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Key Points of Compaction Construction Technology for Roadbed and Pavement in Highway Engineering

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Abstract: ***In recent years, China has constructed various scale and level of road projects. The implementation of these projects has improved China's road transportation system and brought great convenience to people's travel. However, the implementation of roadbed and pavement compaction is an aspect that cannot be ignored in road engineering. The application of technology and construction effectiveness are related to the quality of road engineering. Therefore, in any road engineering project, standardized roadbed and pavement compaction must be carried out based on the construction requirements of the road itself to ensure that the compaction meets the construction requirements. Based on this, the article focuses on the key points of roadbed and pavement compaction technology in road engineering, which has certain guiding value for road engineering construction.***

Keywords: road engineering; Roadbed and pavement construction; Key points of compaction technology.

1. INTRODUCTION

Highway is an important component of China's transportation system, and urban construction and socio-economic development cannot do without highway transportation. The common diseases in highway engineering mainly include roadbed settlement, road potholes, cracks, honeycomb pits, ruts, etc. The occurrence of common diseases in highway engineering is mostly related to the compaction technology and effect of roadbed and pavement. The compaction construction technology of roadbed and pavement plays an important role in highway engineering construction. In the construction process of highway engineering, scientific construction techniques should be applied, with particular emphasis on the compaction construction technology of roadbed and pavement, to improve the overall quality of highway engineering and ensure the durability and driving comfort of highway engineering.

2. THE IMPORTANCE OF ROAD SUBGRADE AND PAVEMENT COMPACTION

2.1 Ensure road surface strength

In the construction of any road engineering project, attention should be paid to the compaction construction of the roadbed and pavement, because in the compaction operation of the roadbed and pavement, impact force, rubbing force, and vibration force are simultaneously applied to the pavement. Under the combined action of these forces, the strength index of the pavement can meet the engineering requirements. Pavement strength is a major indicator closely monitored in road engineering construction. Through the standardized application of roadbed and pavement compaction technology, the quality of road engineering can be greatly improved, avoiding road quality and safety issues caused by substandard pavement strength.

2.2 Reduce road deformation

In the construction of road engineering projects, there is a high level of attention to safety. Today, with the continuous progress of the times, there has been significant progress in the construction process and technology of road engineering. When carrying out road engineering construction, construction personnel can choose the most appropriate compaction technology based on the overall construction requirements of the road engineering to ensure the scientific nature of the road structure. Based on extensive experience in road engineering construction, the compaction construction of roadbed and pavement can not only ensure the strength index of the pavement, but also reduce road deformation. Once the compaction of roadbed and pavement fails to meet the relevant standards during road engineering construction, significant deformation will occur after being subjected to huge load forces in the future. Therefore, the standardized application of roadbed and pavement compaction technology can greatly improve the construction quality of road engineering and create good traffic conditions for vehicles.

3. KEY POINTS OF COMPACTION CONSTRUCTION TECHNOLOGY FOR ROADBED AND PAVEMENT IN HIGHWAY ENGINEERING

3.1 Choose appropriate roadbed and pavement compaction equipment and methods

When selecting compaction equipment, it is necessary to choose appropriate road compaction equipment based on the natural environment and paving layer conditions of the construction site. Small rolling equipment has strong flexibility and is suitable for working in complex terrain environments, but its work efficiency is low. The compactness of the compacted roadbed and pavement layer is not enough, making it difficult to achieve the expected leveling effect. However, some large and medium-sized rolling equipment have high work efficiency and can achieve the compaction effect of the roadbed. However, cracks are prone to appear on the roadbed and pavement after rolling, which affects the overall structure of highway engineering and is suitable for use in situations with larger filler particle sizes. Therefore, when selecting compaction equipment, it is necessary to choose appropriate equipment based on the actual construction situation of the project to ensure the compaction effect of roadbed and pavement construction. In highway engineering construction, segmented construction can be carried out according to different construction conditions, and different compaction methods can be selected based on the construction situation of each section. For example, when carrying out compaction construction on the edge of the roadbed and road surface or the backfill of the bridge abutment, small rollers with strong operational flexibility can be selected; When compacting conventional roadbed and pavement, large and medium-sized rollers can be selected to ensure the overall stability and smoothness of the roadbed and pavement, and improve the durability of the entire highway project.

3.2 In the compaction construction of highway engineering roadbed and pavement engineering

It is necessary to strengthen the control of the thickness, compaction method, and rolling speed of the roadbed and pavement paving layer. The control of the thickness of roadbed and pavement paving, the selection of compaction methods, and the determination of compaction speed. The thickness or thickness of the roadbed and pavement layer is not conducive to the quality control of compaction construction. If the paving layer is too thick, it is easy to cause the lower layer of the paving layer to not be compacted properly and the compaction degree is low; If the paving layer is too thin, it is easy to cause peeling or pressure exceeding the strength limit of the filling layer. The compaction method of the roadbed and pavement should strictly follow the requirements of the roadbed and pavement construction technical specifications, following the principles of first light then heavy, first slow then fast, first static then vibration, and first edge then middle. At the same time, the construction process should strictly follow the construction plan and the compaction speed and number of compaction passes determined by the subgrade inspection section to ensure that the compaction degree meets the requirements.

3.3 Construction Technology of Roadbed Drainage

Roadbed drainage is a very important aspect of the entire highway roadbed construction technology. If the drainage work is not done well, it will lead to a decrease in the stability and safety of the roadbed. Many roads are damaged due to rainwater. For areas with high rainfall, more attention should be paid to the drainage system and reinforcement work when constructing highways to minimize the damage caused by rainwater. Setting up a roadbed drainage system also requires consideration of the local environment and irrigation of nearby farmland. The drainage system should comply with local drainage planning and not cause unnecessary losses to the people. The drainage system is mainly designed around pavement drainage, surface drainage and underground drainage. The focus of pavement drainage is to prevent rainwater from scouring the subgrade slope. There are two methods of pavement drainage. One is concentrated area drainage, and the water retaining belt is set outside the highway. The water retaining belt is often washed by rainwater, so it must be solid and reliable, and can be made of cement concrete, so that it can form a triangular collecting tank with the hard shoulder pavement, And drainage outlets should be set every 20-50m to concentrate rainwater into the drainage ditch and minimize rainwater infiltration into the roadbed. For areas with low rainfall, a trough is directly set in the central Median strip of the road for drainage. The second type is decentralized regional drainage, mainly aimed at areas with flat terrain. In this area, not only should centralized drainage be set up, but also areas with high groundwater levels should be considered. This type of area often has water accumulation on the road surface. A shoulder drainage system can be designed to increase drainage ditches [1-2]. Ground drainage mainly adopts methods such as intercepting ditches and side ditches for drainage. Drainage ditches on high-grade highways require reinforcement with mortar rubble. With the development of the economy, most of them are now made of cement concrete precast slabs, which are more stable and reliable. Underground drainage mostly adopts methods such as seepage ditches and hidden ditches, and seepage pipes are installed in the seepage ditches to achieve drainage purposes through seepage force.

4. KEY POINTS OF CONSTRUCTION TECHNOLOGY FOR SPECIAL ROADBED ENGINEERING

In the construction process of highway subgrade engineering, in addition to conventional subgrade construction, there are also some special subgrades that are more difficult to construct, costly, and have a longer construction period compared to conventional subgrades. However, this does not mean giving up construction. On the contrary, these difficult constructions can improve our construction technology. China has a vast land and a variety of land types, making special types of roadbed numerous. Below, we will mainly analyze the roadbed in soft soil areas, expansive soil areas, and debris flow areas. In this section, we utilize the six indicators selected in the previous section as independent variables, with grain yield serving as the dependent variable. We employ R software to establish a support vector regression model for grain yield prediction. Dr. Wu Enda's guidance regarding kernel function selection for support vector machines is invaluable. It's noted that when dealing with lower sample dimensions and smaller sample sizes, the radial basis kernel function proves to be more effective. Moreover, this kernel function possesses the advantage of having fewer unknown parameters. As more unknown parameters increase the model's complexity, training time extends and generalization ability weakens[13]. Given these considerations and the diverse effects of various kernel functions, we have opted to employ the radial basis kernel function for the model established in this section.

Table 1: Random Forest Regression Predictive Effectiveness

Year	predicted value	actual value	Error rate (%)
2018	63829.51	65789.22	2.98%
2019	63316.97	66384.34	4.62%
2020	62703.83	66949.15	6.34%

The construction of the support vector regression model in this section necessitates the determination of two critical parameters: the penalty parameter and the radial basis kernel function parameter . Parameter can be understood as the balance between optimizing interval sizes and prioritizing classification accuracy. As approaches infinity, it implies that no classification errors are permissible, potentially leading to overfitting. Conversely, when approaches 0, the model becomes less concerned about the accuracy of classification and instead seeks to maximize interval sizes. Excessive reduction of may result in an impractical solution, causing the algorithm to fail to converge and leading to underfitting. The parameter of the radial basis kernel function defines the influence a single training sample exerts. A higher allows greater influence on other samples. Notably, the model's performance is highly sensitive to . When is excessively large, the radius of influence of support vectors becomes so small that it affects only the individual sample itself, rendering parameter tuning ineffective against overfitting. Conversely, a very small prevents the model from capturing the complexity of the data, resulting in unsatisfactory model fit.

It is evident that the model fits the sample data exceptionally well. Specifically, from 2005 to 2014, the model closely aligns with the actual data. Calculations reveal that the average error rate between the fitted value and the actual value of the model is 1.34%. Subsequently, the test set is utilized to predict grain output from 2018 to 2020, and these predictions are compared with the actual values. Detailed results are presented in Table 6.In 2018, the predicted grain output is 638 million tons, with an error rate of 2.98% compared to the actual value of 658 million tons. In 2019, the predicted grain output is 633 million tons, with a 4.62% error rate relative to the actual value of 664 million tons. For 2020, the predicted grain output is 633 million tons, with a 4.62% error rate compared to the actual value of 664 million tons. However, the forecasted grain output for 2020 is 627 million tons, exhibiting a 6.34% error rate in comparison to the actual value of 669 million tons. Despite this, the average three-year forecast error rate remains below 5%, suggesting that the model holds valuable guidance for forecasting future grain output under specific conditions.

Table 2: Predictive effect of principal component regression

Year	Predicted	Actual value	Error
2018	63160.47	65789.22	4.00
2019	63135.98	66384.34	4.89
2020	62979.68	66949.15	5.93

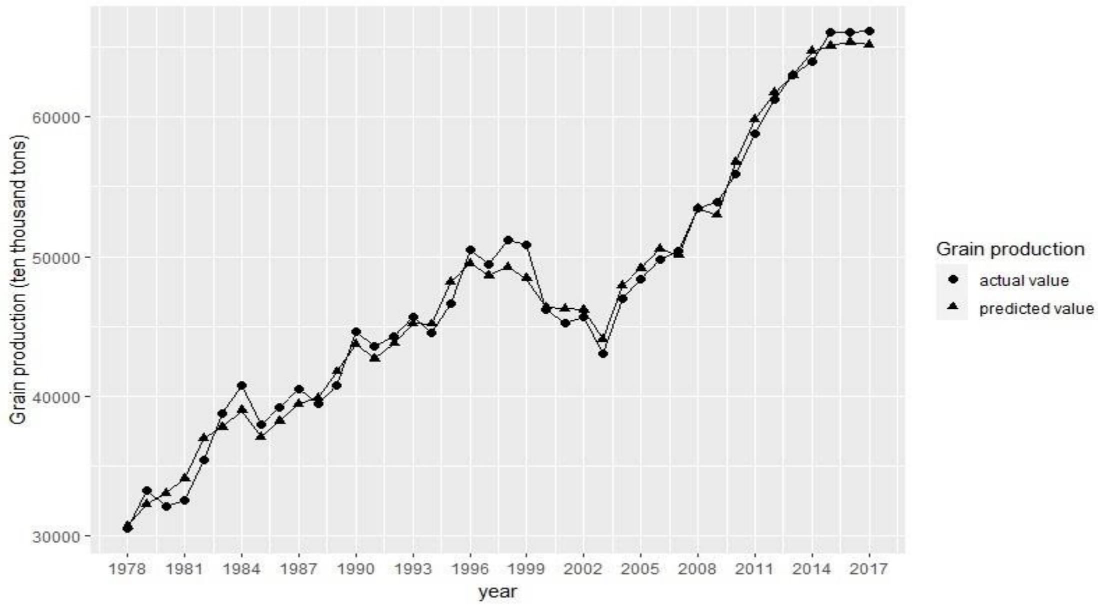

Figure 1: Support vector regression fitting effect

4.1 Roadbed in soft soil areas

Soft soil areas are areas where soft clay dominates. Soft soil contains soft clay with high water content and silt. Roadbed construction in soft soil areas is extremely dangerous and challenging, as road construction in soft soil areas can easily cause instability and excessive settlement of embankments. Soft soil is generally distributed near lakes and rivers. The water content in soft soil areas is too high. During the construction process of the roadbed, more drainage facilities should be installed to reduce the water content in the soft soil, or the soft soil should be replaced with materials suitable for the construction of the roadbed. For example, sand is a good replacement material. If it is considered too troublesome to replace the soil and not conducive to cost control, lime can be added to the soft soil for neutralization. In addition, isolation zones can be set up to reduce the water content of soft soil using chemical methods and improve the stability of the roadbed.

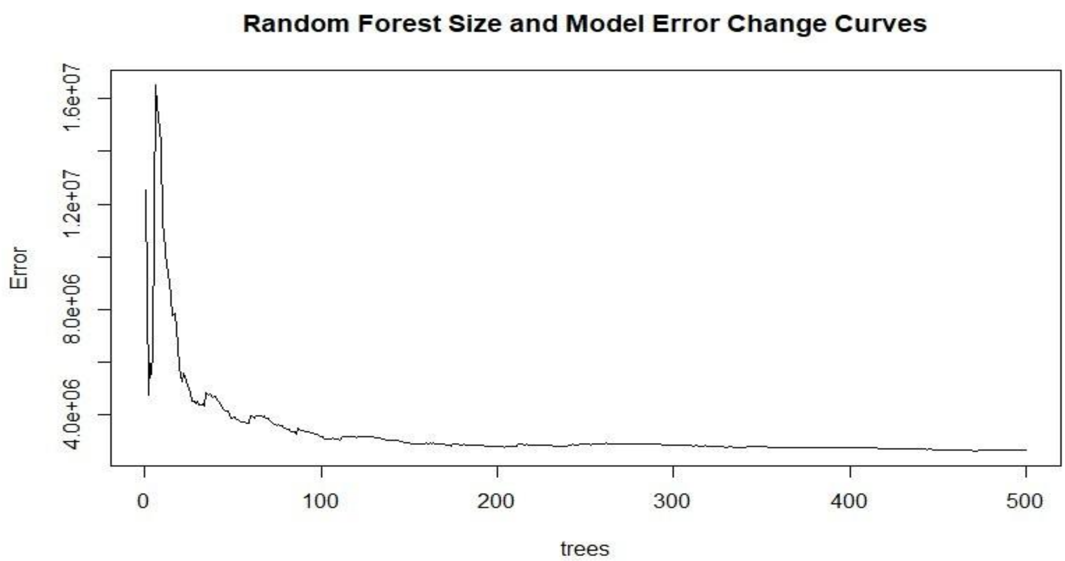

Figure 2: Random Forest Size and Model Error Change Curves

4.2 Embankment in expansive soil area

Expansive soil refers to Clay mineral such as a large number of clay particles and Montmorillonite or Illite with high hydrophilicity. It is a special kind of clay soil. It will expand when encountering water and shrink when losing water, so it is called expansive soil. Usually distributed in China's second or higher level terraces and mountainous hilly areas, the construction of roadbed in expansive soil areas requires the use of lime soil to improve soil quality and increase drainage facilities. As the expansive soil contains Clay mineral with high hydrophilicity, it should not be carried out in rainy days as far as possible during the construction, so that the subgrade will no longer contact with rain. If it rains accidentally, a small amount of lime soil should be added during the filling process [4]. It is evident that when = 120, the model error is minimized, achieving a high level of accuracy and stability. Consequently, we opt to establish the grain yield prediction model with a random forest size of = 120, while consistently selecting a random subset of 2 features each time(= 2). The importance measure of input variables is illustrated in Figure 3:

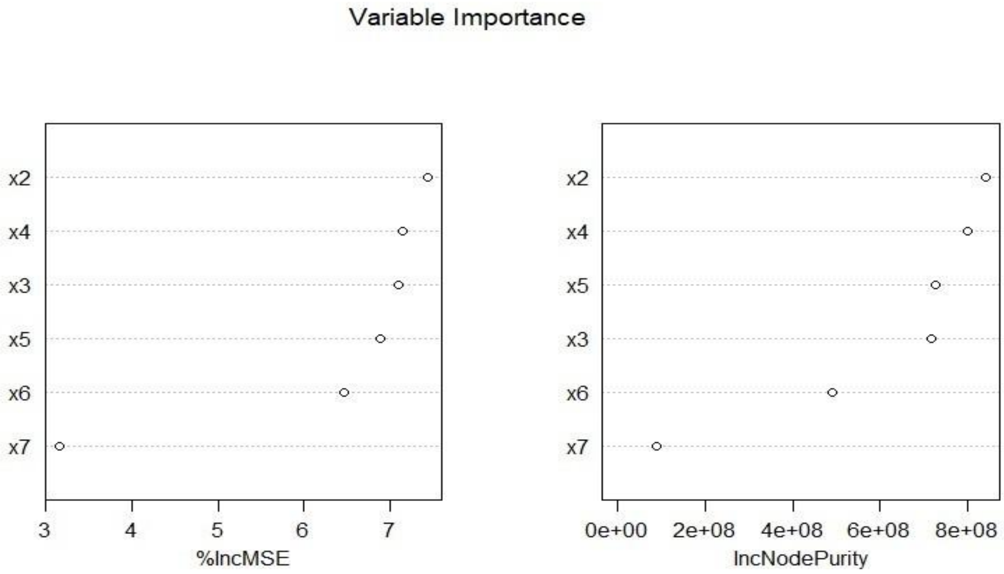

Figure3: Visualization of graphs for importance measures of input variables

4.3 Roadbed in debris flow areas

In recent years, due to natural disasters such as earthquakes, many mountainous areas have experienced mudslides. Mudslides along highways can seriously damage road surfaces, cause road collapses, block traffic, and endanger people's lives and property. Debris flow is due to steep terrain and large amount of loose deposits. When extremely heavy rainstorm or a large amount of ice melt water flows out, a large amount of sediment and stones suddenly break out. When and how often it occurs cannot be accurately predicted, and the degree of harm varies. Debris flow poses great harm to roadbed engineering. On the one hand, it erodes the roadbed, and on the other hand, it silts up the roadbed. In most cases, both are carried out at the same time. It is necessary to do a good job in blocking and protecting the construction of highways. Blocking engineering is a series of protective measures during the occurrence of debris flow, such as building embankments and retaining walls. When constructing a roadbed, it is first necessary to reinforce the foundation. After the roadbed is filled, a load exceeding the roadbed pressure is piled up on the surface of the roadbed to ensure the tightness between the soil layers. The filling material used for roadbed filling should be coarse-grained soil with good quality, and then the foundation should be compacted with a compactor [5]. Debris flow is mainly affected by rainstorm. When precipitation increases, loose deposits will lead to floods of sediment and stones. Therefore, drainage work during subgrade construction also needs to be done well.

5. CONCLUSION

In short, the compaction construction of roadbed and pavement is a key step in construction. When carrying out construction, attention should be paid to various key points. To ensure that the compaction construction of roadbed and pavement meets relevant regulations and requirements, construction personnel should follow the construction standards of road engineering, pay attention to the control of various details of roadbed and pavement compaction construction, to ensure roadbed stability and pavement compaction.

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