JBM Solutions, Inc.
JBM75® MATERIALS & TECHNOLOGY

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THE CASE FOR ABSORPTIVE SOUND WALLS IN THE TRANSPORTATION INDUSTRY

- The main purpose of this white paper is to undertake a state-of-the-art review of the technical aspects of the acoustical performance of sound walls for various noise sources: roads, rails, tunnels, and industrial complexes.
- This report describes different types of barriers and focuses on the advantages of precast concrete absorptive sound walls.
- This document is intended to educate the non-specialist as well as technical designers and engineers on the various aspects of absorptive and reflective sound walls, and was created utilizing relevant industry articles from the National Precast Concrete Association (NPCA).

SUMMARY

Noise is an undesirable byproduct of our modern way of life. Numerous studies indicate that the most pervasive source of noise impacting our communities and our lives today is transportation. The studies also indicate that in this era of ever-widening highways and increasing vehicular traffic, a concentrated effort is needed to control transportation noise using a system that is effective, durable and aesthetically pleasing. (1)

Major sources of unwanted and destructive noise emissions originate from:

- Transportation equipment and facilities;
- Electrical machinery;
- Construction equipment; and
- Noise emitted by means of transport. (2)

Residential dwellings, hospitals, schools, office buildings and nature areas need to be protected from consistent, elevated sound levels that can have effects on

the lives and health of both humans and animals. [2] Regular exposure to noise can have a cumulative effect and lead to hearing impairment, hypertension, cardiovascular disease, sleep impairment and decreased school performance; not to mention annoyance. [3]

In situations where sound cessation and volume control at the source are not possible or feasible, precast concrete sound walls are the most effective method of reducing or diverting noise from major sources. In fact, according to the National Precast Concrete Association, when manufactured and installed properly, precast concrete sound walls will almost always outperform and outlast systems consisting of competing materials such as brick, metal, concrete or wood. [4]

HOW SOUND WALLS WORK

Diffraction

Sound walls force sound waves to take a longer path - over and around the barriers - reducing the amount of sound that reaches the receiver. This is known as diffraction (Figure 1). [1]

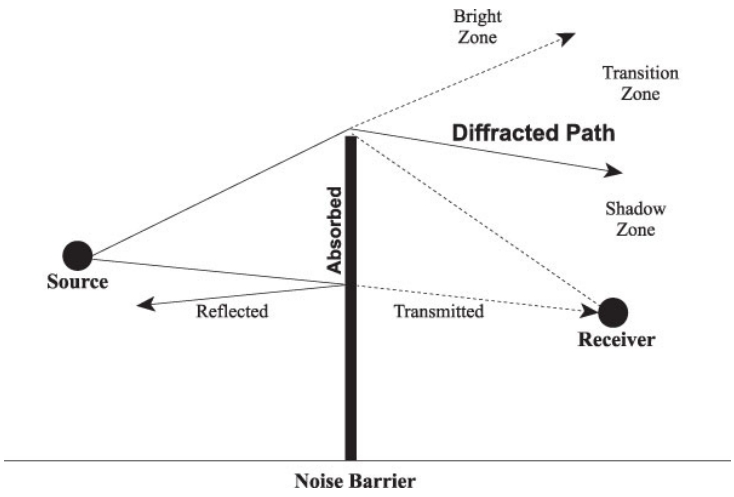


Figure 1: This diagram illustrates how diffraction affects sound.
Photo Courtesy of NPCA

Diffraction occurs when sound waves pass the edge or apex of a sound barrier. 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) as compared with diffraction of lower frequencies (longer wavelengths). (2)

In general, 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

Source: FHWA

To absorb or to reflect?

There are two types of sound walls: absorptive and reflective. The difference is that ***reflective sound walls*** push the remaining sound energy (that which was not diffracted over or around the barrier) back into the atmosphere, while ***absorptive sound walls*** take in or absorb that remaining energy; thus, further reducing the amount of sound energy that re-enters the environment. This results is less noise reaching the ears of the receiver.

Reflective sound walls rely on the natural materials found in concrete to force sound back toward the source or into the atmosphere at a significantly decreased level. (1) Conversely, absorptive precast concrete sound walls use materials and finishes that allow sound waves generated by traffic or other noise sources to enter into the wall structure.

As the 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 decreases the waves' energy. Thus, after passing through this "maze" of materials, there is a very little noise remaining to re-enter the environment and reach the receiver. (2)

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
- Fibrous materials (fiberglass; mineral wool; recycled tire rubber; or recycled wood fibers or shavings)
- Sound-absorptive aggregates (perlite or vermiculite)
- Lightweight cellular material
- Acoustic facing tile
- Composite materials

Sound absorption rates are determined by the size and the shape of the path of the voids between the aggregate particles or admixtures added to the concrete mix. Fibrous materials produce some of the best results for sound absorption, as they are densely packed and randomly arranged in such a manner that makes a difficult path for the pressure wave in the air to be dissipated. (2)

Porous materials increase sound absorption significantly. Thus, when designing a precast concrete absorptive wall, the manufacturer strives to develop an absorptive wall with a porous surface so that sound waves will enter the air-like surface and not be reflected by the wall's surface. Sound traveling through a porous, absorptive material travels significantly slower – approximately 70% slower - than sound traveling in open, non-obstructed air. (2)

When considering materials to be used in designing and constructing sound walls, it is important to weigh the costs of the various options against the benefits they produce. For example, the manufacturer must take into account the durability of the materials, as the walls need to be able to withstand harsh weather conditions when placed along highways in cold temperatures and should be designed to support easy removal of graffiti or other blemishes. (4)

HOW SOUND-ABSORBING EFFECTIVENESS IS MEASURED

A well-designed sound wall can prevent the vast majority of unwanted noise from reaching the sound-sensitive receiver. In general, sound walls need to meet the following conditions:

- 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)

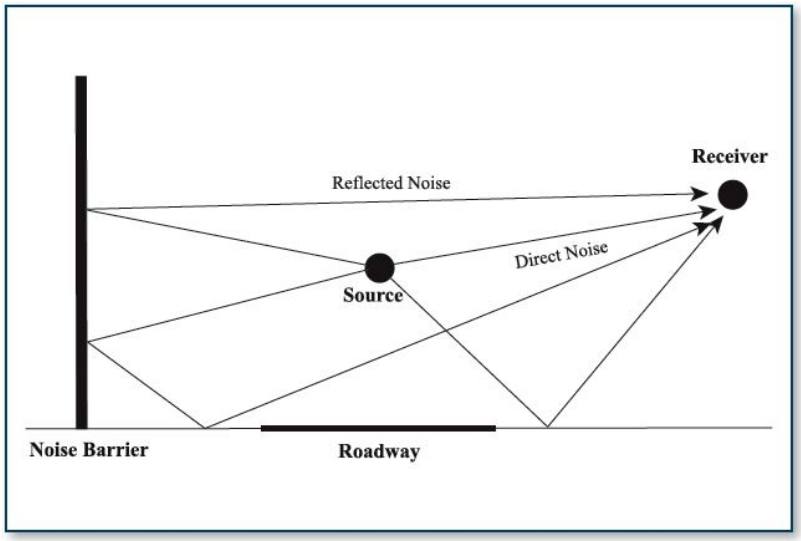
Breaking the line-of-site from the noise source to the receiver can reduce noise by 5 dB. A further reduction of 1.5 dB is attainable for each additional 3 feet of barrier height. A reduction of 9 dB is equivalent to eliminating about 80% of unwanted sound. (4)

There are two key factors that determine the effectiveness or efficiency of absorptive barriers: the ***Noise Reduction Coefficient*** and the ***Sound Transmission Class***. Further, the predictability of resulting sound reduction may vary for different types of sound walls.

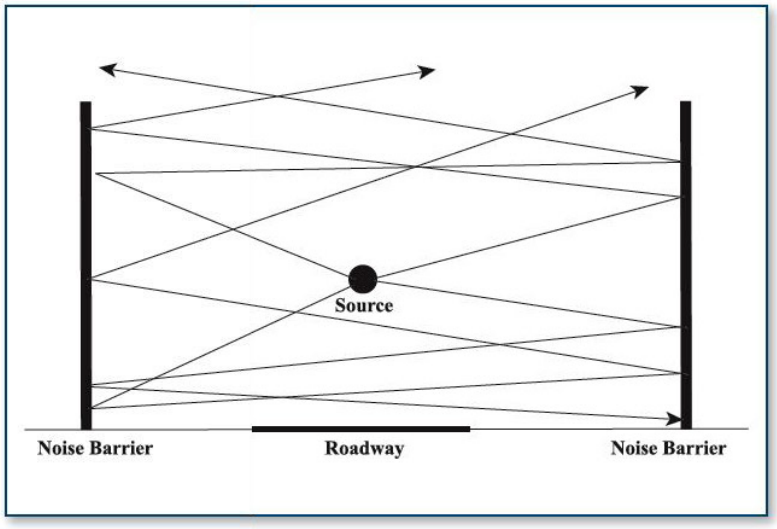
The ***Noise Reduction Coefficient (NRC)*** measures the amount of energy reflected off of the barrier versus the amount of energy absorbed by it. NRC ratings range between 0 and 1, with 0 being 100% reflective and 1 being 100% absorptive. For example, a precast concrete sound wall that has a rating of 0.6 absorbs 60% of the noise and reflects the remaining 40% back to the source. A typical NRC for an absorptive sound wall ranges from 0.6 to 0.9. (4)

The *Sound Transmission Class (STC)* indicates the amount of noise energy that passes through the barrier and reaches the receiver. Many state Departments of Transportation require a minimum STC rating of 24. Ideally, sound walls will surpass that minimum requirement and achieve a rating near 30. That higher rating indicates that less than 0.1% of the noise energy is transmitted through the barrier material. (4)

When further comparing absorptive sound walls to their reflective counterparts, absorptive barriers are more predictable and, thus produce more controllable and expected results than do reflective sound walls. The path of reflected sound waves is difficult to predict with precision, as numerous variables can affect the direction of the diffracted sound wave. (4)



Reflective Diagram #1 *Photo Credit: National Precast Concrete Association*



Reflective Diagram #2 *Photo Credit: National Precast Concrete Association*

WHY PRECAST CONCRETE WALLS?

High Quality Sound Walls Last Longer

Precast concrete walls, as opposed to cast-in-place concrete walls, have the advantage of being readily available and easy to install. In addition, pre-casting the walls in a controlled plant environment ensures quality and uniformity by eliminating many factors which can negatively affect the quality of the walls, such as temperature, curing, site conditions, craftsmanship, material quality, etc. Such quality control typically leads to the precast walls having a significantly longer service life than that of conventional site-cast concrete. (4)

Environmental Attributes

Precast concrete is made primarily from natural materials. In addition to being nontoxic and environmentally safe, the use of precast concrete, specifically that which incorporates recycled cementitious materials and supplementary cementitious materials (such as fly ash and blast furnace slag), reduces waste and leaves a smaller carbon footprint than other materials. (4)

Environmental benefits of manufacturing precast concrete, which can last up to 100 years, in a controlled plant setting include:

- 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.

NPCA Plant Certification & Design Benefits

By employing NPCA-certified manufacturers, regulators and Departments of Transportation (DOTs) can save both time and money. With stringent guidelines and close monitoring of the production process, NPCA certification ensures quality workmanship and requires quality verification logs and materials to be readily available. Such quality assurance spares regulators and DOTs from time-consuming and costly plant inspections. (4)

In addition, engineers, architects and contractors can benefit from including NPCA-certified manufacturers in their design process. These manufacturers have valuable knowledge as to how precast concrete products can be incorporated into designs, and how these products can save both time and money on many projects.

CONCLUSION

In situations where sound cessation and volume control at the source are not possible or feasible, precast concrete sound walls are the most effective method of reducing or diverting the pervasive, often destructive noise caused by transportation sources. These sound barriers have been proven to have numerous distinct advantages over their reflective counterparts, including superior sound reduction, predictability, enhanced durability and better quality control as well as environmental benefits.

Engineers, architects, specifiers and contractors can save both time and money without sacrificing quality by utilizing precast concrete absorptive sound walls manufactured by certified manufacturers.

ABOUT JBM SOLUTIONS

- Jerry J. McNeal, President of JBM Solutions and founder of JBM75®, has produced over 30,000,000 sq. ft. of absorptive sound wall around the world.
- JBM Solutions has the ability and experience to assist you in equipment planning, material sourcing, production set up, quality control and site management.
- JBM Solutions provides their JBM75 Absorptive Sound Walls to State DOT's, pre-casters, municipalities, developers and power and utility companies, as well architects and designers.
- Jerry McNeal, President of JBM Solutions, Inc., has been designing precast plants, equipment and related tooling for over twenty years.
- Jerry has used a combination of strict manufacturing procedures, quality control parameters and a constant eye to ensure the highest quality, most durable and longest lasting walls.
- Jerry and the JBM Solutions team specialize in implementing low-cost, efficient production techniques and procedures, while maintaining the highest standards of quality and safety.

JBM Solutions, Inc.
JBM75® Materials & Technology

ABOUT JBM75® ABSORPTIVE SOUND WALLS

JBM75® is a next generation wood aggregate concrete that is sound absorptive material for use in:

- Highway
- Railway
- Light Transit
- Industrial
- Tunnel Lining
- Residential
- Existing Reflective Wall Retro-Fit Applications

- JBM75 is more durable, more green and ONLY manufactured at NPCA-certified plant facilities.
- JBM75 is the only sound absorptive system that uses recycled materials for the aggregate.
- JBM75 is more appealing than plain concrete and absorbs up to 85% of the sound waves that hit the wall.
- JBM75 is a trademarked material using Green Sustainable Technology.
- JBM75 is an advancement in the evolution of wood fiber concrete. With improved mix formulations and superior raw materials, it is a stronger and more durable product.
- JBM75 is generally less expensive than other absorptive sound wall options; requiring less overhead and uses less expensive raw materials.
- JBM75 meets or exceeds the following ASTM standards: E90-2, E84-04, C672/C672M-02, C666, C423-02a. In addition, JBM75 is resistant to vermin & insect damage.

- JBM75 is available in double-sided absorptive architectural finishes such as ashlar stone, brick, block, etc. Custom options are also available.
- Every unit of JBM75 is closely monitored, inspected and documented by a well-trained and conscientious Quality Control staff.
- JBM75 Precast Concrete Walls provide a service life in excess of 100 years by using the highest quality materials & workmanship.
- JBM75 can be stained in a variety of colors.

RESOURCEFUL, CREATIVE, SUPERIOR

- JBM75 Absorptive Sound Walls are the best and most reliable.
- JBM Solutions' experienced team is comprised of industry experts with over 30 years of experience.
- JBM Solutions is a valued, respected and trusted partner, and will work with you to meet your goals, timeline, & budget.
- JBM Solutions designs precast plants, equipment and related tooling, and has helped build new plants as well as modify and improve existing facilities.
- JBM Solutions partners with Precast Concrete Manufacturing licensees to provide training, techniques, procedures, tooling, equipment requirements, material sourcing, pricing and quality control oversight.
- You can breathe a sigh of relief knowing that you have an experienced and knowledgeable expert alongside you who is available 24x7 and is working on your behalf to ensure a seamless project from start to finish.

Call us today @ 703-861-9004 to get a free assessment for your Absorptive Sound Wall project.

SOURCES:

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(3) Passchier-Vermeer W, Passchier WF (2000). "Noise exposure and public health." Environ Health Perspect. 2000 Mar 108 (Suppl 1:123-31)

(4) Precast Concrete Absorptive Sound Walls Technical Brochure, National Precast Concrete Association, Available at: http://precast.org/wp-content/uploads/2014/08/Absorptive-precast-concrete-soundwall-brochure-edited.pdf