

Below Grade Vibration Testing

Andy Wong ATS Consulting ADC40 Summer Meeting July 22, 2014



Predicting Subway Vibration

- Source is below ground
 - Requires drilling rig/crew
 - o May take a full day to drill to depth
- How to measure
 - o Force input below ground?
 - o Response at high floors?
- What effect does the tunnel construction have?



Borehole Vibration Testing





Drilling Rig For Downhole Testing





Drilling Rig For Downhole Testing





Downhole Load Cell





Downhole Load Cell





Solid Rock

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LOCATION: N 5031549.33 ;E 367448.79						DRILLING DATE: October 21-November 3, 2010														D	ATUM: Geodetic					
INCLINATION: -41" AZIMUTH: 56"									D	RLI	L RO			850 RACI	TOR: Marathon I	Drilling										
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Basements Carved out of Rock

- Basement levels are highly coupled to source
- Drill crew changed to narrower bit
- Progress was still slower than expected





Data Issues

- Only a single point
 - o Repeat at 3 depths, separated by 10 ft
 - o Extrapolate by assuming logarithmic decay with distance
 - Remember to use diagonal distance
- The drop hammer can cycle very quickly

 Puts high forces into the ground 20,000-30,000 lbs



Projected Line Source





Coherence





Projected Line Source At High Floors





Projected Line Source At High Floors





Coherence At High Floors





Impact Response





Impact Response





Finite Element Modeling





Courtesy Eric Ruolo

Finite Element Modeling





Courtesy Eric Ruolo

Lessons

- Communicate with drilling crew (preferably with actual employee in charge)
- Schedule enough time for drilling
- Bring spare parts
- Borehole is good approximation of tunnel
- Be flexible!

