

University of Illinois concrete crosstie group fastens up research challenges

by J. Riley Edwards, Ryan G. Kernes, Marcus S. Dersch and Conrad Ruppert, Jr.



Concrete crossties continue to see extensive use in the U.S. and abroad, and are widely recognized as a cost-effective method of maintaining track geometry under heavy-axle freight and passenger trains, but additional benefits could be recognized through increased performance and durability. Railway industry surveys conducted by the University of Illinois at Urbana-Champaign (UIUC) in 2008 and 2012 have identified the most critical challenges and research topics related to concrete crossties and fasteners.

Materials-related research at UIUC is focused on understanding the mechanisms behind rail seat deterioration (RSD) and materials properties of concrete rail seats, insulators and pad assemblies that affect RSD mechanisms. Component level research is focused on understanding the behavior of the rail pad and elastic fastening system under isolated loads. System level research is focused on gaining a better understanding of how each individual component interacts with other components to affect the overall performance of the crosstie and fastening system. UIUC houses a full-scale pulsating load testing machine (PLTM) that is owned by Amsted RPS. This machine allows researchers to simulate field loading conditions on full-scale ties. In addition to this test, a new laboratory test is being designed by UIUC researchers

that will include ballast support and multiple crossties.

UIUC has been conducting research on concrete crossties since 2008 and the award of a FRA research grant under the FRA's Broad Agency Announcement on Intercity and High Speed Passenger Rail in 2011 allowed the team to grow, increasing the number of faculty and students engaged in this work.

The objectives of the FRA-funded research are threefold: 1) understand the current state of practice for concrete crosstie and fastening systems, 2) conduct field and laboratory experimentation to fill voids in our current understanding of the behavior of the tie and fastening system and 3) use mechanistic design to improve recommended practices for the design of concrete crossties and fastening systems for U.S. infrastructure.

Laboratory testing of crossties and fastening systems began in 2011 and focuses on system-level behavior. In July 2012 extensive field testing was conducted at the Transportation Technology Center, Inc., (TTCI) using both freight and passenger consists that were operated over specially instrumented concrete crossties and fastening systems (see photos). The objective of this testing was to quantify the loads applied at critical interfaces within the crosstie and fastening system, which will provide information to allow a more effective design of components. Researchers monitored rail stresses, rail seat pressures, internal bending stresses within the crosstie, component and system deflections, pad temperatures and insulator stresses using more than 100 channels of instrumentation (see photos). This data is currently being processed and will be available in late 2012.

In addition to laboratory and field experimentation, UIUC is developing a comprehensive concrete crosstie and fastening system finite element model (FEM) which – when validated with lab and field data – will allow researchers to conduct parametric analyses that will facilitate the development of improved recommended practices for the design of concrete crossties and fastening systems. Parametric analyses will allow us to adjust a variety of input and design variables and monitor the output (or performance) of the systems.

Research funding has been provided by the US DOT Federal Railroad Administration (FRA), Amsted RPS, Association of American Railroads (AAR), National University Rail (NURail) Center, and NEXTRANS Region V Transportation Center. Additional industry support for the FRA research program comes from Amsted RPS, Amtrak, BNSF Railway, GIC Ingenieria y Construccion S.A. de C.V., Hanson Professional Services Inc., CXT Concrete Ties (LB Foster), and Union Pacific Railway.

The UIUC concrete crosstie research team, made up of 17 faculty, staff and students is active in AREMA Committee 30 (Ties), Subcommittee 4 (Concrete Tie Technology) and other industry professional groups.