Data Fusion Model of Road Sensors based IoT Feature Clustering

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***Abstract*—The collection of traffic data can play a role in analyzing and predicting highway design, planning, and real-time traffic management. The accuracy requirements for road dynamic data collection are low, and the accuracy is usually 3%-5%. However, it is required that vehicles can pass at high speed and obtain traffic information such as vehicle classification and vehicle speed. The prerequisite for the application of Internet of Things (IoT) technology to road information monitoring lies in the research and development of sensor technology in the perception layer and communication technology in the network layer, so that can obtain a large amount of perception data to serve the development and application of algorithms. To achieve the goal of low-cost and long-term monitoring of comprehensive traffic information and road service status information, this paper constructs a road vibration monitoring system, carries out road vibration monitoring under complex road environments, and proposes a traffic information monitoring method driven by road vibration data. By deploying the pavement vibration monitoring system in the actual road, the original signal of pavement vibration under the action of vehicle moving load is obtained. Through smooth processing and eigenvalue extraction, the monitoring of vehicle speed, wheelbase driving direction, vehicle load position and traffic flow is realized. The experimental results prove that the analysis of the road dynamic response under working conditions, as well as smoothing processing and eigenvalue extraction, the numerical modeling method in this paper realizes the monitoring of the position of the vehicle load and the traffic flow. The calculation error of vehicle speed and wheelbase is within ±4%, which is helpful to find the characteristic index of road vibration signal for evaluating road service status, and provides a reference for the application of road vibration response in road damage early warning and scientific maintenance.**

Keywords*—*Traffic data; Internet of Things (IoT) technology; perception sensors; vibration monitoring; k-means++ algorithm

I. Introduction

The road is the infrastructure for all kinds of trackless vehicles and pedestrians. Road transportation can realize the reasonable allocation of production materials, integrate various resources, promote the flow of materials, talents, information and funds between regions, and ultimately promote economic development [1]. Due to factors such as heavy traffic, heavy-axle trucks, high tire pressures, and harsh weather conditions, many roads have developed fatigue cracking, loose materials, rutting and other diseases, which are likely to cause traffic congestion and accidents. It also severely shortens the service life of the road and reduces the driving efficiency [2]. How to extend the service life of roads and improve the efficiency of transportation under the actual driving load and the external environment has always been a hot issue of concern to the academic and industrial circles at home and abroad. Therefore, it is necessary to establish a comprehensive, intelligent and long-lasting road dynamic response monitoring system to understand the road dynamic response under vehicle load in time. Furthermore, real-time monitoring of road service status and road traffic conditions is carried out to realize scientific road maintenance and intelligent traffic control [3].

Many road information monitoring projects have been carried out at home and abroad. For example, more than 400 sensors are embedded in the test section of the intelligent highway in Virginia, USA to collect data such as stress and strain, temperature and humidity, and traffic volume [4]. Literature [5] develops a stress-based analytical model of pavement performance by burying strain gauges inside the pavement, and points out that the impact of temperature and water on pavement performance should be considered. Literature [6] acquires the lateral and longitudinal strain information of the road surface under different vehicle loads under various working conditions by embedding stress and strain sensors, and establishes the relationship function between the pavement structure modulus and the stress and strain. These works have made many contributions to road dynamic response monitoring. However, because the road structure is different from other building structures, its distribution area is wide, and it is affected by vehicle load and environmental factors for a long time. These will lead to some shortcomings in the existing embedded monitoring system [7], such as the large size of the sensor, which destroys the original road structure after being buried. A large amount of on-site data collection is difficult to process in real time, causing communication jams and data redundancy problems. The data acquisition system is complex and heavy, with high energy consumption, which causes a lot of inconveniences when placed on site. The installation and maintenance cost of the monitoring system is too high. The monitoring data is affected by many factors, and the error of the system monitoring results may become larger as time changes [8]. However, most of the MEMS sensors for stress, strain and displacement monitoring are still in the experimental stage. There are many challenges in applying MEMS sensors to actual road monitoring. Short-term effects such as high temperature, humidity and corrosive environment in construction and long-term effects such as freeze-thaw cycle and vehicle load in actual road structure must be considered. The communication and energy supply of the sensors must also be considered.

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To effectively solve the above problems, this paper uses the IoT technology to monitor the dynamic response information of the road under the action of the moving load of the vehicle, and realize the monitoring of the traffic and structure service status. The road acceleration sensing node collects and analyzes the road vibration response data under the moving load of the vehicle, and carries out the numerical simulation of the road dynamic response, so that can obtain the comprehensive traffic analysis of the impact of the road vibration data under the moving vehicle load on the results. Eventually, intelligent traffic control and scientific road maintenance will be realized, which can improve driving efficiency and extending road service life. It will not only significantly reduce the cost of the monitoring system, but also contribute to the popularization and application of the system.

The innovations of this paper are as follows:

1) A method for road vibration data monitoring is proposed, and a sensor node for road vibration monitoring based on the Internet of Things is developed.

2) Clustering is based on the characteristics of road vibration data, and comprehensive information monitoring methods are used to construct monitoring indicators.

3) The k-means++ algorithm is used for clustering analysis, and the vibration data indicators are domesticated, which improves the accuracy of the algorithm.

II. Related Work

A. Monitoring Technology of Road Vibration

Now, acceleration sensors have been used in the health monitoring of bridge structures. Research and practice show that vibration information can reflect the health of the structure. In the field of road engineering, the application of accelerometer is in the experimental research stage, but it shows a broad application prospect. It can be used not only for traffic information monitoring, but also for road structure state monitoring [9].

There are still many challenges in the application of acceleration sensors to road information monitoring. Due to the complex road driving environment, embedded acceleration sensors often experience data packet loss under wireless transmission. Embedded installation may cause the accelerometer battery power to be difficult to meet the long-term monitoring requirements. If the battery capacity is increased, the volume of the package node will increase and the original road structure will be destroyed. The vibration signal of the road surface under the moving load of vehicles is affected by many factors, such as axle load, vehicle speed, load acting position, node embedding depth, road structure, pavement material, vehicle suspension system, and road surface smoothness. The traditional empirical model is difficult to clarify the relationship between the vibration signal and the load on the road. Moreover, the amplitude of road vibration under vehicle load is very small. How to obtain accurate measurement values in complex interference environments, such as traffic noise, traffic in adjacent lanes, etc. How to ensure that the signal processing algorithm is simple and efficient to achieve real-time data processing and energy saving. How to package and protect the sensor so that it can withstand vehicle loads and the long-term impact of harsh environments [10]?

B. IoT Technology

With the development of time, especially with the development of computer communication technology, Internet technology, and sensor technology, the concept of the IoT has undergone considerable changes. The IoT is a kind of network that connects various networks through sensor equipment in accordance with the agreed protocol to exchange and communicate information, which can realize intelligent identification, positioning, tracking, monitoring and management [11].

It can be seen from the concept of the Internet of Things that the Internet of Things has the following characteristics: The first is a comprehensive perception, which uses RFID (Radio Frequency Identification), sensors or other sensing technologies to collect dynamic information of objects in real time. The second is to transmit the sensed information reliably in real time through various communication networks. The third is intelligent processing, using computing and other technologies to intelligently store and process massive amounts of information to realize communication between people-to-people, people-to-things, and things-to-things. These three characteristics correspond to the three-layer typical architecture of the IoT, namely, the perception layer, the network layer and the application layer. The perception layer provides perception data in the physical world, the network layer provides a link between information transmission and terminal communication, and the application layer provides diversified IoT applications [12].

Now, there are relatively few researches on the application of IoT technology to road information monitoring. The premise of the application of IoT technology to road information monitoring lies in the research and development of sensor technology in the perception layer and communication technology in the network layer, so that can obtain a large amount of perception data to serve the development and application of algorithms [13].

III. Establishment of Finite Element Model for Pavement Structure

A. Model Parameter Setting

1) Structure and material parameters: A three-dimensional finite element model of the structure and materials of the expressway is established. The pavement is mainly composed of an asphalt surface, a semi-rigid base, a sub-base and a soil base [14]. "Code for Design of Highway Asphalt Pavement" (JTGD50-2006) is referred to obtain the material parameters of each pavement structure, as shown in Table I.

The material parameters of AC-30 are estimated by referring to the lower limit value of AC-25 material parameters. Rayleigh damping is used to simulate material viscosity. The damping ratio of the pavement structure is generally between 0.02 and 0.2, and is set to 0.05 [15].

TABLE I. PAVEMENT STRUCTURE AND MATERIAL PARAMETERS

Material	Layer	Thickness of layer (cm)	Elastic Modulus Mpa	Poisson's ratio	Density kg/m^3	Damping ratio
SMA-16	Upper	4	1400	035	2400	0.05
AC-25	Middle	5	1200	0.35	2400	0.05
AC-30	Lower	7	1000	0.35	2400	0.05

2) Model size: The size of the road model (x, y, z) is 9.0m x 6.5m x 4m, the X-axis is the longitudinal direction of the road, the Y-axis is the lateral direction of the road, Z is the vertical direction of the road, and the driving direction is along the positive direction of the X-axis. The road model uses an eight-node linear reduced integral equal-parametric unit (C3D8R), and the road model is divided into 119016 units by the grid [16]. When dividing the grid, the grid in the load movement area is dense, and the distance gradually becomes sparse, as shown in Fig. 1.

The grid length*width of the load movement area is 2cm*2cm. The SMA, AC-25, and AC-30 in the surface layer are divided into two layers of grids in the vertical direction. The model is fixed around the normal direction, and the bottom is fixed in three directions. The contact between the surface layer and the base layer is completely continuous. Due to the small deformation of the soil foundation, the sub-base layer and the soil foundation are bound by Tie binding, which can appropriately reduce the number of grids and improve calculation efficiency [17]. The load movement area is the middle of the model, and the distance from the boundary is at least 3m, which reduces the influence of boundary conditions on it. The boundary conditions of the model and the load movement area are shown in Fig. 2.

B. Random Non-uniform Moving Load Setting

1) The size of the load changes with time: According to the established vehicle model, the road surface level is set as B-level road surface, and the vehicle speed is 10m/s. The random dynamic load of the vehicle on the road is obtained, as shown in Fig. 3.

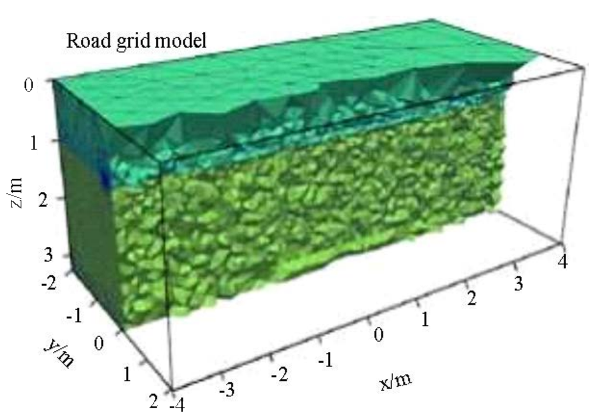

Fig. 1. Grid Road Model.

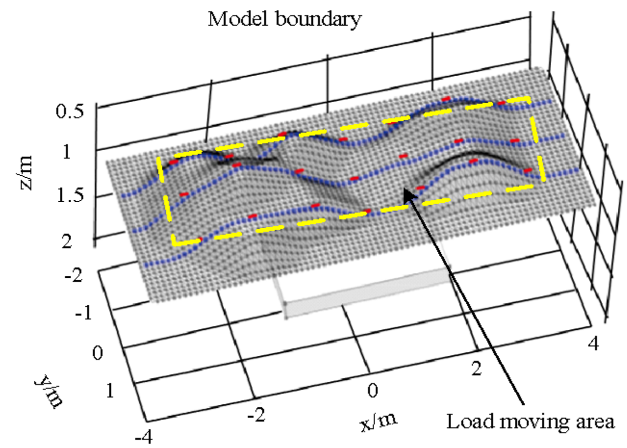

Fig. 2. Model Boundary Conditions and Load Moving Area.

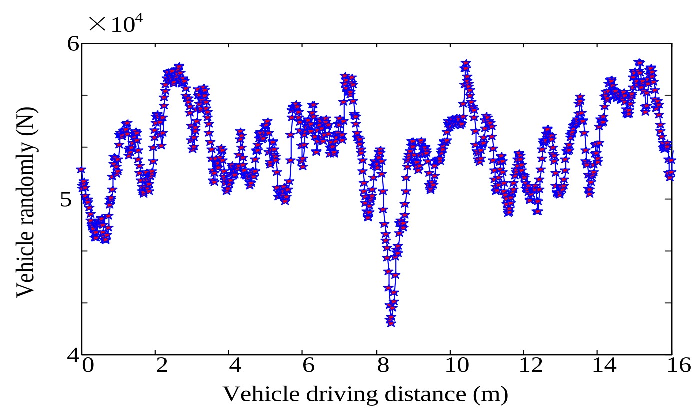

Fig. 3. Random Dynamic Load of the Vehicle.

2) The load size is distributed with space: To obtain a more realistic road dynamic response, it is necessary to consider the randomness and spatial distribution characteristics of vehicle load. After clarifying the dynamic load of the vehicle, by considering the actual contact between the tire and the road surface, a more realistic contact force distribution can be obtained. The contact between the vehicle tire and the road surface is surface contact, and its loading area can be simplified as a rectangular area [18]. In the rectangular area, the load distribution is affected by the tire tread, and the size changes with space. Fig. 4 shows the tire contacting the ground curve. The loading area of the tire on the road is a rectangular area of 20cm*18cm, which is affected by the tire pattern and forms five strip-shaped loading areas.

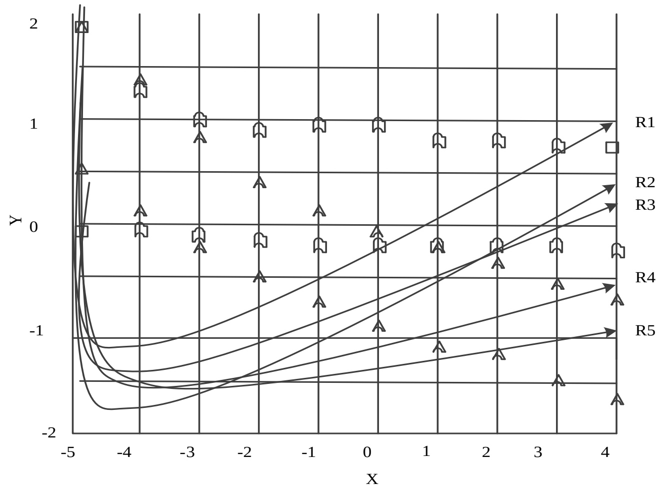

Fig. 4. The Actual Contact between the Tire and the Road.

When the vehicle moves in a straight line at a constant speed, the load amplitude ratio of the central area (R3), the side areas (R2, R4) and the edge area (R1, R5) are about 1:0.9:0.5. Moreover, in each rectangular area, the spatial distribution of the vertical load along the driving direction can be simplified to a half-sine function [19].

3) Application of Random non-uniform moving load: To simulate the moving random non-uniform load, the secondary development of the DLOAD subroutine was carried out based on the finite element software ABAQUS. Parameter analysis is as follows:

a) Sensitivity. The sensitivity of acceleration sensing node refers to the variation of sensor output voltage corresponding to the change of unit acceleration during static measurement. Therefore, the sensitivity of the acceleration sensing node can be obtained by calculating the relationship between the given acceleration and the output voltage.

b) Noise. Due to the inevitable existence of the external vibration and interference, the output signal of the sensing node includes not only the device noise of the sensing structure and the electrical noise of the signal processing module, but also a large part of the output signal is caused by external vibration and interference. Analyze the output voltage data when the sensitive axis of the acceleration sensing node is in the horizontal position.

c) Resolution. The resolution of the sensing node is the minimum variation of the acceleration that can be detected under certain conditions. The resolution can be obtained from the sensitivity and noise.

The specified coordinate function COORDS(*) and time function TIME(1) are applied to define the loading area and realize the movement of the load [20]. Equation (1) indicates that the loading area moves at a constant speed along the X-axis, and the positive direction of the X-axis is defined as the driving direction.

$$X = COORDS(1) - V \times TIME(1) - X_0 \tag{1}$$

Where COORDS(1) is the X-axis coordinate value of the integration point in the load movement area, X_0 is the initial X coordinate value corresponding to the load, V is the vehicle speed, and TIME(1) is the value of the step time [21]. Therefore, X is the X-axis coordinate value of the integration point in the load movement area corresponding to the moving coordinate system.

Equation (2) represents the spatial distribution of the load at time t, which is simplified to a half-sine function along the direction of travel.

$$Y = COORDS(2) - Y_0 \tag{2}$$

Where COORDS(2) is the y-axis coordinate value of the integration point in the load movement area, the direction of the y-axis is perpendicular to the driving direction, and Y_0 is the initial Y coordinate value corresponding to the load. $abs(X) \le \frac{b}{2}$ defines the length of the load application area, $abs(Y) \le \frac{c}{2}$ defines the width of the load application area, and α is the ratio of the load amplitude [22]. R3 is set to 1, R2 and R4 are set to 0.9, R1 and R5 are set to 0.5. b is the length of the load action area along the direction of travel, R3 is 18cm, and R1, R2, R4 and R5 are 16cm. c is the width of the load action area perpendicular to the driving direction, and the width of each small rectangle is set to 3cm. S is the actual contact area, which is the sum of the areas of R1 to R5. It is the pressure set at the integration point in the load action area corresponding to TIME(l), and is the random load value generated by the two-degree-of-freedom vehicle model [23].

The random non-uniformly distributed moving load is realized by Equation (3).

$$\begin{gathered} If\ \ abs(X) \le \frac{b}{2} ab(Y) \le \frac{c}{2} \\ Then\ P(t) = a \times \frac{F(t)}{S} \times \sin\frac{\pi}{b} \times X + \frac{\pi}{2}) \end{gathered} \tag{3}$$

The vehicle speed is set to 10m/s, and the length of the load movement area is set to 3m.

Therefore, the total duration is 0.3 seconds. The increment time is set to 0.001s, which is consistent with the random load sampling frequency (1000Hz). If the loading time is short enough, it can be considered that the applied load is a continuously moving load.

IV. Feature Clustering of Vehicle Data Collection

Feature clustering is used to analyze the data of similar vehicles, which can find out the abnormal vehicle weight among similar vehicles.

1) Feature clustering: The goal of feature clustering is to find k cluster centers for the data set, so that the sum of squared distances from each point to its nearest cluster center is the smallest. Since k-means clustering randomly selects the initial cluster center, and the location of the initial cluster center will affect the clustering result. Therefore, the k-means++ algorithm is used to avoid the influence of random initialization on the result. The steps of the feature clustering algorithm are:

Step 1: A sample from the data set X is randomly selected as the initial cluster center c_I .

Step 2: A new cluster center c_I is taken, and the shortest distance is calculated between each sample $x \in X$ and the existing cluster center, that is, the distance to the nearest cluster center, denoted by $D(x)$. Calculating the probability $\frac{D(x)^2}{\sum_{x \in X} D(x)}$ that each sample is selected as the next cluster center.

Step 3: Repeating step 2 until k cluster centers are selected.

Step 4: For each sample xxx in the data set, its distance is calculated to the k cluster centers, and classified into the cluster corresponding to the cluster center with the smallest distance.

Step 5: For each category c_I , recalculating its cluster center that is the centroid $c_I = \sum_{x \in X} \frac{1}{|c_I|}$ of all samples belonging to that category.

Step 6: Repeating steps 4 and 5 until the position of the cluster center no longer changes.

2) Analysis of abnormal vehicle weight: In this paper, the cluster analysis of the two types of car models is carried out to find outliers. The analysis steps are as follows:

Step 1: Vehicle speed, temperature, and amplitude are normalized, its range is (0,1).

Step 2: K-means++ algorithm is used for clustering analysis. Because it is the same type of vehicle, the category is set to category 1.

Step 3: The coordinates of the center point are obtained, and the distance is calculated between each sample point and the center point.

Step 4: The sample points far from the center point are found out, that is, the outliers in this category.

Step 5: Since the vehicle weight is positively correlated with the amplitude, the sample point with the larger amplitude in the outlier is the point with the larger vehicle weight in the sample data.

The clustering method can be used to find outliers in the data set, which not only improves the efficiency of overweight vehicle inspection, but also reduces the energy consumption of the monitoring system. With the increase of training sample data, the accuracy of the system will be further improved, which can improve the inspection efficiency of overweight vehicles. Moreover, the camera-equipped in the system can be used as a controlling executive. When the system judges that the vehicle is abnormal, it can trigger the camera to start taking pictures instead of real-time video recording or taking pictures of all passing vehicles, which can improve the pertinence and save system energy.

3) Sensor network architecture: Using a fixed threshold for classification will increase the computational complexity and reduce the computational fault tolerance. Therefore, using the ANN (Artificial Neural Networks) for vehicle classification is easy to establish a nonlinear system model, and its programmed calculation method can reduce the complexity of the model, which is conducive to model deployment.

The ANN model has a three-layer structure, including input layer, hidden layer and output layer, as shown in Fig. 5.

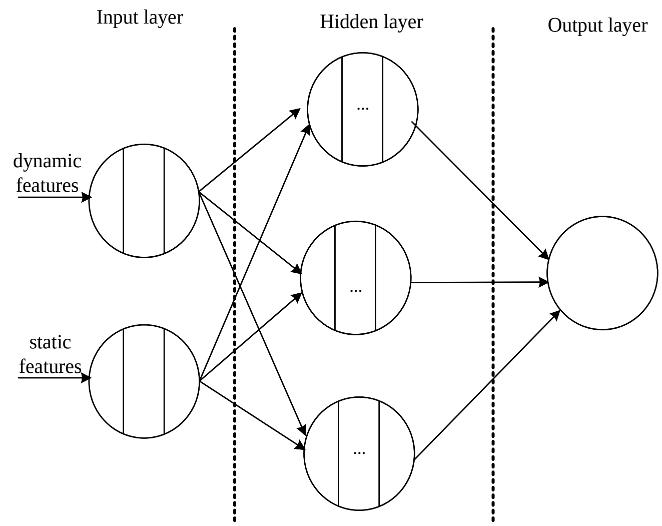

Fig. 5. Sensor Network Architecture.

The input layer contains 10 input parameters, and the vibration amplitude is the sum of the amplitude of each node in the third group. The output layer has only one node; the number of nodes in the hidden layer is set as P; to determine the optimal P value, the network with different P values is trained. When the accuracy of the trained network output is the highest, the P value is considered to be the optimal value.

V. Model Validation

To verify the rationality of the road model, the simulated data are compared with the measured data. The measured strain data comes from the fiber Bragg grating (FBG) sensor embedded on the Beijing Sixth Ring Expressway. The FBG sensor is used to measure the three-way strain response of the road surface under the moving load of the vehicle. The measured vibration data comes from the road vibration monitoring on the G320 highway. Compared to the verified monitoring points, monitoring point A is selected for comparative analysis of strain and vibration response, and monitoring point B is chosen for comparative analysis of strain response.

Wireless data transmission is also possible when the sensor platform is embedded in asphalt and concrete structures. Due to power constraints, the range of RF data transmission is limited to 40 feet. The data is transmitted through an RF wireless link located about 4 meters away from the monitoring point. The ratio of analog data to actual data is 1:100.

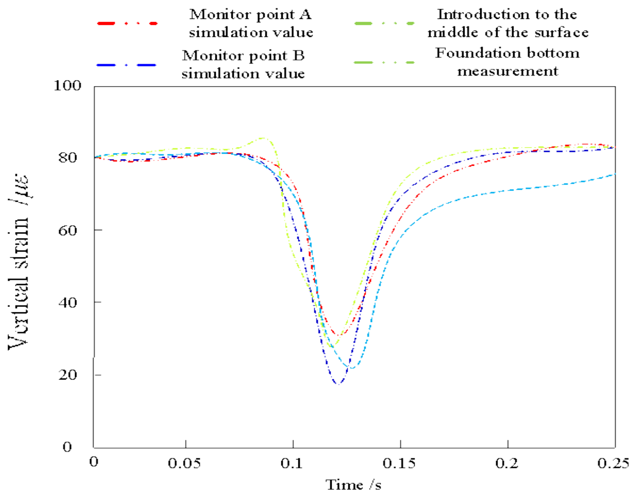

Fig. 6. Comparison of Simulated Data and Measured Data.

Fig. 6 compares the simulated data with the measured data.

It can be seen from Fig. 6 that the simulated and measured strain data match well in trend and size, and the maximum difference between the two is only about 15%. There is a deviation between the two curves, one is due to the inevitable difference between the simulated material parameters and the measured material parameters, and the other is the randomness of the vehicle dynamic load.

A. The Stress Extreme Value Distribution in the Longitudinal Monitoring Area

Under the situation of random non-uniform load and constant non-uniform load, the distribution of extreme longitudinal stress for pavement structure is compared. The constant non-uniform load considers the influence of tire pattern, and its contact area is the sum of the areas of R1 to R5. However, regardless of the randomness of the load, the rated load of the vehicle is adopted, and the size is 4900kN. The monitoring area is shown in Fig. 7.

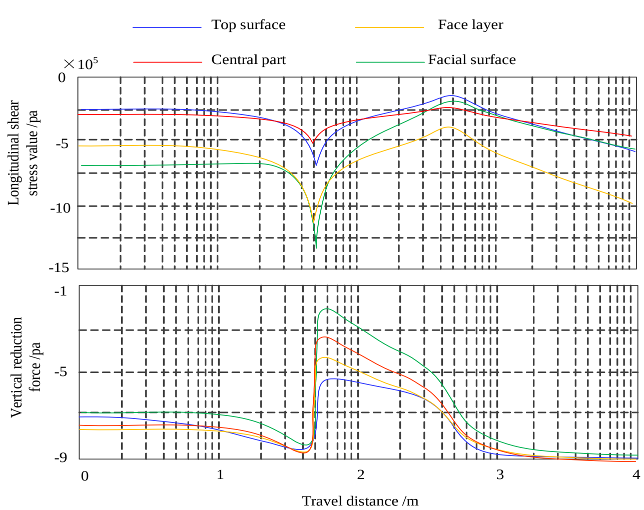

Fig. 7. The Stress Extreme Value Curve of the Longitudinal Monitoring Area of each Layer for the Pavement.

Fig. 7 shows that under the action of random non-uniform load, the extreme stress of each layer of the road surface is constantly changing, and its change characteristics are similar to the change characteristics of the vehicle's random dynamic load. However, under the action of constant non-uniform load, the extreme stress of each layer of the pavement remains unchanged. Under the action of random non-uniform load, the pavement stress fluctuation characteristics become less obvious with the increase of pavement depth. It can be seen that the random non-uniform load has a greater impact on the upper pavement structure. Moreover, under the action of random non-uniform load, the maximum stress of each layer of the pavement structure is greater than the stress extreme under the action of constant non-uniform load. And the damaging effect of random non-uniform load on the pavement is greater than that of constant non-uniform load.

B. Distribution of Stress Extremes in the Lateral Monitoring Area

The vertical stress extreme value is the largest when the vehicle travel distance is X=0.46m. The stress extreme value distribution of the lateral monitoring area at this position is analyzed. The horizontal monitoring area is shown in Fig. 8.

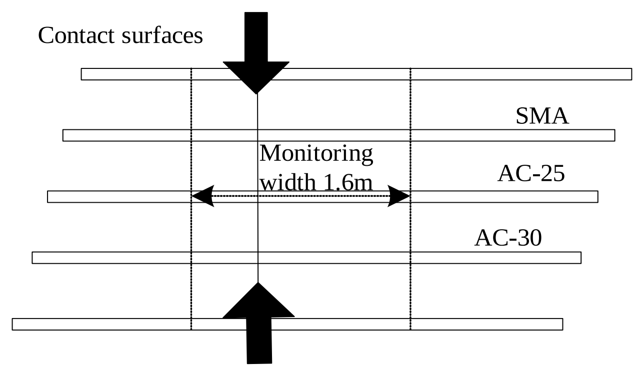

Fig. 8. Schematic Diagram of Lateral Monitoring Area at X=0.46m.

The six areas, such as the middle of SMA, the middle of AC-25, the middle of AC-30, the top of the base, the middle of the base, and the top of the base, are selected. The width of the monitoring area is 1.6m. The distribution of extreme vertical stress in the monitoring area under random non-uniform load, constant non-uniform load, and constant uniform load are compared and analyzed. For a constant uniform load, regardless of the tire pattern, the contact area is rectangular 18cm*20cm, and the rated load of the vehicle is used, and the size is 4900kN. Fig. 9 shows the distribution curve of the extreme vertical stress in the lateral monitoring area.

In comparison with Fig. 9, the uniform load has no stress concentration characteristics, while for non-uniform load, the vertical stress extreme value distribution on the road surface layer is obviously affected by the tire tread pattern. The stress distribution law is similar to the tire pattern distribution law, and the maximum stress is at the center of the tire. Secondly, there are obvious stress peaks at the stripes on both sides. As the depth increases, the overall vertical stress becomes smaller, and its spatial distribution is less affected by the tire tread. It can be seen that the spatial distribution of the load has a greater impact on the upper pavement structure.

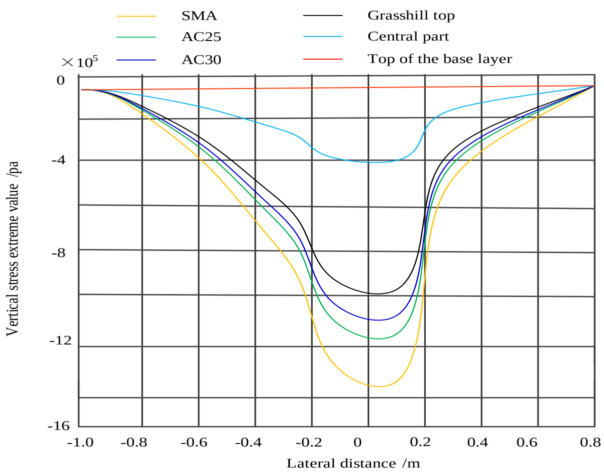

Fig. 9. The Distribution Curve of the Extreme Vertical Stress in the Lateral Monitoring Area.

Fig. 10 compares the maximum vertical stress extremes in each monitoring area.

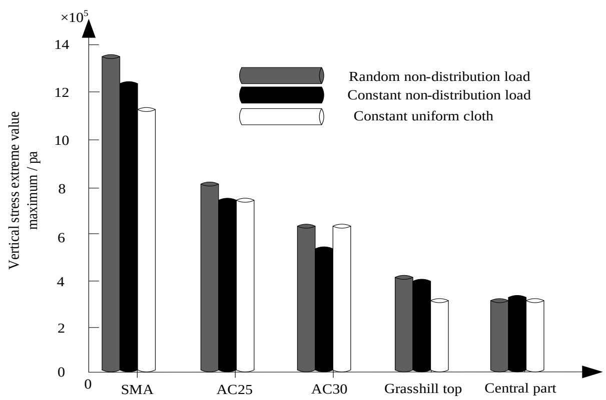

Fig. 10. The Maximum Value of the Extreme Vertical Stress in Each Lateral Monitoring Area.

Fig. 10 shows that in the middle of the SMA, the maximum stress extreme value under random non-uniform load is 32.75% higher than the maximum stress extreme value under constant uniform load. In the middle of AC25, the maximum stress extreme value in the random non-uniform load is only 11.25% higher than the maximum stress extreme value in the constant uniform load. And below the AC30 structural layer, the maximum stress extreme value of the constant uniform load is the highest, but its value is only 1.94% higher than the maximum stress extreme value under the random non-uniform load. It can be seen that as the depth increases, the difference between the maximum stress extremes for the three types of loads continues to decrease. Since the influence of the tire pattern of the vehicle, the stress distribution of the road surface layer is uneven. When the pressure is transferred to the base layer through the surface layer, the uneven stress gradually transforms into the uniform stress. In a word, if the spatial distribution characteristics of the vehicle load are ignored, the damaging effect of the vehicle load on the road surface will be underestimated.

VI. Conclusion

This paper studies the road perception nodes of road vibration monitoring based on the IoT technology, collects road vibration signals under the action of vehicle moving loads, and analyzes the characteristics and influencing factors of road vibration signals to carry out on-site monitoring. The dynamic response of the road surface under the action of random and non-uniformly distributed moving loads is simulated, and the characteristics of the road surface vibration signal under different working conditions are analyzed, and the characteristic evaluation index of the road service state is found. Finally, after the experimental analysis of the model, it is proved that different dynamic loads, surface materials and structural integrity will have a significant impact on the road vibration, and the characteristics of the road vibration signal are significantly different. In which vibration amplitude, time-domain signal waveform and frequency distribution can be used as potential evaluation indicators of road service status. Main research contents are as follows:

1) A road acceleration sensing node used for the road vibration monitoring is developed, which not only has the sensing function, but also can process, store and transmit data. The node resolution can reach 0.199 mg, can withstand the pressure of more than 67.54 Mpa, and has good waterproof packaging.

2) The road vibration amplitude is affected by the vehicle speed, vehicle weight and load position. The vehicle speed and vehicle weight are positively correlated with the road vibration amplitude, and the load position is negatively correlated with the vibration amplitude. Once the load position deviates from the monitoring point, the vibration amplitude at the monitoring point will rapidly attenuate.

3) By simulating and analyzing the dynamic response characteristics of pavement under actual loads, a method for characterizing the service state of pavement based on vibration data is proposed.

This paper realizes the road vibration monitoring under the moving load of the vehicle, and solves some technical problems of the application. In future work, the road vibration IoT monitoring prototype system can be further improved, which includes the self-powered design and performance optimization of the front-end sensing node. Its packaging and installation methods can be compatible with the characteristics of the road structure and construction technology. Through more experimental tests, the obtained monitoring results can be calibrated, and the distributed calculation and real-time processing of data can be realized.

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Declaration

I declare that there are no conflicts of interest regarding the publication of this paper.

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