ASPHALT FATIGUE AT ELEVATED TEMPERATURES

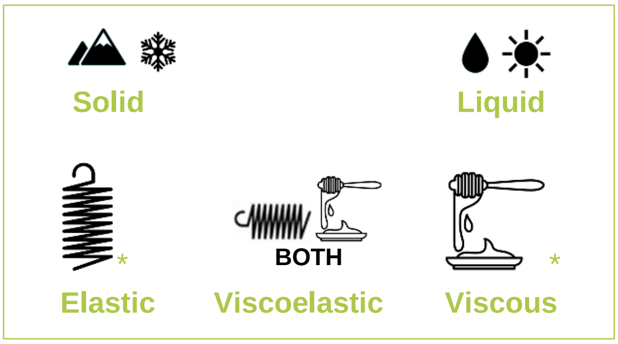
Exploring opportunities to improve asphalt modulus and fatigue characterisation for WA climate conditions.

The purpose of this project is to characterise the stiffness and establish fatigue modulus values and performance of typical Western Australian asphalt mixes and evaluate opportunities for improving current asphalt mix and structural design practices in the states north, where WMAPT's are greater than 35 °C. The aim of this study is to improve the cost-effectiveness and fatigue parameters for design of full depth asphalt (FDA) pavement design outcomes in WA.

Background

Asphalt is a viscoelastic material and the stiffness is dependent on both the rate of loading (speed of traffic) and temperature. At higher temperatures and lower traffic speeds, asphalt exhibits lower modulus values. These concepts are illustrated below.

SIMPLIFIED ILLUSTRATION OF RANGE OF ASPHALT BEHAVIOUR



*Icon Source: Noun Project

In the current design methodology, asphalt fatigue life is directly related to the asphalt modulus. In thick (generally > 150 mm) asphalt pavements, lower modulus values result in greater deflections and higher strains at the bottom of the asphalt layer, thus, leading to increased fatigue damage (i.e. cracking) and a reduction in design life. As a result, increased asphalt pavement layer design thicknesses are required for thick (generally > 150 mm) asphalt pavements where the pavement temperatures are high and/or traffic speeds are low.

However, this is not the failure mechanism observed at high weighted mean annual pavement temperatures (WMAPTs) in the field. Observations of asphalt fatigue damage in service indicate that most of the damage accumulates at low temperatures.

WMAPTs in Western Australia vary from 24 °C in Albany, to 42 °C in Kununurra. The hot climate in the northern areas of the state, with WMAPTs in excess of 30 °C, therefore, leads to very thick FDA pavement design outcomes using the current design procedure.

Approach

- A review of the current asphalt thickness design procedures, including asphalt stiffness characterisation
- A review of findings from related projects
- Asphalt stiffness and fatigue testing of four typical Western Australia mixes
- Development of flexural modulus master curves and mix specific asphalt fatigue models for the mixes tested in accordance with Austroads test method AGPT/T274. Test setup depicted overleaf
- Parametric analysis comparing asphalt pavement layer design thickness using the current design procedure with mix specific input

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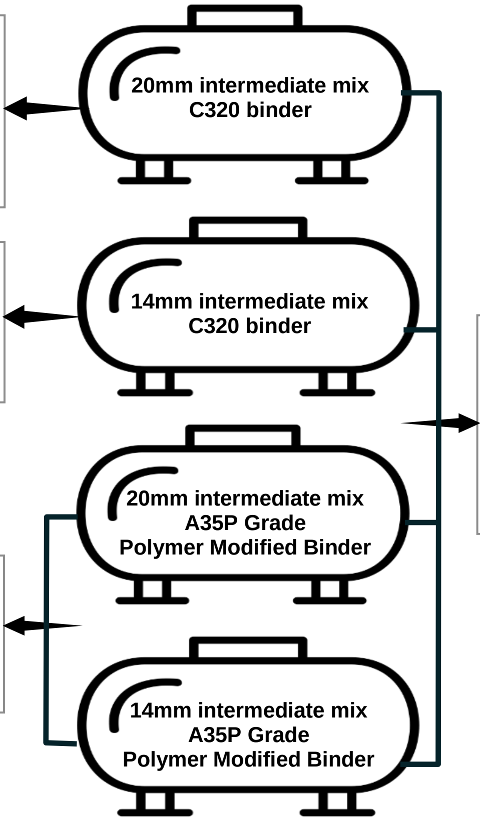
Laboratory Testing and Findings

Four WA asphalt mixes have been tested as part of this project and indicated that:

The use of flexural modulus master curves resulted in lower design modulus at elevated temperatures compared to the values currently assigned in pavement design procedures.

The use of flexural modulus master curves resulted in higher design modulus at 30 °C and approximately the same modules values at 40 °C.

The use of A35P polymer modified binder did not greatly influence the stiffness of the tested mixes, but it increased the fatigue life of those mixes.



Shell International Petroleum (1978) asphalt fatigue model predicts longer fatigue lives than the laboratory performance of the asphalt mixes tested, except for the 20 mm Class A35P binder mix when tested at 30 °C, which presented similar fatigue life compared to the Shell equation prediction.

Icon Source: Noun Project

Futures Studies Recommendations

- Testing at 30 °C and higher pushed the limits of AGPT/T274. The impact of higher temperatures must be investigated.
- Implement interim design approach for the design of asphalt layers that accounts for the reduced fatigue damage expected to occur at elevated pavement temperatures.
- Investigate a WMAPT limit where asphalt fatigue is no longer the critical failure mode.

ASPHALT BEAM IN BENDING BEAM TEST APPRATUS AFTER CRACK FORMATION