Testimony to U.S. Senate Environment and Public Works Committee, Subcommittee on Chemical Safety, Waste Management, Environmental Justice, and Regulatory Oversight, March 30, 2023

By

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Good morning, Chairman Merkley, Ranking Member Mullin, and distinguished members of the subcommittee on Chemical Safety, Waste Management, Environmental Justice, and Ranking Member Capito of the US Senate Environment and Public Works Committee. My name is Hota GangaRao, Professor and Director of the Constructed Facilities Center in the Wadsworth Department of Civil and Environmental Engineering at West Virginia University. I conduct research at the University through the Center for Integration of Composites into Infrastructure (CICI), which is sponsored by the US National Science Foundation (NSF), federal and state government agencies, and private industry.

I am pleased to be speaking on behalf of the American Composites Manufacturers Association (ACMA) which represents the entire spectrum of North American composites supply chain, including universities conducting research and development, (such as the Center for Integration of Composites into Infrastructure sponsored by NSF) suppliers, manufacturers, end users, and other businesses involved in the composites sector. ACMA represents over 300 companies and institutions in 49 states, with over 60 percent, being small and medium sized businesses.

Thank you for inviting me to speak on the topic of the environmental impacts of polymers and plastics which is of utmost importance. **With declining performance of our in-service infrastructure, how do we ensure that the United States uses advanced materials that are the best choice for the environment and the economy while advancing the state of the art for better quality of life to our citizens?**

I have worked for decades with a material system that I believe provides a compelling answer: fiber-reinforced polymer (FRP) composites. FRP composites use a combination of fibers surrounded by a resin system that is then manufactured to a certain shape, often with additives to create specific material properties depending on the end use. The annual resin production in the US is around 120 billion pounds which is increasing due to ready availability of low-cost shale gas, a precursor to make polymers, a quarter of it goes towards the production of reinforced composite materials.

FRP composites are lighter in weight than traditional materials (25% of steel), durable by a factor of 2 to 3, nonconductive, and resistant to corrosion or other types of degradation with mild reaction to certain environments. Hence a broad array of industries (automotive, aerospace, infrastructure, leisure, etc.) have been using composites since early 1940s or even before, and others are continuing to discover innovative uses.

Applications that may interest this committee include the use of composites in infrastructure including bridge components and rebar (Fig.1), a particular area of focus for my research. Rhode Island, for example, has used FRP composites to add pedestrian walkways (Fig.2) to bridges, increasing access (shopping, dining, tourism) to communities. Similarly, West Virginia has been using composites to retrofit deficient bridges in service (Figs.3 & 4), and US Army Corps has been using all composite hydraulic structures developed by WVU (Fig.5). Similarly, FRP composites hybridized with steel substrate can also be used to make rail tankers stronger with high energy absorption and less likely to puncture (Fig.6). This is an issue of national importance because of recent high-profile train derailments of cars with hazardous materials. FRP composites are also important in the energy sector. Composites are the best choice for wind turbine blades, they are an enabling technology to build larger wind turbine blades for efficient and clean (no GHG) power generation (Fig. 7). Similarly, FRP composite utility poles (>80' height) are proving to be resistant to wildfires and hurricanes (Fig. 8), another nationally critical issue.

In contrast to 'single use' plastics such as foam cups and straws, there are many durable plastics and composites that have been in use for 70 to 80 years. For example, a few composite boats built in early 1950s are in service even today. Similarly, PVC pipes have been in service for over half a century.

The durable (~100 yr service life) reinforced composites use only 20% to 25% of polymers by weight and they have high potential for recycling. Based on a percent (~25%) of an estimated ~70 billion pounds of commodity products entering the waste stream in 2021, Europe achieved an overall plastic recycling rate of 23% with projections indicating that rate will increase to 35% by Year 2030. However, the current recycling rate in the US is around 5% to 6% of annual polymer production of 120 billion pounds (80% thermoplastics & 20% thermosets) and 85% of discarded plastic goes to landfills. In coming years, these recycling numbers will improve due to intense ongoing research in government and industry labs and universities, and production of durable composites from recycled content will increase dramatically.

Another important aspect to highlight is the ‘near-future’ development of naturally renewable agricultural resources (natural fibers & resins) which offer solutions to polymer composite product manufacturing. They require lower magnitudes of energy than conventional materials like steel. For example, CO_2 emissions are 1.9 tons for every ton of steel produced while FRP produces 81% less CO_2. The above computation is based on the emissions corresponding to a FRP versus steel pedestrian bridge. In other words, products developed from natural materials require only 20 to 25% of (embodied) energy in comparison to commodity materials.

Therefore, we urge US Congress to kindly direct R&D agencies to focus on developing and implementing multi-functional commodity materials that are durable, recyclable, and biodegradable (e.g., PLA) and gradually move away from single-use plastics. However, as we continue to research and develop alternate biodegradable sources, completely banning the use of common plastics is not advisable at this point because many are used to create the composites mentioned above. I am sure that alternate biodegradable sources will be found soon because of ongoing research enveloped in the American ingenuity.

As you look at how to address plastic waste, I would urge the committee to promote growth of composites and other advanced materials in the United States and lend a direction for faster discovery of alternate material sources and systems, and speedier implementation.

Thank you for allowing me to testify today, I look forward to answering any questions.

Fig.1 FRP Rebars for Highways and Bridges

Project Summary

Lightweight, high strength, non-corrosive FRP rebars as reinforcemnts to replace steel rebars for highway bridges and roadways.

Project Impact

FRP rebars are currently widely used in bridges.

Project Team

WVU-CFC

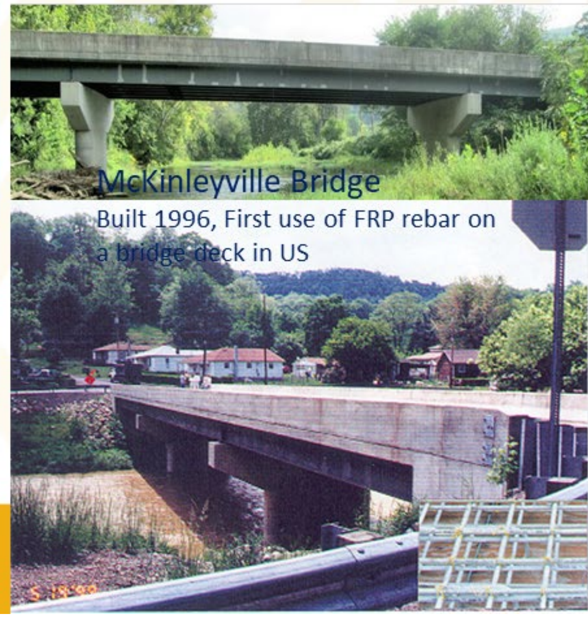

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Fig.2 FRP Pedestrian Truss Bridge

Project Summary, Sponsored by BRP

The GFRP composite pedestrian truss bridge (10' in width x 70' in length) was constructed and tested using individual truss elements in tension and compression in addition to using FRP deck and diaphragm (cross members) elements.

Project Impact

The work leads to the use of FRP pedestrian bridges in an economical and durable manner and help different clients located in urban and rural settings.

Project Team

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Fig.3 FRP Wraps for Retrofitting Bridges

Project Summary

Applying band-aid type of FRP wraps to restore, retrofit and strengthen the exisrting deteriorated highway concrete bridges and railway timber bridges.

Project Impact

WVU CICI has saved the State of West Virginia millions of dollars with innovative technologies.

Project Team

WVU-CFC

West Virginia University.

Fig.4 Rehab of Corroded Steel H-Piles, East Fork Bridge, Huntington, WV

Project Summary

Bring load capacity back to original at 25% of traditional repair cost, with use of composite shell, wrapped, and then filled with SCC.

Project Impact

Demonstrated composites' as enabling technology

Project Team

WVU-CICI in collaboration with USACE

West Virginia University.

Fig.5 FRP Composite Wicket Gates to Replace Timber Wicket Gates

Project Summary

Use of advanced fiber reinforced composite materials integrated with innovative manufacturing method to develop FRP wicket gate in lieu of traditional timber wickets that would deteriorate within few years.

Project Impact

Successfully showcaseing fundamental and applied research leading to field implementation with composite advantages: innovation, design flexibility, non-corrosiveness

Project Team

WVU-CICI in collaboration with USACE

WestVirginiaUniversity.

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Fig.6 FRP Composite Jacketing for Tank Cars under Impact and Fire

Project Summary, Sponsored by USDOT-PHMSA

To develop multifunctional FRP composite jacket that provides performance in terms of high strength and stiffness, better puncture resistance, and excellent energy absorption under the impact.

Project Impact

The being developed FRP composite jacket will offer superior fire and puncture resistance with lower life-cycle cost to prevent chemical spills when derailment occurs.

Project Team

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Fig.7 FRP Composite Turbine Blades for Wind Energy

Project Summary

The more efficient wind mill energy operations will be derived through longer blade lengths. Composite materials as the enabling technology to manufacture lightweight, greater length and durable turbine blades at minimal cost.

Project Impact

US wind energy industry shares 21% of total worldwide wind power generation amounting 10.2% of electricity usage nationally and has a composite market size of US $700 million in value in 2021.

Project Team

LM Wind Power 107.0 Blade Development Team

West Virginia University

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Fig.8 FRP Utility Poles and Crossarms Surviving from Wildfires

Project Summary, Sponsored by EPRI

To develop fire flame test to simulate wildfires and fully evaluate fire performance of FRP utility poles and cross arms for better performance and design of composite utility structures against fire.

Project Impact

FRP utility poles, especially with use of intumescent coatings, are able to survive from general wildfires, helping utility industries to use FRP poles with confidence.

Project Team

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