Safe and Sustainable Highways with ASTM Standards

As billions of dollars are invested to jumpstart the improvement of highway infrastructure, ASTM International standards are ready to contribute to the success of these public works projects. By supporting the science and technology of highway construction, safety, maintenance and sustainability, ASTM standards ensure that our roadways are reliable, safe and built to last. Moreover, during these challenging economic times, ASTM standards offer the quality and performance that can give good returns on infrastructure investments.
COMMITTEE D04: MORE THAN A CENTURY OF INFRASTRUCTURE BUILDING

For more than 100 years, ASTM International Committee D04 on Road and Paving Materials has played a major role in helping to guide highway construction across the United States. D04 has made significant contributions to our infrastructure through developing test methods and specifications used for roadway construction and maintenance. Today, Committee D04 has a diverse membership of approximately 700 stakeholders who participate on 29 technical subcommittees and manage more than 200 standards. Many of these standards have been adopted in regulations by the U.S. Federal Highway Administration, the U.S. Department of Transportation and state departments of transportation.

D04 standards contribute to the quality of road paving and construction materials across several areas, including bituminous mixtures; asphalt; aggregates; sealants used in joints of road pavements and bridges; bridges and structures, including bridge deck protection systems; and highway traffic marking materials, lighting and signal materials.

Among D04’s significant standards is D5, Test Method for Penetration of Bituminous Materials, which gives guidance for measuring the consistency of semi-solid and solid bituminous materials. Pavement design and analysis engineers, asphalt concrete mix designers and laboratory technicians also rely upon D6931, Test Method for Indirect Tensile (IDT) Strength of Bituminous Mixtures, to help predict asphalt concrete performance and evaluating reasons for fatigue cracking, rutting and moisture susceptibility.

Subcommittee D04.51 on Aggregate Tests has developed a test method that shortens the often time-consuming testing of bulk aggregate materials used in asphalt and concrete mixtures. D7370, Test Method for Determination of Relative Density and Absorption of Fine, Coarse and Blended Aggregate Using Combined Vacuum Saturation and Rapid Submersion, enables an entire blend to be tested in less than 30 minutes, making it ideally suited for quality control at asphalt and concrete plants.

SUPPORTING INNOVATION THROUGH SUPERPAVE STANDARDS

Committee D04 is also engaged in developing standards used to promote the Superpave (Superior Performing Asphalt Pavements) system. Superpave, an outcome of the federally funded Strategic Highway Research Program, is a system for designing asphalt mixtures so that highway engineers and contractors can ensure that the right asphalt binder and aggregate structure are used based on the intended roadway’s traffic and climate. Supporting these efforts are D04 standards such as D7312, Test Method for Determining the Permanent Shear Strain and Complex Shear Modulus of Asphalt Mixtures Using the Superpave Shear Tester, a laboratory testing protocol used at the five U.S. Superpave centers.

NAVIGATING A SAFE TRIP

Another important focus for Committee D04 is developing standards for materials used in highway signs and pavement markings. Road safety depends upon the availability of readable information both day and night, regardless of the overhead lighting, under a variety of weather conditions and against backgrounds of varying complexity. Subcommittee D04.38 on Highway Traffic Control Materials helps to achieve these safety goals through standards such as D4956, Specification for Retroreflective Sheetings for Traffic Control.

Guiding motorists is also part of the activities of ASTM Committee E12 on Color and Appearance. Subcommittee E12.10 on Retroreflection focuses on standards for measuring pavement marker performance because road marking retroreflectivity degrades with traffic wear and requires periodic measurement to ensure sufficient visibility. Assisting in this process are E12.10 standards for measuring retroreflective pavement marking materials and for measuring the daytime chromaticity of pavement marking materials, both using portable devices.

In addition, nighttime driving is aided by ASTM E809, Practice for Measuring Photometric Characteristics of Retroreflectors. E809 focuses on the relationship between the vehicle headlamp, retroreflector and the driver’s eye geometry. Also used to aid night drivers is E811, Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions, which helps ensure that drivers receive the same message day or night.

BUILDING HIGHWAYS THAT LAST: COMMITTEES C01 AND C09

The work of ASTM Committees C01 on Cement and C09 on Concrete and Concrete Aggregates has also played an important role in building highways. C01 and C09 are known for their diverse range of members and extensive partnerships with key industry and government organizations.

In the transportation field, Committees C01 and C09 cooperate closely with the American Association of State Highway and Transportation Officials (AASHTO). The group’s mission is to advocate for multimodal and intermodal transportation and to serve the U.S. Department of Transportation and the U.S. Congress. The AASHTO Standing Committee on Highways develops all major engineering standards, guidelines and policies for the highway program, either as a unit or through its subcommittees; investigates, studies and reports on all engineering activities and developments, including all phases of road and bridge design, construction, maintenance, traffic requirements, roadside development, aesthetics, tests and investigations of materials, and protection of the environment. To help achieve its goals, AASHTO adopts and references numerous cement and concrete standards developed by C01 and C09.

The cooperative efforts of Committee C01 and AASHTO are evident in C01’s flagship cement standard, C150, Specification.
for Portland Cement. C150 covers the physical and chemical requirements for manufacturing eight types of portland cement, the basic ingredient of concrete. C150 is used by manufacturers and purchasers of cement as well as concrete producers, specifiers and users, and is harmonized with AASHTO’s M85, Specification for Portland Cement.

As federal, state and local transportation agencies work to rebuild the nation’s infrastructure, Committee C09 performance standards will have a valuable role in maximizing the investments that are made in our highways. Many of the standards in C09’s portfolio contribute to the quality and extended service life of roads and highways. Notable among these is C1202, Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration, which helps ensure that roadways resist salt penetration and related degradation and hazards such as potholes.

Winter driving can be perilous at times, particularly on snow covered and icy roads. To help better gauge the performance of our highways in cold weather conditions, Subcommittee C09.67 on Resistance to the Environment offers C666/C666M, Test Method for Resistance of Concrete to Rapid Freezing and Thawing, and C672/C672M, Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.

Similarly, the standards developed by Subcommittee C09.26 on Chemical Reactions provide guidelines for testing of reactions that cause damage to road surfaces. Many of these standards are focused on alkali-silica reactivity that can cause serious expansion and cracking in concrete, resulting in major structural problems and sometimes necessitating demolition. Among these are: C289, Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method); C1105, Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction; and C1567, Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).

EXTENDING HIGHWAY LIFE THROUGH GEOSYNTHETICS

The use of geosynthetic technologies in the highway system life cycle is also a focus of ASTM activities. Geosynthetics, a range of polymeric materials and products that provide durability in civil engineering applications, improve the lifespan of roads and other structures by stabilizing foundations, promoting drainage and preventing erosion, generally at a lower cost than other products.

ASTM Committee D35 on Geosynthetics has developed more than 130 standards that facilitate the design and selection of geosynthetic materials in the construction and environmental industries. D35 standards such as D4355, Test Method for Degradation of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus, and D4491, Test Methods for Water Permeability of Geotextiles by Permittivity, help measure the endurance of geotextiles for drainage and erosion control in highway construction projects.

SUPPORTING ADVANCES IN STORMWATER MANAGEMENT

Also playing a role in managing our nation’s highways are the standards of ASTM Committee F17 on Plastic Piping Systems. Within F17’s portfolio of standards are specifications that advance the usage of high density polyethylene pipe in municipal stormwater applications, such as culverts for highway drainage. Among the notable F17 standards in this area is F2306/F2306M, Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

STRONGER BRIDGES WITH A01 STEEL STANDARDS

Fortifying the United States’ billions of bridges is just one of the focus areas of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys. A01, ASTM International’s founding committee, has helped specify the steel used in bridge construction for more than 100 years. One of the committee’s first standards, A7, Specification for Steel for Bridges, was released in the early 20th century and was used by engineers for many years to order steel for large bridge construction projects.

This laid the groundwork for current A01 activities in the field of bridge construction. Today, ongoing efforts are coordinated by Subcommittee A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock and Ships. Flagship among the committee’s standards is A709/A709M, Specification for Structural Steel for Bridges, which covers carbon and high-strength low alloy steel structural shapes, plates and bars and quenched and tempered alloy steel for structural plates intended for use in bridges.

A standard from Subcommittee A01.05 on Steel Reinforcement, A1055/A1055M, Specification for Zinc and Epoxy Dual-Coated Steel Reinforcing Bars, offers a tool for promoting the long-term strength of bridges and supports the production of high performance, corrosion-resistant steel. The standard is beneficial to state departments of transportation that require high performance corrosion protection of reinforcing steel bars in coastal environments and that use deicing salts on roads, bridges and decks.

Many standards from ASTM Committee F16 on Fasteners are also utilized in infrastructure construction. F16 provides more than 75 standards for bolts, screws, nails and other fasteners for a wide range of industrial applications. Subcommittee F16.02 on Steel Bolts, Nuts, Rivets and Washers offers standards that specify products and components used in bridge construction. These include A325, Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength, which covers the requirements for two types of heavy hex structural bolts.
made of quenched and tempered. Offering similar utility is the **F436, Specification for Hardened Steel Washers**, covering washers for mechanical and structural use with bolts, nuts, studs and other internally and externally threaded fasteners.

**COMMITTEE E17: ENHANCING ROAD SAFETY AND TRAFFIC MANAGEMENT**

The standards of ASTM Committee E17 on Vehicle-Pavement Systems help to ensure safe journeys on roads and highways. Committee E17 provides more than 70 standards related to pavement management technologies, vehicle pavement interactions and intelligent transportation systems.

One important aspect of E17 activities is measuring pavement friction and skid resistance. E17 standards such as **E274, Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire**, offer transportation industry stakeholders a valuable testing tool. An important standard from Subcommittee E17.21 on Field Methods for Measuring Tire Pavement Friction is **E2340, Test Method for Measuring the Skid Resistance of Pavements and Other Trafficked Surfaces Using a Continuous Reading, Fixed-Slip Technique**. Regulatory agencies and state highway departments can use E2340 to reduce the potential of skidding accidents by identifying pavements that have become too slippery to be safe.

Traffic management agencies and traffic monitoring device manufacturers benefit from E17 standards like **E2300, Specification for Highway Traffic Monitoring Devices**, and **E2334, Test Methods for Evaluating Performance of Highway Traffic Monitoring Devices**. Both of these standards provide methods for specifying and conducting acceptance tests for devices used to monitor and measure traffic flow parameters, such as vehicle count, speed, lane occupancy and vehicle presence.

Many state departments of transportation also collect traffic data to better manage traffic or provide travel information as part of intelligent transportation systems (ITS). Some agencies save and archive this data after its initial real-time use and make it available to other data users, who may know little about the data or how it was collected. To make this historical data more useful in improving the overall efficiency of transportation systems, Committee E17 offers ASTM **E2665, Specification for Archiving ITS-Generated Traffic Monitoring Data**, which covers a consistent way to document such data.

**FACILITATING THE DEVELOPMENT OF GREEN HIGHWAYS**

With the increased focus on our planet’s long-term environmental health, work to rebuild our nation’s infrastructure must be pursued in a manner that considers natural resources. Promoting sustainability in highway construction is the focus of standards development activities in numerous ASTM technical committees, including several mentioned earlier in this article.

Subcommittee D04.99 on Sustainable Asphalt Pavement Materials and Construction is developing standards involving sustainable bituminous materials and construction that consider and improve environmental impact. This includes asphalt materials that utilize recycled materials and industrial byproducts, such as reclaimed asphalt payment and roofing shingles, and ground tire rubber. The group is currently developing its first standard, which will help state agencies implement green programs and inform industry stakeholders on the use of sustainability standards for highway construction materials.

The use of recycled materials in highway construction is also the focus of a new activity in ASTM Committee D18 on Soil and Rock (Subcommittee D18.14 on Geotechnics of Sustainable Construction), which is working on standards related to using industrial byproducts together with earth materials for sustainable infrastructure construction.

The activities of these two groups build on other ongoing ASTM activities for sustainable highway construction materials. These include existing standards from Committee C09 already mentioned. Subcommittee C09.24 on Supplementary Cementitious Materials offers standards that enable the reuse of industrial materials in concrete, including: **C311, Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete**, and **C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete**. Several new standards are also in development by C09.24. Similar goals are being achieved by Subcommittee C09.27 on Ground Slag, which develops standards for reusing ground granulated blast-furnace slag.

The ongoing reliability and safety of America’s roads and highways are essential to the quality of our everyday lives and the long-term economic vitality of our nation. As we set out to strengthen our highway infrastructure for the future, ASTM standards are prepared to help guide the way.

**ASTM INTERNATIONAL TECHNICAL COMMITTEES ON HIGHWAY INFRASTRUCTURE CONSTRUCTION**

The ASTM technical committees highlighted in this piece include:

- **A01 on Steel, Stainless Steel and Related Alloys**
- **C01 on Cement**
- **C09 on Concrete and Concrete Aggregates**
- **D04 on Road and Paving Materials**
- **D18 on Soil and Rock**
- **D35 on Geosynthetics**
- **E12 on Color and Appearance**
- **E17 on Vehicle-Pavement Systems**
- **E16 on Fasteners**
- **E17 on Plastic Piping Systems**