Empty adaptive trial study on airport prestressed concrete road surface

LiuQingjuan[1,a],CaoJialin[2,b]

[1]Remote Wall Town(North Campus), Licheng District, Jinan City, Shandong Province，China

[2]No. 163, Jiluolu, Tianqiao District, Jinan City, Shandong Province,China

[a]870827001@qq.com, [b]664051780@qq.com

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Abstract: At the stage, the airport prestressed concrete pavement of our country is still in the research stage. In this paper, an experimental analysis on mechanical effects about the void prestressed concrete pavement has been done. Deflection has been compared under plain concrete pavement and prestressed concrete pavement by experimental methods. Experimental road panel surface size selected 2m × 1m × 0.25m. Firstly, analyze the deflection effect of ordinary concrete pavement under the void action. Secondly, analyze the deflection effect of prestressed concrete pavement under the void action. Finally, compared the deflection under the two states with plain concrete pavement and prestressed concrete pavement two pavement forms in good condition and void road, the experimental results indicates that performance of pavement is with preferential treatment to the carrier: whole prestressed concrete pavement, the viod pavement of prestressed concrete, whole plain concrete pavement, the viod pavement of plain concrete. Through the analysis, the deflection of prestressed concrete pavement is smaller about 40% than plain concrete road surface. The existence of the prestressed reinforcement makes the strength and stability greatly improved,and effectively improve the way of the bearing capacity and durability.

At present, the normal operating state of the airport concrete pavement is seriously affected by the increase of its working time and the decline of the bearing capacity of the road panel under the unfavorable factors such as the emptying of the bottom of the plate. It is found that the use of prestressed concrete pavement can effectively improve the stiffness, integrity and stability of the road surface, and can effectively adapt to the emptying state of the road panel.

Introduction

Prestressed concrete road surface is composed of prestressed surface layer, sliding layer, base and earth base.In the course of construction, the difference between the prestressed concrete road surface and the ordinary cement concrete road surface lies in the addition of the prestressed steel in the surface layer and the sliding layer at the bottom of the surface layer to prevent the prestressed force loss.Academician Huangwei made a brief study on the design method of prestressed concrete road surface, the bearing capacity and durability of the experimental road surface, and analyzed the mechanical properties of prestressed concrete under the condition of emptying, and the experimental research on the aspect of emptying adaptability.In this paper, we compare the bending and sinking of common concrete road surface and prestressed concrete road panel in two different

states: unemptying and emptying.[1]

Model of Bending and Sinking Value of Prestressed Concrete Road Surface

Prestressed concrete road surface is a kind of rigid concrete road surface that pre-presses the concrete road panel, thereby improving the tensile strength, bearing capacity and overall stiffness of the structure.From the study of mechanical model, the structure of prestressed concrete pavement can be regarded as elastic foundation plate. The basic theory for the deflection analysis of rigid pavement is the theory of elastic small deflection thin plate.The bending and sinking analysis of prestressed concrete road surface is divided into two parts: bending and sinking under load and bending and sinking under prestressed.They are:

$$w(1)=\frac{qRl^3}{D}\int_0^{\infty}\frac{J_0(\frac{r}{l}t)J_1(\frac{R}{l}t)}{1+t^4}dt \quad (1)$$

$$w(2)=-\frac{M_e x}{3EIl}(l^2-x^2) \quad (2)$$

According to the superposition principle, the total bending and sinking value of the prestressed concrete road surface is the sum of the bending and sinking values of the two parts.[2]

In-room Test of Prestressed Concrete Road Surface

Establishment of Experimental Models

The thickness of both road surfaces is 25cm, the size is 2m×1m×0.25m, and the concrete grade is C40.Specific parameters are shown in table 1.The prestressed bar adopts a non-bonded prestressed steel winch with a diameter(Φ=15mm) and a tensile strength of 1470MPa.

Table 1 Design parameters of prestressed channel panel

Road face type	Longitudinal reinforcement	Horizontal steel bars
Prestressed concrete road surface	4Φ15 steel winches	7Φ12 ribbed steel bars

Technical Requirements for Prestressed Concrete Road Panel

Using wood mold(as shown in Figure 1), two road panels, an ordinary concrete road panel and a prestressed concrete road panel were experimentally poured.Due to the strict design of the prestressed concrete road surface, it is necessary to set up reinforcement bars horizontally on the road surface, which is conducive to improving the integrity of the prestressed concrete road surface.The longitudinal structural reinforcement adopts prestressed steel windings.The prestressed

channel plate adopts the form of both ends of tension Anchorage.When concrete is poured, pay attention to the compaction on both sides, and prevent the template from moving when the concrete is pressed.Should be uniform vibration, avoid prestress bar position deviation.Concrete panels are poured, maintained, and molded(as shown in Figure 2).[3]

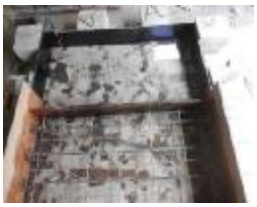

Fig. 1 Wood template

Fig. 2 Common Concrete Road Panel

Fig. 3 Prestressed channel panel

Prestressed tendons are divided into two tensioning. The tension order of the prestressed steel winch line is carried out from one end of the road to the other end in turn, using two jacks to pull at the same time.The tension control stress is σ con = 1112 MPa.In this experiment, the initial tensile stress is 0.3 σ con, the second tensile tension is 1.03 σ con, the charge is 3 min, the load is discharged to σ con, and then the Anchorage is(as shown in Figure 3).

Experimental Test Method

This experiment simulates the B737-400 wheel load with a fetal pressure of 1.38 Mpa. A 10cm cube with a side length is selected as the carrying plate. The load is graded and the final load pressure is 1.2 Mpa, which is close to the theoretical value.The experimental load is loaded with graded loads, the heaping method is loaded as shown in Figure(5), and the maximum bending and sinking at different loading levels are tested using a moving displacement meter(as shown in Figure 6).The loading position of the experiment is shown in Figure 4 below.Board edge, board middle, board angle three parts load, record data.[4]

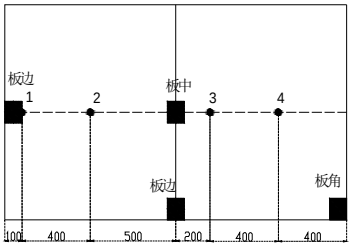

Fig. 4 Test Location Layout

Fig. 5 Prestressed channel surface loading diagram

Fig. 6 Layout of panel displacement meter

Experimental Data Analysis

In order to determine whether the prestressed concrete road surface can adapt to the destruction and emptying of the road surface, we compare the bending basins of the common concrete road surface and the prestressed concrete road surface under the two conditions of emptying, and also

compare the mechanical representation under the most unfavorable conditions.

The Bending of the Downpass Panel Loaded in the Board

The test of bending caisson of prestressed concrete road surface is an important method to investigate the overall effect of concrete structure and reflect the performance of prestressed concrete road surface.In the test of bending and sinking value of prestressed concrete road surface, the structure performance of concrete road panel can be reflected by bending and sinking value of prestressed concrete road surface.

By analyzing the loading results of the prestressed concrete road surface and the ordinary concrete road surface, it is found that the minimum bending sink value is 5.8 mm in the regression equation of the ordinary concrete road surface. The minimum bending and sinking value of the prestressed concrete road surface in the regression equation is 4.5 mm, the minimum measurement value of the ordinary concrete road surface is 3.2 mm, and the minimum value of the prestressed concrete road surface is 2.4 mm. According to the above analysis, The bending and sinking value of the prestressed road surface is about 40 % smaller than that of the ordinary concrete road surface.

The Bending of the Channel Panel When the Middle Edge of the Plate is Loaded

The plate edge appears as one of the most unfavorable positions in the concrete road panel. The results of the experimental research are shown in Figures 7 and 8.

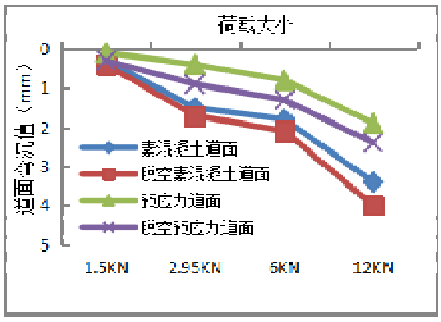

Fig. 7 Bend sink value when loaded in middle of short plate edge

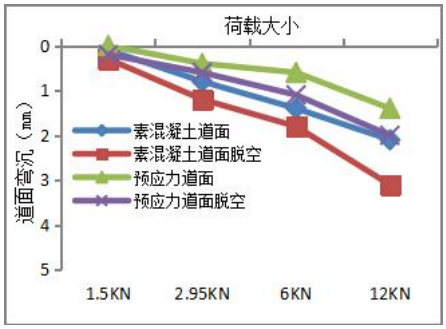

Fig. 8 Bend sink value when loading in middle of long plate edge

Table 2 Table of regression formulas for vertical displacement of two road faces

Ordinary concrete bending and sinking value		Prestressed road surface bending sink value	
Regression formula	coefficient of correlation	Regression formula	coefficient of correlation
y=0.675x2-3.845x+2.575	R^2= 0.9299	y=0.475x2-2.805x+1.875	R^2= 0.9783

Table3 Maximum bending and sinking in the middle of the plate edge

Empty Size[m]	0	0.3	0.5	0.8
Ordinary concrete road surface	1.7	2.6	3.9	6.1
Prestressed concrete road surface	0.7	1.1	1.6	2.4

By comparing the above two figures, it is concluded that when the edge is loaded, The bending and sinking values of the two types of road panels are from large to small, which are the normal concrete road surface, the intact ordinary concrete road surface, the vacated prestressed concrete road surface, and the intact prestressed concrete road surface.Moreover, the maximum value of the bending and sinking value of the long and short sides is 4mm, and the maximum value of the bending and sinking value of the short side is 3.1 mm. Through comparison, it is obtained that the bending and sinking values of the long side of each side are all smaller than the bending and sinking values of the short side.

Bending and sinking when plate edge is loaded with different emptying dimensions

The bending and sinking of the road panel under the emptying state of the plate surface will have a maximum value of bending and stress at the edge of the road surface. The most unfavorable position of bending and sinking is also the middle part of the plate edge. The experimental data under the loading effect on the middle of the plate edge are shown in Table3.

With the increase of the clearance size, the bending and sinking acceleration of the ordinary concrete road surface is very fast.When emptying is 0.64 M2, the bending sink value reaches 6.1 mm, which changes by 4.4 mm when it is not emptying.The bending and sinking of the prestressed concrete road surface is slower.When the clearance is 0.64 M2, the bending sink value is 2.4 mm, which only changes 1.7 mm when it is not empty.Through the analysis, it is found that both road surfaces are the most unfavorable position for the bending and sinking of the plate side.[5]

Conclusion

(1) The bending and sinking value of the prestressed road surface is about 40 % smaller than that of the ordinary concrete road surface.

(2) The mechanical properties of the road surface are from excellent to inferior: intact prestressed concrete road surface, emptying prestressed concrete road surface, intact concrete road surface, and emptying concrete road surface.

(3) The bending and sinking values of the long side of each side are all smaller than the bending and sinking values of the short side side.

(4) Both road surfaces are the most unfavorable position for the bending and sinking of the board.

References

[1]Wangchangheng, Lidongfa, etc.. Analysis of Factors Influencing the Bending and Reclining Value of the Exhaustion of Concrete Concrete Road Plate, Highway Engineering, 2008

[2]Rafal Szydlowaki experimental research of early-age prestressed concrete for road and airport pavements :2008

[3]Zhangjiankang, Experimental Study on High Performance Prestressed Concrete Pavement[J] , 2000.5

[4] Qianzhendong, Huangwei, Niuhe, Construction of Prestressed Concrete Experimental Road[J] .. East China Highway, 2000

[5] Huangwei, Qianzhendong Niuhe, the load analysis and experimental study of prestressed concrete pavement[J] Civil Engineering Journal 2000, 32(1); 88-92