

PRECAST CONCRETE ABSORPTIVE SOUND WALLS

TECHNICAL BROCHURE



NATIONAL PRECAST CONCRETE ASSOCIATION



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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 absorptive sound walls will almost always outperform and outlast systems consisting of competing materials.

EASE OF INSTALLATION

Absorptive precast concrete sound walls have a distinct advantage over other materials such as cast-in-place concrete. Because 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

Because 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.

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:

- Waste water can be captured at the plant and recycled;
- The reinforcing steel used in absorptive 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

(2009 Scorecard)

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 + ½ pre-consumer)

(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 Dis- turbance 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.

Case Study



Power Plant Uses 50-ft-High Precast Sound Walls for Sound Absorption and Aesthetics

Orange Grove Energy L.P. and Industrial Construction Inc. built a simple-cycle, 96-MW power plant in northern San Diego County that went online in 2010. The facility includes two 50-MW combustion turbine generators, a gas metering station, water and natural gas pipelines. Transmission interconnection to San Diego Gas & Electric's grid is via underground lines.

Precast concrete absorptive sound walls play an integral role in providing a noise barrier that contains and reduces the sound generated by the plant's turbines.

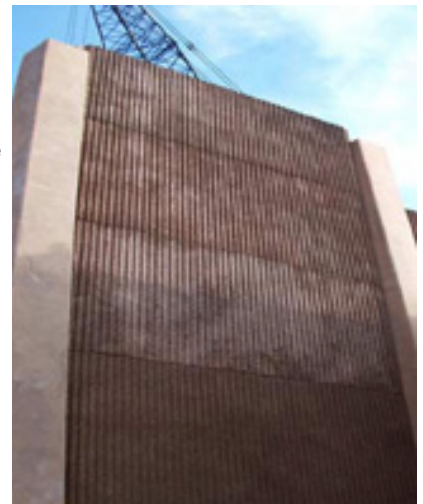
The precast concrete manufacturer created a proprietary design to comply with California's sound level requirements for the project. The precast concrete wall system is comprised of 50-ft.-high panels with sound absorption material facing the turbines to contain and absorb the plant's noise. The structural backbone of the wall is the panel support column. Each prestressed column is 50 ft. high and weighs more than 65,000 lbs. The columns are supported by 48 in.-diameter caissons 25-ft. deep for the Seismic Zone 4 site.

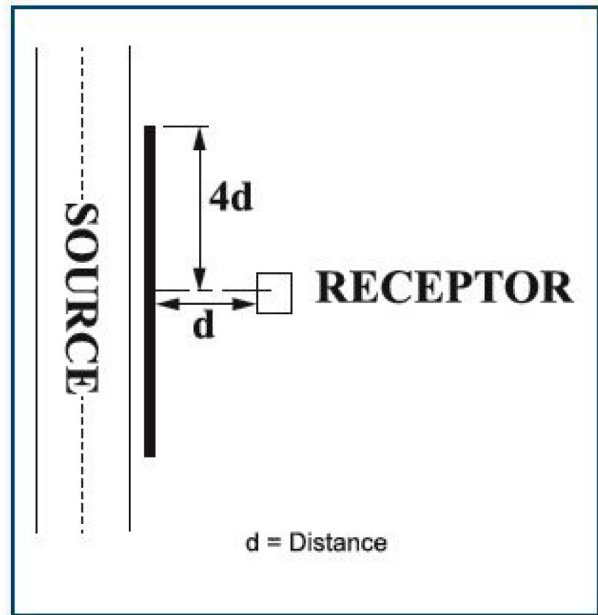
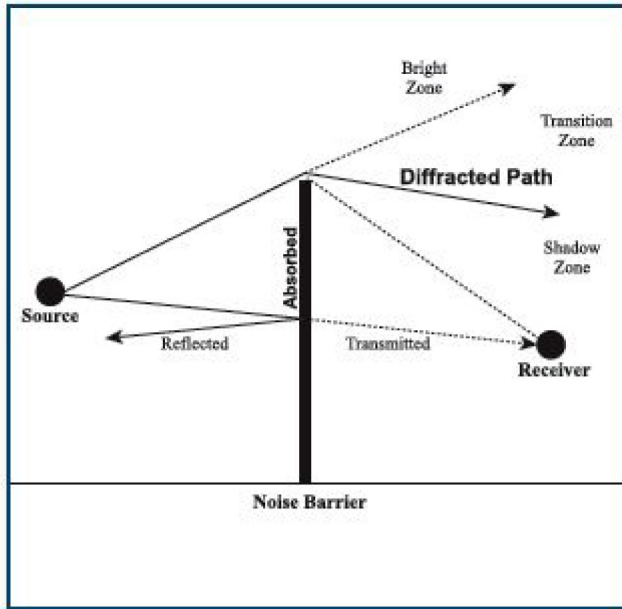
Placed in between each column is a prestressed precast concrete

wall with a smooth finish and absorptive material on the inside. In keeping with the plant's small footprint and the owner's desire to blend with the foothill environment, the manufacturer colored the panels to mimic the region's burnt-red soil.

More than 265 panels were installed around the power plant.

Because the two turbines and the power equipment are too large to install over a 50-ft. wall, the precast concrete manufacturer needed to erect the massive columns and walls in tight spaces around operating equipment. Only the versatility of precast could accomplish such challenging project specifications.





Design Details

Precast concrete sound walls are designed to drastically reduce noise emissions generated by major sources from affecting sound-sensitive receivers in one of two ways: absorbing the sound energy or reflecting the sound energy back across the source (away from the receiver) and into the atmosphere.

In order for a sound wall to be an effective barrier to noise sources, the wall must have:

- Minimum density of 37 lb/yd² (FHWA)
- Sufficient height to block the line-of-site of the noise source
- At least eight times the length of the distance from the receiver to the barrier (to effectively reduce noise coming around the ends of the wall).

Breaking the line-of-site from the noise source to the receiver can account for a 5 dB noise level reduction. After this reduction, sound barriers can achieve approximately 1.5 dB of noise reduction for each additional 3 ft. of barrier height. Because sound levels are measured logarithmically, a reduction of 9 dB is equivalent to eliminating about 80% of unwanted sound. A properly designed sound wall can effectively eliminate the majority of unwanted noise.

HOW SOUND WALLS WORK

Both types of sound walls (absorptive and reflective) force sound waves take a longer path (over and around the barriers) thereby reducing the amount of sound reaching the receiver. Known as diffraction, the phenomenon occurs when sound waves pass an edge, such as the edge or apex of a sound wall. Sound walls are more efficient at eliminating higher frequencies (shorter wavelengths) from reaching the receiver, since higher frequencies

are diffracted at a smaller degree (angle) compared with diffraction of lower frequencies (longer wavelengths).

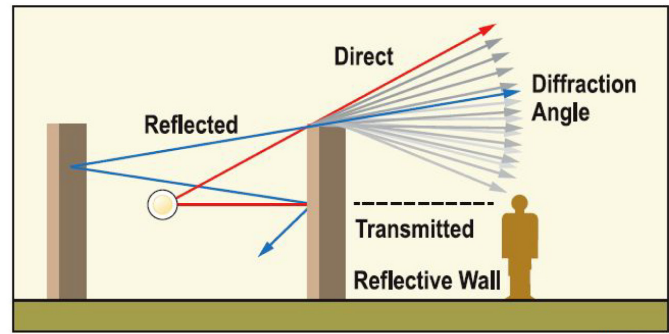
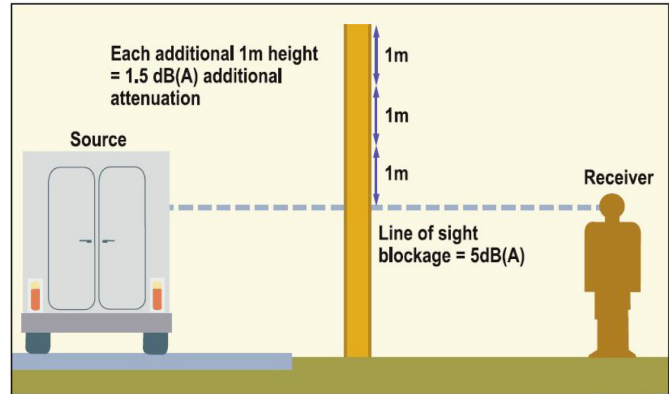
In general, a rule of thumb for sound barriers is that noise reduction falls into one of the following categories:

Noise Reduction Due to Barrier	Design Feasibility	Reduction in Sound Energy	Relative Reduction in Loudness
5 dB(A)	Simple	68%	Readily perceptible
10 dB(A)	Attainable	90%	Half as loud
15 dB(A)	Very Difficult	97%	One-third as loud
20 dB(A)	Nearly Impossible	99%	One-fourth as loud

ABSORPTIVE WALLS ACT AS SOUND SPONGES

Absorptive sound walls enable sound waves generated by the traffic or other noise source to enter the wall structure. As sound waves travel through the acoustical material or textured surface, they are forced to follow a longer path to the end source (forcing directional changes in the sound waves).

Every directional change in the sound wave will decrease the energy of the wave. After passing through a sound-absorbing wall, lower amounts of sound energy remain to re-enter the environment, resulting in less noise reaching the ears of the receiver.



Materials and finishes that are commonly used for manufacturing precast concrete absorptive sound wall panels and posts include:

- Textured/stamped concrete surface (double raked, popcorn or fuzzy finish); porous finish; or stamped brick
- Sound-absorptive aggregates (perlite or vermiculite)
- Lightweight cellular material
- Acoustic facing tile
- Composite materials
- Fibrous materials (fiberglass; mineral wool; recycled tire rubber; or recycled wood fibers or shavings)

The degree of sound absorption is affected by the size and shape of the path of voids between the aggregate particles or admixtures included in the concrete mix. Fibrous materials produce some of the best results for sound absorption because they are densely packed and randomly arranged in a manner that makes a difficult path for the pressure wave in the air to be dissipated. Precast concrete absorptive wall manufacturers typically design absorptive walls with porous surfaces so that sound waves will enter the absorptive air-like surface and not be reflected by the wall's surface. Sound traveling through a porous, absorptive material travels at about 70% of the speed that sound travels in open, non-obstructed air. In this way, porous materials increase low-end sound absorption.

HOW SOUND-ABSORBING EFFECTIVENESS IS MEASURED

Sound absorptive walls have been tested and proven to be effective sound-reduction barriers, although there may be an increased cost associated with some absorptive finishes. A

challenge for sound wall manufacturers is developing a highly sound absorptive, porous material that will be durable in harsh environments along highways in cold climates.

The Noise Reduction Coefficient (NRC) determines the amount of energy reflected back toward the noise source and the amount of energy absorbed by the wall material. NRC ratings will have a range between 0 (100% reflective) and 1 (100% absorptive). A precast concrete sound wall with a rating of 0.7 means that the wall absorbs 70% of the noise and deflects 30% of the noise back toward the source. A typical NRC for an absorptive sound wall ranges from 0.6 to 0.9.

The Sound Transmission Class (STC) is the most common sound reduction measurement in the United States. STC is a measure of how well a material attenuates airborne sound. STC determines the amount of noise energy that is ultimately transmitted through the wall material and the noise energy that reaches the receiver. Sound walls that have an STC rating of 30 or more represent walls in which less than 0.1% of the noise energy is transmitted through the barrier material. Many state DOT specifications require a minimum STC rating of 24.

Absorptive sound wall surfaces avoid the negative effects that may occur with reflective sound wall surfaces. Reflected sound waves may pose a problem, as it is difficult to precisely predict the path of the reflected sound waves. Once a sound wave is reflected from a flat surface, numerous variables can affect the direction of the diffracted sound wave. Therefore, sound absorptive walls are less likely to produce uncontrollable and unexpected results.



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

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 "Guide Specifications for Structural Design of Sound Wall (includes 1992 Interim and 2002 Interim)"

HOW TO FIND A PRECAST CONCRETE ABSORPTIVE 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 absorptive 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.