Environmental Friendly Applications of Ground Tire Rubber (GTR) In Producing Concrete

Project Number:

22CASU01

Start Date:

04/01/2022

Principal Inverstigator(s):

Zahid Hossain

Arkansas State University

Lead Institution:

Arkansas State University

Funding Source(s):

Tran-SET

Arkansas State University

Total Project Cost:

$ 120,106

Assessing Friendly Applications of Ground Tire Rubberfor concrete production

Over 280 million waste tires are generated in the United States on an annual basis. A majority of 3.3 million waste tires generated in Arkansas are either dumped in the landfill or burnt for generating energy; neither of them is a sustainable approach. Handling and disposal of these waste tires is a huge challenge for solid waste management departments of agencies such as the Arkansas Department of Environmental Quality (ADEQ). However, these waste tires can be recycled and utilized as new construction materials to produce durable concrete as the rubber possess favorable engineering properties. The main objective of this study is to assess the feasibility of the use of GTR in preparing durable paving concrete. Specifically, the current study has the following objectives: (a) collect appropriate GTR samples for paving concrete, (b) evaluate fresh and engineering properties of GTR-modified concrete, (c) evaluate the long-term durability properties of GTR-modified concrete, (d) determine the optimum dosage of GTR based on fresh, mechanical, and durability properties tests results, and (e) develop guidelines in implementing GTR-modified concrete.

Problem Statement

The generation of over 4 million tons (over 280 million tires) of waste automobile tires annually in the United States poses serious challenges to the solid waste management agencies [1]. These waste tires in the powdered form of ground tire rubber (GTR) can be used as a filler material to substitute fine aggregate and/or an alternative to supplemental cementitious material (SCM) while preparing paving concrete. The strength reduction due to usage of GTR can also be optimized by controlling the percentage of GTR in the mixture. Limited early studies in the 1990s, mostly from overseas, were carried out to estimate the optimum percent of GTR in Portland Cement Concrete (PCC) and recommended not to use it for structural applications based on the initial setting time and modulus of elasticity requirements. Some recent studies in the 2010s reported that the GTR-modified concrete showed relatively low strength, but improved toughness and elasticity, and recommended GTR-modified concrete for sidewalks or similar structures. Some of these studies also reported that a small amount of GTR (about 5%) can reduce the plastic shrinkage of concrete. In particular, if the grain size of GTR is less than 0.425 mm (powder form), then it can be used as a partial replacement of cement or SCM. Thus, the proposed study will assess the feasibility of the usage of GTR in producing durable and cost-effective concrete through a series of laboratory tests of fresh and hardened concrete along with a field demonstration project. The benefits of the successful use of these waste materials include, but are not limited to, a huge cost saving for the Arkansas Department of Transportation (ARDOT) and other agencies and a reduction of solid waste management burden for the Arkansas Department of Environmental Quality (ADEQ). The findings of the project will be delivered in the form of a technical report and dissemination at conferences and symposia in the region and the national level.

Objectives

The proposed study will assess the feasibility of the use of GTR in preparing concrete. Different percentages of GTR will be tried to find the optimum dosages based on fresh and hardened concrete's performance properties. Performance properties of GTR-modified concrete will be compared with regular concrete (the Control). Specific objectives of the proposed study are to (i) evaluate the fresh and mechanical properties of GTR-modified concrete; (ii) evaluate the long-term durability properties of GTR-modified concrete; (iii) determine the optimum dosages of GTR in terms of fresh, mechanical, and durability properties tests results, and (iv) formulate guidelines in deploying GTR-modified concrete in producing roadway concrete.

Figure 1. (a) Stockpiled Waste Tires in a Landfill and (b) Processed GTR Sample (Mesh #40).

Intended Implementation of Research

Workforce Development, Education, and Outreach: This task supports the federal initiative to build the next generation of transportation professionals to meet the demands of the rapidly changing 21st-century transportation system. The PI currently supports and mentors five graduate students and four undergraduate students from external grants. The proposed study will help the PI to recruit and train more graduate and undergraduate students within the transportation research. If GTR is recommended for deployment, the PI intends to advise the A-State ASCE Concrete Canoe team to incorporate it in their canoe mix design. The PI will also blend the GTR research in the Advance Civil Engineering Materials class at the graduate level that he teaches regularly in the fall semester. Further, a radio podcast will be broadcast to disseminate the research initiatives and findings to a large audience in the local community. The findings from this research study will be disseminated at symposia and conferences such as TRB Meetings, ARDOT TRC Meetings, Tran-SET Conference as well as in the forms of technical papers and the final report. Technical articles, posters, and presentations will be delivered at national and local conferences and symposia such as ASCE, and Create@STATE.

Anticipated Impacts/Benefits of Implementation

The findings of this study will help ARDOT and ready-mix concrete industries in the region to use knowledge learned on GTR- modified concrete. It is expected to be significant cost savings for these agencies in selecting appropriate materials for producing sustainable concrete.

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.