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Superiority analysis of ultrasonic-rebound combined method used in cement concrete pavement detection

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Abstract
Comparing with rebound method, the ultrasonic rebound synthetic method was more close to the strength test results of core sampling method through theoretical analysis and field test data, which embodied the superiority of ultrasonic rebound method for nondestructive test and illustrated that nondestructive test is gradually replacing the destructive test, meanwhile, we explored the fitting function by the mathematical statistic method. The superiority analysis of ultrasonic-rebound combined method could have a deeper understanding of the interior of the pavement strength and provide certain help with exploring the road damage mechanism, which will provide support for premature failure of prevention and control work on the existing cement concrete pavement in HuangShi area.

Keywords: cement concrete pavement; ultrasonic rebound synthetic method; superiority; fitting functions; failure mechanism

Introduction
Concrete as one of the most important structural engineering materials of concrete strength to achieve the design strength is an important measure to ensure structural safety. Compared with other non-destructive testing methods, the ultrasonic rebound method has the advantages of high precision and high precision because of the ultrasonic velocity and the rebound value.

In recent years, although the damage test for the strength of high accuracy and also has only the concrete road surface damage test, but the strength of concrete for the determination of the direction of the main direction or toward the development of non-destructive testing, which non-destructive test comparison damage test not only for the road damage is different, but also for the internal conditions of the roadbed has a general understanding, which for the concrete pavement damage mechanism analysis is not a small help.

In the non-destructive test, there is a rebound method and an ultrasonic rebound method, which can be obtained by a general understanding of the theory and the experimental results of the concrete pavement. Then, we can explore the fitting function of ultrasonic rebound comprehensive method.

2. The Superiority of Ultrasonic Rebound Method
Compared with the rebound method, the superiority of the rebound method is mainly theoretically super- ior and the practical superiority.

2.1. The Theoretical Reality of Ultrasonic Rebound Method
The method of ultrasonic rebound is a kind of non-destructive testing method for the determination of concrete strength by using the two indexes of the velocity of ultrasonic propagation and the re- bound value of the surface of the concrete. The rebound method is to measure the surface of the concrete. The rebound value is used to determine its strength. The results of the ultrasonic rebound method can reflect the internal strength of the concrete and the strength of the surface. In the two indicators, the influence factors of the ultra- sonic value and the springback value can be compensated. For example, the carbonized layer on the concrete surface makes the rebound It is necessary to consider the influence of the carbonized layer on the rebound value test of the concrete surface, but because of the large water content inside the concrete with deep concrete layer, which makes the ultrasonic wave inside the concrete The size of the sound velocity decreases, which increases by a decrease, to some extent caused by the complementary, so when using the ultrasonic rebound method to test the strength of concrete components, do not have to consider the concrete component surface carbon layer on its impact. This is a certain extent that the ultrasonic rebound method is superior to the rebound method.

2.2 Ultrasonic resilience synthesis method is actually excellent
Due to the need to compare the two methods of excellence, field test with core sampling method, ultrasonic rebound method and rebound method. According to JTJ/T23-20 11 "rebound method for testing concrete compressive strength technical code" on the concrete panel to determine the rebound value, and in order to ensure the test results are reasonable, so that each piece of concrete as a component, in each component Divided by A, B, C, D, E five measurement area, as shown in Figure 1, each area of 0.2m × 0.2m area within the layout of 16 points, at 16 points with a hammer to deter- mine the rebound value.

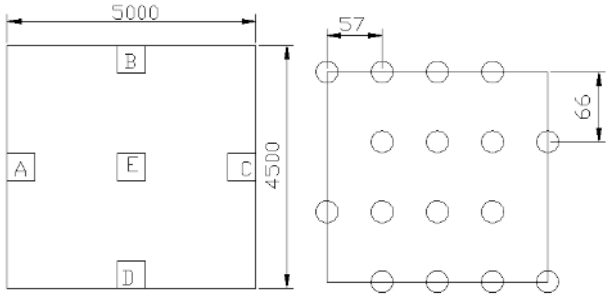

图1 现场回弹测点分布图（单位：mm）

After measuring the rebound value, the ultrasonic measuring points are arranged. The ultras- onic measuring points are arranged in the same measuring area of the springback test. Three measuring points are arranged in each survey area because the measured area of the ultrasonic measurement is 0.4m * 0.4m, so the rebound of the test area along the four sides of the extension of 0.1m, so that the rebound of the entire rebound area of the use of reasonable value. In the field test, the ultrasonic value of the test before the use of butter, petrolatum, toothpaste, etc. coup- ling agent to coupling, and then began to test the ultrasonic velocity value. After the sound velocity test is completed, the core specimen is drilled in the five rebound area by the core drilling machine. When the core sample is taken out, the carbonization depth will be needed. The carbonization depth test method is as follows: First, 1% phenolphthalein solution, And then use a flat screwdriver and a small hammer in the measurement area on the surface of the hole cut out 15mm diameter, remove the hole in the powder debris and then drop- ping 1% phenolphthalein solution at the edge of the hole, and finally see the carbonation and did not occur The carbonized area is measured with a carbonation depth meter, and each hole is measured at least three times and the average is taken as the carbonation depth of the zone. Finally, the core sample is subjected to compressive strength test to obtain the strength value of the core sample.

The above is prepared by the core sampling, rebound method and ultrasonic rebound method to obtain the strength of the value of the chart, as shown in Table 1.

表1 现场试验三种方法测定混凝土强度值

构件	综合法测强	回弹法测强	钻芯法测强
B1	20.35	23.52	29.64
B2	21.00	23.94	27.32
B3	20.57	23.09	24.92
B4	20.69	21.64	26.32
B5	23.45	25.77	29.28

Obviously, by comparing the intensity of the three methods, it can be seen that the intensity measured by the ultrasonic rebound method has the same regularity as that measured by the core sampling method, and the intensity value deviates less. And the law of the rebound method is not obvious with the strength measured by the core sampling compared to the deviation from the larger. The ultrasonic rebound method is superior to the rebound method.

3 Explore the fitting function of ultrasonic rebound comprehensive method

The field test results show that the strength of the concrete measured by the ultrasonic rebound method is different from that of the core specimen. In order to reduce the influence of the intensity of the ultrasonic rebound method, Enhance the accuracy of the data, it is necessary to use mathematical statistical methods to amend. Here are the use of polynomial function, exponential function, logarithmic function of the data curve fitting. By the least squares method to deal with the data can be obtained polynomial function fitting formula $y = 0.07768 \quad x^2 - 0.32197 \quad x - 5.14$ 、exponential function fitting formula $y = e^{0.0451 \ x + 2.199}$ and logar- ithmic function fitting formula $y = 22.3587 \ln^x - 44.6115$.

From the data of the above table, the intensity value obtained by the exponential function fitting equa- ion is smaller than that measured by the core sampling method, and has a high degree of freedom and accuracy. Therefore, the exponent- exponential function equation $y = e^{0.0451 \ x + 2.199}$ Better than poly- nomial functions and logarithmic functions.

4. Explore the road damage mechanism

The exploration of the road failure mechanism is divided into two parts: the traditional theory and the current situation does not match, the road is not smooth to accelerate fatigue。

The traditional pavement design theory assumes that the surface layer and the base layer are in smooth contact, that is, on the contact surface, the normal dis- placement of the surface layer and the base layer is equal to the normal force, but there is a relative displacement along the tangential direction and tangential Shears do not count. However, the current cement concrete pavement is the cement concrete directly poured on the surface of the formation of the base, which makes the actual situation and the theoretical model there are significant differences. In fact, the surface of the grass is generally uneven, and cement concrete in the base surface of the direct pouring makes the actual road and the base between the existence of a transition layer, rather than just think of a smooth contact surface.

With the condensation of concrete, the concrete shrinkage de- formation and periodic temperature deformation of the transition layer produced tensile stress, and because the transition layer will be combined with the base layer and the grassroots reason, the grass will also be corresponding to resistance to tensile stress. Under the periodic action of the temperature stress, the transition layer is gradually destroyed. After the transition layer is completely destroyed, a part of it is attached to the bottom of the surface layer and the other part is attached to the top surface of the base layer, which causes the bottom surface of the surface layer to form a surface crack on the top surface of the base layer. Under the action of vehicle load, the vertical force, the horizontal force and the impact force of the road surface make the surface layer and the base layer of the contact surface wear, which indirectly ac- celebrated the wrong and the deformation of the board. Using the fracture mechanics point of view, the vehicle-plate coupling and fatigue equations can be used to know that the unevenness of the pavement increases the strain and fatigue stress of the plate, which shortens the fatigue life of the board, which reduces the service life of the pavement.

5. Conclusion

Through the theoretical analysis and field test data, the ultrasonic rebound method is compared with the rebound method, which is closer to the results of the core sampling method and the non - destructive test in the process of gradually replacing the damage test. The fitting function of the ultrasonic rebound method is explored by mathematical statistics method, and the fitting function expression is obtained $y = e^{0.0451 \ x + 2.199}$.

As the ultrasonic rebound method can be on the internal strength of the road there is a deep understanding of the situation, which will help the understanding of the internal structure of the road, can be more in-depth analysis of internal damage, but also to the road surface to provide a more accurate and fast Methods.

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