



Transportation Literature Search

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Specific Gravity of Aggregates and Alternatives to AASHTO T84 and T85

Prepared for
Wisconsin Highway Research Program
Flexible Pavements Technical Oversight Committee

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Transportation Literature Searches are prepared for WisDOT staff and principal investigators to heighten awareness of completed research in areas of current interest. The citations below are representative, rather than exhaustive, of available English-language studies on the topic. Primary online resources for the literature searches are OCLC's [WorldCat](#) and [TLCat](#), U.S. DOT's [TRIS Online](#), the National Transportation Library ([NTL](#)), TRB's [Research in Progress \(RiP\)](#) and other academic, engineering and scientific databases as appropriate. Links to online copies of cited literature are noted when available. Hard copies may be obtained through the WisDOT Library at library@dot.state.wi.us or 608-264-8142.

SUMMARY

The issue of finding alternatives to the AASHTO T84 and T85 tests of specific gravity of aggregate has developed momentum in recent years. Of the six publications and three research projects in progress we found, all but one study originated in the year 2004 or more recently, with two federally published articles in 2004, one industry study in 2005, another federal article in 2006, an academic journal article in 2007, and Research in Progress begun by Alaska in 2004, and by New Hampshire and Ohio in 2006. The 2000 citation is from another federally published article.

KEYWORDS

Specific, gravity, AASHTO, aggregate.

CITATIONS

Title: Effect of quarry production process on specific gravities of aggregates

Author(s): Mustaque Hossain, Louis A. Ferreira, Zahidul Q. Saddique, Taslima Khanum, Rodney Montney

Date: 2007

Doc ID/URL: *Journal of Testing and Evaluation*, Vol. 35 (1), January 2007: 45-52.

Description: 8 pp.

Contents: The combined bulk specific gravity of aggregates is a basic input in the Superpave asphalt mixture volumetric design. In order to identify and quantify the factors affecting the aggregate specific gravity values, tests methods similar to AASHTO T84 and T85 were conducted on aggregate samples collected from four different quarries in Kansas. All test results were analyzed statistically to find the significance of the factors—top size and fine loss of the aggregates during replicate testing—used in the experimental program. The results show that the bed from which the aggregates are produced has a significant effect on the specific gravities. However, different aggregate products obtained from the same bed in a quarry may have dissimilar specific gravities. The analysis also shows that the aggregate production process affects the specific gravities significantly when the aggregates are softer, such as soft limestone in Kansas. Fine loss during replicate testing does not affect the results for harder aggregates.

Title: Evaluation of test equipment for determination of fine aggregate specific gravity and absorption

Author(s): Stephen A. Cross, Msengi K. Mgonella, Yatish Jakatimath

Date: 2006

Doc ID/URL: *Transportation Research Record No. 1952*, 2006: 3-11.

Description: 9 pp.

Contents: Concern has been expressed about the repeatability of the current AASHTO T 84 method for determination of fine aggregate specific gravity. Two new methods are available for determining bulk specific gravity and absorption of fine aggregates: the AggPlus system using the CoreLok device and the SSDetect system.

In addition, a new automated Langley de-airing device is available for AASHTO T 84. The objectives of this study were (a) to evaluate the reproducibility of SSDetect, CoreLok, AASHTO T 84, and AASHTO T 84 with the Langley de-airing device and (b) to determine if either of the new systems would produce results statistically similar to those produced by the current AASHTO T 84 procedure. The AASHTO procedure, when used with the Langley de-airing device, gave similar results to AASHTO T 84 but with reduced variability. The SSDetect procedure produced the highest bulk specific gravity and lowest percent absorption followed by the CoreLok and AASHTO T 84 procedures. There was no significant difference in apparent specific gravity values. Increasing the cure time for the SSDetect procedure resulted in increased saturated surface dry mass.

Title: Round Robin Evaluation of New Test Procedures for Determining the Bulk Specific Gravity of Fine Aggregate

Author(s): Brian D. Prowell, Nolan V. Baker

Date: November 2005

Doc ID/URL: NCAT Report 05-07, NCAT: Auburn, Ala., 2005.

<http://www.eng.auburn.edu/center/ncat/reports/rep05-07.pdf>

Description: 85 pp.

Contents: This study evaluated two automated methods for determining the dry bulk specific gravity (G_{sb}) of fine aggregates, the Thermolyne SSDetect and InstroTek Corelok. Each proposed method was evaluated against the standard method described in American Association of State Highway and Transportation Officials (AASHTO) T 84. The evaluation was based on a round robin study with twelve labs and six materials, four crushed fine and two uncrushed (natural) fine aggregate sources. The Corelok and SSDetect methods of determining fine aggregate specific gravity offer significant time savings over AASHTO T 84. Both the Corelok and SSDetect methods generally produce G_{sb} results that are similar to AASHTO T 84. It is believed that AASHTO T 84 may not produce accurate results for angular materials with high dust contents. More frequent statistical differences exist between both the Corelok and SSDetect apparent specific gravity (G_{sa}) and water absorption results and the AASHTO T 84 results than were observed for G_{sb} . However, G_{sa} and water absorption are not used in volumetric calculations for hot mix asphalt. Both new methods offer improved precision as compared to AASHTO T 84, particularly for crushed materials with high dust contents.

Title: Using a single test to determine specific gravity and absorption of aggregate blends

Author(s): Kevin D. Hall

Date: 2004

Doc ID/URL: *Transportation Research Record No. 1874*, 2004: 3-10.

Description: 8 pp.

Contents: The ability to measure the specific gravity of an aggregate accurately and consistently is paramount to transportation materials engineers. Current standard test methods (AASHTO T-84 and T-85) typically are not used for routine quality control purposes because of long testing times and questions about variability. Among new techniques developed for measuring specific gravity and absorption is a vacuum-sealing method, which eliminates the need for long soaking periods and for determining aggregate mass in a saturated-surface-dry moisture state. The vacuum-sealing method also has the potential to measure the specific gravity of a blend of aggregates in a single test. Specific gravity and absorption of six coarse and four fine aggregates composed of various mineralogy types were measured by both traditional and vacuum-seal methods. Ten blends, whose gradations generally met Superpave [registered trademark] hot-mix asphalt specifications, were created by using various combinations of aggregates and tested in a single vacuum-seal test. Five replicate tests were done on all individual aggregates and blends. Aggregate-blend single-test results (specific gravity and absorption) were compared with values obtained with traditional individual test results and mathematical combinations. The comparisons yielded generally strong correlations among methods, indicating the vacuum-seal procedure has promise as a relatively rapid method for determining specific gravity and absorption in a single test of an aggregate blend. However, some real differences in test values suggest that the vacuum-seal method needs refinement before it can be seamlessly substituted for traditional methods.

Title: Evaluation of new test procedures for determining bulk specific gravity of fine aggregate by automated methods

Author(s): Brian D. Prowell, Nolan V. Baker

Date: 2004

Doc ID/URL: *Transportation Research Record No. 1874*, 2004: 11-18.

Description: 8 pp.

Contents: Two automated methods were evaluated for determining the dry bulk specific gravity (G_{sb}) of fine aggregates: Thermolyne SSDetect and InstroTek CoreLok. Each proposed method was evaluated against the

standard method described in AASHTO T-84. The evaluation was based on a round-robin study with 12 laboratories and six materials, four crushed fine and two uncrushed (natural) fine aggregate sources. The CoreLok and SSDetect methods of determining fine aggregate specific gravity offer significant time savings over AASHTO T-84. Both the CoreLok and SSDetect methods generally produce G_{sb} results similar to AASHTO T-84. It is believed that AASHTO T-84 may not produce accurate results for angular materials with high dust contents. More frequent statistical differences exist between the CoreLok and SSDetect apparent specific gravity (G_{sa}) and water absorption results than those produced by AASHTO T-84. However, G_{sa} and water absorption are not used in volumetric calculations for hot-mix asphalt SSDetect offers improved precision over AASHTO T-84. The precision of the CoreLok method is slightly worse than that of AASHTO T-84, but it is expected to improve as technicians become more familiar with the procedure.

Title: Measuring bulk-specific gravity of fine aggregates: Development of new test method

Author(s): P. S. Kandhal, R. B. Mallick, M. Huner

Date: 2000

Doc ID/URL: *Transportation Research Record No. 1721*, 2000: 81-90.

Description: 10 pp.

Contents: Bulk specific gravity of the fine aggregate is used in hot-mix asphalt volumetric-mix design (including Superpave) to determine the amount of asphalt binder absorbed by the aggregate and the percentage of voids in the mineral aggregate. The current test method (AASHTO T84) uses a cone method to establish the saturated surface dry (SSD) condition of the sample, which is necessary to conduct the test. This method does not work satisfactorily for fine aggregates that are very angular and have rough surface texture and, therefore, do not slump readily when in SSD condition. A research project was undertaken to develop automated equipment and a method of establishing the SSD condition of the fine aggregate. The wet sample of the fine aggregate is placed in a rotating drum and subjected to a steady flow of warm air. The temperature gradient of the incoming and outgoing air and the relative humidity of the outgoing air are monitored to establish the SSD condition. Two prototype devices were constructed. The test results obtained with the second prototype device are encouraging and are reported. Further improvements to be made to the second prototype device to improve the repeatability and reproducibility of the test have been identified.

RESEARCH IN PROGRESS

Title: Automated Laboratory Testing Methods for Specific Gravity & Absorption: Verified to Match the Current Test Methods

Principal Investigator(s): Arudi Rajagopal, Infrastructure Management and Engineering Inc.

Start Date: 7/1/2006

RIP URL: <http://rip.trb.org/browse/dproject.asp?n=12797>

Source Organization: Ohio Department of Transportation

Contents: Current methods of testing aggregate are manually intensive and physically demanding. While staffing levels are decreasing, the time demands are increasing; consequently requiring more automated testing processes to continue providing the number of tests needed. To accurately predict the quality of aggregate and provide adequate time to perform new tests that come on-line such as Micro Deval, automated systems in gradation have been developed but are in limited use. In addition, there has been no real work done on automation of specific gravity and absorption tests. The objectives of this project are to: (1) develop aggregate test methods to be used in DOT laboratories, private laboratories, and company laboratories which will provide faster and more numerous results by producers, suppliers and owners; and (2) prepare recommendations to Ohio Department of Transportation (ODOT) for standard specification changes and equipment to purchase based on the capability, precision, and durability of the evaluated equipment.

Title: Evaluation of Petroscope for Automated Analysis of Aggregates

Principal Investigator(s): Denis Boisvert, Project Managers, New Hampshire Department of Transportation, (603) 271-3151, dboisvert@dot.state.nh.us

Start Date: 7/1/2006

RIP URL: <http://rip.trb.org/browse/dproject.asp?n=12331>

Sponsor Organization: New Hampshire DOT

Contents: Petroscope determines 3D imaging, and with the Techmodel statistical software and the Lithodata database software, engineering properties such as LA Wear, specific gravity, and mineralogy are determined. The automated system can return test results in 20 minutes; a labor savings and an increase in safety.

Title: Theoretical Density Determination with Nuclear Gauge

Principal Investigator(s): Steve Saboundjian, Project Manager, Alaska Department of Transportation and Public Facilities, (907) 451-5322, steve_saboundjian@dot.state.ak.us

Start Date: 12/9/2004

RIP URL: <http://rip.trb.org/browse/dproject.asp?n=12127>

Sponsor Organization: Alaska DOT

Contents: The Proctor and Vibratory standard methods for determining the degree of field compaction for soils and aggregates require obtaining a field sample (by digging the compacted layer) for screening/sieving. This is done to correct the values obtained from these tests. Field materials technicians in the Southeast Region observed that a simple calculation could replace this time-consuming procedure. The same was observed for asphalt mixes. It is speculated that by knowing the coarse aggregate specific gravity, the percent voids and air void ratio (through nuclear densometer), one can calculate the maximum density of the material, and subsequently its percent compaction. The objective of this study is to check the validity, applicability and limits of the simple method described above. This will be achieved by compiling and organizing the data collected by the Southeast technicians for soils, aggregates and asphalt mixes; applying the simple calculation method to obtain maximum density values; then comparing these values to those obtained by using the standard tests. Values from projects in other regions could also be analyzed to check the universality of the suggested method.