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International Union of Laboratories and Experts in Construction Materials, Systems and Structures Réunion
Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions

RILEM Task Group 2

Mixture Design and Compaction

RILEM TG2 MEETING – WASHINGTON, D.C.

16 JANUARY 2008

12:00 – 2:30 PM

ROOM 8209 MARRIOTT (PARK TOWER)

In attendance:

Amit Bhasin, Texas A&M U.	Hussain Bahia, UW-Madison
Andrew Hanz, UW-Madison	Julian Mills-Beale, Michigan Tech.
Baron Colbert, Michigan Tech.	Katherine Petros, FHWA
Carl M. Johnson, UW-Madison	Kunnawee Kanitpong, AIT
Chantal de la Roche, LCPC	Lee Gallivan, FHWA
Edith Arambula, FHWA	Manfred Partl, EMPA
Eric Weaver, FHWA	Menglan Zeng, Hunan U./UW-Madison
Ernie Bastian, FHWA	Nelson Gibson, FHWA
Ferhat Hammoum, LCPC	Sanjeev Adhikari, Michigan Tech.
Gordon Airey, U. of Nottingham	Yu Liu, Michigan Tech.
Haifang Wen, UW-Madison	Zhanping You, Michigan Tech.

Purpose: The objective of this meeting was to update the TG2 members on the status of the laboratory compaction study currently underway. Also, there was a focus on image analysis methods in order to standardize the analysis of the compacted samples.

1. Laboratory Compaction Status

Carl began the meeting by presenting the status of the material shipment to the various labs (shown in the table below), as well as the status of the compaction performed by the labs that had already received the loose mix. Compaction results data have been received by UW-Madison from LCPC, EMPA, and Michigan Tech. LCPC has performed gamma densometer analysis on their field slabs, and UW-Madison has sent out US gyratory samples of the material for X-Ray CT imaging. Imaging was performed at both Texas A&M University as well as at the Turner-Fairbank Highway Research Center. Results will be shown during the later presentations.

Table 1. Loose mixture shipment status (as of 01 Feb 2008)

Task #1									
COMPACTION METHODS									
		1	2	3	4	5	7		
LAB No.	LAB name	Gyratory - US	Gyratory - CE	French Roller	German sector	Marshall	Hveem	Total amount (kg)	Number of buckets
10	AIT					20 kg		20 ?	1
14	UC – Davis			30 kg			70 kg	100 ?	3
2	EMPA	20 kg		30 kg		20 kg		70 ?	2
7	LCPC		20 kg	30 kg				50 ?	2
9	Liverpool				40 kg			40 ?	2 1
3	Michigan Tech	20 kg						20 ?	1
10	Technical Univ. of Braunschweig		20 kg		40 kg	20 kg		80 ?	3
5	Total		20 kg	30 kg				50 ?	2
8	UFC – Petrobas	20 kg		30 kg		20 kg		70 ?	3
11	University of Parma				40 kg			40 ?	2
1	UW – Madison	20 kg						20 ?	1
16	Nottingham		20 kg					20 ?	1
21	University of Palermo				40 kg			40 ?	2
							Total	620	25 (perfect)

Sent Loose mix	Have contacted LCPC to ship mix	Have not yet contacted LCPC
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2. State of the Art Report

Dr. Kanitpong has started work on the US gyratory portion of the SOA report, but other sections are behind schedule. However, Dr. Bahia and Carl will have a draft prepared by the RILEM meeting in October. Any volunteers to assist with ideas for the outline or writing are welcome to contact Carl.

3. Presentations on Image Analysis

Dr. Ferhat Hammoum – LCPC:

The presentation given by Dr. Hammoum described the method used by LCPC to analyze two-dimensional images of asphalt cross sections. It can be applied to measuring the gradation of the material, mastic thickness, spatial distribution of the components, orientation of the aggregates, and volumetric distribution using stereometry and probability. It involves the use of a high-resolution digital camera to capture the images of the specimen, which are then transformed into a Voronoi diagram for use in determining aggregate structural characteristics.

Dr. M. Emin Kutay – FHWA:

Dr. Kutay's presentation gave a detailed look at the process of X-Ray CT imaging of asphalt specimens, along with the analysis method used by his group. By using the stacked images obtained from CT imaging, Dr. Kutay outlined the methods used for processing and three-dimensional analysis of the specimens. The critical characteristics of aggregate structure were identified as contact points (or influence zones), aggregate orientation, spatial distribution of different sizes, and angularity. All of these are possible to measure using 3D image analysis methods described by Dr. Kutay.

Mr. Sanjeev Adhikari – Michigan Tech:

Mr. Adhikari outlined the methodology used by the Michigan Tech team to use 2D images to obtain aggregate orientation measurements. The process involves identifying and labeling of the individual aggregates, then digitally "sieving" them to obtain a gradation measurement. Based on the results, thresholding of the image is refined in order for the results to match up with the known gradation of the mixture. The aggregate orientation can then be calculated for either the total number of aggregates, or it can be isolated to only certain sizes of aggregate.

Dr. Amit Bhasin – Texas A&M University

Dr. Bhasin's presentation detailed the work done at Texas A&M University on asphalt mixture image analysis. Analysis of the air void structure has been performed to investigate moisture transport with mixture specimens. Using CT imaging, researchers could determine the flow fields as well as the directional distribution of the permeability within the specimen. Also, use of CT imaging has been used to evaluate damage characteristics in asphalt mastic specimens. Images were taken at different levels of damage within test specimens, and were then analyzed for visual clues as to what is occurring within the mixture during fatigue damage. Work has also been done to include the spatial distribution of aggregates into a mechanistic model for pavement design. The thresholding process for these analysis methods is performed using an iterative process, but work is being done at TAMU to automate the process.

Mr. Carl Johnson – UW-Madison

Carl gave a brief presentation on a method currently being developed at UW-Madison for processing and analyzing 2D images from sliced mixture specimens. Ph.D. candidate KC Kim is currently working on a program uses a scanned image as the input and automates the processing and analysis of that image to create an output that includes gradation, volumetric characteristics, and aggregate orientation. As more specimens become available for the TG2 project, researchers at UW-Madison hope to use them to further develop the software.

Dr. Hussain Bahia – UW-Madison

Dr. Bahia used the remaining time for presentations to briefly illustrate the findings from KC Kim's study that is using 2D image analysis as a tool. Using the US gyratory to compact the mixtures, Mr. Kim has found that the aggregate orientation does show a dependence on the temperature at which is compacted. The work is on-going, but these preliminary results have warranted further investigation.

4. Discussion

- Dr. Hammoum mentioned that LCPC would like to perform gamma-ray testing on the compaction specimens for the TG2 project before any destructive testing was performed. Dr. Manfred Partl then suggested that a small set of specimens be set aside and then tested at each of the labs performing non-destructive evaluation so that the results can be compared and verified.
- Dr. Nelson Gibson suggested that the dynamic implications of aggregate structure be considered for further investigation during this project. Currently, there are plans to test the dynamic modulus of the samples, but there has not been a mention of studying the aggregate structure before and after mechanical testing (similar to what was presented by Dr. Bhasin). It was then mentioned that the group at University of Florida has obtained an X-ray CT setup with a loading frame. An inquiry will be made by Dr. Bahia and Carl about the possibility of UF being able to assist with the TG2 project.
- Dr. Kutay noted that there is a significant difference in the methods used to process the images and the methods used to analyze them. Analysis methods are typically straight-forward and consistent among researchers, but the processing methods can be subjective and need to be standardized.
- Dr. Kutay also noted that calibration of processing techniques should avoid using known vs. measured air voids. This could lead to an increase in calculated macro-voids since micro-voids are often undetected by image capture devices.
- Dr. Gibson suggested that cross-anisotropy measurements could be used as a check for the modeling done on the specimens. Dr. Bhasin offered to possibly contribute papers on the subject to the RILEM website.
- Dr. Bahia asked all presenters to provide a short document detailing the procedures outlined during the meeting.

Please feel free to contact Mr. Carl M. Johnson (cmjohnson3@wisc.edu) regarding this meeting or the project being conducted by TG2.