**1. Project name:**

Numerical Investigation of Impact Load Effects on Railroad Track Systems

**2. Is this a research, education, or technology transfer project, or a combination?** (If a combination, please estimate the percent of your budget that will be devoted to each activity)

100% Research Project

**3. Was this project described in the NURail Center proposal?**

Yes

**4. Suggested by:** (Name, Position, Dept, Institution, Email)

Bassem Andrawes, Assistant Professor, Civil and Environmental Engineering, UIUC, andrawes@illinois.edu

J. Riley Edwards, Lecturer, Civil and Environmental Engineering, UIUC, jedward2@illinois.edu

Marcus Dersch, Research Engineer, Civil and Environmental Engineering, UIUC, mdersch2@illinois.edu

**5. Project summary:** (Include objectives, scope & method, max. 300 words or 1/2 page)

The primary objective of this project is to study the effect impact load (dynamic load) resulting from defects in the rail and/or wheel (e.g. Wheel flat) and better understand the mechanisms through which this load transfer within various track components. The study will help shed the light on some of the uncertainty associate with impact factor and what factors govern it. Further, these impact forces are thought by many as one of the reasons for long term deterioration of track systems. Therefore, understanding how to minimize these loads is essential. This project will aim at capitalizing on the advances in the Finite Element Analysis (FEA) efforts developed over the last few years by the PI and his group to model crossties and fastening systems. Finite element method will be utilized in this project to study the response of multiple crossties under impact wheel loads while considering different fastening system components in the model. The study will first focus on validating the FE model through using field data, and then using the validated model in a comprehensive parametric study. The parametric study will focus on understanding the factors affecting the dynamic impact factor and how track conditions and mechanical properties of the rail seat could possibly affect these factors. Recommendations will be developed to minimize the impact forces on track systems.

**6. Strategic goal(s)/research area(s) addressed (all that apply):** (Check at least one under both USDOT Strategic Goals & NURail Center Topic Areas)

|  |  |  |
| --- | --- | --- |
| **USDOT Strategic Goals** \_X Safety\_X State of Good Repair\_\_ Economic Competitiveness\_\_ Livable Communities \_\_ Environmental Sustainability | **NURail Center Topic Areas**\_\_ Safety & Risk\_X Infrastructure\_\_ Rolling Stock/Equipment\_\_ Operations\_\_ Planning\_\_ Economics | \_\_ Rail Capacity\_\_ Institutional\_\_ Public Transportation\_\_ Multimodal\_\_ Workforce Development\_\_ Other (add below this line) |

**7. Index terms/keywords:**

Crosstie, Concrete, Impact Loads, Track Loads, Finite Element Analysis (FEA), Fastening System

**8. Detailed scope of work:** (Include a description of the project, a list of tasks and associated deliverables**[[1]](#footnote-1)** and how students will be involved, maximum ca. 600 words or 1 page. Provide the timeline for the tasks and deliverables in Appendix)

The work under this project will comprise the following tasks:

**1. Literature Review:** There is lack of information related to the work that has been done in the area of dynamic load effects on track systems. Although a quick inspection will reveal that the literature available on static load is far more than that on dynamic loads, there is no comprehensive idea on the extent done on the later. The first phase of the project will focus on conducting a thorough review of the literature in this area, especially identifying the studies that focused on the FE modeling of railroad track systems.

**2. Model Development and Validation:** The developed FE models should include with an acceptable degree of accuracy the effect of interactions between various track components including fastening system components (clips, pads, shoulders, etc.). Developing these models require in depth analysis of single-tie models first in order to obtain realistic values of the equivalent stiffness and mechanical properties of the springs elements which will comprise the boundary conditions for the multiple-tie model. The developed FE model will be validated using field data acquired under a wheel flat condition.

**3. Conduct Parametric Study:** The developed multiple-tie model will be utilized in conducting detailed parametric study that will aim at understanding the effect of various track components on the distribution of impact load between multiple crossties. In addition to varying the material and geometric properties of the tie and fastening system, the load magnitude, speed, and tie spacing will also be varied. In the light of the results of the parametric study, relationships between the location of the load along the track and the dynamic load impact factor will be established.

The primary deliverables of this project will be conference and peer-reviewed journal papers submitted to both structural and railroad conferences and journals, respectively.

**9. How project relates to USDOT & NURail center goals:**

(Provide an explanation of how the project relates to each of the Strategic Goals that checked in Item 6 above, max 300 words or 1/2 page)

 It is understood among researchers and practitioners in the railroad industry that interaction between components plays significant role in defining the safety and serviceability of railroad track systems. With the increasing interest in replacing timber crossties with concrete crossties, there is a dire need to understand better the interaction between multiple concrete crossties especially under dynamic loading. This relates specifically to the USDOT’s strategic goal of “State of Good Repair” as well as “Safety” given the implications of deterioration of the rail under repeated large impact forces. Understanding impact load distribution mechanism and its controlling parameters will allow engineers to minimize the negative effects of dynamic loads with time. This will protect both crossties and fastening system from excessive deterioration, which had proven to have significant negative implications on the long-term safety and serviceability (state of repair) of railway infrastructure.

**10. Suggested reviewers:** (Include – name, title, mailing address, email & phone number)

* **Jose Mediavilla,** Director of Engineering, Amsted RPS, 8400 W. 110th St. Suite 300, Overland Park, KS, 66210, 913-345-4807, jose@amstedrps.com
* **Bob Coats,** Vice President Engineering, Pandrol USA, 501 Sharptown Road, PO Box 367, Bridgeport, NJ, 08014, 856-467-2994, b.coats@pandrolusa.com

**11. Proposed project dates:**

Begin: 12/01/2014, End: 5/31/2016 (total of 18 months)

**12. Estimated cost** (NURail funds only, match not included)**[[2]](#footnote-2):**

$65,000

**13. Cost share - source, amount, status:[[3]](#footnote-3)**

Amsted RPS 🡪Concrete Crosstie Fastening System Design and Experimentation ($42,622)

PI Base Salary from Illinois (2 Months) 🡪 $22,378

**14. Estimated number of students involved (by academic level):**

**\_\_\_\_\_Primary, \_\_\_\_\_Secondary, \_\_\_\_\_Undergraduate, \_\_2\_\_\_Masters, \_\_\_\_\_PhD, \_\_\_\_\_Post-doc
Type of involvement, eg: Research Assistant, Teaching Assistant, Student, Other (briefly explain)**

This project will involve two Masters level Graduate Research Assistants.

1. For technology transfer projects include a description of the process for the implementation and/or deployment of research results. The focus should be “real-world” application as it relates to the transportation enterprise, not papers, publications or conferences. Examples may include, but are not limited to: patent and/or intellectual property applications; development of software, hardware platforms and/or other technologies that can be utilized by state DOTs and others; evidence of use of research in policy adoption (such as simulation modeling/other technologies/research that have been used to inform policy at the local, state or national level); etc. [↑](#footnote-ref-1)
2. Equipment expenditures greater than $5,000 must be approved by US DOT RITA [↑](#footnote-ref-2)
3. Projects funded by the NURail Center require a minimum 1:1 actual cost match from non-Federal sources. Please provide the source and expected amount of cost-share for the proposed work. Expenditures of any funds used for cost-share must comply with US DOT RITA rules. [↑](#footnote-ref-3)