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The effects of dilatancy in unbound granular pavements on the load carrying capacity predicted by the South African Mechanistic-Empirical Design Method

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ABSTRACT

The South African Mechanistic Empirical Design Method (SAMDM) was developed in the late 1960s and early 1970s for pavement design and analysis. The method has had a number of updates since its original publication by Van Vuuren *et al*. (1974) and it has gained popularity in South Africa over other design methods such as the CBR and AASHO methods. Despite shortcomings such as sensitivity to input parameters, as a design tool the SAMDM provided the pavement designer with a reasonable level of confidence in the pavement structure and the estimated pavement life. This research set out to study the dilatancy of granular material and the effect which dilatancy has on the load carrying capacity of the pavement which is predicted by the SAMDM. Two FEA packages, SIGMA/W and PLAXIS, were used to calculate the stresses and strains required in the SAMDM using the linear elastic and elastic plastic constitutive models. The effects which dilation has on (i) the stresses and strains calculated with the FEA packages and (ii) the predicted factor of safety and load carrying capacity for a typical pavement were evaluated. The results indicate that the effect of small variations (up to 20 %) in the angle of dilatancy input term ψ, on the predicted principal stresses and strains 1) depends on the FEA package used to calculate the stresses and strains; 2) depends on the formulation of the constitutive model which is selected for the analysis; and 3) is in general small and possibly negligible. The findings also demonstrated that the SAMDM is not overly sensitive to small variations in the dilatancy input parameter. Comparison of the calculated Factor of Safety (FOS) and load repetitions to failure using the stresses computed in the elastic plastic model formulation of the SIGMA/W and PLAXIS FEA packages, illustrated that the formulation of the constitutive model used in the selected FEA package has a large effect on the FOS and predicted load repetitions to failure. Incorporating a tension cut-off formulation in the FEA model, had a significant effect on the calculated stresses and strains and also overcame the computation of inadmissible stresses and strains which lead to FOS values that are less than one and thus predict almost immediate failure of the pavement layer.

Key words: DILATION, UNBOUND GRANULAR MATERIALS, SAMDM