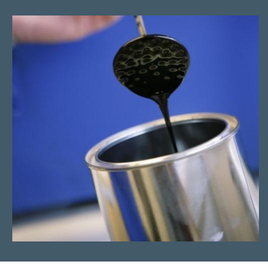
Reliability in Pavement Design

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Introduction

➢ Background

One of the big issues for all highway maintenance authorities is that of durability and future performance of network assets. The maintenance regime is becoming more difficult, and to meet Government congestion targets the maintenance authorities need to minimise treatment and extend pavement life. This research assesses the sensitivity of road pavement life to variability in pavement layer thickness, subgrade stiffness and asphalt stiffness. The research is limited to fully flexible pavements only and to a set of existing UK road schemes.

➢ Methodological Issues

The approaches that have been taken in the past have some limitations, namely:

- Reliability models that are not easily accessible;
- Normal probability distribution generally assumed for the main design variables;
- Fixed design reliability level (i.e., 85% probability of design life survival).

Research Methodology

➢ Research activities

To overcome the limitations and difficulties of current approaches to the reliability of flexible pavement design this research study aims to complete the following tasks:

1. Assess the variability of the major input design variables (layer thickness *h*, asphalt stiffness *E* and subgrade stiffness *k*).
2. Identify and use simple performance equations that relate the expected fatigue and rutting life of a pavement to the major input variables, conducting a sensitivity analysis for each.
3. Run different scenarios (based on the Monte Carlo simulation technique), taken by random sampling of the input variables, and evaluate the resulting distribution of probability of failure.

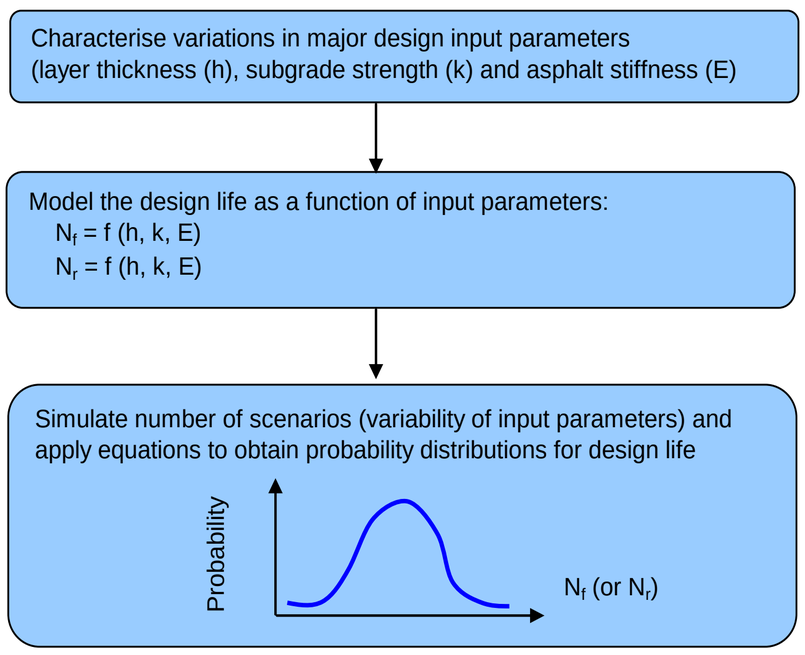

Figure 1: Research activities

➢ Case Study

The scope of the study was to consider data from non-destructive surveys. The sites analysed, all in the UK and Northern Ireland, were mainly motorways or major trunk roads; 1km sections of the most heavily trafficked lane were analysed.

The following data have been collected from each site:

- Radar (GPR) and coring;
- Falling Weight Deflectometer (FWD);
- Dynamic Cone Penetrometer (DCP);
- Laboratory tests (i.e., Indirect Tensile Stiffness Modulus).

Research results

➢ Input parameter variability

Research so far has shown that:

- Pavement layer thickness probability distributions can be assumed to be normal.
- Asphalt and subgrade stiffness probability distributions can be assumed to be lognormal.
- Typical asphalt and sub-base (granular) layer thicknesses can be artificially generated by power spectrum analysis (Figures 2).

➢ Model life as a function of input parameters

An improvement to the Odemark's Method of Equivalent Thicknesses (MET) for calculation of strains and fatigue life for flexible pavements has been achieved. The alternative model provides a simple and efficient method for practical purposes, for example in Pavement Management Systems or in simulation of pavement deterioration, where stresses and strains must be calculated large numbers of times.

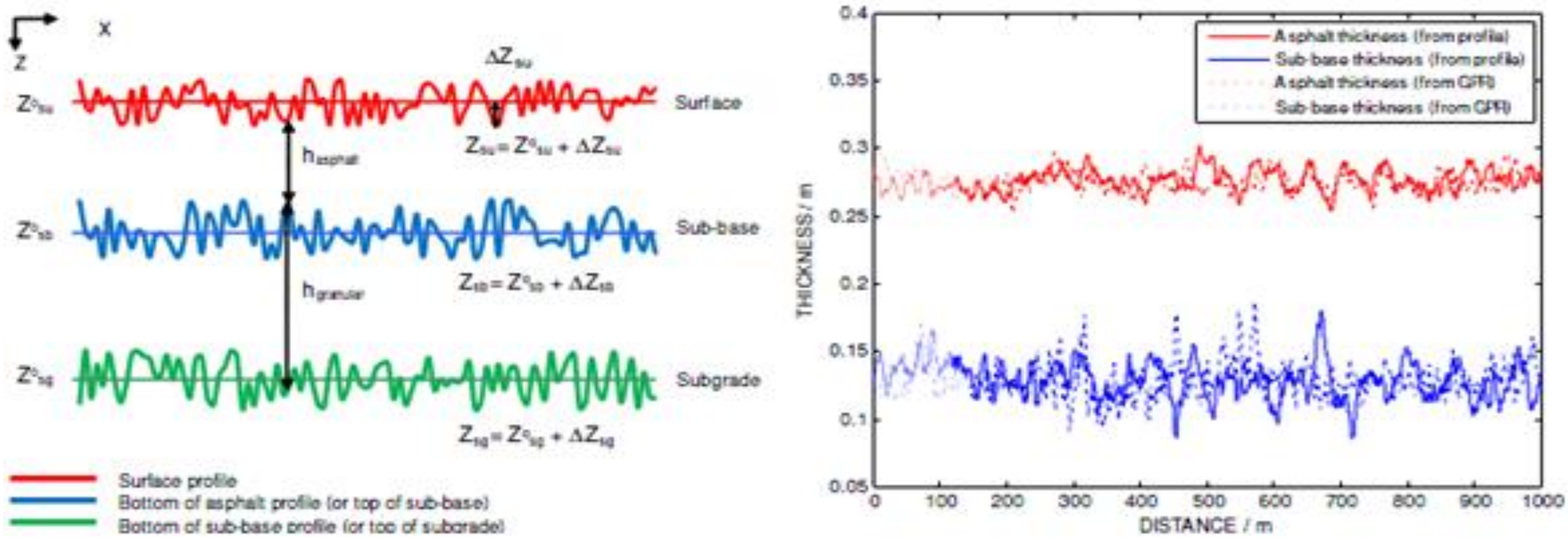

Figure 2: Schematic explanation of random signal generation (left) and comparison between real (from GPR data) and artificially generated layer thicknesses (right)