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October 23, 2013

Mr. Kevin Even
Villlage of Waunakee
500 West Main Street
Waunakee, WI 53597

Re: Blast Monitoring Summary – October 9th – October 22nd, 2013
Falcon Drilling & Blasting / Kilkenny Development

Dear Mr. Even:

The following is our report and analysis of the ground vibrations at the above project for the time period October 9th – October 22nd, 2013. In addition to summarizing the project and the monitoring results this report will also give general historical background information regarding the effects of blasting.

PROJECT DESCRIPTION

Vibra-Tech has been contracted by the Village of Waunakee to conduct independent monitoring of the effects from blasting operations by Falcon Drilling and Blasting in association with the Kilkenny Development project. As required by the Village of Waunakee and the State of Wisconsin the blasting contractor has been monitoring the blasting with their own portable seismograph at the closest structure to the blasting activity. In addition to this monitoring, Vibra-Tech has installed four seismographs at various locations in the vicinity of the blasting activity in order to verify that blasting effects are below all established regulations and to characterize the overall effects of the blasting on the surrounding neighborhoods. Prior to the first blast on October 10, 2013 the seismograph at 1917 Manchester Crossing was relocated to 1005 Winston Way. The map below shows the monitoring locations during this time period.

Figure 1: Map of Seismograph Locations

GROUND VIBRATION and AIR OVERPRESSURE DAMAGE CRITERIA

Seismological research by the U.S. Bureau of Mines, foreign investigative groups and individual seismologists has established criteria relating the occurrence of structural damage to certain frequencies and levels of ground motion.

USBM Report of Investigations 8507[1] states that residential structures are most prone to damage as a result of vibration energy within the frequency range of 4-12 hertz. Within this range a 0.50 inch-per-second maximum particle velocity is recommended for the protection of plaster on lath interior construction. A maximum particle velocity of 0.75 inch-per-second is recommended for the protection of modern drywall interior construction. Above 12 hertz the maximum particle velocity limit increases as the frequency increases up to 40 hertz. Above 40 hertz, a constant 2.0 inches-per-second level is recommended to protect interior walls and ceilings of structures. Figure 2 is a graphical representation of the USBM recommended criteria as shown in the velocity versus frequency curve.

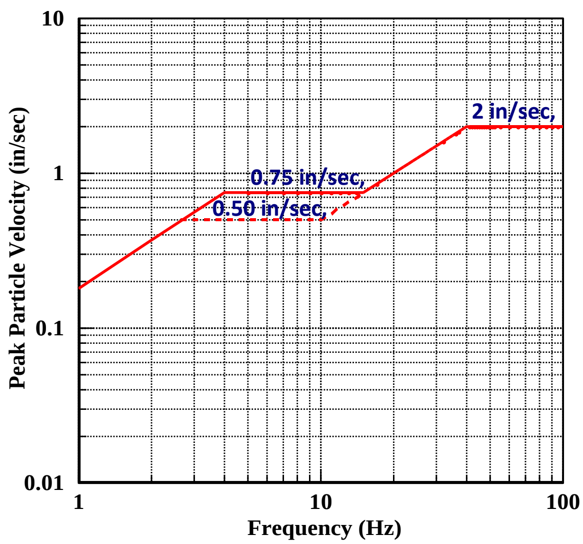

Figure 2: U.S. Bureau of Mines Recommended Vibration Criteria (From RI-8507)

The limits cited above are designed to prevent the occurrence of even threshold damage to the most brittle portions of a structure. More massive materials such as brick and mortar can withstand vibrations greater than 2.0 inches-per-second. A study by Crawford and Ward[2] established the threshold level of damage to be 3.0 inches-per-second for masonry walls regardless of type. Far greater velocities would be required to damage poured concrete. Motion on the order of 8 to 10 inches-per-second would be required before blasting vibrations could be considered responsible.

In conjunction with the ground vibration recording, peak air overpressure was also monitored. Structural damage as a result of air overpressure is generally considered not to be possible without extensive window breakage, as the glass is the weakest portion of a structure's exterior where this pressure acts. Windowpanes are designed to safely withstand changes of 1.0 psi (170 dB) when properly installed, and even in the worst situation a pane should be able to withstand 0.1 lbs/in (150 dB). Air

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1 Siskind, David et al, Structure Response and Damage Produced by the Ground Vibration from Blasting, U.S. Bureau of Mines RI 8507, 1980.

2 Crawford, R., and H.S. Ward, Dynamic Strains in Concrete and Masonry Walls, National Research Council of Canada, Note 54, December 1965.

overpressures from blasting rarely exceed 0.01 psi. (130 dB), about one one-hundredth of the overpressure that a window can safely withstand.

The U.S. Bureau of Mines has concluded in its Report of Investigations RI 8485[3] based on a minimal probability of the most superficial type of damage in a residential-type structure that 133 dB(L) represents a safe maximum air overpressure level for a 2 Hz High-Pass system.

RESEARCH on REPEATED VIBRATIONS from RI-8896

In 1984, the USBM published RI-8896 entitled, "Effects of Repeated Blasting on a Wood Frame House". This study was the first to document long term strain response on a house. Strain is an engineering measure of deformation used to predict failure. A strain of 1 mil/in indicates that on average, every inch of a material was stretched or compressed one thousandth of an inch. For example, the length of an eight foot long section of wallboard would change by approximately ± 0.1 in. Long-term strain measurements allowed blast-induced strains to be compared with those produced by changes in environmental factors such as temperature, humidity, and human activity.

During this study the Bureau arranged to have a wood-frame test house built in the path of an advancing surface coal mine so that the effects of repeated blasting on a residential house could be studied. In a two-year test period 587 production blasts were fired with peak particle velocities ranging from 0.10 in/sec to 6.94 in/sec. Later the entire house was shaken mechanically to produce fatigue cracking in walls. The first crack appeared in a drywall tape joint after the equivalent of 56,000 cycles. This is the equivalent of 28 years of shaking by blast-induced ground motions of 0.50 in/sec twice a day.

HUMAN PERCEPTIBILITY to VIBRATIONS

The objective of this section of the report is to show that human perception to low levels of vibration is extremely sensitive. As evidenced by the graph shown in Figure 3, human perception to vibrations can be as low as 0.01 in/sec, well below any criteria for structural damage. Human tolerance to vibration decreased not only when it occurs within their homes, but also when the cause of the vibration is not readily apparent or anticipated. Human reaction is dependent on the vibration and amplitude of the vibration event, as well as innumerable other factors beyond the operator's control. Because of this great human subjectivity complaints about blast/construction vibrations cannot be totally eliminated. Discernable vibrations however, are by no means criteria for possibility of structural damage.

The startling effect of blast vibrations must not be underestimated when considering human tolerance to vibration in their homes. Often seismographs are used to perform field demonstrations for concerned residents in their homes. The vibrations produced by normal household activity are measured within a residence and compared to the levels resulting from blasting/construction activities. Normal household

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3 Siskind, David et al, Structure Response and Damage Produced by Airblast from Surface Mining, U.S. Bureau of Mines, RI 8485, 1980.

vibration levels frequently exceed those produced by blasting/construction activities by several times. But when the vibration source is familiar, and the vibrations are expected, as with most common household vibrations, people are much less alarmed than when ground vibrations from blasting/construction activities arrive unexpectedly.

The majority of the studies done on human tolerance to vibrations have been of steady-state sources, meaning that the amplitude and frequency content of the energy source remain constant over the test period. This type of testing usually results in an event of relatively longer duration than a typical mine or quarry blast event. Since the vibration limits in the following studies require a reasonable level of comfort from long-term vibration sources; they are certainly more restrictive than for sources of short duration and infrequent occurrence such as blasting.

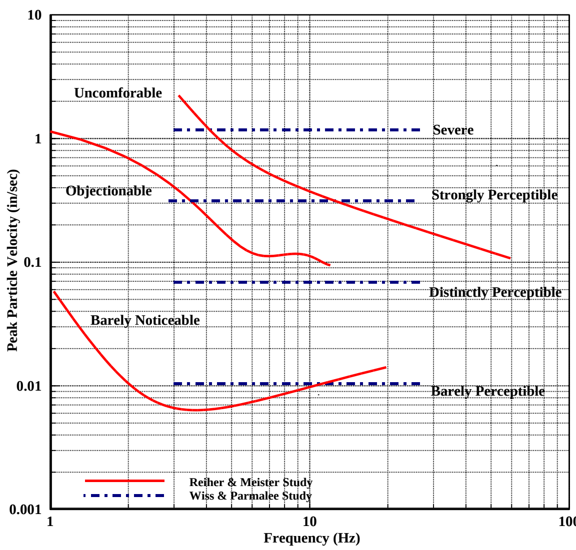

Figure 3: Human Perception to Ground Vibrations

Figure 3 is the compilation of two different studies on human response to steady-state and transient vibrations. The first study denoted on the graph by response levels, represented by the solid line, was completed by Reiher and Meister in 1931. In this study 15 people were subjected to 5-minute duration vertical and horizontal vibrations in a variety of body positions. The study established the threshold levels of subjective human response as defined by three categories. The threshold levels were described as “Barely Noticeable, Objectionable, and Uncomfortable”.

These levels were comparable to subjective responses in a second study completed by Wiss and Parmelee in 1974. The Wiss and Parmelee threshold levels of subjective human response are denoted by response levels represented by the dashed line in Figure 3. Four thresholds of subjective human response to vibration were categorized and are described as “Barely Perceptible, Distinctly Perceptible, Strongly Perceptible, and Severe”. In this study, the responses of 40 people to transient vibrations consisting of damped 5-second sinusoidal pulses between the frequencies of 2.5 to 25 Hertz (Hz) were observed. All subjects were standing on an open platform and subjected to vertical vibrations. The study found that responses depended on vibration levels and damping, but were independent of frequency.

LOCAL BLASTING REGULATIONS

The State of Wisconsin has adopted the USBM RI-8507 vibration criteria shown in Figure 2 as its blasting regulations (SPS 307.44). Furthermore, the Village of Waunakee has a blasting limit of 1.35 in/sec. Both regulations require that blasting operations shall be monitored with a seismograph at the closest structure.

INDEPENDENT BLAST MONITORING RESULTS

During this monitoring period there were a total of twelve (12) blasts that occurred on the project. A summary of the results of the monitoring for each location is shown below.

5915 Woodland Dr. (S/N #9513)
The peak particle velocity for this location during this monitoring period was 0.715 in/sec at 20.8 hertz, which occurred on October 14, 2013 at 13:01.

1517 Regency Ridge Dr. (S/N #9773)
The peak particle velocity for this location during this monitoring period was 0.158 in/sec at 20.8 hertz, which occurred on October 10, 2013 at 12:49.

1409 Danbury Bay (S/N #7240)
The peak particle velocity for this location during this monitoring period was 0.075 in/sec at 5.3 hertz, which occurred on October 10, 2013 at 12:49.

1917 Manchester Circle (S/N #7251)
This seismograph was removed on the morning of October 10, 2013. Therefore, the only date during this monitoring period when data was recorded at this location was October 9, 2013. The peak particle velocity for this location on October 9, 2013 was 0.048 in/sec at 21.7 hertz, which occurred at 10:03.

1005 Winston Way (S/N #7251)
This seismograph was installed on October 10, 2013. The peak particle velocity for this location during this monitoring period was 0.100 in/sec at 15.6 hertz, which occurred on October 14, 2013 at 13:01.

Below, in Figure 4 the data is also plotted against the State of Wisconsin vibration criteria (SPS 307.44) and the Village of Waunakee vibration limit.

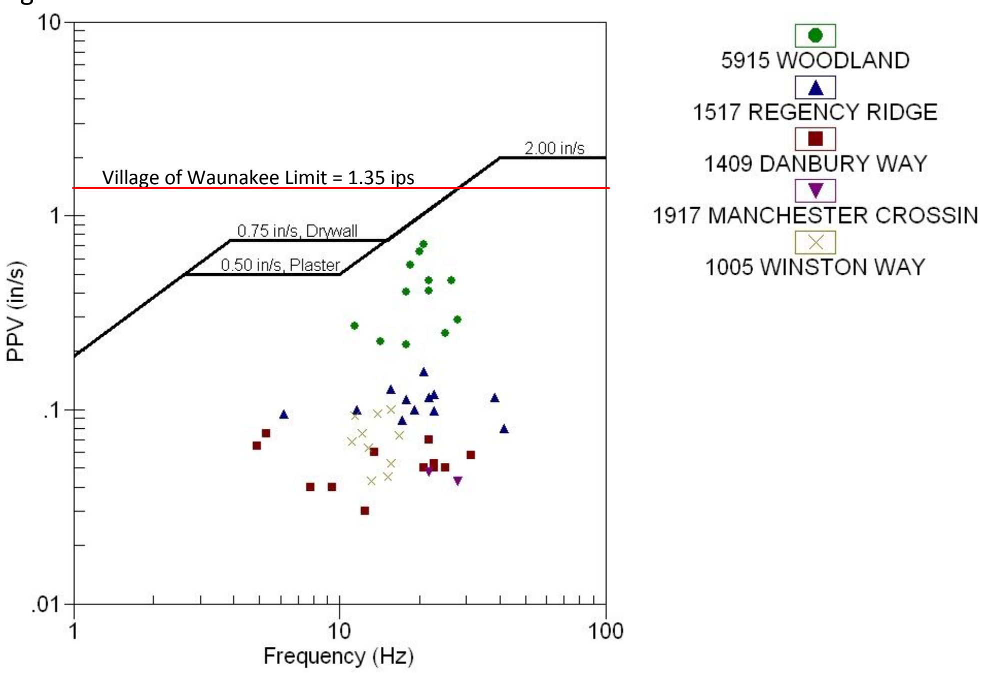

Figure 4: Seismic Data Plotted to USBM RI-8507

CONCLUSIONS

All of the blast monitoring results from this monitoring period were well below the regulatory limits. Particularly, the State of Wisconsin vibration criteria (SPS 307.44), which is derived from the USBM RI-8507 recommended limits for the protection of residential structures was not exceeded. In fact, the peak particle velocity recording for this monitoring period was 0.715 ips at 20.8 hertz, which is only 69% of the limit at that frequency. As discussed earlier in this report, the USBM RI-8507 vibration criteria was established for the protection of the most vulnerable parts of residential home construction. This criteria has been confirmed over the years to be extremely conservative. Therefore, in the opinion of the author it is not possible for the blasting that occurred during this monitoring period to have caused or contributed to any cosmetic or structural damage to neighboring homes.

All seismic monitoring reports for this monitoring period have been included in the appendix of this report. If you have any questions, please contact our office at (630) 858-0681.

Sincerely,
Vibra-Tech, Inc.

Mike Spors, E.I.T.
Area Manager