How to Estimate Resilient Modulus for Unbound Aggregate Materials: A Theoretical Explanation of an Empirical Formula

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Formulation of the problem. To ensure the quality of a road, it is important to make sure that all the pavement layers have reached a certain stiffness level. To characterize stiffness of unbound pavement materials, transportation engineers use *resilient modulus* M_r. A material's resilient modulus is actually an estimate of its modulus of elasticity E, i.e., of ratio of stress by strain; the difference from the usual modulus of elasticity if that the usual modulus corresponds to a *slowly* applied load, while the resilient characterizes the effect of *rapidly* applied loads – like those experienced by pavements. A precise definition of the resilient modulus is given, e.g., in [1].

In the usual (*linear*) elastic materials, the modulus does not depend on the stress value. In contrast, pavement materials are usually *non-linear*, in the sense that the resilient stress depends on the stress. Several empirical formulas have been proposed to describe this dependence. Experimental comparison [2] shows that the best description is provided by the formula (first proposed in [3]) $M_r = k'_1 \cdot \left(\frac{\theta}{P_a} + 1\right)^{k'_2} \cdot \left(\frac{\tau_{\rm oct}}{P_a} + 1\right)^{k'_3}$, where P_a is atmospheric pressure, θ is the *bulk stress*, i.e., the trace $\theta = \sum\limits_{i=1}^{3} \sigma_{ii}$ of the stress tensor σ_{ij} (see, e.g., [4]), and $\tau_{\rm oct} \stackrel{\rm def}{=} \sqrt{\frac{1}{3} \cdot \sum\limits_{ij} \sigma_{ij}^2 - \frac{1}{3} \cdot \theta^2}$ is the *octahedral shear stress.*

What we do in this talk. In this talk, we provide a theoretical explanation for the above empirical formula. This explanation uses the general idea that the fundamental physical formulas should not change if we simply changing the measuring unit and/or the starting point for the measurement scale.

References

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