

# REBUILDING I-93 SALEM TO MANCHESTER



## BLASTING FACTSHEET

In order to construct new roads, bridges and associated drainage, typically a large amount of earth and rock must be excavated. Blasting operations are used to remove rock/ledge that cannot be removed by other means. The blasting operations break the rock / ledge into smaller pieces that can then be handled by construction equipment and hauled away. Roughly two million cubic yards (four million tons) of rock will need to be excavated to complete the improvements to the I-93 Salem to Manchester corridor. The bulk of this rock excavation (80-90 %) will be in the Exit 3 area. Blasting operations create ground and air vibrations that can be felt in the surrounding areas. Some of the most common questions regarding blasting are addressed below. Please see the project website at [RebuildingI93.com](http://RebuildingI93.com) for more detailed information on blasting and its effects.

### WHY DOES MY HOUSE SHAKE DURING BLASTING?

During blasting, energy waves are transmitted through the ground as vibrations, and through the air as overpressure or air blast. Ground vibrations enter a house through the ground and air blast through the roof or building side. Vibration effects on structures can be caused by both ground vibration energy and air blasts. The NHDOT allowable ground vibration and air blast standards are at or below federal government and industry standards.

**BUT IF THESE LIMITS ARE BELOW ALLOWABLE LIMITS, HOW COME I CAN STILL FEEL THE BLAST?** People are extremely responsive to ground vibrations and air blast effects. The human body can feel vibration effects as low as 0.02 in/s, which is 25 times smaller than the lowest allowable ground vibration limit.

A typical house has a natural frequency of 4 to 12 Hz. The natural frequency is the frequency at which a structure naturally vibrates once it has been set into motion. Bells are a simple example of this. Different size bells produce different sounds because they vibrate at different natural frequencies. Although your house does not produce a noise, when the frequency of the incoming vibrations matches the natural frequency of the house, the house will "ring", much like an opera singer can vibrate a glass with her voice. The greater the difference in frequencies between the vibration of the ground and the house, the less the house responds. This significantly impacts people's perception of a blast. It also explains why the same blast will be felt at one house but not the neighbor's (i.e., the neighbor's house has a different natural frequency). NHDOT specification limits for vibrations for frequencies below 40 Hz are lowered from 2.0 in/s to 0.75 in/s for residential structures in order to reduce the risk of damage due to vibrations with frequencies similar to the natural frequency of a house.



BLASTING & LEDGE/ROCK REMOVAL OPERATIONS

### NHDOT Standards for Blasting

#### Maximum Ground Vibration

- 0.75 in/s (below 40 Hz) for newer homes with drywall interior
- 0.5 in/s (below 40 Hz) for older homes with plaster and lath interior
- 2.0 in/s (at or above 40 Hz) for all homes
- 2.0 in/s non-residential structures and buried utilities

#### Maximum Allowable Air Blast

- 134 dB

IN/S = INCHES/SECOND dB = DECIBEL Hz = HERTZ

**HOW AND WHERE ARE GROUND VIBRATIONS AND AIR BLASTS MEASURED?** Ground vibrations and air blasts are measured with a device called a seismometer which is typically set up at the closest occupied structure to the blast location. The seismometer measures the velocity of the energy wave in inches per second (in/s). It is the Contractor's responsibility to ensure that the blasting operation is within the allowable limits for ground vibration and air blast. If the allowable ground vibration or air blast is exceeded, the Contractor is required to change his blasting methods to reduce these effects.

**WHY DOES THE BLASTING SOUND LOUDER ON SOME DAYS THAN ON OTHERS?** Lower temperatures and pressures, along with cloud cover, tend to focus and intensify air blasts. This tends to make smaller blasts sound much larger.

**DOES REPETITIVE BLASTING CAUSE DAMAGE TO MY HOME, EVEN IF THE VIBRATIONS ARE WITHIN THE ALLOWABLE LIMITS?** No. The federal government has conducted studies where they have vibrated entire houses for several days. Their conclusions have shown that repetitive blasting kept below 0.75 in/s will not cause damage.

**IF BLASTING IS NOT CAUSING DAMAGE TO MY HOUSE, THEN WHAT IS?** There are several other factors that have been proven to cause damage equivalent to vibrations, some man-made and some natural. This table compares common occurrences to measured vibration damage levels. It can be seen that cracks appearing in a concrete slab or asphalt pavement would occur long after essentially all of the drywall joints in a home had cracked from the same vibration.

Vibration	Effect, source, or human response
0.02 - 0.06 in/s	Perceptible to humans
0.02 - 0.58 in/s	Fireworks at 1,500 feet
<b>0.50 in/s</b>	<b>Lower NHDOT threshold</b>
0.15 - 1.9 in/s	Slamming a door
0.2 - 2.1 in/s	Driving a nail
1.0 - 2.4 in/s	10% change in humidity will cause small cracks to expand
0.6 - 2.6 in/s	20 mph wind
<b>4.0 in/s</b>	<b>Superficial cracking at drywall joints</b>
1.1 - 6.7 in/s	50 mph wind
<b>10.0 in/s</b>	<b>Damage to concrete slab or driveway</b>

**BUT THEN WHY AM I ONLY NOTICING THIS DAMAGE NOW?** As previously stated, people can perceive vibrations as low as 0.02 in/s, well below those levels necessary to cause damage. Homeowners may look more closely at their home after they feel it shake, finding what they believe to be a new crack. The general thinking is "If I can feel it, then it is affecting my house." However, this is generally not the case. Often, the cracks were preexisting.

**SO WHERE ARE THE CRACKS IN MY FOUNDATION COMING FROM?** Uneven settlement of foundations caused by improper foundation construction on poor soils is the primary cause of foundation cracks. Many houses have cracks in the foundation that will not affect the structural integrity of the house. Furthermore, a high water table can cause cracking of concrete floors.

