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1200 New Jersey Ave, SE
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ATTN: Docket No. DOT-OST-2023-0092

Re: Potential research and development areas of interest for the Advanced Research Projects Agency–Infrastructure (ARPA–I)

The American Society of Civil Engineers (ASCE) is grateful for the opportunity to provide comments to the Department of Transportation (DOT) regarding the new Advanced Research Projects Agency – Infrastructure (ARPA–I). ASCE believes ARPA–I can improve transportation infrastructure through its support of scientific and technological solutions. ARPA–I's scope is rife with possibilities, and ASCE appreciates the opportunity to offer input on potential areas for research and development that ARPA–I may focus on. The perspective offered in this document is in response to a request for information (RFI) published by DOT on June 13.

Founded in 1852, ASCE is the nation's oldest engineering society. ASCE represents more than 150,000 members of the civil engineering profession in 177 countries. As the professionals who design, construct, and maintain transportation infrastructure, ASCE's members are uniquely positioned to suggest research and development opportunities and benefit from innovative solutions. ASCE was a strong supporter of the Infrastructure Investment and Jobs Act (IIJA), which provided a once-in-a-generation investment in our nation's infrastructure and provisions to improve safety and modernize the transportation system. ARPA–I was authorized by the IIJA, and ASCE views it as a privilege to offer input on this newly designated agency while it is still in its early stages.

Modeled on the Defense Advanced Research Projects Agency (DARPA) within the Department of Defense (DOD) and the Advanced Research Projects Agency–Energy (ARPA–E) within the Department of Energy (DOE), ARPA–I has the potential to accelerate improvements to our nation's infrastructure and help address some of the challenges our transportation system faces. ARPA–I's aims include lowering the long-term costs of infrastructure development, reducing the life-cycle impacts of transportation infrastructure on the environment, improving the safe and efficient movement of people and goods, and promoting the resilience of infrastructure from physical and cyber threats. ASCE is a strong proponent of protecting public safety, ensuring resilience, and maintaining infrastructure through asset management, life-cycle cost-based planning, and innovative technologies. We support the aims ARPA–I seeks to achieve. Moreover, the technologies developed and implemented by ARPA–I can benefit civil engineers in their daily work. We appreciate the opportunity to share expertise with DOT.

In its RFI, DOT presented questions on safety; advanced construction materials and methods; digital infrastructure; freight logistics and optimization; climate and resilience; and other areas in transportation infrastructure. For these comments, ASCE and its members would like to offer input on each of these topics.

Safety

Safety is the foundational principle uniting civil engineers' work, regardless of which sector of infrastructure they are professionally involved in. In the transportation sector, safety remains a pressing issue. Estimates from the National Highway Traffic Safety Administration (NHTSA) indicate 42,795 people died in traffic crashes in 2022[1]. Safer roadway systems, which can be aided by technological improvements supported by agencies such as ARPA–I, reduce loss of life and help the nation's economic network function.

Thoughtful, up-to-date codes and standards are important for the development and safe deployment of new scientific and technological solutions. As an organization that engages in setting standards on a large scale, ASCE can serve as a useful source of technical information for government partners. ASCE Standards provide technical guidelines for promoting safety, reliability, productivity, and efficiency in the civil engineering profession. Accredited by the American National Standards Institute (ANSI), ASCE has a rigorous and formal process overseen by the Codes and Standards Committee (CSC). Standards are created or updated by a balanced volunteer standards committee, followed by a public review period. These standards are adopted by state and local jurisdictions and used in the designing of projects around the world. ASCE urges DOT to work with federal, state, and private sector safety experts on codes and standards and would be glad to serve as a source of expertise. ASCE's discipline-specific institutes and technical groups, which bring together volunteers from around the world to advance the profession's expertise, may also be useful sources of guidance for DOT. In particular, ASCE's Transportation & Development Institute (T&DI) represents professionals who could be appropriate points of contact for the agency.

Specifically, ARPA–I should consider the task of establishing a national transportation infrastructure "data dictionary" standard. Such a standard should be developed by an ANSI-accredited standards development organization with a mandate to incorporate any and all existing data dictionaries already in use or ready for adoption. Given the speed at which technological innovations are already being developed and deployed by private and public entities, establishing a national standard and data dictionary is paramount.

At every turn, private and public innovators are hobbled by inconsistencies in data object definitions for points where civil works, telecommunications, and energy systems must connect seamlessly. Telecommunications innovators developing advanced 5G, 6G, and 7G systems are building out their hardware and software systems, but the inconsistencies and ambiguities of the content intended to be transported between vehicles and infrastructure due to the lack of a national transportation infrastructure database could render those investments useless.

Improving safety and embracing technological innovation will not successfully occur without advancing Intelligent Transportation Systems (ITS). ASCE supports federal and state participation and guidance to

[1] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813428

advance the research, development, and deployment of ITS, which can be a cost-effective means to improve safety, optimize transportation performance, and minimize congestion. In addition, technological advancements and the projects that incorporate them should take into consideration the types of vehicles that are traveling on various structures. For example, pavement, traffic barriers, structural supports, and parking deck capacities should account for the substantially heavier weight of electric vehicles (EVs) in addition to the weight of more traditional motor vehicles. Also, while technologies such as connected and autonomous vehicles provide an opportunity to increase safety, ease congestion, and reduce our carbon footprint, consideration needs to be given to how these vehicles impact human lives, including professionals operating in work zones. With regard to work zones, ASCE recommends ARPA–I explore new ways to prevent work zone intrusions during roadway construction and maintenance. With additional funding going to infrastructure projects through the IIJA, the need to prevent work zone intrusions is magnified. Innovations such as vehicle-to-vehicle and vehicle-to-infrastructure technologies can be used to offer work zone and speed information.

In addition to the safety of people using and maintaining the transportation network, the protection of physical equipment is also important, and technological innovation can play a role. Supplies such as aluminum poles, which transportation and construction professionals regularly use in their operations, can be targets of theft due to the value of the metal. ARPA–I may consider technologies such as tracking systems to help construction and maintenance professionals identify and recover stolen equipment. Such systems have the potential to help infrastructure owners manage their assets and reduce costs associated with lost equipment.

Advanced construction materials and methods

ASCE supports the establishment of incentives to foster the use of innovative construction, technologies, sustainability actions, and materials in publicly supported infrastructure renewal activities. Enhancing innovation and sustainability in the construction industry, both in terms of materials and methods, can lead to safety improvements and cost savings. New technologies, materials, and construction methods can help meet the challenges presented by maintaining existing structures and building new ones. For example, glass aggregate is a material that can be incorporated into innovative construction projects. Recycled glass aggregate was a key factor in building interim roadway after an Interstate 95 overpass collapsed in Philadelphia in June. Within 12 days of the collapse, temporary travel lanes made with glass aggregate had opened to the public. While glass aggregate can serve as a sustainable option for construction projects, steps should be taken to make sure the material does not create a glare on roadways, which can be hazardous for travelers. Another consideration associated with glass is its potential to lead to alkali-silica reactions, which occur when aggregates containing certain forms of silica react with alkali hydroxide in concrete to form a gel that swells as it absorbs water. Some glass contains reactive silica, and this process can result in cracking and long-term durability issues. ARPA–I may consider further supporting the research and development of this material, with concern for these potential challenges. Additionally, new studies on the resiliency and durability of construction materials may be beneficial, especially for transportation systems located in extreme weather environments.

In terms of construction methods, Accelerated Bridge Construction (ABC) represents an important shift in bridge delivery. ABC blends innovative design, materials, and construction techniques in a way that minimizes onsite construction time and traffic disruptions while maintaining an emphasis on safety. ASCE recommends ARPA–I support the continued advancement of ABC, which is already in use for many projects, and consider topics that are still being discussed and researched, such as automated construction technology. Digital project delivery is also an area that will continue to advance and may serve as focus for ARPA–I. ASCE's Construction Institute has a specific committee dedicated to sharing best practices to facilitate the transition of civil engineering practices from delivering projects in the traditional analog form of drafted plans and narrative specifications to the emerging capability of delivering projects using digital data contained in advanced models, whether 2D or 3D, and machine-readable technical requirements. After construction, inspection and monitoring methods could be augmented with drones, sensors, and cameras.

Advanced construction materials and methods are also areas in which codes and standards would be significantly beneficial. A lack of taxonomy and standards pertaining to concrete, glass, and steel impedes the unambiguous specification of materials and methods between and among transportation infrastructure designers, builders, and suppliers. Other innovative materials that can be better addressed by codes include composites and timber products.

Need for industry-driven standards

With rapidly accelerating R&D and emerging technologies transforming the way we deliver transportation, developing consensus-based standards will be critical for industry confidence and public sector deployment. Again, ASCE would like to present itself as a resource and partner in the development of standards as an established standards-setting organization with ANSI accreditation. ASCE 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE/SEI 7-22)[2] is the Society's most widely used professional standard and a critical tool in a civil engineer's commitment to protecting the health, safety, and welfare of the public. As in the past, the 2022 edition requires buildings to withstand certain hazards, such as severe winds, seismic activity, and flooding. For decades, the standard has been the authoritative source for specifications of loads and related criteria used by engineers to design safe, economical, and reliable structures. In May, ASCE released Supplement 2 to ASCE 7-22 to address the strain from flooding that the increasing frequency of severe storms and shifting environmental hazards places on communities. The design standard's new flood load provisions will protect against 500-year flood events, which are a significant improvement to the 100-year flood hazard referenced in the previous version. The primary technical updates relative to climate impacts include a requirement to consider relative sea-level rise in addition to new requirements tying flood hazard mitigation design to Risk Category, which is consistent with other environmental hazards in ASCE 7.

Another ASCE standard that can offer sound guidance for transportation engineering and roadway safety is ASCE 58, Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways (ASCE/T&DI/ICPI 58-16)[3], which establishes guidelines for developing appropriate pavement structures for various traffic and subgrade conditions. This standard provides preparatory information for design, key design elements, design tables for pavement equivalent structural design, construction considerations, applicable standards, definitions, and best practices. ASCE stands ready to work with

[2] Minimum Design Loads and Associated Criteria for Buildings and Other Structures (7-22) (asce.org)

[3] Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways | Books (ascelibrary.org)

industry and government partners to assist with the future development of new consensus-based standards for emerging technologies.

Digital infrastructure

As it is with safety, data is a crucial component to digital infrastructure. While many new technologies focus on hardware and software, attention also needs to be paid to the quality and robustness of the data used by these systems. Multi-disciplinary data standards development collaborations are critical to establishing a functional digital infrastructure. Standards related to data object definitions and metadata among public and private databases are essential for the effective communication of critical real-time and archival transportation data to operators and system users.

Another consideration pertinent to evolving transportation technologies is cybersecurity. Cyber attacks can threaten transportation systems, ranging from disruptions to the movement of goods to compromised information relied on by system users. ASCE recommends that all public and private infrastructure owners employ certain actions to avoid disruption and preserve public safety[4]. Recommended actions include the deployment of technologies that can monitor networks, access, data, and control systems to detect malicious activity and facilitate response actions to threats and collaboration between the public and private sectors on cybersecurity initiatives. ASCE urges ARPA–I to place a significant emphasis on cybersecurity in its research and development efforts. ASCE is willing to lend expertise and share best practices to maintain a robust cybersecurity strategy.

Freight logistics and optimization

Industry leaders in the trucking, rail, airport, coastal and inland port, and logistics sectors have demonstrated innovative technologies meant to improve efficiency and reduce greenhouse gas (GHG) emissions. However, there are technological factors that should be considered as innovation continues. For example, while EV technology has the potential to provide substantial environmental benefits, charging for freight vehicles is expensive and can be time-consuming, especially for fleets trying to meet delivery schedules. Considerations related to EV charging time and battery safety should be taken into account by ARPA–I as the agency moves forward. Additionally, ASCE urges DOT to work closely with industry stakeholders in the execution of emergency response and disaster recovery plans, which can be enhanced by the swift exchange of standardized, up-to-date data.

Another transportation innovation that should continue to be explored and adopted is weigh-in-motion technology, which captures and records vehicles' weights as they move over a scale system. This technology is useful because it provides quick results without hindering the flow of traffic and helps enforcement officials determine compliance with weight restrictions on roads. Further innovation should take place in the use of datasets containing bridge load rating information, which has implications for pavement design and management.

Climate and resilience

Climate change presents serious implications for public infrastructure, worldwide water resources, energy production and use, agriculture, forestry, coastal development and resources, and flood control. Civil engineers are responsible for the planning, construction, operation, and maintenance of physical

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[4] Policy statement 565 - Cybersecurity and infrastructure security | ASCE

infrastructure, which is exposed to extreme weather and vulnerable to the effects of climate change. ASCE supports government policies that prepare for the impacts of climate change on the built environment; revisions to engineering design standards, codes, regulations, and laws that strengthen the sustainability and resiliency of infrastructure at high risk of being affected by climate change; and research, development, and demonstration to advance recommended civil engineering practices and standards to effectively address climate change impacts.

ASCE believes infrastructure owners must use new approaches, materials, and technologies to ensure our infrastructure can withstand or quickly recover from natural or man-made hazards. ARPA–I can play a critical role in achieving this recommendation. We think the developments and projects that emerge from ARPA–I should include a focus on resilience in order to make the nation's infrastructure fit for the impacts of climate change. ASCE recommends leveraging the momentum of climate initiatives by building collaborations between DOT and professional societies such as ASCE. Again, data standardization across software and hardware platforms is of great importance for effective communication between transportation entities and climate-related entities.

According to the Environmental Protection Agency (EPA), GHG emissions from transportation account for about 29% of total GHG emissions in the U.S., making it the country's largest contributor of GHG emissions[5]. Recognizing this carbon footprint, ASCE recommends ARPA–I research the effectiveness of clean air strategies, considering community impacts and the effects of freight movement.

Other areas in transportation infrastructure

ASCE recognizes that Artificial Intelligence (AI) has already been applied in a variety of areas, including transportation, manufacturing, and homeland security. Advanced AI techniques and digital twin methods can enhance safety and project monitoring procedures. AI-driven solutions also streamline workflow processes, increase automation, improve asset management, and offer project stakeholders actionable insights they need for effective documentation, collaboration, and coordination on their projects. Applying AI to tasks associated with execution and monitoring of engineering, construction, and operation in the built environment will transform AI research. It can also offer a dynamic response to the emerging realities of safety, productivity, quality, and sustainability associated with our aging infrastructure systems. The benefits are significant. For example, a 10% gain in improved productivity minimizes one-third of resources wasted in non-productive activities in today's construction industry and doubles contractor net profits. Also, an improved condition assessment for aging U.S. infrastructure supports planning and prioritization of funds to help address anticipated costs and protect by 2039 three million jobs and more than $3,300 in a family's annual disposable income[6].

Additionally, ASCE would like to suggest that ARPA–I consider a holistic, ecosystem-wide approach in its assessments, funding, and research to include other aspects of society that transportation funding affects, such as public health, land use, housing, and equity.

Conclusion

ASCE would like to thank DOT for standing up ARPA–I and giving us the opportunity to provide input on this exciting new agency. The transportation sector contains myriad possibilities for the research and

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[5] Carbon Pollution from Transportation | US EPA
[6] FTA_Econ_Impacts_Status_Quo.pdf (infrastructurereportcard.org)

development of technologies that can improve safety, boost efficiency, and increase resilience to the harmful impacts of climate change. Civil engineers are well suited to provide expertise on ARPA–I and benefit from the solutions that emerge from it. We look forward to serving as a partner and are prepared to answer any questions as DOT collects information.