

A Fundamental Study on Evaluation of the Rutting on Asphalt Concrete using a Simple Method

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Background

There are mainly 3 forms of pavement damage. They are rutting, cracking and evenness. In this research, I want to stress out on the RUTTING form. Why? Because it is the most commonly happen. One of the reasons why rutting always happen is because of the increase of heavy traffic which include traffic volume and weight load. Figure 1 shows the picture of a severely rutted road and Figure 2 shows the mechanism of rutting.



Figure 1

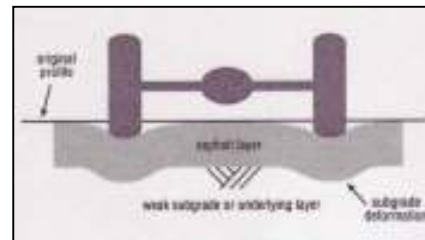


Figure 2

Objective of the Research

The main reason for this research is to prove whether a simple test such as Uniaxial Compression Test (UCT) can be used to replace a high cost test like the Wheel Tracking test (WT). The idea is to put together the result of the officially used WT test with the newly suggested UCT. If the results between the two tests make a straight line, which means the correlation between the tests are good, it means that the suggested UCT test can be used to replace the wheel tracking test.

Mechanism of Rutting

Asphalt pavement is created by mixing kinds of small stones which is called aggregates and using asphalt as the binder to bind all these aggregates. Figure 3 on the right below shows the close up mechanism of an asphalt pavement. The round blue aggregate and the sharp white aggregates were being bind together by the light blue colour asphalt. There is also the orange colour which represents the open space or in other word, air. When the binder moves, the aggregates moves, rutting will occur.

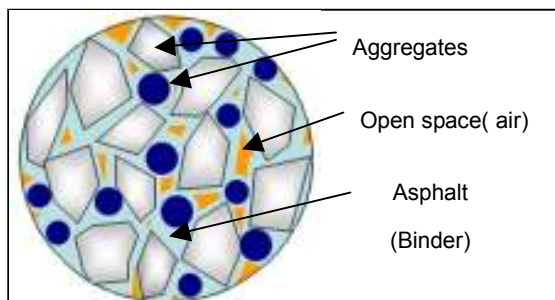


Figure 3

Advantage of Uniaxial Compression Tests for Asphalt Concrete

Wheel Tracking test (WT) is a test to evaluate rutting by moving a wheel on a sample to see how much depth it could occurs. It is like a simulation of the actual rutting on the road. It is done at 60 degree Celsius. However it has its own disadvantages. The test machine is complicated. A lot of time is required to do the test. The machine is very expensive. Therefore, a much more simple method is required. Thus, the Uniaxial Compression test is suggested. Why is the Uniaxial Compression test (UCT) chosen? Rutting occurs when the binder holding the aggregates moves. It moves because the binder was deformed. This means shear stress has occurred. Uniaxial Compression Test is a test to evaluate shear stress therefore UCT is chosen. When UCT is compared to WT, UCT advantages are because it is cheap. The test method is easy. Short time is required.

Flow of Experiment

First is the asphalt mix design. From it we make the test sample. The WT test is in square shape by 300x300x50mm. Then we do the WT test. On the other hand, we make the UCT test sample. The test sample is cylinder shape. Next we cut out the sample so it will be 1:2 ratio of diameter to height.(50mm:100mm). Then we do the UCT test. After doing the tests, we compare the results between WT and UCT.

This is the asphalt mix design for dense-13 and 20. Table 1 shows sieve size and gradation composition of each mixture. Figure 4 shows the graph for dense-13 and Figure 5 shows the graph for dense-20.

Table 1

Sieve size (mm)	Gradation Composition	
	Dense-13	Dense-20
20	100.0	98.3
13	98.7	79.9
5	64.7	56.5
2.5	40.2	39.1
0.6	25.1	24.8
0.3	14.3	14.2
0.15	8.1	8.1
0.074	6.6	6.5

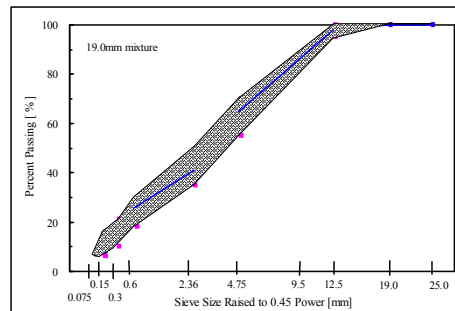


Figure 4

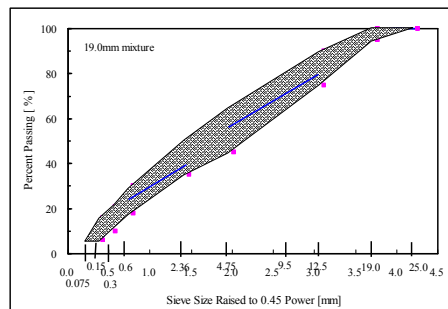


Figure 5

There are 2 kinds of asphalt binder are used in this research. For dense-13 in WT test, we use the modified asphalt (SBS) from content of 3%,4.5%,6%,9%. For dense-13 and dense-20 in UCT test, straight asphalt (StAS) is used by quantity of 4.0%,4.5%,5.0%,5.5%,6.0%,6.5%.

Test Condition

- Mixtures Dense-13, Dense-20
- Binder StAS 4.0%,4.5%,5.0%,5.5%,6.0%,6.5%
- Temperature 60°C
- Recuperation Time 3hour
- Speed 1mm/min
- Test Sample Measurement

Diameter	50mm
Height	100mm



Figure 6

Test Results

Below in Figure 7 is the sample of the test result. It shows the Dense-20 shear stress vs strain graph. Figure 8 shows the graph created from data dense-20 by taking only the max point of shear stress. It seems that from 4.0% to 5.5% the shear stress increases but then until 6.5% it decreases. From this we know that from the peak and above the results can be used because the rutting process occurs. Why can't we use the data before it reached the peak? It is because before it reaches the peak, the asphalt quantity in the test sample is too little which made it not a rutting process. The aggregates were just stick together which is not the asphalt that is binding them. This is a rutting evaluate test therefore other than rutting it cannot be evaluated.

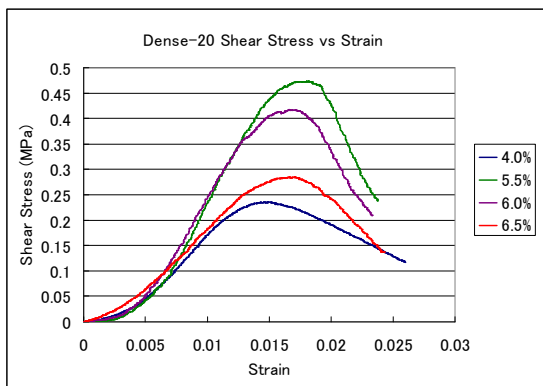


Figure 7

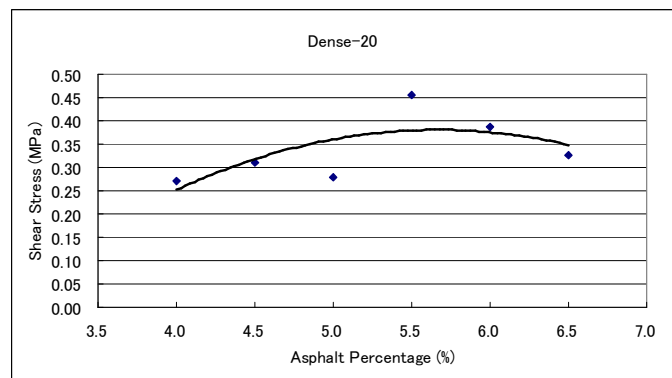


Figure 8

Table 2

			Dense13 DS			Dense20 DS	SBS (%)	Dense13 Shear stress	DS by WT
4.0	0.18	0.09	3412.5	0.27	0.14	4102.5	0.0	0.22	645
4.5	0.26	0.13	2471.5	0.31	0.16	2351	3.0	0.35	4253
5.0	0.29	0.14	1765.5	0.28	0.14	1099	4.5	0.32	5730
5.5	0.43	0.22	1090.5	0.46	0.23	549.5	6.0	0.43	7870
6.0	0.29	0.15	312.5	0.39	0.19	195	9.0	0.50	9000
6.5	0.44	0.22	199.5	0.33	0.16	178.5			

Therefore, as shown in Table 2, only the coloured datas are taken because only these datas are qualified to the rutting test. From here, we make the graph to compare the results of UCT to WT. Figure 9 is the graph which shows the results when comparing UCT to WT. In WT we use DS as the unit which is (times/mm). In UCT we use MPa which is shear stress. This graph shows a correlation of 0.95 which is a high correlation.

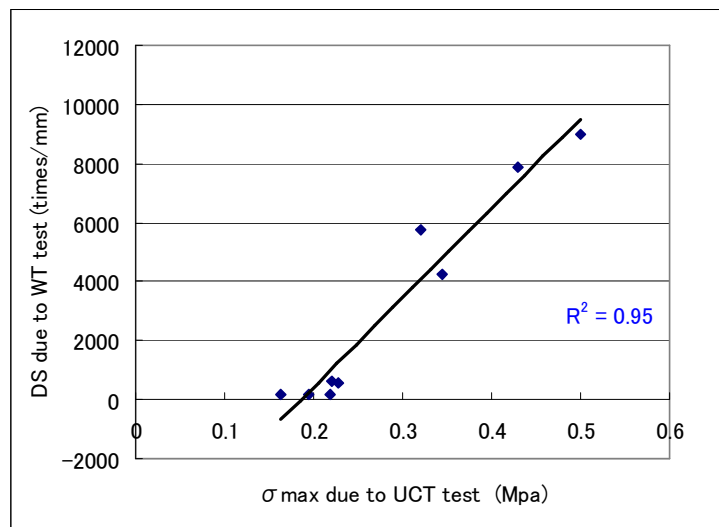


Figure 9

Summary

From comparing the results of WT test and UCT test, we can get a high correlation between the 2 tests. Now in this stage, we still can not say that the Uniaxial Compression test (UCT) can 100% replace the Wheel Tracking test (WT) as another way to evaluate rutting, because only a few kind of mixtures are being used, but UCT looks very promising to be used.