NPCA

NATIONAL **PRECAST CONCRETE** ASSOCIATION

PRECAST CONCRETE SOUND WALL PRODUCTS

National Precast Concrete Association

With nearly 1,000 member companies, NPCA serves as the voice of the precast concrete industry in the United States and Canada. The industry includes a diverse mix of companies, from small single-plant manufacturers to multinational vertically integrated companies that operate in many sectors of the construction industry.

NPCA provides an array of services to these manufacturers that include technical engineering support, the industry's largest certification program, safety programming, educational courses and a suite of print and online publications.

In addition to services to members, NPCA provides specialized technical information to owners, contractors, engineers and designers on precast concrete products.

This Technical Brief provides an overview of the attributes of precast concrete absorptive sound walls that will prove invaluable when considering implementation of this technology.

Manufacturers of precast concrete absorptive sound walls are located throughout North America and can be found through the search engine on the NPCA website.

For more information on these and other precast concrete products, and to find a manufacturer in your region, please visit precast.org.

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Why Precast Concrete Sound Walls?

When manufactured and installed properly, precast concrete sound walls will almost always outperform and outlast systems consisting of competing materials.

Ease Of Installation

Precast concrete sound walls have a distinct advantage over other materials such as cast-in-place concrete. Precast concrete sound walls are manufactured well in advance of installation and stored at the plant, they are ready for transportation to the job site at moment's notice. After delivery, they can be installed with a small crew and minimal erecting equipment.

High Quality Sound Walls Last Longer

Precast concrete products typically are made in a controlled plant environment, they exhibit high quality and uniformity. Each wall panel is inspected and evaluated to meet or exceed project specifications prior to shipment to the job site. Factors affecting quality typically found on a job site – temperature, curing, site conditions, craftsmanship and material quality – are all controlled in a plant environment. Precast concrete walls manufactured in a quality-controlled environment offer the greatest potential for much longer service life than conventional site cast concrete. Why Precast Concrete Sound Walls?

Less Weather Dependent

Precast sound walls can be placed in rainy or cold weather conditions that typically prohibit the installation of cast-in-place concrete walls since the walls are fully cured before they are delivered to the job site. This helps to extend work seasons in colder months and even allows placement during inclement weather.

Looks Good In Green

After water, concrete is the most used material on earth. It is nontoxic and environmentally safe. In an era of increasing environmental regulation of pollutant discharge into waterways, precast concrete provides additional benefits because it is made primarily from natural materials. Recycled steel reinforcement and mix designs that incorporate recycled cementitious materials offer additional sustainability options for designers.

Environmental and LEED Attributes

Brings Personality To The Environment

Precast concrete sound walls can be designed in a wide array of colors and textures to blend in with a city's architecture and local topography or even to capture a community's theme or identity. Precast concrete sound walls provide a sensible choice for sustainable development. Unlike wooden formwork that is build onsite and then thrown away, precast plants reuse formwork, significantly reducing construction waste on the job site. Because precast concrete sound walls are modular and standardized, they are installed quickly with a small crew, reducing labor, energy usage, noise pollution and emissions from heavy equipment.

Supplementary cementitious materials also play a role in increasing the sustainable attributes of precast concrete sound walls. SCMs such as fly ash and blast furnace slag can replace a significant proportion of cement in the mix design. The use of SCMs reduces the overall carbon footprint of the sound wall by replacing some of the cement in the mix design. Here are some additional sustainable properties of precast concrete: Environmental and LEED Attributes

- Waste water can be captured at the plant and recycled;
- The reinforcing steel used in sound walls is typically composed of 95 percent post-consumer recycled content;
- Aggregates used in the manufacturing of precast concrete sound walls are generally extracted regionally;
- Concrete is a very strong and durable material – a significant sustainable attribute. It will not rust, rot or burn and has a service life of up to 100 years.
- Reflective sound walls can reduce the perceived noise by as much as half, while absorptive treatments have been found to further reduce noise pollution.

For these and other reasons, precast concrete sound walls are a smart choice in projects applying for LEED certification. Most of the credits shown below also have additional Innovation in Design points that are tied to exemplary performance of the credit listed.

LEED FOR NEW CONSTRUCTION AND MAJOR RENOVATION

Site Development: Protect or Restore Habitat
(Sustainable Sites Credit 5.1)

Because precast concrete sound walls are manufactured in a plant and delivered to the site ready to set they require very minimal site disturbance to install.

Construction Waste Management: Divert 50% (75%) From Disposal
(Materials and Resources Credit 2.1 & 2.2)

Precast concrete sound walls create minimal to zero amounts of onsite waste material.

Recycled Content: 10% (20%)
(post-consumer + preconsumer)

(Materials and Resources Credit 4.1 & 4.2) Precast concrete sound walls may contain supplementary cementitious materials such as fly ash and blast furnace slag which will add to the project's recycled content goals.

Regional Materials: 10% (20%) Extracted, Processed & Manufactured Regionally
(Materials and Resources Credit 5.1 & 5.2)

The vast majority of materials that go into the construction of precast concrete are within a 500-mile radius of the precast concrete plant.

LEED FOR NEIGHBORHOOD DEVELOPMENT PILOT SCORECARD

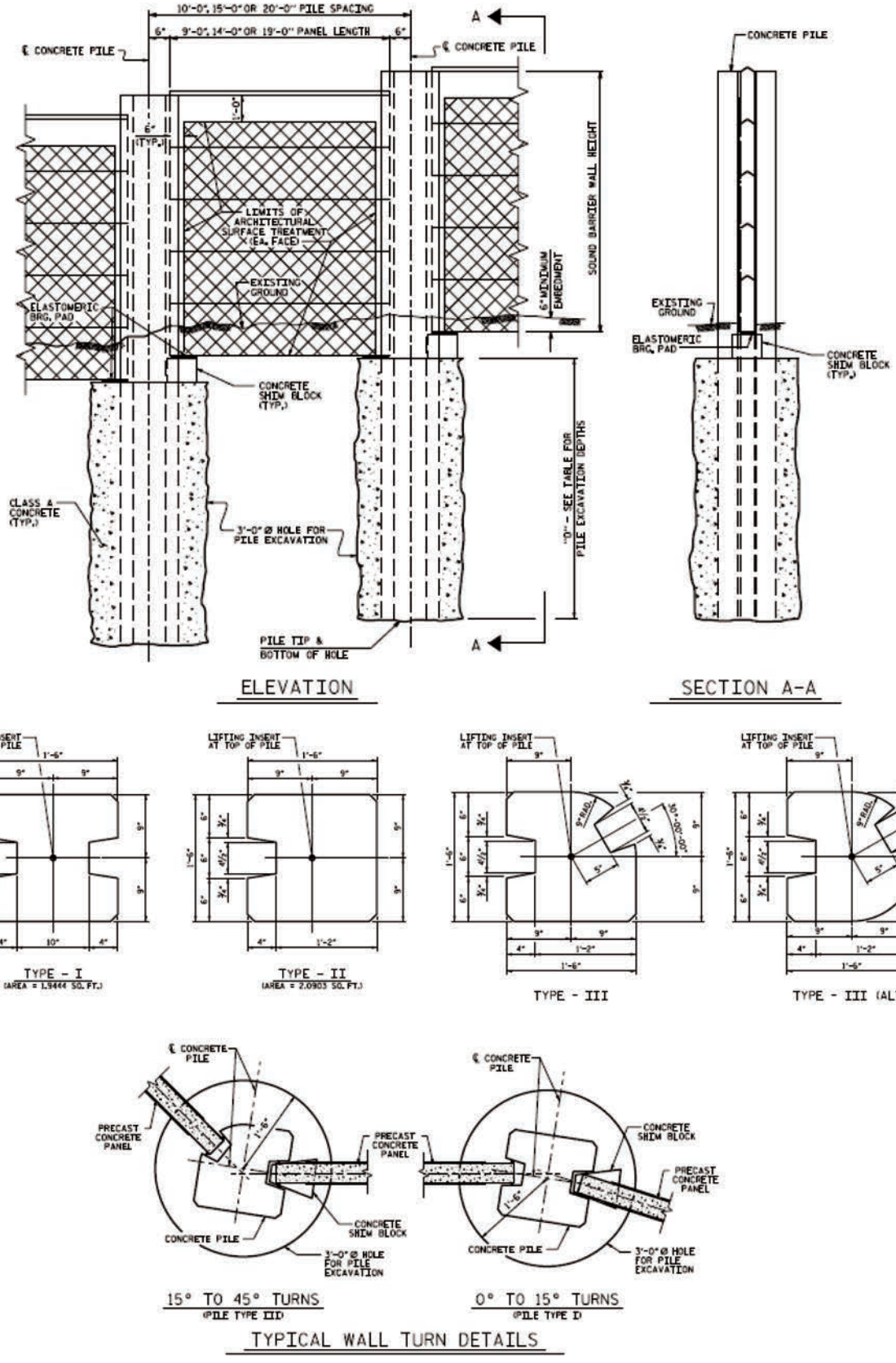
Green Infrastructure & Buildings: Minimize Site Disturbance in Design and Construction
(GIB Credit 6)

Precast concrete sound walls may be installed with a small footprint, enabling structures to be placed closer to high traffic areas.

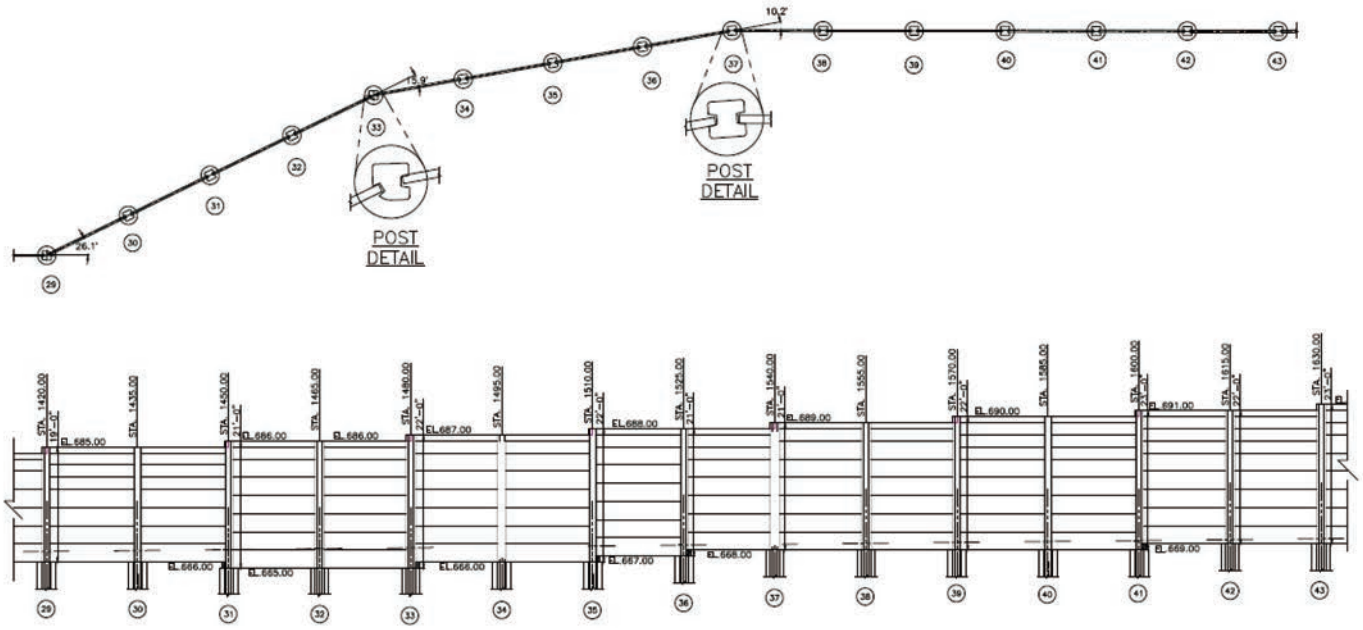
Green Infrastructure & Buildings: Recycled Content in Infrastructure
(GIB Credit 14)

Precast concrete sound walls may contain supplementary cementitious materials such as fly ash and blast furnace slag, adding to the project's recycled content goals.

Sound Wall Detail Drawing - Noise Barrier Wall



Sound Wall Elevation Drawing



Understanding Sound (Noise)

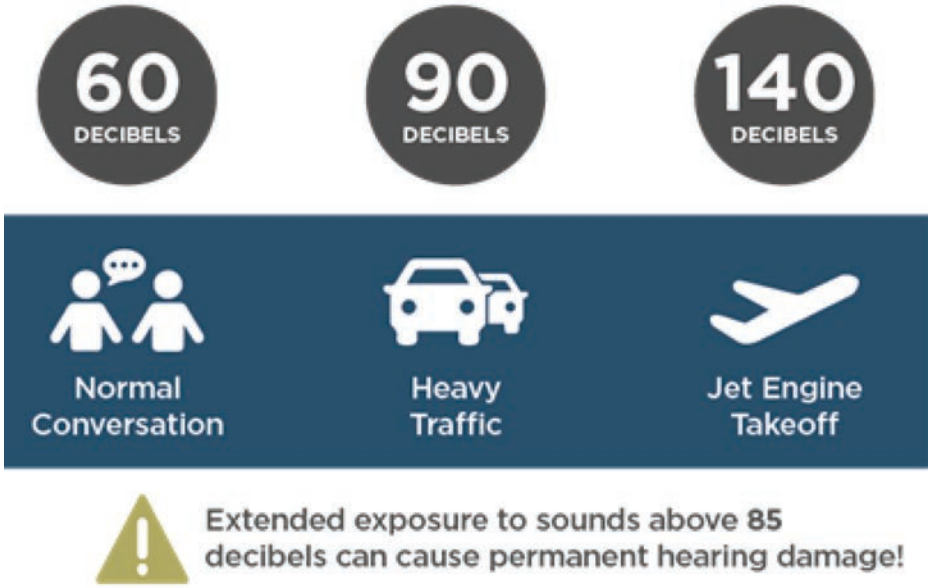
Noise has been an environmental issue throughout the ages. Ancient Romans complained about chariots rattling on cobble stone roadways. Renaissance metal smiths often lost their hearing due to continuous and excessive noise.

Human-Created

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, and trains are all common sounds often described as noise.

Decibels of Common Sound

To give context of how loud is too loud, below are a few commons sounds and their approximate decibel level.



Health Implications

According to the World Health Organization (WHO), sounds above 60 decibels (such as background noise within a city) is enough to raise blood pressure and heart rate. This is the environmental noise that we live with everyday and can cause distraction, disturb sleep and create anxiety. With the noise make-up changing and increasing, we expose our communities to more risks.

Compliance Issues

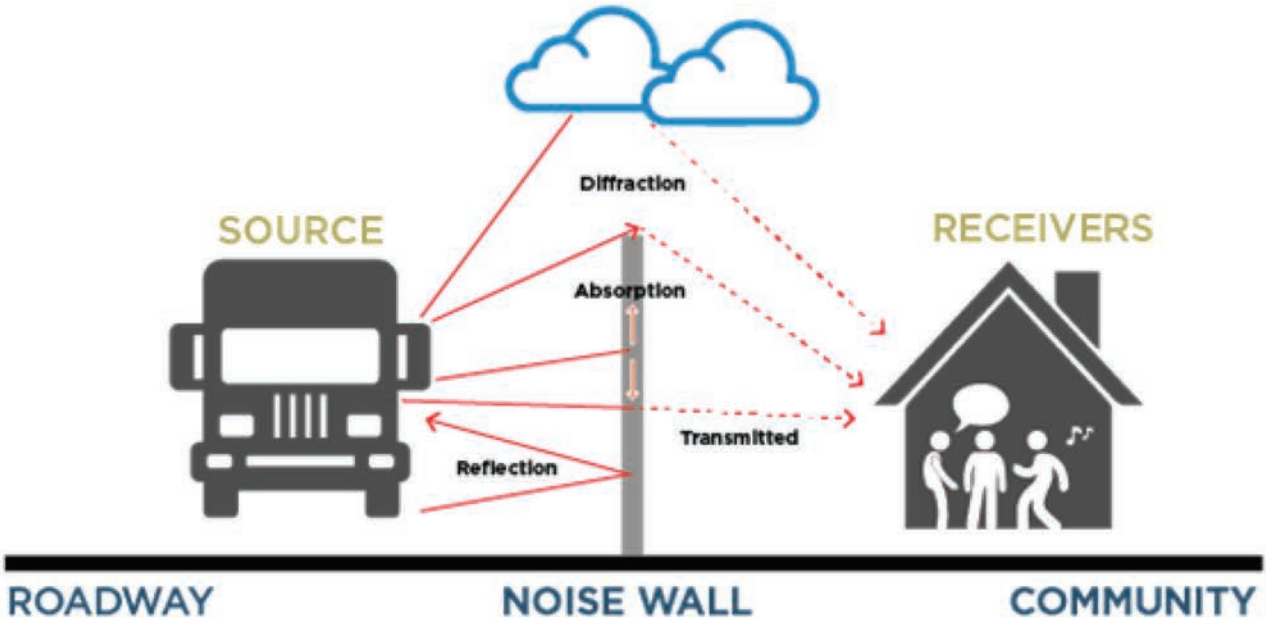
A “noise problem” is only a problem when it is recognized as one in accordance with the local jurisdiction. There are many complex, socio-economic issues that have played into this over time. Who knew noise could be so complicated?

Even when a noise does not meet compliance within a particular regulation, perceived noise levels can still be cause for complaint. 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.

How A Noise Wall Works

Noise barriers reduce the noise that enters a community from a busy highway by either absorbing, transmitting, reflecting it back across the highway, or forcing it to take a longer path over and around the barrier. The effectiveness of a barrier depends on how well it diffracts and absorbs the noise.

A high-performance barrier has negligible noise transmission and reflection.



Reducing Unwanted Noise

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.

If reflections can be subdued quickly, they cannot develop into reverberations. Reverberations become new sources and add to the original noise source.

Height

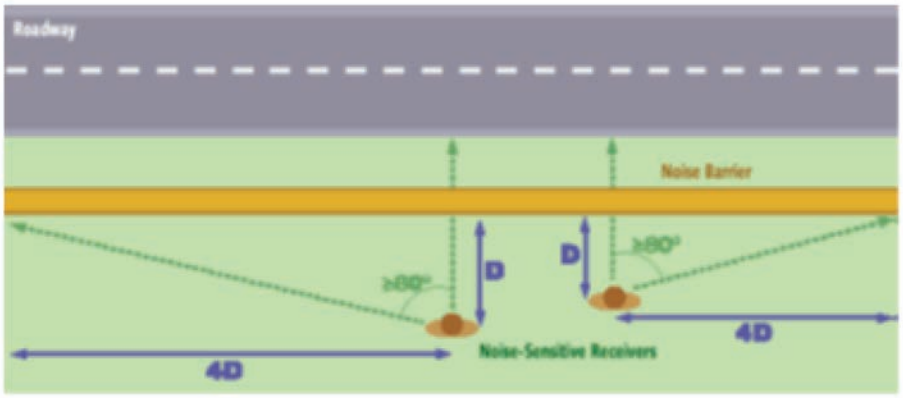
A noise barrier must be tall enough and long enough to block the view of a highway from the area that is to be protected, the "receivers."

A noise barrier can achieve a 5 dB noise level reduction, when it is tall enough to break the line-of-sight from the highway to the home or receiver. After it breaks the line-of-sight, it can achieve approximately 1.5dB of additional noise level reduction for each meter of barrier height.

Length

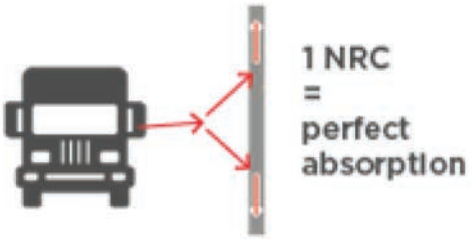
To effectively reduce the noise coming around its ends, a barrier should be at least efour times as long as the distance from the home or receiver to the barrier. Openings in noise barriers for driveway connections or intersecting streets loose destroy their effectiveness.

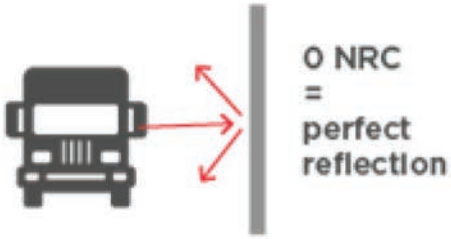
In some areas, homes are scattered too far apart to permit noise walls to be built at a reasonable cost. Noise barriers are normally most effective in reducing noise for areas that are within approximately 61meters (200 feet) of a highway (usually the first row of homes).



Reflective vs Absorptive Walls

Understanding the difference between the 2 types of Noise Walls
Noise walls are either 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 considered absorptive. This means little or no noise is reflected back towards the source.





Noise wall performance is rated by two coefficients: Noise Reduction Coefficient (NRC) and Sound Transmission Class (STC). The STC determines the amount of noise energy transmitted through the wall material. The NRC determines the amount of energy absorbed by the way material and the amount of energy reflected back towards the source.

ABSORPTIVE	REFLECTIVE
- Absorbs the noise that strikes the wall	- Reflects (bounces) noise that strikes the wall
- For absorptive noise walls with an NRC >0.80, means the wall can absorb 80% of the noise that strikes the barrier	- Acoustic performance is based on the geometry of wall (height & length) and material density.
- Prevents unwanted reflections or potential “echo chambers” in parallel barrier scenarios	- Does not account for noise levels increased due to reflections from wall back to multiple surfaces
- Reduces the noise reflections from the community side of the wall as well	- In some cases, can increase noise levels higher than without a noise wall

A good sound wall is a sound-absorbing wall with a STC rating of 30 or more and a minimum NRC rating of 0.80 to 0.85

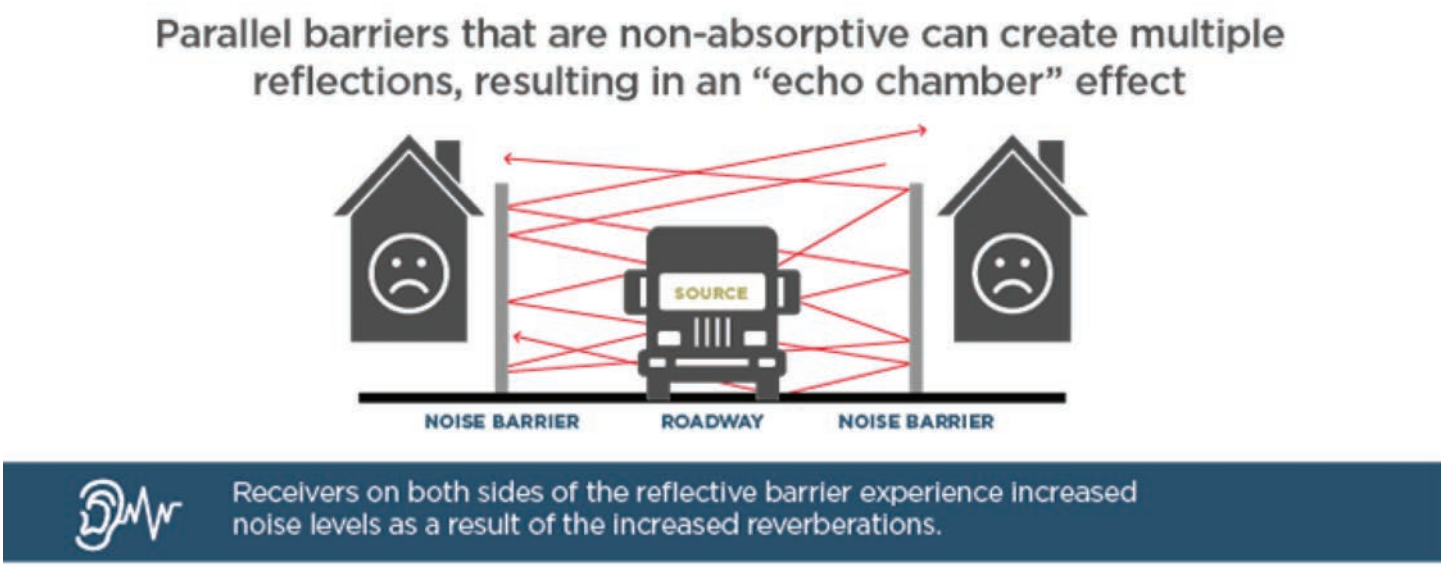
The Effects of Reflections

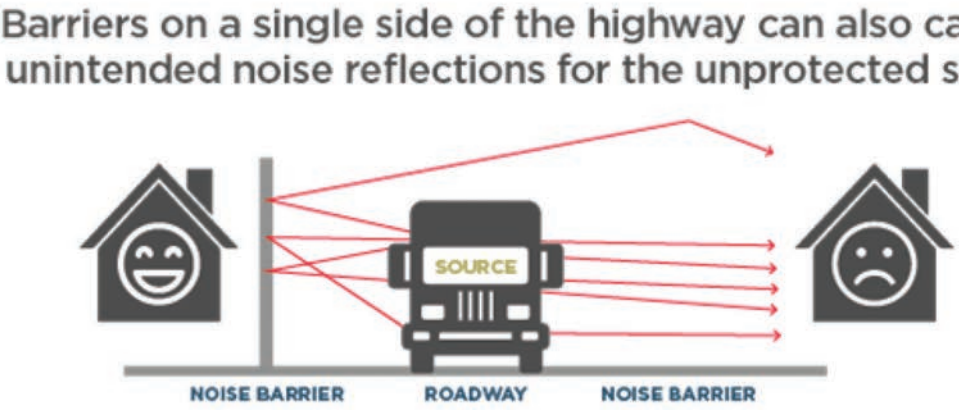
When Absorptive Walls Are Beneficial

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.

There are many surfaces that can act as a reflecting surface and intensifies the noise. This includes the vehicles themselves and parallel walls.

The Echo Chamber Effect





Both of the above scenarios are prime examples of where an absorptive noise barrier system would be much more effective as they actually reduce reflections.

Double-sided absorptive barriers provide an additional benefit by absorbing sounds generated on the receiver side of the barrier, that otherwise may be reflected into adjacent receivers properties.

Installation Procedures

Wall Installation

The final and critical step to the completion of a precast sound wall is proper wall installation. Each precast sound wall system will likely have its own unique recommendations for proper wall component installation. It is essential that the precaster make wall construction guidelines available to the wall contractor. Such guidelines will generally cover site preparation, excavation, leveling pad preparation, drainage considerations and placement of additional courses.

Examination

- Verify that site conditions are ready to receive work and that field measurements are shown on Drawings and inspected by the manufacturer.
- Prior to beginning earthwork and the project, stake the wall location in the field, and establish the final ground line elevations at the barrier walls. Use these elevations to develop the shop plans, including a complete elevation view of each wall indicating top and bottom elevations as well as the roadway grade.

Preparation

Prepare support equipment for the erection procedure, temporary bracing and induced loads during erection.

Construction Method

- Protect the final ground elevations established in the field for the duration of the project, and do not adjust without prior approval of the Engineer. Keep to a minimum the clearing, grubbing and trimming of trees as necessary to construct the walls.
- Erect members without damage to structural capacity, shape or finish. Replace or repair damaged members.
- Align and maintain uniform horizontal and vertical joints as erection progresses.
- Provide temporary lateral support to prevent bowing, twisting or warping of members.
- Set vertical units dry without grout (if required).
- Grout annular spaces between column and precast pier (if required).
- Dispose of all excesss

The NPCA Certified Plant

Precast concrete plant operators committed to excellence seek NPCA certification. A precast plant that maintains NPCA certification has made an investment of time and resources necessary to meet the high standards demanded by the construction industry. Staffed by experienced personnel, plants complying with NPCA guidelines practice quality assurance at every step of the production process. These guidelines require close monitoring of production processes, record-keeping and inspection of products to ensure compliance with rigid industry requirements. As a result, products from NPCA certified plants are characterized by high quality, uniformity and consistency.

Each NPCA certified plant is also required to maintain an active plant safety program that meets or exceeds local, state, provincial and federal laws, including Occupational Safety and Health Administration (OSHA) and Canadian Centre for Occupational Health and Safety requirements.

In addition, NPCA guidelines require certified plants to maintain extensive records to verify that materials used in the manufacturing process conform to appropriate specifications. Work orders, product drawings, equipment calibration records, aggregate and concrete test records, batching reports and product inspection reports are also required as management tools and quality assurance aids.

The NPCA Plant Certification program enables quality-conscious agencies, architects, engineers and users to identify and select high-quality precast concrete manufacturers. At no cost to specifiers, NPCA certification prequalifies manufacturers The NPCA Certified Plant as companies capable of superior workmanship. Specifiers, regulators and departments of transportation save money because there is less need to spend valuable time and resources inspecting a plant to ensure that its products will meet or exceed expectations.

Industry Standards

- AASHTO R20 “Production for Measuring Highway Noise”
- FHWA Highway Noise Barrier Design Handbook
- AASHTO “LFRD Bridge Desgin Guide 7th edition or later

How To Find A Precast Concrete Sound Wall Manufacturer

Whether you need a custom project or standard product visit precast.org and click the “Find a Producer” button on the home page of the National Precast Concrete Association. Or call (800) 366-7731 to find a precast concrete sound wall manufacturer in your area.

Engineers, architects, specifiers and contractors have found that NPCA member companies can supply valuable expertise in incorporating the latest precast concrete products into designs. When considering the many benefits of precast, the best option is to incorporate the precast manufacturer into the design team at the earliest possible phase. Precast manufacturers can often offer helpful advice that will save time and money on a project.

Find a Precast Concrete Sound Wall Producer

Whether you need a custom project or standard product, visit **precast.org** or call (800) 366-7731 to find the producers in your area. Select a zip code radius or state-specific location that will best benefit your project.

The National Precast Concrete Association is the structure behind Precast Solutions. NPCA has proven itself a leader in the development of production and quality standards for precast products in addition to publishing manuals and underwriting research. NPCA Technical Services staff also actively participates in standard establishing organizations such as ASTM and ACI.

NPCA is happy to provide the data and support that you need to incorporate the latest precast concrete products into your design. We offer a Knowledge Base where you can find information addressing specific design issues; and a Community Forum, where you can engage the entire precast concrete community regarding your particular issue. You can also contact NPCA Technical Services directly either by e-mail at technical@precast.org or call toll-free at (800) 366-7731. Staff engineers can help you with technical questions about any stage of the design or installation process.

Sound Wall Definitions

Sound or Noise Walls/Barriers – Walls specified and designed to mitigate roadway, railway, and industrial noise sources. Specifications for these walls will include one or more of the following requirements: sound attenuation line, sound transmission loss (STC), or noise reduction coefficient (NRC).

Vision Walls – Walls specified and designed to block sight. These walls are normally erected to block unwanted sights, headlight glare or to provide privacy or security. Vision walls are not designed or intended to mitigate noise sources.

Privacy Fencing, Security Walls, Industrial/Commercial Enclosures, etc. – These types of walls can be designed to mitigate noise, block sight, or both. Project specifications or special provisions will identify design requirements.

- Noise = noise is sound, typically unwanted sound.
- Decibel (dB) = Measure of sound intensity, measured on a logarithmic scale. Generally a 10 dB increase in noise (for example from a 50 dB conversational level to a 60 dB noisy home level) is perceived as a doubling in noise level.
- Sound Transmission Class = Noise reduction value assigned to a material in accordance with ASTM E90 / E413. Testing occurs over a range of frequencies and reports an averaged reduction of noise transmitted through the material. An STC rating of 25 will meet the requirements of most states.
- Noise Reduction Coefficient = Scalar representation of the amount of sound energy absorbed upon striking a particular surface. NRC = 0 is a purely reflective surface, NRC = 1 means all sound is absorbed, no reflection.
- Diffraction / Refraction = bending of sound waves around wall edges / redirection sound waves by atmospheric conditions such as clouds, humidity, air turbulence, temperature gradients.
- Insertion Loss = Difference in measured noise level with and without a barrier. Target insertion loss for noise barriers is typically 7-8 dB.