Keeping the trains rolling

A vehicle passing over a bridge can be viewed as an intricate structural system. In many practical cases dynamic effects are negligible and a simplified static approach is deemed sufficient as a basis for bridge design. For high-speed railway bridges, where passing vehicles have a comparatively high mass and travel at relatively high velocities, static analysis may prove insufficient and more sophisticated types of analysis may be called for.

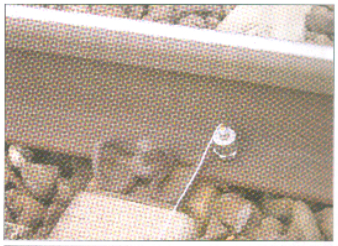
The inclusion of dynamic effects are of interest to the bridge engineer for certain reasons: dynamic stresses are greater than static stresses, and excessive bridge vibration must be prevented in order to design against fatigue. In addition, the dynamic displacements and accelerations of bridge components must be limited in order to guarantee safe and comfortable passage of the vehicle.

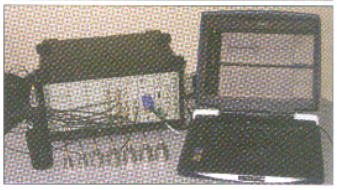
TDV's software package RM2004 offers all the functions necessary to simulate the passing of a train over a bridge. The transient time-history of the bridge as it interacts with the passing train is computed using a modified Newmark time integration approach. This approach allows for the consideration of non-linearities during the analysis. Functions to compute natural frequencies and modes complement this time-history calculation as implemented in RM2004. Specific input functions allow the user to define the train system and the loading of the bridge exactly, via a user-friendly system. Input macros generate this loading information automatically for different train constellations and variations of train velocities. Design codes regulate many details of such an analysis and RM2004 supports the dynamic design of high-speed railway bridges according to all relevant design codes in the field.

High-speed railway projects are currently under way in a large number of European countries as well as elsewhere. Often these new high-speed railway lines consist of upgrades of train lines and existing structures must be checked with regards their suitability for higher train speeds. Certain input parameters such as damping and so on, for a dynamic analysis are given by design codes and can be replaced by measured values. The measurements of these input parameters and also the interpretation of the measurement for a dynamic computer analysis requires expensive instruments and extensive experience.

Specialist TDV, which has developed RM2004 together with its Portuguese partners GIPAC and the University of Coimbra have now developed the expertise to offer not only the software for rolling stock analyses but also the option of carrying out dynamic measurements on bridge structures and incorporating the measurement results into the dynamic analysis.

In a recent application of this product the dynamic properties of a series of existing railway bridges in Austria were measured. A preliminary analysis according to Eurocode raised concerns that a number of these bridges might not be fit for the intended velocities. After the measurement programme the preliminary RM2004 models could be updated using the results and insights gained from the measurement programme. Using the models, and including these measured properties, it could be shown that in some cases the initial concerns were in fact unfounded. Where the concerns were confirmed upgrading work could be specified in much greater detail and with cost savings ■





Top: An accelerometer in position on the rail

Bottom: Equipment for the measurement programme

TDV
www.tdv-consulting.at