

# Research and Performance Analysis of Highway Pavement Widening Construction Technology

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**Keywords:** Expressway, Pavement widening, Construction technology, Performance analysis.

**Abstract:** Influenced by the rapid development of China's economy, China's highway construction has become a key infrastructure project. As the main carrier of transportation, Expressway plays a huge role in daily production and life. Therefore, the research on ways and technologies of expressway expansion is increasing gradually. Pavement widening construction technology has become the key direction of highway construction. In this context, this paper starts with the study of the way of highway pavement widening, and summarizes the construction technology of highway pavement at the present stage. In addition, the performance analysis of highway pavement widening construction technology is carried out in order to provide reference for highway construction.

## 1. Research background

### 1.1 Literature review

With the rapid progress of China's economy and society, Dong Gang scholars put forward that China's existing expressways can not meet the demand of transportation. While building new expressways continuously, they put forward suggestions for widening and rebuilding the original Expressway Pavement (Dong, 2018). Cui Zhi yong 's scholars have studied in detail the causes of the cracks on the expressway pavement after the expansion of expressway, which are caused by the uneven settlement of the new and old roadbeds (Cui, 2012). Tian Bo and Cheng Wei respectively studied the construction technology of roadbed widening from four aspects: construction preparation, base treatment, roadbed widening construction and remedial measures for widening roadbed, and put forward the solution strategy of uneven settlement of roadbed (Tian and Cheng, 2013). The scholars of Lu Pei xian and Li Feng talked about the pavement maintenance of expressway, and took the actual project as an example to analyze and study the problems of asphalt pavement of expressway, discussed the maintenance and construction technology of expressway, and summarized how to improve the service life of Expressway (Lu and Li, 2016). Finally, Yu Jun and Yu Xiao min scholars started with the reconstruction methods of Expressway and the causes of pavement damage to study the construction technology of widening Expressway Pavement (Yu and Yu, 2015).

### 1.2 Purpose of research

With the rapid development of China's social economy, China also attaches great importance to the construction of expressways. In this context, the original expressway has been unable to meet the current traffic demand, so widening and repairing the expressway pavement has become the most urgent need for the development of expressway. Highway is one of the main transport lines in developing countries. It is of far-reaching significance for social and economic development to rebuild and expand Expressway pavement. However, after reviewing the research results of domestic scholars on highway pavement widening construction technology, the author finds that most scholars are more partial and one-sided. This paper studies the widening methods of Expressway pavement, integrates the current construction technology of Expressway Pavement widening and explores it, finds out the key points of the combination of old and new, and finally carries out the performance analysis of the construction technology of pavement widening. In order to meet the construction requirements of highway pavement widening at this stage, alleviate traffic

pressure and promote the economic development of our country.

## **2. Main ways of highway pavement widening**

### **2.1 Unilateral widening**

The first way to widen the road surface is to widen it unilaterally. Unilateral widening can be divided into two kinds: unilateral separation widening and unilateral stitching widening. The first is unilateral splicing widening which is common in engineering. The greatest advantage of this method is to reduce the use of construction pavement, in the construction of the project, do not hinder the normal road traffic. But it is not without shortcomings. When unilaterally widening the construction, it is necessary to remove the middle separation zone of the expressway, which will affect the operation speed of the expressway to a certain extent, but will not completely stop traffic. The second is unilateral separation widening, which is rare in engineering, because unilateral separation widening will separate a lane from the original road. Such road widening is only suitable for integer multiple widening, such as two lanes to four lanes, four lanes to eight lanes. Unilateral separation is to retain the original highway pavement, treat the old pavement as the foundation of the expanded pavement, and lay new subgrade on the other side of the highway to build new pavement (Zhang, 2017). One advantage of unilateral separation widening is that it avoids uneven settlement of new and old roadbed. However, different ways of paving the foundation and pavement of the old and new roads will lead to different elevation of the road, and it will be difficult to set the isolation zone in the middle of the road. This is also the reason why most projects choose unilateral splicing widening to avoid unilateral separation widening.

### **2.2 Bilateral widening**

Bilateral widening is also a construction scheme of highway pavement widening. The same bilateral widening can be divided into two ways. The first one is the bilateral splicing scheme which is chosen first. Bilateral splicing scheme is to organize construction on both sides of the expressway at the same time, and widen splicing on both sides without affecting the operation of the expressway. This splicing method is also the main construction method of widening expressway pavement in China. It not only greatly reduces the impact of expressway traffic of construction team, but also is ideal in engineering cost. Another two-way separation scheme is a widening method relative to bilateral splicing. Not only is the construction difficult, but also the cost of the project is very large. Bilateral separation is mainly aimed at the construction plan of widening both sides of the road, that is to say, adding one lane to each side of the four-lane road and turning it into a construction plan of six lanes. Because such construction schemes need to be carried out on both sides at the same time, the construction is difficult, and will greatly affect the operation of the expressway, and the efficiency of separate construction schemes is too low, which requires a high amount of construction area for road widening (Yu, 2013).

### **2.3 Mixed widening**

Mixed widening refers to the construction of highway pavement widening by fully combining unilateral widening and bilateral widening. For example, two-sided splicing matches one-sided splicing, two-sided splicing matches one-sided splicing. Mixed widening scheme can only be used in special highway pavement type, and generally smooth highway pavement will not use such construction scheme. Mixed widening is suitable for changing geometric alignment and distorting highway sections. Mixed widening can re-fit the plane alignment of pavement to the original (Feng, 2013). There are many shortcomings in the mixed widening method, such as high cost, long construction time, low construction efficiency and so on. Therefore, the mixed widening scheme will not be used in the construction of highway pavement widening.

### **3. Performance analysis of pavement widening construction technology**

#### **3.1 Base treatment technology**

Before the expressway road widening construction scheme is formally constructed, the base treatment should be carried out on the additional roads. Base treatment is more complex than housing base treatment. When the construction plan is issued, the constructors will begin to clean up the obstacles of the roadbed slope, such as weeds, silt, water pits, falling stones and other things that affect the construction. The uneven settlement of the foundation will occur when the new and old roads are widened, which will have a great impact on the service life of the expressway, and accidents will occur in serious cases. Therefore, when cleaning up the pre-implementation section, the old section should also be checked and processed, and the section with frost hazard should be replaced with gravel, while laying the new section, the old section should be maintained and repaired, so as to achieve the purpose of connecting the old section with the new one. Base treatment keeps the base of the old and new pavement consistent, does not affect the combination of the old and new pavement, and provides durability for the widened new and old base of expressway.

#### **3.2 Step processing technology**

When widening the expressway pavement, the basic body of the old road will deform and collapse under long-term dynamic load. If this phenomenon is not dealt with as soon as possible, cracks will occur when the old and new pavements are combined, which will affect the operation of the expressway. In this case, it is necessary to use step excavation method to deal with embankment subsidence. Such steps can increase resistance and reduce sliding force. However, step excavation should pay attention to the condition of the slope, usually when the ratio of the road slope is 1:1.5. Moreover, after tamping the steps, if the old road becomes narrower, it is not conducive to the operation of the expressway. In this case, in order to ensure the quality of Expressway pavement, the area of pre-construction should be widened as far as possible when building steps, and the filling materials of new and old roadbed should be the same as possible, so as to ensure that the joint of new and old pavement is easy to combine. Step treatment increases the combination of the old and new sections of the base, to a certain extent, assists the pavement combination, so as to improve the tension resistance of the new and old sections of the base.

#### **3.3 Subgrade filling material selection technology**

Selecting the filling material of roadbed is an important link to ensure the safety and quality of Expressway in the future. China also has clear provisions in relevant laws and regulations. Subgrade filling materials for expressways should be tested by field soil sampling experiments and strength tests. After passing the tests, they can be used as subgrade filling materials for expressways. Mud, frozen soil, organic soil, domestic refuse and soil containing decaying substances shall be prohibited for roadbed filling materials of expressways. When saline soil, loess and expansive soil are involved in filling soil, relevant regulations should be observed to ensure the quality of expressway. Soils with liquid limit greater than 50 and plastic index greater than 26, including soils with water content exceeding the stipulation, can not be used as filling materials directly. Technical measures to meet the design requirements must be taken before filling can be carried out after qualified tests. When using industrial waste for roadbed filling, an experimental report should be submitted to the project manager of Expressway construction, which can be put into use only after approval. Subgrade filling material selection determines the performance of the foundation in the future, material inconsistency will affect the settlement of the new and old foundation.

#### **3.4 Rolling technology of roadbed**

Rolling roadbed is to consolidate and compact the roadbed to ensure the compactness of the roadbed after the integration of the expressway roadbed. The following three principles should be followed in roadbed rolling of expressway. The first one is light first, then heavy, when it begins to press steadily, after consolidation, heavy and vibratory rolling. The second is slow first and then fast.

That is to say, the speed of the roller should be accelerated with the increase of the number of rolls. The initial slow speed can deepen the influence on the base. With the increase of compaction, the speed of the roller can be increased. The third is to roll the roadside first and then to the central line of the roadbed. According to the different filling materials, the choice of compacting machinery is also different. In general, it is necessary to use vibratory roller in conjunction with ramming roller. After tamping, smooth wheel roller is used for leveling and integration to ensure the normal operation of asphalt paving works. Roller compaction technology of subgrade consolidates the base of old and new expressway sections, and its compaction degree is close to that of old and new expressway sections. It ensures that the pavement will not rupture due to the collapse of the base and improves the stability of the new and old basement of expressway.

### **3.5 Pavement drainage technology**

Pavement drainage is an important link to ensure the road strength of new widened roads in highway pavement widening project. Choosing suitable drainage methods can effectively reduce the impact on road stability. Generally, centralized drainage is adopted to avoid frequent contact with water to dissolve asphalt mixture, which affects the durability of asphalt concrete and produces cracks. To ensure the structural durability of new and old roadbed, after the drainage facilities are installed, it should be avoided to be eroded by foundation or rainwater or groundwater, so as to ensure that the drainage capacity of drainage facilities will not be lost soon. Highway drainage is usually redesigned every five years to ensure road stability. Pavement drainage technology guarantees the dryness of pavement and foundation, does not cause damage to the base and pavement due to long-term water erosion, and provides durability guarantee for the widening section of expressway.

### **3.6 Impact compaction technology**

Impact compaction is the last link of pavement widening construction. The backfill is compacted by impact and vibration of compactor. Where it is necessary to increase the density, it should be compacted. However, such a compaction method can only be applied to small areas of road surface, and the practical hand-held compactor for large areas is unrealistic. Such tamping can improve the bearing capacity and strength of the roadbed, avoid the uneven settlement of the old and new roadbed leading to the destruction of the old and new pavement, and make the expressway pavement have compressive resistance.

## **4. Conclusion**

In this paper, the way of highway pavement widening is introduced in detail, and the most important construction technology of highway pavement widening is also analyzed in detail. Finally, the performance of highway pavement is analyzed. With the continuous increase of highway construction and transportation volume, as well as the increase of traffic flow, people's demand for highway is the most urgent problem to be solved. These problems do not exist in the new expressway, but for the old expressway, only road widening can be carried out. At the present stage, the technology of road widening is still relatively immature. It is urgent for professionals to study and propose solutions to solve the transportation problems in China as soon as possible so as to contribute to the promotion of social economy.

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