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Review on the Ways and Characteristics of Expressway Subgrade Widening

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Abstract: The old road widening reconstruction project and the construction of a new highway construction is difficult, the process is complex, high quality requirements of the characteristics. Due to the old road subgrade settlement has been basically stable, and new road subgrade settlement time is short, of new and old roadbed combination will produce uneven settlement, so as to produce a longitudinal crack, resulting in cement concrete panel under load have broken slab, asphalt concrete pavement has the reflection crack, greatly affect the quality of driving, not only to meet the needs of vehicle, will increase the car's fuel consumption and tire wear, increase transportation costs, increase the transportation time, and even endanger the safe driving, also increased the road maintenance cost. The urgency of the highway widening technology research of expressway expansion project of subgrade widening mode and its features are reviewed, forming reasonable Expressway Widening Engineering of philosophy, in order to lay the foundation for the theoretical research and engineering practice.

Keywords: Expressway; Expansion project; Widening of subgrade; Pavement splicing; Widening way; Differential settlement

1. Introduction

Soft soil foundation section of the extension project and the construction of new projects, whether it is on the design, construction technology requirements or the construction of the difficulty is much greater. Has the following characteristics:

In roadbed construction, to ensure the normal traffic and safety of the vehicle. Reconstruction and expansion of the highway is usually very large traffic, how to ensure the smooth passage of the road and the normal construction of the road is a very difficult problem.

To carry out the expansion of the highway is generally more for the early construction of the highway in our country, due to the historical conditions of the time limit, there is a low standard design technical standards, construction quality defects and other issues. Especially our country "highway law" introduced relatively late, the early construction of the highway within the red line underground, above ground buildings lax control, resulting in widening of highway roadbed underground pipe network intensive, to structure complex, with great demolition projects.

Due to the characteristics of the soft soil foundation, the settlement between the newly widened subgrade and the subgrade is large, and the vertical and horizontal direction is not easy to link up.

2. Widening of the Expansion Project and its Characteristics

He way of widening the road, different periods of different understanding, the corresponding research is also different, widening the way is also different. If most of the center line of the old and new pavement coincidence, double side widening; to a center line deviation between real one side widening, the in is not limited by terrain, choose one side widening, the way of Widening Roadbed just one side widening, convenient construction, widening is bilateral, compaction degree and easy to guarantee, substrate processing a series of construction process in the side, the construction schedule. But one part of the structure is located on the old road, and the other the part may be in the new roadbed. Because the strength and density of the new and old roadbed are different, the new and old roadbed will have different settlement, which will cause the road surface along the seam longitudinal cracks.

Summary at home and abroad to broaden the way has the following: if the two lane widened to four lanes, while broadening, widen on both sides of the, special sections can be the amplitude of subgrade, and on the four lane widening to six lanes and eight lane, one side widening and widen on both sides and widening of amplitude. Lap mode can be used in the plane lap, but also can be separated from the upper and lower.

3. The Types and Characteristics of the Highway Connection

The type of stitching is defined as 3 types: complete splicing, incomplete splicing and separate splicing.

Fully stitching is a highway after the completion of this project, due to the growth of traffic volume requirements, on both sides of the existing highway directly embankment splicing broaden is generally symmetrical on both sides of the loading, including asymmetric loading, such as the ramp of the mosaic, it is the highway road widening engineering of main types.

The original road has been in operation for a period of time, sedimentation has been stable, or complete consolidation of the former part of the road foundation and the geological conditions of the old and new exist larger differences, also due to the effect of stitching load, if not handled properly will cause of the new and old roadbed uneven settlement, in the new and old roadbed combination produces tensile stress, easily lead to pavement cracking. There is a great difference between the settlement deformation characteristics and the new expressway, and the mechanism can be analyzed from 2 aspects of the geological condition and the load.

Widening, the original road has the operation for a period of time, under the embankment load, foundation soil has been basically or completely solidified, the physical and mechanical properties of the foundation have greatly changed, especially in the soft soil foundation, greatly improved strength, even is not fully consolidated sections, soil properties also has the greatly improved, under the same load, and load effect of the relative position with respect to widen the foundation will occur certain settlement increment, triggering between new and old roadbed differential settlement.

Highway after years of operation, the consolidation has been basically completed, the original embankment and foundation soil formed a whole, approximation can be as a rigid body, due to the overall stiffness, if on both sides of road widening, new widening embankment weight, to the center of the original roadbed, functions in form of eccentric load in old subgrade, causing new additional settlement, the size and the eccentric load effect is related to the distance near you. If both sides symmetry widening, the resulting settlement increment distribution, to the center of the original foundation, a basin shaped distribution, in the center of the original roadbed minimum, on both sides of the widening of the section centroid perpendicular is the largest, and between the centroid vertical position to widen new dyke foot decreases gradually.

The width of the widening of the splicing has a certain influence on the deformation characteristics of the settlement. To four lanes, for example, with increase of the width of the splicing, center of embankment settlement increment and at the centroid of the maximum settlement of incremental change curve widening.

With the increase of the width of the joint, the change rate of the settlement increment of the center of the embankment decreases gradually.After the increase of the width of the stitching, the increment of the center of the original road is almost unchanged. Broaden the centroid of the settlement increment, with widening the width increases, when the stitching width up to 30 m, widened at the centroid of the settlement increment and the original four lane center settlement increment at the same.

Incomplete splicing is refers to the highway construction process due to the planning of the change, that is, the design requirements of the roadbed width has been constructed to a certain height, and then by the new standards for splicing widening. The pavement structure of "new and old" road is paved with one time, there is no construction time interval, and there are some differences in the characteristics of the foundation and the complete splicing. If a highway on the basis of the existing four lanes, taking into account the needs of the future traffic volume, the original 4 lane design is changed to 6 lanes. As part of the road has been constructed to the 95 area, and then on both sides of the symmetrical widening 4.5 m, to broaden the part of the construction to the 95 area, and the original road construction of the road structure layer.

Under the action of the original road load, the subgrade is always in a state of compression. The second stage, widening the load construction period. With splicing completely the same, new widening of the load, to the center of the original road, forming a reverse subsidence basin. At this time, the original road in tension, between the old and new embankment will form the uneven settlement, when the additional settlement amount is greater than a certain value, broaden the load of the tensile stress is larger than that of the first stage of the formation of the compressive stress will lead to the original embankment cracking phenomenon. Third stage, pavement structure layer construction period. With the construction of pavement structure layer, the center of subgrade will be gradually compressed, and the tensile stress formed by the splicing load is gradually offset.

From the point of view of the process of the original road, it is different from the complete mosaic that the original road foundation has not been fully consolidated, the difference in the same geological conditions, the amount of the same geological conditions is smaller than the complete splicing.

After the separation of the original highway is completed, the original highway on the side or both sides of the adjacent side of the re construction of a highway. At this time the new subgrade implementation after splicing, caused to side load in the form of highway has built additional settlement increment, mosaic project in the Xicheng Expressway and Shanghai Nanjing Expressway as an example, the typical methods of foundation treatment for in between new and old roadbed construction settlement of the wall, from and to eliminate mosaic load on the original road additional settlement influence.

4. The Problem of Differential Settlement of the New and Old Subgrade at Home and Abroad

At home and abroad on soft soil foundation differential settlement problem study more, mainly from two aspects, the settlement calculation and prediction method. On the other hand, settlement treatment measures, structure type.
In the settlement calculation and prediction, there are 2 main categories: first categories for theoretical methods, it includes the traditional methods and numerical analysis methods. The traditional method is to calculate the final settlement according to the stratified summation method, which is used to calculate the instantaneous settlement and the secondary consolidation settlement, and then the one-dimensional consolidation theory of Terzaghi is adopted.
The difference method, the finite element method and the boundary element method for calculating the final settlement of the foundation are calculated according to the consolidation theory, combined with the various constitutive models of soft soil. Such as the non linear elastic model and the finite element method, the finite element method considering the visco elastic plastic model, the finite element method considering the structural damage model and the finite element method of large deformation consolidation are considered. Second categories are based on the measured data to predict the settlement of the relationship between the time and the forecast method. Such as exponential curve method, logarithmic curve method, hyperbolic method, shallow post method and grey prediction method.

5. Summary

In today's international on the highway changed road expansion project with wide differential settlement treatment has been limited to single method, but a variety of methods with, and differential settlement comprehensive treating measures to study, pay more attention to the form and mode of research and different types of road surface structure of differential settlement of adaptation research, making of uneven settlement of subgrade treatment, from the past after the maintenance into beforehand control. No doubt, the in order to prevent the main ideas, is worth in the study and solve the difference of subgrade settlement problems used for reference and adopted and today of subgrade and pavement integrated design and treatment technology development inevitable trend.

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