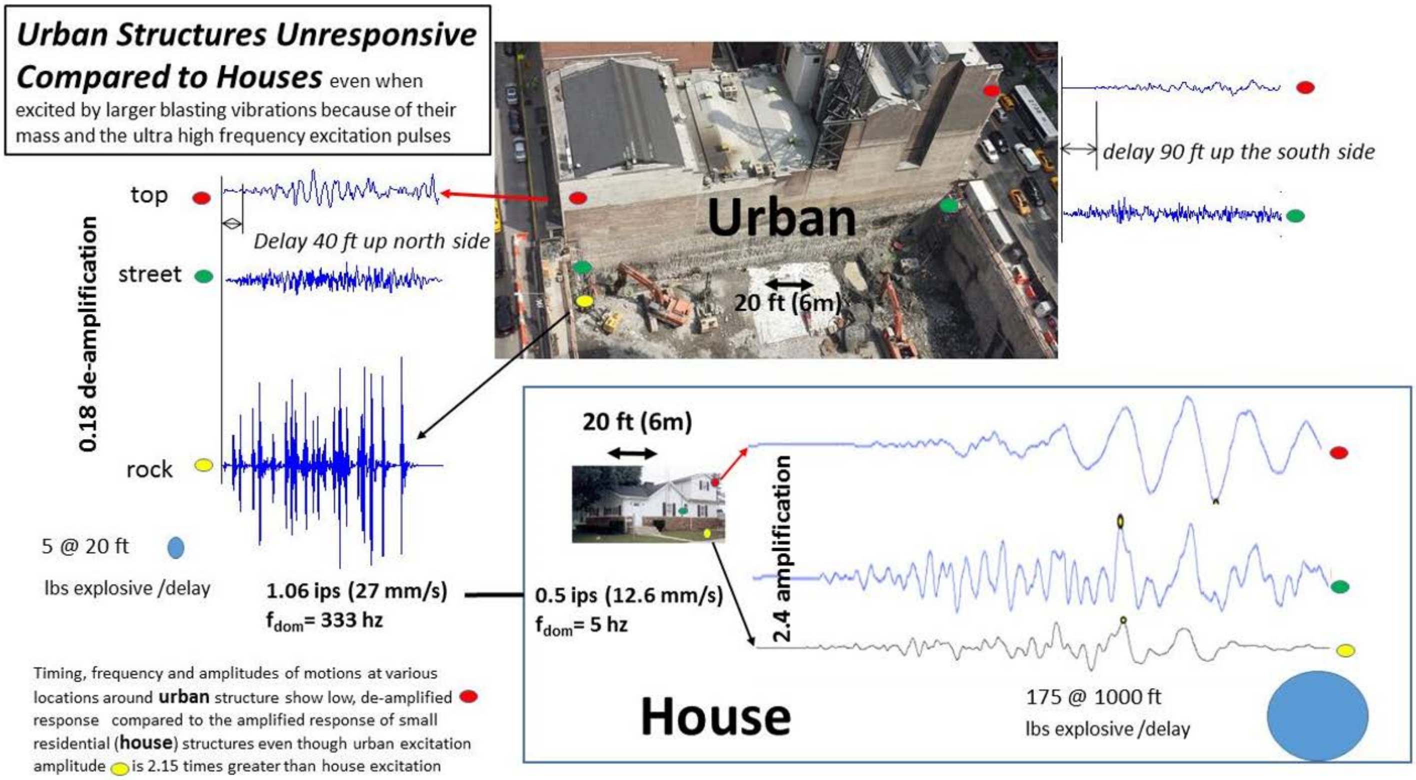
Newsletter # 34
Large Urban Structures Respond Little to
Blast Induced High Particle Velocities with Ultra High Dominant Frequencies



This newsletter presents the results of time synchronized measurements by multiple seismographs of blast induced structural response of large urban structures, one of which is shown in Figure 1. These measurements allowed a test of the hypothesis that low charge weight per delay, ultra-high frequency excitation will not perturb large, urban structures as greatly as typically assumed. Thus vibration controls may be safely reduced and or changed. Time correlation of these measurements to the nearest 0.001 of a second along a large urban structure allowed calculation of building strains, which are responsible for cosmetic cracking, whose avoidance is controlled by regulations. These results can be employed to extend current regulations and understanding, which are based upon response of structures with dynamic properties similar 1 to 2 story residential structures. This newsletter is the first of a series of nine newsletters that present measurements of and techniques for calculating strains in structures subjected to blast and construction vibrations.

Major findings of this study are summarized in Figure 1 by scaled comparison of response of urban structures to close-in, low charge weight per delay, high frequency excitation with that of a house to distant, large charge weight per delay, lower frequency excitation. Scaled photographs of both structures underscores the relatively massive nature of urban structures– by weight and size. All information regarding the smaller "house" example is enclosed in its own box. Blue circles at the bottom compare the amount of explosives detonated in any instant and the distance between blast and structure. Resulting excitation, measured in the ground/rock at each structure at the yellow dots, is shown by the adjacent time histories; urban to the left and house to the right. Response at the red dots shows that despite urban excitation amplitudes twice those at the house, urban response was de-amplified to only 20% of the excitation, while house response was amplified to 2.4 times that of the excitation. This difference is in part the result of higher frequency (333 cycles per second, cps or Hz) urban excitation compared to the lower, 5 Hz, excitation of the house. Urban de-amplification also results from the non-homogenous response compared to the house that will be discussed in later newsletters. Arrival times of the motions differ greatly for the urban structure as shown by the difference in arrival times of the motions at yellow, green and red dots. For the house the peaks of the yellow, green and red coincide in time. The difference in arrival and response times for urban structures demonstrates that the energy of the high frequency excitation motions is insufficient to produce whole body response of the massive urban structure. The implications of this inhomogeneous response will be discussed in later newsletters.

Time histories of measurements made during this study, a report and a prepublication version of a published article (Dowding, et al, 2016) are archived and made available at
http://www.civil.northwestern.edu/people/dowding/acm/
by pressing the “High Frequency Excitation of Urban Structures” button under “publications”. In addition excel spread sheet time histories of excitation and response are also available on the /acm by pressing “High Frequency Excitation”. All of this progress was accomplished with a National Science Foundation grant of only $24,000 by leveraging ongoing measurements of full-scale structures by Aimone-Martin Associates, cooperation of the NY City Fire Department and NYC real estate developers, and a fortuitous confluence of a Fulbright fellowship.

References

Dowding, C., Hamdi, E. and Aimone-Martin, C. (2016) Strains Induced in Urban Structures by Ultra-High Frequency Blasting Rock Motions: A Case Study. Rock Mechanics and Rock Engineering, 1-18. DOI: 10.1007/s00603-016-0921-4