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MULTI-LAYERED ELASTIC ANALYSIS OF AN INNOVATIVELY-EQUIPPED FWD FIELD-TESTING SITE

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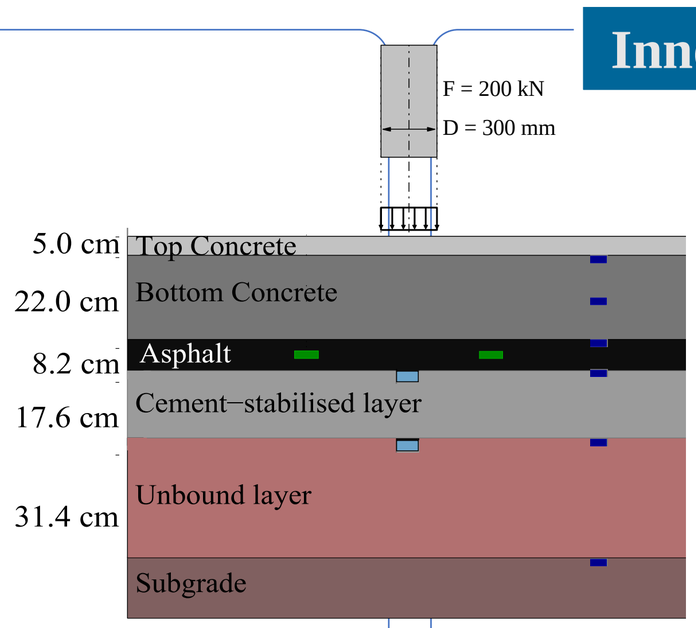
Motivation & Methodology

Introduction

Falling Weight Deflectometer (FWD) tests are used for the design and evaluation of pavement roads. Geophones measure deflections along the driving direction. Layer properties are back-calculated to best fit the deflections measured, see also [1].



Innovative Instrumentation

The pavement structure consisted of six layers. It was innovatively equipped with temperature sensors, acceleration sensors and asphalt strain gauges. The sensors enabled the in-situ characterization of layer properties. Specimens were gathered for further laboratory tests.

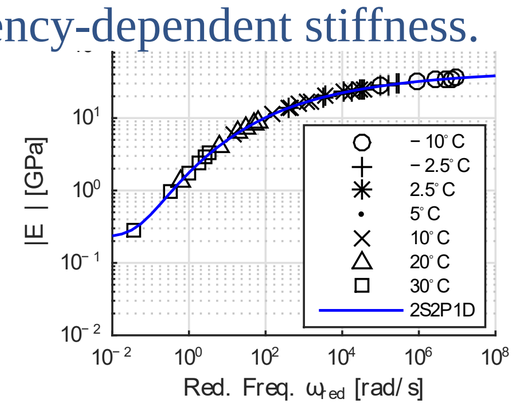
Experimental Data

Layer Properties

Concrete: Temperature-independent properties

	Top Concrete	Bottom Concrete
Unloading Modulus [GPa]	34.1	46.3

Asphalt: Dynamic Mechanical Analysis: Temperature and frequency-dependent stiffness.



WLF Equation: $\log \alpha_T = \frac{-C_1 (T - T_0)}{C_2 + (T - T_0)}$ (from)

Shift factor

2S2P1D Model:

$$E^*(\omega) = E_0 + \frac{E_\infty - E_0}{1 + \delta (i\,\omega \alpha_T \tau)^{-k} + (i\,\omega \alpha_T \tau)^{-h} + (i\,\omega\,\beta \alpha_T \tau)^{-1}}$$

Layer Properties

Cement-stabilised layer: Innovative "hammer tests" – a small hammer is used to manually impact a rubber pad located at the centre of the slab, generating an elastic wave.

$V_{cs} = \frac{h}{\Delta t}$ — h: layer thickness; Δt: Run-time across the layer (from)

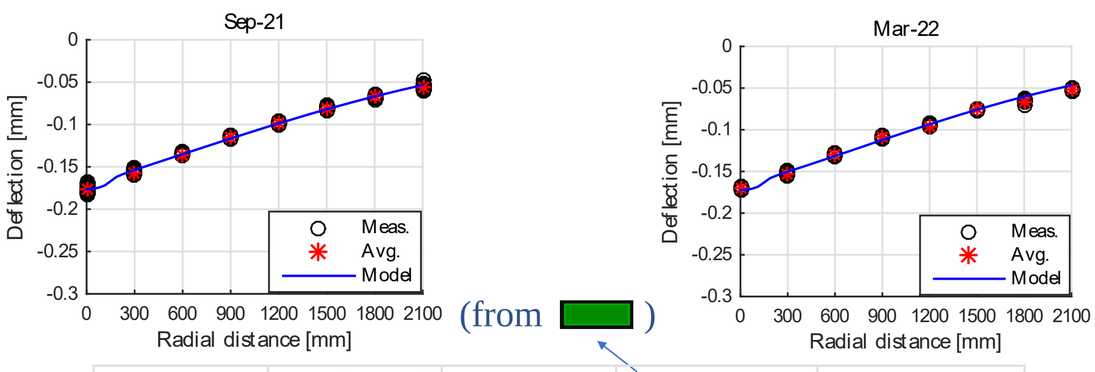
$$E_{cs} = \rho_{cs} V_{cs}^2 \frac{(1 + \nu_{cs})(1 - 2\nu_{cs})}{1 - \nu_{cs}}$$

$\nu_{cs} = 0.2$

Results & Conclusions

Multi-Layered Simulation

The innovative instrumentation and the laboratory tests reduce the unknowns in the back-calculation to two: the elastic modulus E_{sg} and the thickness h_{sg} of the subgrade. They are optimised to best fit the measured deflections.



(from)

	[GPa]	[cm]	[10⁻]	[10⁻]
Sep-21	0.095	100	4.94	5.15
Mar-22	0.105	100	5.85	5.83

fitted validation

Conclusions

- Excellent agreement found between measured and *fitted* values of deflections, if the layer properties are known in advance.
- Good agreement found between measured and *predicted* values of strain in the asphalt layer.

Acknowledgments

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Reference

[1] Díaz, R., Aminbaghai, M., Eberhardsteiner, L., Blab, R., Buchta, M., & Pichler, B. (2021). Multi-directional Falling Weight Deflectometer (FWD) testing and quantification of the effective modulus of subgrade reaction for concrete roads. International Journal of Pavement Engineering, 1-19. https://doi.org/hcnx