UNIVERSITY TRANSPORTATION CENTER FOR RAILWAY SAFETY

Exhibit F - UTCRS

UTC Project Information	
Project Title	Multi-scale Fatigue Damage Life Assessment of Railroad Wheels
University	Texas A&M University (TAMU)
Principal Investigator	David H. Allen, Ph.D., Civil Engineering (PI)
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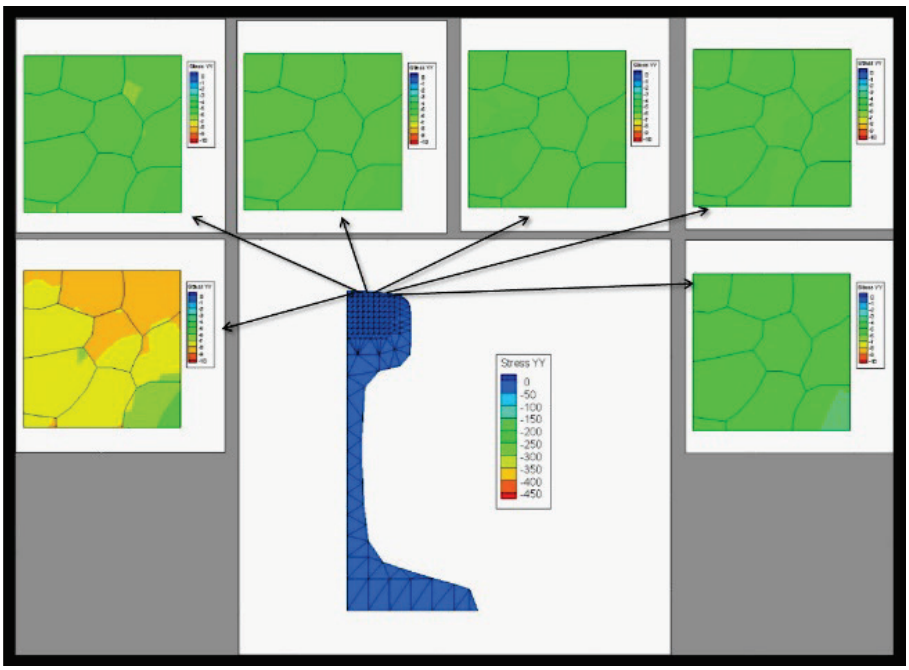
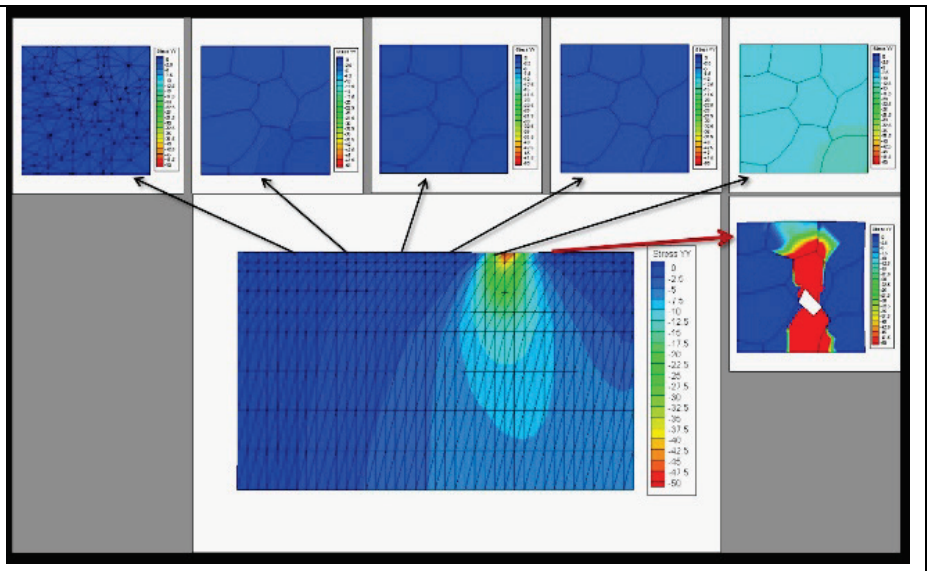
Funding Source(s) and Amounts Provided (by each agency or organization)	Federal Funds (USDOT UTC Program): $75,000
Total Project Cost	$75,000
Agency ID or Contract Number	DTRT13-G-UTC59
Start and End Dates	May 2016 – December 2017
Brief Description of Research Project	This study focused on the presence of a crack in the railway wheel's subsurface and how it affects the wheel's fatigue life. A 3-D FE-model was constructed to simulate the stress/strain fields that take place under the rolling contact of railway wheels on rails. To achieve computational efficiency and accuracy, a multiscale technique was employed. Different locations of the crack from the wheel surface were considered to detect the influence of a crack/defect on stress distribution of wheel/rail contact, as well as to possibly investigate the crack propagation rate and direction as a function of the crack's distance to the wheel thread. Moreover, by changing the crack plane angle in each specific increment of loading, it may be possible to observe mixed mode crack growth behavior based on the crack's orientation with respect to the wheel's surface. The outcome of this work gives valuable insights into fatigue induced cracking in railroad wheels in order to have a better understanding of the root causes of failures such as both shattered rims and vertical split rims (VSR) as a

	means of reducing the probability of derailment.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	An initial study was made of the potential for utilizing a previously developed (by the PI on this project) two-way coupled multiscale finite element computational algorithm for modeling the evolution of cracks in rails. The approach was used to simulate the crystalline grain structure of rail steel at the local level, and of the complete rail at the global level. Two-dimensional simulations were performed for both stationary and moving cyclic loadings. It was demonstrated that the technique is capable of predicting both the location and evolution of microcracks in rails as a function of loading history. Having completed the initial assessment of this approach to modeling the evolution of microcracks in rails, the research team is now seeking additional external funding for the continuation of this research project. This research was intended to be an in-depth and ongoing effort and, while the efficacy of the approach was demonstrated, because additional funding was not available, it was not possible to carry the research to the point of implementation. 

	
Impacts/Benefits of Implementation (actual, not anticipated)	The approach was demonstrated to be a methodology that has potential to provide more accurate predictions of fatigue life of rails than single finite element models currently in use. A textbook on this subject was published by the principal investigator, except that this modeling technique was utilized to model pavement rather than rail. The textbook reference is: ▪ Little D.N., Allen D.H., Bhasin A. (2018) Introduction. In: Modeling and Design of Flexible Pavements and Materials. Springer, Cham. DOI: https://doi.org/10.1007/978-3-319-58443-0_1
Web Links • Reports • Project Website	http://www.utrgv.edu/railwaysafety/research/infrastructure/wheel-fatigue-damage-life-assessment/index.htm