

May 4, 2022

Town of Swampscott
22 Monument Avenue
Swampscott, MA 01907

Attention: Max Kasper, Facilities Director

Blasting Vibration Limits
New Stanley School Building Project
10 Whitman Road
Swampscott, MA

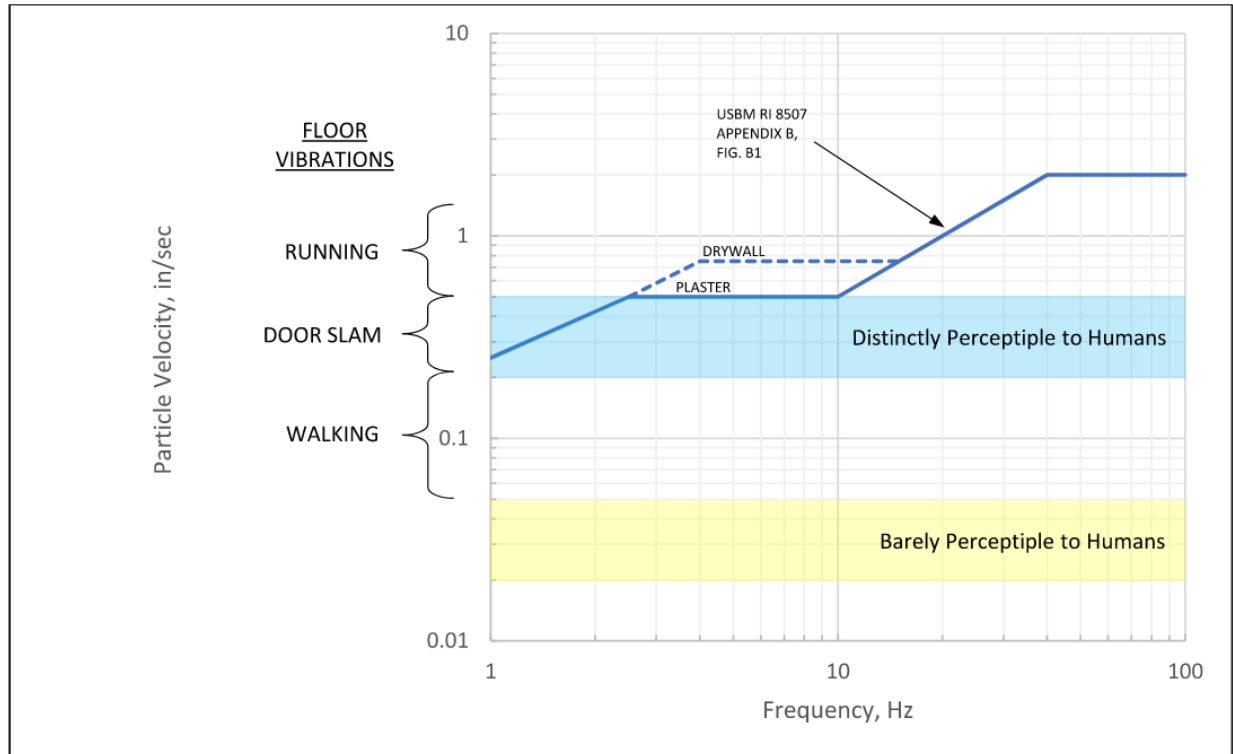
This letter provides our recommendation for blasting vibration limits to be used during construction of the new Stanley School Building located at 10 Whitman Road in Swampscott. Approximately 13,000 cubic yards of bedrock excavation by drill and blast methods will be required for construction of the new building and associated site development. Based on the Nobis Engineering, Inc. Geotechnical Report the rock has been described as hard to very hard, medium grained Salem Gabbro-Diorite. The site is located within a residential neighborhood where the existing school building will be demolished to allow for new building construction. Abutting residential structures will be as close as 20' from the drill and blast activities.

The Town's Earth Removal Advisory Committee (ERAC) has proposed to set the vibration limits for blasting to not exceed a Peak Particle Velocity (PPV) of 1.0 in/sec. This is 50% of the State and National regulations and industry standard of 2.0 in/sec to prevent cosmetic damage to residential structures. We have assumed ERAC proposed reducing the vibration limit of this industry-standard level not because the limit is unsafe or known to cause damage to structures but to minimize potential human annoyance levels of abutting residents from blasting induced vibrations.

Safe vibration limits have been adopted as industry standard and regulatory body from 40 years of research done by US Bureau of Mines (USBM) and documented in the Bureau of Mines Report of Investigations (RI) 8507. This report recommends a maximum safe level of PPV for residential structures based on the frequency of blast vibrations. Above a frequency of 40 Hz USBM recommends a maximum PPV of 2.0 in/sec, to minimize the probability of cosmetic damage to interior walls of residential structures. Based on our experience with blasting similar rock at the quarry, we anticipate a vibration frequency range at the school building site to be between 40 and 60 Hz. These limits are safe for preventing cosmetic damage to the weakest building materials (hairline cracking, or the extension of existing hairline cracks to plaster and sheetrock walls) within residential structures. These "Safe Levels" for blasting are also incorporated into the Massachusetts regulations CMR1: 65.9.1 and National regulations NFPA 495 11.2.1.

These limits are used to protect buildings from potential vibration damage from blasting and do not address the impacts on humans and their annoyance levels. Humans can perceive vibrations that may be "Barely Perceptible" at PPV levels as low as 0.02 to 0.06 in/sec and become "Distinctly Perceptible" at levels between 0.2 and 0.5 in/sec. The figure below is from the USBM study and provides vibration damage criteria or an upper limit line from blasting on residential structures. Also shown on this figure is a qualitative measure of vibration levels perceptible to

humans, and estimated floor vibration levels from common household activities such as running, walking and door slamming.



USBM RI 8507, 1980 – BLASTING VIBRATION LIMITS

The two primary design factors that impact the blasting vibration levels are the weight of explosives detonated for each delay and the distance between the blast and structure of concern. As you are aware, ERAC has recently reduced the vibration limit for blasting at the Town quarry from the industry standard limit of 2.0 in/sec to 0.5 in/sec. The intention for this limit reduction was to provide a long-term solution for reducing the human annoyance level and subsequent complaints from the abutting residents. In general, we agree with this limit reduction at the quarry knowing there will be minimal impacts to mining production and given the blasting duration for quarry operation could be for infinite time. In addition, the range of explosive weight per delay at the quarry has been between 100 and 900 pounds and the distance from the quarry blasting to the nearest residence has been between 700' and 2,000'. With these very large ranges we feel there is significant flexibility with blast designs to easily limit the vibration level to less than 0.5 in/sec without impacting quarry production.

Such is not the case for blasting at the school site where blasting designs for the school project will be an extremely scaled-down version of explosive weight and distance to that of the quarry blast designs allowing for virtually no flexibility. Using industry standards, our preliminary production blast design shows a maximum charge weight of 1.5 pounds of explosives (1/2 stick) per delay at a 20' distance to the nearest structure generates a vibration level of just under 2.0 in/sec.

We have estimated the blasting duration to be approximately 3 months with a vibration limit set at 2.0 in/sec. Reducing the limit to 1.0 in/sec will require the need for smaller and more blasts rounds necessary to achieve the required rock excavation that could increase total blasting duration by up to 200%. This assumes conducting 1 to 2 blast rounds at the school site per day.

If the objective at the school project is to minimize human annoyance by reducing the vibration limit by 50%, a comparison must be made on the estimated blast duration with each limit. You must also consider the all-day activities associated with blasting such as breaking the blasted rock with a mechanical hammer (hoeram), drilling the blast holes with a rock drill, processing (crushing) the fractured rock for reuse on site and truck traffic throughout the neighborhood. All these activities can be extremely annoying to humans relative to noise and ground vibrations.

Based on the above information, our recommendation would be to consider the shorter duration for exposing the abutters to noise and vibrations of approximately 3 months using the industry standard vibration limit of 2.0 in/sec rather than a prolonged exposure to noise and vibrations with the reduced limit.

If you have any questions about our recommendations, or require additional information, please feel free to contact me.

Sincerely yours,
BRIERLEY ASSOCIATES



Jay R. Perkins, P.E.
Geotechnical Engineer