structural condition assessment of the bridge in Ostrava

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Abstract. This paper deals with the comparison of results of dynamic test and numerical modelling of a road bridge across the Dr. Kudela street in the street Rudná in Ostrava. The bridge is a reinforced concrete structure, made of post-tensioned KA-beams. On the bridge were verified material properties. Calculation model to validate the static and dynamic behavior of structures was created. On the bridge were measured dynamic properties (frequency, mode shapes and attenuation) during excitation construction by hydraulic vibration exciter. Article will focus on comparing the results of the calculation of dynamic structures and properties measured on real structure upon excitation.

1 Description of structure

The bridge object consists of two bridge structures, which are composed of three fields (11 m + 16 m + 11 m). Each bridge structure is formed by 14 prefabricated KA-61 beams (in each field). The width of bearing structure is 13.25 m. The bridge is placed on the supports and elastomeric bearings. Bridge foundations are monolithic reinforced concrete. Outer supports are massive reinforced concrete. Spans of individual fields of the bridge are 11 m (short field) and 16 m (long field). During the reconstruction was made a coupling plate of thickness 160 to 300 mm.



Fig. 1. View of the bridge structure.

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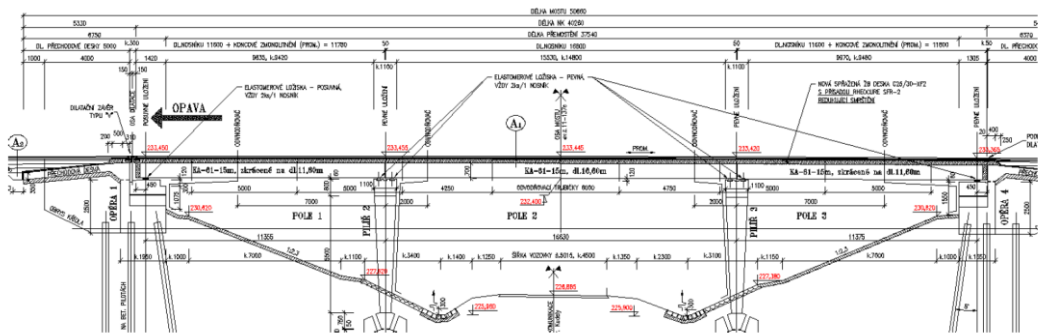


Fig. 2. Longitudinal section of the bridge structure.

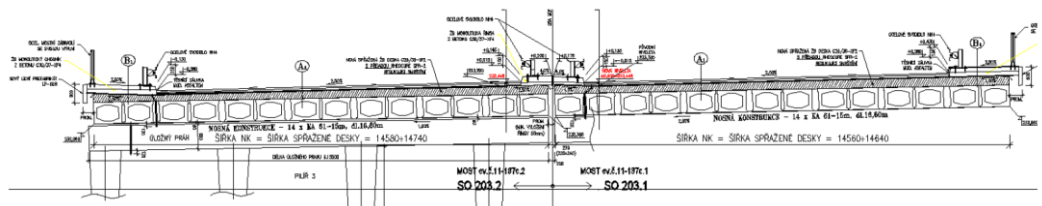


Fig. 3. Cross-section of the bridge structure.

2 Diagnosis and load tests

2.1 Diagnosis

The lower surface of the bearing structure is locally disrupted by leaking through the bridge deck waterproofing and longitudinal cracks in lower slabs of beams. Two outer cable canals are exposed with exposed corroded prestressing wires at the bridge structure ev. Nr. 11-137c.1. Outer beams of the bridge structure is further disrupted by longitudinal cracks. Near the cracks occur coatings/extracts of bright colour. The above mentioned failures were identified mainly as a result of alkali-silica reaction of aggregate [1].

Tensile strength of concrete was tested in the corner areas of reinforced concrete blocks. Tests were performed on the upper and lower surfaces of the sample. Core drill, which could affect measured values negatively, was not used for thinning of test sites with respect to anticipated concrete structure defects.

Tests of compressive strength were performed on cube samples, which were carved from the central part of the block. For strength tests were excluded samples that had been disrupted by pruning from tensile strength tests and drilled (dismantling) holes. Further parts of the concrete with visible cracks from alkali-silica reaction or samples with a higher rate of reinforcement rods have been omitted.

2.2 Load tests

Dynamic loading test of the bridge was performed using electrohydraulic vibration exciter with a movable mass of 500 kg and electronics FlexTest (MTS Systems Corp.). Modal analysis was performed for each field separately with broadband excitation in the frequency band 7 Hz to 20 Hz. From the transfer functions were estimated lowest natural frequency of individual fields and the response was recorded on the bridge excitation by harmonic forces with these frequencies (Table 1). The course of transfer functions and the response of the

bridge after the end of excitation by harmonic force show a large attenuation of the bridge structure. The response was measured in 9 sections (over the supporting blocks and columns, in the middle of the short fields and in the middle and quarters of span of middle field) [2]. To measure of the response of the bridge was in each section used 7 acceleration sensors BK 4379 with amplifiers of charge BK2635 (Bruel&Kjaer). PULSE system (Bruel&Kjaer) was used for the record response and evaluation of complex transfer functions. Evaluation of modal characteristic was performed using MEScope (Vibrant Technology, Inc.).

3 Numerical modeling

The numerical computational model of individual fields of the bridge was made in an environment of software Scia Engineer 15.3. As the material of the walls and slabs forming in the model KA beams was chosen material model C40/50 from the catalog of program Scia. As the material of the coupling plate was chosen C30/37. Individual KA beams were supported in the model at the edges of the bottom plates, always on one side of a fixed joint and on the second side of a displaceable joint in the length direction of the beam. Slabs and walls of the model were meshed of planar finite elements with side 1 m. On the thus modelled structure were identified shapes and values of relevant frequencies.

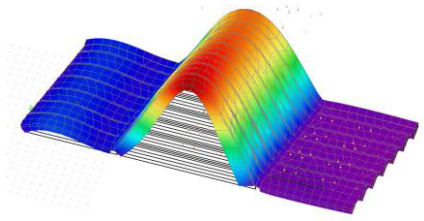


Fig. 4. The first natural shape of the bridge structure – frequency 8.84 Hz.

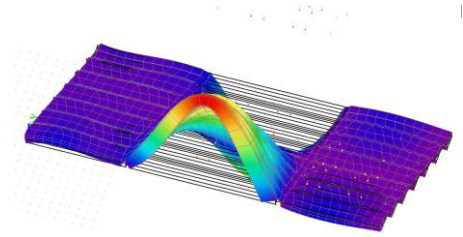


Fig. 5. The second natural shape of the bridge structure – frequency 11.07 Hz

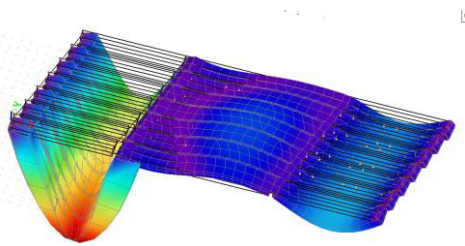


Fig. 6. The third natural shape of the bridge structure – frequency 14.95 Hz.

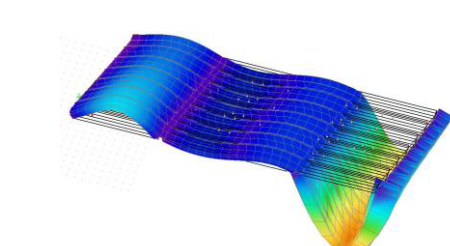


Fig. 7. The fourth natural shape of the bridge structure – frequency 15.76 Hz

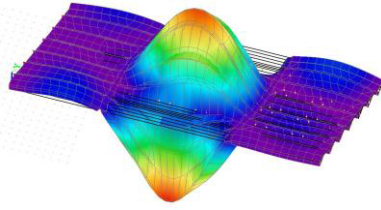


Fig. 8. Fifth natural shape of the bridge structure – frequency 16.42 Hz.

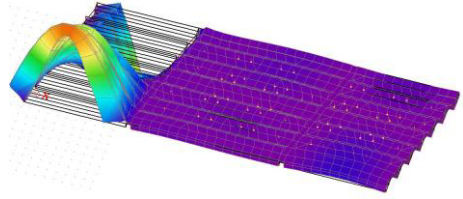


Fig. 9. Sixth natural shape of the bridge structure – frequency 17.24 Hz

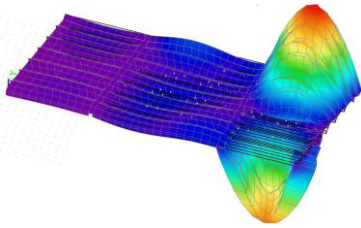


Fig. 10. Seventh natural shape of the bridge structure – frequency 18.54 Hz

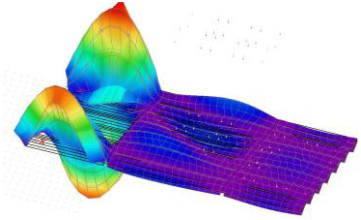


Fig. 11. Eighth natural shape of the bridge structure – frequency 23.39 Hz

4 Conclusions

Table 1. The natural frequency and damping in the middle span.

f [Hz] (dynamic load test)	f [Hz] (numerical modelling)	[%]	Description of vibration shape
9.1	8.84	4.8	B1
11.4	11.07	5.1	B2
13.9	14.95	2.3	C1
15.4	15.76	1.1	A1
17.2	16.42	4.4	C2, B3, A2
18.4	17.24	3.7	B3,C2
21.0	18.54	4.5	A1, B4
23.4	23.39	1.0	B4; A3 a C3 in antiphase
23.9	-	2.2	A3 a C3 in antiphase

Shorter spans are marked A and C, the middle span is B. The number B2 in the specification in Table indicates the second shape of vibration of middle span. The bridge at this level of amplitude vibrates as continuous beam with three spans. I.e. artificially created joints between each field do not show the shapes of the vibration considerably (they are bypassed with a plate probably). It is impossible to separate the second and higher shapes of vibration with a large attenuation as they occur simultaneously in pairs or threes.

The measured natural frequencies correspond roughly wall-slab computational model, shapes of vibration not. The maximum amplitudes of oscillation at mid-span, and in the outer fields are identical in all cases regardless of whether the driver in the middle span or in one of the outer spans.

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