INNOVATIVE FOUNDATION ALTERNATIVE FOR HIGH SPEED RAIL APPLICATION

Quarterly Progress Report
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Submitted to:
ABC-UTC
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1 Background and Introduction

Bridges are key components of the high-speed rail (HSR) infrastructure, while the whole new construction of HSR bridges along an HSR line will take some tremendous cost and time. Utilizing the existing structure and foundation for HSR applications provides a good alternative to the challenge, but the methods for upgrading the existing substandard bridges to meet the HSR standards remain largely undeveloped in the engineering community. Focus also needs to be given to the seismic retrofit, considering California started the first HSR line construction to connect the bay area and southern California. This project aims to provide a guideline that compiles and synthesizes the existing and ongoing efforts for HSR bridge systems and analyze the approaches to provide potential solutions to new design and construction.

2 Problem Statement

One of the transportation solutions that have been always considered in the past few decades is the high-speed rail (HSR) where plans for the HSR date back to the High Speed Ground Transportation Act of 1965 (Public Law 89-220, 79 Stat. 893). However, full implementation of an inter-state HSR has never been accomplished. Only recently and after several delays, California is on track for an HSR line that connects the bay area to southern California and construction for the HSR infrastructure started as of 2017. Bridges are key components of the HSR infrastructure and the state plan is to consider new construction as well as utilizing existing structure and foundation if appropriate. The inherent characteristics of HSR raise new problems beyond those found in typical highway construction, so comprehensive approach on the bridge structure and foundation system needs to be made to systematically tackle the challenges. Upgrading of existing bridges is of particular concern, e.g., (a) HSR bridge superstructures require high stiffness and are likely to be heavy, so upgrading of the existing structure for HSR will apply significant surcharge on the bridge foundation, for which a retrofit solution also needs to be developed; (b) The stiff, heavy components will induce seismic forces that are much higher than in highway bridges, so the ABC solutions developed for highway bridges will have to be reworked to satisfy the more stringent requirements in seismic areas; (c) Construction issues also have to be optimized regarding how this upgrade can be best accommodated in a short period time without causing high costs and traffic disruptions. The overall goal of this project is to compile and synthesize the existing and ongoing efforts for HSR bridge systems and analyze the approaches to provide potential solutions to new design and construction.

3 Research Approach and Methods

The guideline development will be conducted in a collaborative effort among FIU, UW and UNR. Table 1 below overviews the guideline contents and the university responsible for development of each chapter.

Table 1. Overview of guideline contents

Chapter	Contents
1. Introduction (FIU)	• Background of HSR and HSR bridge systems • Purpose and scope of this report
2. Current HSR Systems 2.1. Introduction (FIU) 2.2. Japan HSR (UNR) 2.3. China HSR (FIU) 2.4. Europe HSR (UW) 2.5. USA HSR (FIU)	• The objective of this chapter is to discuss the primary methods for their perceived benefits / drawbacks if they were to be used in the USA. • The key features of each selected bridge (including deck component with rail, super- and sub-structures) are discussed for the existing HSR examples in each county.
3. HSR Bridge Design Specifications and Selection Methods 3.1. Superstructure Systems (UW) 3.2. Substructure Systems (FIU)	• Loadings • Design criteria • Strategic system selection with flowchart and process for design • Advantages and disadvantages of a few substructure systems • Effects of different parameters (structure length, construction constraints, project delivery methods, etc.) • Shortcomings in existing systems and possible improvements
4. Numerical Modeling Strategies (UNR)	• Overview of vehicle-track-structure-soil interaction modeling • HSR loading models • Available software and methods for the numerical modeling • Discussion of modeling strategies are appropriate for various design considerations
5. Summary and Conclusions (FIU)	

4 Description of Research Project Tasks

Each chapter of the guideline is considered as separate tasks, and FIU leads the compilation of the collaborative efforts provided by each university to develop the guideline. The current version of guideline is linked below:

https://uofi.box.com/shared/static/a5212tg5wu7tjc2l337dyypewti68k37.pdf

5 Expected Results and Specific Deliverables

5.1 ABC-UTC Guideline for HSR Bridge Systems

One format to disseminate the results from this project is to develop a guideline for HSR. The guideline will include comprehensive review of design and detailing steps for HSR bridges.

5.2 Final Report and Publications

A comprehensive report will be developed to summarize the design and modeling approaches as well as all the analysis results. The produced analytical datasets could also be published using existing or new cyber infrastructure or data platforms if a unified research repository is employed by ABC-UTC for the research center projects. Publications in peer-reviewed journals and conference presentations will also be considered for delivering project results.

6 Schedule

Progress of tasks in this project (FIU's part in the guideline) is shown in the table below.

FIU Task	% Completed
1. Introduction	40%
2. Current High-Speed Rail Bridge Systems	
2.1. Introduction	70%
2.3. China HSR	90%
2.5. USA HSR	90%
3. HSR Bridge Design Specifications and Selection Methods	
3.2. Substructure Systems	70%
4. Numerical Modeling Strategies	50%

Item	% Completed
Percentage of Completion of this project to Date	80%