Experimentální Analýza Napětí
2004

EXPERIMENTAL INVESTIGATION OF TUNNEL VAULT VIBRATION
EXPERIMENTÁLNE SLEDOVANIE OTRASOV TUNELOVEJ KLENBY

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The contribution is dedicated to the methodology of experimental monitoring of tunnel vault vibration in a rail tunnel under the effect of moving transport means. It describes the used apparatuses, methodology of measurements and it presents the results of measurements in characteristics cross sections of the tunnel. The results are evaluate in regard to the validity of today´s technical seismic standard. It presents analyses in time and spectral domain.

Príspevok pojednáva o metodike experimentálneho sledovania otrasov tunelovej klenby v železničnom tuneli od účinkov pohybujúcich sa dopravných prostriedkov. Popisuje použité prístroje, metodiku merania a uvádza výsledky merania v charakteristických priečnych rezoch tunela. Výsledky hodnotí vzhľadom k platnosti súčasnej technickej normy o seizmických účinkoch. Prezentuje analýzy v časovej i spektrálnej oblasti.

Keywords *Experimental measurements, vibration, tunnel, seismic problems.*

Klíčová slova *Experimentálne merania, otrasy, tunel, seizmické problémy.*

Methodology of experimental measurements

In the sense of the Standard STN 73 0036 the response of a structure on a seismic load is evaluated by means of effective speed of vibration [1]. So the effective speeds of tunnel vault vibration were elected as determining quantities. The determining quantities were measured in 6 characteristic cross sections of the tunnel. The arrangement of sensors in every cross section is shown in the Fig. 1. For the measurement of effective speeds of vibration two types of sensors were adopted – Sensors Bruer-Kjaer BK 8306 and amplifiers BK 2635 and Sensors KB12 and amplifiers Robotron 00042. The electrical signal from the sensors was converted by analo-digital interface to digital form. The digital interface DAS 16 was used. The digitized signal was stored on the disc of PC Computer. All analyses were done by numerical way. The measurement line usually used on the Department of Structural Mechanics University of Zilina is shown on the Fig. 2. Sensors BK3, KB6, kB9, BK12 were situated upright on the tunnel vault, sensors BK2, kB5, KB8, BK11 were situated parallel with longitudinal axis of tunnel and sensors BK1, KB,4 KB7, BK10 were situated upright on the longitudinal tunnel axis and parallel with face of tunnel vault. The interaction forces accruing between rail and sleepers and speeds of vehicle motions were also registered during the experimental investigations.

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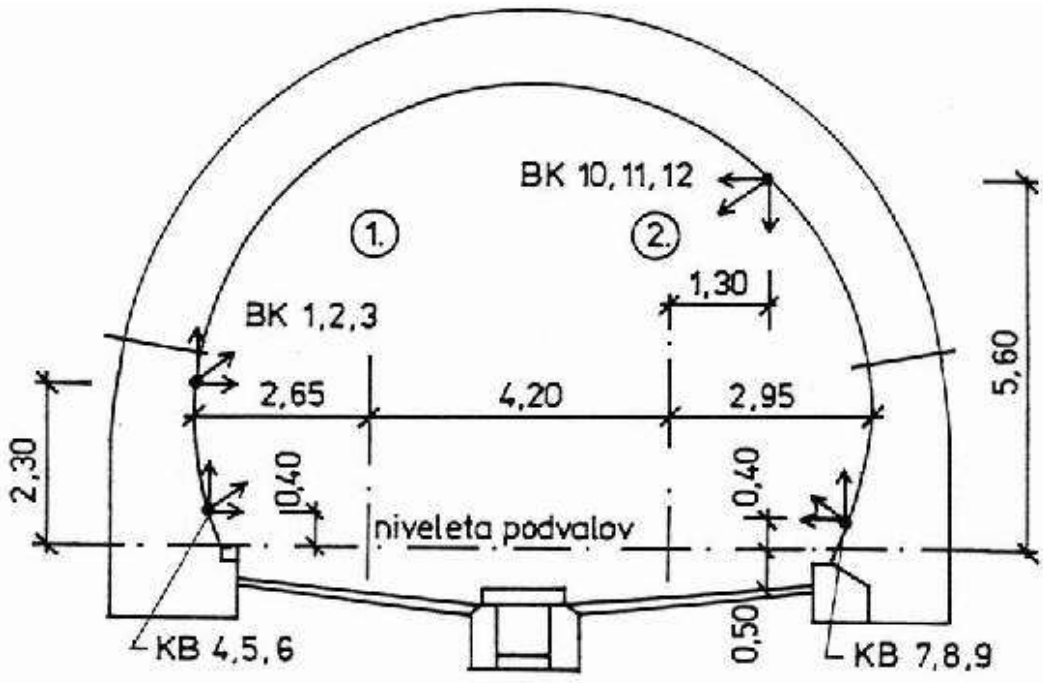

Fig. 1 Arrangement of sensors

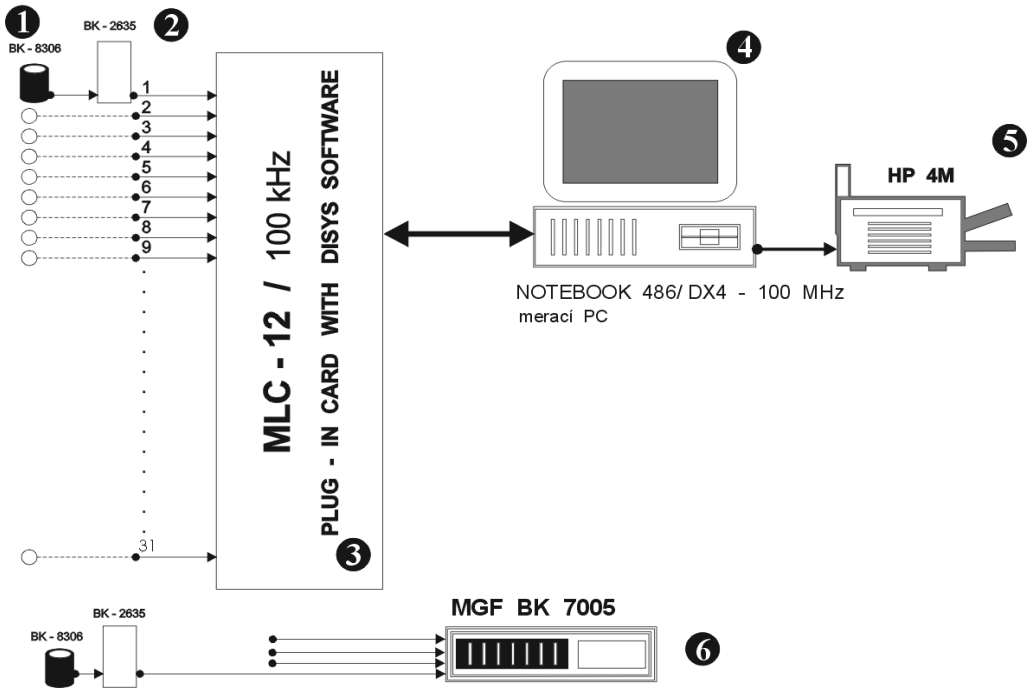

Fig. 2 Measurement line used within experimental measurements

Results of experimental measurements

In the sense of the Standard 73 0036 the analysed tunnel structure is arranger in the class E. In the sense of the Standard 73 0031 [2] the class of importance is I. Following these two documents [1], [2] the dynamic response of the structure due to seismic load is not necessary to analyse if the effective speed of vibration of reference point is lower then 2,5 mm/s. Volume of effective speeds measured in individual cross sections of the tunnel are presented in the Table 1. The maximal experimentally obtained value of effective speed of vibration was observed in the cross section P1 with sensor KB7. Its value is $v_{ef,\ max}$ = 0,3553 mm/s. This value is essentially lower than limit value $v_{ef,\ lim}$ = 2,5 mm/s. Example of obtained time records and its Power Spectral Densities is in the Fig. 3.

			min v_{ef}	max v_{ef}
P1	Snímač		KB6	KB7
	EH	mm/s	0,0010	0,3553
	DV	druh	01NS	01NA
		smer	K - ZA	K – ZA
	RY	km/h	48,4	48,4
pás č. 14	Snímač		KB5	KB7
	EH	mm/s	0,0008	0,2308
	DV	druh	01RY	12NA
		smer	K - ZA	ZA - K
	RY	km/h	90,2	61,1
pás č. 27	Snímač		KB4	BK10
	EH	mm/s	0,0004	0,1463
	DV	druh	02NA	12NA
		smer	K – ZA	K – ZA
	RY	km/h		
pás č. 41	Snímač		BK3	BK10
	EH	mm/s	0,0088	0,1088
	DV	druh	02NA	13NA
		smer	ZA – K	K – ZA
	RY	km/h	70,2	73,6
pás č. 58	Snímač		KB6	BK1
	EH	mm/s	0,0056	0,2277
	DV	druh	01IC	02NA
		smer	K – ZA	K – ZA
	RY	km/h	93,6	83,3
P2	Snímač		KB4	KB5
	EH	mm/s	0,0058	0,1807
	DV	druh	12NA	03NA
		smer	ZA – K	ZA – K
	RY	km/h	11,8	65,9

Table 1 Limit values of effective speeds of vibrations

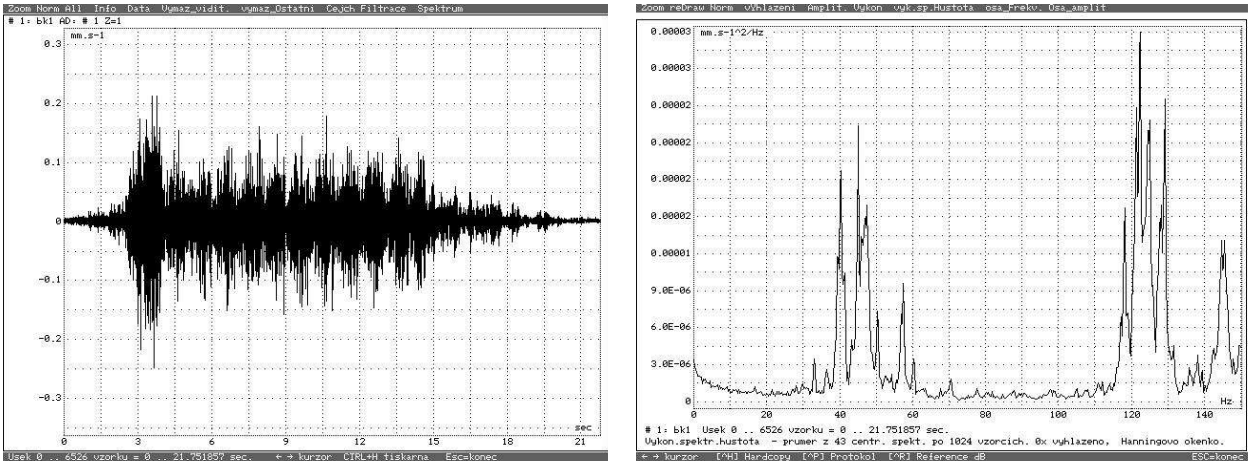

Fig. 3 Example of time record of effective speed of vibration and its Power Spectral Density

The questions of the problems of technical seismicity are also solved in another works [3], [4], [5], [6], [7].

References

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