RESEARCH NOTES

OREGON DEPARTMENT OF TRANSPORTATION
MATERIALS & RESEARCH SECTION
800 AIRPORT ROAD S.E.
SALEM, OREGON (503) 378-2318

FREE DRAINING BASE MATERIALS PROPERTIES

April 1992 **RSN 92-1**

The importance of providing a positive drainage system and removing free water from pavement structures has long been recognized. Inadequate drainage of the pavement structures has been identified as one of the primary causes of pavement distress. For many years, researchers have theorized that improving pavement drainage might combat many pavement problems associated with water-related distresses and consequently, extend the pavement service life.

In the last few years, the Oregon Department of Transportation (ODOT) has started designing and constructing permeable bases in both flexible and rigid pavements. Two types of permeable bases have been used: one is asphalt treated permeable base and the other is open graded aggregate base. The desirable characteristics (permeability and resilient modulus) of both materials have not been determined. During pavement structural design using the AASHTO Guide, layer and drainage coefficients had to be assumed to establish pavement thickness designs. In addition, construction with the existing open-graded aggregate gradation revealed that the material was less stable and would ravel easily under construction traffic. Because of this ravelling, compaction was poor, the grade was difficult to control, and the open-graded aggregate materials did not provide a suitable surface for paving.

This project was initiated to obtain a better understanding of the characteristics of these permeable base materials, to develop appropriate layer and drainage coefficients for use in pavement thickness design, and to improve stability and constructability of the existing open graded aggregate material. Two permeable base materials were investigated; an open-graded aggregate and an asphalt-treated permeable material (ATPM). For comparison, a dense-graded aggregate material was also evaluated. The project consisted primarily of a laboratory investigation. Pavement cores of the asphalt treated permeable base and samples of aggregate materials were tested in the laboratory for permeability and resilient modulus. The permeability was determined using both constant and falling head test procedures.

The laboratory study indicated that the current ODOT ATPM has sufficient drainage capability and the resilient modulus of this material is typical of other states' findings. A modified open-graded aggregate gradation is proposed. The proposed aggregate gradation has a higher permeability and a higher resilient modulus than the existing gradation.

Based on the literature review and the laboratory test results, the following conclusions and recommendations for implementation are offered.

Conclusions:

- Many states are paying great attention to subsurface drainage. Design and construction of a positive drainage system in pavement structures is becoming more common. Typical ATPM layer thickness ranges from three to four inches. Typical asphalt content used in ATPM is two to three percent.

- The current ODOT ATPM has a sufficient drainage capability. The resilient modulus of this material is typical of other states' findings.

- The proposed gradation for open-graded aggregate with 100% fractured faces has a considerably higher permeability than the existing gradation. The aggregate with the proposed gradation also has a higher resilient modulus.

- The percent of fractured faces has a substantial influence on the permeability of open-graded aggregate. For the same type of gradation, the aggregate with 100% fractured faces is more permeable than the aggregate with 88% fractured faces. For dense-graded aggregate, the difference in permeability due to fractured faces is not significant. The percent of fractured faces also has a significant influence on the resilient modulus of open-graded aggregate. For the same type of gradation, the aggregates with 100% fractured faces has a much higher resilient modulus than aggregates with 88% fractured faces. For dense-graded aggregate, the difference in resilient modulus due to fractured faces is not obvious.

Recommendations for Implementation:

- For pavement structural design with ATPM, a layer coefficient of 0.14 to 0.19 and a drainage coefficient of 1.15 to 1.25 are recommended.

- The proposed gradation for FDAB is recommended for use. The layer coefficient may be determined knowing the percent of aggregate fractured faces and the anticipated stress in the base. A drainage coefficient of 1.05 to 1.15 is recommended for the FDAB with 100% of the material retained above the 1/4" inch sieve fractured on two faces and 1.00 to 1.05 for 90% fractured on at least two faces.

- A prime coat is recommended for use on the top of FDAB. This will make the FDAB material easier to run construction equipment on and more stable.

- Plant mix is recommended when using FDAB to reduce aggregate segregation.

Recently, the results of this study were published in a final report titled, "Free Draining Base Materials Properties." To obtain a copy of this report or any additional information on this topic, please contact:

Scott Nodes or Haiping Zhou
Oregon Department of Transportation
Research Unit
800 Airport Road S.E.
Salem, Oregon 97310
(503) 378-2318