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# Technology Scanning Update – Status of 2006 Texas Transportation Institute/Texas A&M University Affiliated Laboratory Projects

David D. Davis, Gary Fry, and Semih Kalay

## SUMMARY

The Association of American Railroads Affiliated Laboratory (Affiliated Lab) Program is one way in which the railroads maintain awareness of, adopt, and assimilate new technologies. The Affiliated Lab Program also provides a pool of engineers and scientists who are familiar with railroads and who are available to solve technological problems. Additionally, Affiliated Lab projects help train the young engineers who will build and maintain the railroads in the future.

There are currently three Affiliated Labs:

- Texas Transportation Institute (TTI)/Texas A&M University (TAMU)
- University of Illinois Urbana-Champaign
- Virginia Polytechnic Institute and State University

This *Technology Digest* provides a status report of projects at TTI/TAMU funded in 2006. Findings from these projects include:

- Track Surface Degradation at Approach/Bridge Transitions – A survey of track transition issues was conducted. Analysis tools were developed.
- Improved Center Bowls – TAMU developed a prototype freight car truck center bowl design, which is intended to reduce truck turning resistance and occurrences of harmful center plate-center bowl edge contact.
- Light Detection and Ranging (LIDAR) scanning of Rock Falls – A system for assessment of rock fall/landslide potential was developed using LIDAR surveying. It is effective at assessing the potential for landslides, but requires expert interpretation.
- Assessment of Timber Bridge Piles – An in-situ method assessing timber piles in the bridge has been developed. This method, which requires in-track measurements, is nondestructive and is intended to help prioritize timber bridge work.
- Wireless Instrumentation for Remote Monitoring of Infrastructure – This soil moisture measurement demonstration project is intended to show that smart sensors in the track are possible.
- Optimal Rail Grinding – TAMU has advanced the state of the art in wheel-rail contact modeling. The new analysis tools will be used to enhance the service life of rail.
- Spill Mitigation/Elimination of Oxidants – Laboratory tests of a method for processing contaminated soils, using metallic oxides (e.g., titanium), look promising.
- Nanocomposites – The technology of developing engineered surface materials still has significant technical and economic hurdles to overcome for railroad applications and is not feasible at this time.

Please contact **David Davis (719) 584-0754** with questions or concerns regarding this *Technology Digest.* E-mail: david_davis@ttci.aar.com.

## INTRODUCTION

The Affiliated Lab Program is one way in which the railroads maintain awareness of, adopt, and assimilate new technologies. The Affiliated Lab Program also provides a pool of engineers and scientists who are familiar with railroads and who are available to solve technological problems. Additionally, Affiliated Lab projects help train the young engineers who will build and maintain the railroads in the future.

The program was started in 1981 under the leadership of William J. Harris, then head of the Association of American Railroads (AAR) Research and Test Department. There are currently three Affiliated Labs:

- TTI/TAMU – College Station, Texas. Joined the program in 1992. Gary Fry (979) 862-1339 is the laboratory director.
- University of Illinois – Urbana, Illinois. A charter member of the program. Illinois has a long history of affiliation with railroad engineering. Chris Barkan is the laboratory director.
- Virginia Polytechnic Institute and State University – Blacksburg, VA. Our newest laboratory, VT joined the program in 2005. Mehdi Ahmadian is the laboratory director.

## STATUS OF 2006 PROJECTS

There are 19 projects currently funded under the Affiliated Lab Program. Table 1 describes each of the eight TTI/TAMU projects.

## NANOCOMPOSITES

The Nanocomposites project is intended to develop materials with improved surface properties to better resist wear and rolling contact fatigue in the railroad environment. Laboratory tests show that nanocomposites can be used to develop materials with desired surface friction characteristics. However, issues of material durability in the railroad service environment and the current costs of producing the nanocomposites make the probability of implementation very low at this point in time.

## TRACK SURFACE DEGRADATION AT APPROACH/BRIDGE TRANSITIONS

This project is investigating the track transition problem, where the geometry and stiffness of the track structure changes abruptly. Road crossings, bridges and their approaches, and diamond crossings are all examples of potential track transition problem areas. Initial efforts focused on understanding the extent of the problem with a survey of the track design and maintenance experts. Figure 1 shows the effect of the bump slope on vehicle forces. Findings from the work include:

- Up to 50 percent of bridge approach/bridge locations have transition problems
- Differential settlement at these locations creates a 1:150 slope bump (on average)

**Table 1. 2006 AAR Sponsored Technology Scanning Projects at TTI/TAMU**

| TTI/TAMU 2006 Tech Scan Projects | Principal Investigator | Objective | Status |
|---|---|---|---|
| Nanocomposites | Helen Liang | Prototype materials for wheels and rail | Does not appear to be economically feasible. |
| Track Surface Degradation at Approach/Bridge Transitions | Jean-Louis Briaud | Track designs for transitions | Survey of problem completed. Initial assessment of ramp rates completed. |
| Improved Center Bowls | Gary Fry | Prototype center bowls | Candidate materials selected. Prototype design completed. |
| LIDAR Scanning of Rock Falls | Tanner Blackburn | Assessment of rock slide potential | Proof-of-concept completed. |
| Assessment of Timber Bridge Piles | Gary Fry | Device to assess pile strength | Design of field evaluation system completed. |
| Wireless Instrumentation for Remote Monitoring of Infrastructure | Tanner Blackburn | Application of networked sensors to railroad | Breadboard proof-of-concept completed. |
| Optimal Rail Grinding | Gary Fry | Report and grind rates | Models of deformable wheels and rails completed. |
| Spill Mitigation – Elimination of Oxidants | Tim Kramer | Report | Analysis of titanium, iron, and aluminum oxides completed. Optimal method determined. |

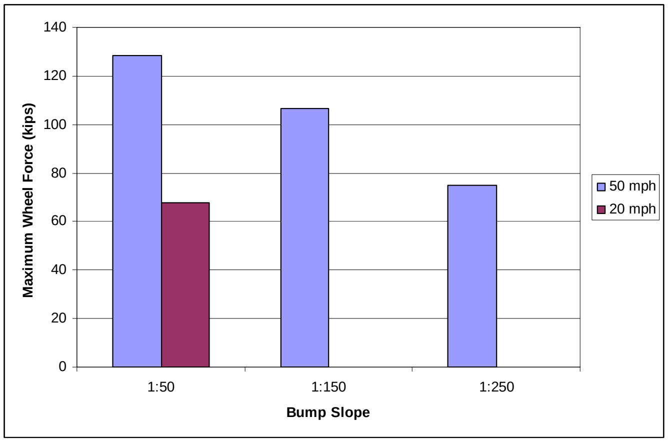


**Figure 1. Effect of Bump Slope on Vehicle Forces**

## IMPROVED CENTER BOWLS

The railroad truck center bowl is the truck/carbody interface that largely controls car curving forces and car stability for a given truck design. The current center-bowl/center-plate interface designs have horizontal surfaces (i.e., flat surfaces) and are lubricated with a variety of solid polymers and organic liquids. The TTI/TAMU design differs in that it is a ball (carbody center plate) and socket (truck center bowl) configuration. This configuration will make edge loading of the plate on the bowl less likely when the carbody rolls (as in curving). Additionally, both surfaces are coated with ceramic material: silicon nitride. This material has high strength and relatively low friction. Figure 2 shows the proposed prototype.

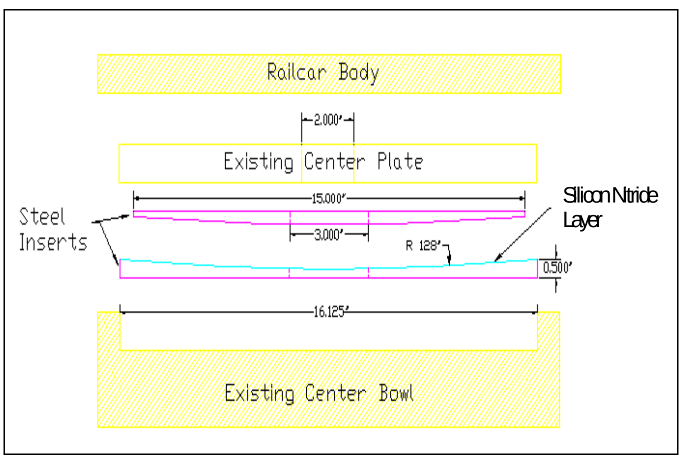


**Figure 2. Proposed Center-Bowl/Center-Plate Prototype**

## LIDAR SCANNING OF ROCK FALLS

TTI/TAMU is developing a method to assist in identifying and assessing potential landslide and rock fall hazards using LIDAR scanning. Potential rock fall areas are scanned with a radar system to map the surface. From this three-dimensional image, areas of potential risk are identified and can be mitigated.

Figure 3 shows an image of a rock face generated from LIDAR scanning data. From analysis of the images, a rock fall/earth slide hazard map was generated. There is potential for this technology to be applied to railroads. However, the current state of the art requires an expert to operate the equipment and interpret the results of the scanning.

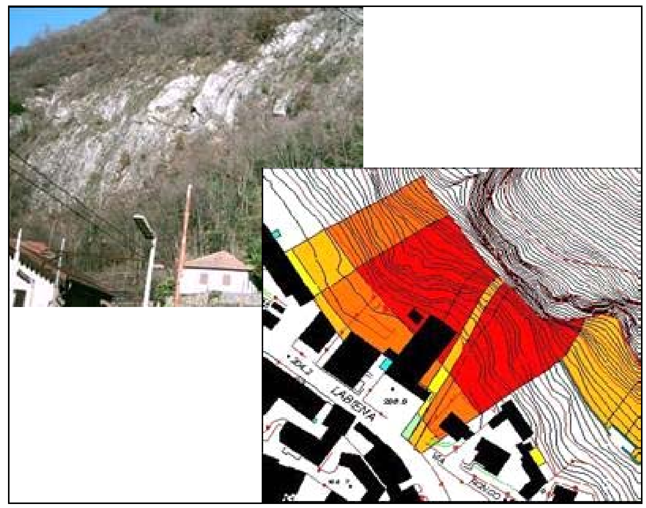

**Figure 3. LIDAR Scanning of Hillsides for Risk**

## ASSESSMENT OF TIMBER BRIDGE PILES

This methodology uses train loading to measure the performance of the bridge piles individually. The process requires installation of gages to measure the load below the pile cap and deflection under load. This information is used to assess the actual capacity and condition of each pile.

## WIRELESS INSTRUMENTATION FOR REMOTE MONITORING

TTI/TAMU is developing in-ground sensors and the ability to network the sensors to produce useful information about track substructure conditions. Prototype sensors have been built and durability tested on the TAMU campus. Figure 4 shows a soil moisture sensor in test.

**Figure 4. Prototype Self Networking Soil Moisture Sensor**

Some of the remaining challenges to be addressed include the implementation and management of a network of infrastructure sensors. Limiting operator interpretation and minimizing the number of false positive indications will be critical to a successful implementation.

## OPTIMAL RAIL GRINDING

This project explores the relationships between wheel and rail profiles, rail wear, and the development of rail subsurface defects. Work in 2006 has been focused on developing the models of wheels and rails needed to conduct the analysis. The models developed have the capability to simulate correctly the contact conditions between wheel and rail, accounting for deformation and plastic flow. This capability does not exist in the wheel/rail contact models being used by railroads today.

## SPILL MITIGATION – ELIMINATE OXIDANTS

A feasibility study to determine the effectiveness of titanium oxides as spill mitigators has been conducted. Titanium, iron, and aluminum oxides appear to be good candidates for on-site cleanup of chemical spills. A study of the mechanisms that reduces the potentially harmful chemicals has been conducted. These mechanisms are now understood and documented. Figure 5 shows how the process would work.

## ACKNOWLEDGEMENTS

The authors gratefully acknowledge the guidance of the AAR Technology Scanning Committee in steering the Affiliated Lab projects. The committee is chaired by Mike Iden, Director Locomotives, Union Pacific.

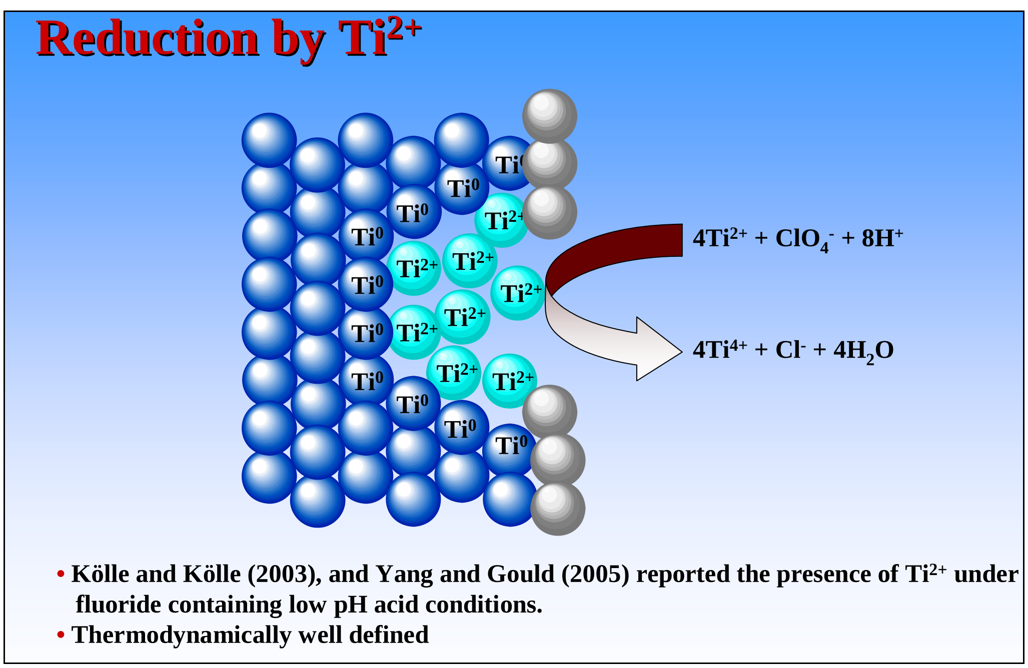


**Figure 5. Spill Mitigation Process using Titanium**