ACRP Problem Statement: 97 **Recommended Allocation:** $180,000

Using Recycled Carbon Fibers in Electrically Heated Pavement

Click here to see problem statement in IdeaHub: http://ideascale.com/t/UKsrZBVD4 *(Note: you must be a registered user in myACRP/IdeaHub.)*

TAGS: Construction, Finance Economics, Maintenance, Operations, Sustainability, Water Quality

STAFF COMMENTS

No comments.

AVERAGE INDUSTRY RATING SUMMARY

	Committees[1]	Airport Community[2]
Achievable	2.33	2.00
Applicable	2.33	2.00
Implementable	1.67	1.00
Understandable	2.67	3.50
OVERALL	2.25	3.00

Notes: 1. Includes TRB aviation committees and committees from ACI-NA and AAAE.
2. Includes airport employees serving on active ACRP project panels.

USE THIS LINK TO SEE DETAILED INDUSTRY RATINGS. Click on the arrow in the Problem Statements dropdown menu in the upper right and select the problem statement number.

USE THIS LINK TO SEE DETAILED INDUSTRY COMMENTS. Click on the arrow in the Problem Statements dropdown menu in the upper right and select the problem statement number.

ACRP OVERSIGHT COMMITTEE (AOC) DISPOSITION

The average AOC rating among its voting members was 1.7 on a scale of 1 to 5. There was no discussion. The problem statement was not selected for ACRP funding and will be returned to the idea collection phase of ACRP's IdeaHub.

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TAGS: Construction, Finance Economics, Maintenance, Operations, Sustainability, Water Quality

OBJECTIVE

Establish if and how recycled (pyrolyzed) carbon fibers can be used in place of virgin carbon fibers for achieving comparable performance at lower material costs.

BACKGROUND

Many US airfields experience snow, ice, or slush in the winter time. Less than perfect conditions of runways or aprons lead to slower, less efficient and less safe operations. Typical removal practices are costly, time consuming and can have environmental and corrosive impacts.

Heated Pavement Systems (HPS) are offering an alternative. Of the different types available, Electrically Conductive Concrete (ECC) has proven to be a viable approach (Sassani et al., 2018). In general, ECC consists of cement, sand, aggregates, water, additives and an electrically conductive component. Among various other possibilities (metallic wires or particles, carbon based powders, carbon nano materials), short carbon fibers (CF) have proven to be the best performing conductive material in terms of effectiveness, non-corrosiveness, installation and operating costs. They also improve other concrete properties such as compressive strength, tensile strength, and fatigue cracking.

Of those, typical PAN-based carbon fibers with diameters of up to 15 μm and lengths of up to 6mm have proven most effective, with aspect ratios of about 430 being sufficient. Typically used in volume dosages below 1%, their cost nevertheless has a big influence on the overall economics of any HPS. The to date most successful, or at least most tested, formulation uses a combination of nominally 70% 6mm and 30% 3mm virgin carbon fibers. In practice, the mixing process is sure to diminish the actual fiber length distribution. The price range for contracted and regularly available volumes of short, standard modulus carbon fibers is around $8 - $12 per lb.

If processed properly, recycled (pyrolyzed) carbon fibers can be produced with minimal reduction of their actual fiber properties, and costs under $3 per lb (per Modern Recovery Systems, Inc.). However, while their average length can be controlled, it is never entirely consistent, and rather a length distribution around a median. But it stands to reason that recycled fibers with the right average length will match the conductive performance of virgin fibers, and at a much lower total cost, even if the actual quantity of fibers should need to be somewhat higher.

In practice, the challenge will be to find the optimum combination of average length and quantity of recycled fibers, since neither amount nor length of fibers in concrete mixtures can be increased indefinitely without affecting its workability.

APPROACH TO RESEARCH

- Review latest carbon fiber & cement application practices and research. Focus on formulations, mixing technology and mixing sequences
- Develop an experimental plan to compare effect of using various recycled (pyrolyzed) carbon fiber samples vs. virgin carbon fiber (3mm and 6mm)
- Conduct experimental work
- Develop a use profile of how to substitute recycled for virgin carbon fibers (<6mm) in cement applications

COST AND JUSTIFICATION

Estimated problem funding: $180,000

RELATED RESEARCH

Electrically conductive pavement as a solution for de-icing/anti-icing systems is currently being investigated.

Early work was conducted by Tuan, incorporating conductive concrete to develop a deicing concrete pavement for a bridge deck (Yehia et al., 2000). The system was implemented in Nebraska and tested. At the Iowa State University a research team led by Halil Ceylan is currently researching electrically conductive concrete heated pavements with promising results. (Abdualla et al., 2016). They conclude that short carbon fibers (3mm-6mm) are superior to all other alternatives, but that construction costs, especially the costs of the conducting component, are critical for overall feasibility (Sassani et al., 2018).

Carbon fiber composites are being recycled in different ways, however, the only method which is capable of extracting clean, raw fibers from all types of wastes and polymer matrixes (regardless of their curing stage), is pyrolysis (Oliveux 2015). When processed optimally, the recovered fibers maintain their original fiber properties (Boulanghien 2013).

References:

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IDEA CREATOR
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