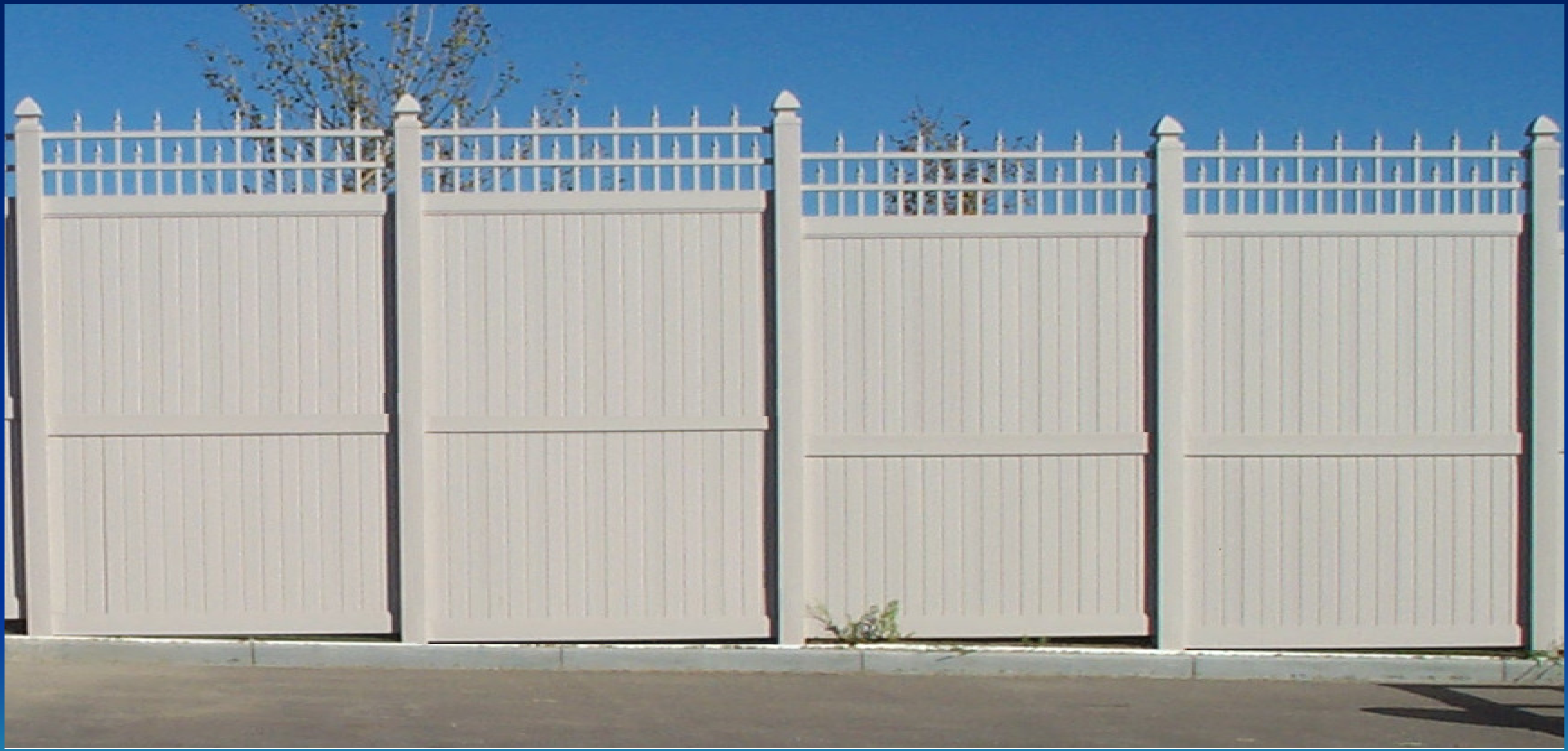
UNDERSTANDING SOUND/NOISE



- Noise has been an environmental issue throughout the ages. Ancient Romans complained about chariots rattling on cobble stone roadways. Renaissance metal smiths often lost their hearing due to continuous and excessive noise. Noise has been called "the natural by-product of expanding human technology." In other words, disagreeable sounds are mostly the fruits of our own creation. Automotive and truck traffic, airplanes, generators, air conditioning units, dishwashers, car alarms and trains are common sounds often described as noise.

  Environmental noise can distract attention, disturb sleep and create anxiety. Prolonged exposure to sound levels above 85dB can impair hearing and can be hazardous to overall health.

  Noise might be described as any sound that is annoying. This subjective definition of noise causes serious problems when defining the nature of noise since "one man's music can be another man's misery." In many situations, a noise problem is defined as not being in compliance with a particular specification or regulation. Unfortunately, compliance to specific regulations is not a guarantee that individuals, communities and organizations will not complain about perceived noise levels. Their concerns and complaints need to be addressed.

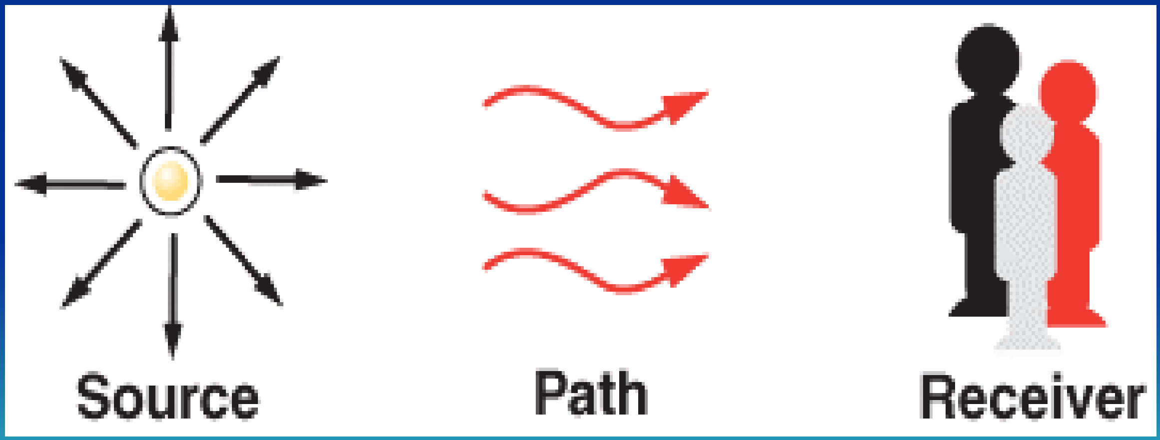
  The first goal when dealing with noise complaints is determining a reasonable solution. Understanding the subjective nature of sound is a step in the right direction for finding a reasonable solution.

SOURCE, PATH & RECIEVER

Three components must be present for noise to exist:

1.Source
2.Path
3.Receiver

- Without a source there obviously is no sound.
- Without a path, the medium through which sound passes to the receiver, there is no sound.
- Without a receiver, someone who hears the sound, there is no sound problem.



SOURCE

- Sound is the result of rapid fluctuations of pressure, which reach a receiver. The frequency of sound is the number of times in a period of one second that the pressure changes from zero to maximum to minimum to zero, thus completing a cycle. In music it is perceived as the pitch or tone of a note. Frequencies produce sound waves; the length of the sound wave depends on the specific frequency. Humans tend to be more sensitive to high and mid range frequencies such as sirens, whistles and traffic noise. Lower frequencies tend to be less irritating.

  Amplitude refers to the loudness of sound. The loudness of sound is often expressed in decibels (dB). Human hearing is impacted by the way it perceives sound levels. Higher and lower frequencies of the same magnitude can be perceived as less intense; therefore, to approximate the response of the human ear adjustments are made to account for human sensitivity to certain frequencies. These adjustments are identified as dBA's.

  For the majority of people, the threshold of hearing is higher than 0 dBA, probably closer to 10 dBA. A change of 1 dBA in sound is the smallest change most people can recognize when comparing two sounds.

  Many State Department of Transportation agencies claim a change of 3 dBA is the smallest change most people can recognize. A change of 10 dBA is generally thought to be "twice as loud."

Common Outdoor Activities	Noise Level dBA	Common Indoor Activities
Jet Fly-over at 300m (1000ft)	--110--	Rock Band
	--100--	
Gas Lawn Mower at 1m (3ft)		
	--90--	
Diesel Truck at 15m (50ft), at 80km/hr (50mph)	--80--	Food Blender at 1m (3ft)
Noisy Urban Area, Daytime		Garbage Disposal at 1m (3ft)
Gas Lawn Mower, 30m (100ft)	--70--	Vacuum Cleaner at 3m (10ft)
Commercial Area		
Heavy Traffic at 90m (300ft)	--60--	
		Large Business Office
Quiet Urban Daytime	--50--	Dishwasher Next Door
Quiet Urban Nighttime	--40--	Theater, Large Conference Room (Background)
Quiet Suburban Nighttime		
	--30--	Library
Quiet Rural Nighttime		Bedroom at Night, Concert Hall (Background)
	--20--	
		Broadcast/Recording Studio
	--10--	
Lowest Threshold of Human Hearing	--0--	Lowest Threshold of Human Hearing

- Decibels are logarithmic units; therefore, multiple dB cannot be added by ordinary arithmetic means. For example, if one automobile generates 70 dB when it passes an individual, two cars passing simultaneously would not produce 140 dB. In fact, they would combine to produce 73 dB. The chart below can be used to reasonably estimate the impact of two or more noise sources together.

When Two Decibel Values Differ By:	Add this Amount to the Higher Value:	Example:
0 or 1 db	3 db	70+69=73
2 or 3 dB	2 dB	74+71=76
4 to 9 dB	1 dB	66+60=67
10 dB or more	0 dB	65+55=65

PATH & RECEIVER

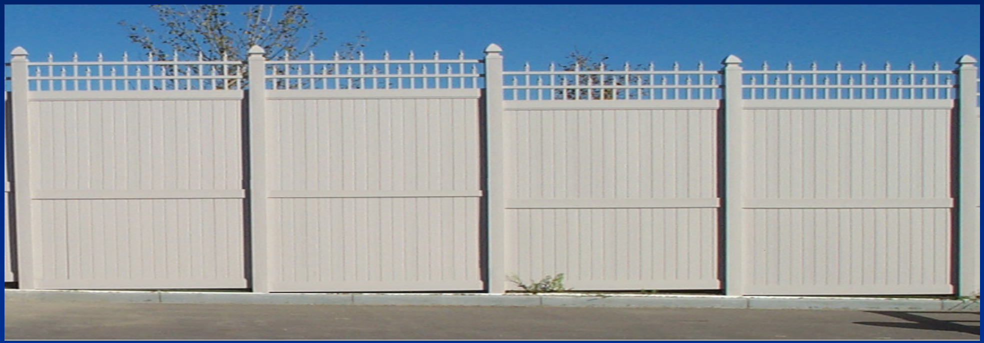
- **PATH**

Although frequency and amplitude originate at the source, both are significantly altered by the physical variables in the path to the receivers. For example, walls, structures, ground absorption, atmospheric conditions such as temperature, humidity, wind and rain all contribute to changes in source noise levels before it reaches the receiver. A detailed study of the path is a critical step in understanding how to reduce noise levels at specific locations.

- **RECIEVER**

Ultimately, we are concerned with the effect and perception of sound on the receiver. Two elements determine the sound levels upon the receiver: the sound power levels of the source and the characteristics of the path between the source and receiver. A third and critical element is the individual sensitivity of the human receiver. The individual's sensitivity plays a significant role in his perception of noise levels.

The best place to control noise is close to the source. Enclosing a noise source is an effective method and commonly used in commercial and industrial applications but impractical when addressing traffic noise issues. When the noise source has been minimized or isolated the next step is to interrupt the direct noise path by introducing a sound barrier. The next objective is to remove reflected sound energy as soon as possible. The most practical method is to replace reflective surfaces with absorptive surfaces.



Sound-absorptive walls installed between the noise source and the receivers are effective in reducing reflective noise. The height, location and orientation of the sound wall play a significant role in the wall's effectiveness. Sound walls are most effective when built close to the source or close to the receiver. The height of the wall should interrupt line-of-sight between the source and the receiver.

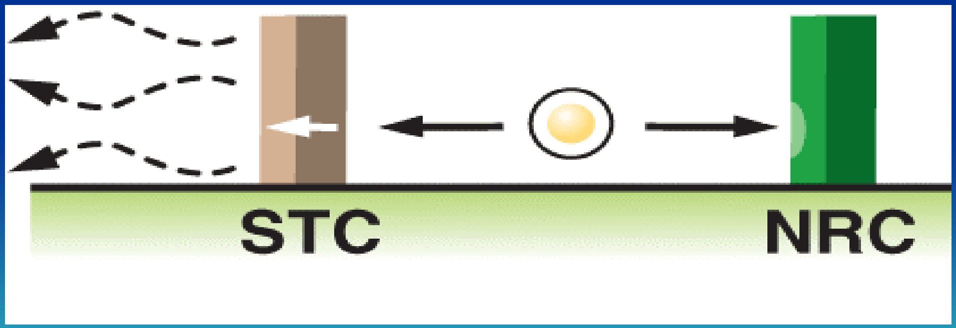
If reflections can be subdued quickly, they cannot develop into reverberations. Reverberations become new sources and add to the original noise source. Minimizing reflections means noise is localized to the extent whereby only direct sound, line-of-sight sound, will be heard.

WHAT MAKES A GOOD SOUND WALL

- The most often asked question is are trees, vegetation and landscaping effective noise barriers? Although they help with aesthetics, they, unfortunately, do little to reduce noise.

  Sound walls are classified as *reflective* or *absorptive*. Hard surfaces such as masonry or concrete are considered to be perfectly *reflective*. This means most of the noise is reflected back towards the noise source and beyond. A barrier wall with a surface material that is porous with many voids is said to be *absorptive*. This means little or no noise is reflected back towards the source.

  Sound walls are performance rated in two categories ***Sound Transmission Class*** (*STC*) and ***Noise Reduction Coefficient*** (*NRC*). The *STC* determines the amount of noise energy transmitted through the wall material. The *NRC* determines the amount of energy absorbed by the wall material and the amount of energy reflected back towards the source.



WHAT MAKES A GOOD SOUND WALL

- Walls having STC ratings of 30 or more means that less than 0.1 percent of the noise energy is transmitted through the barrier material. Many State Department of Transportation specifications require minimum STC ratings of 24. Sound Fighter® LSE Walls have an STC rating of 33.

  NRC measures the amount of sound energy absorbed and measures the amount of sound energy reflected back towards the source. NRC ratings will range between 0 (100% reflective) to 1 (100% absorptive). A wall with an NRC rating of .85 means the wall absorbs 85% of the noise and reflects 15% of the noise back towards the source. NRC ratings equal to or greater than .85 are considered to be good sound absorbers and are often used as the minimum requirement when considering absorptive walls. Sound Fighter® Wall Systems have an NRC rating of 1.05, making the wall 100% absorptive.

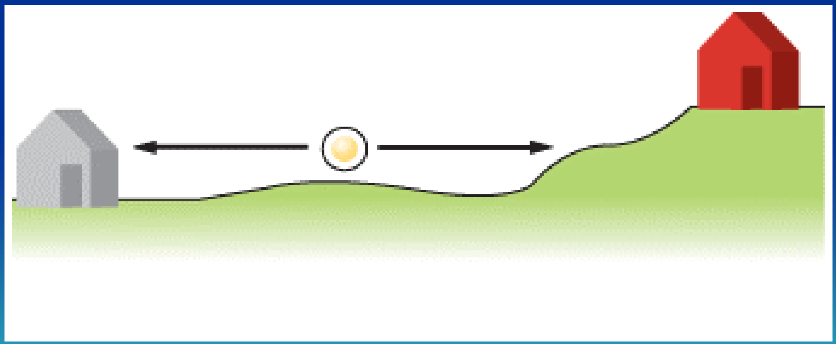
  A good sound wall is a sound-absorbing wall with a STC rating of 30 or more and a minimum NRC rating of .85

WHEN ARE ABSORPTIVE WALLS BENEFICIAL

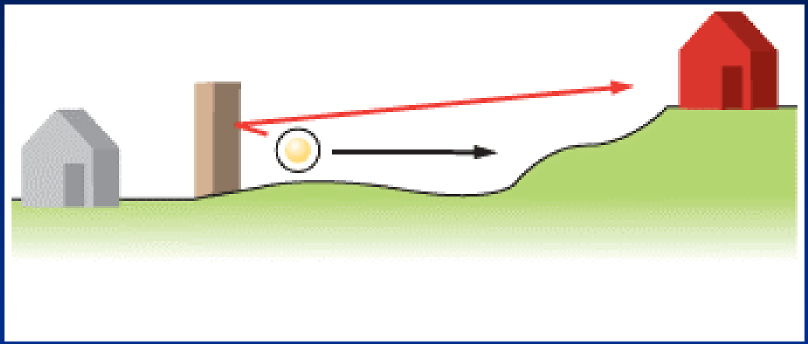
Absorptive wall applications are numerous. The primary intent is to isolate the noise source and minimize possible reflections. As stated earlier, if reflections are not subdued they become reverberations and become new noise sources.

The following illustrations show the impact of having no sound wall, a reflective sound wall and an absorptive sound wall.

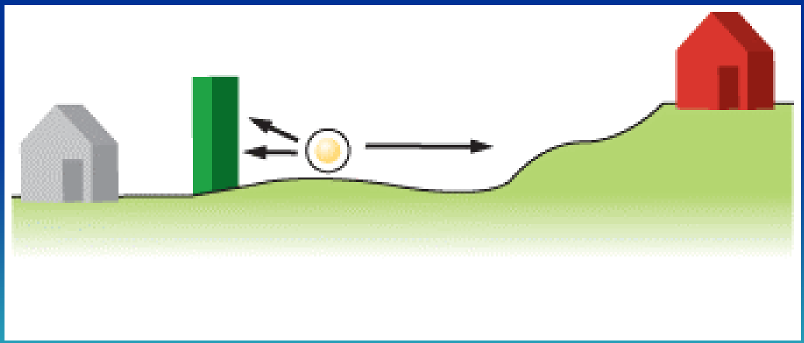
The illustration demonstrates the noise source directly impacts the house built at a similar grade as the roadway. The house on the hill is not impacted by the noise source because the ground absorbs the sound.



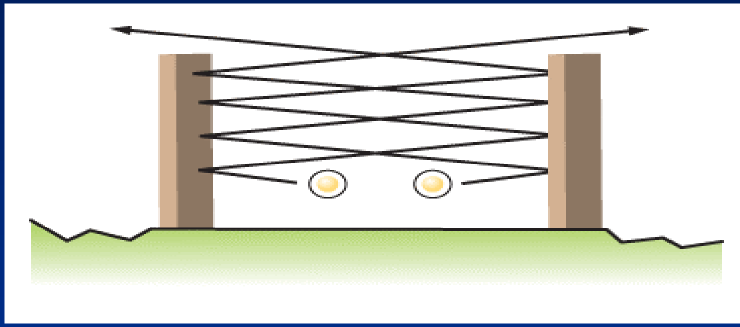
The addition of a reflective sound wall shields the house at the same grade as the roadway. Unfortunately, the reflections from the wall directly impact the house on the hill that was previously not impacted by the roadway noise. This situation depicted usually increases the noise level by 3-5 dBA for the house on the hill



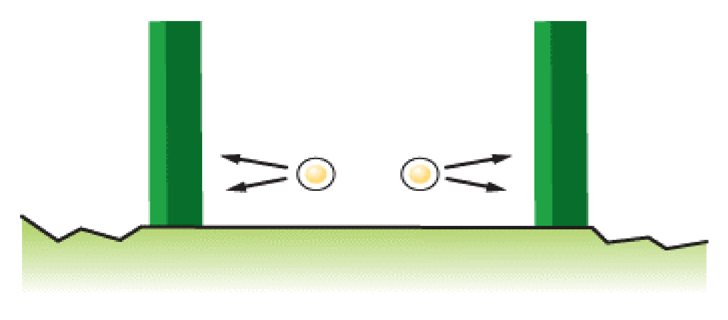
Using an absorptive sound wall shields the house at the same grade as the roadway and does not reflect noise up towards the house on the hill. Both houses are protected from the roadway noise.



It is common to see parallel sound walls on roadways. Reflective parallel sound walls potentially reduce the walls acoustical performance. The net result is less than optimal performance and increased noise levels on and adjacent to the roadway.



Absorptive parallel sound walls reduce reflections and are able to maintain the effectiveness of the barrier. In addition, the noise level on the freeway is reduced.



ANGLES OF DIFFRACTION

- Although technically any natural or man-made feature in the path between a noise source and receiver that reduces noise is a noise barrier, the term is generally reserved for a wall specifically constructed for noise mitigation. When a noise barrier is inserted between a noise source and receiver, the direct noise path along the line of sight between the two is interrupted. Some of the acoustical energy will be transmitted through the barrier material and continue towards the source, but at a significantly reduced level. The amount of this reduction depends on the material's mass and rigidity, and is call the "Transmission Loss". Effective barriers have TL's of 30 dBA or more. This value means only 0.1 percent of the noise energy is transmitted through the barrier.

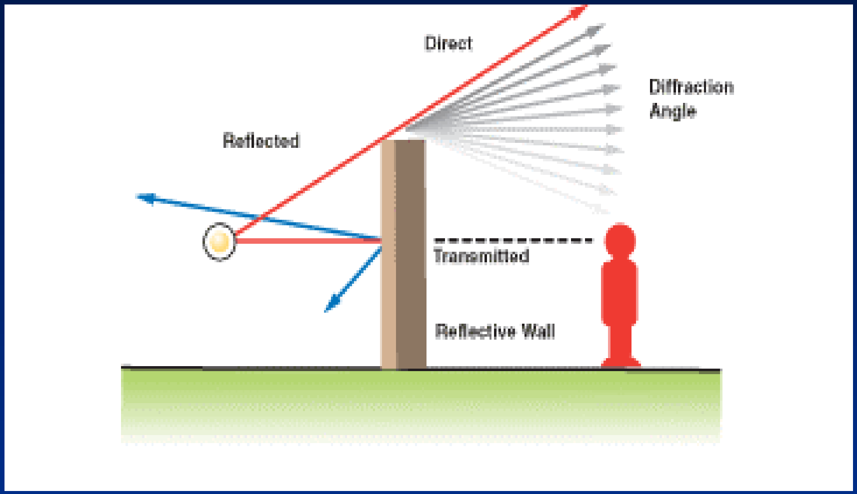
- The remaining direct noise is either partially or entirely absorbed by the noise barrier if the barrier material is absorptive, and/or partially or entirely reflected if the barrier material is reflective. Whether the barrier is absorptive or reflective depends on its ability to absorb sound energy.

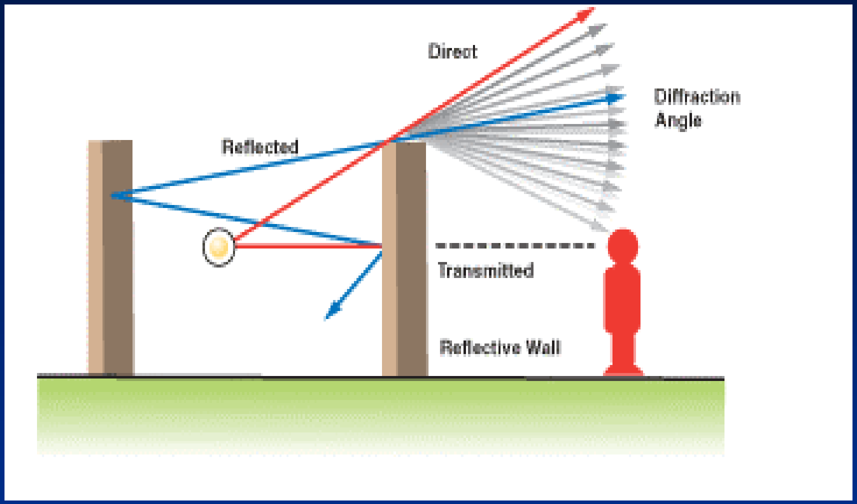
- Direct, transmitted, absorbed and reflected noise paths represent all the variations of the direct noise path due to the insertion of a noise barrier. Only the transmitted noise reaches the receivers behind the barrier. However there is another path, diffraction. Diffraction is the most important path that reaches the receiver.

- Diffraction is a characteristic of all “wave” phenomena including light, water and sound. It is described as the “bending” of waves around objects. The amount of diffraction depends on the wavelength and the size of the object. Low frequency waves with long wavelengths are easily diffracted. Higher frequencies with short wavelengths are not as easily diffracted. This is why light, with short wavelengths cast clearly defined shadows. Sound waves also cast “noise shadows” when they strike an object. However, because of their much longer wavelengths “noise shadows” are not very well defined and amount to “noise reductions”, rather than an “absence of noise”.

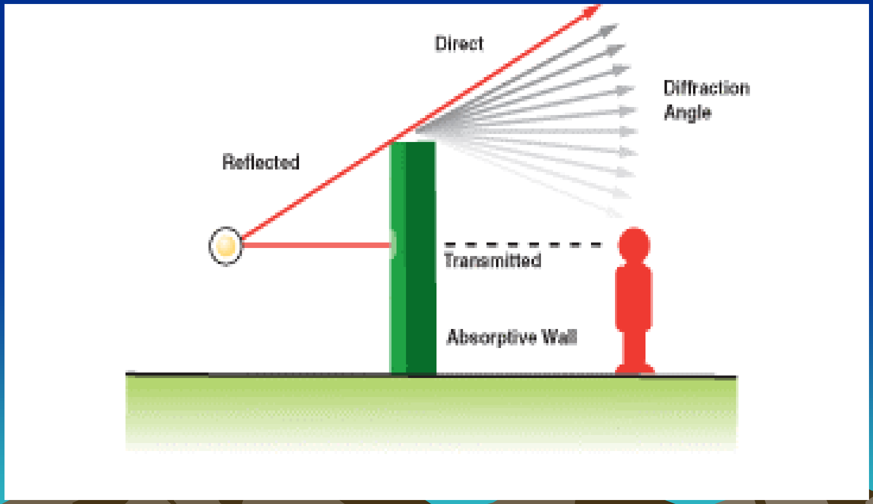
- Greater “angles of diffraction” will result in more frequencies being attenuated. The higher frequencies will be attenuated first, then middle frequencies and lower frequencies last. The top of the shadow zone and the line from the top of the wall to the receiver defines the “diffraction angle”. The position of the source relative to the top of the barrier determines the extent of the shadow zone and the diffraction angle to the receiver. Similarly, the receiver location relative to the top of the wall is also important in determining the diffraction angle.

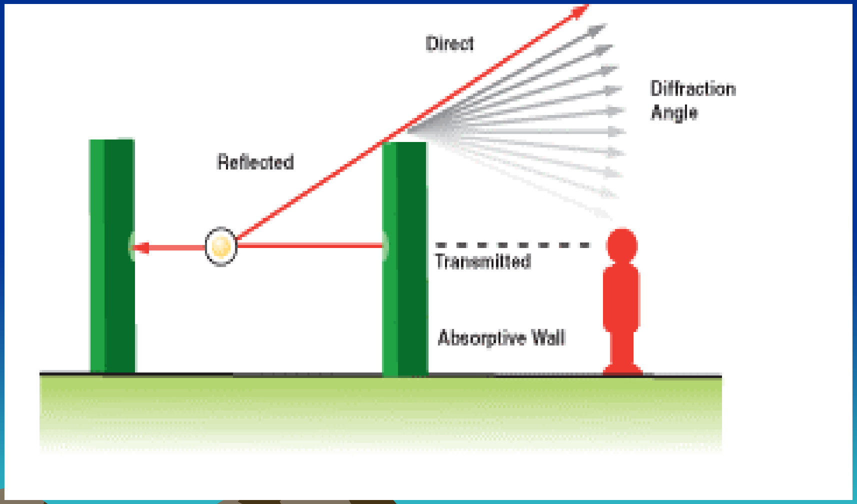
ANGLES OF DIFFRACTION REFLECTIVE WALL





ANGLES OF DIFFRACTION ABSORPTIVE WALL





Community Issues

Sound walls significantly benefit local communities, families and individuals from unwanted noise and help preserve property values. State Department of Transportation agencies are very interested in having community participation when designing sound walls. It is important to have community input and support when building such visible structures.

When traffic noise impacts have been identified, noise abatement measures must be considered according to state and federal environmental statutes. Traffic noise impacts occur when one or more of the following conditions are present: 1) when the predicted noise levels exceed existing noise levels by 12dBA and 2) when predicted noise levels approach within 1 dBA, or exceed the noise abatement criteria

Most communities' top priority is to reduce unwanted direct and reflective noise. Many sound walls reduce direct noise, but only sound-absorbing walls can reduce or eliminate reflective noise.

Homes located directly behind a sound wall are protected from direct noise, but homes elevated above the freeway and homes located several blocks back from the freeway can experience increased noise levels due to noise reflections. Reflective walls can adversely affect a home previously not impacted by freeway noise.

SUMMARY

Noise has been an issue for centuries and continues to be a major concern. Although technology has generated most of the noise, it is also part of the solution.

Cost has been the single most prohibitive reason for not using absorbing material on roadways. PVC Fence is cost competitive with most reflective block and concrete walls on commercial and industrial applications.