Statement of Scott Reeve
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(on behalf of the American Composites Manufacturers Association)
Before the Subcommittee on Oversight and Investigations
"The Need for Resilience: Preparing America's Transportation Infrastructure for Climate Change"
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Chairwoman Sherrill, Ranking Member Norman and members of the Subcommittee on Oversight and Investigations, my name is Scott Reeve and I am the President of Composite Advantage in Dayton, Ohio. On behalf of our company and my fellow members of the American Composites Manufacturers Association (ACMA), I appreciate the opportunity to testify before you today.

This hearing on building a more resilient infrastructure network comes at a critical time, as increasing stresses are being put on our built environment. In this testimony, I will provide examples of technologies from the composites industry that can be used to mitigate against those stresses, as well as recommendations Congress should consider as you work with the Administration and the states to rebuild and restore America for the 21st Century.

Composite Advantage is one of over 3000 manufacturers of fiber reinforced polymer (FRP) composites industry in the United States. This includes manufacturers in every district represented in this Committee. ACMA would be pleased to meet with each office to provide information on these manufacturers and further elaborate on the benefits composites bring to infrastructure and other markets.

Composites, combinations of polymer resins and fiber reinforcements like glass, carbon or basalt, are used in a wide range of sectors. Their performance characteristics, which I will elaborate on, allow for delivery of greatly improved performance relative to other material options while reducing long term costs and extending service life.

The domestic composites industry contributes more than $50 billion to the US economy and is growing at more than twice the national Gross Domestic Product. Composite materials were first developed for the US military during World War II and the United States continues to be the world’s largest producer.

Fiberglass recreational boats are a well-known and instructive example of composites. Saltwater destroys traditional metal and wood hulls for boats, but fiberglass remains unscathed after decades of high salinity contact and has come to dominate that sector due to its superb performance. Over 50 years of demonstrated superiority provides a parallel to what can be accomplished in infrastructure through increased application of composite materials.

I have been in the composites industry for the bulk of my career. I founded Composite Advantage fifteen years ago after experience in aerospace composites, recognizing the capability of these materials to improve our infrastructure network. We design and manufacture a range of large infrastructure products including vehicle bridge decks, rail platforms, waterway protection systems, and mooring systems for the US Navy’s submarines and aircraft carriers. All made of composite materials.

Key Characteristics of Composite Materials

There are many attributes of composite materials that make them uniquely capable of addressing American infrastructure challenges, including those caused by climate and environmental factors.

Durability
Because they are corrosion-proof, the service life of composite structures typically last at least twice as long as steel and wood equivalents and require little maintenance.

Strength
Per pound, composites are stronger than other materials such as steel, aluminum, concrete and wood. The two primary components of composites – fibers and resins – contribute to their strength. Fibers carry the load, while resins protect the product from the environment and distribute the stresses and loads throughout the composite part as required.

Weight
Composites are light in weight compared to most woods and metals. Lighter leads to lower transportation and construction costs and fewer installation delays. Lighter components also require less additional supporting materials, further reducing costs.

Resiliency
Composites resist damage from weather and harsh chemicals that can eat away at other materials. They will never rust or rot, making them a good choice for applications that face constant exposure to saltwater, deicing salts, toxic chemicals, temperature fluctuations and other severe conditions.

Design Flexibility
A wide range of material combinations can be used in composites, which allows for design flexibility that tailors performance exactly to the unique specifications of each application. Composites can also be easily molded into complicated shapes.

Positive Environmental Impact
Composite structures require significantly lower amounts of energy to be produced than traditional construction materials such as steel, aluminum and concrete. In addition, the resulting structure is chemically inert and will not degrade or leach harmful substances into the environment.

Prefabrication
Large composite structures like bridge decks can be fabricated offsite in a factory, minimizing service disruption to only a brief installation period. Where traditional construction methods could cause traffic disruptions for several weeks as a structure is built from the ground up, prefabricated composites structures with superior performance can be installed in less than one day.

American Made
While our industry has a global footprint, most products available in the market are produced in the United States from raw materials (reinforcements, resins, and other chemicals) produced in the United States.

Climate Resiliency Further Explored

There are greater environmental and weather-related stresses placed on infrastructure than ever before. Severe winter storms necessitate more road salt and other treatments that can accelerate degradation of traditional construction materials. Hurricanes and other related weather events also cause increased exposure to moisture and similarly expose constructed assets to high wind and other factors that can damage infrastructure assets. Rising sea levels put increased strain on coastal maritime infrastructure.

Greater use of composites will allow infrastructure to be more resilient in the face of these challenges. Composite structures in place prior to the severe events will regularly withstand the impact of storms and remain fully operable.

In addition to mitigating against the environmental impact of a changing climate, the materials themselves have environmental benefits worth noting. Composites have lower embodied energy, meaning they require less energy to produce. Because they are longer lasting than alternative options, they need to be replaced less and therefore manufactured and constructed less often. They relatedly consume less materials for repair purposes. These factors lessen the overall consumption of resources needed for the service period of an asset relative to alternatives. Because composites are lighter, they also require less fuel consumption per unit for transportation and installation.

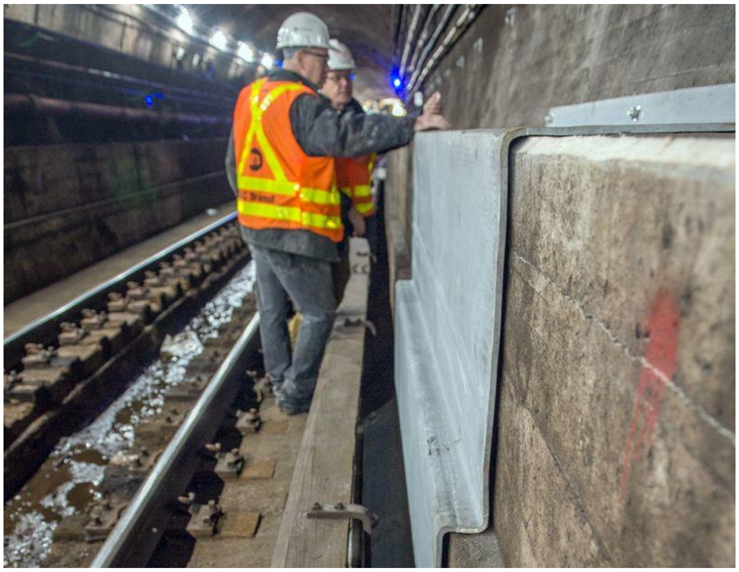
Examples of Resiliency Based Installations

For all the reasons previously described, composites make enormous sense for broader deployment in infrastructure of all types, and, relevant to this hearing, transportation infrastructure in particular. The following examples from Composite Advantage and fellow ACMA member companies may be instructive to Congress as you consider ways to rebuild and restore American infrastructure to withstand 21st Century challenges.

Tunnel

Superstorm Sandy in October 2012 has become the example of disruption and danger that can occur. A costly and disruptive result of Sandy is currently being avoided by using fiber composites.

The storm surge from Sandy flooded the Canarsie Subway Tunnel in New York City, used by 225,000 train passengers per day between Brooklyn and Manhattan. The 7 million gallons of saltwater in the tunnel started corrosion of the sides of the concrete tunnel. These bench walls carry utility cables and provide emergency egress. The crumbling walls threatened the safety and function of the rail line. The traditional repair plan would mean 15 months of shutdown that was unacceptable to the commuting public and city and state government. Once FRP composites were added to the options, the new repair plan means 99% less demolition work and no tunnel shutdown. The lightweight, prefabricated shells can be carried into the tunnel every night after a busy train schedule and repaired. Composite Advantage is starting production of these shells so the first tunnel can be repaired by end of summer. This effort will make the tunnel more resilient in future storms, by reinforcing it against potential damage and minimizing service disruptions.



Coastal Seawall

The Long Beach Boardwalk was severely damaged during Hurricane Sandy. After the boardwalk was replaced, a retaining wall of composite sheet pile was constructed to protect the board walk and flooding of the residential neighborhood from future devastating storms.

Bridge Decks

There are various components to bridges, including entire bridge systems, that can be fabricated with composites. Our company provided components to the Franklin Street Bridge in Michigan City, IN. During the very cold spell last February, concrete and steel decking on the draw bridge buckled from extreme cold. The bridge was unusable by vehicles. Being in the down position, the bridge blocked boats from getting to Lake Michigan. The City selected composite bridge decking for the emergency repair since the composite panels could be prefabricated for fast installation. The bridge was repaired in just over one month. The corrosion resistant deck will not deteriorate from water and chemicals so it will not be susceptible to this weather-related failure in the future.

After seeing the many benefits of composites after damage, engineers are now designing with the material to make new structures more resilient. Higher loads are being specified to counteract extreme weather.

Sarah Mildred Long Bridge is a vital link carrying US Route 1 between Portsmouth, New Hampshire and Kittery, Maine. Carrying both vehicle and rail traffic, this lift bridge moves vertically to allow larger ships to pass underneath. The bridge is the first of its kind in the U.S. with four 200 ft. tall towers that support a 300 ft. long lift span. The area is prone to high winds which destabilize traditional constructions. To stabilize the bridge during severe weather and deflect high winds, engineers needed a strong, yet lightweight wind fairing. FRP composites were molded in an angle shape to help the bridge withstand the 100 mph winds that could occur.

Concrete Reinforcement

Composite rebar is another revolutionary application being produced by many companies. These rebars are a quarter of the weight and twice as strong of traditional steel, last more than twice as long and will never rust and degrade. Degradation of the internal reinforcement is the primary cause of degradation of the superstructure of concrete bridges. Concrete is porous by its nature, with moisture and deicing salt causing the rusting of the steel. Rusted steel expands and weakens, causing spalling of the concrete and reductions in strength.

Corroding steel rebar was the start of the problem for the Canarsie Tunnel. Composite rebar has been used and in service for concrete bridge decks for over 20 years and is starting to be used to reinforce concrete structures in tunnels, piers and structures in harsh marine environments. When the storm surges hit those structures, the rust-proof, composite reinforcements will prevent the start of a corrosive chain reaction. Many states with either high salinity atmospheres, like coastal Southern states, or that use significant amounts of road salt, like many states in the Northeast and Midwest, have begun using composite rebar more.

Rail Transit Platforms

Since composites are unaffected by the deicing chemicals, more rail platforms are being constructed using composite materials. Besides the corrosion resistance, the lightweight, prefabricated platform panels allow for fast installation around train schedule. We are also seeing constantly increasing design requirements including higher snow loads.

Waterways

Waterways are a critical part of the transportation infrastructure; it is just not as noticeable to the general public. There are 12,000 navigable waterways in the US and the economic impact is huge. One barge is equivalent to 58 semi-trailers. Composites are being used in increasing quantities on the waterways since the materials are forever resistant to water corrosion. There is no leaching of chemicals into the water as happens with treated wood.

Composites are a key part of the protection systems built around critical infrastructure like bridge piers and to make waterways more resilient. The FRP piles offer the strength of steel, but a much lower bending stiffness which allows for far greater energy absorption than traditional materials. Unlike rigid concrete and steel fender systems, the FRP fender pile system is designed to deflect and then recover, without damaging either the vessel or the fender.
There are increasing requirements from larger vessels navigating in higher winds and faster currents; and composites are designed to handle these impacts.

Advanced ultraviolet additives protect coastal reinforcements from sunlight and heat degradation and are coupled with composites' proven ability to withstand corrosion and structural degradation in fresh and saltwater environments. These properties allow for extended service life along with reduced maintenance costs. This type of system was used to rehabilitate the service dock at the Statue of Liberty in the wake of Superstorm Sandy

External Repair

In addition to new construction, composites have the ability to repair aging concrete structures and restore nearly all of their functional strength. Composite wraps can be affixed to deteriorating structures, extending service life for several more decades. External strengthening systems also allow structures to better withstand the impact of destructive seismic forces in earthquakes. This can be done without taking the bridge, tunnel, or dam out of service thus minimizing disruption. The cost is much lower than new construction.

Considerations to Accelerate Deployment

Given the relatively short period of time that composites have existed in the infrastructure market by comparison to traditional materials, the strides made on product development and performance improvement have been significant. There are still barriers to broader deployment that need to be addressed to further accelerate the use of resilient composite infrastructure.

Composite solutions can contribute longer service life and making a bigger impact with its inherent design flexibility. As federal research institutions like Turner Fairbank Highway Research Center and others continue to explore the next generation of building materials for transportation structures, it is worth exploring ways to build and validate larger assets with innovative materials like composites than are currently being deployed, like long span bridge decks for example. This would allow composites to be used to in larger scale applications, which are increasingly needed as the impact of extreme weather becomes more pervasive.

Another barrier the industry is working aggressively to overcome is recyclability. The reason composites perform so well in construction applications is because of the extreme strength of thermoset polymers. By design, these materials do not breakdown. They are chemically inert so they will cause no pollution in a landfill, but nevertheless it would be ideal if materials taken out of service could have a second functional life. Our industry, aided by the Department of Energy backed Institute for Advanced Composites Manufacturing Innovation, is developing several promising recycling technologies that will make our products even more sustainable.

Perhaps the biggest barrier for broader use of composites can be boiled down to is the awareness of this material. Most civil engineers active today probably received little academic training on composites, particularly as a material for infrastructure. Because these materials are newer and less understood, there is a natural reluctance to take a perceived risk and use them. The way to overcome this is through development of more design standards, which provide assurance to engineers on how materials will perform under specific conditions, and ongoing stakeholder education.

What Congress Can Do

That National Institute of Standards and Technology developed a roadmap[1] for activities that can overcome these barriers, including specific activities the agency can take toward this end. These include aggregation and validation of existing data in a publicly available clearinghouse, development of durability testing protocols that will facilitate development of more standards, and development of a stakeholder outreach program to diffuse information about composite materials to the academic and engineering communities. Having NIST as the central clearinghouse for the composite technology data and information would greatly aid the use of composite materials. If owners and designers could find the necessary information, then they can apply it to solve their issues and have more confidence in a successful application.

Legislation authorizing a NIST composites program as described has been introduced by Congressman Webster (R-FL-11) with bipartisan cosponsors. The bill is HR 2393, known as the NIST Creation of Composite Standards Act, and has been referred to the Science, Space and Technology Committee. I strongly urge Members to consider supporting this important legislation.

As Congress works with the Administration to develop infrastructure policies for the future, consideration should be given to innovation grant programs. A recent Transportation Research Board[2] report explored the effectiveness of a previous Federal Highway Administration program

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[1] Sheridan, Richard J. et al. *Road Mapping Workshop Report on Overcoming Barriers to Adoption of Composites in Sustainable Infrastructure.* December 2017. https://www.nist.gov/publications/road-mapping-workshop-report-overcoming-barriers-adoption-composites-sustainable

[2]TRB Special Report 330: *Performance of Bridges That Received Funding Under the Innovative Bridge Research and Construction Program.* January 2019. http://www.trb.org/Main/Blurbs/178664.aspx

called the Innovative Bridge Research and Construction program, which existed in the late 1990s and early 2000s and funded the construction of more than 300 bridges with varying newer technologies and techniques, including widespread use of composites. The TRB panel determined that these innovative materials have great promise for building a stronger, more resilient, and longer lasting infrastructure. Likewise, the panel found that innovation grant programs have great success in highlighting new technologies and seeding wider implementation.

Recognizing the success of previous programs and the value newer materials can have, bipartisan members of the House and Senate have introduced legislation called the IMAGINE Act in both chambers, HR 1159 in the House. The legislation would create new bridge and water infrastructure innovation grant programs, as well as direct needed research on innovative materials to facilitate broader adoption. I also encourage members of this panel to support that legislation as a stand-alone bill and to encourage its inclusion in any broader infrastructure packages.

As the Committee on Science, Space and Technology considers needed components of the federal research portfolio, infrastructure should not be taken lightly. Additional attention should be paid to applications like breakwater structures and movable walls that can be deployed prior to storm surges in coastal areas and reused.

Additionally, while allocating federal funds for infrastructure projects of all modes, special consideration needs to be given to critical at-risk infrastructure. In many instances, it would make sense to spend a small percentage to make infrastructure stronger that connects people to key services like schools, hospitals and government buildings, or in remote areas that may only have one thoroughfare connecting a community to the broader region.

State and Regional Activities

Many states have begun considering and adopting policies to mitigate infrastructure against climate and weather impacts, such as Maryland's CoastSmart Communities Program that assists coastal communities address short- and long-term hazards, or New York State requiring construction permit applications to demonstrate consideration of sea level rise. These activities should be encouraged.

Many state and regional authorities have begun to deploy preventative structures to protect the most at-risk infrastructure. Composite sea walls will not corrode so they will be in place to protect vulnerable coastal roads from wash-outs whether the storm occurs next year or in 100 years. Breakwater structures and movable walls can be deployed prior to the incoming storm to protect roads, bridges and ports. Being corrosion resistant and light weight makes composites the perfect material for protection from storm surges on the coast.

One of the difficulties in making longer term decisions is having the data on the economic impact. This is especially true for understanding the economic cost of extreme weather events. Storms that damage transportation infrastructure have a cost for loss of use and a cost for replacement. Spending a fraction of that later cost to make the structure resilient to weather now can save a lot more when a storm arrives. At the upfront point, better materials and preventive structures can be employed so the damage never occurs.

Procurement of infrastructure is primarily based on initial acquisition cost; with little consideration for long term maintenance and replacement costs. Owners who want to account for long term costs must do extra work justifying the choice and obtaining funding. Long term costs should be considered in procurement decisions. The Federal government could do a great service to state and local asset owners by helping them better understand the full economic impact of extreme weather and the implication that has on maintenance costs of various material options. This could help facilitate greater consideration of total lifecycle costs to assure the most effective use of taxpayer dollars. Infrastructure planning and design needs to consider the magnitude of the increased weather events.

While not transportation infrastructure specifically, another key element of our built environment that is largely impacted by extreme weather is the electric grid. Composite utility structures outperform traditional wood polls and cross-arms because of the performance benefits described previously. Hurricane Maria in 2017 wiped out every utility pole in the US Virgin Islands, except for the eight composite poles that had been previously installed. Upon testing, those poles showed a negligible impact on performance. As part of their rebuilding, the Virgin Islands Water and Power Authority has widely deployed composite poles to mitigate against future storms. This is an example of effectively rebuilding for mitigation that should be considered by other jurisdictions across various modes of infrastructure.

Conclusion

It is encouraging that Congress is grappling with ways to strengthen our national infrastructure in the face of increasing extreme weather events and environmental changes. The demands placed on America's infrastructure today have never been greater. To build an infrastructure network that can support the realities of a 21st Century population, economy, and environment, it is more important than ever to take advantage of 21st Century technologies. Composite infrastructure products are one such technology.

Infrastructure applications are unique because the parameters around it are unique and changing. Like any material, composites are not a one-size fits all solution; they are highly engineered to guarantee the level of performance that is needed will be maintained forever. As advanced as composites are today, there is still so much farther we can go. Material advancements can allow for imbedded sensors with instantaneous monitoring of performance, ensuring that any needed upgrades can happen long before an asset is at risk. Materials are becoming stronger, meaning less will be needed per unit lowering the economic and environmental footprint of production. Importantly, newer materials can work well in combination with traditional materials, so that we can harness the best qualities of all to build structures that can last centuries rather than years.

Opportunities abound to build a more resilient tomorrow and should not be wasted. It is important that Congress work with federal and state agencies to further study, develop and deploy solutions that can make transportation more reliable for all Americans. There are immediate actions like the NIST Composite Standards Act and the IMAGINE act that will strengthen our infrastructure in the long term. The composites industry stands ready to work with Congress on this mission, to rebuild America to be a country ready to face tomorrow's challenges.

SCOTT REEVE
PRESIDENT
COMPOSITE ADVANTAGE

Scott Reeve is founder and President of Composite Advantage. With more than 35 years of experience in the composites industry, Scott provides composite FRP solutions to new markets. His company builds large structural parts for the infrastructure market including bridges, rail platforms, waterfront protection systems and mooring structures for the US Navy. Prior to starting Composite Advantage in 2005, Scott successfully managed technical projects for Lockheed Martin and as the Vice-President for the National Composite Center. He is very active in the composite industry trade association and community development organizations. He received a Master's Degree in Engineering Management from Washington University and Master and Bachelor of Science degrees in Aeronautical Engineering from Purdue University.