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# The Study of the Dynamic Modulus of High Modulus Asphalt Concrete

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**Abstract:** The present study presents an investigation into the dynamic modulus of asphalt mixture and mixing different PR. MODULE of asphalt mixture under different temperature and different loading frequency .The results show that the load frequency is constant, the dynamic modulus decreases with the increase of temperature;At a certain temperature, the dynamic modulus increases with the increase of frequency;When frequency and temperature are constant, the dynamic modulus of asphalt mixture is widely increases as amount of PR. The MODULE increases, and there must be a optimum content of the PR. MODULE.

**Keywords:** Asphalt mixture; PR. The MODULE; Dynamic modulus; Temperature

## 1. Introduction

Traffic volume increase sharply, most of the highway in China cannot reach the design of the premise before entered the stage of major repair or reconstruction of the surge of traffic volume and overload and overloading is rampant in our country .Road use can not meet the design life of the main reasons. Aiming at this problem, road researchers tested many methods at home and abroad, including high modulus asphalt mixture research .High modulus of asphalt mixture pavement maintenance cycle is longer time than ordinary asphalt pavement, and on the economic front, it can reduce the thickness of my meager sensibilities layer to reduce the funds required for the road construction and stone as well as the effect of oil saving.

Now, our country is not comprehensive on the study of high modulus asphalt mixture , the high modulus asphalt mixture in the actual use of the composition of material and its pavement performance is not clear to be understood. Therefore, this article devotes to the high modulus asphalt mixture of dynamic modulus test through to join in the 70 # asphalt matrix of different proportion of PR - Module high modulus asphalt mixture.

## 2. Test Parameters

In this paper, the PR. The MODULE content was 0.3%, 0.5%,0.7%,and0％,adding AC-25 dynamic modulus of asphalt mixture in the experiment. The experiment used grading for AC-25, the dynamic modulus of experimental parameters are shown in Table 1.

**Table 1. Experimental parameters**

| | |
|---|---|
| Granular composition | AC-25 |
| Additive dosage | 0.3%, 0.5%, 0.7% and 0％ |
| Asphalt-aggregate ratio | 4.1% |
| Design air voids | 4.0%±2% |
| Temperature | 10, 20, 30, 40 |
| Loading frequency (Hz) | 0, 1, 0.2, 0.5, 1, 2, 5, 10, 20 |
| Load waveform | sine wave |

## 3. Experimental Steps

(1) The sample on both ends of the leveling can contact with the upper and lower loading plate.
(2) The displacement sensor is placed in the middle of the test piece and the distance between the end face of the test piece and the end face of the test piece is 3. Adjust displacement sensor,and the compression deformation of the middle part of the test piece can be measured.
(3) The test piece is placed in the center of the loading plate of the test load frame, and a piece of plate is placed between the test piece and the upper and lower loading plate, and the center of the test piece center and the center of the loading frame should be paid attention.
(4)Puting the test piece into the test machine in the environmental chamber and setting the test temperature until the test piece in the middle of the test temperature.Tolerance is $\pm$ 0.3.
(5) When the specimen temperature reaches the specified temperature, we can start the loading test. A size of 5% of the contact load of specimens was applied for preloading (the size of the load test is by regulating the test control system between 50-150 micro strain axial strain in

order to obtain the appropriate load test, it is recommended multi forming one of the same type of test specimens). Continue 10s and be sure the vertical load is in good contact, and then adjust the displacement sensor.

(6)The specimens is applied haversine wave or offset sinusoidal axial compressive force test load under the set temperature from 20~0.1Hz, from high frequency to low frequency of repeated loading test. Before the test, specimens were preloaded treatment. Pretreatment method is the applied haversine wave or offset sinusoidal axial pressure should force load test, the frequency of 25 Hz, 200 cycle. At two frequencies, the test should be at least 2min, but not more than 30min. The load and deformation curves of the final 5 waveforms were recorded and calculated, and the axial deformation and dynamic modulus of the specimens were calculated.

(7) To test the temperature of the test piece, the choice of the temperature is from the high temperature. When the test piece in the set temperature of the frequency of the cumulative plastic deformation is more than 1500 micro strain, the test should be abandoned.

## 4. Experimental Results

Experimental results are shown in Table 2 to Table 5. According to the experimental results, using Excel software for data generation line graph, Figure 1 to Figure 4 respectively depicts the dynamic modulus curve of AC-25 asphalt mixture of the PR.MODULE content of 0,0.3%, 0.5%, 0.7% at different temperatures.

**Table 2. Test results dynamic modulus of 0.7%PR.MODULE**

| Temperature (℃) | Modulus (MPa) Frequency (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.1 | 0.2 | 0.5 | 1 | 2 | 5 | 10 | 20 |
| 10 | 6787 | 8312 | 10281 | 11890 | 13354 | 15790 | 17011 | 18721 |
| 20 | 2631 | 3331 | 4710 | 5723 | 6962 | 8842 | 10334 | 12054 |
| 30 | 1074 | 1402 | 2011 | 2701 | 3561 | 4780 | 5969 | 7281 |
| 40 | 401 | 487 | 665 | 867 | 1345 | 1781 | 2422 | 3236 |

**Table 3. Test results dynamic modulus of 0.5% PR.MODULE**

| Temperature (℃) | Modulus (MPa) Frequency (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.1 | 0.2 | 0.5 | 1 | 2 | 5 | 10 | 20 |
| 10 | 6561 | 7991 | 9656 | 12201 | 12891 | 13574 | 16281 | 17996 |
| 20 | 2601 | 3321 | 4365 | 5632 | 6987 | 8504 | 9962 | 11483 |
| 30 | 895 | 1187 | 1453 | 2201 | 2917 | 4001 | 5060 | 6305 |
| 40 | 372 | 487 | 604 | 787 | 1121 | 1619 | 2241 | 3094 |

**Table 4. Test results dynamic modulus of 0.3% PR.MODULE**

| Temperature (℃) | Modulus (MPa) Frequency (HZ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.1 | 0.2 | 0.5 | 1 | 2 | 5 | 10 | 20 |
| 10 | 6287 | 7521 | 9371 | 11321 | 12765 | 14403 | 15894 | 17467 |
| 20 | 2387 | 3012 | 4221 | 5471 | 6754 | 8391 | 9856 | 11324 |
| 30 | 729 | 956 | 1401 | 1921 | 2534 | 3653 | 4731 | 5941 |
| 40 | 356 | 399 | 578 | 787 | 1087 | 1571 | 2142 | 2851 |

**Table 5. Test results dynamic modulus of 0 PR.MODULE**

| Temperature (℃) | Modulus (MPa) Frequence (HZ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.1 | 0.2 | 0.5 | 1 | 2 | 5 | 10 | 20 |
| 10 | 5799 | 7532 | 9289 | 10798 | 12476 | 14207 | 15781 | 17246 |
| 20 | 1670 | 2650 | 3789 | 4856 | 6031 | 7646 | 9102 | 10571 |
| 30 | 720 | 926 | 1352 | 1877 | 2531 | 3522 | 4557 | 5792 |
| 40 | 269 | 347 | 477 | 543 | 912 | 1327 | 1867 | 2567 |

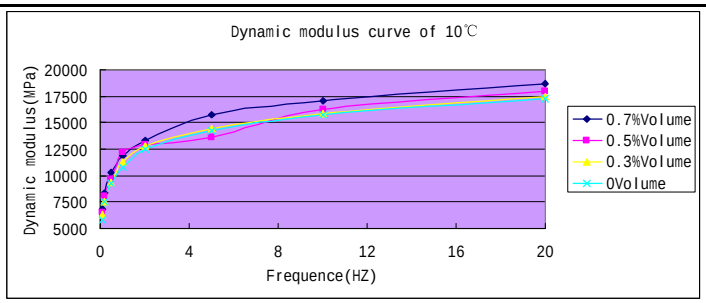


**Figure 1. Dynamic modulus test curve of 10 ℃**

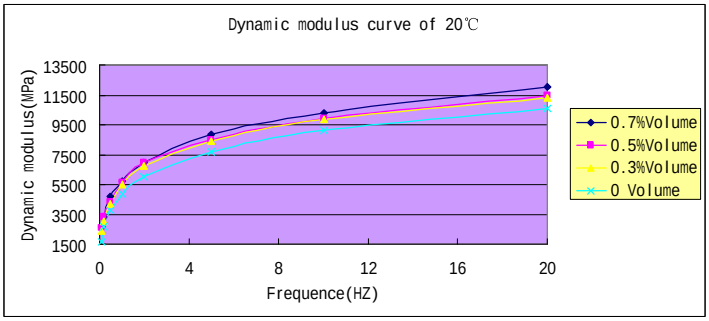


**Figure 2. Dynamic modulus test curve of 10 ℃**

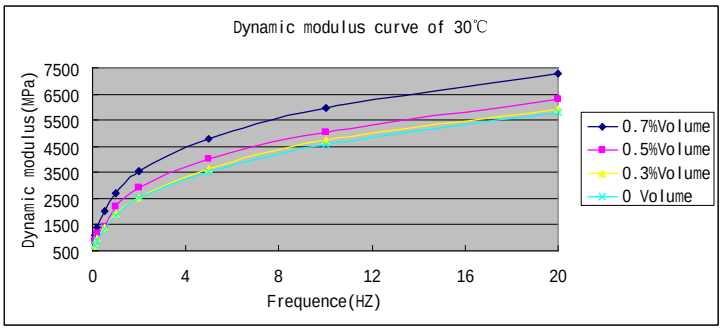


**Figure 3. Dynamic modulus test curve of 10 ℃**

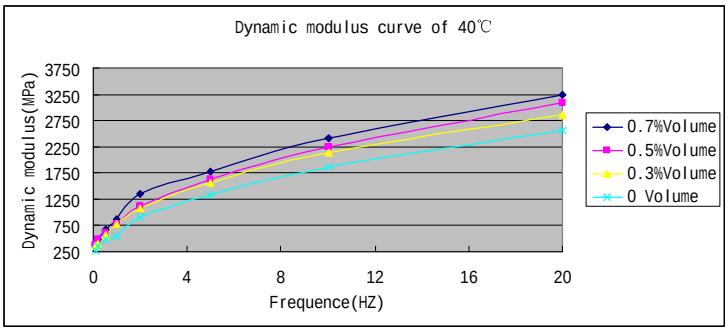


**Figure 4. Dynamic modulus test curve of 10 ℃**

## 5. Test Results

From Figure 1 to Figure 4 can be seen, four kinds of mixed material dynamic modulus in loading frequency must decrease with the increase of temperature. When a certain temperature and loading frequency gradually reduced, dynamic modulus value decreases. In any temperature and loading frequency ,dynamic modulus values of AC-25 asphalt mixture are generally increases with the amount of doped PR-Module high modulus additive . In comparison with ordinary AC-25,dynamic modulus values of PR. Module dosage for 0.7% of AC-25 asphalt mixture are showing a downward trend, when the temperature increases or loading frequency decreases. But dynamic modulus of PR. Module dosage for 0.7% of AC-25 mixture material is rising trend compared to AC-25 , such as in the loading frequency 0.1Hz, 10℃, 20℃, 30℃ and 40℃ increase the proportion of 17%, 35%, 49% and 49%, respectively. Therefore, the results show that performance of PR-Module additives in high temperature and loading frequency on the mixture dynamic modulus increase.

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