CREEP ADJUSTED MODULUS OF ELASTICITY

INTRODUCTION

This study documents the model proposed for HIPERPAV to incorporate the effects of creep into the modulus of elasticity. The need for this new model was due to short comings in the Umehara [(1)], Byfors [(2)], Double Power [(3)], Triple Power [(4)] and Extended Triple Power laws [(5)]. The proposed method was developed and calibrated based on the field data.

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During the validation exercise [(6)] ,the adjustment factor for early age creep as proposed by Byfors [(2)]was used to modify the Umehara predicted modulus. The correction factor Byfors developed, is used to account for the influence of the loading age.[(7)] The creep-adjusted modulus of elasticity to account for the influence of the loading age, proposed by Byfors, is then computed.

It should be noted that the model developed by Byfors [(2)] is incomplete, as Byfors only provides an adjustment to account for the rapid effects of creep at early age. For this reason, it was deemed necessary to use the 72-h modulus of elasticity value, as provided by Umehara, however, the shape of the curve will be modified based on the recommendations from Byfors. Figure 1 presents the basic modulus of elasticity, the Umehara predicted Modulus, and the Byfors modified Umehara Modulus for slab 5, Arizona. Note from figure 1 the difference in the predicted modulus of elasticity at early age.

A shortcoming of this method is that during the HIPERPAV analysis, the 72-h Umehara predicted modulus of elasticity is unknown until the whole HIPERPAV has been executed. Therefore, the modulus of elasticity predicted with the Byfors correction can not be scaled-up, as the scaling magnitude (72-hour Umehara prediction) is unknown. In order to obtain the 72-h Umehara Predicted modulus of elasticity it would be necessary to run the heat transfer finite element model twice in HIPERPAV, and this would not be time efficient.

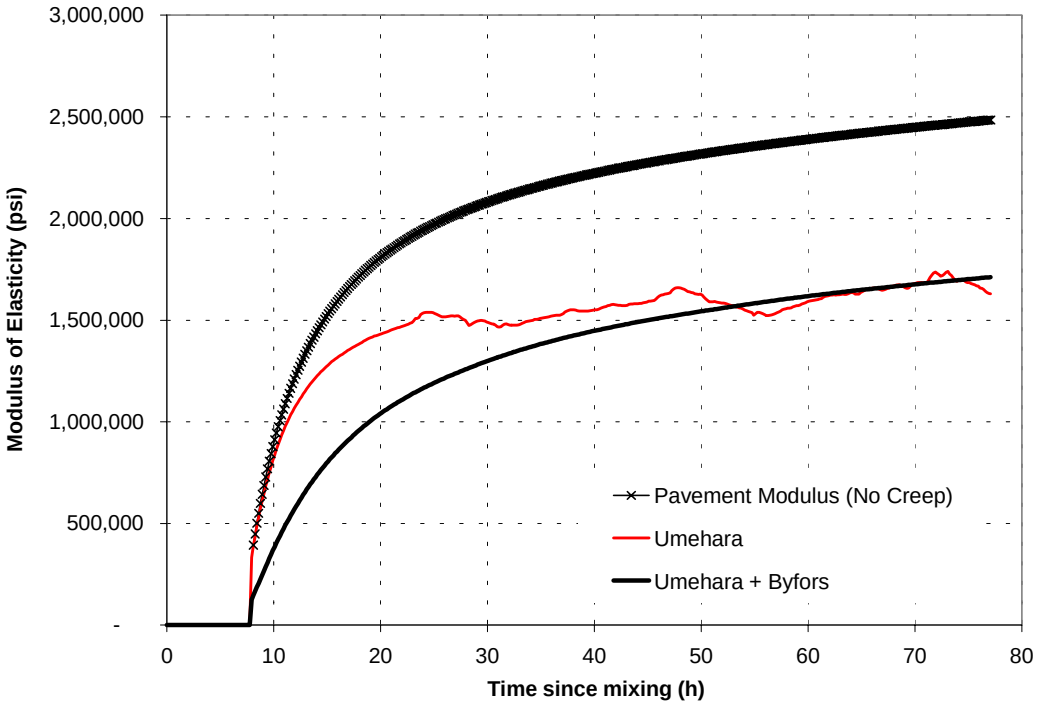

Figure 1. The creep adjusted modulus of elasticity values as compared to no creep allowance.

In order to bridge this problem, a scale factor for the difference between the Umehara and Byfors modulus of elasticity, for each time increment, was developed.[7]

This method should produce acceptable results as the magnitude of adjustment is always a function of the calculated Umehara and Byfors creep adjusted modulus of elasticity, which are in turn dependent on the concrete mix properties.

Figure 2 shows the results of the proposed method as compared to the creep adjusted modulus of elasticity predicted by Umehara. For this particular site the proposed method provided reasonable estimate of the Umehara adjusted with Byfors, modulus of elasticity. For the creep adjustment of modulus of elasticity for other slabs, please refer to reference 8.

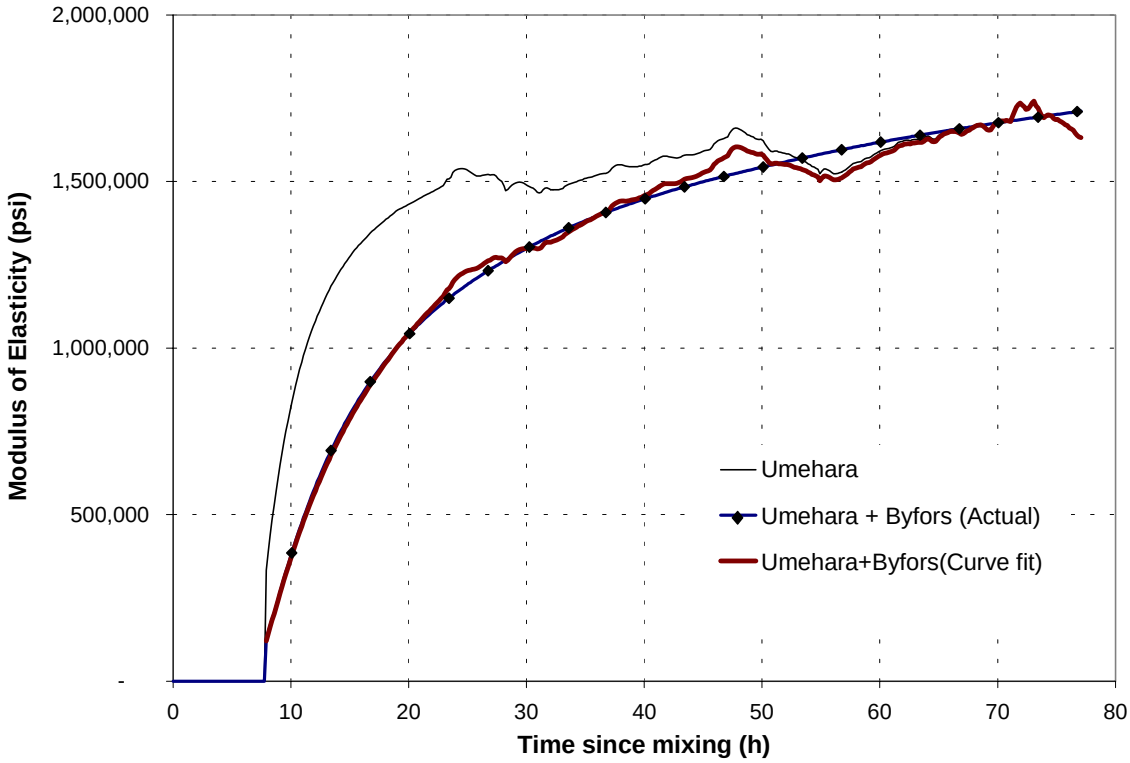

Figure 2. Comparison of the Umehara and the Proposed Umehara adjusted with Byfors Creep modulus of elasticity.

REFERENCES

(1) Umehara, H., and Uehara, T., "Effect of Creep in Concrete at Early Ages on the Thermal Stresses," Proceedings of the International RILEM Symposium, Munich, E & FN Spon, Germany, October 1994.

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(6) Technical Memorandum No. 12, Slab Curling Prediction Model, Poisson's Ratio, and Temperature Gradient Adjustments

(7) Technical Memorandum No. 14, Creep Adjusted Modulus of Elasticity

(8) Technical Memorandum No. 18, Modulus of Elasticity Validation