RPP Calibration

Traditionally, most methods for predicting pavement life (eg Shell) used fatigue criteria developed in one specific country, often from laboratory testing, accelerated pavement testing tracks (AASHO Road Test) or from in-service roads from one specific form of observed terminal distress (eg the Austroads subgrade strain criterion). The Precedent Performance method was developed in the 70's to determine an individual criterion for any specific project, provided the terminal condition was subgrade rutting. In the 90's when FWD data became generally available, the precedent approach was extended to determine appropriate criteria for a network or region where multiple modes of distress were resulting in terminal conditions in any layer. Termed the Regional Precedent Performance (RPP) method this is just as transparent as the original Precedent method (ie can still be done manually). However once large datasets became available from extensive FWD tests and now TSD/MSD and there was more awareness of multiple modes of distress, the RPP package was structured to use multi-variate analysis to analyse the large data sets providing informed understanding of pavement deterioration and modelling of future performance. RPP establishes the simplest mechanistic-empirical model that includes all key characteristics of pavement performance which is then calibrated to all available facts in the local database including the condition of all terminal sites: historic, current and those that develop in subsequent years, ie the calibration is ongoing for continuous improvement. There are multiple steps in the complete calibration process, with most networks completed to date taken to Step 5 or 6 in minimal time, although as the percentage of the network surveyed increases there may be benefit in progressing with some of the later steps.

- Assemble all surface condition, structural condition, traffic (both in terms of ESA and its component categories), historic data (HSD, FWD, Deflectograph, TSD, MSD, RAMM)
- Multi-Region Analyses. Establish the general form of surface condition criteria (eg limits on rut depth, roughness, cracking intensity etc) and also structural criteria (eg subgrade strain criterion plus criteria for other layers either from traditional global or national recommendations and apply any other cost criteria (NPV of maintenance vs rehabilitation). This provides a very preliminary scoping of remaining life that has essentially no calibration and may be regarded as Level 0 in terms of reliability.
- Level 1: Regional Analysis. Determine the adequacy of available data, ie whether the data set from the specific region (ie local network) is sufficient to determine a specific regional calibration using the general form of the criteria from the multi- regions. If so, use the regional data or weight towards the local model otherwise adopt the multi-region model as an interim calibration.
- Level 2. Calibrate criteria based on interpolation and curve fitting to the distribution of all non-destructive structural data, separating extremes from customary distributions (expected terminal conditions based on frequency). At this level, the calibration is a desktop study only, based on mechanistic characteristics and analytical principles derived from other networks and will give indications of both relative performance and which parts of the network have very short life, but cannot be used for longer term forward work plans.
- Level 3. Calibrate terminal state criteria based on determination of valid load damage exponents for each relevant distress mode to enable extrapolation using longer term models incorporating multi-region historic rates of area wide rehabilitation treatment (AWT), resulting in a preliminary model at 10-20m intervals or greater viewable on spreadsheet or GIS (PaveState).

- Level 4. Compliance: Refine calibration based on regional rates of recent rehabilitation (where the database of surface condition state and subsurface conditions is adequate). Note that up to this Level, only desktop studies are carried out based on supervised machine learning of multi-variate analyses which are then related to images of the pavement taken from the cab windscreen at time of testing or from Google Streetview where recent and historic images can be viewed. The assumption is made that most of the network complies generally with relevant specifications and standards for materials and practices (B/2, M/4, M/4 Notes and M/3 Notes).
- Level 5. 80/20. Detailed calibration supplemented by (drive-by) visual inspections of the principal roads of concern to ensure a selection of specific sites that are close to terminal condition are consistent with the models (both in terms of distress mode and their extents) for resurfacing, heavy maintenance and AWT. At this level an "80/20" approach is used, with the objective of providing a useful degree of reliability that achieves around 80% effectiveness of both the distress mode characterisation and at least medium-term predictions of pavement structural life, while limiting time inputs to 20% of that which would be necessary to provide a comprehensive outcome. Output at 10-20m typically.
- Level 6. Drive by of the region used for calibration to confirm reliability from terminal sites as at this stage it is immediately obvious from the PaveState mobile app and/or the FWP generated for that region, using the oldest data available as that gives a basis determining just how many years ahead the model predictions will be reliable. If the model is too conservative and is predicting for a specific location a terminal state prior to the date of the drive-by, the absence of any field indication of terminal distress or heavy maintenance patching at that location is used by the analyst to relax the criterion for the predicted critical distress mode. If the model is unconservative eg terminal distress observed in the drive-by is shown as having more than 1 year of remaining life, the criterion is tightened progressively. Each adjustment ensures such model-site consistency in terms of extents, severity of observed distress and distress mode until a sufficiently reliable regional calibration is established. At this level, the model can also incorporate all available as-built data, all relevant source material properties, construction procedures, compaction compliance and maintenance practices. In practice, for roads that are mature, quality as-built records are not common, hence all the steps above are structured to produce useable output in view of this limitation. For a recently constructed rehabilitation or greenfield road / sub-network, such information should be available, and its inclusion is critical for evaluation. In its absence, it should be appreciated there is the possibility that a specific site has been constructed and/or maintained more effectively than has been the "customary practice" for the region in which case the results for RPP predicted life would be conservative. Alternatively, the onverse applies.
- Level 7. The network which is typically sub-sectioned into 10 to 50m intervals is subdivided down to 0.5-2m intervals to characterise the non-uniformity of parameters, in particular the modulus of the upper layer to determine potential for block cracking and/or local shear instability, while still outputting at network level.
- Level 8. Maintenance. An additional output is generated at 0.5-2 m intervals so that localised heavy maintenance can be distinguished (timing and extents) with a corresponding medium term forward work plan.
- Level 9. Integrated. Once the maintenance plan priorities have been identified, reallocation of structural treatment length is required each year with an iterative recursive mechanistic model that tracks how moduli (and hence stresses and strains) change with respect to the 3 principal variables ie traffic, age and maintenance practices (both resurfacing and heavy maintenance). For each subsequent year the test points that were in the relevant year of the maintenance plan are replaced with upgraded moduli so that reallocation of structural treatment lengths can be applied to each road with consequent revision of the area wide FWP. The result is a pair of integrated FWP's for both heavy maintenance and AWT for consideration with the resurfacing plan (usually prepared by others).

- Level 10. (Project) At this level, for those sites where the decision has been made for rehabilitation it is expected that destructive testing and evaluation of the materials in each layer and the subgrade is likely to be warranted and would be carried out under the direction and input from pavement engineers who are closely familiar with both the historic performance of the network and the current state of each specific site.