Finite Element Analysis of Strain in Avenue Widening Subgrade Engineering

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Abstract

Landscape road widening project, often because of differential settlement and additional stress caused by the old road, causing damage, surface layer cracking, were analyzed by using plane strain finite element method on the difference of widening project and the central settlement between the old road shoulder, combined with the foundation treatment method to explore how to reasonably design the old and the new road.

Keywords

Finite element, Additional stress, Strain.

1. Introduction

According to the asphalt pavement of asphalt concrete road widening engineering of cracking this common phenomenon, combined with the design requirements of my courtyard landscape avenue sidewalk widening projects and key points of construction [1], the focus on the design of widening subgrade and pavement layers is analyzed and explained.

2. Analysis of the Disease in Pavement

2.1 Pavement Description.

The longitudinal cracks in the pavement is one of the common diseases of pavement early damage, high grade highway and road reconstruction project, due to channel traffic is not obvious, cracks widen old road reconstruction project in the position of general subgrade widening part or near the central position of the longitudinal seam width, generally in the 5 - 10mm, often in the form of a single crack. It differs from the pavement material shrinkage or temperature shrinkage crack of asphalt surface layer horizontal interval caused by the hazard is from the cracks in continuously into the water, so that basic even subgrade softening, cause pavement strength decrease and the decrease of bearing capacity, accelerated pavement damage, which is more destructive than the transverse crack of road surface, and difficult to maintain [2, 3, 4, 5].

2.2 Analysis of Longitudinal Crack.

(1) The settlement of subgrade construction quality and reason :The degree of consolidation of new and old roadbed settlement is different, will inevitably produce some differences, especially the new fill subgrade large settlement, and the old roadbed has completed most of the settlement after construction, which inevitably with the Department in the new and old roadbed settlement difference produced a point mutation, sinking new widening partial radical will first lead to damage of pavement the structure layer corresponding to the longitudinal crack, become the main causes of cracks in the road. In addition, because the construction process control reasons, such as the construction of subgrade compaction degree is not uniform, especially the old base junction compaction machine is difficult to work, the compaction quality does not meet the requirements of subgrade is not good, resulting in subgrade and pavement due to uneven subsidence; or because of subgrade side edge by water erosion have uneven subsidence caused by.

(2) Primary causes of construction quality:Construction framing, longitudinal seams mixture segregation and health does not reach the designated position, not to paint the cement slurry treatment, rolling is not standard or two layers of base construction, longitudinal not according to the provisions of the equal treatment of all overlapping dislocation causes such parts loose, insufficient strength, and is easy to produce crack and reflection to the asphalt surface layer.

(3) Construction quality of the asphalt surface layer:Framing paving, two pieces of some unresolved or layers of the asphalt pavement structure, the upper and lower longitudinal construction joints without construction joints according to the requirements of all parts of fault, caused by weak, gradually cracking in the traffic load and atmospheric factors, the formation of longitudinal seam, sometimes rutting edge will produce longitudinal cracks [6, 7].

2.3 Widening Project Overview.

The landscape Avenue in 2010 August has completed the treatment and asphalt concrete surface layer of subgrade pavement, both sides of the sidewalk widening, due to different degree of consolidation of new and old roadbed, roadbed widening part of subgrade, which belongs to the consolidated soil, subgrade soil medium, the settlement is more than the old pavement. Thus causing additional stress in asphalt surface course and base course, this force if greater than the surface layer of the tensile strength, the road will be a cracking.

In view of this kind of longitudinal seam causes, engineering staff in old road widening project has taken appropriate measures, including: soft foundation treatment, base dredging for fill, the old road embankment step excavation, reinforcement layer and the reinforced soil embankment. However, these methods use from the practical engineering effect, some conservative waste is caused, but some neglected problems, caused the pavement early cracking [8, 9].

Reasons for this phenomenon lies in the blind, engineers could not quantitative grasp the uneven settlement of size, and the damage caused by the additional stress of pavement whether can cause, therefore grasps not good treatment measures of scale[10]. In view of this situation, the calculation of additional stress using finite element method, and put forward considering the uneven settlement of widening pavement design method.

3. Calculation of the additional stress caused by the settlement of subgrade pavement

3.1 The uneven settlement calculation.

The old embankment after years of the traffic load has been fully consolidated widening part of the settlement, is caused mainly by the new subgrade and pavement under the occurrence of consolidation settlement. Compression of pavement itself is very small, can be neglected. At the same time, because the junction of old and new base and surface contact is good, think completely continuous.

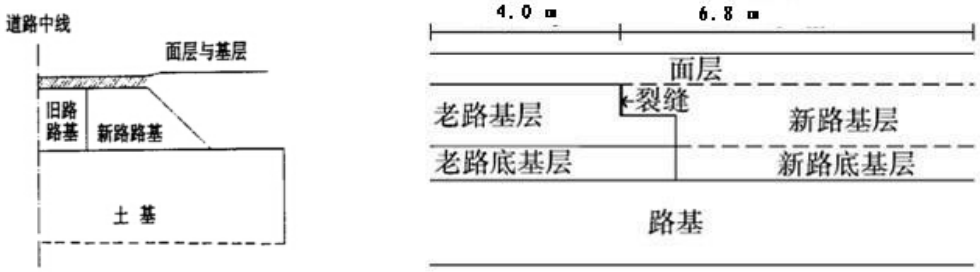

Fig. 1 cracking part

3.2 Calculation and analysis of additional stress.

Below is the top surface of subgrade settlement curve, calculation of the additional stress of the base layer and the surface layer of subgrade, the calculated settlement values as the top surface of the known displacement, imposed on the nodes of finite element can be [11].

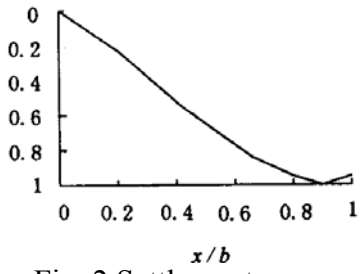

Fig. 2 Settlement curve

Calculation of the additional stress only take part widening the road, widening part with the original road jointed x, Y direction are fixed mesh finite element, see figure 4. The calculation results show that the maximum tensile stress appeared in the surface layer at the junction of the old and new pavement.

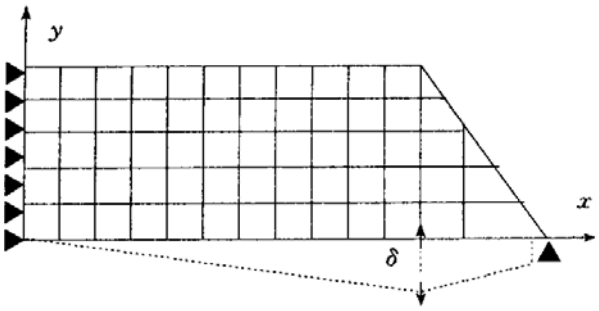

Fig. 3 Finite element mesh

The sedimentation value of certain circumstances, the size and surface layer thickness and modulus of additional stress, base thickness, modulus. To widen the road, the new pavement layer and the base layer thickness and the old one is basically the same, so this paper only discusses the influence of surface layer and a base layer modulus on additional stress. From Figure 5, Figure 6 indicates that the surface layer and the base modulus is too high will increase the maximum tension at the junction of the old and new pavement of the stress should be reduced, so to meet the facet layer and basic requirements of the bearing capacity under the condition of modulus.

3.3 The design method of road widening.

Calculation of the final purpose of settlement and additional stress is applied to the design of widened road. In order to prevent the crack, a kind of method is in the reserved amount of new Pu widened top surface of a certain thickness of the base. Reserve size can be determined through the following methods.

The tensile strength of a surface layer for Rho R, can according to the specific conditions, using the method of drawing to 2.2 of maximum tensile stress and the uneven settlement of the diagram, the maximum tensile stress extrapolation to improve R settlement amount corresponding to the critical settlement wl. If uneven settlement amount is greater than the critical value, the road will be a cracking. On the other hand, can use method.

3.4 calculate.

The actual uneven subsidence value (predicted) w_s, if the value is small and the critical value, can not be taken many measures. This value is greater than the critical value, the difference is the top of the base reserve.

$$\Delta = w_s - w_l. \quad (1)$$

If not adopt the processing method of reserve, the additional stress can also be calculated as the design reference value, its value is bigger that the differential settlement of the corresponding methods to take, and this should be more thoroughly.

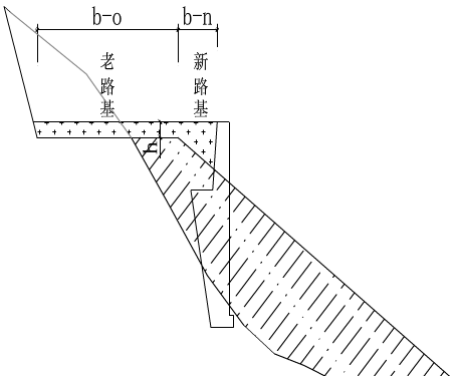

Fig. 4 Stress diagram

4. Design of subgrade section

In the landscape avenue on both sides to increase the pavement subgrade design of non-uniform settlement computation and additional stress, and the results as the basis, puts forward the design scheme

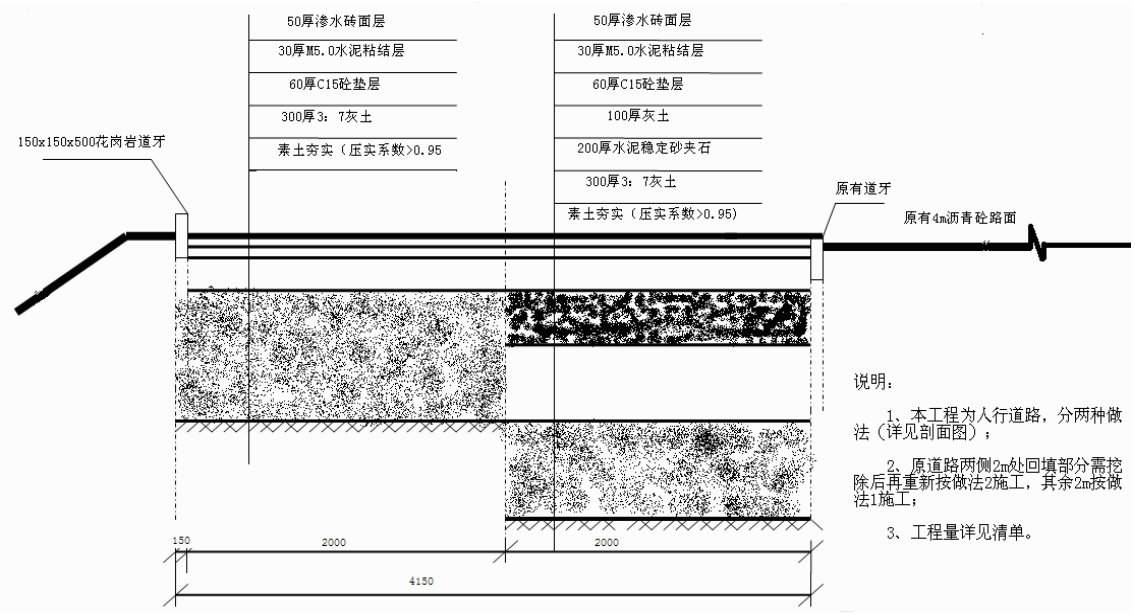

Fig. 5 Design scheme

5. Conclusion

By using the plane strain finite element method, discusses the calculation method of additional stress of uneven settlement of subgrade and calculate the resulting pavement, and it is used to widen the road design, avoid the widening pavement design resulting in old differential settlement and surface layer.

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