Every four years, the American Society of Civil Engineers — the nation’s oldest engineering society — provides a comprehensive infrastructure assessment of America’s infrastructure using a simple A to F school report card format. The highly-respected ASCE Infrastructure Report Card examines the condition, needs and recommendations for 17 major categories of infrastructure, including rail. For the last two report cards, rail has received the highest grade.

As the report notes, rail’s high grade is thanks in part to freight rail’s massive annual investments. Data show a direct correlation between increased investment in the rail network and enhanced safety performance; since 2000, America’s Class I railroads have spent $439 billion on network maintenance and capital expenditures, while the train accident rate has decreased 28% since 2000. In fact, the last decade was the safest ever for railroads.

Part of these safety gains is due to investments in the development and deployment of new inspection technologies — from track-side detectors to ultrasound, machine imaging, big data and drones — designed to monitor infrastructure and equipment health. Railroads use these tools to increase both the frequency and accuracy of inspections — often above and beyond federal regulatory requirements — while the resulting data informs proactive maintenance plans. Thanks to these and other efforts, America’s freight rail network is largely regarded as the safest, most efficient rail network in the world.
**Railroad Bridge Safety**

Thousands of bridges are vital to rail’s expansive network, which allow trains to cross rivers, gorges and ravines. Railroad overpasses also help pedestrian and highway vehicle traffic flow better. Without strong and structurally sound bridges, America’s freight rail network would not work. That is why freight railroads invest billions of dollars annually, employ the most-well trained bridge safety personnel, and annually inspect the more than 61,000 Class I railroad bridges in the United States.

Regardless of age, history, traffic or conditions, regular inspection of railroad bridges contributes more to the ability to carry trains than any other component of bridge maintenance safely. In adherence with federal regulations, trained experts inspect railroad bridges at least once a year. More frequent inspections occur for bridges with more intensive traffic or whose conditions may warrant closer monitoring. Railroads follow an aggressive “safety first” policy and immediately alter or suspend service on any bridge until all concerns are addressed and, if necessary, repairs are made.

**Bridge Programs**

Every railroad has a bridge program. Federal Railroad Administration (FRA) regulations require that all railroads have comprehensive bridge safety management programs, which guide bridge safety efforts and include specific requirements concerning railroads’ inspection, evaluation and structural work methods. Each railroad’s program is available to all relevant railroad personnel and any other individual or organization responsible for applying any portion of the program. The FRA oversees these programs, and many states have additional oversight to ensure the safety of communities large and small. Through its field enforcement staff, the FRA:

- Participates in bridge accident investigations.
- Performs bridge assessments and bridge management program reviews.
- Provides direction and technical advice in bridge inspection, maintenance and management.
- Guides railroad bridge worker safety.
- Works directly with railroads to resolve any issues found through an evaluation.
- If necessary, issues civil penalties and emergency orders, including prohibiting the use of any rail bridge it deems unsafe.

As required by law, every bridge management program thoroughly documents and describes all railroad bridges in the railroad’s network. Recorded information includes the loads, weights and speeds safe for each bridge. Additionally, each program:

- Prohibits the transportation of all loads except for those approved within the bridge safety program. Only a qualified railroad bridge engineer can make exceptions and may impose speed restrictions, limit the weight loads of other cars in the train or limit traffic from other tracks to maintain safety.
• Dictates annual inspections (at a minimum) of all rail bridges in a railroad’s network and the process for carrying out any necessary repairs, modifications or bridge replacements.

• Requires additional inspections for bridges after accidents, incidents or weather events that may impact the structural integrity of a rail bridge.

• Undergoes regular internal and FRA audits to ensure the program’s effectiveness, the validity of bridge inspection reports and bridge inventory data, the correct application of movement restrictions to railroad equipment of exceptional weight or configuration and a railroad’s adherence to all requirements contained within the program.

**Safety Inspections**

Railroads designate a highly trained and qualified team to design custom inspection procedures for each railroad bridge. Each inspection procedure is designed to detect, report and address deterioration and deficiencies before they present a hazard to safe train operation. Inspection procedures are customized to address the biggest threats to a bridge’s safety. For example, freight networks in areas prone to earthquakes take proactive steps to reinforce their railroad bridges and monitor seismic activity. As technology advances over the next decade, so will bridge inspection techniques.

A team composed of a railroad bridge engineer, inspector and supervisor carries out the inspection function. To conduct a rail bridge inspection, this team of experts visually reviews all bridge components, including its foundation, which sometimes requires dive crews for underwater analysis. Inspectors look for any anomalies or structural changes. Indications such as cracks, loose connections, strained bolts or rivets, and distortion of bridge components all prompt further analysis.

For any part of a bridge that is not directly visible, inspectors can employ other inspection techniques, such as ‘sounding’ or ‘boring,’ to understand the condition of non-visible bridge elements. After an inspection, an initial and complete report of the inspection’s findings is quickly filed with a railroad’s bridge management program. Railroad bridge supervisors and engineers then review all completed bridge inspection reports and make them available to the FRA for review and reproduction.

Finally, the railroad funds and executes the work when a bridge inspection identifies necessary maintenance, repairs, or wholesale replacement. Railroad bridge supervisors oversee each repair or modification and ensure that railroad traffic traveling over the bridge adheres to the design specifications.
Technology

- Railroads use drones for bridge inspection, and this will continue to be built upon as a strong form of predictive maintenance.
- Railroads are considering alternative bridge designs and materials, alternative steel bridge retrofits, higher-strength concrete bridges and innovative steel and concrete bridge designs using new and cost-effective bridge construction materials.
- Using science-based inspection methods, robotic-assisted inspection tools in conjunction with machine vision and onboard detection of changes in bridge condition will provide better information for capital and maintenance decisions.
- Selected bridges in the future may have in-track, self-diagnosing condition monitoring systems to monitor the health of the critical track components and communicate potential failures well in advance of the failures occurring.
- Through wireless communication systems, various smart sensor networks could provide actionable information to the railroads regarding bridge structural integrity.

Bridge Appearance

Cosmetic blemishes don’t mean a bridge is unsafe. To the trained eye of railroad bridge safety experts, each bridge is amazingly complex. Of the more than 61,000 Class I railroad bridges in the United States, each one has a unique history, is tasked with supporting a unique pattern of rail traffic and must ensure safe and smooth travel for passengers and freight.

This complex reality guides the operation and maintenance of existing rail bridges and the design and construction of new ones. As just one example, when determining the capacity of a bridge, freight railroads must take into account natural forces, such as average wind speeds and the soil composition upon which the bridge is built. They must also analyze how the weight of a train’s cargo will be distributed across a bridge, which can vary significantly from intermodal to automobile or coal shipments.

Railroad bridge experts must also understand how the entire freight and passenger rail industry — driven by technological innovation — will change over time. No example illustrates this important dynamic more than the evolution of the locomotive. Many of the oldest rail bridges today were built to support locomotives that, due to technological and engineering limitations, were significantly heavier than today’s lighter, more environmentally friendly ones.

This is one reason why bridges — even those built of a material such as timber — remain safe and structurally sound. It is also one of the many reasons why rail bridge inspectors are highly trained to look beyond what’s visible to the untrained eye to determine the safety of rail bridges across the entire network. While cosmetic blemishes, such as rust and cracks, may be alarming to a passerby, only trained engineers can determine if they impact a bridge’s safety. This is also why freight railroads share their findings with other highly trained individuals and organizations — including the FRA — to ensure that facts determine safety, not casual observation.