Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Best Practices to Address Issues of Excess Aggregate Dust in Nebraska

Research Objectives

Determined the best practice to address potential issues of excess aggregate dust in Nebraska concrete. To achieve the goal, three specific objectives of this study are to:

1. Select and conduct various laboratory tests to characterize different types of aggregate dusts
2. Accessed the negative impact of excess dust on NDOT concrete properties and performance
3. Identified the best practice to further improve current NDOT methods to control the negative effects of for excess dust in concrete mixtures

Research Benefits

Provided a better understanding of the impact of excess dust in Nebraska aggregates and effective measures to minimize the potential deleterious contribution to concrete performance. The outcome of this study provided NDOT with the alternative options to be more proactive to address the potential issues, so that extended service life of concrete pavement and bridge decks can be achieved.

Principal Investigators

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Background

Excess aggregate dust, also known as "dirty" aggregate, can cause issues in concrete at different stages. While potentially negative impact is well-recognized, it is also known that the mineralogy of the dust is critical. For example, clay coatings showed a more harmful impact on concrete performance compared with other dusts such as carbonates (limestone dust) or stone dust. Clays weakly adhere to aggregate will be dispersed in the mixing water; therefore, will be integrated into the cement paste and could lead to workability issues. Specific clays mixed with a particular type of air entraining admixtures (AEA) can largely neutralize the function of the AEA and make it difficult to achieve the required freeze/thaw resistance. On the other hand, clays that are strongly bonded to the aggregate surface will remain mostly located on the aggregate surface after the mixing process; therefore, may disrupt the aggregate-paste bond (usually referred to as interfacial transition zone (ITZ) and results in strength and durability issues.

Conclusion

The negative impacts of an excessive amount of aggregate dust have been known and reported in different states. The extent and impact of dust on concrete performance, which depends not only on the quantity but also on the nature of the dust can be complicated. For example, clay coatings showed a more harmful impact on concrete performance compared with carbonates (limestone dust) or stone dust. While clays that weakly adhere to aggregate will be dispersed in the mixing water and could lead to workability or air entrainment issues, clays that are strongly bonded to the aggregate surface will remain at the aggregate surface after the mixing process and may disrupt the aggregate-paste bond and results in strength and durability issues. The upper limits of aggregate dust (fines) currently in most state agencies' specifications are not necessarily sufficient to prevent aggregate issues.

This research included five different types of aggregates which were specified, limestone, gravel, dolomite, granite, and quartz, these aggregates were collected from Nebraska, South Dakota, and Wyoming. A comprehensive evaluation of the aggregate dust was performed using sieve analysis, washing test, sand equivalent test, methylene blue test, and X-ray powder diffraction. Besides the evaluation of fresh, hardened, and durability properties of concrete, advanced tests were used to characterize aggregate-paste bonding inside concrete prepared with different aggregate types and cleanliness. While aggregate collected in this study meet the currents NDOT criteria of coarse aggregate fine content and fine aggregate sand equivalent, additional tests such as methylene blue value could provide more insights into the type of dust on the aggregate surface. The Modified Methylene blue value (MMBV) could potentially be used to reduce the coarse aggregate dust. However, future investigation is needed to establish a correlation between MMBV and field concrete performance that can be eventually used to set up criteria for quality control.

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NDOT Recommendations Based Off of Research Project

The Department will review the proposed Modified Methylene blue value (MMBV) test method and look at the feasibility and the required equipment for testing.

- *As provided by Wally Heyen, Lead TAC Member*

Research Readiness Level (RRL) Assessment

RRL 2

Level 2: Applied Research/Proof Concept
More Internal- Lab Level testing for proof of concept

Technology Transfer

Conferences/Presentations

- T. Barissov, J. Hu, and Y. Kim, "Effects of Aggregate Dusts on Pavement Concrete Performance", International Airfield and Highway Pavements Conference, Virtual Conference, June 6-9, 2021

This brief summarizes Project SPR-P1 (20) M114
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