

# Measures for the Optimization of Subgrade and Pavement Design in the Reconstruction and Expansion of Highways

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**Abstract:** In comparison to the construction of modern highway engineering, several of China's early pavement construction concerns, such as pavement collapse, are rather clear. Limited by historical and technical factors, the subgrade and pavement design for highways lacks scientificity, thus inducing potential safety problems in the operation. In order to comprehensively improve the subgrade and pavement design as well as ensure the quality and safety of highway engineering projects, this paper takes the reconstructed and expanded highway projects as research subjects and focuses on proposing optimization measures for the subgrade and pavement design of reconstructed and expanded highways, so as to provide adequate reference.

**Keywords:** Reconstructed and expanded highway; Subgrade and pavement; Design issues; Measures for optimization

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## 1. Introduction

Transportation construction has always been an important construction content to effectively drive the sustainable development of local economy. Due to the influence of previous economic factors and technical factors, there are several problems in the construction of old transportation roads in China. Even some roads in certain areas have difficulty in meeting the needs of modern highway transportation, which seriously hinders the local economic development. In recent years, in order to comprehensively improve the level of transportation construction in China, most provinces and cities are focusing on the concept of building highways as well as the timely improvement and optimization of unreasonable subgrade and pavement design. Among them, relevant government departments and highway construction units have actively responded to the call of relevant national policies and carried out reconstruction and expansion of old subgrades and pavements. They are promoting a healthy and sustainable development of highway transportation by continuously improving the service capacity of highway transportation in certain regions.

## 2. Importance of subgrade and pavement design optimization in the reconstruction and expansion of highways

From an objective point of view, the essential purpose of optimizing the subgrade and pavement design in the reconstruction and expansion of highways is to prolong their service life, improve their overall quality, and ensure the safety of highway operation. In recent years, with the continuous increase of highway traffic carrying capacity and the rapid growth of the number of privately-owned vehicles, the operation pressure faced by old subgrades and pavements has increased significantly. Among them, some highway subgrades

and pavements are restricted by previous design factors and technical factors. There are also obvious deficiencies in bearing capacity and operation capacity. If we do not optimize and improve the design in time, the strength and stability of subgrades and pavements will be weakened, and this may even lead to accidents <sup>[1]</sup>.

At present, in order to improve the operation capacity and bearing level of highway subgrades and pavements, relevant government departments and highway construction units are focusing on scientific deployment for the implementation of reconstruction and expansion projects. Reconstruction and expansion projects mainly refer to the timely improvement and optimization of quality issues existing in the original subgrade and pavement or other construction work, so as to better adapt to the development of China's transportation system. In view of the current optimization of subgrade and pavement design in highway reconstruction and expansion, the participating units can further enhance the stability of the overall road structure and effectively meet the development of urban economic construction by taking the initiative to incorporate the surrounding environment and construction requirements of highway reconstruction and expansion projects.

### **3. Problems and performance of subgrade and pavement design in the reconstruction and expansion of highways**

The negative effects brought by previous technical factors and design factors cannot be completely eliminated in a short period of time. Coupled with the influence of other factors, there are many design issues faced by the reconstruction and expansion of highway subgrades and pavements. At the same time, there are many professional construction coordination problems involved in these projects. If the construction problems of various disciplines are not coordinated and optimized in advance, a series of safety problems may occur.

One of the problems occurring in the reconstruction and expansion of highways is the designers do not produce reasonable reconstruction and optimization design in line with the actual traffic volume. The reason may be that the designers do not have a good grasp of the actual traffic volume or estimated volume, which ultimately leads to the phenomenon where the reconstruction and expansion design does not meet the expectations or deviate from the original expansion requirements. Even if the project has been completed, it is difficult to completely eliminate the existing problems from the past <sup>[2]</sup>.

On the other hand, there are many issues in the splicing design of new and old subgrades. Splicing design can be regarded as a common problem in the reconstructed and expanded highway subgrade and pavement design. If a construction personnel fails to carry out construction operation in line with the actual state of the site and the requirements of the design scheme, structural cracks may occur. In serious cases, it will lead to the settlement of old and new subgrades as well as affect the quality of highway engineering construction.

In addition, in the current environment of energy conservation, environmental protection, and sustainable development, the key consideration in the current reconstruction and expansion of highway subgrade and pavement is how to realize the scientific and rational utilization of the old subgrade and pavement as well as reduce the use of raw materials. However, due to the influence of various factors, there are many issues that need to be solved urgently, such as the inadequate implementation of processes and the low efficiency of resource utilization during the design and construction of subgrade and pavement in the reconstruction and expansion of highways.

## **4. Measures for the optimization of subgrade and pavement design in the reconstruction and expansion of highways**

### **4.1. Focus on the alignment index of subgrade and pavement**

Compared with the old highway engineering grade, the highway engineering grade after reconstruction and expansion significantly improves. In that way, the comprehensive performance requirements will be stricter. In order to ensure that the grade of the reconstruction and expansion project meets the expected requirements, the designer should take scientific and reasonable measures to reduce the influence of the longitudinal slope caused by reconstruction and expansion under the premise of ensuring the safety and reasonableness of the original construction quality. At the same time, the designer also needs to focus on the optimization of the pavement's radius and length. If the radius and length of the pavement do meet the curve requirements, the pavement should be redesigned in consideration of the actual situation. It should be noted that in order to further enhance the safety performance of vehicles, designers should give priority to the length and radius of large curves.

### **4.2. Implement subgrade widening and connection**

Subgrade widening, as the key but difficult feature in the design of subgrade and pavement in the reconstruction and expansion of highways, often has a decisive impact on the construction quality and effect of reconstructed and expanded highway projects. From previous construction experience, the widening of reconstructed and expanded subgrades can be divided into two forms – unilateral subgrade widening and bilateral subgrade widening – according to different construction needs. In order to ensure the expected effect of highway subgrade widening and connection, it is suggested that construction units should take several measures to strengthen the effect of highway subgrade widening and connection <sup>[3]</sup>.

#### **4.2.1. Optimize the treatment method of subgrade expansion**

The old subgrade structure has problems with subgrade settlement after long-term operation and high-load impact from vehicles, but the new subgrade structure has good performance and does not have settlement issues. There will be obvious performance gaps in terms of widening and connection. In view of this problem, if it is not handled in time, longitudinal cracks may occur. Therefore, in order to strengthen the connection between the old and new subgrades, a series of measures such as replacement and compaction should be carried out. For areas rich in groundwater, the method of laying waterproof materials under the subgrade can be used for operation and treatment. In the foundation compaction stage, construction operations should be carried out in accordance with relevant design specifications to reduce unreasonable connection between the old and new structures.

#### **4.2.2. Accurately handle the issue of excavation steps**

Constructors should optimize and improve the old subgrade structure by digging it into a step shape, so as to better connect with the new subgrade. During construction, construction personnel can appropriately reduce the width of excavation steps. Encountering certain environmental conditions during construction, it can be excavated into an inward inclined slope in consideration of the actual situation. In this way, it can further enhance the connection effect between the old and new subgrades.

#### **4.2.3. Control the compaction and rolling process**

Strictly controlling the compaction and rolling operation process can be regarded as an important measure to enhance the structural strength of subgrades and pavements in reconstructed and expanded highways. During the construction operation, construction personnel should give priority to impact rolling to enhance the compactness of the new subgrade. In addition, the strength and quality of the structure can be further

enhanced by means of layered compaction and preloaded soil construction. It should be noted that upon the completion of the operation, the on-site construction personnel must wait until the subgrade settlement is stable before they can carry out the next construction process, so as to avoid construction risks <sup>[4]</sup>.

### **4.3. Effectively improve the utilization rate of the old highway**

The structure and quality of some old pavements are relatively stable, and the construction materials used are in line with the construction standards of modern highway engineering. If the field inspection quality meets the standard, construction personnel can reuse the original reconstructed and expanded pavement to meet the requirements of energy conservation and environmental protection construction. At the same time, in the embodiment of construction design details, designers should pay attention to the connection between the old and new subgrades. If the subgrade and pavement structure is relatively complete or there are slight cracks during construction, the minor cracks can be effectively treated by reinforcement after passing a series of standard tests.

It should be noted that the original foundation can be used for treatment in the reinforcement operation to prevent destructive impact on the original pavement structure. For serious damages or cracks over large areas, the reinforcement treatment of the original pavement should be ceased. It is better to re-plan and design the pavement in line with the requirements of highway reconstruction and expansion. For raw materials used in subgrade and pavement construction, it is suggested that on-site construction personnel should give priority to materials with good energy conservation and environmental protection benefits for construction, so as to effectively enhance the sustainable effect of reconstructed and expanded highway subgrades and pavements <sup>[5]</sup>.

## **5. Conclusion**

In a word, there are many important, yet difficult issues involved in the design of reconstructed and expanded highway subgrades and pavements. In the process of optimizing the design, designers should actively deploy and implement the current connection and optimization improvement of the new and old subgrades and pavements in line with the design standards of reconstructed and expanded highway subgrades and pavements as well as relevant construction contents. At the same time, during on-site construction operation, construction personnel should effectively deal with the details and key points in strict accordance with the deployment requirements of the construction scheme, so as to prevent the occurrence of construction risks. In addition, the on-site management personnel should stick to their individual post responsibilities, visit the construction site regularly, and accurately grasp the on-site process flow. Once the construction risks are found, targeted measures must be taken to eliminate them, so as to fundamentally enhance the operation quality of the reconstructed and expanded highway subgrades and pavements.

## **Disclosure statement**

The author declares no conflict of interest.

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