Refinement and Implementation of Asphalt Binder Cracking Device (ABCD)

Abbreviated Project Management Plan

Refinement of Test Procedures

There is a high possibility reducing total preparation and test time for 8 test specimens from current 4 hours to 2 hours or less by increasing cooling rate. Since the total mass of each binder specimen is small (15 grams), the test specimen could attain thermal equilibrium quickly and may produce comparable results to those of slower rate of cooling. For previous investigation only 10°C/hr rate has been used with few exceptions.

The length of thermal conditioning prior to ABCD test may need to be carefully examined in relationship to the observed changes in asphalt binder by physical hardening. In the current ABCD test procedure, there is no isothermal conditioning time. If physical hardening exists in ABCD test, proper thermal conditioning will further reduce variability of test. For this task, 4 asphalt binders (high/low polymer modified PG binders, high/low unmodified PG binders) will be tested at 10, 20, and 40°C/hr rates. Various isothermal conditioning periods (0, 1, 24 and 72 hours) will be studied to determine the existence of physical hardening and its effects on repeatability of ABCD test.

With understanding the effects of cooling rate and isothermal conditioning time on ABCD results, the best or the optimum ABCD test procedure will be delivered.

Field Validation of ABCD

Partial validation of ABCD was successfully completed as a part of NCHRP-IDEA No. 99 project where 16 binders from 3 test pavements were used;

1. Pennsylvania Elk County Test Road: 6 binders
2. Lamont Test Road (C-SHRP, Canada): 5 binders
3. Highway 17 (SPS-9A) near Petawawa Ontario: 5 binders

More binders used in other test road projects concerning low temperature thermal cracking of asphalt pavements will be tested.

In addition, four 2007 Ohio DOT paving projects, asphalt binders will be tested by both current ABCD test procedure and AASHTO (BBR). Their results will be compared with the low temperature performance of mixture determined by indirect tensile creep and strength tests as outlined in Simple Performance Test. Performance of pavement will be monitored after one year of service. The binder test results will be documented for future comparison with field performance.

Refinement of Equipment and Analysis Software

For current ABCD test, a generic cascading (dual refrigerants) environmental chamber is used. The chamber is heavy (over 300 lb) and noisy when compressor is on. A light (about 50 lb), quiet, compact, and durable integrated system will be built using

free piston sterling cooler (FPSC). FPSC is a small, energy efficient, light (6.2 lb) and commercially available product. Because moving internal components are supported by a gas bearing technology, there is essentially no friction between internal components during operation. This makes FPSC have extremely low noise during operation and long lifespan. FPSC is also environmentally friendly since it uses single phase helium as refrigerant. Because of its small size and almost vibration-free operation, it is feasible install signal conditioning unit within the cooling unit. Because of quiet and light FPSC, complete ABCD testing system can be light and operator friendly with almost no mechanical break down. An analyses software will also be developed to process ABCD raw data and determine cracking temperature and failure stress automatically at the end of the experiment.

Task 4. Ruggedness Test

A ruggedness test will be conducted following ASTM C 1067 – 00 "Standard Practice for Conducting A Ruggedness or Screening Program for Test Methods for Construction Materials". For this task, following matrix will be used.

Number of Laboratory	3 including Ohio University
Materials	4 binders (PG xx-16, PG xx-22, PG xx-28, and PG xx-34) (2 polymer modified binders & 2 unmodified binders)
Factors	1. Sample Trimming (even trimming vs. 2mm over trimming) 2. Lubrication (Lubrication vs. No Lubrication) 3. Bonding between ABCD ring and specimen (Bonding vs. No Bonding) 4. Size of Protrusion (6.35mm diameter vs. 5.85mm diameter) 5. Cooling Rate (11°C/hr vs. 9°C/hr)* 6. Conditioning Time (0 minute vs. 30 minutes)* 7. Degassing of Sample (Degassing vs. No Degassing)

* May changes based on the results of Task 1 Refinement of Test Procedures

Phase 2:

Round Robin Test

Based on the data from Tasks 1 and 2, an experiment will be designed following ASTM C 802 – 02 "Standard Practice for Conducting an Interlaboratory Test Program to Determine the Precision of Test Methods for Construction Materials". For this task, 10 laboratories will be recruited to test 4 types of asphalt binders (PG xx-16, PG xx-22, PG xx-28, and PG xx-34; 2 polymer modified binders & 2 unmodified binders) with 8 replications. These four binders will be from different sources from those used in Task 4 Ruggedness Test.

The statistical model for this factorial design with replications will be

$$y_{ijkl} = \mu + ABCD_i + Lab_j + Type_k + \varepsilon_{ijkl}$$

where, y = measurement

μ= mean
ABCD = ABCD unit effect (i= 1 to 5)
Lab = laboratory effect (*j*= 1 to 10)
Type = binder type effect (*k*= 1 to 4)
l= replication, 1 to 8
ε = random error