EXPERIMENTAL ASSESSMENT OF AGGREGATE SURFACING MATERIALS

Final Project Report

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EXECUTIVE SUMMARY

Highway base courses are typically constructed using crushed and processed aggregate. Roadway designers currently have a number of options for specifying base course material on Montana Department of Transportation (MDT) highway projects. An extensive suite of geotechnical laboratory tests were conducted on 14 different material sources to quantify relative differences in engineering properties of three crushed aggregate types commonly used on MDT highway projects. The material types are identified in the Montana Supplemental Specifications as CBC-6A, CBC-5A, and CTS-2A. The two crushed base course (CBC) materials, CBC-6A and CBC-5A, have maximum particle sizes of 1.5 inches and 2 inches, respectively. The Type A designation indicates that they are untreated. On some projects, a finer-grained leveling course is substituted for the top 0.15 feet of CBC. This leveling course has a smaller maximum particle size and is used in place of CBC at the top of the base course layer to provide a smooth level surface for the placement of asphalt concrete. This study utilized a 0.75-inch maximum particle size material, which is denoted by MDT as crushed top surfacing (CTS) Grade 2 Type A (CTS-2A).

Engineering properties examined in this study included: compaction, durability, strength, stiffness, and drainage. These properties were quantified by synthesizing and analyzing results from the following laboratory tests: geotechnical index tests, direct shear, R-value, and permeability. Multiple repeat tests were conducted on each material. Statistical analyses were performed using the two sample t-test to determine if apparent trends in measured laboratory test results represented true differences between aggregate types.

The CBC-6A aggregates generally exhibited the highest strength and stiffness of the three material types based on R-value tests and direct shear tests on 12-in by 12-in samples. The CBC-6A aggregates exhibited higher ϕ' values and higher R-values than the CTS-2A materials. In terms of strength parameters measured in direct shear testing, there was no statistically significant difference between CBC-5A and CTS-2A materials. The CBC-6A and 5A materials exhibited similar average R-values, which were both slightly greater than the CTS-2A materials. Overall, the CTS-2A materials generally exhibited the lowest average strength and stiffness; however, it still exhibited relatively high strength and stiffness.

Drainage capacity was quantified by conducting multiple saturated constant head permeability tests on 10-inch-diameter samples. The CBC-6A and CTS-2A materials exhibited the highest average permeability (k) values, while the CBC-5A materials had the lowest. Permeability was shown to depend more on the fine fraction void ratio (e_f) than on aggregate type or maximum particle size. A method of predicting k based on e_f was developed, which will allow MDT designers to estimate k based on gradation and state of compaction. This equation could be useful for comparing the hydraulic properties of base course aggregates, for estimating hydraulic properties of materials that are out of specification, or to determine the maximum amount of material passing the No. 10 sieve to achieve a particular minimum *k*.

Based on results from strength, stiffness, and drainage testing, the CBC-6A materials were generally the best performers in this study. The CBC-5A aggregates generally exhibited the second highest strength and stiffness, but also had the lowest drainage capacity. The CTS-2A aggregates generally exhibited the lowest strength and stiffness, but had relatively good drainage capacity. The ability to substitute CTS-2A material for CBC aggregates depends on the relative importance that is assigned to strength, stiffness, and drainage in the pavement design model.