Exhibit F - UTCRS

UTC Project Information	
Project Title	High Speed Train Geotechnics
University	Texas A&M University (TAMU)
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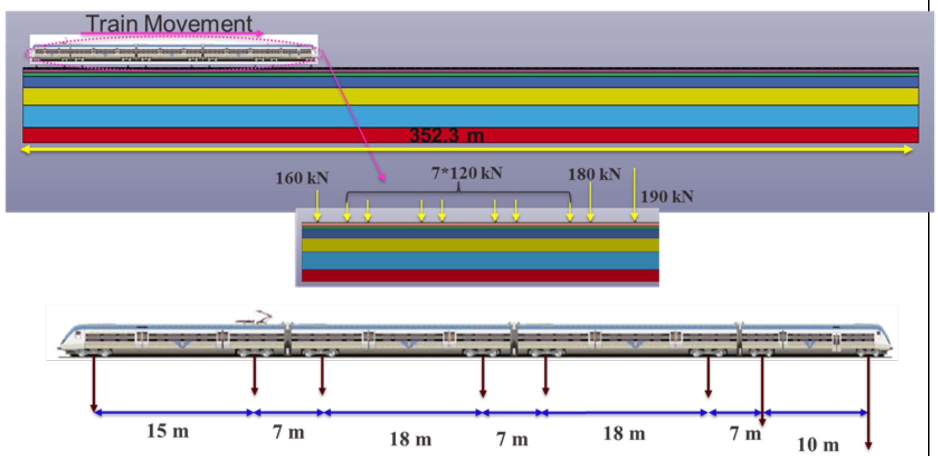
Funding Source(s) and Amounts Provided (by each agency or organization)	Federal Funds (USDOT UTC Program): $35,635 Cost Share Funds (TAMU): $0
Total Project Cost	$35,635
Agency ID or Contract Number	DTRT13-G-UTC59
Start and End Dates	January 2014 — December 2015
Brief Description of Research Project	California is planning a high speed train (HST) to link Los Angeles, San Francisco, and Sacramento. The project is estimated at 68.4 billion dollars for 1300 kilometers of rail or about 53M$ per kilometer. The first design-build contract for this project has been awarded. This is a proposal for Texas A&M University and the Center for Railroad Safety to help the project team by sponsoring a graduate student for one year to investigate issues relevant to the safety concerns. The research approach will consist of three parts. One part will be an attempt to simulate the HST passing the Rayleigh wave barrier by using LSDYNA. This is a major challenge. The second part is to help quantify the stiffness of the subgrade soil using pressure meter testing, BCD testing, and simple plate testing. The third part is to simulate the intended solution for minimizing the problem of the

	bump at the end of the bridge. Part 1 will indicate how the pressure meter modulus compares with other soil moduli measured in the test pads. This will lead to guidance on how to best use the pressure meter, the BCD, and the simple plate test in the future for HST embankments. Part 2, if successful, will show what happens when the HST passes the Rayleigh wave barrier; will there be major shaking at resonance of the HST with possible derailment or simply minor vibration. Part 3 will give information on the impact of the depth and extent of the soil cement wedge on the bump at the end of the bridge.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	**Task 1. Breaking Rayleigh wave barrier** Results from instrumented tests performed with a high-speed train on a soft soil at different sites and associated numerical analyses have indicated that a large dynamic amplification appears in the vertical dynamic movement of the HSR as the train speed approaches the Rayleigh wave speed. This Rayleigh wave speed is the equivalent Rayleigh wave speed of the rail/embankment/ ground systems. This threshold speed is called the critical speed and is known as Ground Mach 1 or GM1. In this research, the numerical simulations (Fig. 1), calibrated to the measurement from a soft soil site in Sweden, show that the maximum deflection of the rail occurs at the critical speed, at GM1, and is about three times larger than the static deflection (Fig. 2). This maximum deflection raises concerns about high maintenance cost, uncomfortable ride, if not derailment. In addition, we are performing a parametric study to determine the height and stiffness of embankments to raise the equivalent Rayleigh wave of the soil system above the top speed of the train. The guidelines (Fig. 3) will give the designers a way to choose the height and stiffness of the embankment given a natural soil stiffness. **Task 2. Long term moisture softening of compacted embankment** As documented for the China HST, softening of the soil may occur as time goes by. A loss of stiffness has been seen due to wetting of the fill; this wetting occurs by capillary action as the water is attracted upward into the dry embankment. This loss of stiffness induces uneven settlement of the embankments and associated roughness of the train ride. This process was simulated in the

laboratory by measuring the soil modulus and water tension in a manmade porcelain clay for different water contents. The results for this porcelain clay (Fig. 4) indicate that the soil modulus decreases significantly as the soil water content increases.

a)



b)

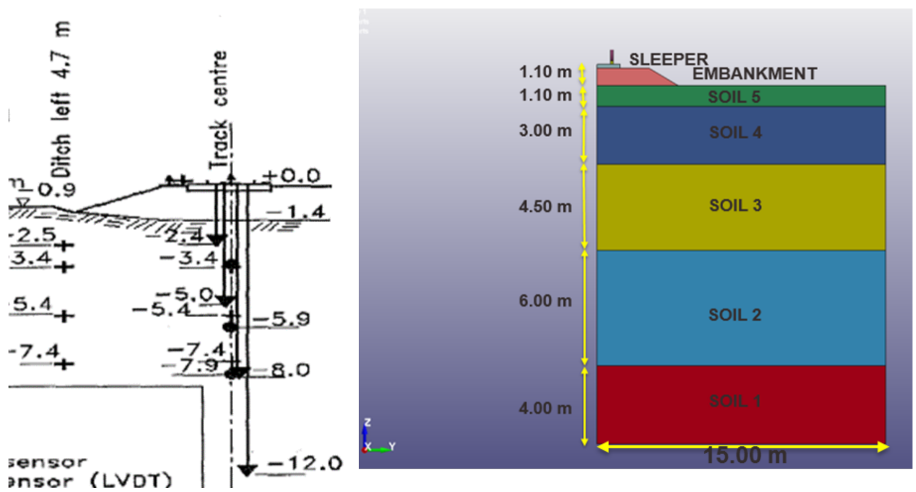


Fig. 1. a. The HST embankment model for numerical simulation and the bogie loads of the X-2000 trains, b. the embankment cross section for numerical simulation, c. cross section of the embankment in Sweden site (with curtesy of Kent Adolfsson et al., 1999)

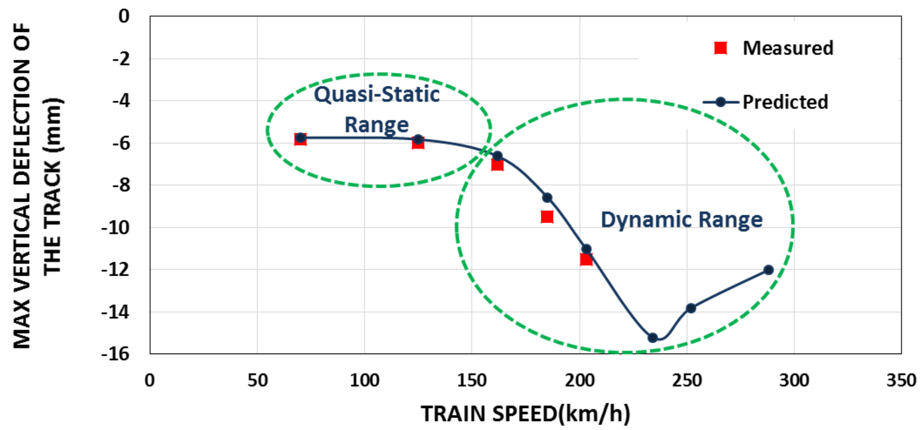


Fig. 2. Measured and predicted peak vertical track deflection vs. train speed

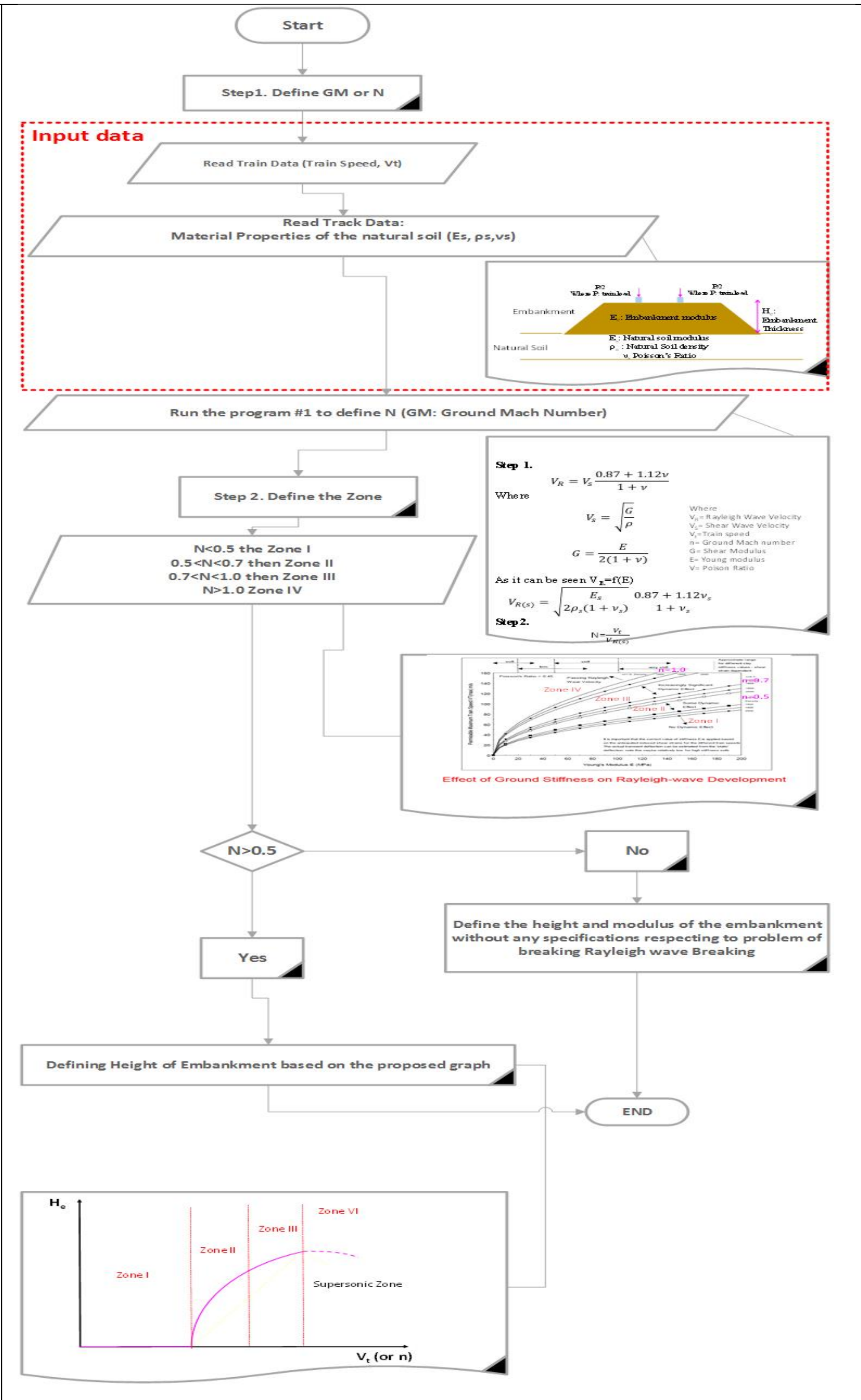
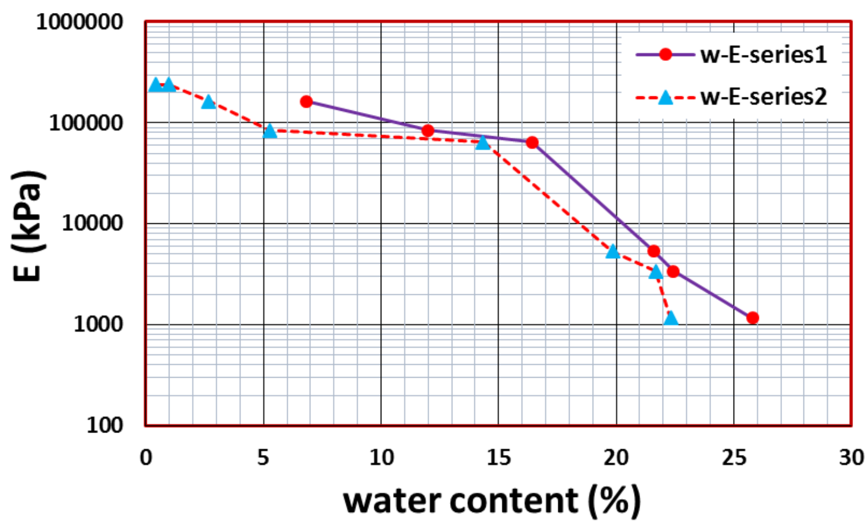


Fig. 3. Flowchart for selecting High Speed Railway Embankments

	 Fig. 4. Water content vs. Young modulus for porcelain clay
Impacts/Benefits of Implementation (actual, not anticipated)	California is planning to build a 62 billion dollar high speed rail line to link Los Angeles, San Francisco, and Sacramento. We are connected with the people who have won the first phase study (AMEC in San Francisco) and share with them the results of our study on an informal basis, which they appreciated. In addition to the California HST project, Texas is planning a 15 billion dollar high speed rail line to link Houston to Dallas. We are connected with some people working on this project at Terracon and ARUP. We had several teleconferences and meetings with them and sent them some of our outcomes. We are also cooperating with Zhejiang University in Hangzhou, China which is working on the Chinese high speed train embankments. They have made impressive measurements in a full scale laboratory experiment simulating the loading of a high speed train embankment.
Web Links • Report • Project Website	http://www.utrgv.edu/railwaysafety/research/infrastructure/high-speed-train-geotechnics/index.htm