AASHTO Technology Implementation Group

Nomination of Technology Ready for Implementation

2010 NOMINATIONS DUE BY FRIDAY, SEPTEMBER 11, 2009

Sponsor	*Nominations must be submitted by an AASHTO member DOT willing to help promote the technology.*	1. Sponsoring State DOT: Missouri
		2. Name: Timothy M. Chojnacki
		Title: Maintenance Liaision Engineer
		Mailing Address: 2211 St. Mary's Boulevard
		City: Jefferson City | State: Missouri | Zip Code: 65102
		E-mail: tim.chojnacki@modot.mo.gov | Phone: .573.751.1040 | Fax: 573.526.4868
		3. Date Submitted: 09/09/2009
		4. Is the Sponsoring State DOT willing to promote this technology to other states by participating on a Lead States Team supported by the AASHTO Technology Implementation Group? Please check one: ☒ Yes ☐ No
Technology Description (10 points)	*The term "technology" may include processes, products, techniques, procedures, and practices.*	5. Name the technology: TowPLow
		6. Please describe the technology: The TowPLow integrates a trailer plow by pulling it behind a snowplow truck. While most snowplow trucks clear only ten to 11 feet, and special wing plows clear up to 16 feet, the TowPLow technology has enabled one truck and operator to clear more than 24 feet. Because of the vast increase in clearance area, one TowPLow combination can actually replace about 2.5 conventional snowplow trucks in gang plowing and improves safety when compared to special snowplow trucks with wing plows in gangs. Additionally, the TowPLow has an expected life cycle of 30 years or more compared to the typical expected life of 15 to 17 years for snowplow trucks.
		7. If appropriate, please attach photographs, diagrams, or other images illustrating the appearance or functionality of the technology. (If electronic, please provide a separate file.) Please check one: ☒ Yes, images are attached. ☐ No images are attached.
State of Development (30 points)	*Technologies must be successfully deployed in at least one State DOT. The TIG selection process will favor technologies that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.*	8. Please describe the history of the technology's development. MoDOT technical staff identified a potential need for technological improvement in 1996 when viewing photographs of gang plowing. MoDOT was using six to ten trucks to plow multi-lane interstate routes in St. Louis. In 2004, a partnership between MoDOT and Viking Cives identified methods to plow more snow with a single truck. The implementation of TowPLows, began as an idea of one of MoDOT's technical experts. Based on his farming experience and knowledge of newer farming equipment technologies, he questioned why the concepts of wide farming equipment could not be used to dramatically improve snowplowing on Missouri highways. The first TowPLow was placed into service January 2005 in Kansas City. The innovation proved itself in November 2006, when two Kansas City units cleared Interstate 70 from shoulder to shoulder.
		9. For how long and in approximately how many applications has your State DOT used this technology? The first TowPLow was placed into service in January of 2005. Since that time, the TowPLow has proved its usefullness as a time-saving, safe alternative to conventional snowplowing trucks while providing a higher-level of service to the roadway users. For the winter of 2009-2010, MoDOT will have 47 TowPLows in its fleet statewide.
		10. What additional development is necessary to enable routine deployment of the technology? None. This technology is ready for use. MoDOT operators and managers are continually identifying specific snow plowing operations and processes in which the TowPLow can be used.
		11. Have other organizations used this technology? Please check one: ☒ Yes ☐ No If so, please list organizations and contacts.

Organization	*Name*	*Phone*	*E-mail*

		Minnesota DOT	Norm Ashfeld Mark Fischbach Randy Reznicek	651-234-7942 651-437-2109 320-223-6568	Norm.Ashfeld@dot.state.mn.us Mark.Fischbach@dot.state.mn.us
		Utah DOT	Steve McCarthy	801-965-4122	smccarthy@utah.gov
		Maine DOT	Stephen Colson Dale Peabody	207-941-4529 207-624-3305	stephen.colson@maine.gov dale.peabody@maine.gov
		Brun-Way Highway Operations Inc. New Brunswick, CA	Robin Hathoway	506-325-8663	
		MRDC Operations Corp. New Brunswick, CA	Mark Kenny or Terry Thornton	506-357-1240	
		407 ETR_Ontario, CA	Craig White	416-989-3182	
		Carillion Canada Inc. Ontario, CA	Richard Burno	800-390-2242	
Payoff Potential (30 points)	*Payoff is defined as the combination of broad applicability and significant benefit or advantage over other currently available technologies.*	12. How does the technology meet customer or stakeholder needs in your State DOT or other organizations that have used it? The TowPLow technology directly impacts two customer needs: prudent stewardship of taxpayers funding and safety on Missouri roadways. By creating a method to increase performance of our snowplows, production more than doubled for the same manpower. One snowplow truck and TowPLow can replace about 2.5 conventional snowplow trucks. Safety of the roadway users is improved when compared to special snowplow trucks with wing plows in gangs. The snowplow truck with a TowPLow allows for faster plowing, which can reduce rear end accidents with snowplow tucks. Fewer snowplow trucks, traveling faster, will reduce the likelihood of traffic accidents.			
		13. What type and scale of benefits has your DOT realized from using this technology? Include cost savings, safety improvements, transportation efficiency or effectiveness, environmental benefits, or any other advantages over other existing technologies. The benefits that MoDOT has realized with the implementation of the TowPLow have all been extremely positive. However, the true realization of benefits varies dependent on the use of the innovation. In urban gang plowing operations, such as in St. Louis and Kansas City, two trucks with TowPLows can directly replace four snowplow trucks. In this configuration, the use of two TowPLows eliminates the need for two trucks and two operators, resulting in a 28.6 percent reduction in labor and fuel costs. An even more substantial impact is made on snowplowing operations on rural divided four-lane highways. With the TowPLow, the four-lane highway can be cleared with two trucks, one pass each - one truck with the lefthand TowPLow can clear the passing lane and inside shoulder, while the other truck can clear the driving lane and outside shoulder. Similar to the gang-plowing example, the same amount of clearing can be done with half the truck operators, saving 50 percent on labor and fuel costs on this operation.			
		14. Please describe the potential extent of implementation in terms of geography, organization type (including other branches of government and private industry) and size, or other relevant factors. How broadly might the technology be deployed? Due to the precise purpose of the TowPLow, the extent of implementation would be limited to businesses and organizations that are in charge of large area snow removal. More specifically, transportation departments - both state-based and internationally - could replicate the TowPLow model and experience similar reductions in labor and fuel costs. Those responsible for clearing snow from airports and large parking areas could also benefit from this technology.			

Market Readiness (30 points)	*The TIG selection process will favor technologies that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.*	15. What actions would another organization need to take to adopt this technology? Procuring the equipment and training operators is all that is required. Some slight modification of the snowplow truck hydraulic system may be required to operate the TowPLow.
		16. What is the estimated cost, effort, and length of time required to deploy the technology in another organization? Costs of the TowPLow vary depending on what options are ordered. The TowPLow can be equiped with either a material spreader or a liquid dispensing tank. The TowPLow can also be made to deploy either to the passenger or driver's side of the towing vehicle. The TowPLows purchased this year by Missouri DOT have ranged in cost from $67,000 to $82,000. Length of time to deploy can also vary. Some agencies may choose to proceed slowly, as Missouri has, starting with a few TowPLows to gain confidence. Others may look at a broader initial implementation. Missouri has expanded our TowPLow fleet from two in 2005 to 47 by the end of 2009.
		17. What resources—such as technical specifications, training materials, and user guides—are already available to assist deployment? Viking Cives designed and manufactures the TowPLows and therefore has current specifications. TowPLows are furnished with operator and parts manual. Viking Cives provides initial training for operators and mechanics. MoDOT has developed operator training and field exercises for MoDOT's applications in the Kansas City district. Modot training maybe updated next winter for other districts.
		18. What organizations currently supply and provide technical support for the technology? There are three Viking Cives sites which bid and furnish TowPLows across the USA and Canada. Viking Cives contact information can be found at http://www.vikingcives.com/. Shops are in New York, Missouri and Ontario, CA. Technical information, product design, expected applications and field performance can also be found by contacting the inventor, Bob Lannert at MoSnowKing@aol.com or going through the site www.TowPLow.com.
		19. Please describe any legal, environmental, social, intellectual property, or other barriers that might affect ease of implementation. None
Submit Completed form to		***http://transportation1.org/tig_solicitation/Submit.aspx***

Figure 1: Tow Plow in Use

Figure 2: TowPlow in Use

Figure 3: TowPlow Equipt with Material Spreader

Figure 4: TowPlow Equipped with Material Spreader

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Nomination of Technology Ready for Implementation

2010 NOMINATIONS DUE BY FRIDAY, SEPTEMBER 11, 2009

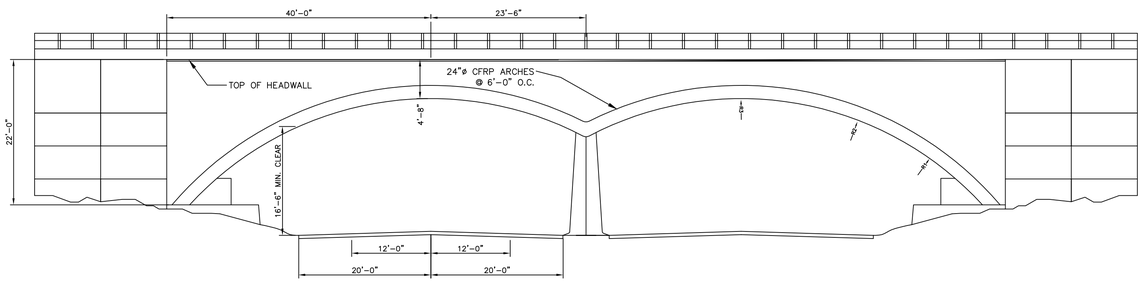
Sponsor	*Nominations must be submitted by an AASHTO member DOT willing to help promote the technology.*	1. Sponsoring State DOT: Maine		
		2. Name: Kenneth Sweeney		
		Title: Director, Bureau of Project Development		
		Mailing Address: 16 State House Station		
		City: Augusta	State: Maine	Zip Code: 04333-0016
		E-mail: ken.sweeney@maine.gov	Phone: 207-624-3400	Fax: 207-624-3401
		3. Date Submitted: 07/21/2009		
		4. Is the Sponsoring State DOT willing to promote this technology to other states by participating on a Lead States Team supported by the AASHTO Technology Implementation Group? Please check one: ☒ Yes ☐ No		
Technology Description (10 points)	*The term "technology" may include processes, products, techniques, procedures, and practices.*	5. Name the technology: Rigidified FRP Tube Arch Bridges		
		6. Please describe the technology: Site infused FRP tube-arches are used as both formwork and reinforcing for cast-in-place buried concrete arch bridges. All required tubes for a single span bridge can be placed in one work day without using heavy equipment. The tubes are tied into the footing formwork and an FRP decking system is attached. After the pouring the footings, the arches are filled with self-consolidating concrete. Soil is placed and compacted over the decking up to the required level, and the roadway is paved. The system includes the FRP tubes, decking, and a headwall system.		
		7. If appropriate, please attach photographs, diagrams, or other images illustrating the appearance or functionality of the technology. (If electronic, please provide a separate file.) Please check one: ☒ Yes, images are attached. ☐ No images are attached.		
State of Development (30 points)	*Technologies must be successfully deployed in at least one State DOT. The TIG selection process will favor technologies that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.*	8. Please describe the history of the technology's development. Funded by the U.S. Army Natick Soldier Center, the AEWC/University of Maine researched and developed the Rigified FRP Tube Arch Bridge technology. In 2008 the AEWC successfully constructed the Neal Bridge in Pittsfield. As a result of the project, a new company, Advanced Infrastructure Technologies, LLC, was created to commercialize and further develop this bridge technology.		
		9. For how long and in approximately how many applications has your State DOT used this technology? The first bridge made with Rigified FRP Tube Arch Bridge technology, the Neal Bridge, was installed in the Fall of 2008 in Pittsfield, Maine. Advanced Infrastructure Technologies (AIT), MDoT, and AEWC are now working together to build six additional tube-arch bridges over the next two years. Advanced Infrastructure Technologies, LLC, is currenlty designing these bridges for spans ranging from 30 ft to 70 ft.		
		10. What additional development is necessary to enable routine deployment of the technology? The AEWC is currently working with AIT to reduce installation costs through more refined modeling techniques, and to improve inspection and maintenance training methodologies. In addition, structural testing of the longer span systems needs to be completed to confirm functionality of design tools.		
		11. Have other organizations used this technology? Please check one: ☒ Yes ☐ No If so, please list organizations and contacts.		
		Organization	*Name*	*Phone*	*E-mail*
		Gardner Construction Enterprises	Randy Gardner	207 478-6369	gcenterprises1@myfairpoint.net

Payoff Potential (30 points)	*Payoff is defined as the combination of broad applicability and significant benefit or advantage over other currently available technologies.*	12. How does the technology meet customer or stakeholder needs in your State DOT or other organizations that have used it? Smaller stakeholders without ready access to large equipment, such as municipal governments and private industries, can self-install bridges using the Rigified FRP Tube Arch Bridge technology. Being both cheaper and more comapct than pre-cast components, shipping costs and requirements are lower. Also, with abbreviated construction time, there are fewer traffic interruptions and detouring, reducing the inconvenience to both personal and commercial traffic.
		13. What type and scale of benefits has your DOT realized from using this technology? Include cost savings, safety improvements, transportation efficiency or effectiveness, environmental benefits, or any other advantages over other existing technologies. This innovative technology improves the ability to construct economical bridges and shows progress towards making the next set of installed bridges less expensive than traditional alternatives. We anticipate a long, low-maintenance service life for these structures due to the combination of composite materials and a joint-free, rebar-free bridge structure, which also leads to substantial fiscal benefits. Construction safety concerns would be greatly reduced through minimal usage of heavy machinery, such as cranes, and an overall minimization of on-site work. This technology, by employing the use of factory manufacturing, lessens the potential for on-site accidents and improves the overall safety of construction. This technology improves current transportation effectiveness and efficiency by minimizing the obstruction of traffic in that, after the footing is placed the bridge can be open for traffic within one week. Minimizing traffic obstructions and detouring is also beneficial to the environment. By reducing the carbon footprint of bridge construction, both through reduced material delivery expenditure and extended lifespan, an original and 'green' technology has been created.
		14. Please describe the potential extent of implementation in terms of geography, organization type (including other branches of government and private industry) and size, or other relevant factors. How broadly might the technology be deployed? The Rigified FRP Tube Arch Bridge can not only replace traditional bridge structures, but can be installed in locations that heavy equipment can't easily access. This may include national parks and other areas that demand minimal environmental impact, remote areas in the United States, and in developing countries.
Market Readiness (30 points)	*The TIG selection process will favor technologies that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.*	15. What actions would another organization need to take to adopt this technology? Organization should contact Advanced Infrastructure Technologies, LLC to design and manufacture a Rigified FRP Tube Arch Bridge system.
		16. What is the estimated cost, effort, and length of time required to deploy the technology in another organization? As it is a pre-engineered bridge system, the Rigified FRP Tube Arch Bridge technology is easily adopted. AIT recommends that contractors participate in two four-hour training sessions. The learning curve for installation is very short, as the process closely mimics existing construction techniques.
		17. What resources—such as technical specifications, training materials, and user guides—are already available to assist deployment? To further assist deployment, drawings are available, specifically those of the successful Neal Bridge and other various geometries. Material specifications, installation videos and guides are also available; additional formal training materials continue to be developed. For general information, a summary report and testing results about the technology are available and more specificially, a Manual for Bridge Evaluation-based report on the Neal Bridge has been completed. The Neal Bridge was load rated using both testing and analysis and the report is available as an exemplar for future load ratings.
		18. What organizations currently supply and provide technical support for the technology? The AEWC at the University of Maine and Advanced Infrastructure Technologies, LLC.

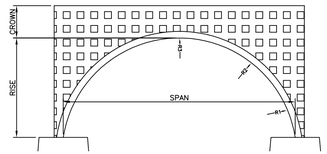
		19. Please describe any legal, environmental, social, intellectual property, or other barriers that might affect ease of implementation. The intellectual property is owned by the University of Maine and licensed to Advanced Infrastructure Technologies, who are currently the only suppliers of the primary system components.
Submit Completed form to		***http://transportation1.org/tig_solicitation/Submit.aspx***

AEWC RIGIDIFIED INFLATABLE ARCHES
VARIOUS GEOMETRIES FOR
INTERSTATE OVERPASS/UNDERPASS, STREAM CROSSING AND RAILWAY OVERPASS

INTERSTATE OVERPASS
NORTH AND SOUTH DIRECTIONS
MINIMAL MEDIAN



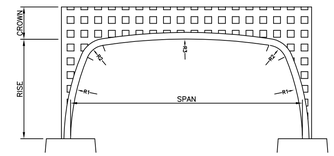
SINGLE RADIUS ARCH
OTHER GEOMETRIES AVAILABLE



SPAN	RISE	CROWN
30'	7'-15'	3'8"+
45'	10'-24'	4'4"+
60'	14'-30'	4'10"+
70'	15'-35'	4'10"+
MAX SKEW APPROX. 30 DEG.		
NO MAX OR MIN WIDTH		
ANY ROAD SLOPE/VERT. CURVE		

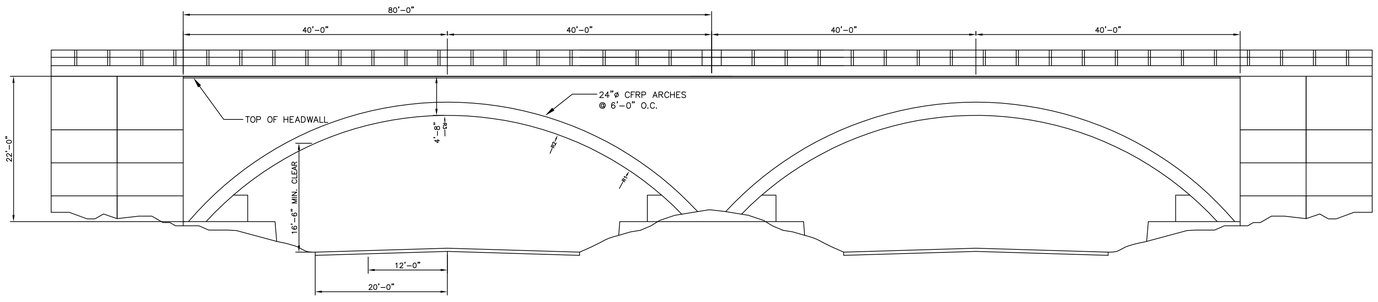
NOTE: TUBE DIAMETER MAY VARY THROUGHOUT LENGTH OF ARCH

VARIABLE RADIUS ARCH
GREATER CLEAR AREA FOR GIVEN SPAN

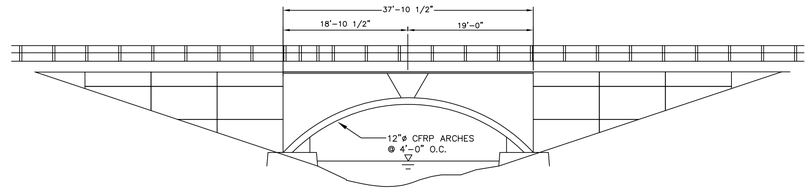


NOTE: ALL RADII INFINITELY VARIABLE FOR ARBITRARY ARCH GEOMETRY

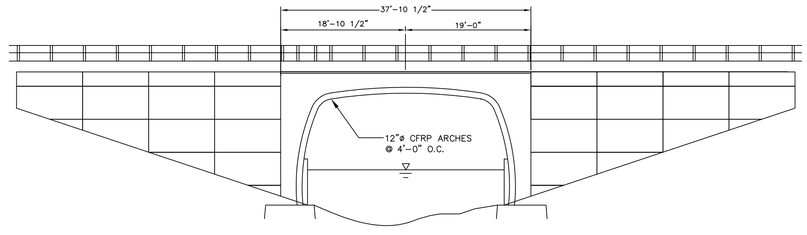
INTERSTATE OVERPASS
NORTH AND SOUTH DIRECTIONS
40' MEDIAN



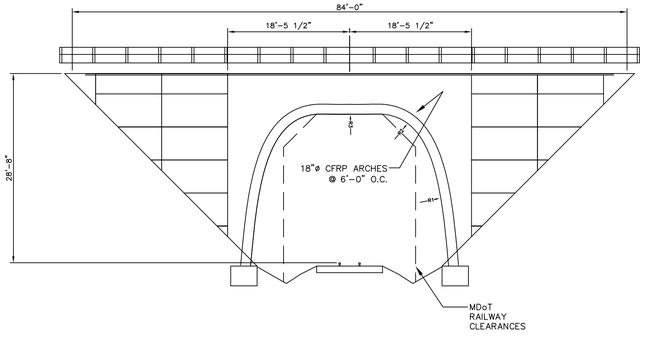
SHALLOW STREAM CROSSING



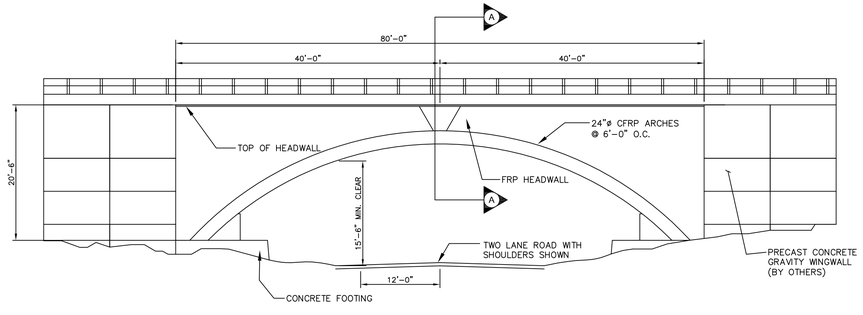
DEEP STREAM CROSSING

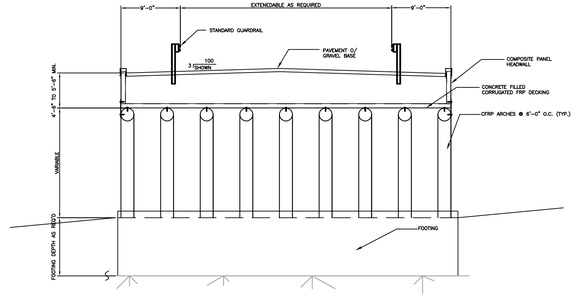


SINGLE TRACK RAILWAY CROSSING



TYPICAL GRADE CHANGE
TWO-LANE ROAD CROSSING/
INTERSTATE UNDERPASS



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2010 NOMINATIONS DUE BY FRIDAY, SEPTEMBER 11, 2009

<table>
<tr><td rowspan="8">Sponsor</td><td rowspan="8">Nominations <u>must</u> be submitted by an AASHTO member DOT willing to help promote the technology.</td><td colspan="3">1. Sponsoring State DOT: Maine</td></tr>
<tr><td colspan="3">2. Name: Kenneth Sweeney</td></tr>
<tr><td colspan="3">Title: Director, Bureau of Project Development</td></tr>
<tr><td colspan="3">Mailing Address: 16 State House Station</td></tr>
<tr><td>City: Augusta</td><td>State: Maine</td><td>Zip Code: 04333-0016</td></tr>
<tr><td>E-mail:
ken.sweeney@maine.gov</td><td>Phone: 207-624-3400</td><td>Fax: 207-624-3401</td></tr>
<tr><td colspan="3">3. Date Submitted:</td></tr>
<tr><td colspan="3">4. Is the Sponsoring State DOT willing to promote this technology to other states by participating on a Lead States Team supported by the AASHTO Technology Implementation Group?
Please check one: ☒ Yes ☐ No</td></tr>
<tr><td rowspan="3">Technology Description (10 points)</td><td rowspan="3">The term “technology” may include processes, products, techniques, procedures, and practices.</td><td colspan="3">5. Name the technology: Hybrid Composite Beam (HCB)</td></tr>
<tr><td colspan="3">6. Please describe the technology:
The "Hybrid-Composite Beam” (HCB), is a new type of structural member developed for use in bridges and other structures. The HCB is comprised of three main sub-components that are a shell, compression reinforcement and tension reinforcement. In the preferred embodiment, the shell is comprised of a fiber reinforced plastic (FRP) box beam. The compression reinforcement consists of concrete which is pumped into a profiled conduit (generally an arch) within the beam shell. The tension reinforcement consists of carbon, glass or steel fibers anchored at the ends of the compression reinforcement. The HCB basically combines the strength and stiffness of conventional concrete and steel with the lightweight and corrosion advantages of advanced composite materials. What results is a new alternative for rebuilding our nation’s infrastructure with state-of-the-art sustainable structures.</td></tr>
<tr><td colspan="3">7. If appropriate, please attach photographs, diagrams, or other images illustrating the appearance or functionality of the technology. (If electronic, please provide a separate file.)
Please check one: ☒ Yes, images are attached. ☐ No images are attached.</td></tr>
<tr><td>State of Development (30 points)</td><td>Technologies must be successfully deployed in at least one State DOT. The TIG selection process will favor technologies that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.</td><td colspan="3">8. Please describe the history of the technology’s development.
The technology was invented by John Hillman, PE, SE of Wilmette, IL in 1996. Mr. Hillman was able to validate the concept through a Type 1 IDEA Grant from the Transportation Research Board (TRB), High-Speed Rail - Innovations Deserving Exploratory Analysis (HSR-IDEA) Project. This grant facilitated the fabrication and successful testing of the first HCB and led to a Type 2 IDEA grant co-funded by HSR and NCHRP. The Type 2 Grant resulted in the construction of the world's first composite railroad bridge. The bridge was deployed on the Heavy Tonnage Loop - (HTL-FAST Loop) at TTCI in Pueblo, CO in November 2007. Since this time, the bridge has been subjected to over 95 Million Gross Tons of heavy axle, Class 1 Railroad loading with no change in performance. The success of the IDEA projects led to the construction of the first two permanent highway bridges utilizing the HCB. These include the High Road Bridge over Long Run Creek in Lockport Township, IL and the Route 23 Bridge over Peckman Brook in Cedar Grove, NJ. Both of these bridges were constructed with funds from FHWA - IBRD Awards. In 2007, Mr. Hillman established HC Bridge Company, LLC to further develop, license, market, deploy and support HCB technology. To date, Mr. Hillman has secured and spent over $1.4 million dollars for research and development of this technology from various sources and programs. The High Road Bridge was recognized in April 2009 with a National "Grand Award" at the ACEC-Engineering Excellence Awards. This is the top category nationally and limited to the top eight civil engineering projects in the country. HCB technology has also been recognized as one of the top 25 inventions by Modern Marvels - Invent Now Competition and it was recognized by Popular Science Magazine as one of the top 10 Inventions of 2008.</td></tr>
</table>

9. For how long and in approximately how many applications has your State DOT used this technology?

To date the Maine Department of Transportation has finished prototype testing and is currently having HCB's fabricated for the 8-span, 540 foot long Knickerbocker Bridge in Boothbay, ME. When completed, this will be the longest composite bridge in the world and to our knowledge, the first multi-span composite bridge made continuous for live load over the supports. Previous installations include the 57-foot High Road Bridge by the Illinois Department of Transportation in Aug 2008, and the Route 23 in Cedar Grove, NJ by the NJDOT to be completed in Oct 2009. Missouri DOT has already committed to building a 3-span bridge as part of the Safe and Sound Project in 2010 and BNSF Railroad has committed to the first revenue service RR bridge in 2010. Several other states have also expressed an interest in HCB bridges.

10. What additional development is necessary to enable routine deployment of the technology?

To date, at least one full size prototype HCB for each project has been successfully tested in the laboratory, including fatigue loading and loading to failure. Although through the course of development Mr. Hillman has developed limit states design methodologies for the design and analysis of the HCB, additional work is required to develop AASHTO code specification recommendations and/or a Guide Specification for HCB technology. The results of this research will also lead to commercial grade design and analysis software that will simplify design and specification of HCB bridges by other engineers and DOT's. Additionally, broader scale deployment of the technology will create the economies of scale to drive down fabrication costs and make the HCB cost competitive on a first cost basis with conventional concrete and steel structures.

11. Have other organizations used this technology? Please check one: ☒ Yes ☐ No

If so, please list organizations and contacts.

Organization	*Name*	*Phone*	*E-mail*
New Jersey DOT	Richard Dunne	609-530-2557	richard.dunne@dot.state.nj.us
Illinois DOT	Ralph Anderson	217-782-2124	ralph.anderson@illinois.gov
Missouri DOT	Pete Rahn	573-751-4622	pete.rahn@modot.mo.gov
Association of American Railroads	Duane Otter	719-584-0594	duane_otter@aar.com

Payoff Potential (30 points)

Payoff is defined as the combination of broad applicability and significant benefit or advantage over other currently available technologies.

12. How does the technology meet customer or stakeholder needs in your State DOT or other organizations that have used it?

The HCB provides an optimized structural element for reconstruction of our nation's infrastructure that offers the following benefits:

- LIGHTWEIGHT - 1/10th the weight of concrete and 1/3rd the weight of steel.
- SAFER – Internal redundancy and serviceability design result in capacities that greatly exceed code requirements, coupled with infinite fatigue life.
- REDUCED CARBON FOOTPRINT – Beams use 80% less cement, one of the largest contributors to the carbon footprint. They also require 75 to 80% fewer trucks for shipping and smaller cranes for erection for reduced emissions.
- CONGESTION RELIEF – Lighter, modular bridge system allows for “Accelerated Bridge Construction” and reducing traffic congestion during construction.
- SUSTAINABLE – No painting, rusting, cracking, spalling or alkali-silica reactions (ASR) results in a sustainable technology that provides for “100+ Year Service Life”.

13. What type and scale of benefits has your DOT realized from using this technology? Include cost savings, safety improvements, transportation efficiency or effectiveness, environmental benefits, or any other advantages over other existing technologies.

Specific benefits of the technology can be realized from the construction of the High Road Bridge in IL. The bridge consisted of six beams, each 58-feet long. Because each beam weighed less than 4,000 lbs, all six beams could be shipped on one truck. Had these been precast concrete beams, it would have required six trucks instead of one. The contractor was also able to erect the beams with a 30 ton utility crane instead of a 150 to 200 ton crane. The HCB's will not rust or spall and therefore require little or no maintenance. The HCB's are designed to satisfy deflection requirements, subsequently the beams generally exhibit strength capacity 30 to 60% beyond the code specified demand, resulting in safer structures. Lastly, in high seismic regions, an HCB superstructure will result in 60% less mass than a concrete structure, resulting in reduced seismic forces and a superstructure that can maintain an elastic response due to the resilient characteristics of the fiber reinforced plastic materials.

		14. Please describe the potential extent of implementation in terms of geography, organization type (including other branches of government and private industry) and size, or other relevant factors. How broadly might the technology be deployed? There are approximately 600,000 bridges in the National Bridge Inventory, of which over 150,000 are functionally obsolete or structurally deficient. Of these 600,000 bridges, over 90% have spans of 100-feet or less. With the exception of a few highly skewed bridges or those requiring tight radius curved steel girders, the HCB can cost effectively be utilized for the majority of these bridges. The HCB is particularly beneficial in geographic locations subject to heavy salt applications for cold weather, salt fog, brakish water as well as regions of high seismicity. The HCB can also be deployed in a prefabricated bridge system with the concrete arch and deck already in place, lending itself to "Accelerated Bridge Construction" in congested urban environments. It is applicable to both highway and railroad bridge construction. Further, the HCB lends itself to structural framing and roof panels in buildings housing corrosive materials, such as water treatment plants and chemical processing facilities. There have also been numerous inquiries and ongoing developments using the HCB for pier and wharf structures by the Coast Guard and other industries with heavy load, deep water handling facilities.
Market Readiness (30 points)	*The TIG selection process will favor technologies that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.*	15. What actions would another organization need to take to adopt this technology? Although there are unique characteristics to the structural behavior of the HCB, sufficient information is available in the current AASHTO and AREMA design codes with respect to quantifying the demand and the capacity based on the limit states for reinforced concrete, that would allow a practicing structural engineer to safely design and specifiy a structure using HCB's with minimal guidance. HC Bridge Company, LLC will provide support and guidance to organizations interested in adopting this technology for the design and deployment of an HCB structure. HC Bridge also provides field support to contractors to help understand the methods of installation and concrete placement. However, because every aspect of the HCB has been intentionally developed to be interchangeable with conventional beams and construction equipment, both from a design and installation standpoint, the learning curve for deployment of this technology is almost negligible. With a modest investment in design guides and specifications for fabrication and erection, this technology can be deployed with little or no guidance from HC Bridge.
		16. What is the estimated cost, effort, and length of time required to deploy the technology in another organization? The length of time required by another organization to deploy this technology is the same as it would be for the reconstruction or deployment of any new bridge in the owner's inventory. It's simply a matter of providing for a direct substitution of the HCB for a conventional concrete or steel beam. HC Bridge can either provide a signed and sealed design or provide the guidance for the organization to perform their own design. The fabrication capacity already exists under license agreements between HC Bridge and qualified fabricators. However, the cost for a fabricator to establish a manufacturing facility for HCB's is on the order of 20% of what it would cost to build a new precast concrete facility, due to the mitigation of stressing equipment, batch plants and heavy lifting equipment. The primary cost for deployment of this technology on a grand scale resides in educating the organizations and making them aware of this technology through a well thought out marketing effort.
		17. What resources—such as technical specifications, training materials, and user guides—are already available to assist deployment? HC Bridge has compiled a significant amount of information to assist in the deployment of the HCB. This includes numerous research and test reports from the IDEA Program and prototype testing, sample plans and detailed special provisions for fabrication and erection of HCB's prepared in a standard DOT format, PowerPoint presentations, design spreadsheets and literally hundreds of photographs and videos of fabrication, testing and installation of HCB projects completed to date.

		18. What organizations currently supply and provide technical support for the technology? HC Bridge Company, LLC is currently the most comprehensive source for technical support of this technology. Additional technical support has been provided by the AEWC at the University of Maine and Eriksson Technologies, who is currently working with HC Bridge to develop commercial grade design software to assist engineers in specifying HCB as an alternative framing system.
		19. Please describe any legal, environmental, social, intellectual property, or other barriers that might affect ease of implementation. The HCB technology is currently protected by US Patents 6,145,270 and 7,562,499, that which are assigned to HC Bridge Company, LLC. HC Bridge also has patents pending in the European Union Countries as well as seven other countries. Currently Harbor Technologies, Inc. of Brunswick, ME, is licensed to manufacture HCB technology in the US. Despite the proprietary nature of this technology, the transportation industry provides for cost controls through competition with conventional building materials. No regulatory, environmental or social risks have been identified.
Submit Completed form to		***http://transportation1.org/tig_solicitation/Submit.aspx***

Fig 1 - 2008 ACEC Grand Award Winner – High Road Bridge over Long Run Creek
First permanent HCB Highway Bridge funded by FHWA – IBRD Award

Fig 2 – April 2009 - Prototype Test Beam for Knickerbocker Bridge in Boothbay, ME.
33-inch deep HCB with 7-inch deck, 70-foot long was load tested to 2M cycles with ultimate capacity having:
Operating Rating Factor = 3.48
Inventory Rating Factor = 2.68

Fig 3. June 2009 **-** Route 23 Bridge in Cedar Grove, NJ. Ritacco Construction sets 31-foot x 6-foot HCB using excavator.

Fig 4. Nov 2007 – TTCI, Pueblo, CO. World's first Composite Railroad Bridge, constructed with HCB's developed with funding from TRB, High Speed Rail-IDEA Program. Endurance testing to date includes over 95 million gross tons (MGT) of heavy axle railroad loading.

AASHTO Technology Implementation Group

Nomination of Technology Ready for Implementation

2010 NOMINATIONS DUE BY FRIDAY, SEPTEMBER 11, 2009

<table>
<tr><td rowspan="8">Sponsor</td><td rowspan="8">Nominations <u>must</u> be submitted by an AASHTO member DOT willing to help promote the technology.</td><td colspan="3">1. Sponsoring State DOT: US Army Corps of Engineers</td></tr>
<tr><td colspan="3">2. Name: James Dalton</td></tr>
<tr><td colspan="3">Title: US Army Corps of Engineers Chief, Engineering and Construction</td></tr>
<tr><td colspan="3">Mailing Address: 441 G Str. N.W.</td></tr>
<tr><td>City: Washington</td><td>State: DC</td><td>Zip Code: 20314-1000</td></tr>
<tr><td>E-mail:
james.c.dalton@usace.army.mil</td><td>Phone: 202-761-8826</td><td>Fax: 202-761-1803</td></tr>
<tr><td colspan="3">3. Date Submitted: 09/11/09</td></tr>
<tr><td colspan="3">4. Is the Sponsoring State DOT willing to promote this technology to other states by participating on a Lead States Team supported by the AASHTO Technology Implementation Group?
Please check one: ☒ Yes ☐ No</td></tr>
<tr><td rowspan="3">Technology Description (10 points)</td><td rowspan="3">The term “technology” may include processes, products, techniques, procedures, and practices.</td><td colspan="3">5. Name the technology: Thermoplastic Timber</td></tr>
<tr><td colspan="3">6. Please describe the technology:

Two AASHTO HS25 Rated bridges, made from 100% thermoplastic timber and designed to replace deteriorated short span timber bridges, were recently completed at Ft. Bragg. This innovative structural grade material is made from 100% post consumer recycled HDPE (#2Plastic) and industrial scrap. The bridges recently completed were part of an innovative technology demonstration project funded in part by the Deputy Under Secretary of Defense’s Corrosion Prevention and Control (CPC) Program and the Army Chief of Staff for Installation Management’s (ACSIM’s) Installation Technology Transition Program (ITTP). Both of these Programs focus on validating emerging technologies and processes that show a potential for cost savings to the Army and the rest of the Department of Defense (DoD) through the use of more durable and cost effective materials and processes

Thermoplastic composite lumber materials are resistant to moisture, rot, insects, and the degradation that occurs with natural wood when exposed to the outdoor environment, chemically treated or not. Because it does not use toxic chemical treatments, it is a viable alternative material to treated-wood. While there certainly are property differences between thermoplastic composite materials and natural wood, appropriate design considerations and material formulation (i.e., unreinforced versus reinforced) enable these materials to be used in high load bearing applications for all-types of structures such as the subject bridges at Fort Bragg.

Not only can these bridges be cost competitive on a first-cost basis but are clear winners on a lifecycle basis considering the low-maintenance requirements of these materials. The innovative thermoplastic composite I-beam bridge at Fort Bragg shows the design and materials should be considered for replacement of the thousands of wood timber bridges that exist on Army Installations and Federal and State Parks and Forests throughout the U.S.</td></tr>
<tr><td colspan="3">7. If appropriate, please attach photographs, diagrams, or other images illustrating the appearance or functionality of the technology. (If electronic, please provide a separate file.)
Please check one: ☒ Yes, images are attached. ☐ No images are attached.</td></tr>
</table>

State of Development (30 points)	*Technologies must be successfully deployed in at least one State DOT. The TIG selection process will favor technologies that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.*	8. Please describe the history of the technology's development. Plastic lumber made primarily from recycled high-density polyethylene first emerged on the United States marketplace in the early 1990's. Plastic lumber is an attractive substitute for natural wood because it diverts waste plastic from landfills and is inherently resistant to moisture, rot, and insects. The material also avoids the need for toxic chemical treatments commonly used as preservatives, and the subsequent release of these chemicals into the surrounding environment. Although original plastic lumber products were as strong as an equivalent-sized piece of wood, these products had an elastic modulus (stiffness) at least an order of magnitude less than even the most common wood species used in construction. Eventually manufacturers started incorporating fibers into the formulation to produce a reinforced thermoplastic composite lumber with a higher elastic modulus. The first plastic vehicular bridge using reinforced thermoplastic composite lumber (in typical rectangular shapes) was built at a mid-west Army Installation in 1998. This bridge has not had any maintenance done to it since its completion and still looks like new. Due to its no-maintenance needs, when viewed on a lifecycle basis, this bridge has now more than paid for its higher initial material costs. However, first costs are still most often the deciding factor whether these type materials are or are not used over traditional treated-wood. Since 1998, researchers and engineers have looked at arch and I-beam designs as a means to reduce the material and installation costs for a given load capacity in order to come up with a design that is cost competitive to traditional wood designs on a first cost basis. The first bridge to be competitive on a first cost basis was built at Wharton State Park and was a sponsored by New Jersey EPA and Rutgers University. The latest demonstrations of this technology are the thermoplastic composite I-beam bridges constructed at an east coast Army Installation in North Carolina designed for the crossing of M-1 battle tanks. This innovative design is cost competitive to a wood timber bridge to carry the same load and virtually maintenance-free and impervious from the degradation effects of moisture, rot, insects, and weather. A third bridge is planned for award this fall as well as two additional railroad bridges to support 121-Ton loads at another Army installation.

9. For how long and in approximately how many applications has your State DOT used this technology?

This technology has been tested over the past decade by USACE, Army, DoD Corrosion Policy and Oversight Committee, New Jersey Department of Environmental Protection, University of Illinois and Rutgers University.

Railroad Installations: The first applications were for composite plastic lumber railroad ties and were developed in 1994 by a research group that included Rutgers University, Conrail, Norfolk southern, The US Army Corps of Engineers Construction Engineering Research Laboratories, and U.S. Plastic Lumber Company. This team developed plastic composite specifications and manufacturing and installation processes. Today composite plastic ties have been successfully tested at American Association of Railroads Test Track in Pueblo, Colorado for the past 12 years and over 1,500,000 million ties are installed inline.

Tiffany Street Pier, Bronx, NY: The first all-plastic lumber civil structure of major significance was the Tiffany Street Pier located at the end of Tiffany Street in the Bronx in New York City. This roughly 125 meter (410 ft) long by 15 meter (49 ft) wide recreation pier was designed by the New York City Department of General Services. The structure incorporates recycled-plastic pilings, thermoplastic timber joists, decking, and railings. While the Tiffany Street Pier showed that a large all-plastic structure could be built, the structural design of the pier was sub-optimal in materials usage.

Ft. Leonard Wood Bridge, Ft. Leonard Wood, MO: With the help of funding from the U.S. Environmental Protection Agency, an existing wood timber bridge at Ft. Leonard Wood, MO, was selected to demonstrate applications of “structural-grade” plastic lumber. The 25-ft (7.6-meter) long by 26-1/2-ft (7.8-meter) wide plastic lumber bridge sits on the original six steel girders that had supported the replaeced wooden bridge. Although the bridge is used primarily for pedestrian traffic, the replacement plastic lumber bridge was designed to carry light vehicular traffic. M. G. McLaren Consulting Engineers, New York, designed the bridge structure using the protocol developed for plastic lumber as part of the ASTM standards developed for these products. The safe capacity of the new bridge is more than 30 tons over the entire structure.

Structural-grade plastic lumber 3x12 boards that incorporated polystyrene for added stiffness were used as the main support joists over the steel girders. The decking was also 3x12 plastic lumber but a standard-grade material. In all, products from four different manufacturers were used in the structure. The bridge was constructed with standard woodworking power tools and fasteners. A typical treated wood bridge structure at this site would need to be replaced every 15 years with biannual inspections and maintenance to replace deteriorated boards and loose fasteners. The plastic lumber bridge is expected to last 50 years with minimal maintenance. When this bridge was built, a plastic lumber products cost more than double what they would be for a replacement treated wood bridge, a lifecycle cost analysis showed the plastic lumber bridge would begin to pay for itself in less than 8 years.

Laminated Arch-Truss Designed Bridge, New York: One way that wooden structures are designed involves “laminated beams” where smaller dimensional lumber such as 2x6’s or 2x8’s are used to make “built-up” beams and arches resulting in a more efficient and cost-effective use of materials. Therefore, a 30-foot (9-meter) span bridge was used as a demonstration project to investigate if reinforced plastic lumber may be used to construct laminated beams and arches. The arched top chord of the bridge consists of laminated 2x8 curved members while the bottom chord is a standarddimensional 8x8 glass fiber reinforced plastic lumber. Although the bridge only needed to be designed for H-10 [10 ton (9,070 kg)] emergency vehicular loading, it was designed and tested for H-15 loading [15 ton (13,600 kg)]. A loaded dump truck weighing almost 32,000 lb (14,500 kg) was used for testing the bridge. The maximum deflection was only 1.2 inches (30 mm), which is more than acceptable for such structures. The bridge was designed and built by M. G. McLaren Consulting Engineers in a remote area using no heavy equipment.

I-Beam Bridge at Wharton State Forest, NJ: In 2003 another all-plastic lumber bridge was built using I-beam plastic lumber structural members. This bridge, located in the Wharton State Forest, New Jersey, was designed for a Class H-20 rating [18,100 kg (20 ton)] since it must be able to support a fire truck which might be needed to answer a call within this part of the forest. Attached pictures show the I-beam design bridge under construction. The I-beam design reduced the construction time and materials needed to build a bridge structure with the same load capacity using conventional joist and beam construction. The design and construction was a collaborative effort between M. G. McLaren Consulting Engineers and Rutgers University, NJ. While the costs were not fully analyzed and documented, because of the reduced labor time to complete the bridge, this I- beam design appears to be competitive on a first-cost basis with conventional treated-wood with life-cycle considerations making the design even more advantageous.

Army & Fort Bragg Bridges: In June 2009, two bridges were completed to support 71 Tons with an HS25 Rating and a third bridge is planned at Ft. Bragg, NC, which were discussed earlier in this paper. Two railroad bridges with a Cooper rating of E-60 are also planned for construction later this year.

10. What additional development is necessary to enable routine deployment of the technology? The material itself is ready for routine deployment. We are working with Parsons Brinckerhoff to develop designs to allow longer spans as well as new applications. However AASHTO certification and subsequent standards development and acceptance is essential for widespread acceptance, approval and adoption by state and federal government agencies.

11. Have other organizations used this technology? Please check one: ☒ Yes ☐ No
If so, please list organizations and contacts.

Organization	*Name*	*Phone*	*E-mail*
Ft. Bragg/ USACE CERL	Greg Bean	910 396 7202	gregory.g.bean@us.army.mil
Wharton State Forest/ New Jersey Department of Environmental Protection	Dave Rosenblat	609-292-9236	dave.rosenblatt@dep.state.nj.us
Ft. Leonard Wood/EPA & USACE	Richard Lampo	217-373-6765	r-lampo@cecer.army.mil
American Association of Railroads TransportationTechnology Center/Rutgers University	Joe Lopreski Dr. Tom Nosker	 732-672-1131	719-584-0750 Joe_lopreski@aar.com TJNosker@gmail.com

Payoff Potential (30 points)

Payoff is defined as the combination of broad applicability and significant benefit or advantage over other currently available technologies.

12. How does the technology meet customer or stakeholder needs in your State DOT or other organizations that have used it?

The bridges made out of Thermoplastic Timber have saved the Army bases that have deployed these bridges considerable money in maintenace fees and now in the case of the bridges at Ft. Bragg and NJ, saved money on initial costs too. In addition, these bridges will last a minimum of 50 years or more with virtually no maintenance.

The use of thermoplastic timber offers a significant enviromental benefits: It creates a use for recycled plastic, reducing the amount of plastic going to landfills. The material is non-toxic, eliminating the risk of toxins seeping into the surrounding water or soil, unlike alternate materials requiring chemical preservatives such as creosote, CCA and ACQ treatments. This is a sustainable technology allowing the thermoplatic material to recycled again and again after each use.

The material offers significant local economic benefits to stakeholders. The technology was designed to allow manufacturing in a wide range of plastic extrusion manufacturing facilities. This allows the shipping of the molds required to local manufacturers, allowing the material to be produced locally. Not only does this create jobs in the area where bridges are built, but it also cuts the cost of transporting the material. Because the plastic waste recycled to produce the material is found throughout the country, raw material can be found locally, manufactured into structure elements locally and constructed into bridges locally. The use of recycled plastic also offers a reduction in greenhouse gas emmisions over other materials. For example, one 40Ft bridge at Ft. Bragg saved 196 Metric Tons of Greenhouse gas or the equivalent of 22,296 Gallons of Gasoline not consumed.

The material requires limited equipment for construction. With a density similar to wood, beams are easily handled without heavy equipment. The material can be cut and drilled with standard tools, such as chain saws, circular saws and cordless drills.

		13. What type and scale of benefits has your DOT realized from using this technology? Include cost savings, safety improvements, transportation efficiency or effectiveness, environmental benefits, or any other advantages over other existing technologies. 1) These bridges will last a minimum of 50 years and in most cases they will last significantly longer with no maintenance. This material will not rot, rust or corrode. Today the US spends over $300 Billion a year fighting corrosion. 2) Minimal risk of catastrophic failure. The bridges are built and designed to have a working stress that is no more than about 15% of the ultimate strength of these materials. Therefore, there is a large safety factor against failure, and the materials are ductile by their nature, so visible signs will be present before failure. Compare this to steel that is built to 40-60% stress and concrete typically built to 33% stress; the risk of catastrophic failure is far less utilizing thermoplastic materials. Likewise, the fracture strain is 3% or more which is more than 4 times that of wood. 3) The bridges can be built quickly with minimal equipment, and training installers is a simple process, which minimize cost. 4) Thermoplastic lumber is 100% inert and will not leach toxins into the environment making an ideal solution to wetlands. HDPE is highly resistant to abrasion making it ideal material in salt water and it is impervious to water. It can be coated with a fire inhibitor as well as a heating element to melt ice and snow. 5) We are creating a demand and use for recyled plastic which removes plastics from landfills. 6) These products create American Jobs and because we are using recyled material from our landfills these jobs will always stay in America.
		14. Please describe the potential extent of implementation in terms of geography, organization type (including other branches of government and private industry) and size, or other relevant factors. How broadly might the technology be deployed? The potential size and impact Thermoplastic Timber could have on the United States is substantial. Although the FHWA estimated (1992) only 8% of road and highway bridges are timber structures, this still represents nearly 50,000 structures. This number increased substantially when timber bridges designed for foot traffic (trail bridges) are included. In addition to replacing existing timber bridge structures, Thermoplastic Timber offers significant benefits in a number of application currently using concrete, steel and reinforced concrete structures. The material has the potential to be deployed in new and replacement constrcution for the tens of thousands of short span DOT bridges and the 2,000 bridges the Army maintains. Additionally, short span bridges suitable for thermoplastic timber make up a large percentage of Federal bridges. Some of the other basic applications for Thermoplastic Timber include: 1) Bridges - Vehicular bridges, Railroad Bridges, Pedestrian bridges, Boardwalks 2) Railroad Ties - Over 1,500,000 thermoplastic timber ties are currently installed in US. This represents a very small percentage of the total installed ties, where over 20 million deteriorated ties are replaced each year. 3) Marine Applications - Pilings, Retaining Walls, Wharfs, Docks, Breakwaters, Sheet Piling, stop logs, guide walls 4) Commercial Appplications - Abutments, Culverts, Retaining Walls, Guard Rails, Sheet Pilings, Pallets, Cellular and RadarTowers, Temporary bridges 5) Utilities - Telephone poles, Light Poles
Market Readiness (30 points)	*The TIG selection process will favor technologies that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.*	15. What actions would another organization need to take to adopt this technology? An organization can readily adopt this technology by generating specifications and guidelines to enable the design and engineering of appropriate structures. Mechanical property details are available including allowable stress levels in all key modes. In addition, fabrication and construction guidelines have been generated for guidance during the installation process. Full support will be provided to enable the creation of all appropriate documentation.
		16. What is the estimated cost, effort, and length of time required to deploy the technology in another organization? The cost and time would be minimal and only involve documentation and education of technical staff.

		17. What resources—such as technical specifications, training materials, and user guides—are already available to assist deployment? As noted, mechanical property specifications are available as well as fabrication and construction guidelines. In addition, quality control manuals are available for both the material production and for the fabrication process.
		18. What organizations currently supply and provide technical support for the technology? Rutgers University provides technical liaison for material science and product development. In addition, ASTM had developed testing methods for the technology. Axion International has licensed the Rutgers formula and manufacturing process. Innovative Green Solutions is building a distribution channel and has partnered with Parsons Brinckerhoff for architectural design for RailRoad bridges. US Army Corps of Engineers Construction Engineering Research Laboratory have developed recommendations to Unified Facilities Guide Specifications.
		19. Please describe any legal, environmental, social, intellectual property, or other barriers that might affect ease of implementation. The biggest Barrier to implementation of this technology is the lack of education of its capabilites and applications . Recommeded additions to UFSG to include specifications for structural grade composite plastic lumber are pending. The use of Thermoplastic Timber addresses both the spirit and letter of the Federal government's procurement laws to go "green," as specified Section 2228 Title 10 US Code, as well as Presidential Executive Order 13423. This technology uses 100% post consumer and post industrial waste otherwise destined for the landfill.
Submit Completed form to		***http://transportation1.org/tig_solicitation/Submit.aspx***

Thermoplastic Ties-12 years inline and tested at AAR TTCI without incident

The first plastic lumber bridge built in the summer of 1998.

Load testing the plastic lumber, arch-truss bridge in Albany, NY.

I-beam designed bridge being constructed at Wharton State Forest, NJ

Finished I Beam Bridge at Wharton State Park. First Cost effective thermoplastic bridge

Thermoplastic Timber Pilings being driven at Ft. Bragg

Construction of thermoplastic composite I-beam bridge at Fort Bragg.

M-1 tank crossing the thermoplastic composite bridge during initial load testing

Dr. Tom Nosker from Rutgers University Advanced Materials via Immiscible Polymer Processing Program with Project Sponsors sign.