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Research on Airport Road Surface Evaluation Technology

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Abstract: The content, technology and method of airport road surface evaluation of cement concrete are analyzed in the paper. The existing working status of airport road surface can be effectively evaluated by using airport road surface evaluation technology.
Keywords: airport ground; evaluation technology; research.

1. INTRODUCTION

With the passage of time, the increasing number of flights and the repeated action of loads, the comprehensive performance of the airport road surface in all aspects is on a downward trend. In order to ensure the normal use of the road surface, regular maintenance or retrofit measures must be taken. Both maintenance plan formulation and paving and other renovation design, must use of existing road surface performance fully survey and evaluation, to ensure the economy and reliability of the actions. Timely and accurately grasp the surface properties of normal use and safety for airport operation is extremely important, and airport pavement evaluation system is the pavement investigation, evaluation and management of the most important technical basis. Domestic use fixed number of year for a long time, many civil airport pavement damage is in serious condition, need in the scientific evaluation system framework, targeted investigation of pavement, testing, analysis, evaluation and prediction.

At present, most airports in China use rigid pavement. The rigid pavement has the advantages of large rigidity, high strength, good physical property, durability and stability, low maintenance cost and strong anti-erosion ability [1]. For full and accurate grasp of Shenzhen airport cement concrete runway the status quo and development trend, for pavement repair, reinforcement to provide reliable technical parameters for airport airfield the establishment of the management system to provide the basic data, for the airport at the same time the evaluation data and experience in a row, according to the need of comprehensive test and evaluation of the airport runway.

2. CONTENT OF ROAD SURFACE EVALUATION

The airport management department conducts regular investigation and evaluation for the purpose of timely understanding the use of the road surface or irregular special investigation

and evaluation for the large-scale repair and reconstruction of the road surface. Purpose is to fully and accurately grasp the airport road surface status and provide scientific decision basis for airport operations management, or for pavement repair, reinforcement and reconstruction to provide reliable technical parameters, to determine the economic and reasonable maintenance cycle, formulate corresponding maintenance, repair or expansion plans, which was carried out on the pavement investigation and evaluation [2].

The evaluation mainly includes:

1) The pavement performance investigation, testing and evaluation, including pavement damage condition investigation, pavement roughness, anti-sliding performance, and vertical and horizontal slope and drainage performance of determination, as well as the pavement structure bearing capacity test and evaluation.

2) Adaptability analysis and evaluation of road in the face of current and future air traffic volume.

3) Residual service life prediction of road surface under various conditions.

4) Analysis on the mechanism and influencing factors of road surface damage.

5) According to site conditions and relevant design standards and specifications, put forward road surface repair countermeasures and formulated project plans.

3. ROAD SURFACE EVALUATION METHOD

3.1 Investigation on damage condition of cement concrete pavement

Due to the difference of pavement structure, load grade and pavement damage condition in each survey area, for scientifically and accurately grasping the state of each area, the whole investigation area must be partitioned, that is to provide an average evaluation result for each region with similar conditions.

The general principles of a partition are as follows:

1) The pavement type and structure combination are the same.

2) The soil foundation types are basically the same.

3) The construction period is the same.

4) Located in the same functional area.

5) The damage condition is consistent (the leading damage is the same and the damage degree is similar).

6) Cement concrete pavement is generally divided into dozens to hundreds of pavement panels. Therefore, the whole road surface is divided according to the above principles. According to the technical specification for road cement concrete pavement maintenance (JTJ073.1-2001), the road surface of cement concrete is investigated [3]. The types and extent of damage of each subdivision road surface and the overall damage of the road surface can be classified in detail, indicating the specific damage of the road surface.

3.2 Road surface damage assessment

According to the technical specification for highway cement concrete pavement maintenance (JTJ073.1-2001), using "pavement condition index (PCI)", "comments the damage level, PCI

by the investigation of various damage type and extent of damage and damage the unit to determine the density, calculation formula is [4]:

$$PCI=100-\sum_{i=1}^{n}\sum_{j=1}^{m}DP_{ij}W_{ij} \tag{1}$$

In which, $DP_{ij}=A_{ij}D_{ij}B_{ij}$; $W_{ij}=2.5R_{ij}$, $R_{ij} < 0.2$; $W_{ij}=0.5+0.686(R_{ij}-0.2)$, $0.2\leq R_{ij} < 0.55$; $W_{ij}=0.74+0.28(R_{ij}-0.55)$, $0.55\leq R_{ij} < 0.8$; $W_{ij}=0.81+0.95(R_{ij}-0.8)$, $R_{ij}\geq 0.8$.

$$R_{ij}=\frac{DP_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{m}DP_{ij}} \tag{2}$$

Where, i and j respectively represent the damage type (i=1, 2… n) and severity grade (j=1, 2… , m); DP_{ijk} is class i index and j level. W_{ij} is a class i correction weight function for j damage degree of various damages.

Table 1. airport road surface evaluation status grade

Pavement PCI	≥85	70～85	50～70	25～50	< 25
Road condition grade	excellent	good	medium	bad	Very bad

According to the pavement condition index (PCI), the pavement damage status is divided into five grades. The evaluation criteria are shown in table 1. The investigation results were evaluated according to plate longitudinal division, and the overall damage condition of each channel was evaluated.

3.3 Evaluation of road surface flatness

Laser cross section instrument (RSP) was used to detect the airfield road surface, and the IRI value of international flatness index was measured. According to the IRI value, the level of pavement flatness is evaluated from table 2.

Table 2. pavement flatness standards

IPI/m·km^{-1}	< 2.0	2.0～4.0	4.0～6.0	6.0～8.0	>8.0
Road surface flatness rating	excellent	good	medium	bad	very bad

3.4 Test and evaluation of pavement foundation strength

Test and evaluation method of pavement foundation strength: according to HVVD test bending basin in road panel, the modulus is calculated backwards, and the modulus of foundation is calculated backwards for evaluation.

Each road surface deflection statistic results and each layer modulus values shown in table 3, from the back calculation of modulus of D column is the largest, the second is the G column, and in the center of the runway is E, F two columns is relatively lower. But it should be noted that the time for the dynamic modulus of inversion, only way the bearing capacity of relative evaluation, for the modulus of the foundation, according to the experience, the static modulus is about one third of the dynamic modulus.

Table 3. statistical results of HWD test bending and sinking and structural layer modulus of airport runway

Plate column number		Deflection（0.001mm）							Modulus（MPa）	
		D1	D3	D5	D6	D7	D8	D9	The surface layer	The subgrade
D	The average	68	58	52	45	40	35	31	57496	573
	Standard values	7.6	7.6	6.9	6.2	5.5	4.9	4.2	11140.1	92.6
	Coefficient of variation	11%	13%	13%	14%	14%	14%	14%	19%	16%
E	The average	73	63	56	49	44	39	34	58451	515
	Standard values	15.5	8.3	7.6	6.7	5.6	5.5	4.4	12280.1	72.5
	Coefficient of variation	21%	13%	14%	13%	13%	14%	13%	21%	14%
F	The average	75	66	59	52	45	41	36	58491	496
	Standard values	9.9	9.4	8.8	7.7	7.1	6.2	5.6	10973.7	82.7
	Coefficient of variation	13%	14%	15%	15%	16%	15%	16%	19%	17%
G	The average	71	62	55	48	43	38	33	59837	524
	Standard values	9.4	8.7	7.8	6.8	6.1	5.3	4.6	12720.1	72.3
	Coefficient of variation	13%	14%	14%	14%	14%	14%	14%	21%	14%

3.5 Detection and evaluation of runway road surface clearance

1) Inspection of floor clearance

HWD detection was used to evaluate runway road surface clearance. According to AASHTO pavement design method, the panel edge or voids location of three different loading, deflection, make the relationship between load and deflection curve, the relation between load and deflection, roughly linear relationship, if the relationship between load and deflection line through the origin or intercept and deflection axis is less than 50 microns, argues that the position does not have the basis; Otherwise, if the intercept is greater than 50 centimeters, it is considered to be empty (see figure 1). According to this method, the correlation between load and deflection is established for the test results of each board measurement point [3, 4]. The correlation is as follows:

$$W=aP+b \tag{3}$$

Where, W central bending and sinking value, μm; P-load value, kPa; a, b is the relationship coefficient, and b is the intercept of the bending shaft.

According to the above judgment rules, it can be concluded that the cement concrete slab in the test section is empty. Table 4 shows the empty condition of an airport road surface.

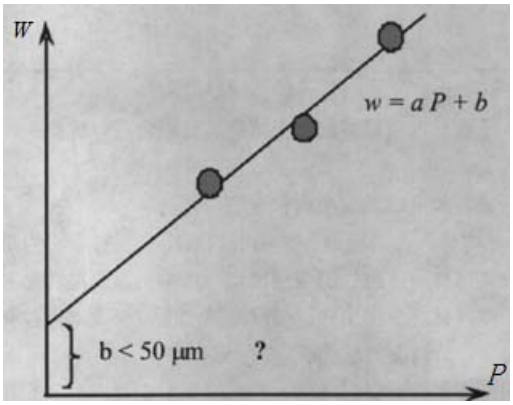

Figure 1. Three - point regression method for determining Void of concrete slab

Table 4. the lane surfaces of each column are emptied out

Location	Pavement plate no.	Intercept b values	Testing evaluation	Pavement plate no.	Intercept b values	Testing evaluation
Voids	D0-1	50.6	disengaging	F1460-3	93.9	disengaging
	D1600-1	66.9	disengaging	F1820-3	58.9	disengaging
	D1960-1	80.9	disengaging	F2180-3	72.5	disengaging
	D2480-1	60.4	disengaging	F2300-3	65.7	disengaging
	D2760-1	51.6	disengaging	F2500-3	59.3	disengaging
	E1960-3	64	disengaging	F2540-3	134.1	disengaging
	E2480-3	66.7	disengaging	F2580-3	72.9	disengaging
	E2600-3	1019.4	disengaging	F2620-3	78.1	disengaging
	F820-3	69.4	disengaging	F2660-3	113.7	disengaging
	F860-3	101.4	disengaging	F2700-3	86.8	disengaging
	F900-3	70.9	disengaging			
In the plate	D3040-1	760.5	disengaging	E1720-3	225.9	disengaging

2) Investigation and assessment of load transfer capacity of panel joints

According to the code for design of cement concrete pavement (JTG d40-2002): the load of 50KN is applied to the surface of the road adjacent to the joint to test the bending and sinking value of both sides of the joint, and the seam propagation can be calculated loading efficiency [5].

$$K_j = \frac{W_u}{W_l} \times 100\% \tag{4}$$

Where, K_j is load transfer coefficient of joint; W_u is not subject to the bending and sinking value at the edge of the joint of the load plate, i.e. W_l is the bending and sinking value at the

edge of the joint of the load bearing plate, that is, the bending and sinking value of the second bending sensor.

The load transfer capacity of joints in the old concrete surface layer is divided into four grades. The grading standards are shown in table 5. According to the calculation results, the load transfer capacity of concrete joints can be evaluated according to the grading standard.

Table 5. grading standards for load transfer capacity of joints.

level	excellent	medium	Defective	bad
Joint load transfer coefficient（%）	>80	56-80	31-55	<31

3.6 Bearing capacity evaluation

There are two methods of damage test and non - damage test.

Passed more damage test and core samples of each structural layer of pavement physical, mechanical test, namely according to the acquired more specimens, after measuring its thickness, cleavage strength tests are carried out. The flexural strength of pavement concrete can be calculated based on the empirical relationship between split strength and flexural strength. The calculated mechanical index is compared with the designed value to evaluate the bearing capacity of the tunnel surface.

Not damage test by a heavy hammer type deflection instrument (HWD) on the surface of the road surface deflection, according to HWD measured deflection basin and the thickness of the layers, using the theory of elastic foundation plate (rigid pavement), according to the principle of system identification of inversion runway subgrade and pavement modulus of layers, and evaluate the pavement bearing capacity.

PCN(Pavement Classification Number) is the Pavement Classification Number of Pavement surface, representing a value of Pavement bearing strength of Pavement surface.This is twice the equivalent single wheel load (ESWL in tons) that the road surface can safely withstand. According to the regulations of the international civil aviation organization, the PCN of rigid pavement is calculated according to the load situation of the center of west card plate [6]. The formula is as follows:

$$\sigma=\frac{0.275G}{hh}\ (1+\mu)\ \log[\frac{Ehhh}{Kbbbb}] \tag{5}$$

Where, σ is the allowable flexural working stress of concrete (kg/m^3); G is the derivation of the single wheel load (kg) that the path surface can safely withstand; h is the equivalent thickness of cement concrete slab (cm); E is the elastic modulus of cement concrete (kg/m^2); K is the basic reaction modulus (kg/m^3); a is the radius (cm) of the contact area of the tire, obtained by the load of the dummy order wheel and the pressure of the standard tire of 1.25 MPa; b is the equivalent radius of loading area (cm), b=$\sqrt{1.6a\cdot a+h\cdot h}$ -0.675h; μ is cement concrete poison ratio, which is 0.150.

According to the actual flexural strength of the concrete is 3 ~ 5MPa, the flexural modulus of 3×10^4 ~ 4×10^4 MPa, based on the above calculation formulas, adopt the method of multiple parameters fitting, after repeated iteration is calculated for each PCN. In the pavement strength report, in addition to informing the PCN value, and giving the corresponding codes of the outlet

surface type, the strength of the foundation, the allowable tire pressure and the evaluation method, the calculated PCN results are shown in table 6.

Table 6. PCN values of airport road surface

NO.	Start-stop number of piles		Parameters							PCN
			R Mpa	Rw Mpa	E Mpa	Eb MN/m^3	K MN/m^3	h m	σ Mpa	
D	K0+000	K0+500	5.21	5.88	39143.3	573	84.9	0.41	3.26	105/R/B/WT
	K0+500	K3+100	5.21	5.88	39143.3	554	82.7	0.36	3.26	78/R/B/WT
	K3+100	K3+400	5.2	5.87	39116.74	573	84.9	0.41	3.26	104/R/B/WT
G	K0+000	K0+500	4.32	5.32	36697.56	594	87.3	0.41	2.96	92/R/B/WT
	K0+500	K3+100	5.05	5.78	38715.84	501	76.5	0.36	3.21	76/R/B/WT
	K3+100	K3+400	5.05	5.78	38715.84	524	79.2	0.41	3.21	102/R/B/WT

It can be seen from table 6 that the soil foundation strength of the airport is medium strength. The value of PCN in the middle of d-column plate pavement is 78, and PCN in the middle of g-column plate pavement is 76, while the value of PCN calculated at the end is greater than the design value, which is around 100 due to the limited core removal.

4. CONCLUSION

According to the techniques of road surface investigation and evaluation, the main parameters of road surface in each district or specific location are summarized. Obtained with the pavement structure bearing capacity and related to the use function of technical parameters, mainly includes: partition of cement concrete pavement, and pavement damage condition investigation according to partition, do to pavement damage evaluation; Checking the plane flatness of airport road surface; The strength and characteristics of foundation (mainly the reaction modulus of foundation, the inversion modulus of soil foundation, etc.); Existing flexural strength of concrete slab; Elastic modulus of existing cement concrete pavement; The empty condition under the channel panel and the load transfer capacity of the joint of the concrete channel panel; According to the actual aircraft load (including the main aircraft type and its service frequency) of the road surface structure in each region, the current road surface grade number of the road surface structure is analyzed and calculated. The residual life of airport runway is predicted.

In short, the use of airport pavement evaluation technology of airport road surface current working status can be evaluated effectively, to the airport pavement preventive maintenance management, so as to meet the needs of the development of the airport.

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