GeoDesign Inc

Memorandum

To:	Thomas Lebo	From:	Erick J. Staley, C.E.G. and Elliott C. Mecham, P.E.
Company:	Brown and Caldwell	Date:	October 9, 2013
Address:	6500 SW Macadam Avenue, Suite 200 Portland, OR 97239		

cc:	n/a

GDI Project:	BrownCald-49-20
RE:	Proposed Water Treatment Plant South Kenthorpe Way West Linn, Oregon Vibration Monitoring Data, Plots, and Thresholds

GeoDesign conducted vibration monitoring of construction activities for the proposed water treatment plant located on South Kenthorpe Way in West Linn, Oregon. Ground vibrations from earthwork and grading activities were monitored using vibration monitors (called "seismographs"), which were located on the construction site and at two residences near the site. Vibration data from the seismographs were provided to Brown and Caldwell in daily field reports that included data summaries and plots of the vibration data collected over a time period of seven days.

The seismographs are equipped with geophones that measure ground motion along three perpendicular axes: longitudinal (generally parallel to a line between the geophone and the source of vibration), transverse (generally perpendicular to the source of vibration), and vertical. The most common measure used to quantify ground vibration amplitude, to assess potential damage to buildings, is the peak particle velocity (PPV), defined as the maximum instantaneous peak of the vibratory motion. PPV is typically used in monitoring blasting and other types of construction-generated vibration, as it is related to the stresses experienced by building elements. The data summaries in our daily reports include a table showing the maximum measured PPV and a plot of the maximum PPV recorded over five-minute intervals for each of the three axes at each monitor. The vibration monitors where set to record the entire waveform in addition to the peak value and frequency if the PPV exceeded 0.5 inch per second.

There are various standards used in the construction industry to establish thresholds for monitoring ground vibrations. A common standard is from a study of blast vibrations on model homes completed by the U.S. Bureau of Mines. The results of the study were published (U.S. Bureau of Mines, Report of Investigations RI8507, "Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting," 1980) and have become one of the most cited references for damage thresholds from ground vibrations.

The criteria developed by the U.S. Bureau of Mines recommends damage thresholds to residential structures from that study consist of consideration of two cases: one set of vibration thresholds for homes with drywall (typically newer homes) and another for homes with plaster wall (typically older homes) as shown in the attached figure. For most lower frequencies (generally less than 40 cycles per second, or Hertz), newer homes have a PPV damage threshold of 0.75 inch per second, while older homes have a PPV threshold of 0.5 inch per second. More recent studies have also used consideration of construction type and condition of the structure. Based on typical frequencies observed during construction, Dowding (1996) recommends a threshold PPV of 0.5 inch per second for residential structures.

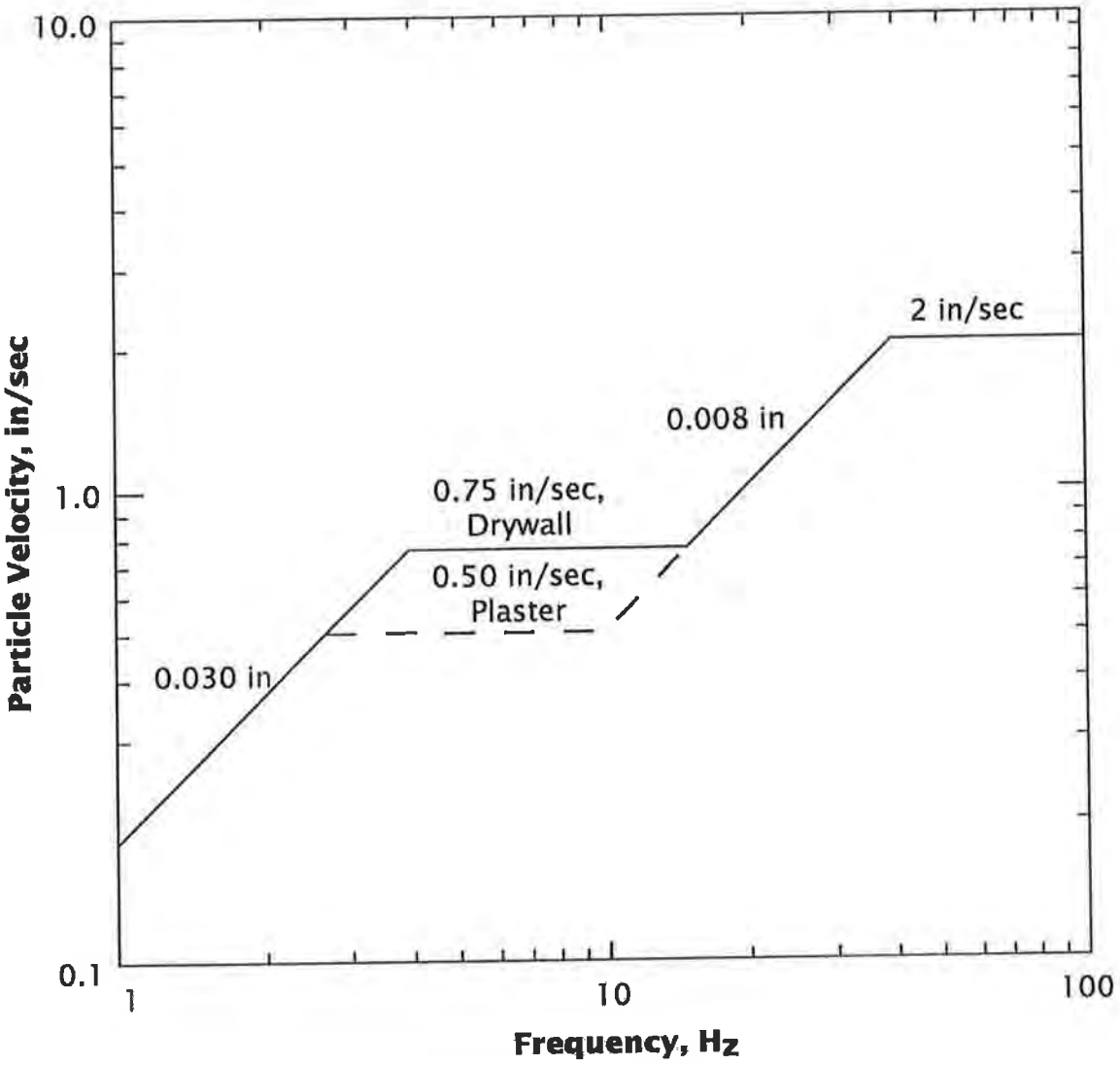
However, it should be noted that other studies recommend more stringent vibration thresholds. A compilation of vibration thresholds established from various studies was performed by Jones and Stokes for the California Department of Transportation (Transportation and Construction Induced Vibration Guidance Manual, Prepared for California Department of Transportation, Noise, Vibration, and Hazardous Waste Management Office, June 2004). The guidelines developed by Jones and Stokes, based on a synthesis of the published recommendations, suggest a maximum allowable PPV of 0.3 inch per second for older residential structures subjected to continuous or frequent vibrations and a maximum allowable PPV of 0.5 inch per second for new residential structures subjected to frequent or intermittent sources. For transient sources the suggested vibration limit guideline by Jones and Stokes is 0.5 inch per second and 1.0 inch per second for older and newer structures, respectively. It is recognized that structures with plaster walls (found in older homes) are more sensitive to vibration than homes constructed using drywall.

Maximum vibrations measured on the construction site ranged from 0.030 to 0.250 inch per second. The maximum vibration data collected from monitors near the residences ranged from 0.015 to 0.055 inch per second, except for where the geophone was likely disturbed by human or animal activity near the trash storage area at 4068 South Kenthorpe Way. As such, the vibrations measured at the residences from construction activities are approximately one-tenth or less of the damage threshold criteria as recommended by Dowding (1996) and the U.S. Bureau of Mines.

ECM:BAS:EJS:kt
Attachment
One copy submitted (via email only)
Document ID: BrownCald-49-20-100913-geom.docx

ATTACHMENT

Vibration Limits



Vibration limits to prevent cosmetic damage in homes from blast-induced vibrations (U.S. Bureau of Mines, 1980). Note that the measured vibrations fall below the minimum 0.1 inch per second value on the horizontal axis.