# Montana Department of Transportation

## Stage 2 - Research Topic Statement

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

| RESEARCH PROGRAMS USE ONLY | |
|---|---|
| RESEARCH IDEA NO: | 22-008 |
| DATE OF RECEIPT: | Apr 29, 2021 |
| TOTAL MDT COST W/ICAP: | |

# RESEARCH PROGRAMS

**Please submit completed forms via e-mail to MDTResearch@mt.gov. All fields are required, except the last field: XVIII, Sponsor(s). Incomplete forms will not be accepted.**

**TITLE (required):** Aging Conditions for Hot Mix Asphalt Cracking Test

**TOPIC STATEMENT:**

Cracking, either due to reflection, fatigue and/or low temperature, is one of major distresses of asphalt pavements. Like many other agencies, Montana Department of Transportation (MDT) is considering to implement laboratory cracking performance test(s) into the hot mix asphalt design process to ensure that asphalt mix to be used for construction is cracking resistant. One of key components of the cracking test(s) is the aging condition of asphalt mix prior to the tests. Aging level greatly affects the cracking test results and, therefore, needs to be determined before an acceptance threshold of cracking index is established as a specification. The aging level of asphalt mix in the laboratory needs to match that of asphalt materials in the field at the time of occurrence of pavement cracking. The 5-day aging at 95 Celsius (or 12 hours at 135 Celsius) simulates field aging of 7~10 years of asphalt surface layer. However, MDT often places chip seal within one year after the asphalt paving. The presence of chip seal significantly reduces the aging of underlying asphalt mix, based on previous studies. Therefore, determination of appropriate aging condition of asphalt mix that is suitable for MDT paving practices and for climatic conditions in Montana is greatly needed before a specification of cracking test(s) can be developed.

The proposed study includes collection of hot mix asphalt samples from pavements in Montana at the initial stage of cracking. The asphalt binders will be extracted and recovered, and performance grades of recovered asphalt binders will be determined and compared to original performance grades at the time of paving to determine the aging over the years. Laboratory-produced asphalt mixes will be aged in the laboratory to determine appropriate aging time and temperature that would render equivalent aging in the laboratory to that of asphalt mixes in the field. The aging conditions then can be included in the protocols of cracking test(s).

**RELATED RESEARCH SUMMARY FROM STAGE 1:**

Cracking typically starts occurring a few years after the pavement or its overlay has been in service. During the service, asphalt materials age as a result of oxidation and/or ultraviolet lights. In the laboratory, asphalt mixes are often aged at an elevated temperature to accelerate the aging to a level that mimics the aging in the field. AASHTO R30, "Standard Practice for Mixture Conditioning of Hot Mix Asphalt (HMA)" is the current standard on long-term laboratory aging which specifies 5-day aging at 85 Celsius. However, studies have reported that 5-day 85 Celsius aging does not represent long-term field aging. However, recently completed NCHRP 09-54 has found that on average, 5-day at 95°C represents the long-term aging nationwide [Kim et. Al 2017]. Other researchers also studied the effects of aging on cracking performance. However, the recommendations on aging conditions are inconclusive, ranging from 1-day at 95 Celsius [Al-Qadi et al. 2019], to 8 hours at 135 Celsius [Chen et al. 2019], to 12 days at 95 Celsius [Rahbar-Rastegar et al. 2019].

In addition, these studies focused on the aging of hot mix asphalt as surface materials. It is a common practice of MDT to

***Note: All research topics submitted become public property and submitters are not guaranteed to receive a contract for any work that may result from this topic statement.***

# Montana Department of Transportation

## Stage 2 - Research Topic Statement

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

place chip seal on top of newly paved hot mix asphalt within one year of completion of HMA paving. The presence of chip seal significantly affects the field aging of hot mix asphalt. One study by Washington State University indicated that after seven years in service, an asphalt binder in HMA without chip seal had a performance grade of PG75, compared to PG67 of binder in HMA covered with chip seal [Wen et al. 2016]. Therefore, it is imperative to determine the aging conditions that mimic the aging of HMA under the chip seal in Montana.

REFERENCES:

Al-Qadi, Imad L; Ozer, Hasan; Zhu, Zehui; Singhvi, Punit; Ali, Uthman Mohamed; Sawalha, Mohammed; Luque, Arturo Francisco Espinoza; Mainieri, Javier Jesus Garcia; Zehr, Thomas G. Development of Long-Term Aging Protocol for Implementation of the Illinois Flexibility Index Test (I-FIT). Civil Engineering Studies, Illinois Center for Transportation Series, University of Illinois, Urbana-Champaign; Illinois Department of Transportation; Federal Highway Administration, Issue 19-012, 2019, 156p

Chen C., F. Yin, P. Turner, R. C.West, and N. Tran “Selecting a Laboratory Loose Mix Aging Protocol for the NCAT Top-Down Cracking Experiment,” Transportation Research Record 2018, Vol. 2672(28) 359–371

Kim et al., 2017, “Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction,” NCHRP Report 871, Washington, DC: The National Academies Press.

Rahbar-Rastegar R., Zhang R., Sias J.E., and Dave E.V., "Evaluation of laboratory ageing procedures on cracking performance of asphalt mixtures," Road Materials and Pavement Design, 2019, Vol. 20, No. S2, S647–S662

Wen H., Wu S., Chaney S., Littleton K., and Muench S., "Quantification of Effects of Bitumen Surface Treatments on Material Properties of Existing Asphalt Pavement," Journal of Materials in Civil Engineering, Vol. 29, Issue 4 (April 2017)

**RESEARCH PROPOSED:**

It is expected the proposed project will consist of the following tasks:

(1) Conduct a comprehensive literature search to review methodology of aging condition in the United States and overseas.
(2) Prepare a survey to be submitted to various transportation agencies to collect relevant information on their current practices related to aging condition.
(3) Collect asphalt pavement materials (roadway cores) from roads within different climatic conditions in Montana at the time of occurrence of pavement cracking .
(4) Extract/recover asphalt binders and conduct experiments on recovered binders to determine the performance grades of recovered asphalt binders and compare to original performance grades at the time of paving to determine the aging over the years.
(5) Collect loose mixes that represent pavements in Montana to determine the appropriate aging conditions in the laboratory that would mimic the aging level observed from the field-aged materials, based on extracted and recovered binder.
(6) Make recommendations on the aging conditions for cracking test.

**RESEARCH PERIOD (Time to complete research project.):**

July 2021-June 2022

***Note: All research topics submitted become public property and submitters are not guaranteed to receive a contract for any work that may result from this topic statement.***

# Montana Department of Transportation

## Stage 2 - Research Topic Statement

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

**IT COMPONENT: Identify if the project includes an IT component (purchasing of IT hardware, development of databases, acquisition of existing applications, etc.). If so, describe IT component in as much detail as possible.**

None

**FEASIBILITY, PROBABILITY OF SUCCESS, AND RISK:**

This study includes literature review, sampling of asphalt materials from the field, and testing in the laboratory. These tasks are based on well-established procotols. The probability of success is very high.

**URGENCY, IMPORTANCE, AND EXPECTED BENEFITS/PAY-OFF: Address urgency, timeliness, and importance of the research. Identify if the research is required for any federal or state initiative or compliance. This section must include a description of how this research will help to meet MDT's mission (i.e., serve the public by providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality and/or sensitivity to the environment).**

Most of paved roadways in State of Montana are surfaced with asphalt materials. Each year, MDT spends hundreds of millions on asphalt roadways. Like many other highway agencies, MDT is considering to implement IDEAL-CT test as the HMA cracking test to prevent the use of cracking-prone hot mix asphalt from highway construction. The determination of laboratory aging conditions is the fist step needed to implement the cracking test. The selection and use of cracking-resistant hot mix asphalt would increase the pavement service life, reduce the life cycle costs and also reduce user costs associated with traffic disruptions during roadway repairs.

**IMPLEMENTABILITY, IMPLEMENTATION PLAN, AND RESPONSIBILITY: Address the implementability of the expected results from the proposed project. Identify products that will enhance implementation. Identify any known implementation barriers and how these barriers might be eliminated or reduced. Identify MDT office or entity outside of MDT responsible for implementation. Describe initial implementation plan, include timeframe for implementation.**

The aging conditions which are determined from this proposed study will be directly included in the MDT's Materials Manual and the test protocol of IDEAL-CT test. It is expected that the implementation of the aging condition will be completed within 6 months after the proposed study.

**MDT PRIORITY FOCUS AREAS: MDT may, as often as annually, identify priority research focus areas. These focus areas will be listed on http://www.mdt.mt.gov/research/unique/solicit.shtml.**

Materials and Construction

**TOTAL COST ESTIMATE (If the project proposal comes in at a higher cost, it may require further approval and may be delayed.):**

$68,000

**MDT FUNDING SOURCE (If MDT Research, enter SPR):** SPR

**FUNDING MATCH SOURCE AND AMOUNT:** None

**FUNDING PARTNER(S):** None

***Note: All research topics submitted become public property and submitters are not guaranteed to receive a contract for any work that may result from this topic statement.***

# Montana Department of Transportation

## Stage 2 - Research Topic Statement

2701 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
www.mdt.mt.gov

Print Form

**POTENTIAL TECHNICAL PANEL MEMBERS (At this time, individuals do not necessarily need to be identified; rather, MDT offices and outside entities can be named. However, if known, individuals may be named):**

Ross "Oak" Metcalfe and MDT Materials and Pavement Engineers

| **SUBMITTED BY: (required)** | |
|---|---|
| **NAME:** | Haifang Wen |
| **TITLE:** | Associate Professor, Co-Director of Washington Center for Asphalt Tech |
| **AFFILIATION:** | Washington State University |
| **ADDRESS:** | 405 NE Spokane St., Pullman, WA 99164 |
| **PHONE NO.:** | 509-335-4602 |
| **E-MAIL:** | haifang_wen@wsu.edu |

**CHAMPION: Must be internal to MDT, feel strongly that the research will benefit the Department, and is willing to chair the technical panel. Note: If a champion is not identified by you or Research staff, this topic statement will not move forward.**

| | |
|---|---|
| **NAME:** | Ross "Oak" Metcalfe |
| **TITLE:** | State Materials Engineer |
| **AFFILIATION:** | Montana Department of Transportation |
| **ADDRESS:** | 2701 Prospect Avenue, Helena, MT 59620-1001 |
| **PHONE NO.:** | 406-444-9201 |
| **E-MAIL:** | rmetcalfe@mt.gov |

**SPONSOR(S) (optional): Must be internal to MDT (Division Administrator or higher) and willing to ensure implementation occurs, as appropriate. If a sponsor is not identified by you or Research staff, this topic statement will not move forward.**

| | |
|---|---|
| **NAME:** | |
| **TITLE:** | |
| **AFFILIATION:** | |
| **ADDRESS:** | |
| **PHONE NO.:** | |
| **E-MAIL:** | |

***Note: All research topics submitted become public property and submitters are not guaranteed to receive a contract for any work that may result from this topic statement.***