CONST-VIBRATIONS Listserv Newsletter #14

Extensive Search for Cosmetic Cracks Induced by Low Frequency Excitation Results in Observation of Only Two Cosmetic Cracks at PPV's above 12.7 mm/s (0.5 ips)

Combined study by the US Bureau of Mines (USBM), Office of Surface Mining, and the US Army Corps of Engineers and the US Geologic Survey in the 1990's lead to observation of only one cosmetic crack near the Z curve produced by a 6.4 Hz driving pulse with a PPV of 13.5 mm/s (0.53 ips).

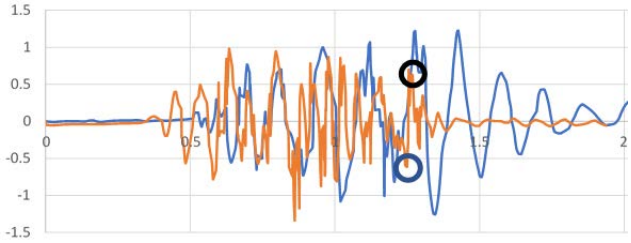

Figure 1. Comparison of 1.46 ips excitation motion (orange) with peaks of possible "driving" motions defined by black circles) compared to upper structural Lhemkhuler house response (blue)

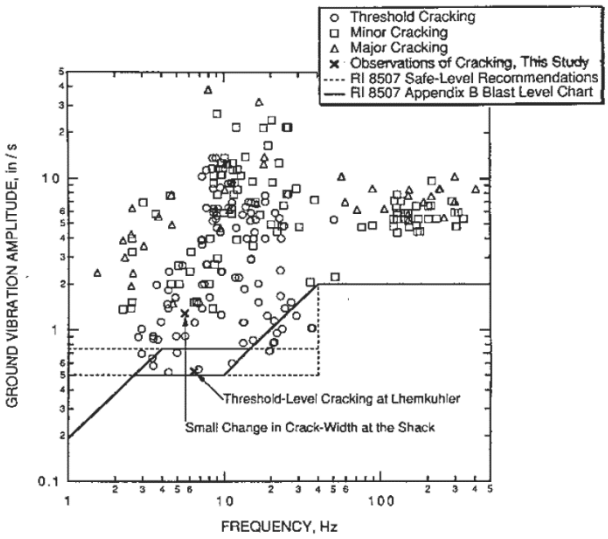

Figure 2 (right) Z curve and location of threshold crack observed in the plaster and lathe Lhemkuhler house (Crum, 1997)

Codification of the leftmost declining PPV limb of the Z curve below a PPV of 12.7 mm/s (0.5 in/s) has contributed to a continuing search for cases of cosmetic cracking at low frequency-low PPV ground motion. This search is made more compelling with complaints of adverse effects of blasting vibrations at PPV's below 12.7 mm/s (0.5 ips) at large distances from blasting. Since there is a declining limb of the Z curve in regulatory documents, the response of those without experience is that these complaints have merit, even though there is no supporting field evidence.

Search for cases of cosmetic cracking at low excitation frequencies is made difficult and fruitless, as verified by the continuing inability to find them, by two physics based reasons. First locations where low frequency (say 2 Hz) excitation ground motions dominate are so far from construction or mine blasting that PPV's have attenuated below 12.7 mm/s (0.5 ips). Secondly 2Hz ground motions are so much lower in frequency than the (10 to 5 Hz) natural frequency of one and two story residential structures. This frequency mismatch prevents amplification of structural response necessary to cause the strains associated with cosmetic cracking. Structural dynamics reasons for this low strain response at low excitation frequency were explained in an earlier newsletter #13.

Because of extensive public concern of cracking near large surface coal mines extensive, post 8507 field studies were undertaken to find cosmetic cracking at low excitation frequencies. These studies are summarized in two principal reports; USBM work in Indiana, Pennsylvania, and Florida by Crum (1997); and a combined Office of Surface Mining, Army Corps of Engineers and Geologic Survey

study in Indiana (OSM, 1994). All of this work uncovered only one new crack and one crack widening in plaster and lathe walls.

The new cosmetic crack produced by the orange excitation time history in Figure 1 was observed in a plaster and lathe wall (Lhemkhuler house) after a surface mine blast with a PPV of 37 mm/s (1.46 ips). Blue structural response was maximized near the end of the ground motion shown in Figure 1 with an orange, 6.4 Hz "driving" pulse with a reported particle velocity of 13.5 mm/s (0.53 ips). This cosmetic crack observation is shown relative to the Z curve in Figure 2. The concept of the driving pulse was described in Newsletter #5. Crack widening of approximately 0.05 mm occurred in the Shack house after excitation by a blast with a 5.6 Hz driving pulse and maximum pulse PPV of 32.5 mm/s (1.28 ips).

References

Investigation of Damage to Structures in the McCutchanville-Daylight Area of Southwestern Indiana, Office of Surface Mining Reclamation and Enforcement Technical Report 1974. Available at https://www.osmre.gov/resources/blasting/arblast.shtm.

Crum, S. V. (1997) House Response from Blast-Induced low Frequency Ground Vibrations and Inspections for Related Interior Cracking. Final Report to the Office of Surface Mining, Contract ID: 143868-P096-12616. https://www.osmre.gov/resources/blasting/arblast.shtm.