

The Impact of Climate Change on Pavement Lifespan



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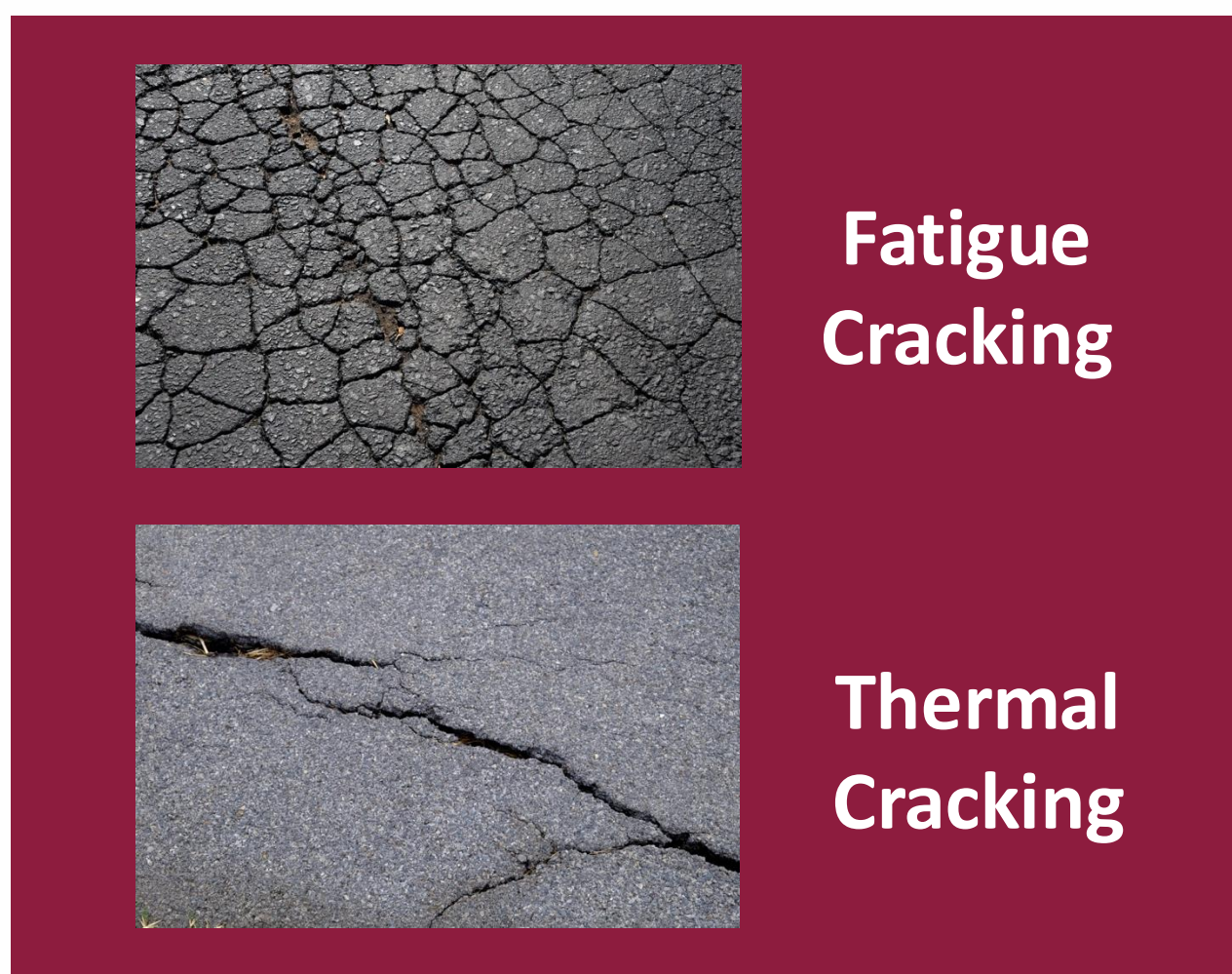
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1. Research Objective

Quantifying the effects of climate induced aging on the viscoelastic properties of asphalt materials

2. Background

- Phoenix is experiencing longer and hotter summers due to climate change
- Increased temperatures accelerate the aging and oxidation of asphalt materials, resulting in a reduction of the pavement's lifespan



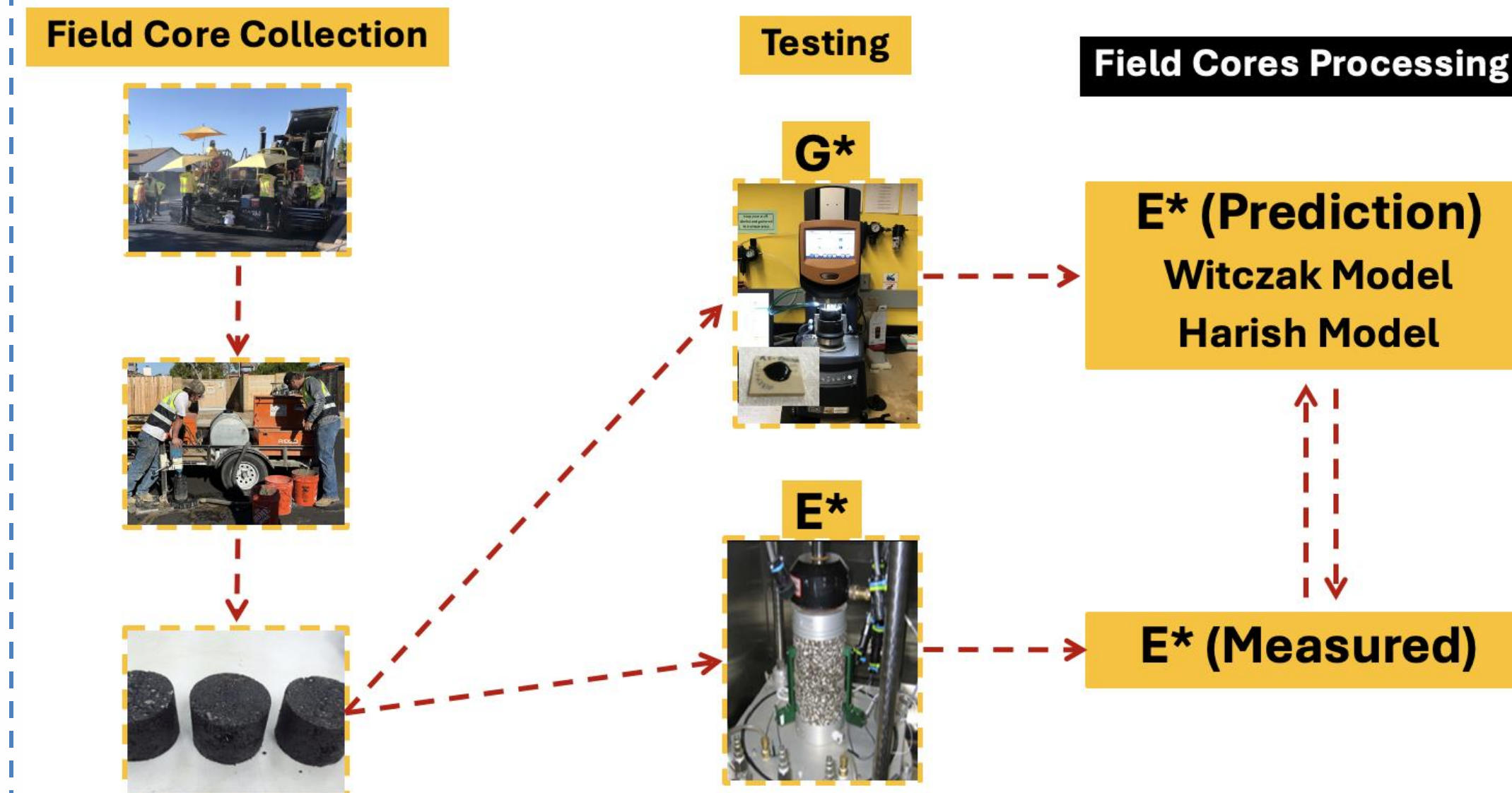
- The impacts of aging can be measured through the viscoelastic properties of asphalt materials and mixtures

3. Significance

According to *The Hill*, poor pavement conditions cost U.S. motorists \$119 billion in vehicle repairs annually. Improving mix designs or using different materials can significantly increase pavement durability and reduce these costs.

4. Methods

- Two predictive models, Hirsch and Witczak, are investigated
- Measured binder shear modulus (G^*) data is fed to the models to predict the complex modulus of mixes (E^*)
- The accuracy of both models is investigated using the data from a test site in Mesa, AZ



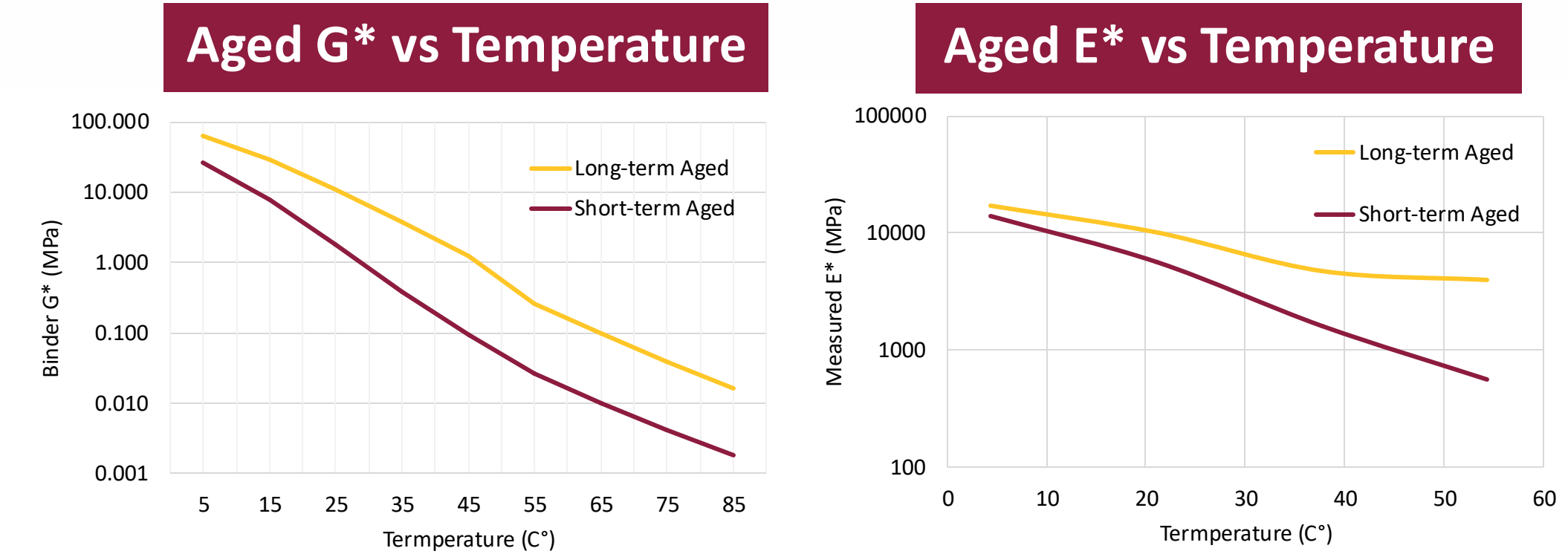
Witczak

$$\log_{10} |E^*| = -0.349 + 0.754 \left(|G^*|_b^{-0.0052} \left[\frac{6.65 - 0.032P_{200} + 0.0027(P_{200})^2 + 0.011P_4 - 0.0001(P_4)^2}{+0.006P_{3/8} - 0.00014(P_{3/8})^2 - 0.08V_a - 1.06 \left(\frac{V_{b,off}}{V_{b,off} + V_a} \right)} \right] \right. \\ \left. + \frac{2.558 + 0.032V_a + 0.713 \left(\frac{V_{b,off}}{V_{b,off} + V_a} \right) + 0.0124P_{3/8} - 0.0001(P_{3/8})^2 - 0.0098P_{3/4}}{1 + \exp(-0.7814 - 0.5785 \log |G^*|_b + 0.8834 \log \delta_b)} \right)$$

Hirsch

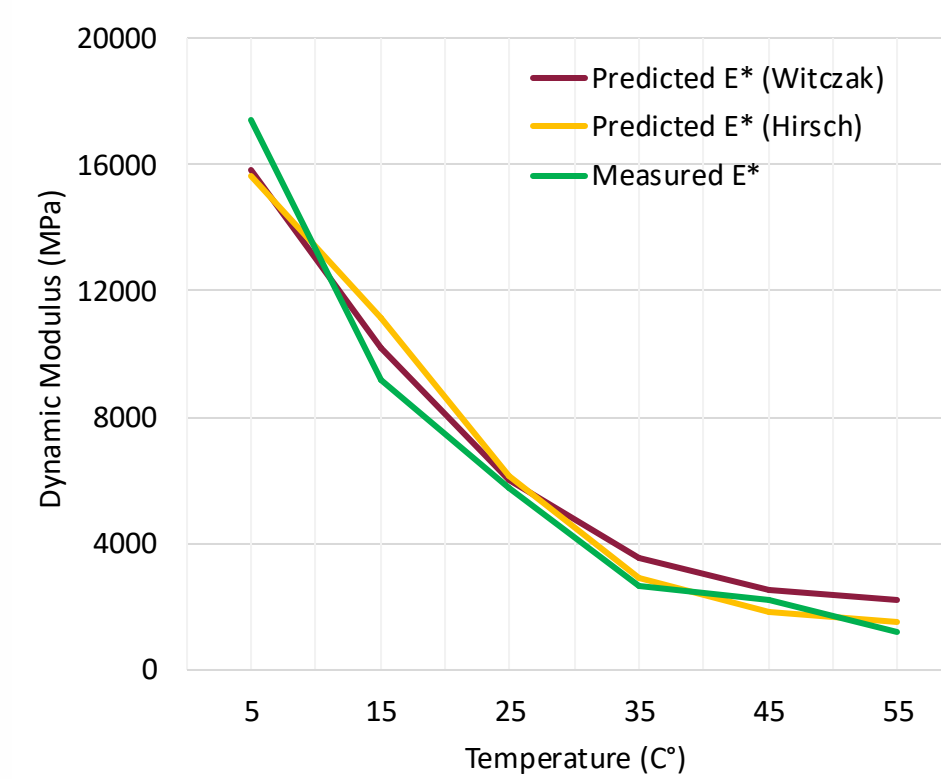
$$|E^*|_m = P_c \left[4,200,000 \left(1 - \frac{VMA}{100} \right) + 3 |G^*|_b \left(\frac{VFA * VMA}{10,000} \right) \right] + \frac{(1 - P_c)}{\left(1 - \frac{VMA}{100} \right) + \frac{VMA}{4,200,000} + 3 |G^*|_b (VFA)}$$

5. Results

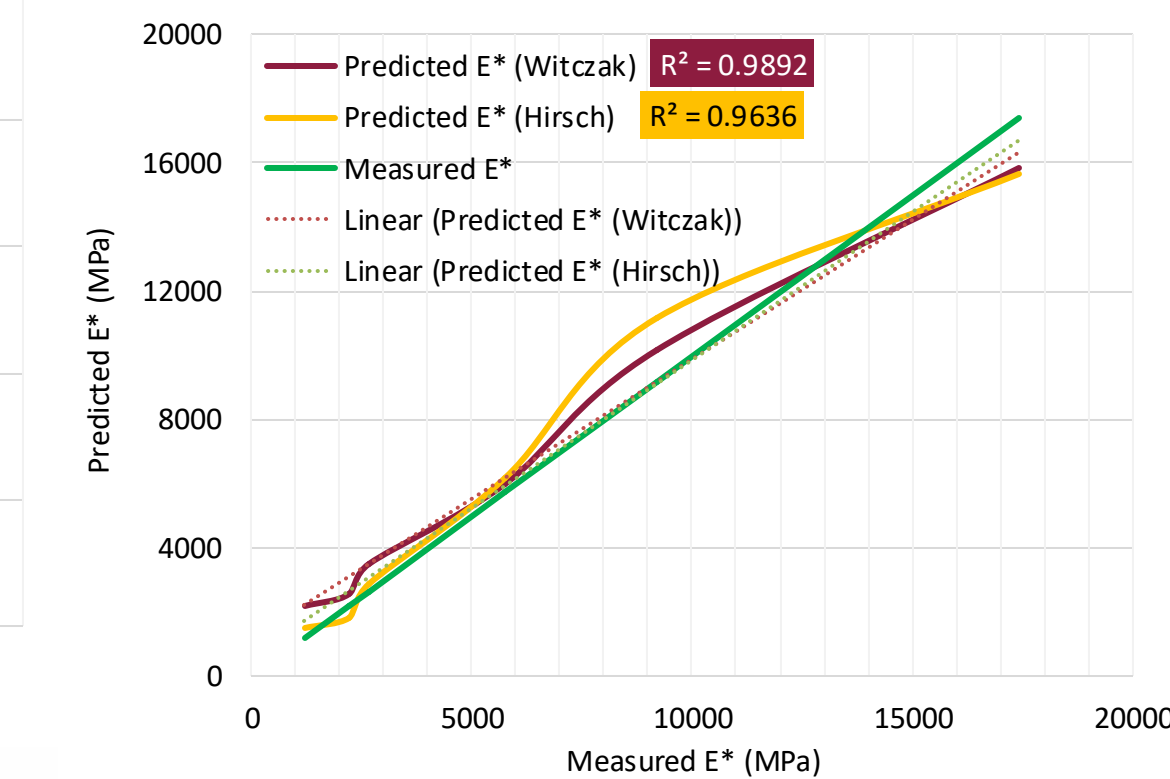


- Both G^* and E^* decrease with temperature but increase with age

Predicted vs Measured E^*



Predicted vs Measured E^* (Regression)



- Witczak and Hirsch both demonstrate strong predictive accuracy, with R^2 values much greater than 0.90

6. Discussion

- The implementation of G^* data from field cores into the Hirsch and Witczak models has allowed for accurate prediction of E^*
- To build on the current research, the prediction of time dependent effects on the E^* can be studied and incorporated into the model