

Analysis of Pavement Performance Evaluation Index

Huiping CAO

School of Civil Engineering, Chongqing Jiaotong University, Chongqing, 400074, CHINA

Abstract: In this paper, the application scope and the specific evaluation methods of several evaluation indexes of the current road pavement performance are summarized, and the objective necessity of using a number of indexes to evaluate the performance of pavement is also described. This paper discusses in detail the thinking process of the evaluation method of pavement performance from four aspects, including The quality of road travel, Pavement structure and damage conditions, The safety capability of anti sliding bearing capacity and pavement pavement structure. At the end of through the analysis and summary of the above content, the development direction and trend of pavement performance are put forward.

Keywords: Road engineering; Asphalt pavement; Performance; Evaluation index

1. Introduction

In order to understand and master the changes of pavement performance, it is necessary to evaluate the performance of the pavement on a regular basis in order to take various maintenance and reconstruction measures in time to delay the decay and restore its performance. Pavement performance evaluation is based on the collected pavement condition data, to meet the requirements of the performance of the pavement to make judgments. Using this judgment can find out road network service level, discrimination network need to take the road maintenance and reconstruction measures, choose corresponding maintenance and Reconstruction Countermeasures for, and as a project priority basis.

Pavement performance has many attributes, each from a different point of view to meet the requirements of the use of. These properties have objective attributes, such as structural bearing capacity and anti sliding ability, can use objective index to evaluate its performance; and some have both objective attributes, and with a subjective attributes, such as riding quality, pavement condition. It is difficult for these attributes to make a quantitative evaluation of the individual, it is necessary to rely on the experience of the maintenance personnel to carry out a comprehensive evaluation of [1-2].

It is due to the pavement performance has many attributes, on the road use performance evaluation must be using a number of indicators, such as by the use of the performance of each sub attribute, namely drive quality evaluation, damaged condition evaluation, structure bearing capacity evaluation, anti sliding ability evaluation and anti permanent deformation shape ability evaluation etc.. At the same time, in order to have a comprehensive evaluation of the road, there is a general need to have a comprehensive characterization of the quality of the road

surface, the anti sliding performance, pavement damage condition, the structural bearing capacity of the composite index.

2. Pavement Performance Evaluation Method

2.1. Pavement quality evaluation

Pavement quality is characterized by the road surface roughness, and the surface roughness is the elevation change of the road surface to induce the vehicle to appear vibration [2]. Pavement quality is related to the uneven degree of the road surface, the dynamic response of the vehicle and the three factors of the person's ability to feel. Therefore, different passengers ride with a car traveling in the car with a section, due to personal driving comfort requirements of the bumps and the ability to accept different, the ride quality of the road will take a different evaluation. Due to the uneven pavement caused by vehicle vibration, it will directly affect the wear of vehicle, fuel consumption, ride comfort, and the basic function of the highway is car high speed, safe and comfortable travel to provide a flat surface, and smoothness of the said measure pavement performance is an important indicator. There are three methods to measure the flatness of the flatness measurement, which reflects the flatness measurement of the class and the subjective evaluation method.

The flatness measurement is the elevation of the surface of the road surface which is directly measured by the wheel track of the running vehicle, and the longitudinal section of the road surface is obtained. Reflect the flatness measurement is in the car mounted by the sensor and the display of the instrument, you can sense and accumulate the vehicle to a certain speed, the vertical displacement of the suspension system. Pavement quality

index (RQI) is used as the evaluation index, and the quality index of the road is calculated by the international roughness index (IRI).

The international roughness index IRI can be determined by the type of equipment, and the results need to be calibrated by the test. The calibration relationship between IRI and other equipment is [3]:

$$IRI = a + b \times BI$$

Test results of BI----- flatness test equipment;
 A, b----- calibration coefficient, in use, according to the actual calibration results determine its value;

IRI----- International Roughness Index (m/Km).

The relationship between the pavement quality index (RQI) and the international roughness index (IRI) is:

$$RQI = 11.5 - 0.75 \times IRI$$

Formula: RQI----- driving quality index, numerical range of 0~10; if there is a negative value, then RQI takes 0 values; if the result is greater than 10, then RQI takes 10.

2.2. Pavement distress evaluation

The damage of pavement structure reflects the degree of integrity or integrity of the pavement structure under the action of traffic and natural factors. The purpose of investigation and evaluation of pavement damage condition is to identify the needs of the maintenance of the sections and choose appropriate measures to take. Damage due to pavement of randomness, types of diversity, severity of the difference, and pavement distress situation of the evaluation of pavement performance evaluation in the most complex part of usually pavement damage is characterized by three aspects: types of damage; severity; damage density.

Asphalt pavement and cement pavement damage types are different, according to the highway asphalt pavement maintenance technical specifications [4], asphalt pavement damage is roughly divided into four categories: crack type; loose class; deformation; other types.

- (1)Crack: massive cracks, cracks, horizontal cracks, vertical cracks, irregular crack.
- (2)Loose pits (including pit), loose (including peeling, Ma).
- (3)Deformation upheaval, subsidence, wave (washboard), rutting.
- (4)Other categories: bleeding, explicit, aging, patching, polishing, frothing, repair damaged.

Damage classification: to distinguish the different effects of the same damage on the performance of the pavement, the severity of the damage is divided into several grades according to the severity of the impact. A variety of damage to the scope of the asphalt pavement, usually by area, length or the number of measurements, divided by the area or length of the survey section of the road, in order to damage the density of.

In our country highway asphalt pavement maintenance technical specifications [4], pavement condition index PCI directly and pavement comprehensive damage rate establish empirical relationship. Usually expressed as $PCI = f(DR, IRI, \dots)$. Pavement condition index (PCI) was used to evaluate the pavement distress condition, and the pavement condition index was calculated by the asphalt pavement distress rate (DR):

$$PCI = 100 - a_0 DR a_1$$

$$DR = 10$$

Formula: PCI----- pavement damage index, the value of 0~100, the greater the value, the better the road conditions;

Reduced wear area in the DR----- section, m²;

A----- road section of the total surface area, m²;

Dij----- class I damage, J class severity of the actual damage area, M², such as longitudinal and transverse cracks, the damaged area is: crack length (m) x 0.2; rutting damage area is: length (m) x 0.4;

Kij----- The conversion coefficient of the class I damage and the severity of the J class;

a₀----- calibration coefficient, 15.00;

a₁----- calibration coefficient, 0.412.

Pavement condition evaluation standard: according to the situation of road damage, the pavement quality is divided into excellent, good, and poor in five grades. Detailed criteria are shown in Table 1.

Table 1. Pavement quality evaluation criteria

Grade	excellent	good	medium	second	poor
PCI	≥85	[70,85)	[55,70)	[40,55)	<40
SSI	≥1.0	[0.83,1)	[0.66,0.83)	[0.5,0.66)	<0.5
RQI	≥8.5	[7.0,8.5)	[5.5,7.0)	[4.0,5.5)	<4.0
SFC	≥50	[40,50)	[30,40)	[20,30)	<20
BPN	≥42	[37,42)	[32,37)	[27,32)	<27
PQI	≥85	[70,85)	[55,70)	[40,55)	<40

In pavement distress evaluation in, firstly, the provisions of the pavement maintenance technology specification "(JTJ073--96) damaged regression equation calculation of PCI, but when combined with the actual traffic situation evaluation will find differ greatly, therefore the PAVER subtraction method results with the actual road conditions, calculation, with the actual road conditions are consistent. The following points method:

- (1) The total score of one hundred points, the subjective evaluation of the road, used to check;
- (2) On the pavement of different damage types, severity and the scope of the provisions of different points according to the values of sub total deduction points and the number of making weight for partial deduction;
- (3) Compared with the prior scores, the weights are adjusted repeatedly until the data is stable;
- (4) According to the damage conditions of the road accumulated the points, to the remaining numerical characterization of pavement condition, the evaluation of

pavement quality. The numerical value of the road condition index PCI is a comprehensive representation of the three aspects of its type, severity and damage density.

Determination of weight: from the above analysis, to get a comprehensive evaluation index of pavement damage, the damage type, severity and scope should be weighted. The determination process of weight is more complex, and it is generally to be calculated and adjusted in order to get a more stable and non contradictory weight.

2.3. Evaluation of carrying capacity of pavement structure

In the provisions of the asphalt concrete pavement design specification, freeway asphalt concrete pavement is to design bending deflection LD as structural strength to control index is designed. It can ensure highway pavement in late design under equivalent cumulative axial load times can still in certain allowable bending deflection within. Therefore pavement for the overall carrying capacity can be determined according to the determination of the pavement deflection value, through the bending deflection to obtain the pavement for the overall carrying capacity index (SI), this index is important index of pavement structure and function of the overall evaluation. Highway pavement structure carrying capacity, the guiding surface before reaching the intended damage condition can continue to bear the number of driving load, or the number of years can be used. It can not only determine the number of remaining years of the road surface, but also can predict when the road needs to be maintained, and provide relevant and useful parameters for the maintenance personnel. Pavement structure bearing capacity evaluation is overall pavement bearing capacity index (SI) to determine the. The purpose is to determine the remaining pavement service life, from the length of its remaining life to judge the degree of pavement structure in good condition and damage speed, pavement overall carrying capacity expressed as [3,5]:

SI= pavement design deflection value / section represents the deflection value of =ld/lr

Type: ld----- pavement design deflection value;

Lr----- pavement represents deflection value;

SI----- pavement structure carrying index, the range of 0~1. Proves vehicles on the road load has exceeded the pavement itself capable of carrying capacity when the SI<1; when SI=1 that the structural strength of the pavement is just about to disrupt the critical state; when the SI>1 that pavement still have enough structural strength to meet the vehicle driving.

2.4. Evaluation of pavement skid resistance

In China in recent years with the rapid development of transportation, highway is characterized by its fast, safe, comfortable, increasingly highlighted its advantages in transportation and can not be replaced. However, cars on

the road at high speed, if the friction between the tire and the road surface is very small, especially pavement in wet condition, the water film barrier the tire and road surface contact, the friction loss caused by tires at high speed and road surface generated hydroplaning. In the aspect of the safety of the highway, it is mainly characterized by the anti slide ability index of the highway surface. Pavement skid resistance index refers to the anti - sliding ability when the tire and road surface slip. In our country, three kinds of pavement skid resistance ability indexes are put forward, namely, the pavement structure depth TD, the pavement skid resistance value and the pavement lateral force coefficient SFC.

(1) TD refers to the area in a certain road uneven opening gap of average depth, i.e. macroscopic structure depth, in mm, it is pavement roughness is an important index, mainly depends on the aggregate gradation, commonly used manual sanding test.

(2) FN refers to the pavement skid resistance value, the method for the determination of the pendulum swing value and aggregate the microscopically rough degree of, by standard portable pendulum coefficient of friction tester of pavement under wet conditions of friction pendulum. This is a kind of method that is widely used in China. However, under normal circumstances that it simply reflects the low running speed of pavement anti slide performance and thus is not suitable for highway.

SFC is a standard friction coefficient measurement car, in the determination of wheel and driving direction into a certain angle, at the same time at a certain speed, the friction between the tire and wet road and the contact area ratio. It reflects the value of the road surface at high speed.

In order to ensure the safety of the high-speed vehicle, it is necessary to take the anti sliding ability of road surface as an important evaluation index. For highway environment of the region, climate and its own special characteristics, affecting the pavement skid resistance factors is mainly manifested in the pavement surface characteristics (coarse structure index), driving speed and pavement humidity, and so. The coarse structure of the highway will be gradually reduced with the repeated wear of the vehicle.

02 years of highway maintenance technical specifications to the lateral force coefficient SFC characterization of the road surface skid resistance, and SFC hundred percent are divided into the following:

$$SRI = \frac{100 - SRIm in}{1 + \alpha 0 \exp(\alpha 1 SFC)} + SRIm in$$

Type: SFC----- lateral force coefficient, according to the actual value

SRIm in----- anti sliding performance limits, using 25;

Alpha 0----- calibration coefficient by 266;

Alpha 1----- calibration coefficient by 0.139.

In combination with the actual situation, the specific evaluation criteria for the anti sliding capability are formulated as follows Table 2:

Table 2. Evaluation criteria of pavement skid resistance

evaluating indicator	excellent	good	medium	second	poor
SFC	≥ 0.5	$\geq 0.4 \sim < 0.5$	$\geq 0.3 \sim < 0.4$	$\geq 0.2 \sim < 0.3$	< 0.2

3. Development Direction of Pavement Performance Evaluation Index

For the development direction of pavement performance evaluation index at home and abroad, Huang Wenxiong[6] in his paper by the analysis of the following aspects:

(1)The current road survey method is not very scientific, labor intensity is too large (especially the investigation of road damage), is not suitable for the direction of social progress. Along with the progress of society, the development of science and technology, the research of the development of the high efficiency detecting instrument and the research of the diagnosis method of scientific investigation is an important development direction of pavement detection;

(2) In view of the shortcomings of the current 073-96 JTJ (Highway Maintenance Technology), many researchers

are working on the study of the correction and improvement of it;

(3)In view of the current commonly used evaluation index can not meet the needs of the development of highway engineering, with in-depth study, the development of science and technology, development and application of new instruments, a variety of new and more scientific evaluation index will be constantly;

(4)The road surface is a complex system, and there is a complex relationship between each evaluation index, and each index has its own characteristics. Research, clarify the characteristics of each evaluation index and the relationship between the various indicators for the development of the road project has a certain role in promoting the development of. Therefore, the analysis of the index itself is an important direction of the study of pavement evaluation index.

References

- [1] Pan Yuli. Principle of pavement management system [M]. Beijing: People's communication press, 1998.
- [2] Yao Zukang. Pavement management system [M]. Beijing: People's communication press, 2001.7.
- [3] Huang Wenxiong. Based on hybrid genetic algorithm neural network of expressway asphalt pavement use performance evaluation method [D]. Wuhan: Wuhan University of science and technology.
- [4] Huang Wenxiong. Highway asphalt pavement performance evaluation index [J]. Journal of China & Foreign Highway, 2003,23(4): 74-76.