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Safe and Sustainable Highways with ASTM Standards

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ASTM International standards contribute to public infrastructure project success. By supporting the science and technology of highway construction, safety, maintenance, and sustainability, standards ensure that roads are reliable, safe, and durable. Standards offer quality and performance for good returns on infrastructure investments.

Road and Paving Materials (D04)

The committee on road and paving materials (D04) helps guide highway construction with test methods and specifications that underpin road construction and maintenance.

D04 standards contribute to high quality paving materials, including bituminous mixtures; asphalt; aggregates; sealants for road and bridge joints; bridges and structures, including bridge deck protection systems; and marking, lighting, and signal materials.

Today, D04 has close to 700 stakeholders who participate on 25+ technical subcommittees and manage over 200 standards. Many of these standards have been adopted in regulations such as those from the U.S. Department of Transportation and state departments of transportation.

- One D04 standard tests the consistency of semi-solid and solid bituminous materials (D5). Design and analysis engineers and laboratory technicians also rely on a method for indirect tensile (IDT) strength of bituminous mixtures (D6931) to help predict asphalt concrete performance and evaluate pavement fatigue cracking, rutting, and moisture susceptibility.

- Subcommittee D04.51 on Aggregate Tests has developed a method to shorten the often time-consuming testing of bulk aggregate materials used in asphalt and concrete mixtures. A test to determine the relative density and absorption of fine, coarse, and blended aggregate using combined vacuum saturation and rapid submersion (D7370/D7370M) 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

- Committee D04 is also developing standards used in the Superpave (Superior Performing Asphalt Pavements) system. Superpave is a system for designing asphalt mixtures so that highway engineers and contractors can choose the right asphalt binder and aggregate structure for an intended roadway's traffic and climate. Supporting these efforts are standards such as a test for preparing and determining the relative density of asphalt mix specimens

by means of the Superpave gyratory compactor (D6925).

Navigating a Safe Trip

The D04 committee also develops standards for materials used in highway signs and pavement markings. These devices contribute to road safety, particularly at night, regardless of weather or lighting. The subcommittee on highway traffic control materials (D04.38) supports safety with standards such as a specification for retroreflective sheeting for traffic control (D4956). Another standard emphasizes performance criteria for in-service pavement markings (D7942).

The committee on color and appearance (E12) helps guide motorists through standards for retroreflection, which uses devices to direct light back toward drivers' eyes. Standards cover, among other topics, measuring retroreflective pavement marking materials and daytime chromaticity of pavement marking devices with portable devices.

Nighttime driving is especially aided by pavement retroreflectors. One standard focuses on the relationship between the vehicle headlamp, retroreflector, and the driver's eye geometry (E809). Another measures colorimetric characteristics of retroreflectors at night (E811).



Committees C01 and C09 Cement and Concrete for Roads

The work of the committees on cement (C01) and concrete and concrete aggregates (C09) also support highway construction. The committees are known for their members' diverse affiliations and extensive partnerships with industry and government organizations.

The C01 and C09 committees, like the road and paving materials committee, cooperate closely with organizations such as the American Association of State Highway and Transportation Officials (AASHTO), which develops major engineering standards, guides, and policies for highways. A growing number of government and industry organizations in other regions of the world also use C01 and C09 standards.

- C01's flagship cement standard, the specification for portland cement (C150), covers the physical and chemical requirements to manufacture 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 the AASHTO specification for portland cement.
- Concrete and concrete aggregates performance standards have a valuable role in making the most of the investments in highways. Many C09 standards contribute to the quality and extended service life of roads and highways. One test measures electrical conductance of concrete — its ability to resist chloride ion penetration (C1202), which helps ensure that roadways resist salt penetration and related problems such as potholes.
- Winter driving can be perilous on snow-covered and icy roads. To better gauge the performance of highways in cold weather conditions, the subcommittee on resistance to the environment (C09.67) has developed a standard to test how concrete responds to rapid freezing and thawing (C666/C666M) and a test method for scaling resistance of concrete surfaces exposed to deicing chemicals (C672/C672M).
- In addition, standards from the committee guide testing for reactions that can cause damage to road surfaces. Many of these standards are focused on alkali-silica reactivity, which can cause expansion and cracking in concrete. This situation can result in major structural problems that might require demolition. Among these are the test method for length change

of concrete due to alkali-carbonate rock reaction (C1105); and the test method for determining the potential alkali-silica reactivity of combinations of cementitious materials and aggregate (accelerated mortar-bar method) (C1567).

Combined, the cement and concrete committees are responsible for more than 240 standards.





Supporting Highway Design and Construction

The committee on soil and rock (D18) is responsible for more than 350 standards related to the physical and chemical properties and behavior of soil, rock, and the fluids in them. A number of standards are relevant to highway design and construction.

- D18 standards guide materials characterization with a soils classification system (D2487); and methods for the liquid and plastic limits and plasticity index of soils (D4318), which are used to characterize soils and correlate their behavior.
- Other standards address materials performance, including methods for soil laboratory compaction characteristics (D698 and D1557) and a test for California bearing ratio of laboratory-compacted soils (D1883).
- These standards are used in maintenance and evaluation along with such standards as a method for density and weight of soil in place (D1556/D1556M), a specification for soil-aggregate subbases and bases, and a test for in-place density and water content (D6938).

Relevant

Soil and rock standards guide materials characterization with tests to characterize soils and correlate their behavior.



Extending Highway Life through Geosynthetics

The use of geosynthetics in highway systems is the focus of another committee (D35). These polymeric materials and products provide durability in civil engineering applications and extend the life of roads and structures. The materials stabilize foundations, promote drainage, and help prevent erosion.

- More than 150 geosynthetics standards support the design and selection of geosynthetic materials in the construction and environmental industries.
- D35 standards such as tests for deterioration of geotextiles by exposure to light, moisture, and heat in a xenon arc type apparatus (D4355) and for water permeability of geotextiles by permittivity (D4491/D4491M) help measure the endurance of geotextiles for drainage and erosion control in highway construction.

Durable

More than 150 standards cover the design and selection of geosynthetics in the construction and environmental industries.



Advancing Safety

Additional committees help ensure safety through standards that prevent water and stormwater from causing highway hazards.

- The committee on plastic piping systems (F17) and the subcommittee on precast concrete products for stormwater management (C27.70) support water management around roads. One F17 standard that advances piping for public infrastructure is a specification for 12 to 60 in. [300 to 1500 mm] annular corrugated profile-wall polyethylene pipe and fittings for gravity-flow storm sewer and subsurface drainage use (F2306/F2306M). Three C27.70 standards support stormwater management with tests for separators and underground settling devices as well as filters.

Notable

Standards help keep roadways from flooding thanks to standards for stormwater management and plastic piping.



Steel and Fasteners Stronger Bridges and Infrastructure with A01 and F16

Fortifying bridges is just one focus of the committee on steel, stainless steel, and related alloys (A01). A01, ASTM International's founding committee, has helped specify the steel used in bridge construction for more than 100 years.

- The subcommittee on structural steel for bridges, buildings, rolling stock, and ships (A01.02) coordinates standards work in these areas. One of its standards specifies structural steel for bridges (A709/A709M). The standard 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 the subcommittee on steel reinforcement (A01.05) has developed a tool to promote the long-term strength of bridges and support the production of high performance, corrosion-resistant steel; the specification covers zinc and epoxy dual-coated steel reinforcing bars (A1055/A1055M). The standard helps responsible groups such

as transportation agencies that require high performance corrosion protection of reinforcing steel bars in coastal environments and those that use deicing salts on roads, bridges, and decks.

- Standards from the committee on fasteners (F16) are also used in infrastructure. More than 60 standards from the committee cover bolts, screws, nails, and other fasteners for a wide range of applications. The subcommittee on steel bolts, nuts, rivets, and washers (F16.02), for example, is responsible for specifications that cover bridge construction products and components. One standard in this area is a specification for structural bolts, steel, heat treated, 120/105 ksi minimum tensile strength (F3125/F3125M), which consolidates six standards on structural fasteners. The specification covers requirements for quenched and tempered bolts made of steel and alloy steel.

A01

ASTM International's founding committee has helped to specify the steel used in bridge construction for more than 100 years.

Vehicle-Pavement Systems E17 Enhances Road Safety and Traffic Management

The committee on vehicle-pavement systems (E17) helps to ensure safe journeys on roads and highways. The committee maintains more than 75 standards for pavement management technologies, vehicle-pavement interactions, and intelligent transportation systems.

- One part of E17's work is measuring pavement friction and skid resistance. Its test method for skid resistance of paved surfaces using a full-scale tire (E274/E274M) offers transportation industry stakeholders a valuable testing tool. Also, one standard from the subcommittee on field methods for measuring tire pavement friction (E17.21) provides a way to measure the skid resistance of runways, roads, and various other traffic surfaces using a continuous reading, fixed-slip technique (E2340/E2340M).

Regulators and highway departments can use E2340 to reduce the potential for skidding accidents by identifying pavements that have become too slippery to be safe.

- Traffic management agencies and monitoring device manufacturers benefit from E17 standards such as the specification for highway traffic monitoring devices (E2300) and the tests to evaluate the performance of highway traffic monitoring devices (E2532). The standards cover requirements and acceptance tests for devices used to monitor and measure traffic flow parameters such as vehicle count, speed, lane occupancy, and vehicle presence.
- Profilograph simulation programs, such as those currently in use by the U.S. Federal Aviation Administration and the U.S. Federal Highway Administration, are used for pavement construction quality control. A standard practice for simulating profilograph response to longitudinal

profiles of traveled surfaces (E2955) provides a practical way to evaluate smoothness and rideability.

- Many transportation groups 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, the committee developed a specification for archiving ITS-generated traffic monitoring data (E2665), which covers a consistent way to record the information.



Supporting the Growth of Green Highways

With the increased focus on our planet's long-term environmental health, building and rebuilding infrastructure should be pursued in a manner that considers natural resources. Promoting sustainability in highway construction is the focus of additional committee work.

Sustainable Asphalt

The subcommittee on sustainable asphalt pavement materials and construction (D04.99) works on standards for sustainable bituminous materials and construction that consider environmental impact. This work includes asphalt materials that use recycled materials and industrial byproducts such as reclaimed asphalt pavement and roofing shingles, and ground tire rubber. The group is also developing new standards for using recycled asphalt pavement and recycled asphalt shingles, among others.

Geotechnics and Construction

The use of recycled materials in highway construction is also the focus of the subcommittee on geotechnics of sustainable construction (D18.14). The group is developing standards for using industrial byproducts together with earth materials for sustainable infrastructure construction.

The work of these two groups complement other activities for sustainable highway construction materials.

For example, the subcommittee on supplementary cementitious materials (C09.24) is responsible for standards that enable the reuse of industrial materials in concrete, including tests for sampling and testing fly ash or natural pozzolans for use in portland cement concrete (C311/C311M) and the specification for coal fly ash and raw or calcined natural pozzolan for use in concrete (C618). Additional standards are underway.



The ongoing reliability and safety of roads and highways are essential to the quality of our everyday lives and long-term economic vitality. As we work to strengthen highway infrastructure worldwide, ASTM International standards will help guide the way.



ASTM International technical committees highlighted in this piece include:

- Cement (C01)
- Color and Appearance (E12)
- Concrete and Concrete Aggregates (C09)
- Fasteners (F16)
- Geosynthetics (D35)
- Plastic Piping Systems (F17)
- Road and Paving Materials (D04)
- Soil and Rock (D18)
- Steel, Stainless Steel, and Related Alloys (A01)
- Vehicle-Pavement Systems (E17)

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