Oregon Department of Transportation

Stage 1 Research Problem Statement

Number 25-04

Proposed Title: Reducing plastic pollution by turning waste plastics into beneficial additive for concrete pavement

1. Concisely describe the **transportation issue** (including problems, improvements, or untested solutions) that Oregon needs to research.

Oregon has a great amount of concrete pavement for highways, rest areas, etc. where innovative technologies are needed to enable significant and reliable recycling of waste materials for cost reduction and sustainability benefits. At the national level, the total amount of plastic products in the municipal solid waste (MSW) was 35.7 million tons in 2018, whereas the annual production of concrete is approximately 500 million tons. Considering this, one can expect that the inclusion of only 7 wt.% of waste plastics in concrete can sufficiently eliminate all plastics in municipal solid waste in the U.S.

2. Document how this **transportation issue** is important to Oregon and will meet the Oregon Research Advisory Committee Priorities

Despite ongoing efforts to improve recovery of plastic waste, Oregon has failed to meet the plastic waste recovery goal. This is an important issue to the Oregon Department of Transportation, because beneficial use of waste plastics can help reduce the construction cost of concrete pavement, improve value-added application of this *misplaced resource*, and produce innovative technologies for implementation.

The incompatibility of polymers with concrete mixture is a major challenge, where the differences in surface chemistry result in weak polymer/concrete interfacial interactions and poor dispersion. We will build on the novel modification methods of waste plastics and leverage their influence on the engineering properties and durability performance of concrete. The project will take the advantage of chemical surface functionalization using coupling agents as well as enzymatic surface treatment using bacteria or fungi to promote the adhesion bonding between waste plastic and concrete. The modified additive will be dispersed into a concrete mixture to investigate its effect on the functional properties of the concrete. It is expected that the value-added application of waste plastics can not only address health and environmental risks related to plastics pollution but also decrease the demand for fine and coarse aggregates. Additionally, waste plastics can act as a reinforcing additive to benefit the mechanical properties of the concrete.

3. What **final product or information** needs to be produced to enable this research to be implemented?

This project will generate a document that identifies the major sources of waste plastics in the State of Oregon that can be beneficially used in concrete, how the representative types of plastics could be surface treated to prepare them for dispersion in the concrete mixture, and the properties of plastic-amended fresh and hardened concretes with different loading levels (up to 7 wt.%). The project will also produce viable concrete mix designs that feature good workability, proper air content, reasonable cost, and acceptable mechanical properties and durability performance for adoption by the Oregon DOT for concrete pavement applications. Overall, the findings will de-risk the recycling of several types of waste plastics for use by highway agencies and potentially others.

4. (Optional) Are there any individuals in Oregon who will be instrumental to the success of implementing any solution that is identified by this research? If so, please list them below.

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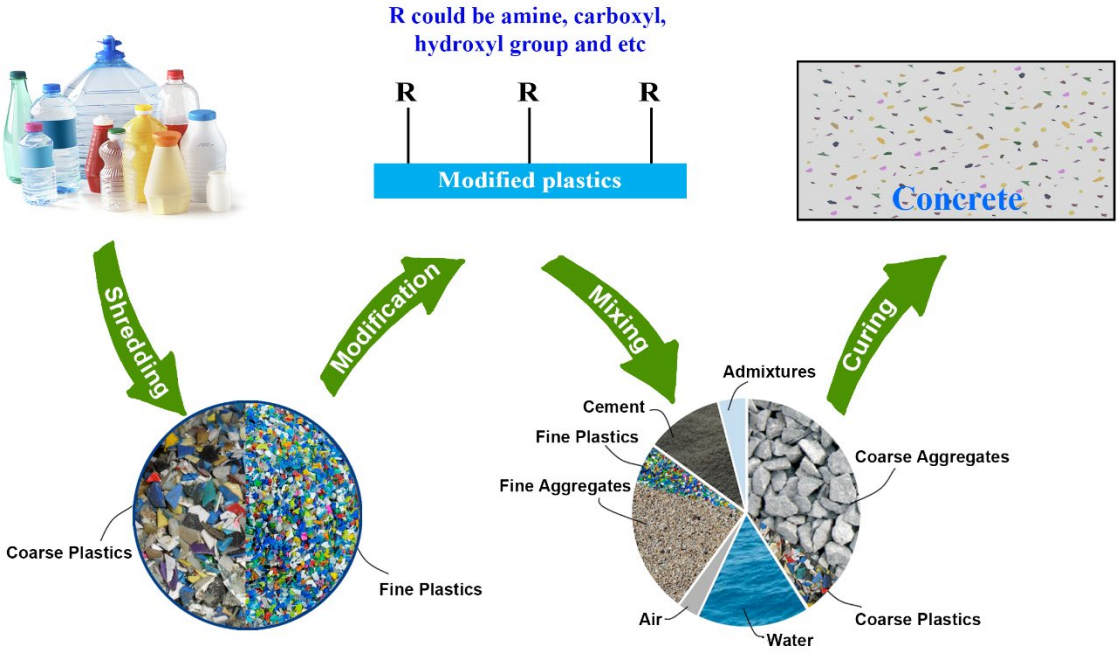
5. Other comments:

This effort will demonstrate the conversion of "waste" into beneficial products, while providing a foundation for longer term benefits associated with workforce training, education, and economic development in recycling and construction industries. We aim to achieve value-added application of plastics for durable, environmentally friendly concrete pavement. First, for value-added application, the size-fractioned plastics should be affordable such that the plastics-amended concrete mixes remain cost-competitive if the LCCA of the pavement is conducted. Second, the plastics-amended concrete mixes should achieve at least comparable, if not better mechanical strengths and durability performance than the control concrete mix. These outcomes can be readily evaluated. Next phase would be field demonstration of this technology to showcase the feasibility of plastics concrete and thus speed up the adoption of plastics concrete by practicing engineers.



6. Corresponding Submitter's Contact Information:

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