Proceedings of the 8th International Conference On Civil Structural and Transportation Engineering (ICCSTE'23)
Canada – June 04-06, 2023
Paper No. 163
DOI: 10.11159/iccste23.163

Investigating the Influence of Temperature on the Weight-In-Motion Measurements Using In-Pavement Strain Sensors

Xinyi Yang[1], Ying Huang[1], Pan Lu[2]
[1]North Dakota State University
Department of Civil and Environmental Engineering, Fargo, North Dakota, 58102
xinyi.yang@ndsu.edu; ying.huang@ndsu.edu
[2]North Dakota State University
Department of Transportation, Logistics and Finance, Fargo, North Dakota, 58102
pan.lu@ndsu.edu

Extended Abstract

Weight control is of great importance for traffic management and road infrastructure maintenance since it is well known that overweighed vehicles would significantly degrade the performances of the road infrastructure. To manage the vehicle weights, weight station and weight-in-motion (WIM) have been widely used in traffic engineering for collecting weight information of trucks. Compared to weight stations, weight-in-motion has the advantages of fast data collection and less interruption of traffic, which has shown a growing trend for vehicle weight management worldwide. As most of the weight-in-motion stations rely on in-pavement strain sensors to collect data for weight measurements, the temperature changes influence the measurement accuracy of the WIM. To address this issue, a field test was conducted at MnROAD, where strain and temperature sensors were installed at depths ranging from 0.25 inch to 12 inches to collect data on strain changes and temperature under the road. To determine the under-road temperature, this study utilized data from two weather stations that provided nine weather factors, including air temperature and humidity. Since all the features did not conform to a normal distribution, the strength of the relationship between the weather factors and temperature under the road was determined using Spearman's correlation coefficient, ranging from perfect to weak. Subsequently, four different regression analysis methods were employed, namely linear regression model, polynomial regression model (with interaction term but without the power of the same features), and artificial neural network (ANN) modelling. The ANN model outperformed the other models, achieving an R-squared of 0.95 and an MSE of 1.81 degrees Celsius. This study presented a possible solution to derive under-road temperature based on weather factors gathered from weather stations, achieving higher accuracy compared to temperature measurements collected by under-road sensors. Accurate temperature information in the vicinity of the strain sensor can enhance the measurement accuracy of field sensors installed for WIM management for traffic management purposes.