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Experimental Investigation of Dynamic Behavior of Viaducts by Shock Loading

The viaducts are constructions designed to provide ground communication over different geographical barriers such as examples valleys (depressions). To avoid partial or total destruction that may occur after dynamic stress from road (or railroad) or seismic activity, in viaducts structure is placed systems for dynamic isolation. Thus, the viaduct deck is mounted on viscoelastic type systems designed to provide protection from the shock loading. Over time, due to an intensive and varied of dynamic loadings, these isolation systems suffer degradation of viscoelastic links, something that leads to uncontrolled movements of the system. In this work, are established and quantified on experimental way, kinematics parameters of the vibration of the viaduct deck loading by shocks, which will be monitored over time to establish the degree of normality in the functioning of viscoelastic systems.

Keywords: *shock, vibration, bridge, damage*

1. Introduction

Experimental investigation of dynamic behavior of bridges loaded by the shock generated by a vehicle passing over an obstacle, is a part of the testing procedure bridges for the dynamic actions according to STAS 12504-86. Thus, experimental tests were made on the Transylvania highway viaduct with 5 openings located between km 29+602,75 and 29+801,25 km on the part of the Tg. Mures and Cluj Napoca.

2. Conditions of the experimental determinations

Across the road was install a barrier of rectangular section with a height of 40 mm. To generate short-term impulsive actions, the obstacle was crossed by a four-axle road-truck weighing 41 tons, these regimes speed: 10 km / h, 20km / h 30 km / h and 50 km / h. Moving of road-truck over obstacle was done with coupled traction.

Figure 1. Truck passing over obstacle.

Registration acceleration signals was performed using Bruel&Kjaer triaxial accelerometer type 003 4506 B series 10145, mounted transversely in the vertical plane of symmetry of the bridge. In this way, acceleration signals were recorded for the following directions:

- longitudinal direction OX;
- transverse direction OY;
- vertical direction OZ.

3. Analysis of experimental results

The acceleration signals vibrograms in the dumping regime were analyzed in comparison for these regimes speed: 10 km/h, 30 km/h and 50 km/h.

Thus, the movement of truck speed of 10 km/h and traction coupled graphical representations were obtained from Fig. 2-4 in that notice the following:

- the maximum acceleration of bridge vibration is 0.51 m/s^2;
- the significant spectral components is between 2.61-12.48 Hz, it was remarkable the frequency component of 4.17 Hz with an amplitude of 0.0019 m/s^2.

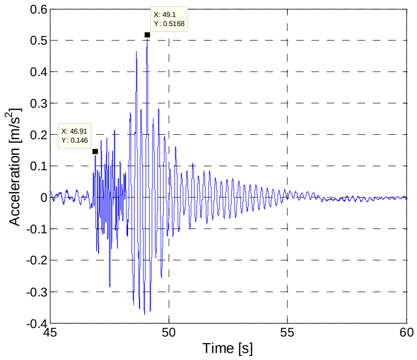

Figure 2. Acceleration system at 10 km/h speed.

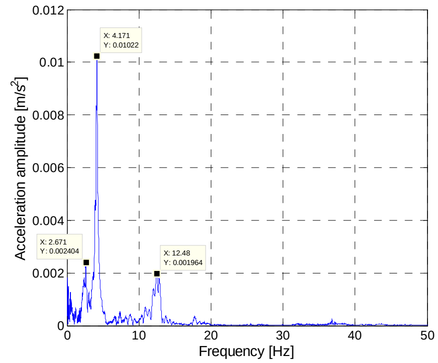

Figure 3. Acceleration amplitude of the system at 10 km/h speed.

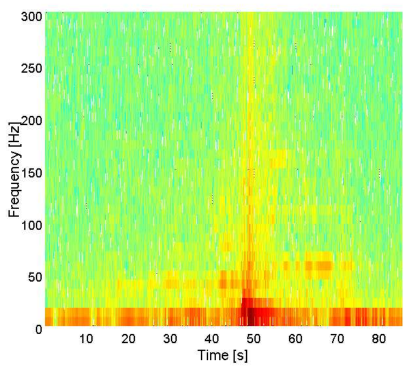

Figure 4. Acceleration system spectrogram at 10 km/h speed (2D).

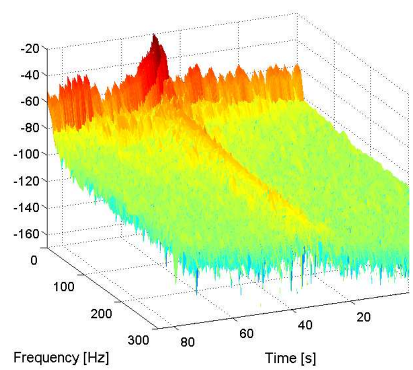

Figure 5. Acceleration system spectrogram at 10 km/h speed (3D).

Acceleration system representations at speed of the truck 30 km/h with coupled traction were obtained graphical representations of Fig. 6-9, which were observed the following:

- maximum acceleration of the bridge vibration is 1.1 m/s^2;
- the significant spectral components is between 4.18-12.48 Hz, it was distinguished the frequency component of 12.48 Hz component, with amplitude of 0.0051 m/s^2.

Spectrogram acceleration in the OZ direction is another parameter able to monitor the state of normality in the functioning of bearing systems.

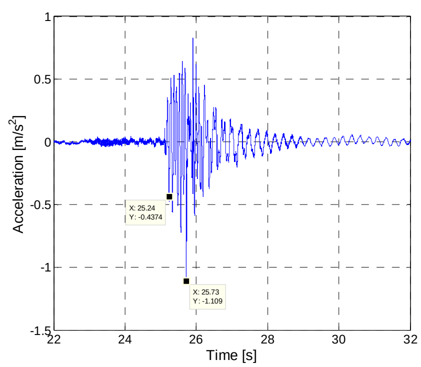

Figure 6. Acceleration system at 30 km/h speed.

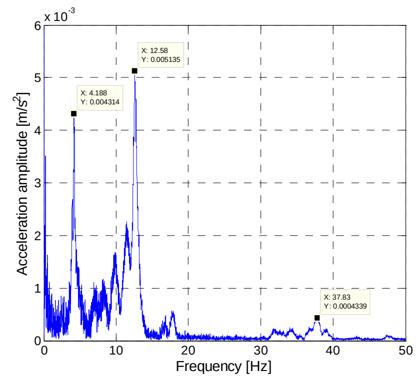

Figure 7. Acceleration amplitude of the system at 30 km/h speed.

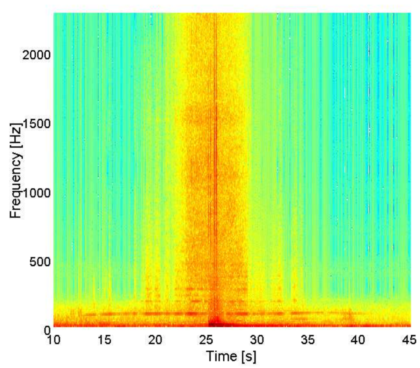

Figure 8. Acceleration system spectrogram at 30 km/h speed (2D).

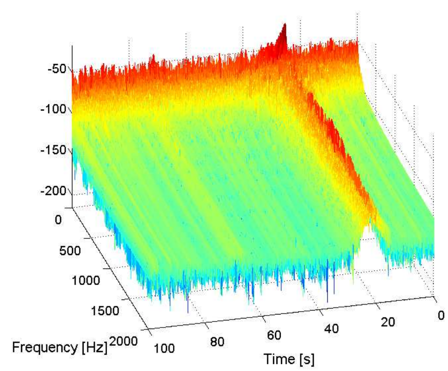

Figure 9. Acceleration system spectrogram at 30 km/h speed (3D).

When driving the truck over obstacle with 50 km/h speed and coupled traction were obtained the next graphics, fig. 10-13:

- amplitude of acceleration system is 1.46 m/s^2;
- the significant spectral components is between 4.18-12.53 Hz, it was distinguished the frequency component of 12.53 Hz component, with amplitude of 0.0083 m/s^2.

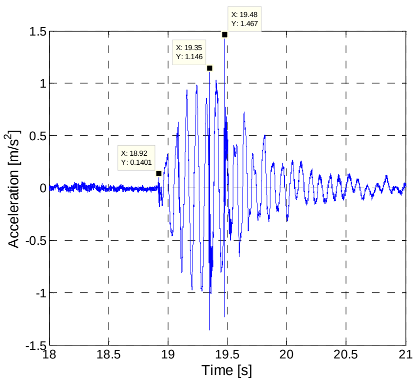

Figure 10. Acceleration system at 50 km/h speed.

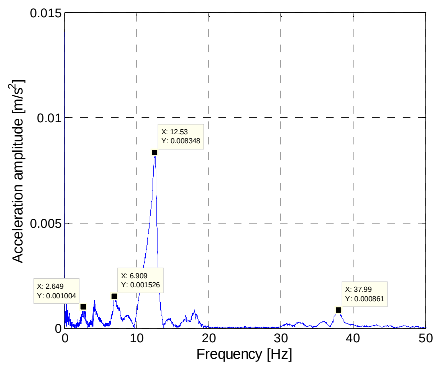

Figure 11. Acceleration amplitude of the system at 50 km/h speed.

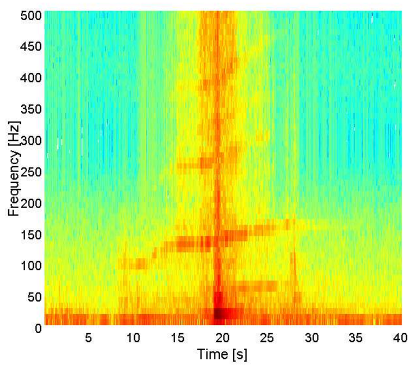

Figure 12. Acceleration system spectrogram at 50 km/h speed (2D).

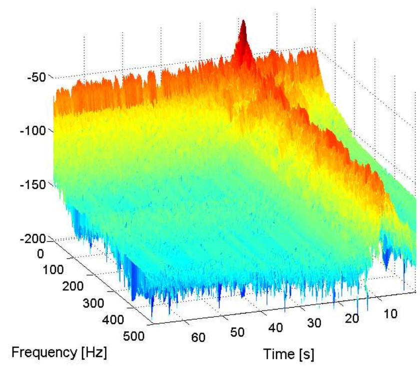

Figure 13. Acceleration system spectrogram at 30 km/h speed (3D).

4. Experiment Relevance

In addition to dynamic testing of bridge, something which is required by standards in this area, these experimental measurements can develop a methodology for predictive maintenance of normal operating state of the bearing system of the bridge deck. Based on repeated, from time to time, of these experimental measurements and comparative analysis of cinematic parameters features can highlight their changes in time, determined by the state of degradation of viscoelastic links of the bearing systems.

5. Conclusion

This methodology of determining the state of normal functioning of the bearing system is very useful in bridges and viaducts maintenance, on its determining the optimal timing of replacement systems. In this way, are avoided possible malfunction of dynamic isolation systems, which can cause partial or total destruction in the event of seismic activity. In this paper acceleration signals were analyzed only in the direction OZ, but for a more complete study can be analyzed and signals the other two directions OX and OY.

This methodology opens the possibility to determine the structural integrity of concrete bridges: if after replacing the dynamic isolation systems do not get the same values of the kinematics parameters of the bridge deck vibration, means that it is a matter of structural integrity of the bridge elements.

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