RUTTING PERFORMANCE OF PAVEMENT UNDER AUTONOMOUS VEHICLE CONSIDERATION

Nitish R. Bastola[1] and Mena Souliman[2]
[1]Graduate Research Assistant, The University of Texas at Tyler, [2]Associate Professor, The University of Texas at Tyler

Objectives: The objective of this study is to determine rutting susceptibility of pavement structure when it accounts for autonomous vehicle and its traffic wandering under various traffic loadings, climatic conditions, and pavement overlays structures.

Introduction

➢ The 21st century has been remarkable in terms of technology development. Among the various forms of development being carried out, transportation and infrastructure development cannot be excluded.

➢ Various automotive industries have developed various kinds of automotive vehicles which will be driven by the technology but not with the perception of the individual drivers.

➢ The automotive vehicles will have the wheel wandering nearly fixed as they are operated by the automatic computers. This states that more automotive vehicles on the road means more load on the pavement structures.

➢ Pavement will be more habituated with the regular form of distresses such as fatigue cracking and rutting.

➢ Therefore, there is a strong need on judging the long-term performance of the pavement when it is accounted for the relatively same wandering with the introduction of automated vehicles on pavement structures.

Figure 1 Automated vehicle in a same path (Ref. DOT)

Background

➢ The autonomous vehicle is a boon in this century. The performance and safety have always been the top priorities in autonomous vehicles. The various effect such as rutting, and fatigue cracking associated with them are yet to be analyzed in detail.

➢ Various researchers have presented their research in the performance of the pavement if the autonomous vehicles are being used.

➢ Noorvand et. al in their analysis concluded that the repeated positioning of the trucks in the same location results in highly detrimental damage and this damage will occur although the percentage of the trucks volumes are low as 10 %

➢ Chen et. al assessed the impacts of control modes provided by the autonomous truck on asphalt pavement and concluded that Under zero wander mode, the maintenance year may advance by 1.56 years.

➢ National Cooperative Highway Research Program (NCHRP) report 468 also points out the need for the rutting related studies on the channelized automated vehicles on different pavement structures types. Various Transverse surface profile is utilized in this report to determine the rutting susceptibility of various asphalt layers.

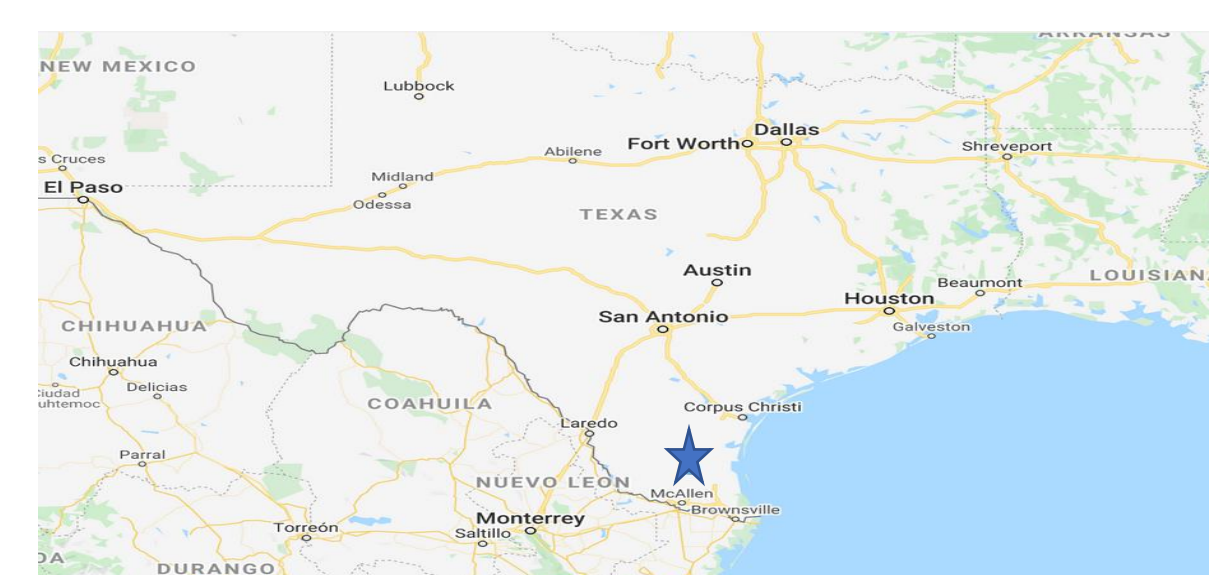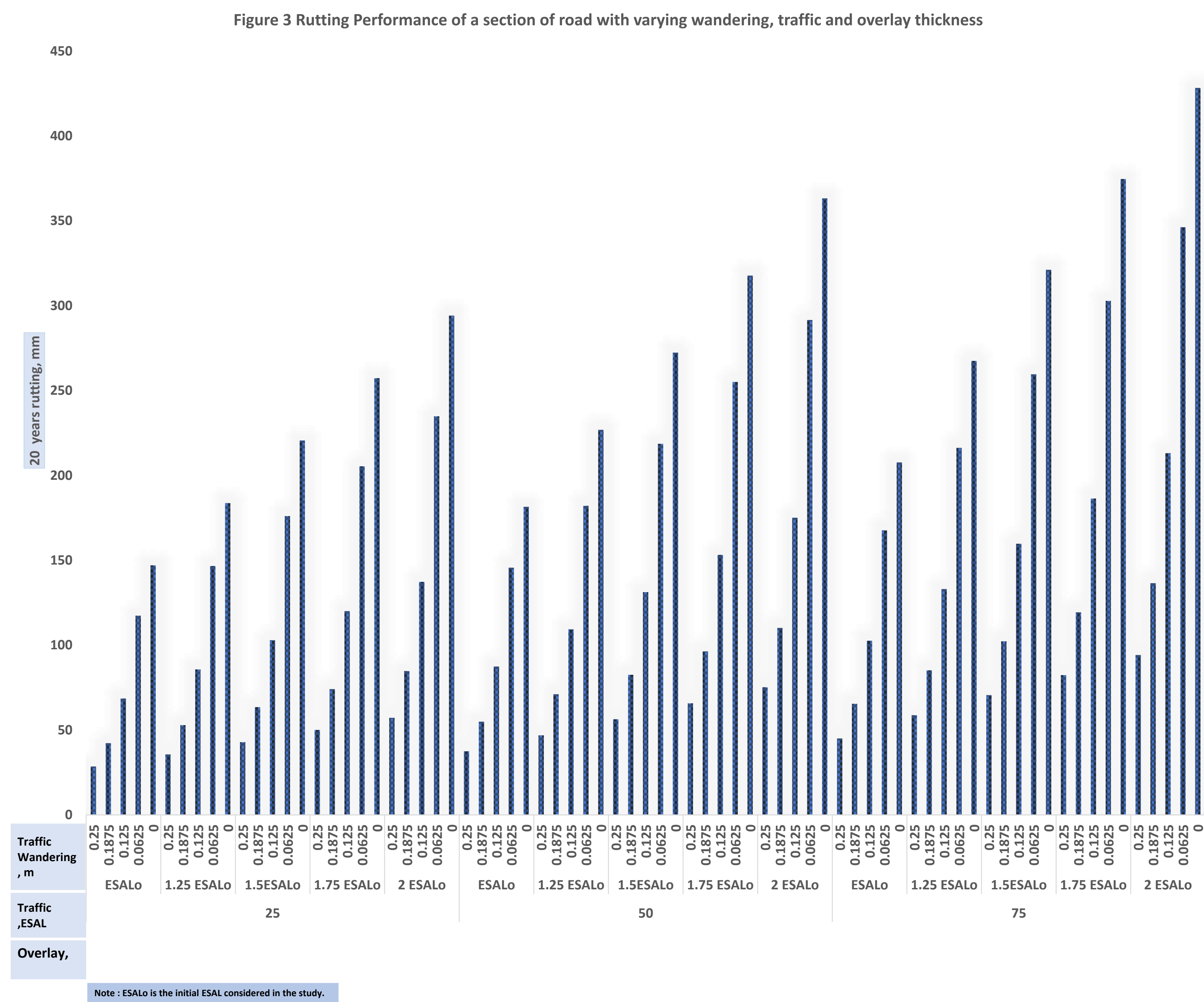## Data Collection and Approach Used

Figure 2 Location of test section

➢ One section from the state of Texas was chosen for the analysis.

➢ The pavement characteristics and other data related to the analysis were collected from the Long-Term Pavement Performance (LTPP) Info pave database..

➢ The approach used in this analysis is the application of PEDRO software. The use of the specific software has been carried due to this capability of analyzing the viscous nature of the asphalt pavement and has the provision for traffic wandering and climatic factors.

Wandering Induced Rutting Analysis

➢ Rutting refers to the wheel path depression which tends to grow with the accumulated traffic loadings and the lateral movement of the vehicle referred as wandering also has an influential effect on the rutting.

➢ This study analyzes the rutting susceptibility of the flexible pavement. Increased rutting susceptibility (IRS) when there are numerous factors considered are vividly analyzed in the study.

➢ The parameters which are considered for the study are climate, traffic, and vehicular speed along with different pavement structures in terms of overlay thickness.

➢ Long term pavement increased rutting susceptibility is calculated with the help of layer-wise rutting obtained from permanent deformation analysis procedure. The given equation shows the IRS calculation procedure used in the analysis.

$$IRS = \frac{Changed\ in\ Rutting}{Initial\ Rutting} * 100\ \%$$

➢ An original pavement structure with three types of overlay, five types of traffic wandering and five types of AADT are considered. The first parameter is the fit for varying pavement structures practice throughout, second provides the movement of the automated vehicle in the lateral direction and the third parameter provides the clustering and traffic platooning scenarios with the excess numbers of vehicles moving in a pavement.

➢ The total number analysis performed for a single section is 75.

➢ The figure below depicts the 75-analyses performed between these different factors .

Figure 3 Rutting Performance of a section of road with varying wandering, traffic and overlay thickness

Observations

➢ In the figure 3 presented above it is found that the pavement structures with varying overlay have different rutting performance. Higher rutting is seen in the thicker overlay than in the thinner overlay.

➢ Similarly, in the case of higher Equivalent Single Axle Load (ESAL), there will be more rutting of the pavement structures.

➢ Wandering effect due to autonomous vehicles also has the detrimental effect on the pavement rutting susceptibility. Decreasing wandering resulted in the increasing of the pavement rutting.
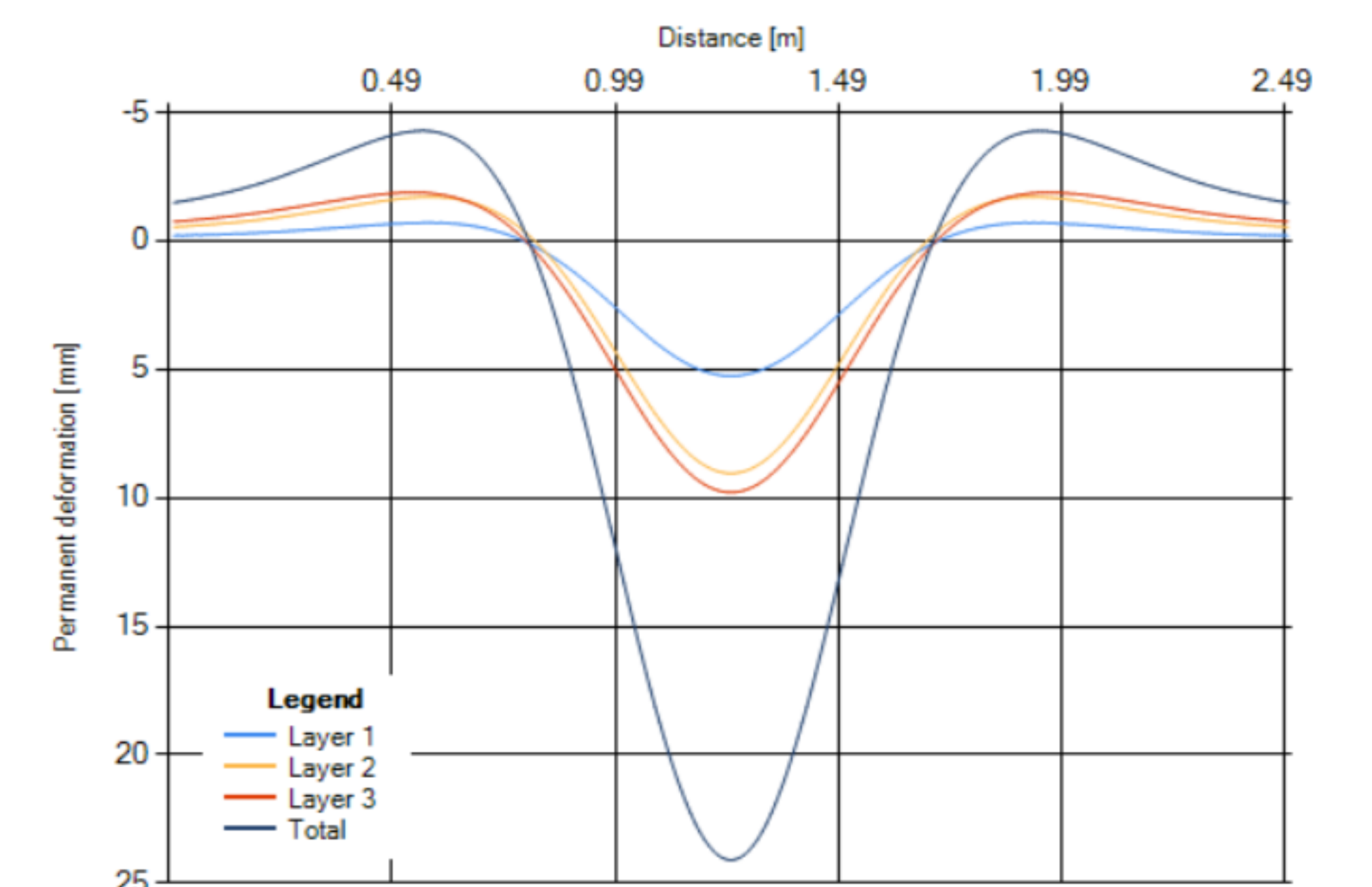

Figure 4 Scenario of Rutting Development on different pavement layers

➢ In figure 4 , a graphical sketch of rutting development with one of the conditions in the analysis is presented .

➢ Various layers of pavement are equally subjected to rutting, although top layer experiences more rutting than the bottom one.

Conclusions

➢ The rutting susceptibility of a pavement is one of the detrimental factors in knowing the performance of the pavement.

➢ The analyses presented above predicted that the autonomous vehicle with less wandering makes an asphalt pavement more prone to the rutting.

➢ The traffic factors also showed some changes in the rutting behaviors.

➢ The current pavement structures ARE NOT ready for autonomous vehicles' adverse effects.

Recommendations

➢ Similarly, the study presented in this paper is a study on a single section of pavement in the state of Texas with one climatic condition. Therefore, an extended analysis of the various sections around the States can lead to the more validated and diversified results.