OFFICE OF RESEARCH & DEVELOPMENT

2012 R&D REVIEW

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AMTRAK

Development of Dynamic Track Model for Mixed Traffic – High-Speed Rail & Freight

U.S. Department of Transportation
Federal Railroad Administration

Outline

- Introduction
- Track Modeling
- “3-D Sandwich” Model
- Dynamic Response under Mixed Traffic
- Ballast Settlement under Mixed Traffic
- Conclusions and Future Recommendations
- Acknowledgement

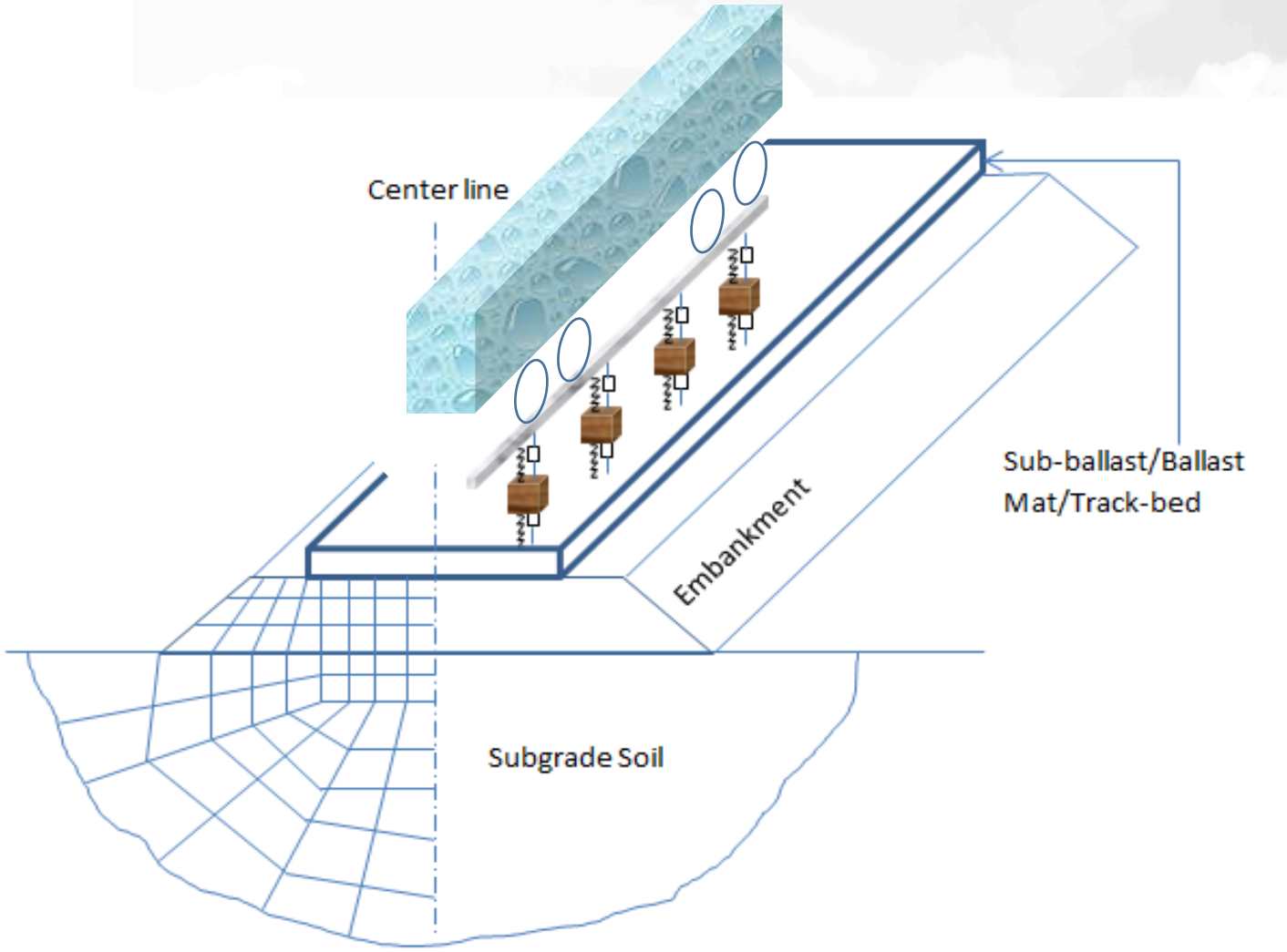
Introduction

Critical Speed

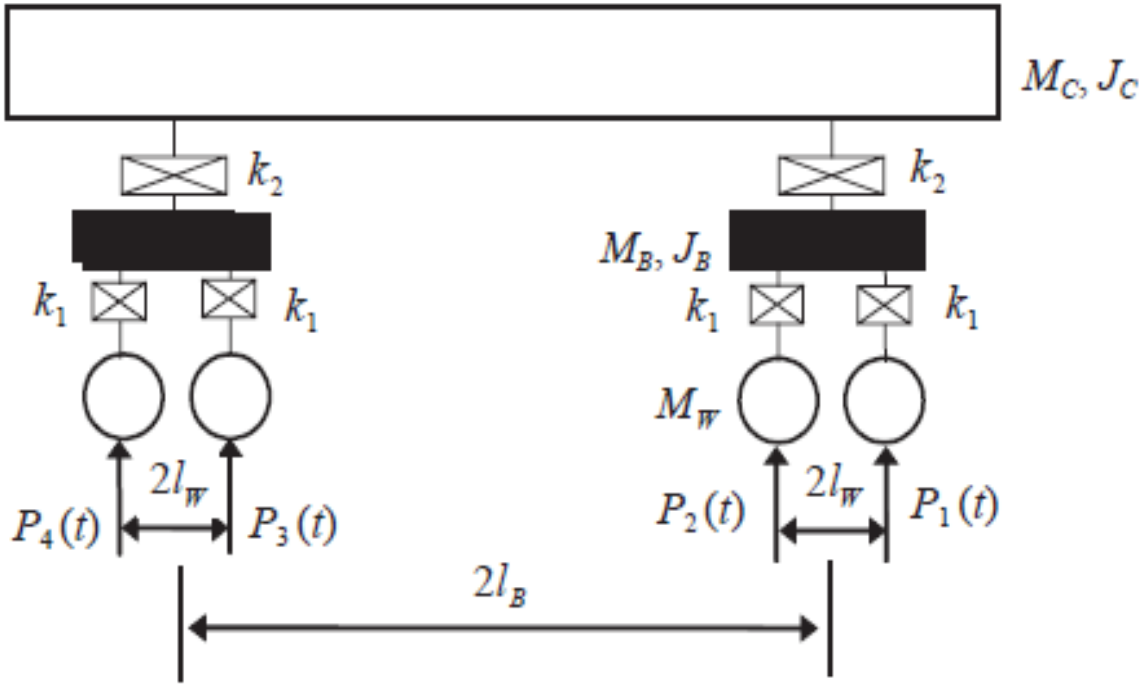
- "Critical speed" is considered as the train speed causing resonance between train and track or/and soil

- State-of-Art Field Study Done by Swedish Scientists (1996-2004):
  - Cause of "Critical Speed"
  - Treatments
  - Counter measurements

3-D “Sandwich” Model

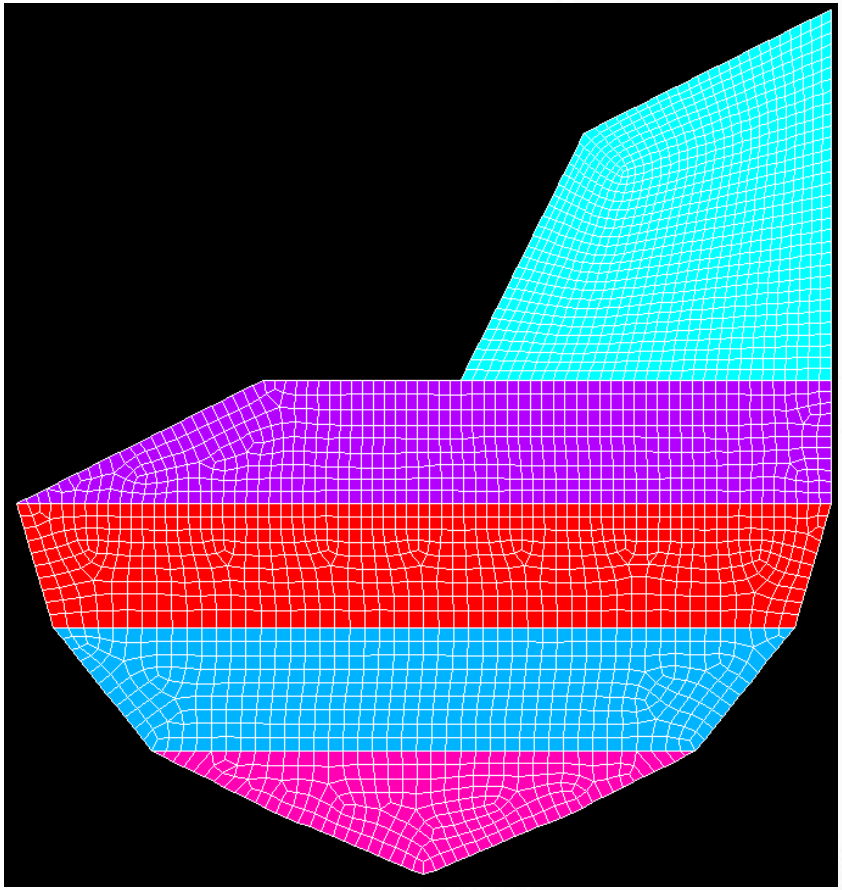


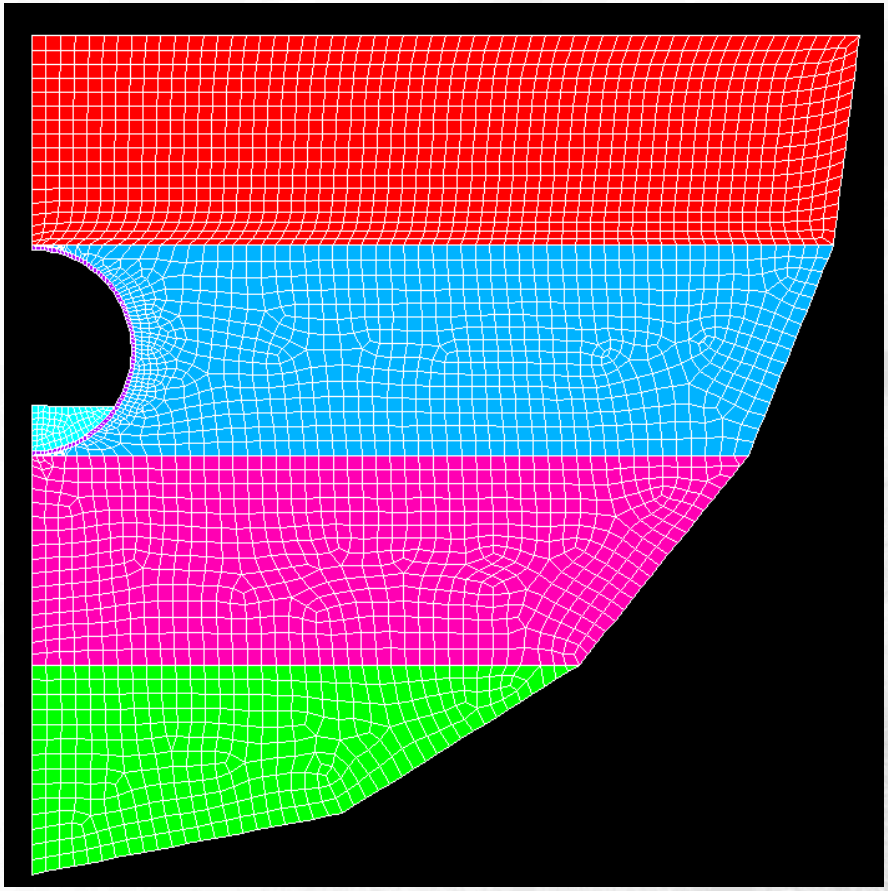
Car



Velocity →

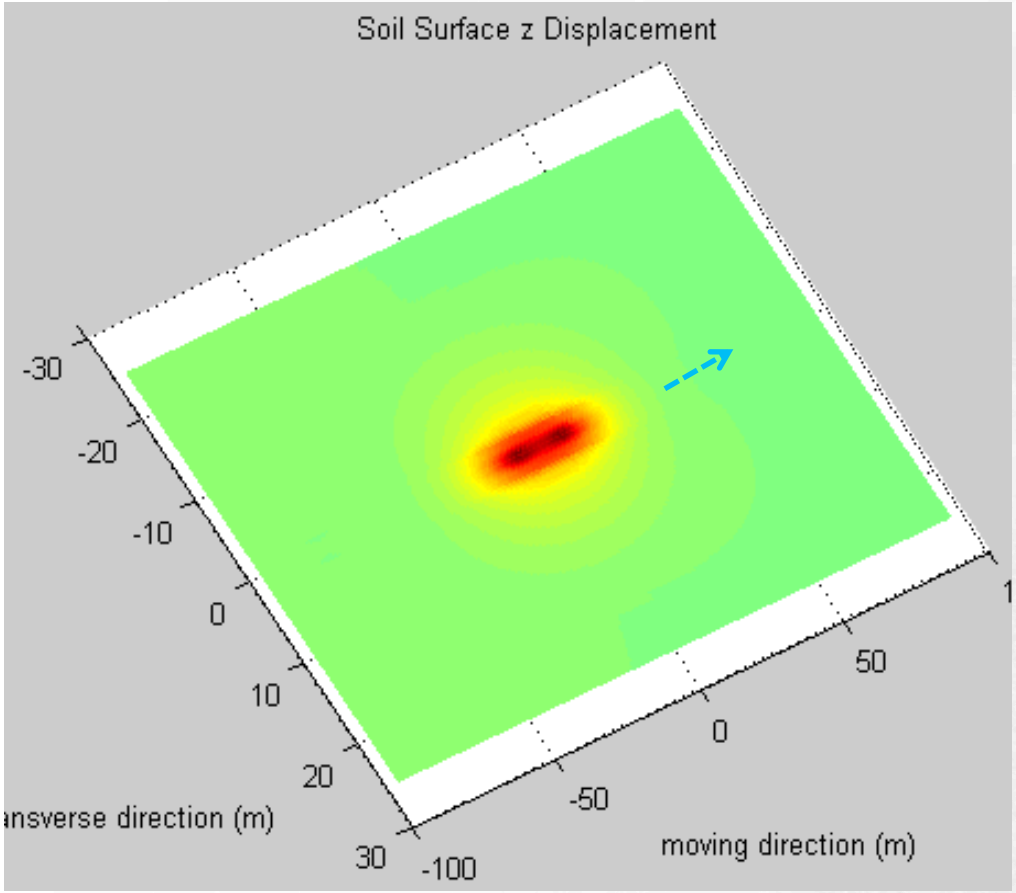
Soil





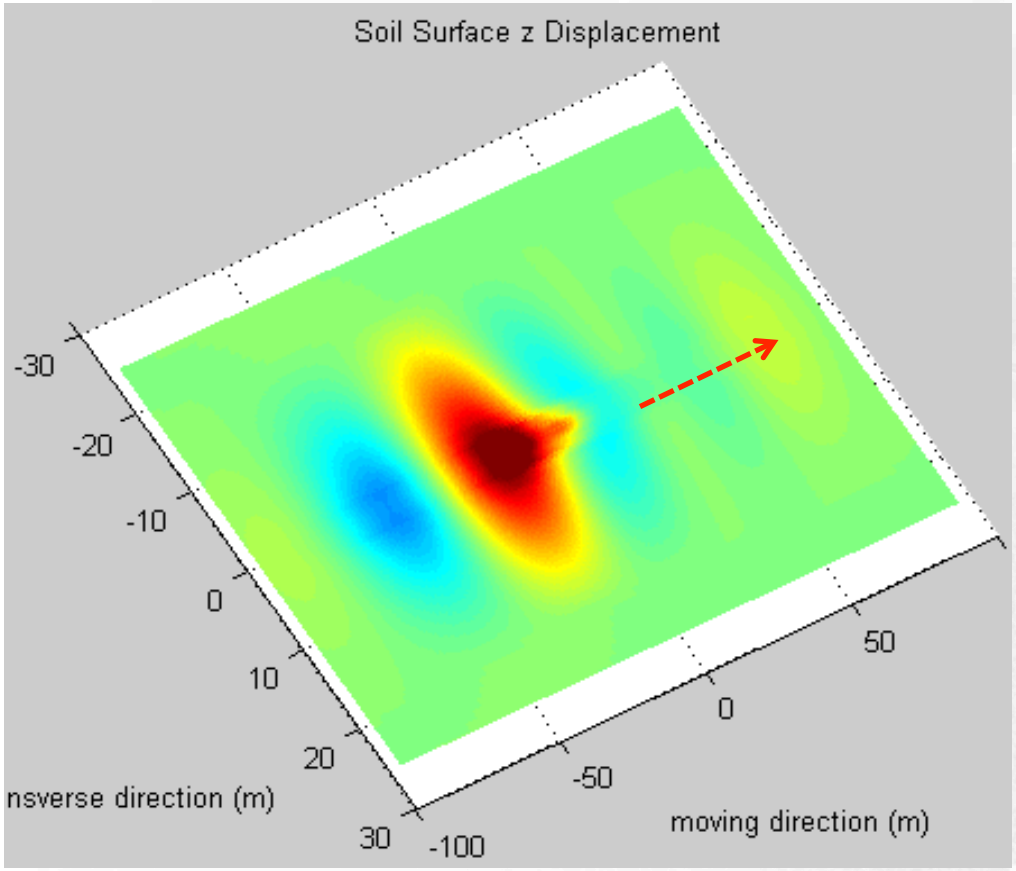
Normal Speed

Soil Surface Vibration Profile (both horizontal and vertical)



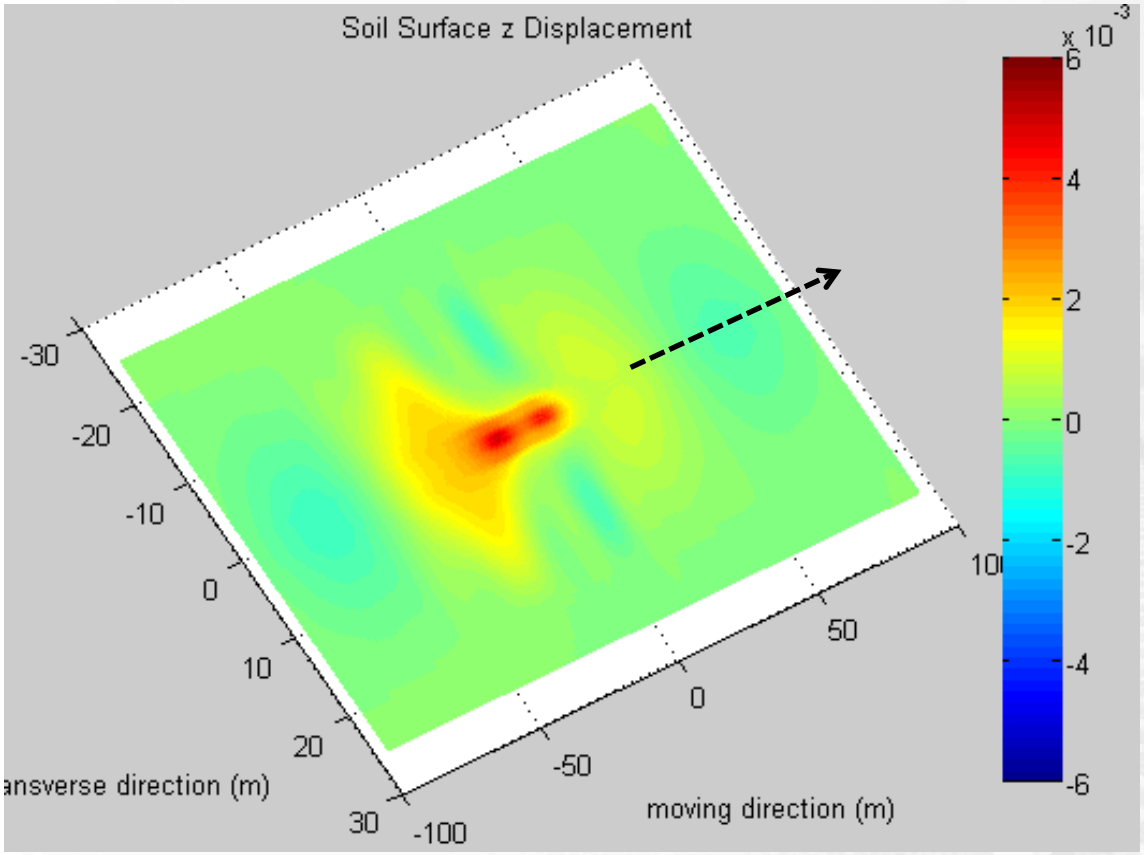
Critical Speed

Soil Surface Vibration Profile (both horizontal and vertical)



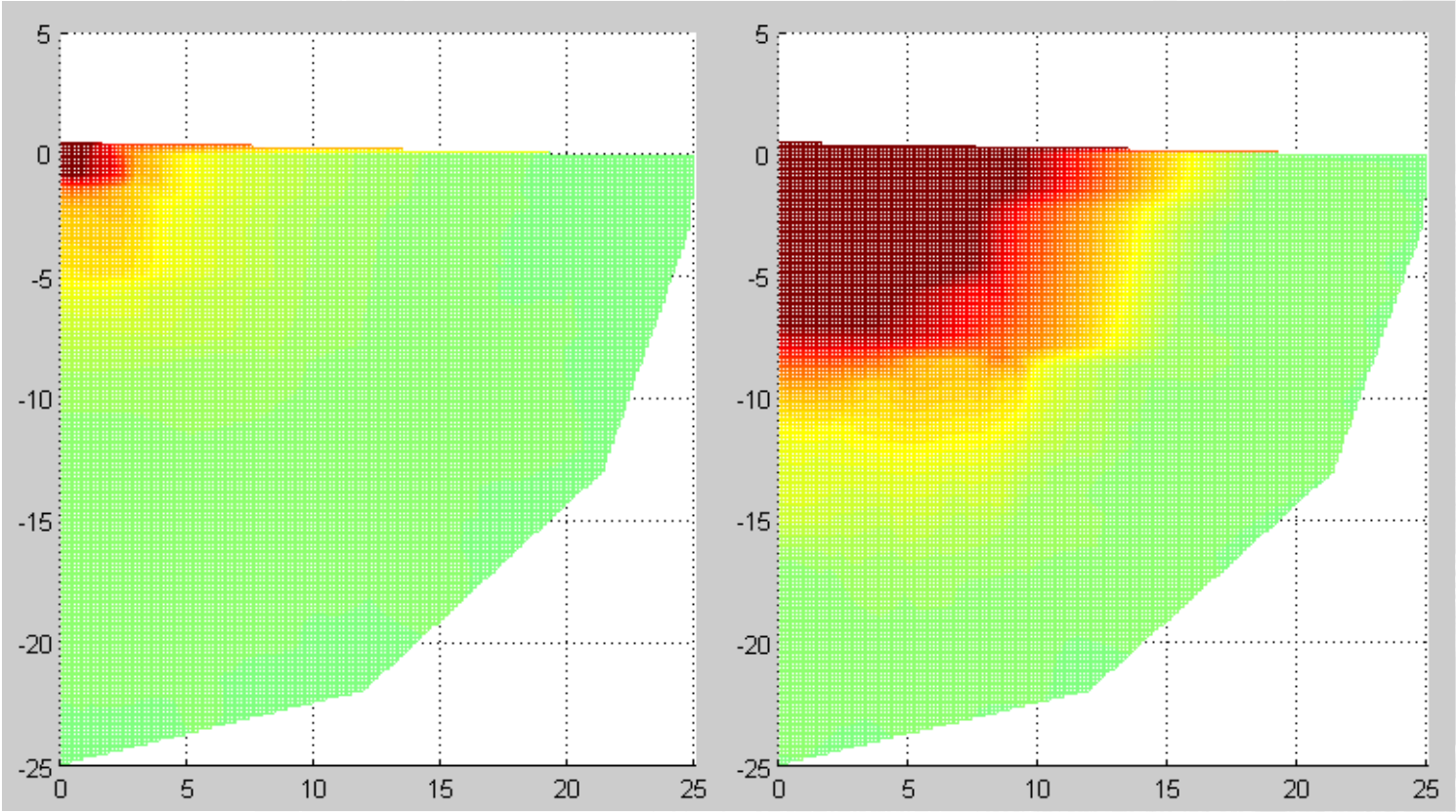
Super-Critical Speed

Soil Surface Vibration Profile (both horizontal and vertical)



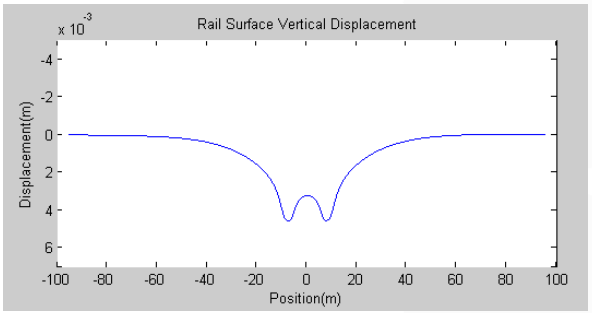
Dynamic Responses

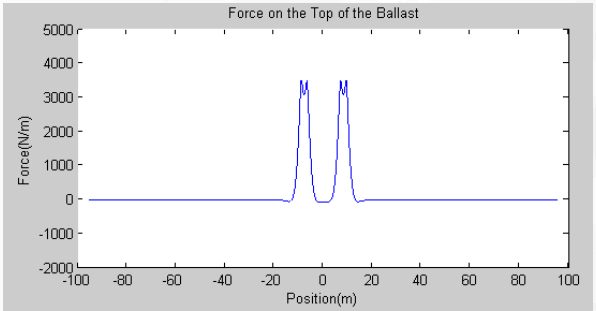
"Higher Speed" increases the soil vibration (both horizontal and vertical)



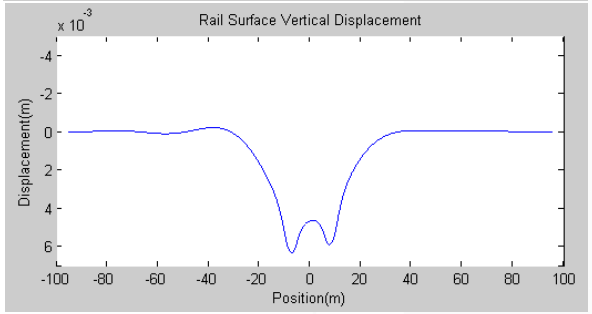
Dynamic Responses

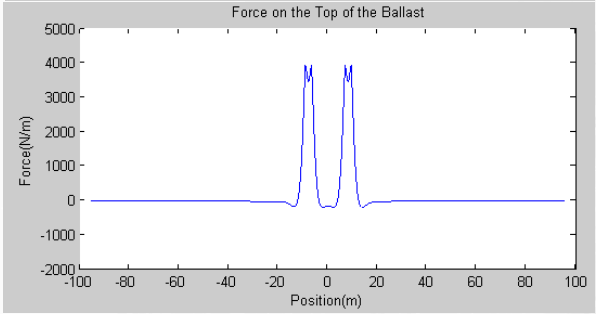
"Higher Speed" causes increasing in rail bending and force



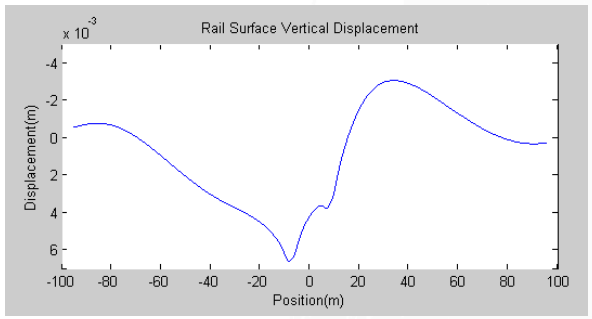


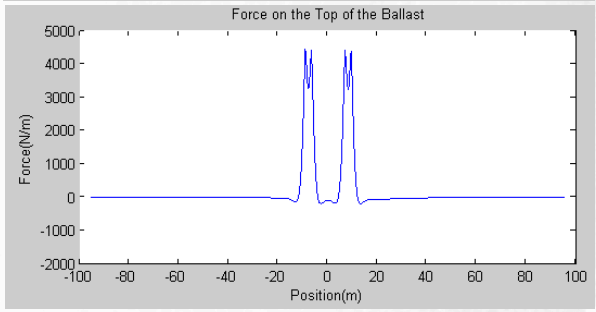
Normal Speed





Critical Speed

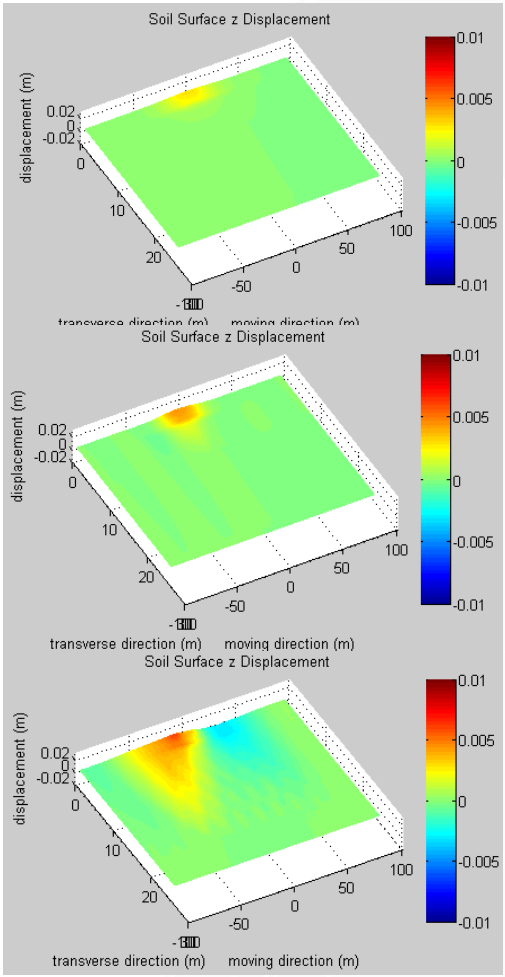


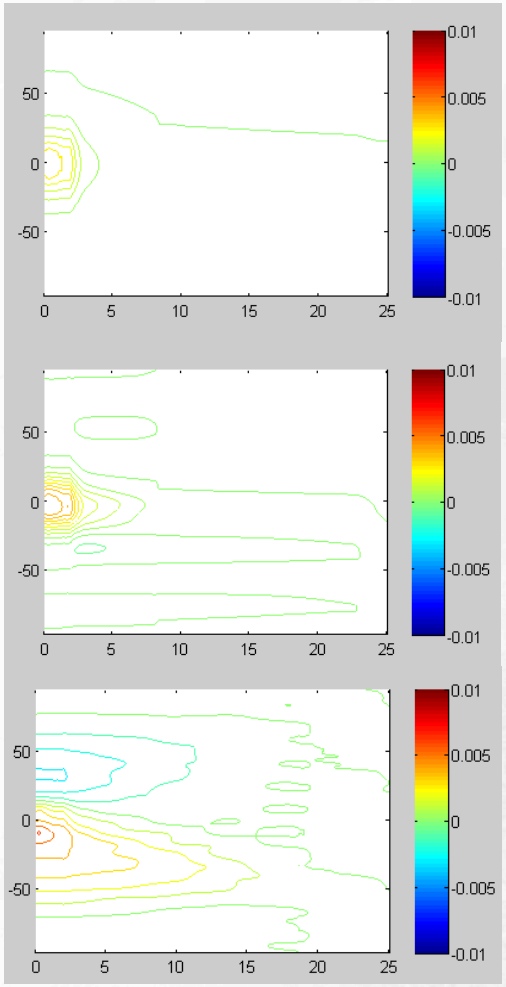


Super Critical Speed

Dynamic Responses

"Higher Speed" causes increasing in influencing area



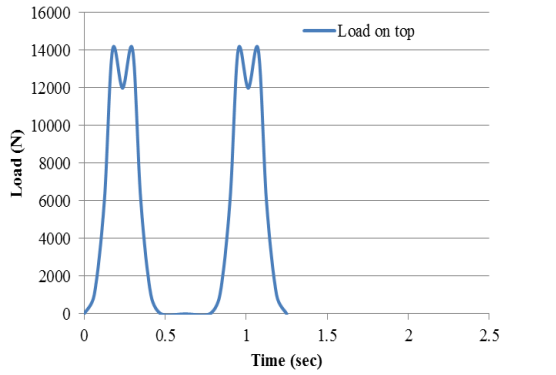


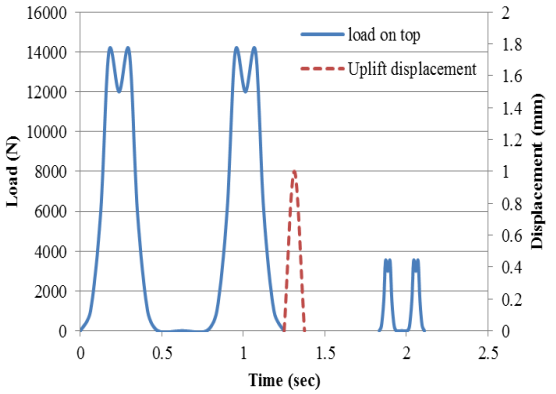
Normal Speed

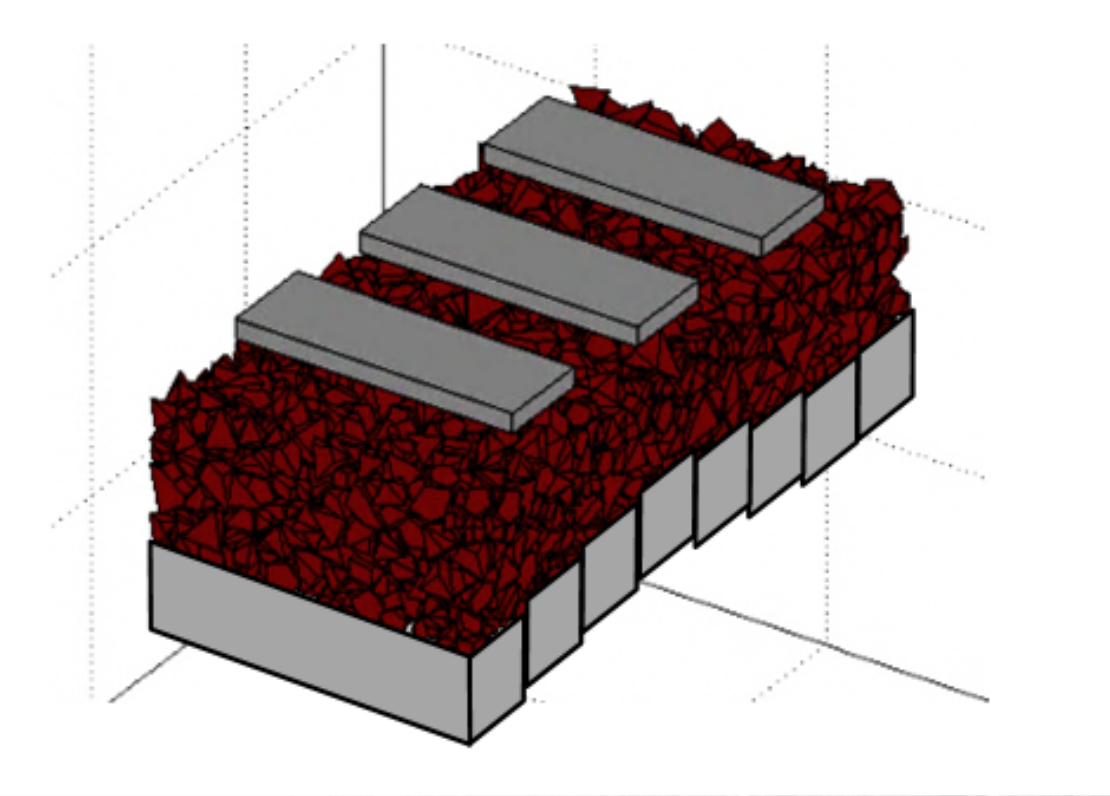
Critical Speed

Super Critical Speed

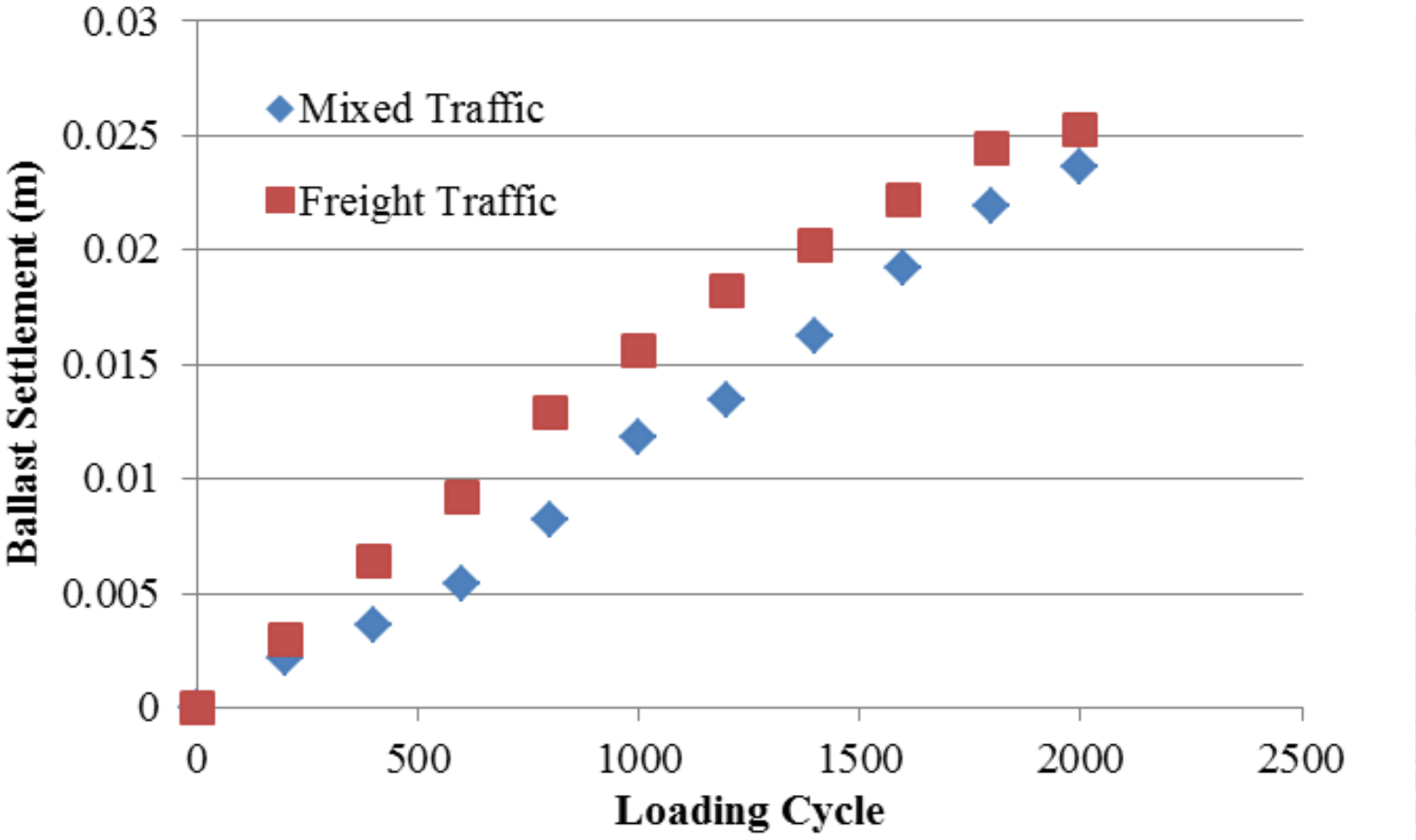
Ballast Settlement Simulation







Ballast Settlement Simulation



Conclusions

- Increasing train speed introduces amplified track responses.
- Train moving at “critical speed” could generate uplifting pulse at the ballast-soil interface far ahead of the train.
- Mixed traffic has a higher settlement rate and could potentially yield more settlement.
- It is also worth noticing that through uplift and settlement cycles ballast will degrade and displaces more quickly under mixed traffic loading to cause higher settlement rate, which would be associated with more frequent maintenance cycles.

Recommendations

- Model field validation
- Field investigation
- Study and possibly optimize the treatment solutions

Acknowledgement

- Support from Dr. Erol Tutumluer’ s research group at University of Illinois

- Graduate Research Assistant (Mr. Gao Yin)

- Undergraduate Research Assistant (Mr. Braun Brennecke)

Lunch | Nearby Food Options
(all within 5-7 minutes walking distance)

- Au Bon Pain: 601 Indiana Ave NW # 1Washington, DC 20004
- Burger King: 501 G Street NW, Washington, DC 20001
- Chipotle: 601 F Street NW, Washington, DC 20005
- Cosi: 601 Pennsylvania Ave NW # 2 Washington, DC 20004
- Dunkin Donuts: 601 F Street NW, Washington, DC 20004
- Firehook Bakery & Coffee House: 441 4th Street NW, Washington, DC 20001
- Jack's Famous Deli: 501 3rd St NW # 2, Washington, DC 20001
- Quiznos Sandwiches: 772 5th St NW, Washington, DC 20001
- Starbucks: 443 7th St. NW, Washington, DC 20004
- Subway: 501 D Street NW, Washington, DC 20001