Validation of empirical prediction procedure for ground-borne vibration from rail transit trains

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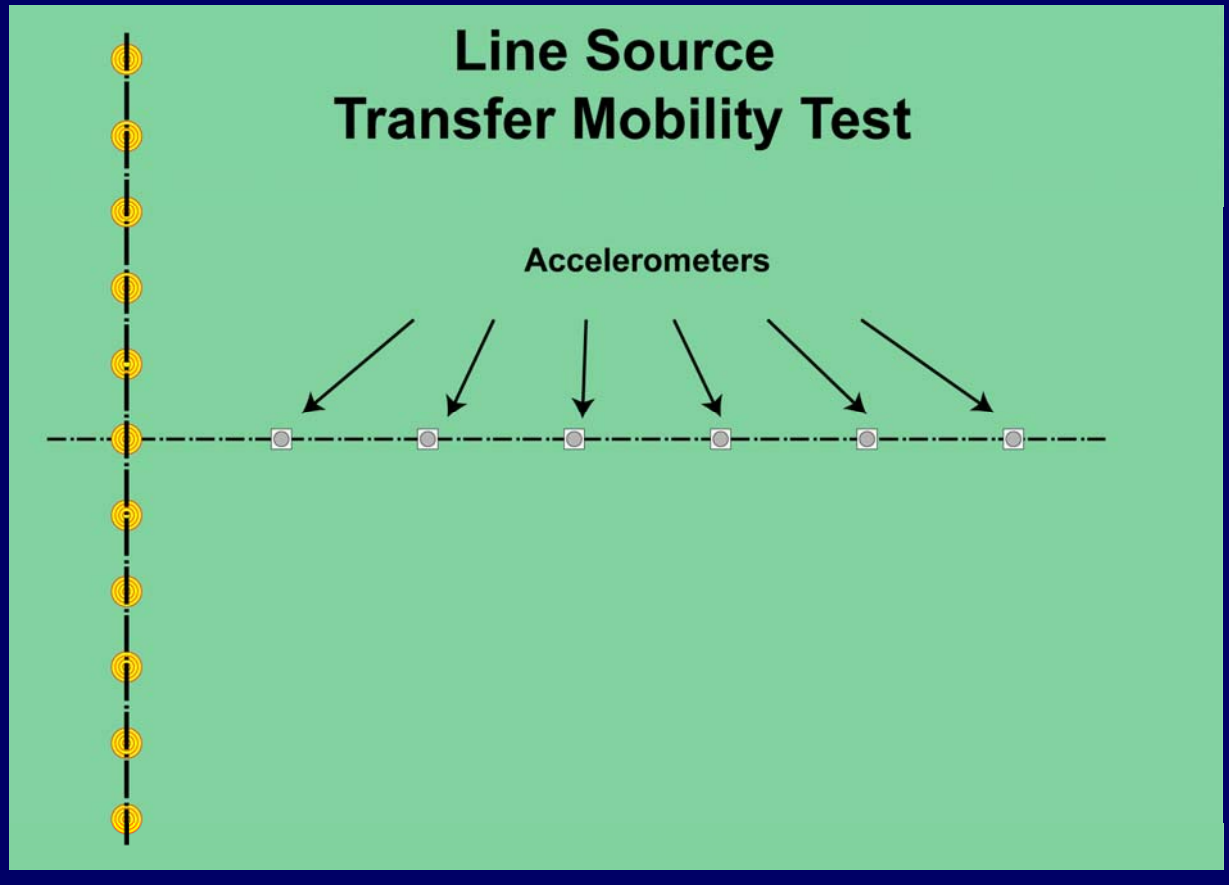
Basic Procedure

- Combine measured force density level (FDL) and line source transfer mobility (LSTM) to predict vibration

Lv = FDL + LSTM

(values in decibels with a consistent set of decibel reference values)

Force density
Step 1: Measure LSTM



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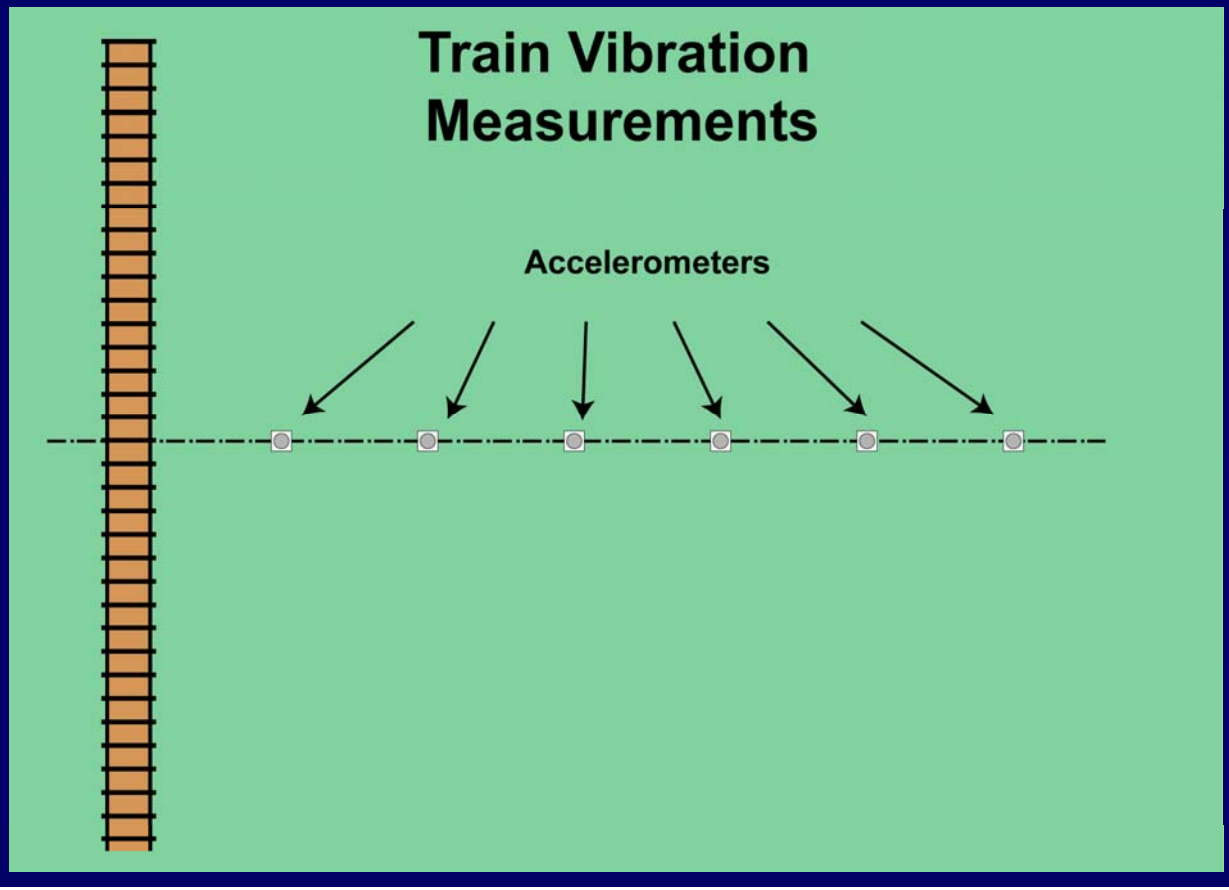
Force density
Step 2: Measure train vibration



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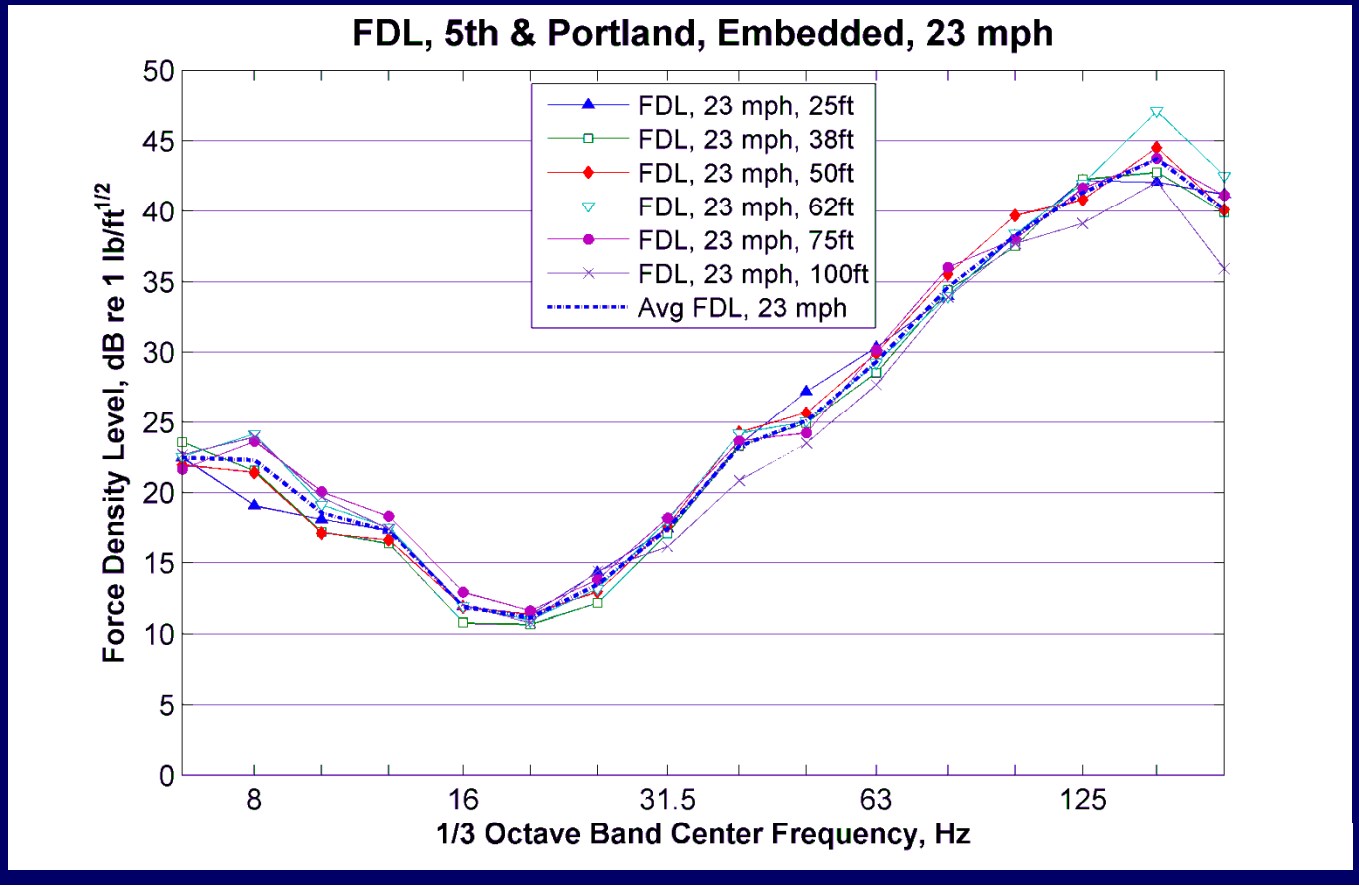
Force Density
Step 3: Calculate FDL, Example 1



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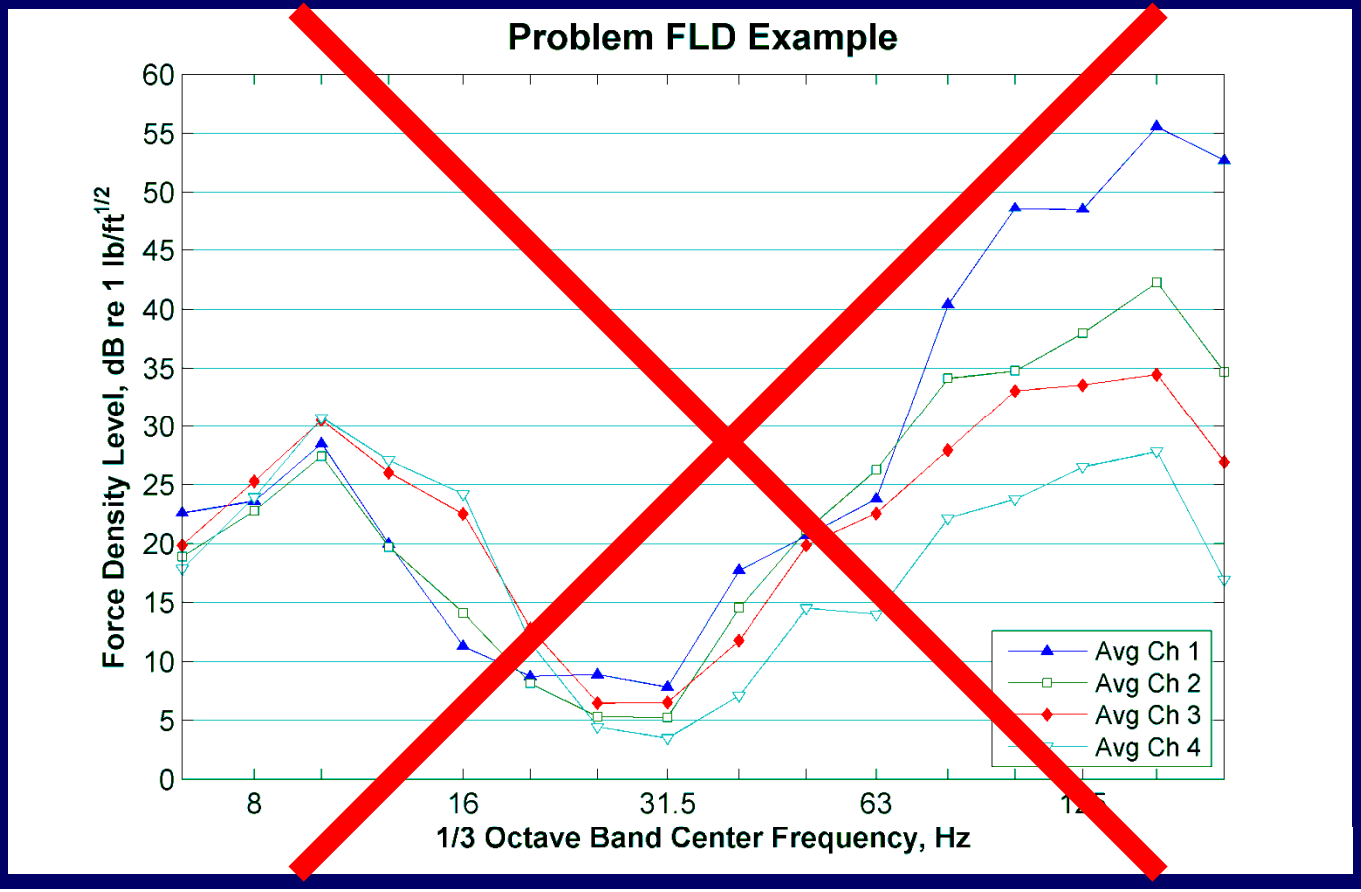
Force Density
Step 3: Calculate FDL, Example 2



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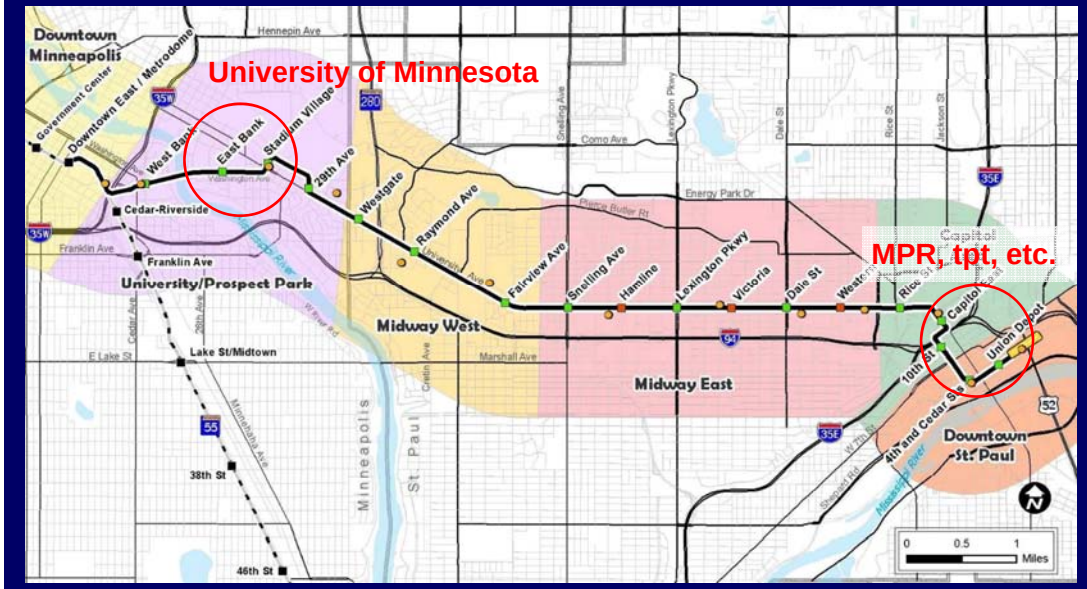
Twin Cities LRT alignments

Hiawatha Line

Proposed CCLRT Line



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Star Tribune test site

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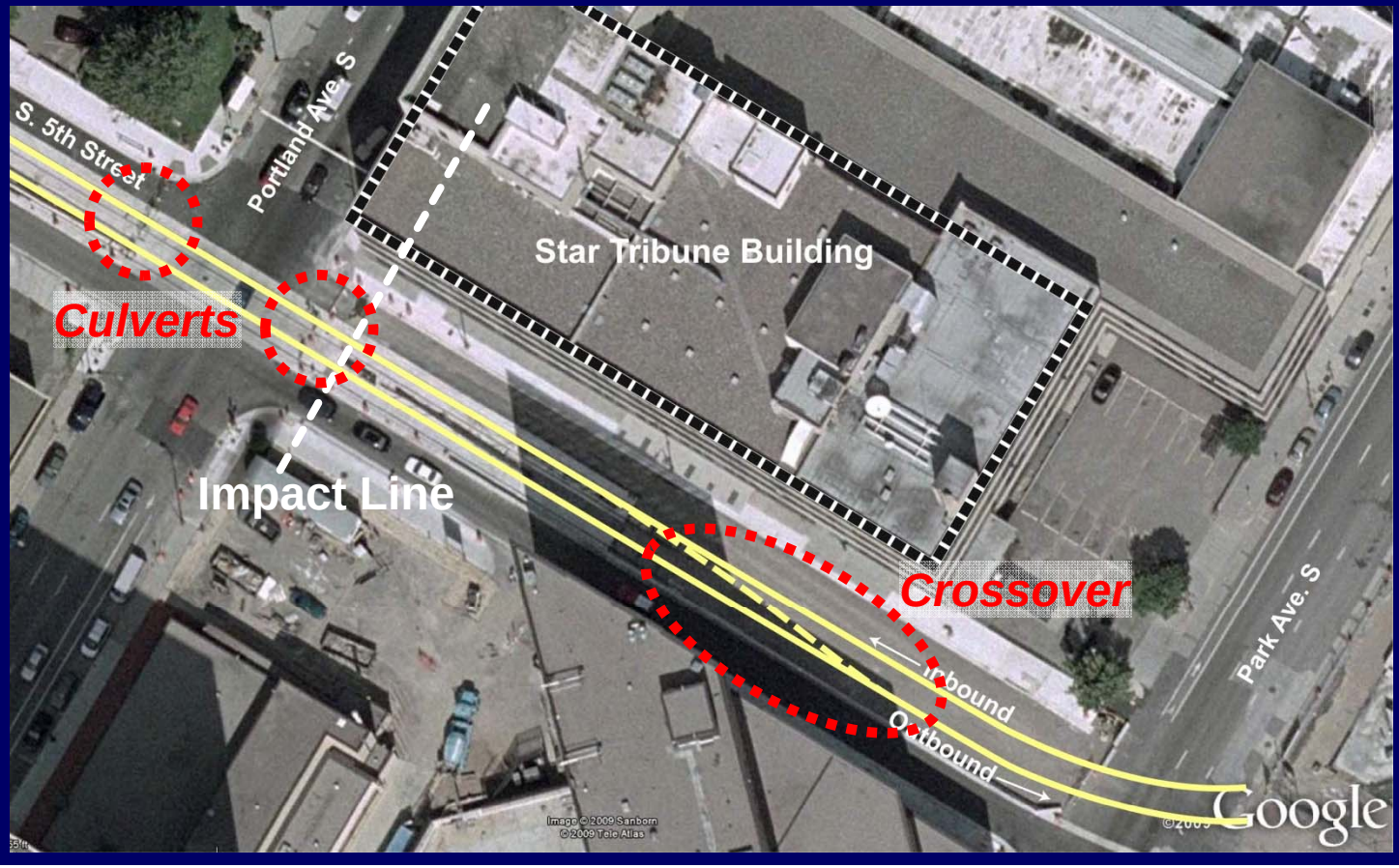

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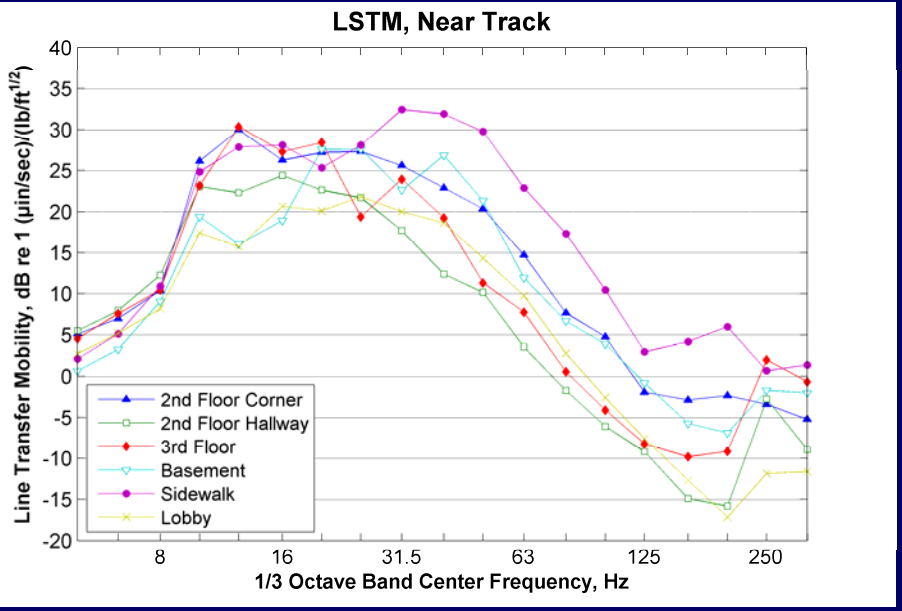
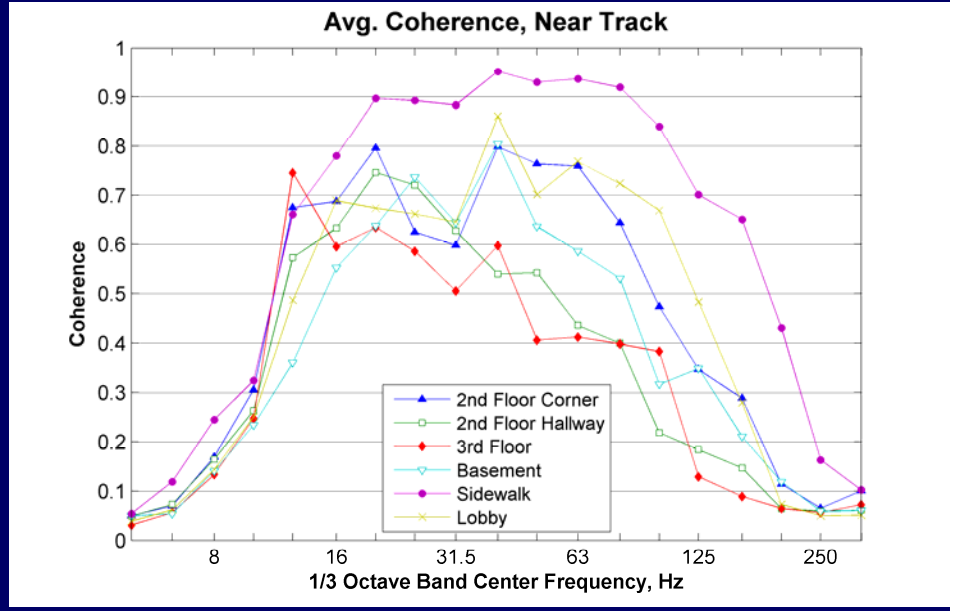
Measured LSTM and coherence





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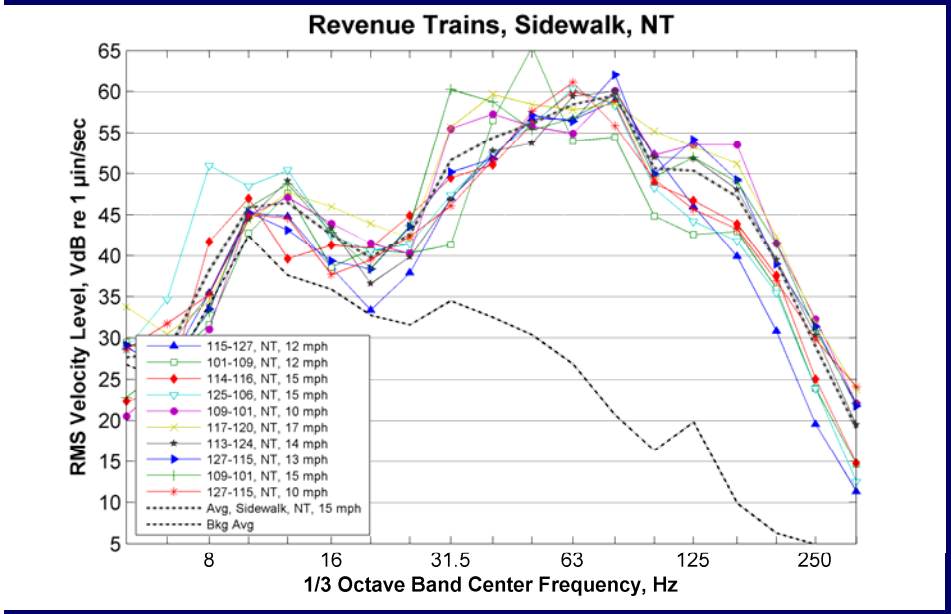
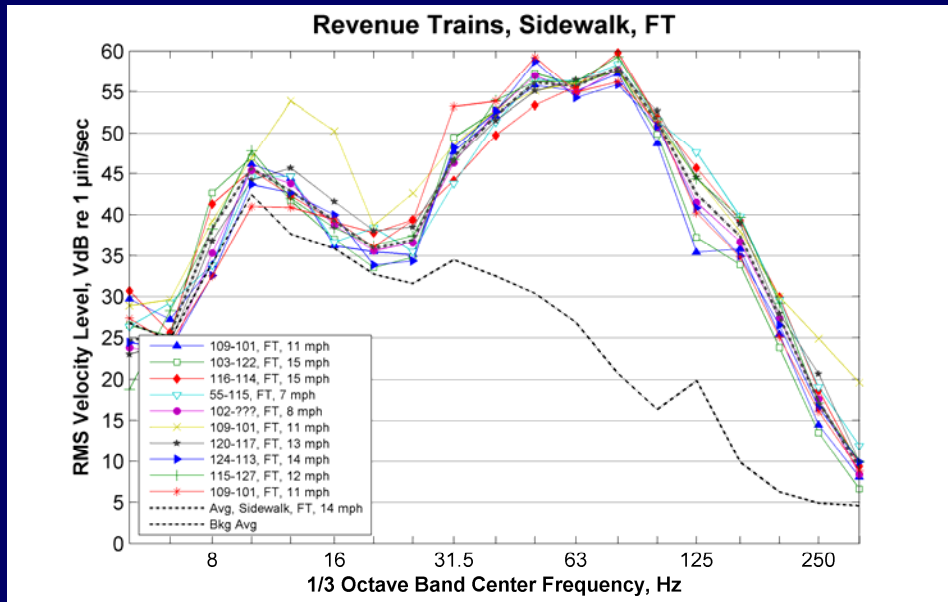
Measured vibration, sidewalk





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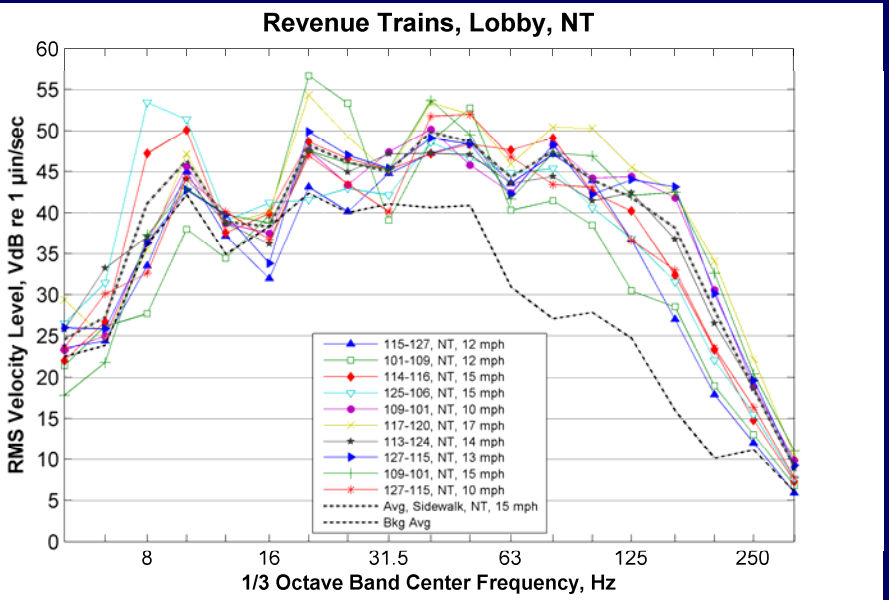
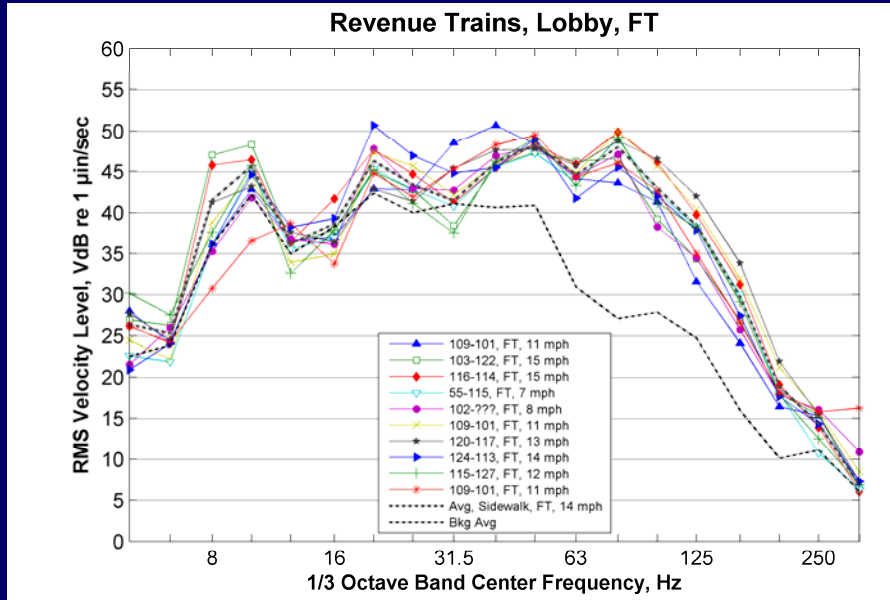
Measured vibration, lobby





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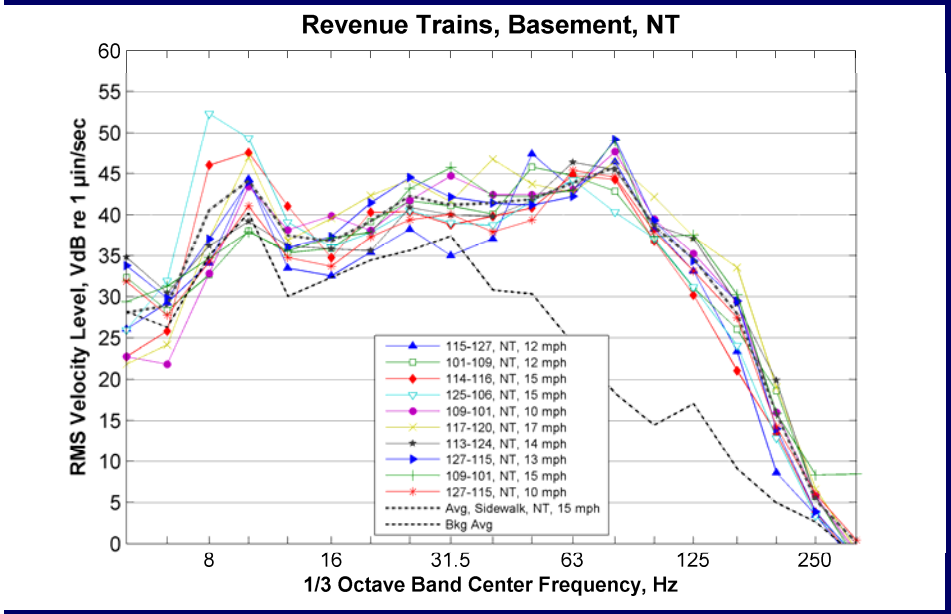
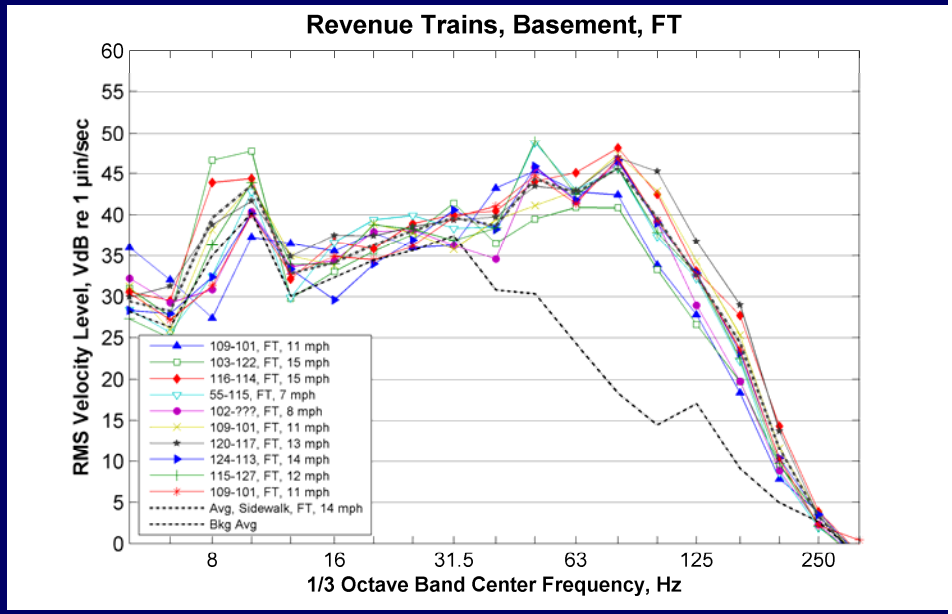
Measured vibration, basement





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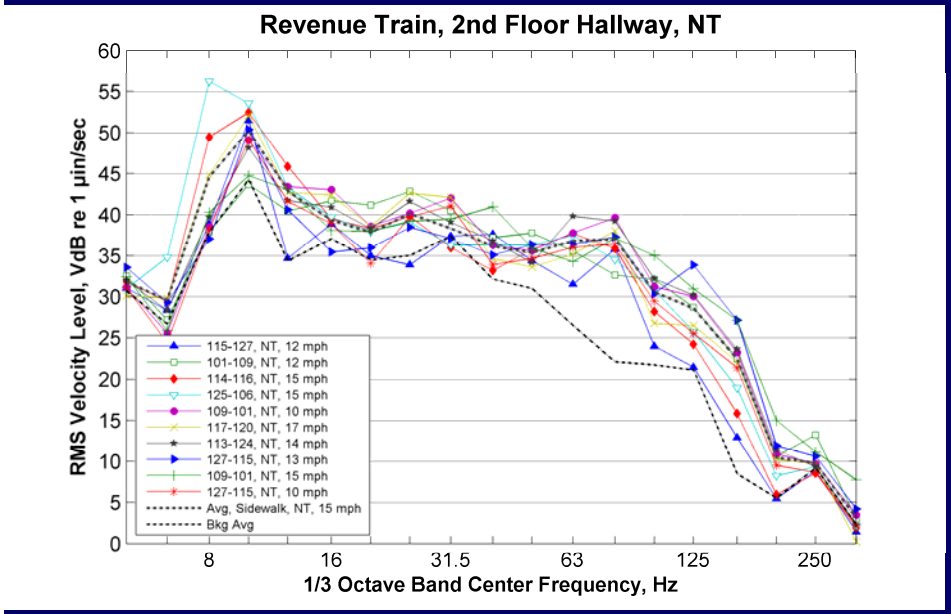
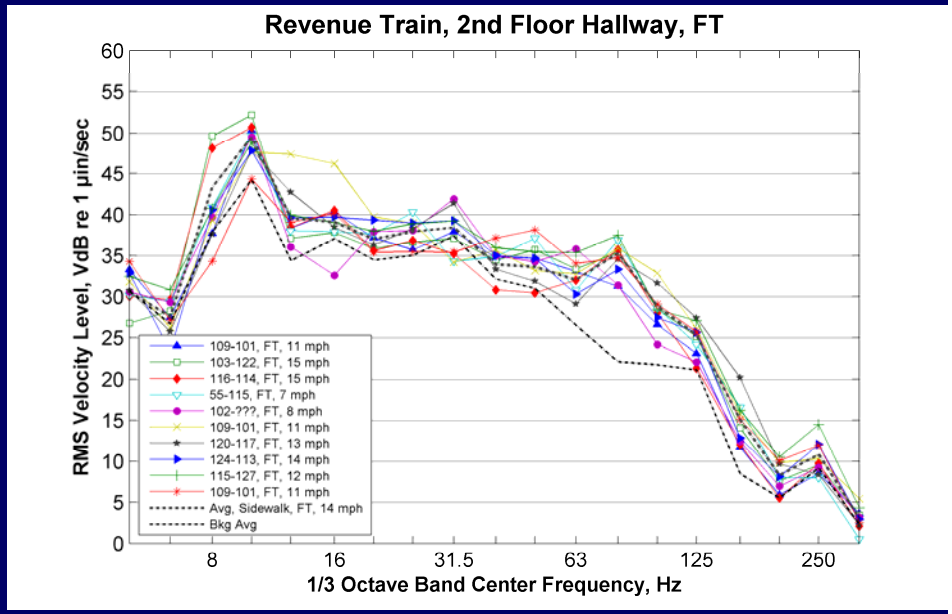
Measured vibration, 2nd floor





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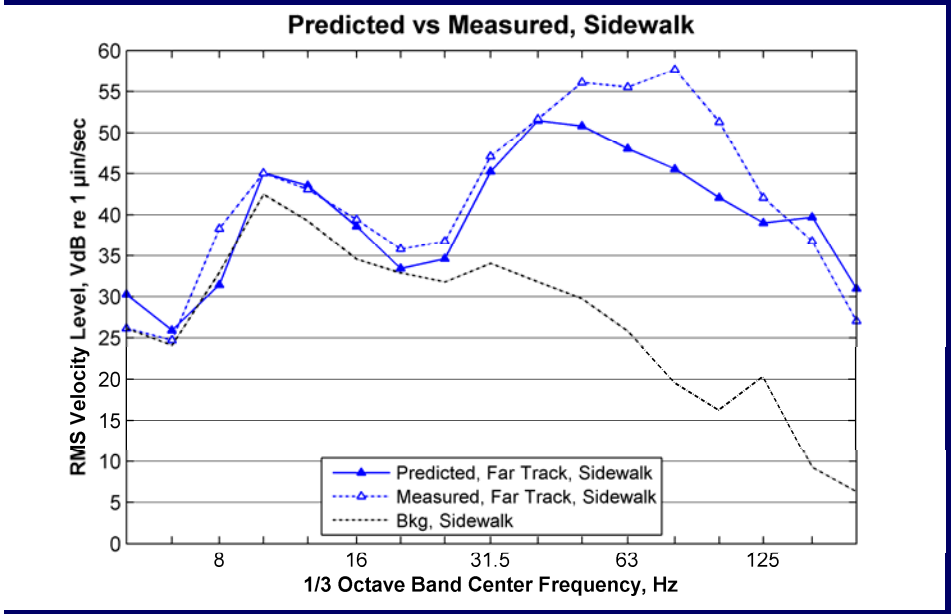
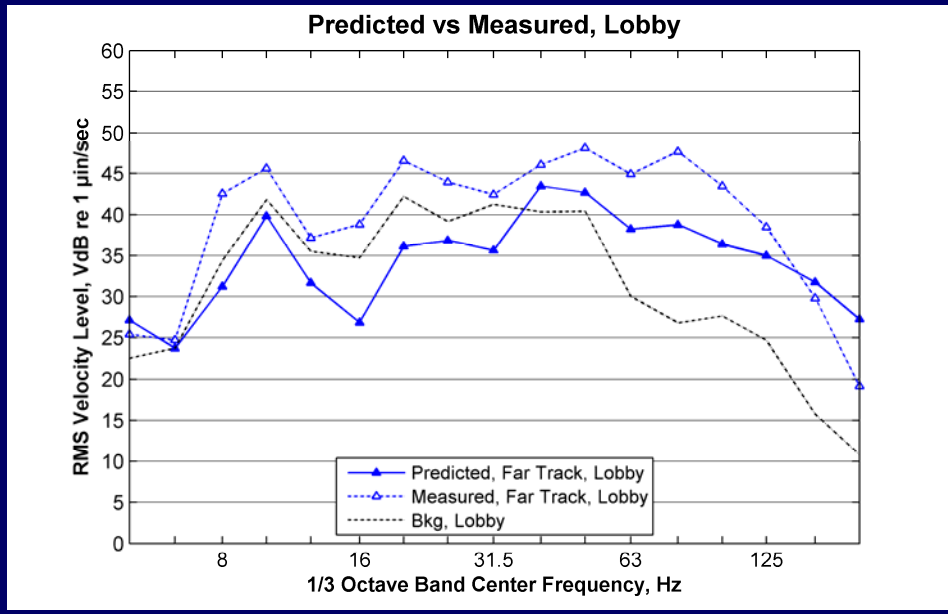
Predicted vs. measured vibration, sidewalk and lobby





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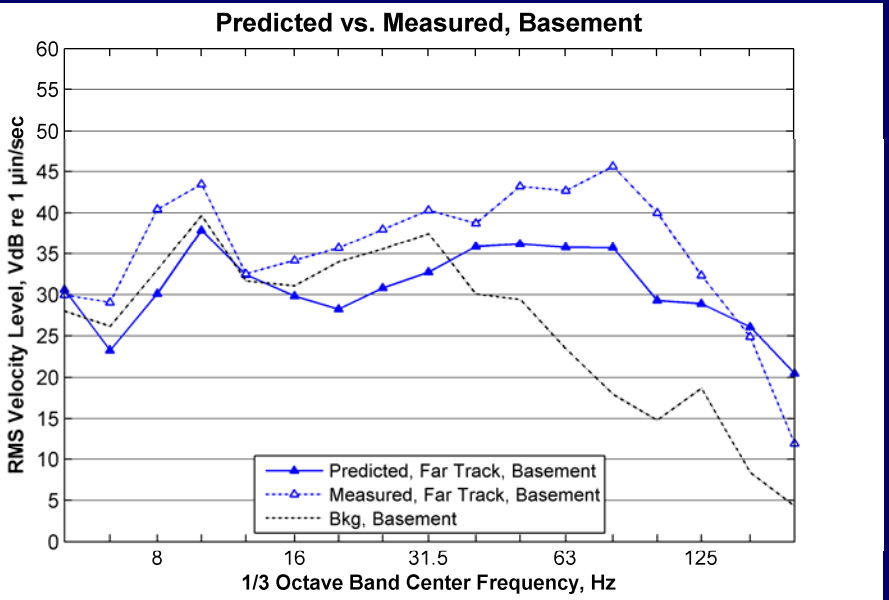
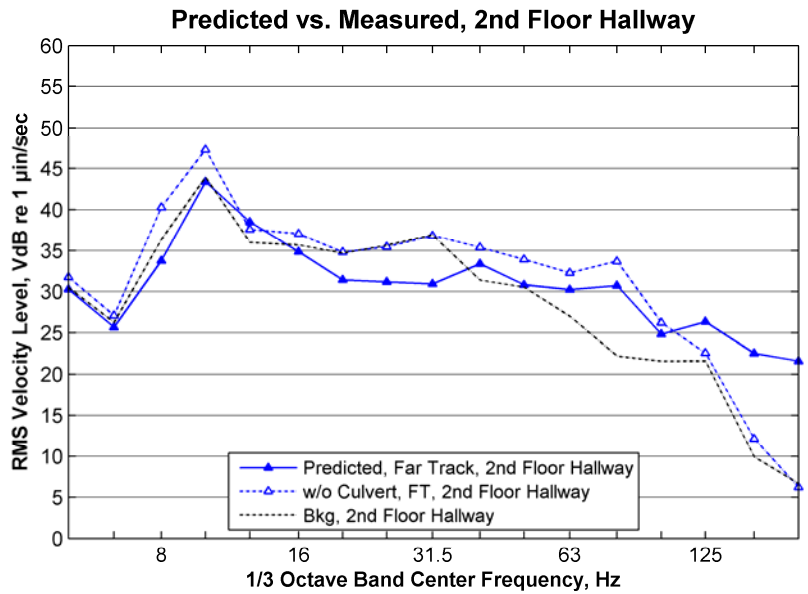
Predicted vs. measured vibration, basement and 2nd floor hallway





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Diagnosing problem

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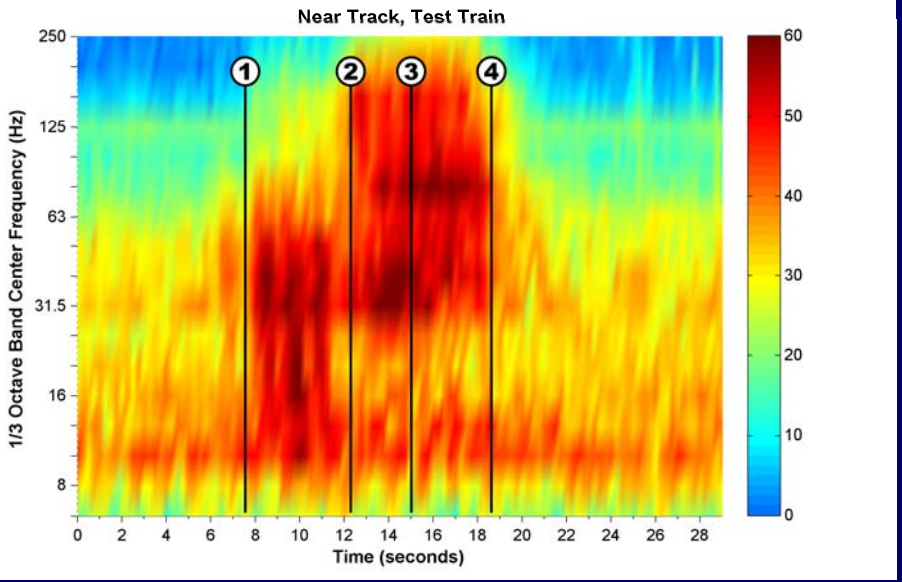
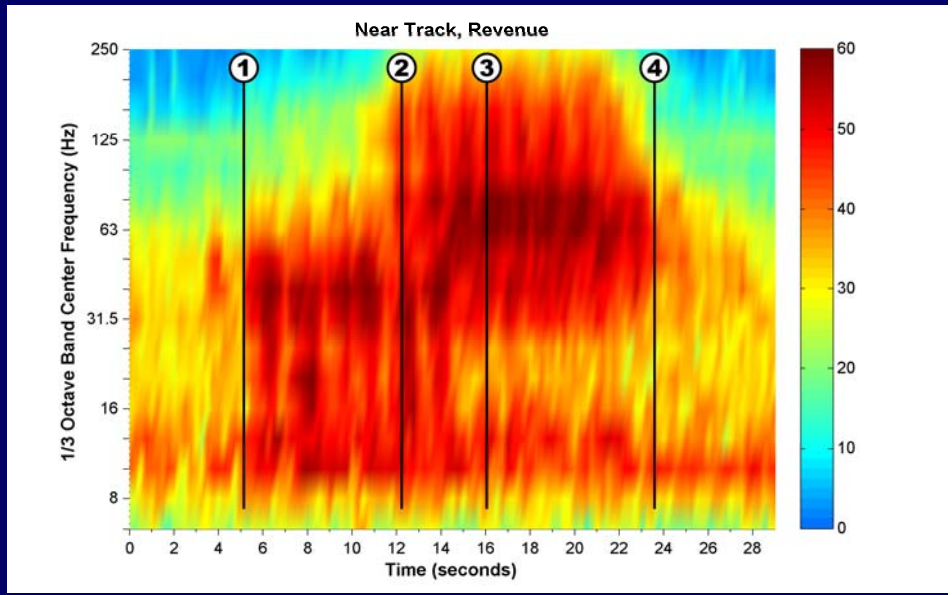
Effect of culvert, near track trains





Point 1: Lead car passes over switch

Point 2: Lead car reaches the drainage culvert east of Portland Avenue

Point 3: Lead car reaches the drainage culvert west of Portland Avenue

Point 4: Trailing car is past the culvert west of Portland Avenue

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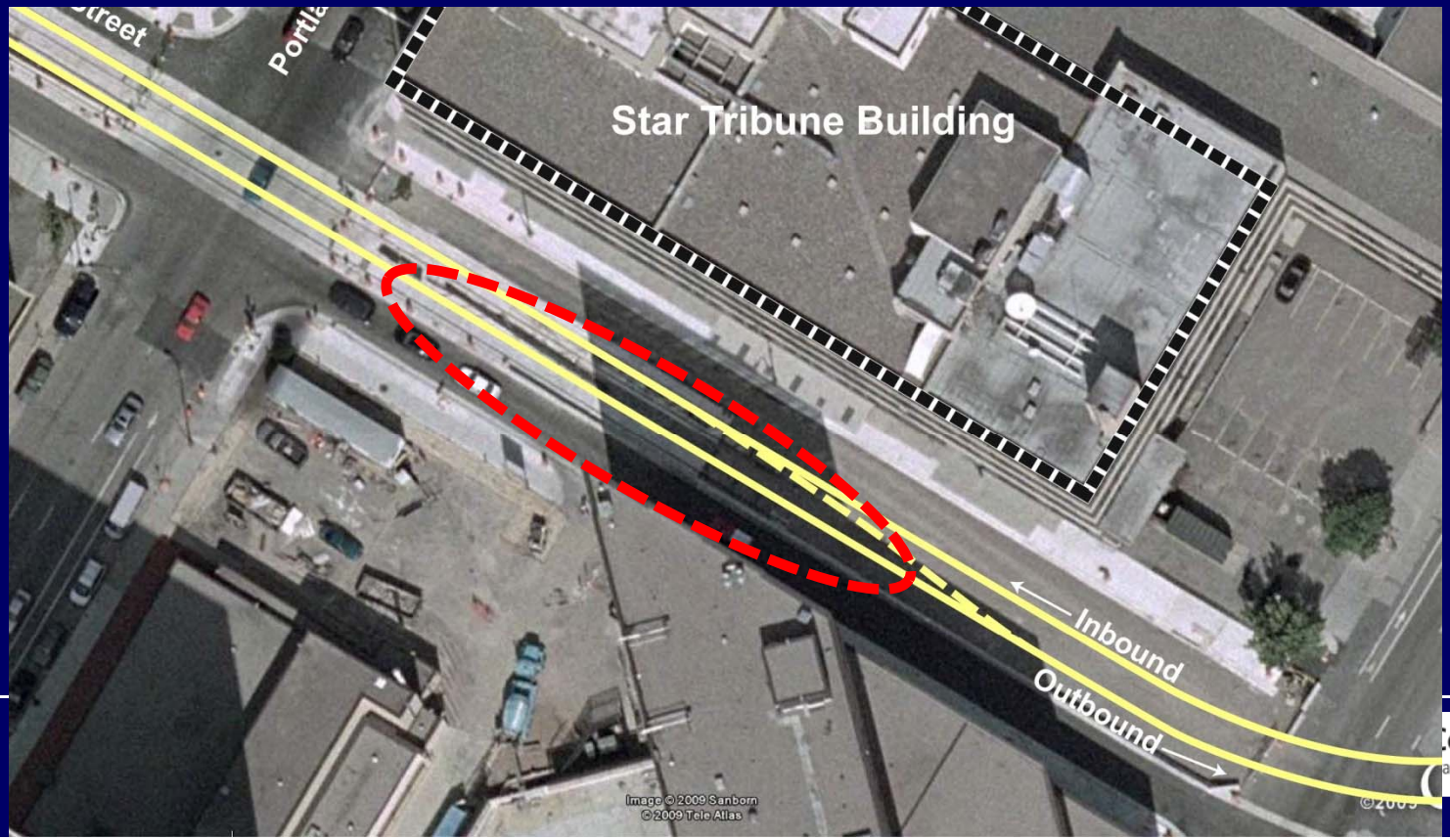
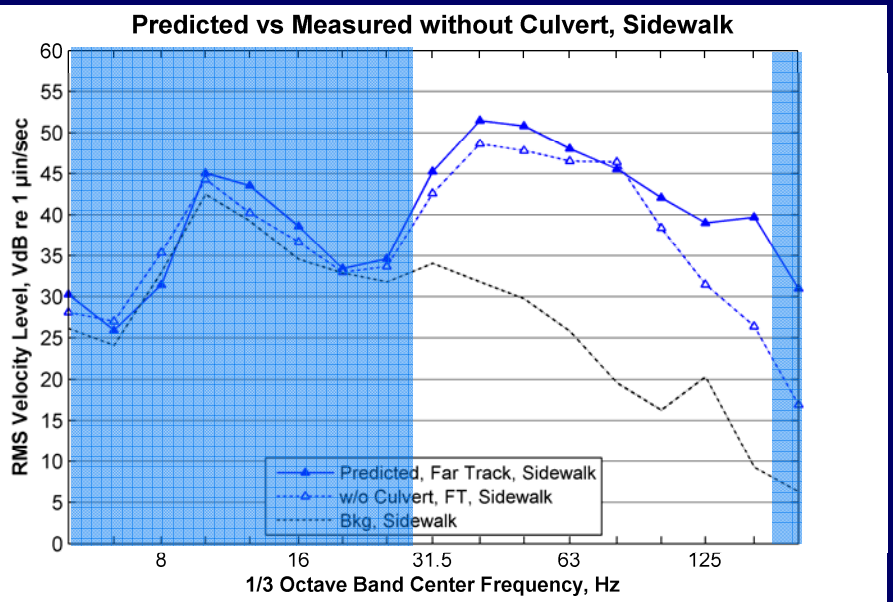
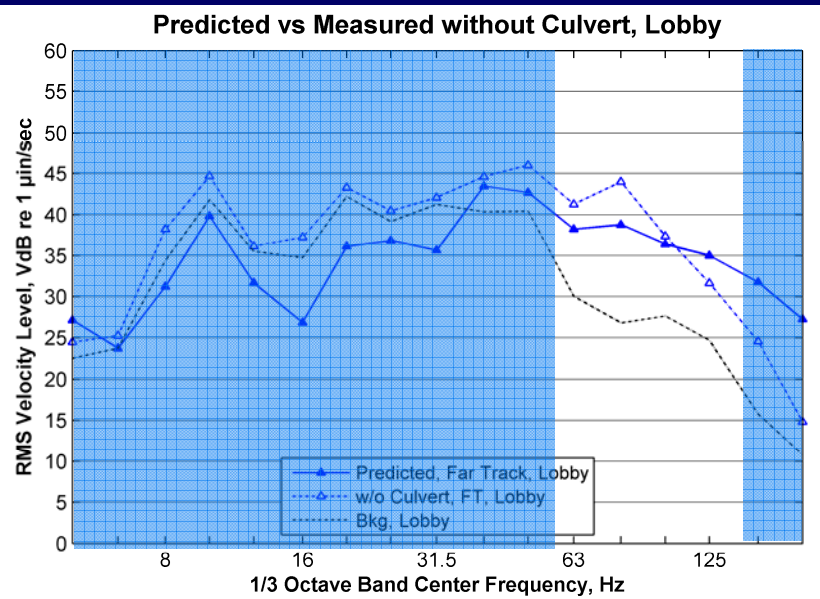
Approach for eliminating effect of culverts

- Select periods when far track trains were between the culvert and the switch



Comparison of predicted and measured without culvert, sidewalk and lobby





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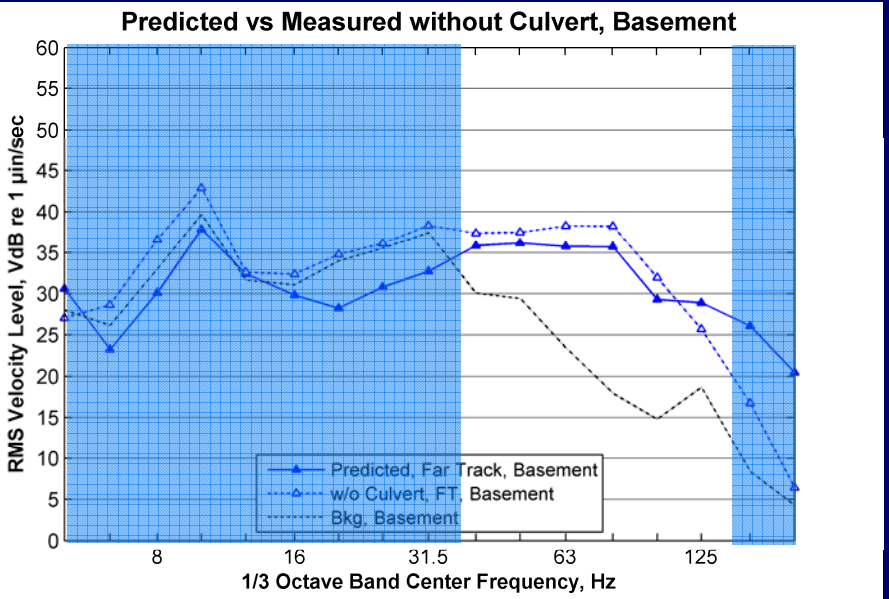
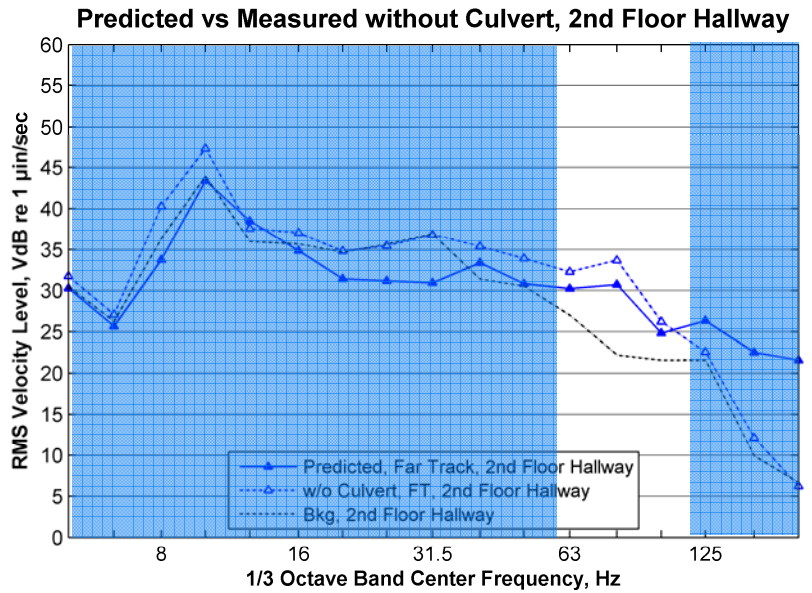
Comparison of predicted and measured without culvert





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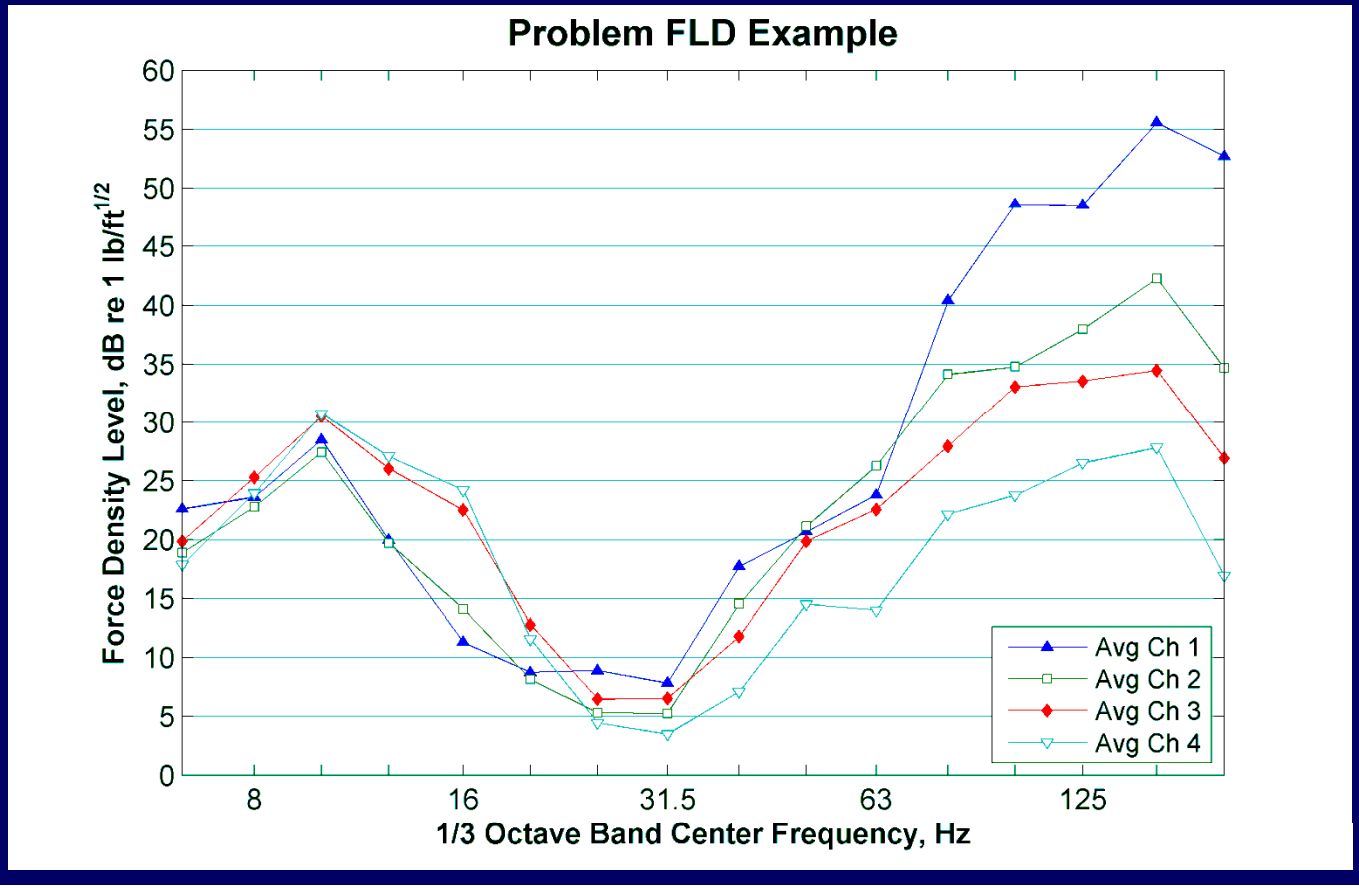
Conclusions

- The FDL Method Works (assuming that trackforms are substantially the same and background vibration is not too high)
- The predictions will be on the high side where coherence is low
- Features directly under tracks can substantially increase vibration levels
- The drainage culvert was probably responsible for the poor FDL result

Non-converging FDL, probably caused by culvert at test location



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