Digital preservation of pavement performance data

Animesh Das[1] and Sneha Mandal[2]

1. Introduction

Pavement is a multi-layered structure which comprises of different materials used in each layer. Each of these materials individually exhibits complex response to traffic load and thermal variations. Researchers have developed several models that aid in characterization and prediction of response of these materials (Krishnan and Rajagopal, 2003; Kim, 2009; Tutumluer, 2013; Han and Vanapalli 2016). However, for a pavement made up of these materials as individual layers, prediction of overall response is an involved process.

2. Significance of performance data in pavement design and maintenance

The failure of a pavement structure occurs due to repetitive loading. These repetitions are spread over a few decades, equal to the design life of the pavement. Thus, the laboratory studies simulating pavement performance essentially involve accelerated methods of testing. For such a scheme to be followed in a laboratory setup, certain compromises are made in the conditioning/ testing procedures, for example, in terms of boundary conditions, loading type, failure definitions, and so on. This necessitates collection of field data on performance of in-service pavements.

Field data is used to develop models for prediction of future health of a given pavement. Many such models, based on empirical or semi-empirical framework, have been developed by past researchers (Cebon, 2000; Gupta et al., 2014; Hu et al., 2022). These field-calibrated models can be used for (i) design of a new pavement (NCHRP 1-37 A, 2004; Das, 2015), (ii) scheduling possible maintenance scheme for a pavement in accordance with a given threshold value of structural/ functional health condition (Chen and Zheng, 2021), (iii) design of the overlay thickness (NCHRP 1-37A, 2004), and (iv) predicting performance of a rehabilitated pavement.

3. Modern data collection techniques

The technologies related to automated data acquisition of pavement performance have undergone significant improvement over the last few years. Broadly there could be two types of assessment tools – external and internal. External assessment tools include various non-destructive techniques, such as ground-penetrating radar, falling weight deflectometer, ultrasound and infrared imaging technique, acoustic emission, laser surface profiling etc. (Goel and Das 2008; Nguyen et al., 2019). Internal tools

[1] Professor, Department of Civil Engineering, IIT Kanpur 208 016, e-mail: adas@iitk.ac.in
[2] Ph.D. Student, Department of Civil Engineering, IIT Kanpur 208 016, e-mail: msneha20@iitk.ac.in

include various sensors related to assessment of temperature, strain, moisture, pressure conditions and so on. (Xue et al., 2014; Graziano et al., 2020).

Pavement instrumentation, in particular the internal sensors, can collect real-time data and transmit to the central servers. The assembled data can be utilized to develop a digital replicate of the pavement stretch under consideration (Steyn and Broekman, 2021). Continuous power supply to the sensors (if needed), efficacy of sensor-performance under varied environmental conditions, organization of large volume of data and its storage, identification of missing /erroneous data, along with the analysis and interpretation of the collected data are some of the challenges involved (Alavi et al., 2016; Chang, 2019).

The feedback from the data collected by various sensors placed within the pavement structure can be utilized in continuously improving/ updating the performance prediction model(s) (refer to Figure 1) (Tran et al., 2022). Subsequently, the revised model(s) can be utilized for planning maintenance actions, with improved level of reliability.

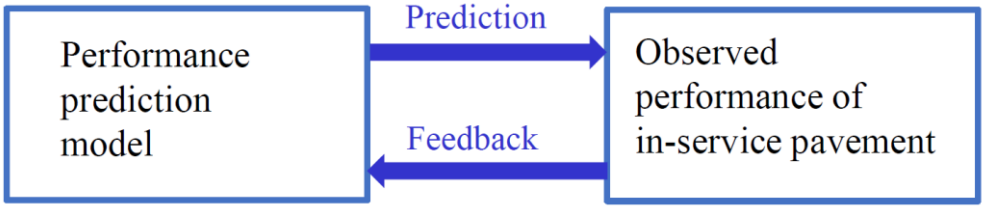

Figure 1: Feedback on performance of in-service pavement improves the prediction model

4. Closure

Considerable volume of data, on material characterization and construction quality, is routinely collected during and immediately after construction of any given project. Further, performance data is also collected routinely for various projects. In a pavement structure, the sensors (if installed) can additionally provide a continuous data-feed on its health status.

There is a need to preserve and integrate various isolated efforts of data collection. A data repository with such a huge volume of data is extremely valuable to the researchers for developing more sophisticated models of pavement structures and predicting future performance of the pavements with improved degree of accuracy.

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