Load testing result analysis of the Latvian bridges

Ilze PAEGLITE
Assistant
Riga Technical University
Riga, LATVIA
ilze.paeglite@rtu.lv

Ainars PAEGLITIS
Professor
Riga Technical University
Riga,LATVIA
paeglitisa@apollo.lv

Summary

The paper presents results obtained from bridge dynamic load tests over a period of more than 50 years. The main values obtained from the load testing are - the vertical displacement of the deck including dynamic load factor, the natural frequency of the bridge, the dynamic increment and the logarithmic decrement. The obtained results show that the natural frequency highly depends on the length of the span, the static scheme of the bridge, type of the span cross-section, structural materials, construction methods and bearing type. It was found that the dynamic increment did not depend on the natural frequency, but was dependent on the logarithmic decrement. The logarithmic decrement showed a dependency on the length and the type of the span structures.

Keywords: bridge, dynamic loading, loads testing.

1. Introduction

The bridge structure is exposed to various dynamic loads such as: traffic load, wind load, impact load. The load carrying capacity of the bridge is usually estimated by empirical calculations, but considering the dynamic loading due to the heavy traffic, the actual deflection and the behaviour of the bridge superstructure can be different.

In Latvia dynamic tests under special vehicle loads are the standard proof -load test before opening a bridge for use. Heavy trucks with controlled parameters are usually used as dynamic loads. Test results obtained during a more than 50 years were analysed and the main characteristics of the bridge load tests discussed. 51 bridge dynamic parameters were analysed in this research.

Figure 1.1 Dynamic load testing done by passing trucks

2. Dynamic load testing

Load testing of a bridge is usually done to determine the static and dynamic response of the bridge structure. Dynamic load testing is carried out by introducing excitation of the bridge structure and measuring its properties. Different methods for excitation of a bridge are available, but the methods most often used in Latvia are the impact of heavy weight and the passage of a loaded truck. The passage of a loaded truck makes the most real effect on the structure hence it gives reasonably accurate dynamic results.

3. Vibration characteristics

The main dynamic characteristics of a structure are the natural frequency, dynamic increment and the logarithmic decrement. These values are rarely analysed in detail in the design phase of a structure. Values of these characteristics can be roughly calculated while designing the structure, however these values are easy to obtain from experiments that give valuable information about the real structural behaviour.

https://doi.org/10.2749/222137813806474228

4. Results

4.1 Natural frequency

Natural frequency was analysed for bridges with span length from 6 to 83 m. The frequency ratio is given in Figure 4.1.

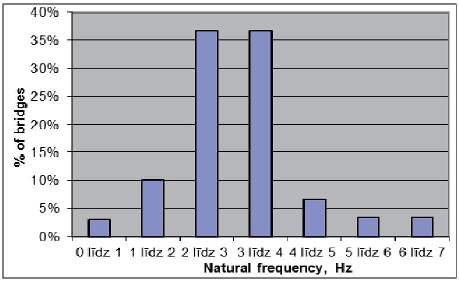

Figure 4.1 Histogram of natural frequency

The obtained results show that the experimentally measured natural frequency of the Latvian bridges varies between 0,7 and 6,5 Hz, with mean value 3,8 Hz.

4.2 Vibration damping

Vibration damping of a structure is a very complex process, according to [2] it happens in various ways: vibration damping in the structure material, vibration damping in structural elements, vibration damping in whole system. The logarithmic decrement is used to characterize vibration damping.

4.3 Dynamic Increment

If a vehicle crosses the bridge, stresses are increased and the structure is subjected to a larger load. This effect is called a dynamic load effect and its influence is being included in the dynamic increment. The obtained results show that the dynamic increment does not depend on natural frequency.

5. Conclusions

The natural frequency most often found on Latvian bridges is from 2 to 4 Hz and does not depend on the bridge superstructure material.This natural frequency depends on the bridge span length and slenderness, structural system, cross section type, structure material, structure type, support type and other factors. Increasing the span length decreases the natural frequency values.

The obtained result show that about 45% of results have a small logarithmical decrement (0,05 – 0,2) but 58% has middle range results (0,2 – 0,5).The logarithmical decrement distribution tendency shows that shorter span has a larger logarithmical decrement but longer spans have smaller values.

The obtained results show that the dynamic increment does not depend on the span length. In the case of smooth pavement the surface increment oscillates from 1 to 1,7, while in the case of a damaged surface it oscillates from 1 to 4,2.

Acknowledgements

Travel costs and participation fee for this conference are financially supported by ERDF project „ The development of international cooperation, projects and capacities in science and technology at Riga Technical University" Nr.2DP/2.1.1.2.0/10/APIA/VIAA/003.

References

[1] C.O'CONNOR., P.A.SHAW., "Bridge loads. An international perspective", Spon Press, 2000, 350 p.

[2] R.CANTIENI., "Dynamic Load tests on Highway bridges in Switzerland, 60 Years experience of EMPA", *EMPA Report Nr.211*, 1983, 79 p.

[3] R.CANTIENI, "Dynamic behaviour of highway bridges under the passage of heavy vehicles", *EMPA Report Nr. 220*, 1992, 240 p.

[4] H.LUDESGER, "Berűcksichtigung von Dynamischen Verkehrslasten beim Tragsichercheitnachweiss von Strassenbrűcken", *These Nr.2894*, 2003, EPFL, Switzerland

[5] J.BIEN, J.KRZYZANOWSKI, P.RAWA, J.ZWOLOSKI., "Dynamic load tests in bridge management", *Archives of civil and mechanical engineering*, 2004, Vol.IV, No.2, 63 – 78 pp.

[6] R.KAROUMI, A.ANDERSSON, "Load testing of the new Svinesund bridge", TRITA-BKN Rapport 96, Royal Institute of Technology, Sweden, 2007, 173 p.