

# Technical Analysis of Subgrade and Pavement Construction in Settlement Section of Municipal Road and Bridge Engineering

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**Abstract:** The construction of municipal roads and bridges is an important foundation for the smooth traveling and transportation. However, if there a reduction in the subgrade and pavement part, the safety and the comfort of the driver will be seriously affected, therefore, reasonable measures should be taken on time to tackle the related issues. The significance of subgrade and pavement construction in the subsidence section, the key points of the construction, and the appropriate control measures that are should be taken in the actual construction, was discussed in this paper. Further, this paper analyzes the availability of the subgrade and pavement construction technology for the municipal roads and bridges, to provide a reference for engineers.

**Keywords:** Municipal Road; Bridge works; Subgrade and pavement in settlement section; Construction technique

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## 1. Introduction

Municipal road and bridge engineering is an important basic engineering in the contemporary society, which influence the impact on the travelling, and the development of the urban economy. Therefore, in the settlement section of the subgrade and pavement construction, it is important to ensure the use of standardized technology, to ensure that the location is handled reasonably, to avoid adverse conditions in the later stage of the construction, and to the reduce overall maintenance cost of the roads and bridges. In addition, the construction technology, should be reasonably applied during the construction, to fully control the settlement, and to improve the overall construction level of municipal roads and bridges. Therefore, it is essential to analyze the subgrade and pavement construction technology in the settlement section of municipal road and bridge engineering.

## 2. Significance of subgrade and pavement construction in the settlement section of the municipal road and bridge engineering

On the actual, municipal road and bridge construction process, there is an uneven terrain on the construction site or other complex geological conditions, which may affect the implementation, or the progress of the construction work. Additionally, large water content in the soil, may also contribute to the pavement

settlement. Further, once the roads or bridges is ready to use, the load or weight generated by the vehicles, may also affect the pavement settlement, especially when there is a difference in the load bearing capacity, which will lead to a relatively significant deformation in a shorter duration.

Roads and bridges are one of the important infrastructures in the city, which indirectly can reflect the overall developmental level of the city. At present, the number of roads and bridge construction is increasing, with more attention was given on the construction quality. Therefore, it is essential to conduct in-depth research on the subgrade and pavement construction technology, to improve and optimize the construction quality<sup>[1]</sup>.

### **3. Causes of settlement condition in the municipal road and bridge engineering**

#### **3.1. Unreasonable setting of approach slab**

The setting of approach slabs, in the settlement sections of the roads and bridges are unreasonable. The setting of the approach slabs for the subgrade can control the settlement difference, therefore, it is important to use the appropriate setting, to improve the pavement flatness and embankment strength. In additional, if there is a difference between the settlement of the abutment, and the filling of bridge head, it can easily lead to an insufficient connection between the approach slab at the bridge head, and the expansion joint of the beam. Further, peak stress can be generally generated by the vehicles that is using the road and bridge, especially at the approach slab position, which may cause the deformation of road and bridge.

#### **3.2. Foundation treatment**

One of the main reasons, which lead to vehicle jumping during driving at the bridge head is due to foundation settlement, resulting from the poor construction design. For example, during the construction work, failure to confirm certain key points such as, the type of the soil foundation, the depth, and the scope of the soft soil foundation, and the number and depth of the boreholes with relevant requirements, may cause the default in the foundation. Further, when performing the treatment work for soft soil foundation, the inaccuracy of parameters applied in the calculation process, may produce inconsistent results, which is may differ from the actual situation, leading to difficulty in controlling the settlement effectively<sup>[2]</sup>.

### **4. Project overview**

In this paper, the national highway construction project has been used as an example. The national highway runs from the East to the West, with a total length of the road is about 0.94km, with a standard width of 40m, and it is an urban trunk road, with a design speed of 60km/h. Further, to cooperate with the development of the surrounding water purification plants, an access road with the length of 0.12km, and a width of 10.5m is included in the national highway construction project. According to the current branch of road standard, the design speed of the access road is about 20km/h. In order to prevent settlement, it is essential to follow reasonable construction points, and to take appropriate control measures according to the actual situation.

#### **4.1. Key points of subgrade and pavement construction in the settlement section of the municipal road and bridge engineering**

##### **4.1.1. Preparatory work**

In the construction of roads and bridges, the settlement section is a main arising issue with high occurrence. To ensure the overall construction quality, the construction personnel, has to deal with this issue in a timely and effective way<sup>[3]</sup>, therefore, it is essential to improve the relevant preparations, confirm the construction site of roads and bridges, carry out the analysis of the natural environment, the pavement trend, hydrogeology, and other aspects such as, the problems that is prone to happen during the construction work,

finally, formulate targeted solutions, to prevent, or to reduce the settlement problem as much as possible, simultaneously, ensure the construction quality. For example, in the national highway construction project, the main road should be the major construction part, therefore, it is important to ensure the construction work is according to the actual situation, and achieve the overall requirement of the project, while complying with the management specifications [4].

#### **4.1.2. Tamp the foundation**

The firmness of the soil itself, can determine the settlement of the subgrade and pavement. Large water content in the soil will increase the plasticity, porosity, and easily can cause deformation of the road, therefore, it is important to implement the compaction treatment, by removing the water, and strengthening the compactness of the soil before starting the construction work [5], however, different treatment measures should be applied in construction conditions. Further, when treating the foundation, the form of compaction pile, and driven pile should be applied by arranging them in a specific sequence, where compaction pile is installed first, followed by driven pile, and finally the implementing the foundation pile. Meanwhile, for the filling subgrade work, if the thickness of the soft soil foundation is thicker, the filling material may move to one side of the soft foundation, resulting in the increase of foundation pile pressure, and the horizontal displacement of the subgrade, which will affect the overall quality of the municipal road and bridge construction work. Therefore, when selecting the filling materials, one should select the lighter materials, and fully implement the ground drainage work. Lastly, when dealing with loose, expansive, and soft soil and soft soil foundation sections, one should ensure that, the precipitation, and surface runoff of the road section will not affect the construction quality [6].

#### **4.1.3. Embankment construction**

During the construction of the embankment, it is important to effectively improve the overall settlement stability and strength of the embankment, improve the detection work, and further, confirm that the construction work is following the relevant requirements. Especially, in the construction of the national highway, there, is a certain degree of deviation of the road centerline, and it is essential to reasonably control the overall strength and stability of the highway, therefore, the following measures should be selected in implementing the embankment construction:

(1) Before starting the construction, the grass, and bushes within the construction scope, should be cropped to avoid the influence of plants on the subgrade land. Next, the sediment in the holes on the original ground, should be completely removed, and backfilled with an appropriate material. Lastly, the ground should be compacted in layers to achieve more than 90% of compaction degree, and the lateral slope of the embankment base should be more than 1:10, further the base should be trimmed into step shape with a width of 2-5cm, and the slope with outwards inclination at the bottom is around 4% [7].

(2) The selection of the filling materials should be based on the water stability, strength, compaction, and excavation. In addition, the minimum strength, and the maximum particle size, should be reasonably selected according to the soil sampling test. In the national highway construction project, the stone type soil should be selected and applied. This material is composed of gravel, with the particle size of more than 2mm, with the characteristics of large gap and low compressibility. It is an embankment material with excellent quality.

(3) In the process of embankment filling, the cross section should be taken as the basic requirement. During the filling subgrade compaction, the rolling speed should be controlled to 3km/h. Further, after one rolling, the secondary rolling should be performed by adopting the longitudinal form method, in contrast the turning around method of the rolling should be avoided, this action can cause soil rubbing and squeezing [8].

#### **4.1.4. Setting of approach slab**

When, setting the approach slab in the settlement section, one has to ensure that the position of the approach slab is completely parallel to the top position, to hold the excessive load pressure caused by the vehicles once the road and bridge is ready to use <sup>[9]</sup>. Further, to ensure the overall flatness of the pavement, and to prevent reverse slope, it is essential that the top height of the subgrade in the conventional section is exactly the same as the elevation of the connection position on the approach slab. In the planning work of the national highway construction project, before the formal construction operation begin, it is required to set a horizontal tie rod, and fix it longitudinally with an anchor bolt, and effectively control the distance between various instruments with the help of the reinforcement with appropriate strength, to improve the safety during construction. In the process of fixing the anchor bolt, it is essential to reasonably control the position between the transverse tie rod and the anchor bolt, to improve the application effect of the approach slab. Additionally, the approach slab support should be reasonably selected based on the actual situation. When it is required to set the approach slab support, a cushion should be placed on the abutment, followed by the setting of the rubber approach slab support position, with setting parameter is within 80cm around the cushion, to ensure the overall stability of the construction <sup>[10]</sup>.

#### **4.1.5. Filling backstage**

For the construction of filling background, the quality, and the performance of the applied materials can influence the settlement. According to the previous construction experience, if a light material is used, the settlement, which is caused by compression deformation can be fully controlled. Therefore, in the national highway construction project, the filling materials should be strictly controlled, to ensure that the material performance and quality can meet the standard requirements <sup>[11]</sup>. Further, the settlement in the national highway construction, is belong to the rigid and flexible settlement, and the stiffness of the material is between the subgrade material, and the abutment material. Material stiffness should not be too large, or too small, to avoid the situation of difficulty in compacting the material, due to the influence of the natural environment. In addition, the construction of the abutment back requires a high degree of compaction, therefore, the materials must have a good water permeability, plasticity and easy compaction, to ensure the quality of construction, simultaneously reduce the probability of the settlement <sup>[12]</sup>.

### **5. The control measurement of the subgrade and pavement construction in the settlement section of the municipal road and bridge engineering**

#### **5.1. Strengthen construction organization**

A construction organization should be created, throughout the construction work, to monitor, to coordinate, and to balance the construction. There are few key points that need to be mindful while creating a construction organization as stated below:

- (1) The management team is formed, by including the staff that has high professional skills, and rich in work experience, and the team should be able to carry out the construction work with a high technical level and good comprehensive quality <sup>[13]</sup>.
- (2) Relevant personnel in all the aspects, should fully understand the construction drawings, clarify the specific contents of design documents, improve the on-site verification, and disclosure, bring forward the irrationalities in the drawings, comprehensively grasp the influencing factors, understand the possible impact of pipelines in all aspects, reasonably design the pipeline relocation report, and cooperate with the relevant departments, to further implement the relocation work.

(3) It is important to implement a survey, and accurately retest the precise traverse points and benchmarks provided by the design staff, to build a survey control network, which can reasonably provide point protection <sup>[14]</sup>. Additionally, a site laboratory should be established, to comprehensively sample the construction materials, to ensure the quality of construction raw materials, and to upload the test results to the database <sup>[15]</sup>.

## **5.2. Improve the construction quality**

In the construction of municipal roads and bridges, it is important to build, and implement the quality assurance system, to confirm the post responsibility system, to ensure the safety production of the responsibility system, to optimize the cooperative relationship between various departments, to reduce the probability of rework and lastly to control the construction cost <sup>[16]</sup>. Further, all the relevant construction personnel must establish a sense of responsibility, and quality awareness, adhere to the ‘quality first’ concept, and reasonably prepare the quality control plans. Additionally, all the staff should follow the construction plan, and procedures to implement the work, and continue to improve in writing the records, or report. The management team also, carries out the process of on-site tracking, inspection and guidance. Lastly, to ensure that the appearance of municipal roads and bridges is good, a clear line and sophisticated technology should be implemented, to achieve the aesthetic needs of the people, simultaneously meets the needs of road traffic development <sup>[17]</sup>.

## **5.3. Optimize schedule management**

The construction progress of the municipal road and bridge works requires high requirements, therefore, it is essential to optimize the progress management for the settlement section, to improve the overall quality of the roads and bridges, further to avoid adverse effects on the daily appearance, and transportation of the people <sup>[18]</sup>. In addition, to optimize the progress management during the construction of the municipal roads and bridges, the following measures should be implemented:

(1) Design the schedule according to the actual situation, which involves the integration and combination of various units and types of work, and the labor force, and construction materials. After the construction plan is approved, the stage plan should be strictly implemented during the construction work, further, the materials, funds, and human resources should be reasonably allocated according to the plan content and the actual situation <sup>[19]</sup>.

(2) It is necessary to regularly perform a construction progress inspection, constantly optimize the construction schedule, and also timely identify the influencing factors before the construction plan is completed, to effectively control the overall situation on the construction site, to ensure the continuous balance of the construction process, to constantly coordinate various technologies, organizations, and lastly to avoid contradictions between links and projects. Similar to other management activities, the construction plan has the characteristics of periodicity, and the plan content can be divided into several parts, including preparation, implementation, inspection and correction, and the implementation of the schedule is controlled in the form of network plan, to effectively control the construction process, and subsequently, to control of construction quality and cost <sup>[20]</sup>.

## **6. Conclusion**

For municipal roads and bridges, the construction of settlement subgrade and pavement is essential key point involved in the construction process. The construction process includes preparation, tamping foundation, building an embankment, setting approach slab, filling the background, optimizing drainage, and others process, need to be implement scientific, and reasonable construction technology should be included in all the aspects, such as perfecting preparation, solid foundation, embankment construction, and

setting the strap. Further, focus should be given to the improvement of construction quality, construction organization, construction schedule management, to promote the quality of the municipal road and bridge engineering, subsequently promote regional economic development and transportation development.

### **Disclosure statement**

The authors declare no conflict of interest.

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