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Research on Detection of Transverse Cracks in the Cement Stabilized Macadam Base of Expressways and the Influencing Factors

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Abstract: Subgrade cement stabilized macadam base is the base of Pavement Base,which plays an important role in the whole road structure.However,transverse cracks often occur in the construction of cement stabilized macadam base,which affect the integrity,strength and stability of the roadbed and enable that the road cannot bear the load of vehicles.Therefore,it is necessary to study how to control transverse cracks.Based on the analysis of a large number of field detection data and geological radar detection results,this paper studies the main influencing factors of transverse cracks in the subgrade cement stabilized macadam base.

Keywords: Expressways;Subgrade cement stabilized macadam base;Transverse cracks detection;Influencing factors

1. Introduction

Due to the strong structural strength of the cement stabilized macadam base of the subgrade,transverse cracks often appear in the pavement base in the construction of expressways,which are mainly caused by the defects of the base itself.For example,the crack is large,but not cracked;The crack is small in width,but long in length.According to the geological radar detection results,most of the cracks occur at the bottom of the subgrade,and the cracks appear on the lower surface of the cement stabilized macadam base of the subgrade.Because there are many vehicles and heavy vehicles on the expressway,when the vehicle passes from both sides,the transverse cracks will appear in the base because of severe impact and repeated rolling.Therefore,it is necessary to study how to control transverse cracks.

At present,a lot of research work has been carried out on the transverse cracks of subgrade cement stabilized macadam base in China,including disease investigation,detection,mechanism analysis and evaluation methods of subgrade cement stabilized macadam base.Jianjun Feng et al.studied the mechanical properties and crack resistance of semi-rigid base material through field test and theoretical analysis,and proposed a method to ensure its crack resistance.Wenlin Deng et al.put forward the range of rational use of cement-based crushed stone base materials and semi-rigid base materials by analyzing and comparing the laboratory test,engineering field test and test results.Mingmin Luo et al.studied the mix ratio design,strength and fatigue test,deformation characteristics and crack resistance of cement stabilized crushed stone mixture,and obtained the law of the change of strength and crack resistance of cement stabilized gravel mixture at different ages with the change of dosage of cement and grading of gravel.

The above research shows that at present,a lot of research work has been done on the transverse cracks of subgrade cement stabilized macadam base in our country,and some achievements have been achieved.However,due to different research methods and data sources and different research objects,the results are also different.There is no systematic research system and uniform standard for transverse cracks in cement stabilized macadam base of subgrade.Therefore,how to accurately and reliably detect and evaluate transverse cracks of subgrade cement stabilized macadam base through advanced instruments and equipment and scientific and reasonable detection methods is particularly important.This paper combines practical engineering to conduct detection and evaluation research on transverse cracks in cement stabilized macadam base of subgrade.The influencing factors of transverse cracks in cement stabilized macadam base of subgrade are obtained through analysis and comparative analysis of a large number of field test data.The transverse crack of cement stabilized macadam base of subgrade is evaluated by geological radar detection results.

2. Project Overview

This paper studies the cement stabilized macadam base cracks in the construction process of an expressway.Firstly,the causes of transverse cracks are analyzed,and then measures are taken to control the transverse cracks.An expressway route is with length of about 48 km,two-way four lanes and design speed of 80 km/h.The subgrade is composed of 6m thick graded gravel and 5m thick cement stabilized gravel.The subgrade base is 15cm thick cement stabilized gravel.According to the construction site test results,the thickness of the cement stabilized macadam base is 18 cm~24 cm.The geological radar was used to detect the cement stabilized macadam base of the subgrade.The test results show that the thickness of the cement stabilized macadam base is basically uniform. After a period of construction,some sections of the road appeared transverse cracks.Therefore,we decided to explore and analyze the cement stabilized macadam base of this section.In order to find out the causes and influencing factors of transverse cracks in the cement stabilized macadam base,we have carried out detailed field investigation and test on this section.The test results show that when the thickness of the cement stabilized macadam base is 18 cm~24 cm,the transverse cracks are more serious.When the thickness of the cement stabilized macadam base is 18 cm~24 cm,the transverse cracks are less.When the thickness of the cement stabilized macadam base is 25 cm~30 cm,the cracks are less.

3. Geological Radar Detection Principle

Geological radar technology is one of the most widely used nondestructive testing methods at present.The technology uses high-frequency electromagnetic pulse as the emission of electromagnetic waves,and transmits a series of electromagnetic waves with different frequencies to the underground through the transmitting antenna.The reflected signal of electromagnetic waves in various geological bodies in the underground medium will be reflected during the propagation process.Due to the different media,the reflected signal is related to its reflection wavelength,frequency,phase,amplitude and other parameters.These parameters are processed by the acquisition system,and the reflected signal is input into a computer for various analysis and interpretation through software.When the radar antenna moves in the direction of the detected object,its wave speed will change.When there is a certain distance between the object and the antenna,the propagation speed of the electromagnetic wave will attenuate.When the distance between the object and the antenna is less than the wave speed of the medium,the electromagnetic wave will be reflected back and forth in the medium at different frequencies.If the medium is not uniform,the electromagnetic wave will be reflected many times.Multiple reflections are superimposed to create a high-resolution image.It may show the following states:the speed of electromagnetic wave propagation in different media;The resistance of electromagnetic waves propagating in the medium;The intensity of the electromagnetic field received when electromagnetic waves propagate in a medium;The relation between the resistance of an electromagnetic wave propagating in a medium and the wavelength,frequency and phase of the electromagnetic wave.

4. Analysis of Detection Methods and Detection Results

In order to detect transverse cracks in the cement stabilized macadam base of expressway subgrade,we choose a geological radar equipment with high sensitivity,high precision and high stability.The device can accurately detect the presence of cracks and provide detailed crack information,including the location,length,width,and so on.

In the process of detection,we need to adjust the detection parameters according to different geological conditions and fracture characteristics.These parameters include operating frequency,antenna type,polarization mode,etc.Through reasonable parameter setting,we can improve the accuracy and efficiency of detection.After collecting the geo-radar data,we need to process and analyze the data,which includes steps such as de-noising,filtering,and focusing.Through data processing,we can eliminate noise interference and improve the signal-to-noise ratio of the data.Through data analysis,we can extract relevant information about cracks to provide a basis for subsequent research.Through the detection of geological radar,we find that there are a lot of transverse cracks in the cement stabilized macadam base of expressway subgrade.These cracks are distributed in different locations and depths,and vary in length and width.These cracks have a certain impact on the performance of the cement stabilized macadam base and the safety of the expressway.

5. Analysis of Influencing Factors

Through the analysis of a large number of field test data,the following main influencing factors are obtained:the higher the water content,the more easily the cement stabilized macadam base is cracked,and the water content should be strictly controlled in the field construction;The higher the proportion of aggregate,the more cracks there will be.If the proportion of aggregate is relatively low,even if the water content is strictly controlled,it cannot effectively prevent cracks;When the temperature is 10~30°C,the cracks will be well controlled.When the temperature is lower than 10°C,the cement stabilized macadam base cannot be completely solidified and cracks appear.Fly ash,cement,lime and other materials are added to cement stabilized gravel to make the cement stabilized macadam

base form a complete binder skeleton structure.In the construction process,due to mechanical rolling and other reasons,the strength of the mixture is not uniform,and it is easy to form cracks.In the field construction,health preservation time should be extended;In the construction process,it should be ensured that the thickness of the base meets the requirements.If the thickness is not enough,it will also lead to cracking of the cement stabilized macadam base;When the strength of subgrade cement stabilized macadam base is not enough,when the vehicle load is too large,the subgrade structure is prone to cracks.In the construction process,special attention should be paid to this point,and the thickness and strength level of the cement stabilized macadam base should be reasonably controlled to avoid cracks.

6. Conclusion and Future Direction

In this paper,we study in detail the detection methods of transverse in cement stabilized macadam base of expressway subgrade and the influencing factors.By deeply discussing the detection principle of geological radar,we put forward the applicable detection method and analysis of detection results.Through the analysis of various influencing factors,we draw some useful conclusions.Due to the limitation of space,it is not possible to discuss each influencing factor in depth.In addition,this study mainly focuses on the data analysis of laboratory and field surveys,and the long-term performance prediction and repair methods of transverse cracks and others in the cement stabilized macadam base still need to be further studied.

In the future research,we will continue to deeply study the influencing factors of transverse in the cement stabilized macadam base,especially the influence of material properties and construction technology.We will further explore how to optimize the material formulation and construction process of the cement stabilized macadam base to reduce the possibility of cracks.In addition,we will focus on the long-term performance prediction and repair methods of transverse in the cement stabilized macadam base.By introducing more experimental data and field cases,we will build a more accurate crack prediction model to provide a basis for long-term performance evaluation of expressways.At the same time,we will study the repair methods for different types of cracks to improve the service life and safety of the expressway.Finally,we will focus on the application of new technologies,such as the Internet of Things,big data and artificial intelligence,to improve the detection accuracy and repair efficiency of transverse cracks in the cement stabilized macadam base.By introducing these new technologies,we will achieve a more accurate and efficient detection and repair of transverse in the cement stabilized macadam base of the expressway subgrade.

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