11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

SIMPLIFIED MODEL FOR STRUCTURAL VIBRATION OF A VIADUCT DUE TO RAILWAY TRAFFIC

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Key Words: *Structural Vibration, Elevated Railway, Viaduct, Beam.*

Concrete viaduct structure is used for the elevated lines in the metropolitan light rail systems. Although its construction is easier and costs less than the underground tunnel, the sound radiated from the viaduct structure during the train passage causes environmental noise problem. It is therefore necessary to design effective measures for reducting the structure-borne noise from the viaduct.

Before implementation of the noise control measures designed their performance should be estimated by simulation or test. In terms of simmulation the FE softwares are usually used such as ANSYS for vibration analysis. As the viaduct is a large structure and the analysis frequencies can be up to hundreds Hertz, the calculations are very time-consuming. Especially in the design stage, different parameters should be tried in the calculations in order to find cost-effective results, and thus it is important to develop a simplified and effective model for the dynamic simulations.

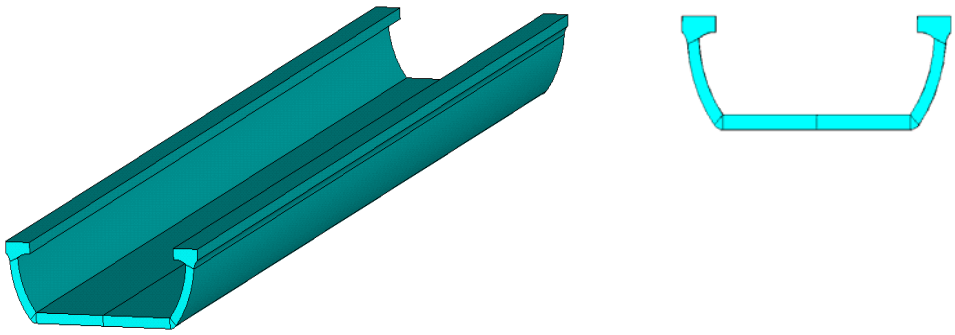

Fig. 1. U-section viaduct structure

In this work a simplified model is developed for calculation of vibrational energy of a viaduct structure during the train passage to predict the performance of the track to which the measures of vibration isolation are applied for reducing the structure-borne noise. The viaduct to be analysed is a U-section structure as shown in Fig. 1. The railway track is laid on the bottom plate of the structure and the viaduct is supported by two piers at its ends. In the simplified model two kinds of beam model are used to represent the dynamic properties of the viaduct. One is a longitudinal beam to simulate the vibration modes of the viaduct along the track, and the other is a multi-beam frame to simulate the dinamic properties of the cross-

section of the viaduct. The two beam models compose a two-and-half dimensional (2.5D) model to approximate the dynamic behaviour of the viaduct structure.

Firstly, the development procedure of the simplified model for the viaduct is introduced. Then it is demonstrated how to use the 2.5D model for calculation of vibration of the viaduct. A FE model of the viaduct is also developed using the ANSYS software and compaired with the 2.5D model. A harmonic load evenly distributed along the track is applied to the viaduct at each frequency up to 500Hz, and the response to the harmonic load is calculated in terms of the total vibration energy of the structure, which is the sum of the product of the element area and its vibrational velocity squared. The calculation results show that the differences between the two models are less than 2dB averaged in 1-10Hz and about 10dB both in 11-100Hz and in 101-500Hz. Moreover, the vibration energy calculated is lower from the simplified model than that from the FE model because the logitudinally and laterally coupled vibration modes of the viaduct structure do not appear in the simplified 2.5D model.

Although the simplified beam model is not accurate enough for predicting the absolute response of the viaduct structure, it can effectively be used for performance comparison among the measures of vibration and noise control, as the system errors due to the incompleteness of the simplified model may be cancelled when carrying out comparisons. As the calculations by the simplified beam model are much easier, compaired to the FE model, it is therefore suitable for quick prediction of the performances of the vibration and noise control measures.

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