Dynamic Pavement Modeling

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Backcalculation tools based on a static methodology are currently the most used ones. In these models, only the maximum vertical deflections under the sensors are considered. Even though these maxima occur at different times, from sensor to sensor, they are used to create a “deflection bowl”. The bowl is assumed to represent the deflected shape of the pavement surface due to a traffic load and is utilized in order to estimate the stiffness of the pavement layers. In this approach, the wave propagation and its effects are ignored.

The shortcomings of the static methods and the computational inconvenience of the present dynamic methods, have prevented the adoption of a commonly accepted procedure for harmonization of FWD tests with different load durations. This harmonization issue was the incentive for a European consortium to establish a European co-operative research project. under the project name SpecifiQ. The objective of this research project is the development of a new FWD data harmonization methodology based on exploiting the dynamic nature of the test. The methodology is meant to be implementable in normal PCs, which can be used in every day engineering practice.

For this harmonization, a dynamic pavement model in needed. The Technical University in Delft (the Netherlands) developed the computer program LAMDA. An axi-symmetric layer spectral element and a half-space spectral element were developed and implemented in this program. The spectral element technique was utilized here. LAMDA has a forward model and an inverse model for the backcalculation procedure.

Because waves are described exactly in the spectral element, one element is adequate to describe a whole layer. Consequently, the size of the mesh of a pavement structure is only as large as the number of the layers involved. This makes

1. the system of equations very small, and
2. it is able to describe the transfer functions of the system exactly.

In the backcalculation procedure, measured displacements in the field are analyzed and compared with those obtained from the LAMDA forward model by use of seed values for the unknown parameters. If matching occurs between the measured and computed displacements, this indicates that the used parameters are representative of those in the field.

The advantages of LAMDA are:

1. The forward model is able to simulate the dynamic nature of the FWD test accurately. This is important because waves carry significant information about the properties of the materials involved in making up the layers of the structure. As a result harmonization of data obtained from different FWD instruments with different load pulse characteristics can be made. This is a major advantage over the currently used static methods.
2. The objective function is formulated in a way that data at only one frequency is adequate for utilization in solving the system of equations for backcalculation (of only) E-moduli. This is important because the computational requirements in this case are kept minimal.
3. It is possible to backcalculate the material moduli and the layer thicknesses but in that case more frequencies have to be used.
4. The methodology to incorporate more data for improving the uniqueness of the solution.