Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Feasibility of Using Recycled Waste Plastic in Concrete Pavements in Nebraska

Research Objectives

This study aims to investigate the feasibility of utilizing RP as a partial substitute in concrete and its effects on the physical and mechanical properties of concrete. Investigate the performance of concrete mixtures containing RP by casting several slab and beam specimens using ready-mixed concrete (4 cu.yd each) to determine the behavior of fresh and hardened concrete in terms of workability, unit weight, temperature, air content, set time, compressive strength, flexural strength, modulus of elasticity, and tensile strength. Investigate factors that need to be considered when designing concrete mixtures containing this waste material and develop guidelines for successfully producing, placing, and curing concrete that meets NDOT's specifications for concrete construction.

Research Benefits

The information collected from this project will significantly encourage the development and adoption of this new "green" material. The success of the study is expected to bring new opportunities and positive economic and environmental benefits, and create a more economical and sustainable infrastructure in the state of Nebraska, and the U.S. The proposed study has great potential to be implemented by NDOT.

Principal Investigator

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Background

The cement and concrete industries have been under tremendous pressure to reduce their carbon footprint, which forces them to explore alternative ways to reduce the carbon footprint in the transportation industry. Solid waste is one of the many factors that negatively affect the environment. Problems stem from factors such as difficulty of waste recycling and limited reuse. Plastic is an important type of solid waste with a strong environmental impact. This study aims to investigate the effects of utilizing recycled plastic (RP) in concrete. The investigation will aim to look at plastic waste as a partial substitute for coarse and/or fine aggregates in concrete and s fiber reinforcement (plastic strands) in concrete for crack control.

Conclusion

Waste plastic (WP) is a growing environmental concern due to its non-biodegradable nature, large-scale production, and harmful impact on natural resources. With nearly 75% of WP in the U.S. ending up in landfills, effective recycling strategies are urgently needed. In parallel, the limited availability of natural aggregates highlights the need for alternative materials in concrete construction. This study investigates the feasibility of using recycled waste plastic (RWP) in concrete mixtures, both as aggregates and fibers for rigid pavement applications in Nebraska. Concrete mixtures were prepared by partially replacing natural fine aggregates with recycled plastic aggregates (RPA) at replacement levels of 5%, 10%, and 15% by volume of the natural fine aggregates. Additionally, recycled plastic fibers (RPF) were incorporated into the mixtures at dosages of 0.5%, 1%, and 1.5% by total volume of the concrete. RWP materials underwent characterization tests to compare with traditional materials. A preliminary investigation evaluated fresh properties and compressive strength to assess suitability based on Nebraska Department of Transportation standards (NDOT), using the standard (47B) pavement mixture as a control. Mixtures meeting performance criteria were selected for further testing, including splitting tensile strength, flexural strength, and modulus of elasticity. Fracture behavior was assessed through semi-circular bending (SCB) tests. Also, durability was evaluated using the surface resistivity test, which assesses electrical resistivity as an indication of chloride ion penetration. Results showed that the inclusion of RWP aggregates can increase workability. Statistical analysis indicates that up to 10% RPA replacement does not significantly reduce compressive strength while satisfying the standard requirements set by the NDOT for paving applications. When RWP was used as fiber, a reduction in workability was observed. Nevertheless, the addition of RWP fibers had a positive influence on the flexural strength, ductility, and cracking resistance, with an optimum content of 1.5%. Surface resistivity confirmed acceptable durability performance with respect to NDOT requirements. Overall, incorporating RWP into concrete as aggregate or fibers offers a sustainable solution by reducing WP in landfills while maintaining or improving concrete performance for pavement applications.

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NDOT Recommendations Based Off Research Project – 2026 – RRL3

In the Phase I, the research showed the feasibility of incorporating recycled plastic aggregates (RPA) and recycled plastic fibers (RPF) into concrete, at up to 10% RPA or 1.5% RPF. Despite the promise shown in Phase I, there was no large-scale field monitoring to validate constructability, durability, and performance under real-world conditions. Therefore, Phase II of this project, SPR-FY27(064), has been funded to identify application pathways, determine long-term mix performance, and adjust the mix to a 45/55 fine aggregate to coarse aggregate ratio rather than the 70/30 explored in Phase I.

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

Research Readiness Level (RRL) Assessment

RRL 3

Level 3: Development

Follow up upon completion of Phase II, SPR-FY27(064), in 2028.

Technology Transfer

Webinars/Presentations

- Teixeira, J.E. S. L., Morcous, G.. Feasibility Assessment of Waste Plastic as Aggregate and Fiber Reinforcement in Concrete Pavements. 2026 Nebraska Concrete Paving Association's Annual Concrete Paving (NCPA) Workshop, Lincoln, NE, 2026.
- Teixeira, J.E. S. L. Plastic Roadway Project. Presented at Solid Waste Association of North America 2025 Joint Fall Conference (Nebraska Chapter), Kearney, NE, 2025.

This brief summarizes Project SPR-RRR (002)
"Feasibility Study of Local Waste Plastic Materials in Concrete"
Nebraska Department of Transportation Research Program