# Evaluating Track Geometry Using a Train Vertical Motion Prediction Model

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Track conditions are normally evaluated using the amplitudes of track geometry waveforms. However, an evaluation of track conditions using vehicle dynamic response on the track better suits the purpose of track maintenance, which is to ensure good riding comfort and high running safety. The author has therefore developed a method for accurately predicting vehicle dynamic response, with a comparatively light load on the computer.

To predict the dynamic response of a complicated vibration system such as rolling stock, either of two methods is commonly used. In one method, the response is directly obtained by solving kinematic equations. In the other, measured input and output values are transformed into a frequency band by Fourier transformation to obtain a frequency response function. However, these methods have certain drawbacks - for example, they require a huge amount of calculation work, or involve calculation errors that are not insignificant. It may be said, therefore, that they are unsuitable for practical use in track maintenance.

The author's adopted method involves applying to railways a technique called system identification. In this method, the vehicle transfer function is directly identified on the space axis (or time axis) from measured track geometry and time-serial data for vehicle response, and a digital filter equivalent to the identified function is used to predict vehicle response. This method requires less computer capacity, and offers greater prediction accuracy.

As a case in point, since track maintenance units in the JR Group already have a database system for track maintenance and management that uses digital signal processing technology, Group members can easily introduce the new prediction method that employs a digital filter.

Since the method can easily be expanded into a multi-input model, it also permits predicting even vehicle responses such as horizontal vibration and wheel load that are influenced by various track geometry parameters.

Examples of predicted and measured vertical acceleration waveforms are shown in Fig. 1. They represent the predicted vertical motion of a Shinkansen car. The predictions only require obtaining the sum of the results of polynomials of degree 50 or so, hence the calculation time is extremely short. Even with such a short calculation time, the predicted waveforms agree well with the measured waveforms, as shown in Fig. 1.

The author has developed a technique to apply this method to predict wheel load, as well as to predict horizontal vibration and lateral forces while the train is passing through a curved section. To permit application of the method to track sections where train speed is variable, and to vehicle models whose measurement data is unavailable, the author is presently studying a vehicle response prediction technique that combines time-serial simulations with this method.

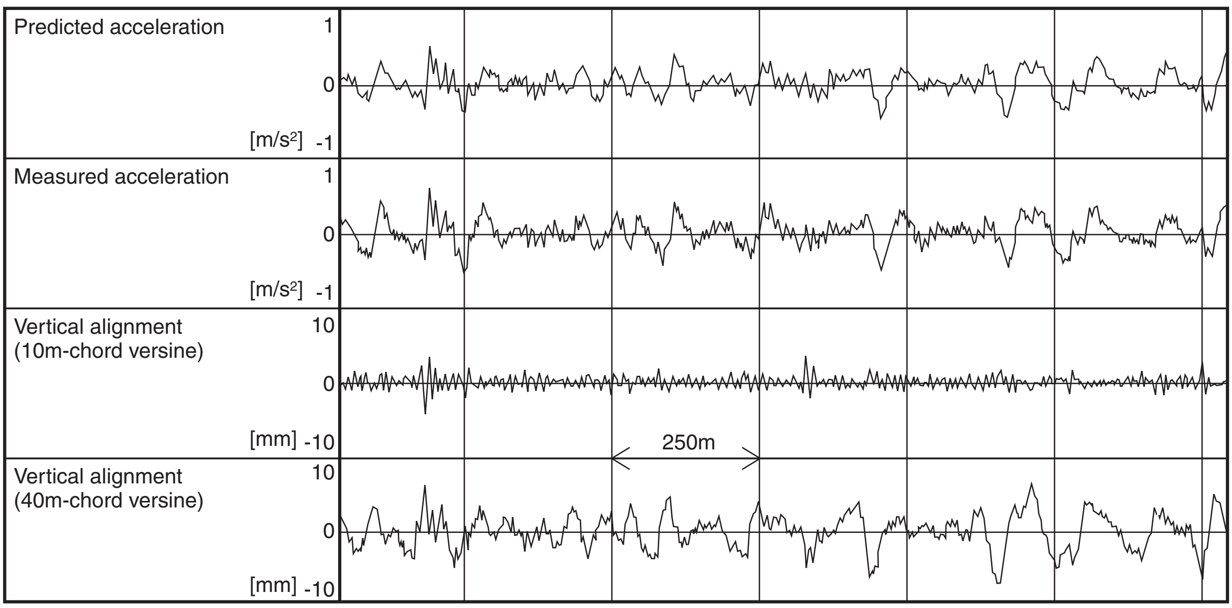


**Figure 1.** Predicted and measured vertical acceleration waveforms (Frequency band=0.01~0.16 [1/m])