International Association of Chinese Infrastructure Professionals
IACIP

TRB
Transportation Research Board
Washington, DC January 9–13, 2022
101st Annual Meeting

Sensitivity of Flexible Pavement M-E inputs to Michigan's Long-Life pavement

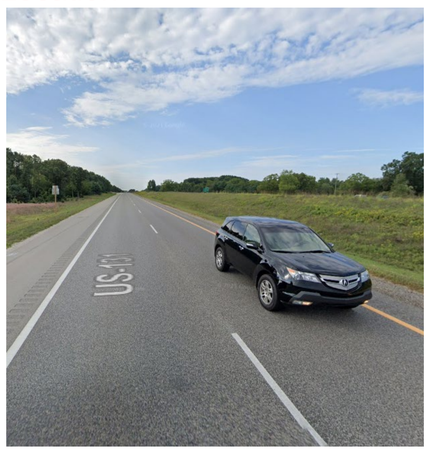
Dongzhao Jin, Michigan Technological University, dongj@mtu.edu
Siyu Chen, Michigan Technological University, siychen@mtu.edu
Xiaodong Zhou, Michigan Technological University, xzhou3@mtu.edu
Dongdong Ge, Michigan Technological University, dge1@mtu.edu
Zhanping You*, Michigan Technological University, zyou@mtu.edu

1. Introduction and Motivation

Material parameters are important factors that affect the performance of pavements and distress predictions using mechanistic-empirical (ME) design. This study aims to analyze the sensitivity of flexible pavement distress predictions to materials parameters inputs using the Pavement ME Design software, AASHTOWare, in Michigan's US131 road. US131(located at 14 Miles Road to White Creek Avenue in Kent County) consists of two pavement structures. One is the road southbound lanes designed by standard pavement, while another is the northbound lanes designed by 30-year pavement. Traffic parameters, pavement structures and material properties for the two types of roads were used as inputs for the analysis of flexible pavement performance. Two typical traffic levels (high and medium) were incorporated in a comprehensive analysis of the effects of materials parameters on flexible pavement performance predictions. A normalized sensitivity index was adopted to quantitatively evaluate the sensitivity of distress predictions.

2. Project Background and information

2.1 Project Location



This 30-year asphalt pavement design project consists of 3.6miles of freeway reconstruction, including ramp and bridge work, from north of M-57(14 Mile Road) to White Creek Avenue in Kent County.

Fig.1 30-year Asphalt pavement Project location at Kent County

2.2 Pavement Structure and thickness

30-years pavement	Standard pavement
1.5" GGSP, PG 70-28P	1.75" 5E10 , PG 64-28
2.5" 4E30, PG 70-28P	3" 3E10, PG 64-28
7.25" 3E30, PG 64-28	4.5" 2E10, PG 58-28
12" Aggregate base	6" Aggregate base
24" Subbase	18" Subbase
Subgrade	Subgrade

2.3 Coefficients and normalized sensitivity index

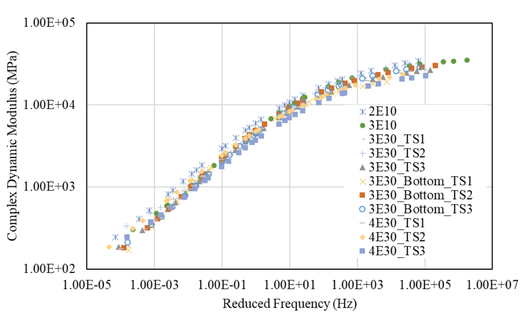
$$\mathrm{NSI} = \frac{\Delta Y}{\mathrm{DL}} \Big/ \frac{\Delta X}{X} = \frac{\Delta Y}{\Delta X}\frac{X}{\mathrm{DL}} \qquad (1)$$

where ΔX is the change in the climatic variable; X is the initial value of the climatic variable; ΔY is the change in predicted distress corresponding to ΔX; and DL is the design limit for the predicted distress. NSI values of 0.1, 1 and 5 were selected as the thresholds of 'sensitive', 'very sensitive' and 'hypersensitive', as in Schwartz *et al.* (2011)

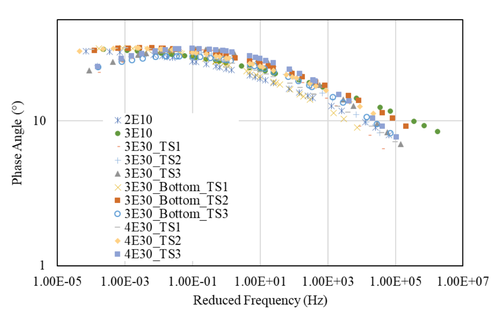
$$CV = \frac{\sigma}{\mu} \qquad (2)$$

σ: Population standard deviation, here means the dynamic modulus data and dynamic shear modulus data
μ: Population mean, here means the dynamic modulus data and dynamic shear modulus data

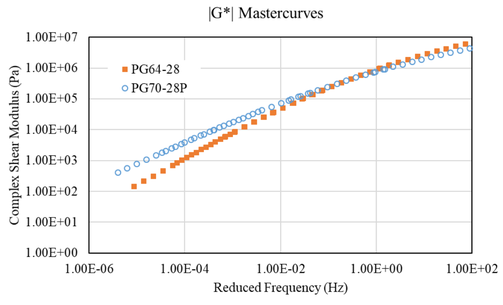
3.Results and Discussions



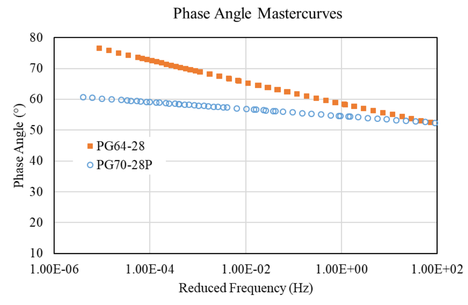
(a) Dynamic Modulus Mastercurves at 21 °C for 11 mixtures



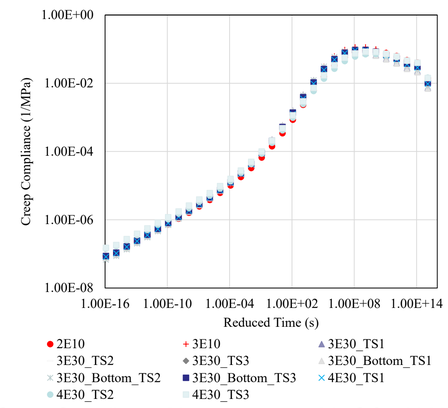
(b) Phase Angle Mastercurves at 21 °C for the 11 Mixtures



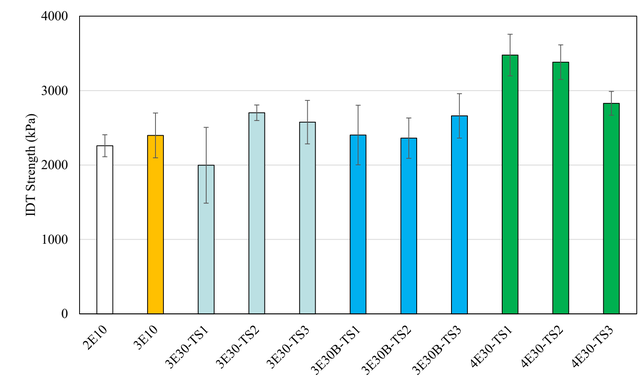
(c) Complex Shear Modulus Mastercurves at 21 °C for 11 mixtures



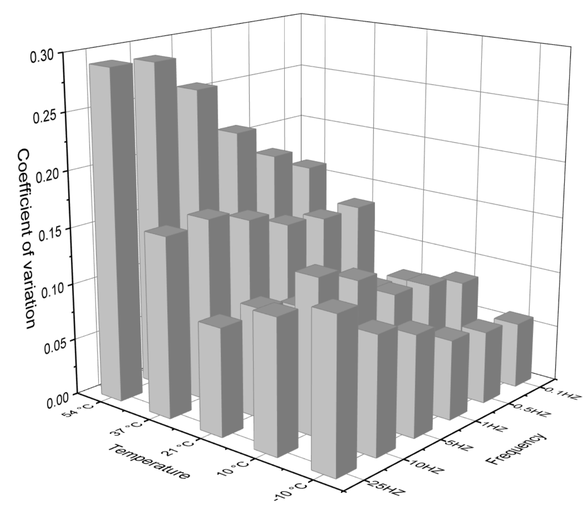
(d) Phase angle Mastercurves at 21 °C for 11 mixtures



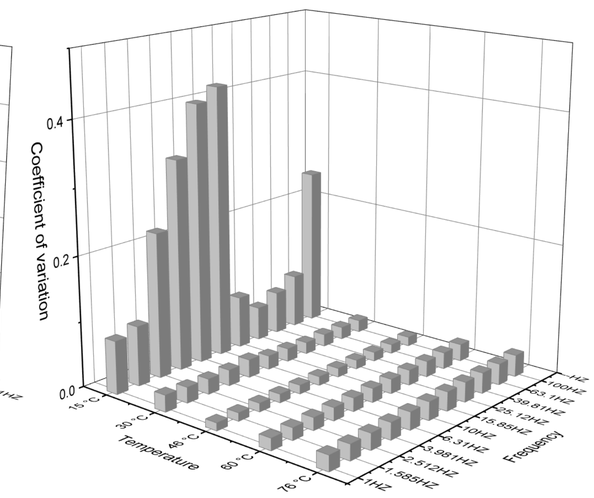
(e) Creep Compliance Mastercurves at 21 °C for 11 Mixtures



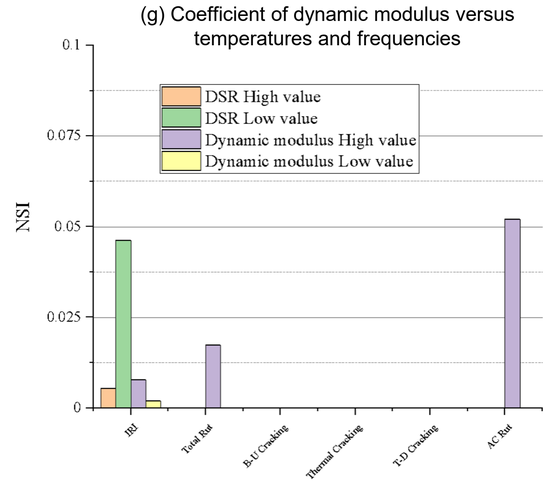
(f) Indirect Tensile Strength at - 10 °C for 11 Mixtures



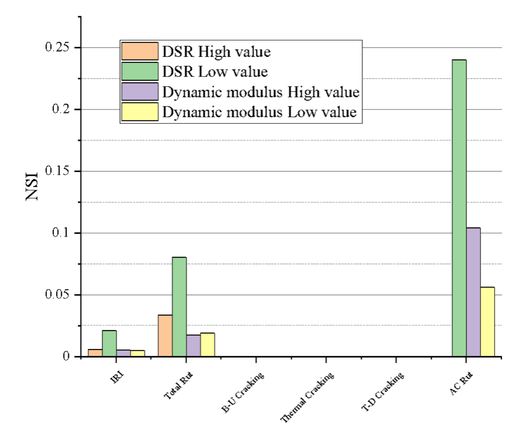
(g) Coefficient of dynamic modulus versus temperatures and frequencies



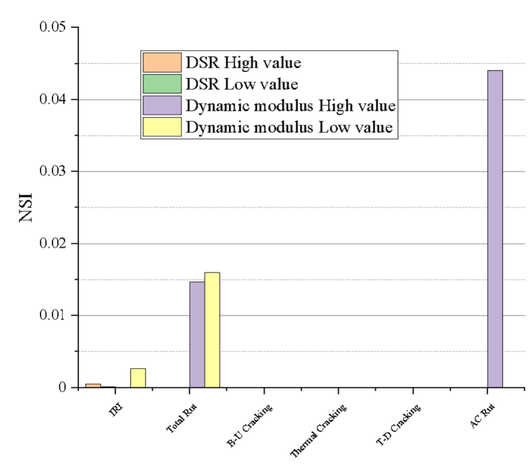
(h) Coefficient of dynamic shear modulus versus temperatures and frequencies



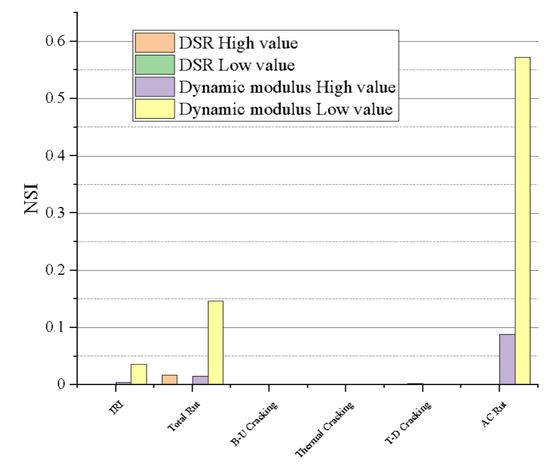
(i)The NSI values of predicted distresses for 30 year road (AADTT 2000)



(j)The NSI values of predicted distresses for 30 year road (AADTT 9000)



(e)The NSI values of predicted distresses for Standard road (AADTT 2000)



(f)The NSI values of predicted distresses for Standard road (AADTT 9000)

Fig.2 Lab experiment data and ME analysis results

4. Summary and Conclusion

This study focused on the sensitivity of flexible pavement distress predictions to materials parameters inputs using the Pavement ME Design software, AASHTOWare, in Michigan's US131 road, The following conclusions were summarized form this study:

(1) 2E10 has higher dynamic modulus, while the 4E30 has the higher Indirect tensile strength.

(2) The coefficient of variation of dynamic modulus increases with increase temperatures and decrease frequencies. The main reason behind this is that asphalt mixture as viscoelastic materials displays higher viscous at higher temperatures and lower frequencies.

(3) The coefficient of variation of asphalt binder shows difference at lower temperatures the reason is that the lower temperature makes the asphalt stiffer.

(4) The prediction asphalt pavement rutting of flexible pavement in 30-year road is most sensitive to changes in low dynamic shear modulus value. And the NSI increase with the traffic volume increase.

(5) The prediction asphalt pavement rutting and total rutting of flexible pavement in standard road is most sensitive to changes in low dynamic modulus value. And the NSI increase with the traffic volume increase.