Center for Rail Infrastructure Durability and Sustainability

Background
Railways are the backbone of the United States’ economic system, because they allow swift, economical, fuel-efficient movement of agricultural products, coal, and finished goods. However, maintaining freight movement requires efficient train networking and reliable track systems. Kansas State University (K-State) currently utilizes multi-disciplinary expertise in railway track systems for $4.1 million in research contracts with the Federal Railroad Administration, to investigate methods of improving safety and durability of concrete railroad ties. Additionally, K-State researchers are assisting KDOT to evaluate track infrastructure for heavier car loads and to evaluate track ballast non-destructively. K-State departments involved in this research include civil engineering, mechanical and nuclear engineering, and industrial and manufacturing systems engineering.

Description
The overarching objective of this multi-disciplinary research is to enhance current understanding of how various materials and fabrication processes interact, and consequently affect railway durability and sustainability. K-State has pioneered development of a laser-speckle imaging (LSI) device that can be used in rugged environments such as railroad tie production facilities. This patented device has led to development of a system that images concrete railroad ties in order to determine if they are properly assembled at the manufacturing plant, to prevent cracking and failure in track.

K-State researchers are also developing methods to determine how raw materials and manufacturing processes affect durability of the railroad ties in states such as Kansas, where many freezing and thawing cycles occur each year. Therefore, K-State recently installed a specially designed, 120-cubic-foot environmental chamber dedicated to testing full-size railroad ties under water-saturated freezing and thawing cycles. This chamber is the only test apparatus of its kind in the U.S. capable of testing full-scale railroad ties.

Use of LSI techniques and full-scale freeze-thaw testing of concrete railroad ties has positioned K-State at the forefront of railroad track systems’ durability research. Therefore, K-State proposes to establish a Center for Rail Infrastructure Durability and Sustainability (CRIDS). The proposed center will be used to further develop and deploy existing K-State-developed technologies, in order to improve durability and sustainability of the U.S. rail infrastructure. Funding for the Rail Infrastructure Durability and Sustainability Center will have the following objectives:

- **New Railway Infrastructure Environmental Test Chamber.** Long-term durability of railroad ties under repeated loading from heavy-freight and high-speed railway lines should be tested under extreme weather conditions, including hot and cold temperatures, wet and dry conditions, and varying subgrade materials and temperatures. Funds will be used to design and build the first high-tech, varying-climate, full-scale test chamber for railroad track systems in the U.S.

- **Durability of Railroad Ties under Various Load and Support Conditions.** Railroad ties made with newly developed materials could provide longer life, thereby increasing sustainability of the railroad infrastructure. Existing full-scale testing capabilities at K-State will be enhanced to include the ability to evaluate the performance of railroad ties under varying load and support conditions, such as found on heavy-freight and high-speed railways with different supporting ballast conditions.

- **Deployment of Existing Laser-Speckle Technology.** K-State researchers will demonstrate application of the newly developed LSI technology at concrete railroad tie manufacturing plants in the U.S., and assist with implementation of the technology in these plants for improved quality assurance. This technology will allow optimal components (concrete mixtures and prestressing reinforcement) to be selected for maximum durability.

Relevance
Sharp increases in rail traffic in the last 10 years have caused railways to become increasingly critical to the U.S. economy. Improved materials and test methods for railroad tie systems, and development of reliable test procedures for new ties and components, will help prevent derailments and increase the lifespan of current railways.

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