Review on long-term settlements on MSEW abutments in service stage

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ABSTRACT: Though the mechanically stabilized earth wall abutment can be minimalized different settlements, it is continuously receiving dead loads and traffic loads. So time-dependent long-term settlement can occur. Hence, assessments on the long-term settlement of the MSEW abutment reviewed on this study. The hyperbolic model and the Singh-Mitchell model were reviewed for estimating long-term settlements. The Singh-Mitchell model cannot determine the creep termination period or the final creep amount, which causes an unrealistic excessive settlement. Contrary, the hyperbolic model is converged to time and can be more realistic model for estimating long-term settlement.

Keywords: mechanically stabilized earth wall abutment, long-term settlement, Singh-Mitchell model, hyperbolic model

1 INTRODUCTION

The driving discomfort on the bridge ends have become an important issue for high users. There are many reasons for the driving discomfort on the bridge ends. The main factor for driving discomfort at the bridge ends can be the compression of natural soil and embankment. It is reported that long-term compressive settlement of 0.2 ~ 0.5% of the height of the embankment occurs over a long period even if the embankment is sufficiently compacted. These long-term settlements are not considered at all in the design and construction stages. Conversely, the foundation of the abutment is supported on hard strata over weathered rock, and the allowable settlement of the foundation is strictly controlled within 25 mm in within the design and construction phases. As a result, the differential settlement between the abutment and the embankment can inevitably occur. To solve this problem, MSEW (Mechanically Stabilized Earth Wall) abutments have been developed and widely used in USA and Europe.

Though the MSEW (Mechanically Stabilized Earth Wall) abutment can be minimalized different settlements, it is continuously receiving dead loads and traffic loads. So time-dependent long-term settlement (creep deformation) can occur on the MSEW abutment. Hence, assessments on the long-term settlement of the MSEW abutment reviewed on this study.

2 ASSESSMENT METHODS ON LONG-TERM SETTLEMENTS OF SOILS

Various models have been proposed to predict the long-term settlement of soils from geotechnical point of view. The most commonly used model is the Singh-Mitchell (SM) model (Singh and Mitchell, 1968), which is a model in which the settlement diverges over time (Figure 1). This Singh-Mitchell model has a problem that cannot determine the creep termination period or the final creep amount. Another researcher Ling et al. (1998) used a hyperbolic model to predict long-term settlement of landfills (Figure 2). The biggest difference of two models is whether to converge or converge in time. Assuming that the lifetime of the MSEW abutment is 100 years, an unrealistic excessive settlement can be estimated for the MSEW abutment when the Singh-Mitchell model is applied because Singh-Mitchell model's settlement diverges over time. Hence, the hyperbolic model can be more suitable for estimating long-term settlement for the MSEW abutment that has long period service time.

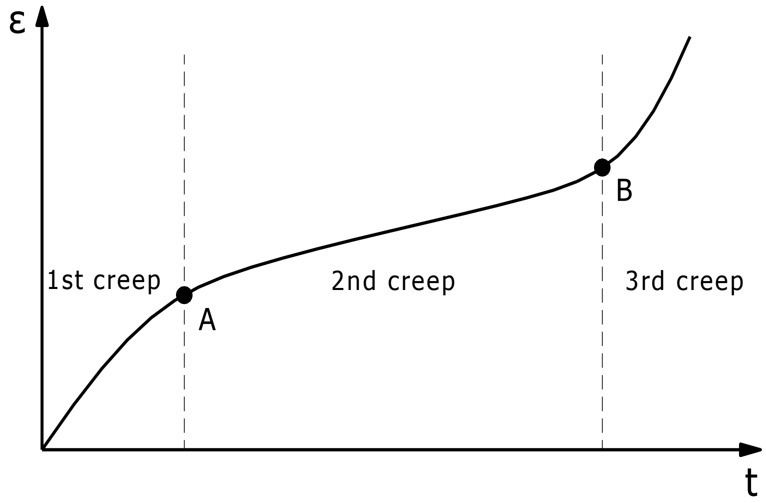

Figure 1. Singh-Mitchell model (Singh and Mitchell, 1968)

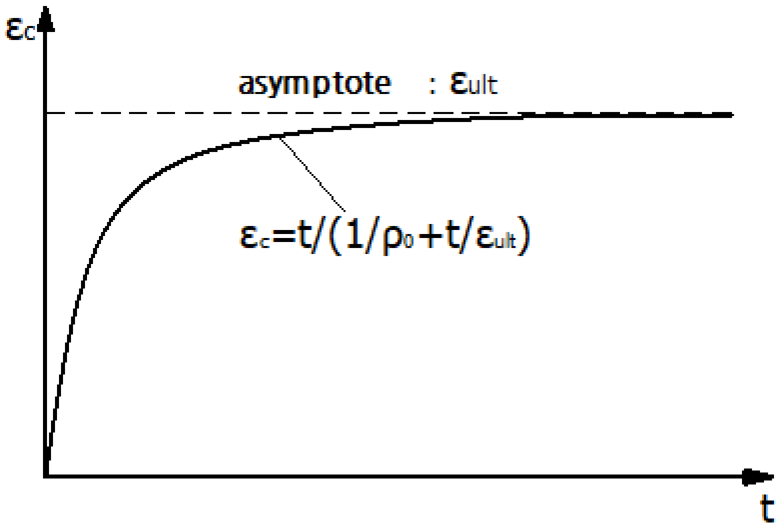

Figure 2. hyperbolic model (Ling et al., 1998)

3 VERIFICATION OF LONG-TERM SETTLEMENT ASSESSMENT METHOD

In order to compare two models, two model were applied on the creep test result done by Kim (2010) to verify their application. Kim (2009) conducted a creep test on weathered soil containing 15% of fine particles and applied a confining pressure of 50 kPa. Deviator stress for developing creep were applied 40%, 60% and 80% of a compressive failure load. Figure 3 and 4 show the regression curve by Singh-Mitchell model and hyperbolic model based on Kim (2010)'s test data, respectively. The hyperbolic model shows more accurate trend than SM model.

Based on two creep models (Figures 3 and 4), creep strains for 1 year can be estimate as shown in Figure 5. The SM model is continuously increasing without convergence and approximately 7% of creep strain for 80% of the failure load case is developed for 1 year. The 7% of creep strain can cause about 1.4 m creep settlement if an embankment height of 20 m which settlement is an unrealistic excessive settlement. Contrary, the hyperbolic model is converged and approximately 2% of creep strain for 80% of the failure load case is developed for 1 year. The 2% of creep strain can cause about 0.4 m creep settlement if an embankment height of 20 m which settlement still an excessive settlement but it is more realistic value than the SM model.

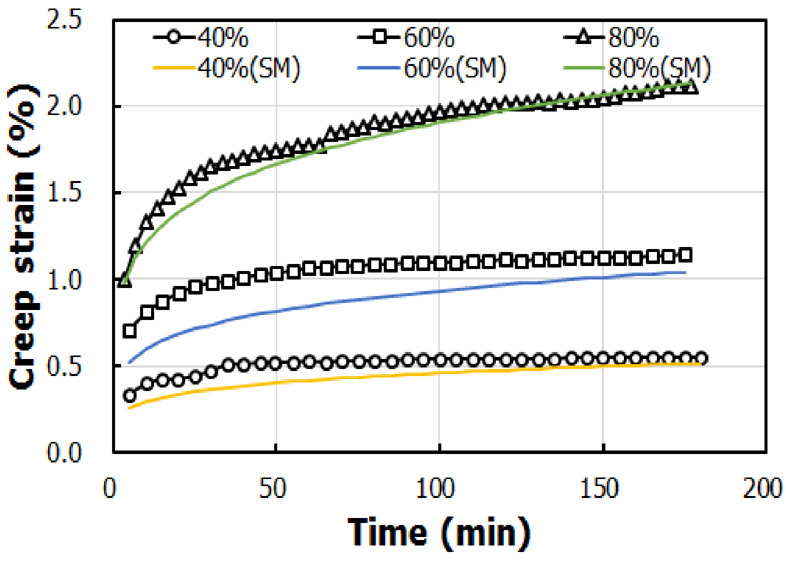

Figure 3. Regression by Singh-Mitchell model (modified from Kim, 2010)

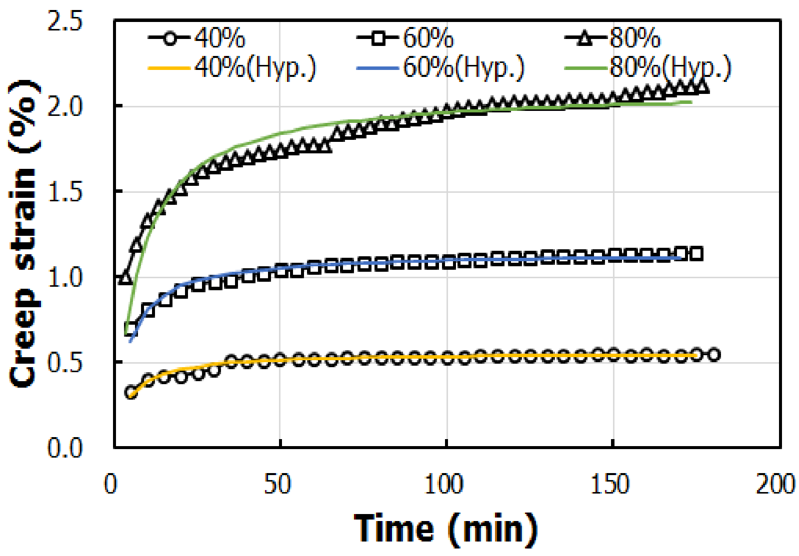

Figure 4. Regression by Hyperbolic model (modified from Kim, 2010)

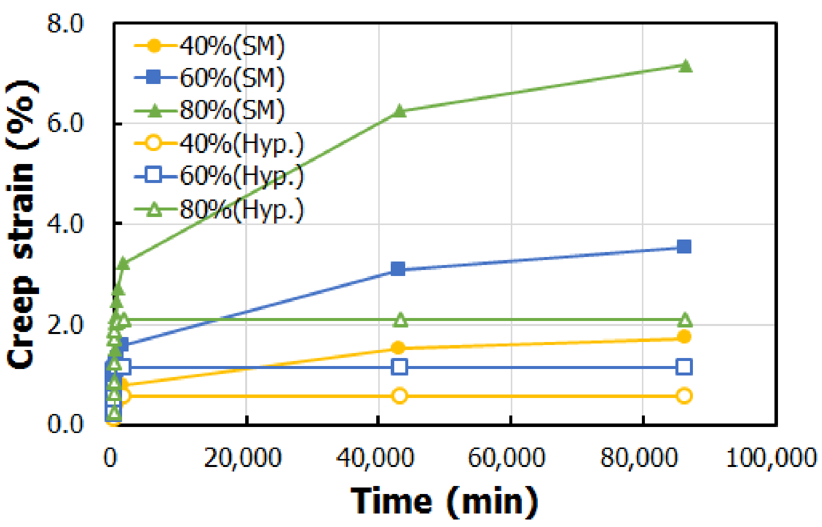

Figure 5. Comparison between SM and Hyperbolic models

4 CONCLUSIONS

In this study, the hyperbolic model and the SM model were reviewed for estimating long-term settlements of the MSEW abutment. The SM model cannot determine the creep termination period or the final creep amount, which causes an unrealistic excessive settlement. Contrary, the hyperbolic model is converged to time and can be more realistic model for estimating long-term settlement for the MSEW abutment.

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