The Wall Journal™

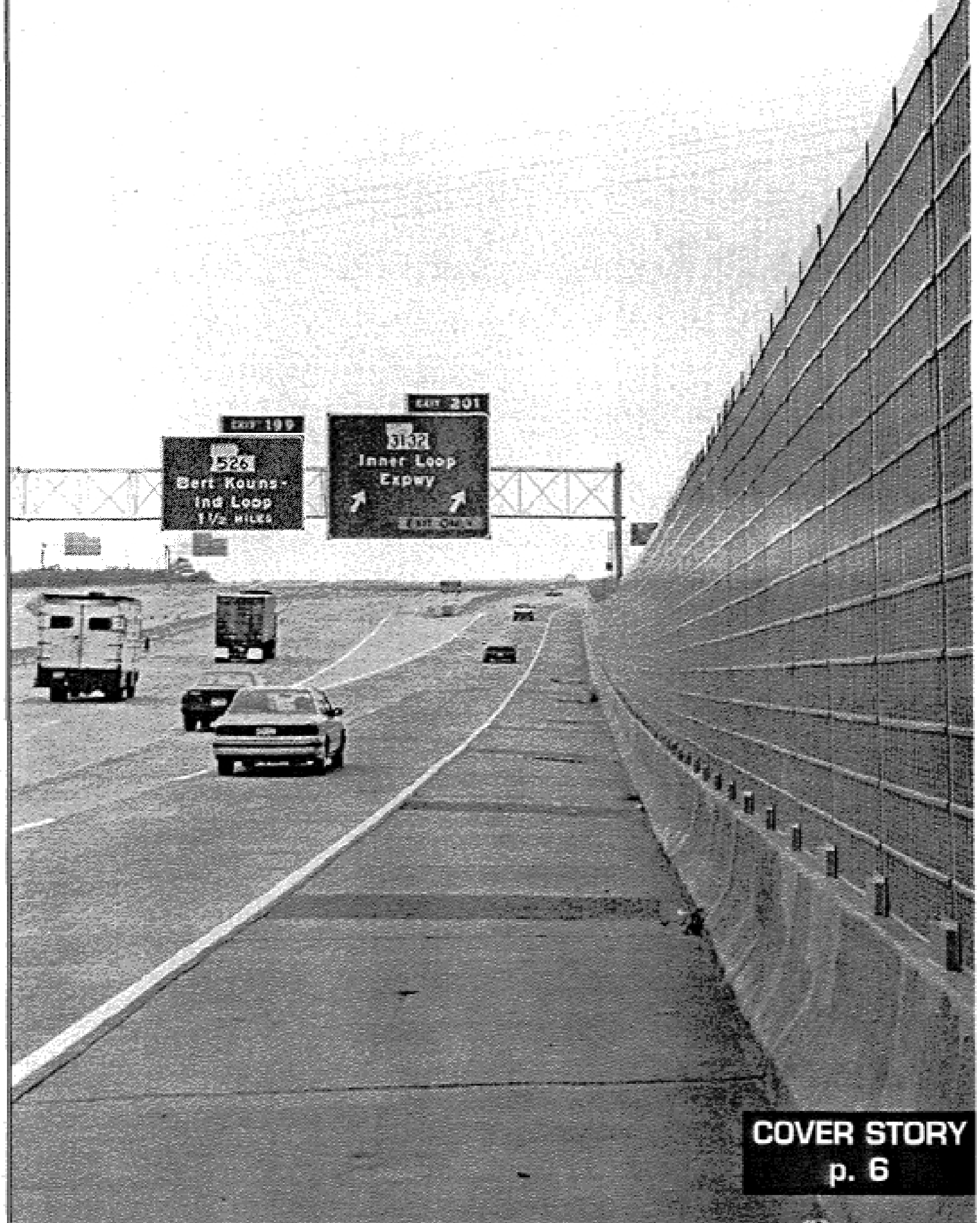
THE INTERNATIONAL JOURNAL OF TRANSPORTATION-RELATED ENVIRONMENTAL ISSUES

Issue No. 26

Nov/Dec 1996

In This Issue:

Sound Fighter® Noise Barrier installed along New Interstate 49 in Louisiana



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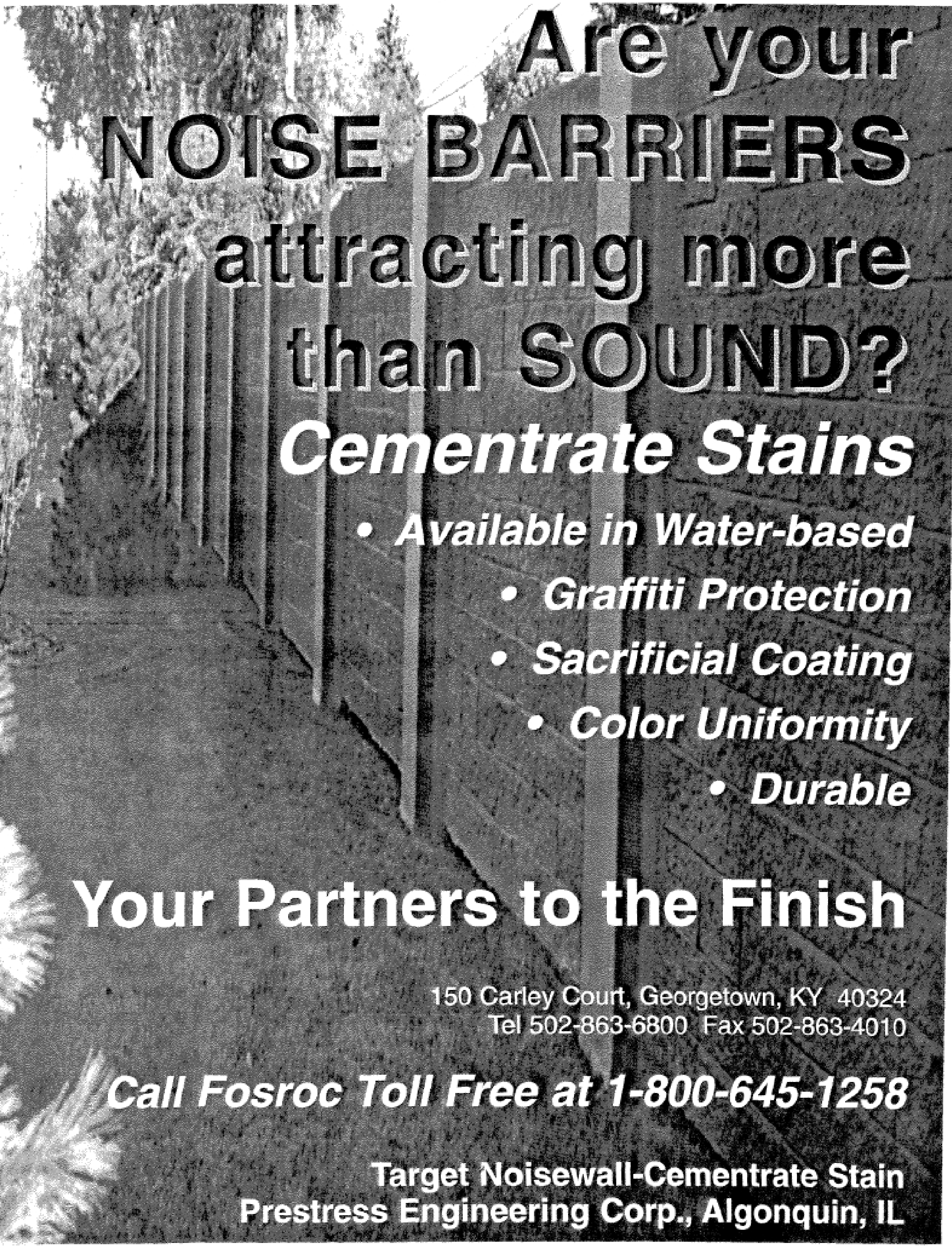
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The Wall Journal

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EDITOR'S CORNER

by El Angove

Holy mackerel, Andy! Look at all those Noise Barriers!

Most of you probably never listened to Amos and Andy on the radio, so you really can't fully appreciate the awe and wonder in the above headline. You would have to have heard Amos or the Kingfish holler it out.

I don't know what a holy mackerel is (and I don't want to know), but I do know that whenever I heard that "Holy mackerel, Andy" on the radio, I knew that something *really big* was happening, and my brother and I would fall down on the living room floor and howl with laughter (we were only kids, then).

If Amos and Andy and Kingfish and Sapphire were here today, and they took a long ride down our interstate highways, you would hear a whole bunch of "Holy mackerel! Look at all those noise barriers!" I still do it myself.

When you get to page 13 in this issue, and add in an estimate for 1996, you will learn that in the United States, we have constructed more than **100,000,000** square feet of highway noise barriers, at a cost exceeding **$1,500,000,000**. That's a whole lot of mackerels. We're getting into Carl Sagan territory with those numbers.

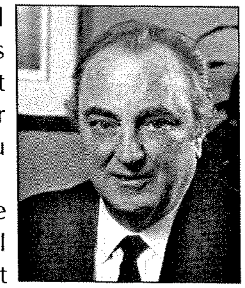
Two-thirds of those noise barriers were constructed in the last one-third (8) of all the years. If we keep building at the present pace, we should crack the **TWO BILLION DOLLAR TOTAL** by the year 2000.

Think about it.

Letters, We Get Letters

We get a lot of nice letters from our readers, saying nice things about our publication. They are certainly well-received and appreciated, and we thank you very much.

But, I am not sure we are giving you everything we could. I would like to see the occasional letter which starts "I think you ought to print more ..." or "Why don't you include some..."



It would help me a great deal if I knew more about your principal interest in this publication. Is it professional papers? Is it case histories of completed barrier projects? Is it technical acoustics? Or materials? Or construction? Or what?

My original plan for The Journal was to create a forum for the exchange of ideas and information among the public and private sectors. So far, I have not had too much success in obtaining a consistent stream of input from the readers, which I severely need to be able to preplan and schedule issues.

With all the noise barriers that have been constructed, there must be a treasure chest of project reports, photos and other information to share with other readers. It's all out there somewhere — I just can't seem to get it coming in the door.

As I have said before, this is your Journal. All I get to write is this little old column. Please write.

Registrations

In the last issue, my hit man Gus asked that those readers who receive free subscriptions (government and academe) who have not knowingly registered, to please do so. The response has been very good, and I have ordered ten stems of bananas for Gus, and I thank you all for registering.

I need to keep my mailing database current, and can only do so with your help. If you haven't done so, a brief note would be appreciated, and your issues will keep coming.

Have a Merry Christmas.

In the Next Issue:

- Further breakdowns and massaging of the data from "Noise Barrier Construction Trends" in this issue
- A look at a leading consulting firm's work in process in the three transportation-related noise problem areas
- Engineering a solution to parallel barrier performance

TRB A1F04 Committee on Transportation Related Noise and Vibration

The Transportation Research Board's 76th Annual Meeting will be held January 12-16 in Washington, DC. The A1F04 Committee holds its annual meeting during the TRB Annual Meeting.

The partial agenda of the A1F04 meeting is presented in the table at right. The designated Sessions refer to those printed below, which are taken from the master agenda of the TRB Annual Meeting.

As is our custom, we shall publish (in summary form) the professional papers from the Sessions below in the March/April issue of The Wall Journal.

The information presented here was provided by Gregg Fleming, Chair of the A1F04 Committee, and Jon Williams, Senior Programs Officer of the Transportation Research Board. ■

	MONDAY	TUESDAY	WEDNESDAY
MORNING SESSIONS	9:00 to 12:00 am HIGHWAY NOISE SUBCOMMITTEE	9:00 to 12:00 am A1F04 COMMITTEE	8:00 to 9:45 am SESSION 306 10:15 to 12:00 am SESSION 332
AFTERNOON SESSIONS	2:00 TO 5:00 pm AIRCRAFT NOISE SUBCOMMITTEE		
EVENING SESSIONS	7:30 TO 9:30 pm SESSION 130 7:30 TO 10:30 pm GUIDED TRANSIT NOISE SUBCOMMITTEE		7:30 TO 9:30 pm SESSION 379

130 Monday, 7:30-9:30 p.m., HILTON
NASA Advanced Subsonic Noise Reduction Program
William Wilshire, NASA, presiding
Project Overview:
William Wilshire, NASA
Aircraft Community Noise Impact Model
Eric Stusnick and Xin Shuang, Wyle Laboratories Inc.
Validation of Aircraft Noise Models at Lower Levels of Exposure
Juliet A. Page and Kenneth J. Plotkin, Wyle Laboratories, Inc.
Computation of Measured and INM-Predicted Aircraft Sound Levels
Nicholas P. Miller, Harris Miller Miller & Hanson Inc
Assessment of the Effects of Growth in Commuter Operations on Communities Neighboring Airports
Sanford Fidell, Bolt Beranek and Newman Inc.

306 Wednesday, 8:00-9:45 a.m., HILTON
Transportation Noise Issues, Part 1 (Part 2, Session 332)
Christopher W. Menge, Harris, Miller, Miller and Hanson, presiding
Standards for Noise Barriers Using Recycled Plastic, 970579
Osman Hag-Elsafi, David Elwell, Gary Glath, and Melanie Hiris, New York State Department of Transportation
Laboratory Experimentation of Sound Absorbing Concrete Block Filled with Shredded Tire Rubber, 971099
Heesuk Lee, Jinkyung Kim, Ben Moloney, Hosin Lee, and William VanMoorhem, University of Utah
Good Fences Make Good Neighbors: Highway Noise Barriers and the Built Environment, 971144
Domenick J. Billera, New Jersey Department of Transportation; Richard Parsons and Sharon Hetrick, Gannett Fleming Engineers
Perception of Traffic Noise Barrier Effectiveness: A Public Opinion Survey of Residents Living Near I-71, 970230
Lloyd A. Herman, Michael Finney, and Craig Clum, Ohio University; Elvin Pinckney, Ohio Department of Transportation

332 Wednesday, 10:15-12:00 noon, HILTON
Transportation Noise Issues, Part 2 (Part 1, Session 306)
Kenneth D. Polcak, Maryland State Highway Administration, presiding
A Simulation Approach to Traffic Noise Modeling (AAMA Community Noise Model Version 3.0), 970858
Roger L. Wayson, University of Central Florida; John M. MacDonald, University of Central Florida; Ronald Eaglin, University of Central Florida
Research and Development by an Australian Road Authority Using Object Oriented and GIS Technologies: The Example of Urban Road Traffic Noise, 970493
John Black, Stephen Samuels, Upali Vandebona, Ewen Masters, and John Trinder, University of New South Wales, Australia; Brian Morrison and Rod Tudge, Roads and Traffic Authority, New South Wales, Australia
Implementation of Proponent Mitigated Development Strategies for Traffic Noise and Land Use Compatability Planning, 971058
Lloyd A. Herman, Ohio University; William Bowlby, Vanderbilt University
Stop the Whine! Narrow Band Noise Level Measurements of Three Highway Pavements, 971296
Domenick J. Billera, New Jersey Department of Transportation; Bela Schmidt and Wayne Miller, Louis Berger and Associates

379 Wednesday, 7:30-9:30 p.m., HILTON
The Federal Highway Administration's Traffic Noise Model (FHWA TNM)
Robert E. Armstrong, Federal Highway Administration, presiding
TNM Demonstration
Grant S. Anderson, Harris, Miller, Miller & Hanson, Inc.
TNM Phase-in, Training and Other Policy Issues
Robert E. Armstrong, Federal Highway Administration
TNM User Support, Future Development, and Validation
Cynthia S.Y. Lee, U.S. Department of Transportation Volpe Center

HITEC panel evaluates new Sight and Sound Screen system from U.S. Gypsum Company

Members of the Highway Innovative Technology Evaluation Center (HITEC) have completed their second phase of an ongoing evaluation of the Sight and Sound Screen System, an innovative new highway wall system being developed by United States Gypsum Company.

Convening at the USG Research Center, in Libertyville, Illinois in early October, the HITEC committee reviewed the status of several field demonstration projects, inspected a specially erected Sight and Sound Screen System demonstration wall, and drafted an evaluation of laboratory test results for the system.

"I think we have made some good progress," said Kenneth D. Polcak, Environmental Specialist of the Maryland State Highway Administration, who presided at the meeting. "We're going to come out with a good set of guidelines for evaluating highway noise barrier systems, which will help state and local governments to quickly and fully evaluate and possibly utilize these systems and technologies."

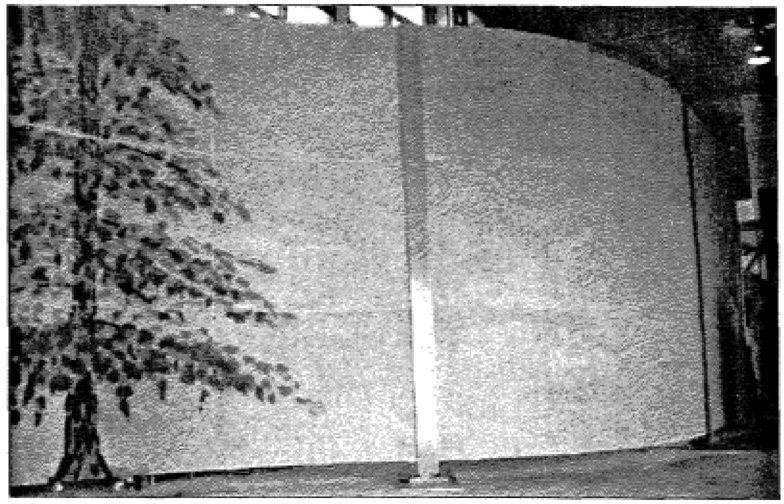
The HITEC panel is nearing the completion of a two-year program of laboratory and field testing of the U.S. Gypsum Sight and Sound Screen System, which is being conducted in collaboration with several volunteer state agencies. Dr. Louis F. Cohn of the University of Louisville Department of Civil Engineering is the consultant to the project. He will draft a final report, which will be reviewed and approved by the HITEC committee. The report will then be sent out to the transportation community.

U.S. Gypsum's Sight and Sound Screen System is a lightweight, factory-produced post and-panel highway wall system, consisting of a polystyrene core sandwiched by two DUROCK Exterior Cement Board panels and reinforced by steel strips. The cement board panels can be finished with a variety of textures and colors.

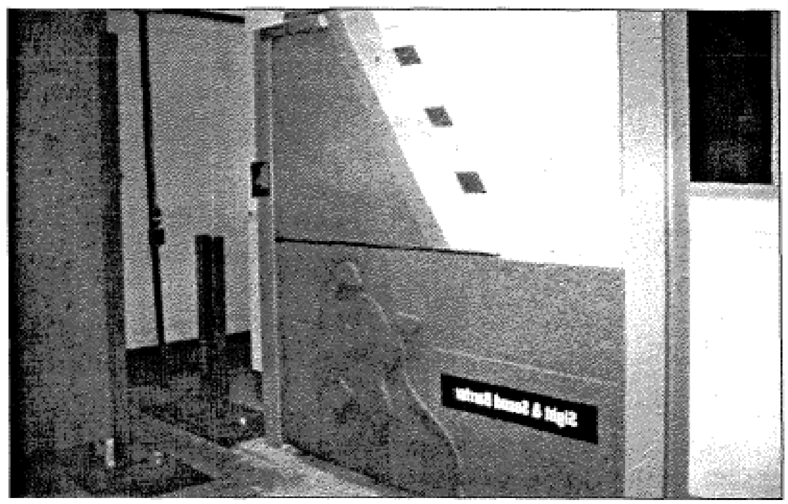
HITEC, a service center of the Civil Engineering Research Foundation, reviews highway products and generates evaluation standards for governmental agencies. Its goal is to encourage private industry to invest in highway-oriented research and development.

The first installation of the Sight and Sound Screen is scheduled for November. A 250' long by 17'-high wall will be installed for the New York Department of Transportation on a bridge near Corning, N.Y. A report on the HITEC evaluation of the installation will be forthcoming.

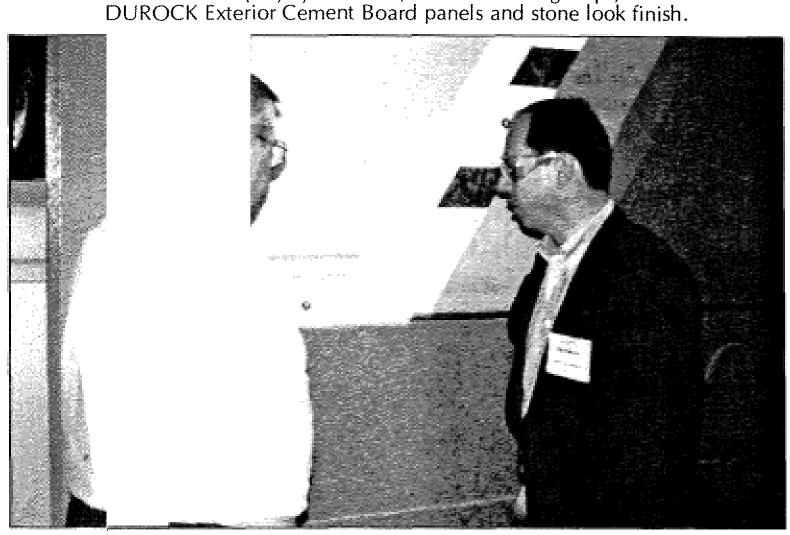
For more information on U.S. Gypsum Company's Sight and Sound Screen System, contact United States Gypsum Company, P.O. Box 806278, Chicago, IL 60680-4124. ■



This curved Sight and Sound Screen demonstration wall, constructed at the USG Research Center in Libertyville, Illinois was recently inspected by a HITEC evaluation committee.



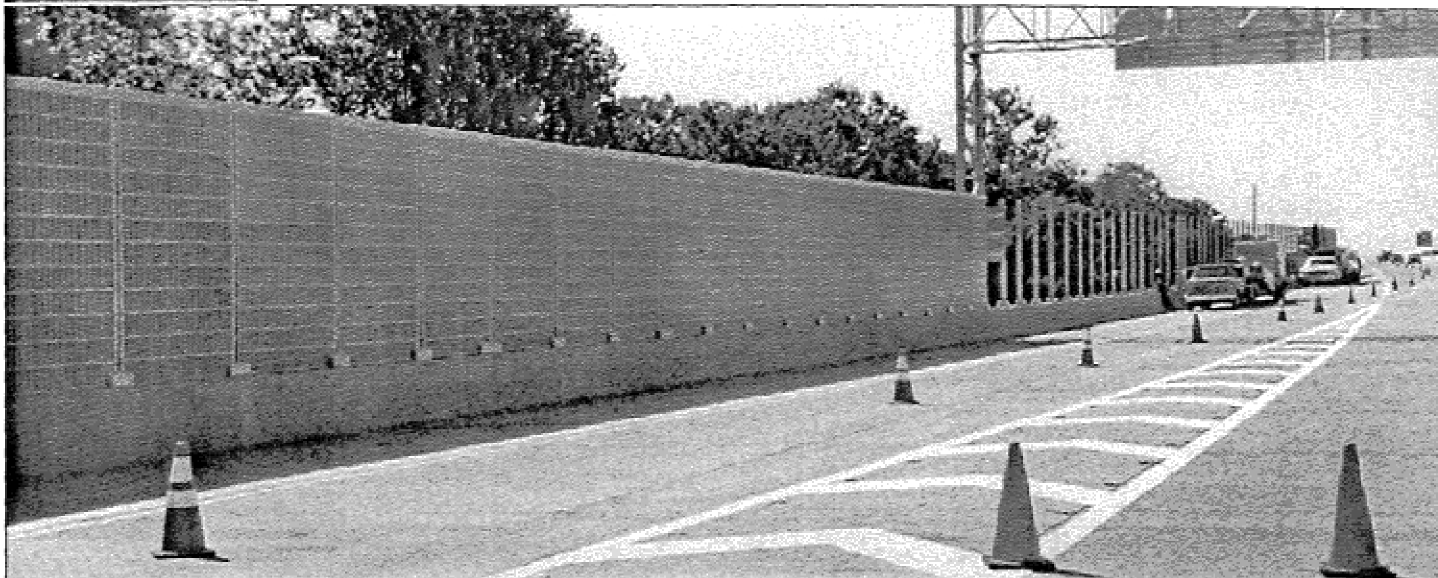
Cut-away view of U.S. Gypsum's Sight and Sound Screen wall reveals polystyrene core, steel reinforcing strips, DUROCK Exterior Cement Board panels and stone look finish.



Members of the HITEC evaluation committee, Soren Pedersen of the Ontario Ministry of Transportation and Dr. Lloyd Herman of Ohio University, inspect Sight and Sound demonstration wall at the USG Research Center.

COVER STORY

Traffic noise along new Interstate 49 reduced by Sound Fighter Noise Barrier



No traffic stoppage was necessary as noise barriers were installed on Louisiana's new Interstate 49 at its northern terminus at Shreveport.

Traffic noise created by the opening of Louisiana's new Interstate 49 has been greatly reduced by installation of the Sound Fighter® Systems LSE Noise Barrier Wall.

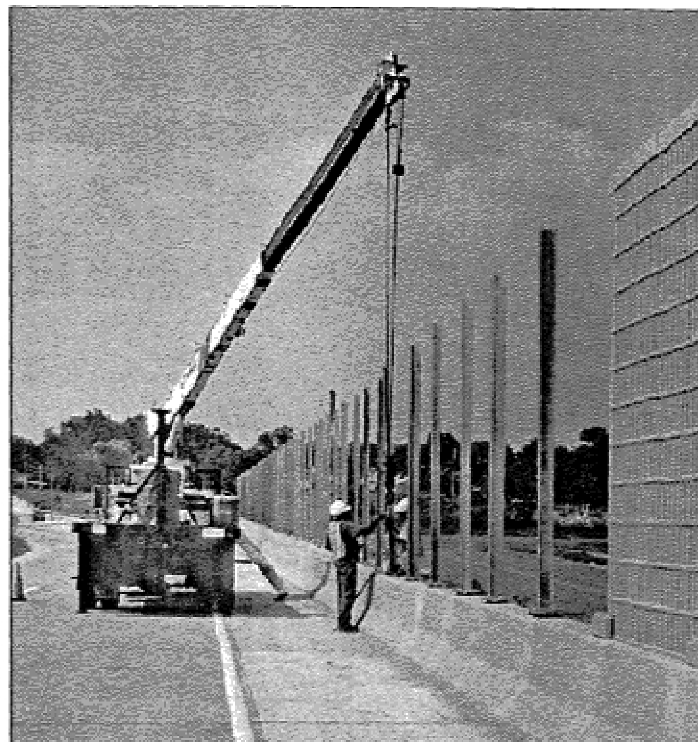
The new highway stretches some 210 miles from the Louisiana coast northward to Shreveport, where it intersects with Interstate 20. Approximately five miles of the highway passes through residential areas where the traffic noise was of great concern to property owners.

Sound Fighter Systems, located in Shreveport, has worked with the Louisiana DOTD for many years in helping to develop effective noise wall systems. In fact, some 18 years ago Sound Fighter erected a noise barrier at a busy intersection on Shreveport's Inner Loop and Linwood Avenue. That wall is still in place today, still providing the adjacent neighborhood with protection from the unwanted traffic noises.

27,500 feet on I-49

Today, not far from this initial installation, the LSE System is being installed on Interstate 49. The DOTD selected a medium gray color for 27,500 feet of barrier. The barrier varies from eight feet to 20 feet in height, and runs intermittently from the Inner Loop northward to the junction of 1-49 with 1-20.

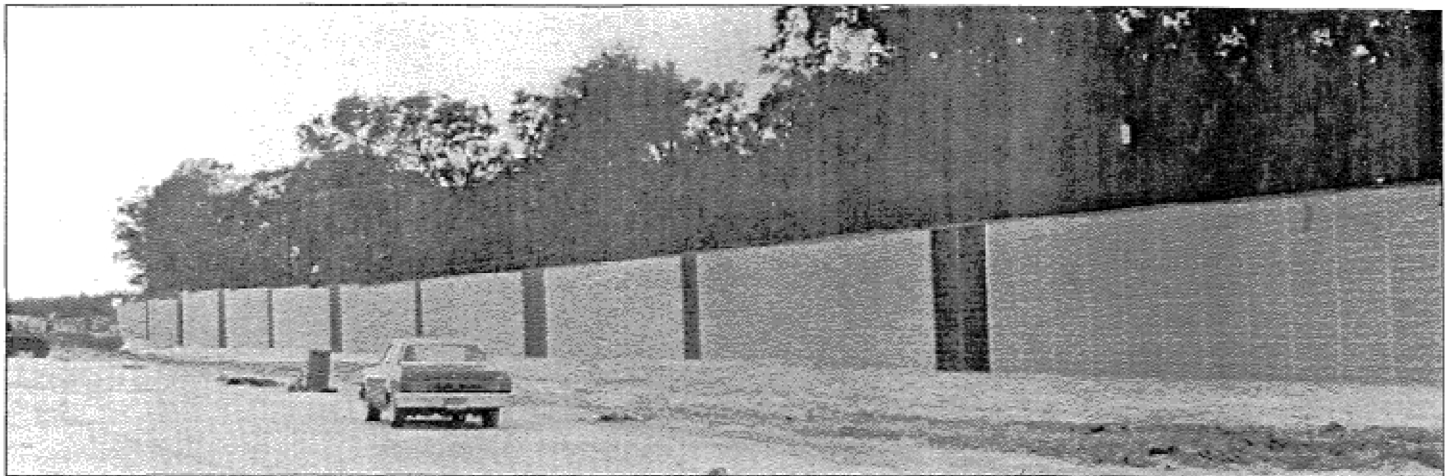
The wall installation and support structure design was an engineering challenge due to the many different types of in-place highway structures on which to attach the steel columns necessary to support the wall. D & F, Inc., of Shreveport, and Huval & Associates of Lafayette, La., worked with Sound Fighter Systems on engineering. CFC, Inc., of Lafayette, is installing the LSE barrier. Apex, Inc., of Paris, Ky., is the general contractor.



Steel columns being put in place hold noise barrier components

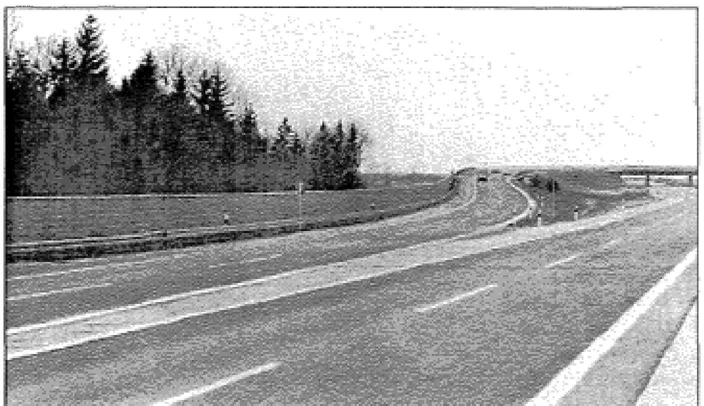
(continued on page 8)

Barrier Still Effective After 18 Years

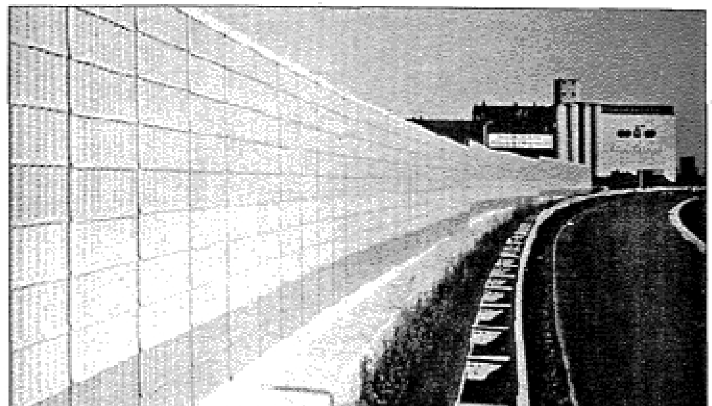


Sound Fighter noise barrier at urban Shreveport intersection is still effective 18 years after installation.

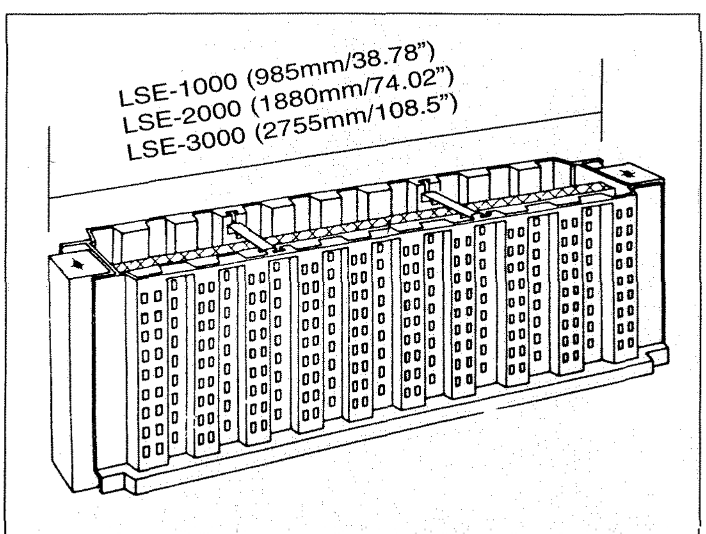
Sound Fighter Walls Used Internationally



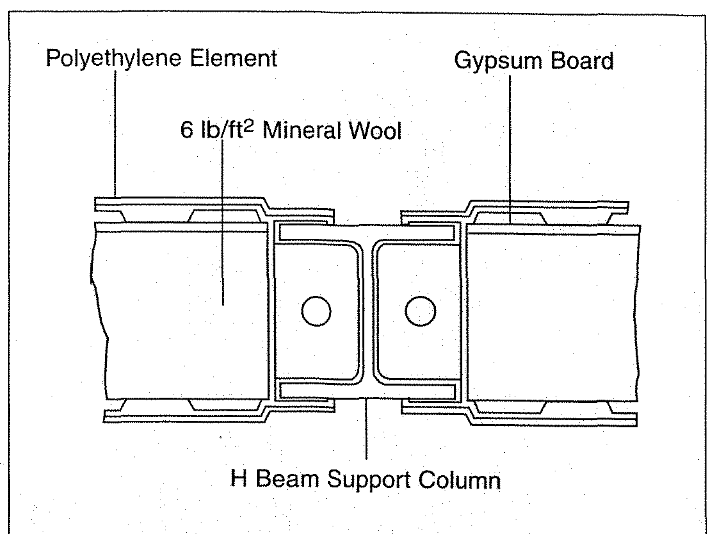
Impact of Autobahn traffic noise on nearby community is lessened by noise barrier.



Industrial area in Germany is shielded from noise of highway traffic by Sound Fighter noise barrier.



Cutaway view of Sound Fighter Panel showing standard panel widths.

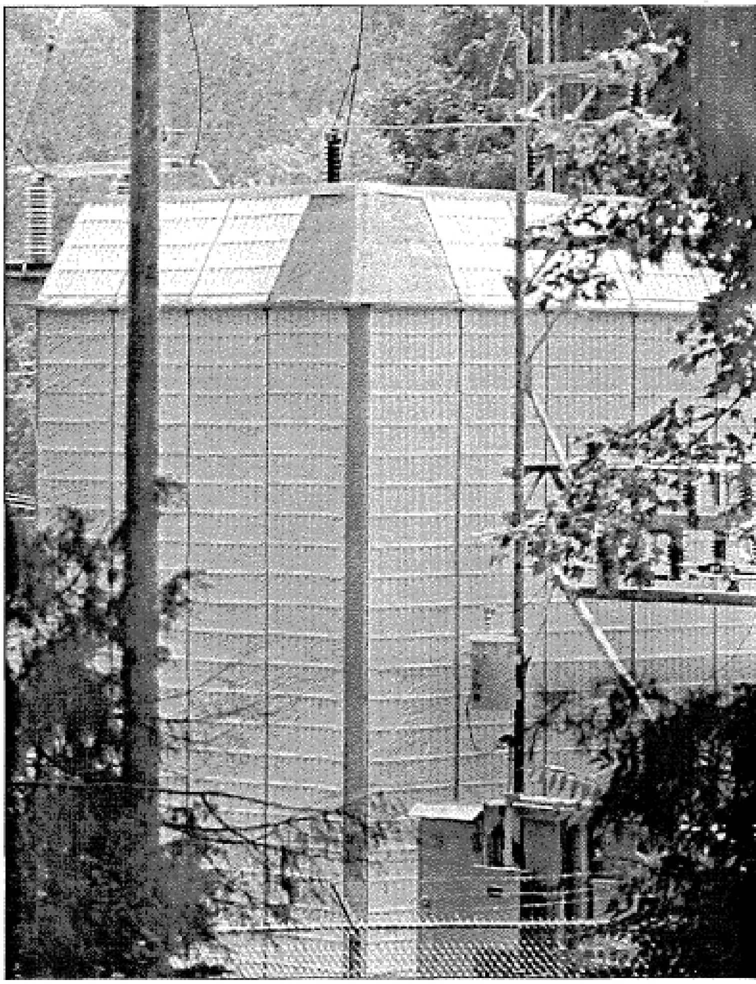


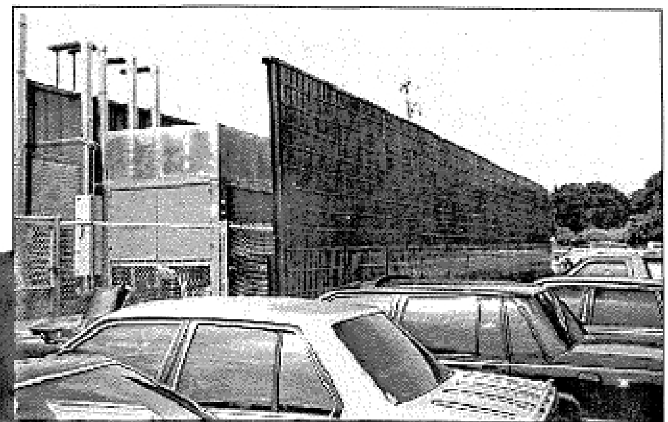
Section detail at H Beam Support Column showing engagement of Panels to column.

(continued on page 8)

(**Sound Fighter**, continued from page 7)

Noise Control Wall Reduces Cost for Condenser and Cooling Towers





Barrier wall reduces noise impact from transformer station in left photo.

Above — Air cooled condenser and cooling tower manufacturers find that noise barrier walls allow customers a lower cost product (higher speed fans - more tower capacity) for reduced footprint while meeting low noise requirements.

(contlnued from page 6)

Unique in Market

The Sound Fighter LSE Wall System is unique in today's market because it is constructed using an injected molded high-density polyethylene element or module, which is perforated on one or both sides. The cavity in the module is then filled with 6 lb. per cu.ft. density absorptive media backed with a half inch thick piece of sheathing for reflection. The modules stack vertically between wide flange beams with a stack height of 9.8 in. They interlock top to bottom for added rigidity. The standard LSE modules are available in one, two, and three meters long with special lengths available if necessary.

Lightweight Modules

The Sound Fighter LSE modules can be produced in any color, and do not rust, rot or stain. They also are lightweight - 4.9 lb. per sq. ft. - and non-conducting. Graffiti may easily be removed. With wind load test equivalent to 200 mph, STC of 33 and an NRC of 1.05, the LSE System offers the lowest cost per DB of noise reduction - a fact supported by the long history of the product. The Sound Fighter Wall has been in use for over 25 years in both the U.S. and overseas with great success. The system is versatile: It can be used for barriers around cooling towers, chillers, compressors, transformers or any equipment or machinery that produces problem noises. ■

(For further information, telephone Guy Le Gendre at 318 861-6640 (see ad on page 22).

Federal regulations and other activities in noise control

By Robert L. Miller

INTRODUCTION

In the present-day climate of reduced budgets and increased vigilance over Federal spending, it would hardly be surprising to hear the question "So what has the Federal government actually done to control noise?" Perhaps more unexpectedly, the answer is "Actually, quite a lot." Despite the action of former President Reagan to limit government's role in controlling noise by eliminating funding for the U.S. Environmental Protection Agency's Office of Noise Abatement and Control (ONAC), it is, in fact, a rather daunting task to contemplate the breadth of the Federal government's activities in noise control over the past 25 years. Even restricting this paper to an overview only of transportation noise does little to reduce the scope of Federal initiatives which have led to significant advances in the quantification, assessment, and mitigation of our daily noise exposure.

This retrospective summarizes several of the more significant actions of the past, implemented unilaterally through the 1980s and early 1990s by agencies such as the Federal Aviation Administration (FAA) and the Federal Highway Administration (FHWA)—in direct support of their own individual needs. However, the paper also anticipates a more coordinated Federal approach to noise control in the future—an era in which limited funding has and will continue to spawn new dialogue and cooperation between agencies, prompting joint research and coordinated mitigation efforts to help address the noise problems of the next 25 years.

PROGRESS IN AVIATION NOISE CONTROL

By now, nearly everyone in acoustics has at least heard of Federal Aviation Regulation (FAR) Part 36 (Code of Federal Regulations, Title 14, Part 36) noise standards for the certification of new aircraft. Initially applicable to all aircraft manufactured after 1973 December 1, the weight dependent noise limits have become increasingly restrictive over time, leading to the categorization of airplanes into three groups identified as Stage 1, Stage 2, and Stage 3. Under a related regulation (FAR Part 91), Stage 1 aircraft (those manufactured before the promulgation of Part 36, and hence the loudest) are no longer permitted to operate in the U.S., while Stage 2 aircraft will not be permitted to operate here after 1999 December 31. This will leave only Stage 3 aircraft—the newest, quietest planes—many of which are certified at Effective Perceived Noise Levels (EPNLs) as much as 15 dB or more below their Stage 2 counterparts. As an example, on takeoff, the quietest Stage 2 Boeing 727-200 (one of the most common aircraft in the U.S. fleet) is certified at an EPNL value 7.4 dB above the loudest 757-200 Stage 3 counterpart, and 17.5 dB above the quietest 757-200.[1]

With air carrier fleets converting to larger and larger percentages of Stage 3 airplanes, such significant improvements in EPNL values generally mean that Day-Night Average Sound Levels (DNLs) around most major airports have been decreasing on the order of several dB over the past 5 years and are projected to decrease an additional 3 to 5 dB over the next 4 years—truly significant improvements for residents living near these facilities. Part 36 noise standards also extend to supersonic transport (Concorde) operations in the U.S. and now include light propeller aircraft and helicopters as well.

Looking further to the future, FAR Part 36 is likely to be modified again in 1 to 2 years, this time establishing noise limits for a new category of quiet aircraft—Stage 4 air planes. These will probably be required to meet an EPNL cap 3 or 4 dB below the present Stage 3 limits; and if the FAA yields to pressure from the International Civil Aviation Organization (ICAO) and adopts the Stage 4 limits advocated by the international body responsible for certifying new airplanes manufactured outside the U.S., this will mean that even the U.S.'s newest aircraft, the Boeing 777, will not comply as a Stage 4 airplane. In any case, the additional downward ratcheting of aircraft noise levels appears to be inevitable. In other regulatory matters, the FAA adopted another very effective regulation known as FAR Part 150 which provides for airport noise compatibility planning. First implemented as an interim regulation on 1981 January 19, the rule was amended and made final on 1985 January 18. It permits airports to evaluate and submit for FAA approval a set of proposed operational and land use planning measures that can include noise abatement flight corridors, a preferential runway use program, residential and school sound insulation programs, compatible use zoning, construction of an enclosure to reduce noise from engine maintenance activity, and so on — all measures designed to reduce the numbers of people exposed to the FAA's criterion for impact: DNL values above 65 dB. Though Part 150 is voluntary in nature, airports that submit such noise compatibility plans for FAA review become eligible for Federal funding of approved measures. Follow-on grants covering up to 80 and sometimes 90 percent of the cost of individual program elements are paid for out of Airport Improvement Program funds collected from the 10 percent ticket tax on each airline ticket sold.

To indicate the popularity of Part 150, as of the end of the government's fiscal year 1994—(1994 September 31— the latest date for which data have been compiled), some 225 airports had participated in the program, funded by FAA grants of $38.9 million to complete the noise compatibility studies, plus another $1.51 billion to implement the program elements—most going to pay for extensive sound insulation and land acquisition programs.[2] Also, as of 1990, airports themselves have the authority to raise supplemental funds for noise abatement programs by collecting Passenger Facility Charges (PFCs) of $1 to $3 per passenger, subject to FAA review. To date, an

(continued next page)

(**Federal Regulations,** *from page 9*)
additional $782.2 million has been approved for collection by this means.[3]

Clearly, at these funding levels noise control programs have become a reality for many airport operators who, in turn, have made substantive improvements to the noise environments of literally thousands of their neighbors. Active programs at airports such as Atlanta-Hartsfield, Baltimore/ Washington International, Fort Lauderdale International, Dallas-Love Field, John Wayne (Orange County), Logan, Minneapolis/St. Paul, Palm Beach, San Diego, Seattle Tacoma and others show without question real noise reduction and the resulting improved public relations that come with it.

PROGRESS BY THE FEDERAL HIGHWAY ADMINISTRATION AND OTHERS

Moving next to surface transportation issues, in 1973 the Code of Federal Regulations, Title 23, Part 722 established FHWA's procedures and criteria for evaluating and abating highway noise. STAMINA and OPTIMA computer programs developed for the agency more than 15 years ago predict peak hour Equivalent Sound Levels and optimize the cost/benefit of alternative barrier designs.

Though implementation of mitigation measures by FHWA is nowhere near the level occurring at airports, still, by the end of calendar year 1992 (the most recent date for which these data are available), some 40 states and Puerto Rico had installed barriers or berms along their highways to protect nearby residents. In total, the approximately 900 miles of barriers have cost the agency some $816 million to construct, with almost half the money disparately apportioned to two states—California and New Jersey, and 80 percent of the funds going to the top ten states.[4]

Can every Federal agency cite even these kinds of successes over the past 25 years? Not uniformly. The EPA's Office of Noise Abatement and Control, mentioned earlier, was established under the authority of the Noise Control Act of 1972 and remained active throughout the mid-1970s. During that time it funded various working groups which, among other things, were tasked with responsibilities such as "identifying the level of environmental noise requisite to protect public health and welfare with an adequate margin of safety." Their findings were compiled in what has come to be known as the "Levels Document,"[5] and they remain current today. ONAC also set noise limits for heavy trucks, motorcycles, locomotives, rail cars, interstate rail carrier operations, and several consumer products. In its prime, the office had a staff of 800.

Now, ONAC receives no Federal funding. EPA has long since dismantled the operation, has given away its library, and provides no staffing, though the legislative mandate for the office remains in force. The agency has even been sued on multiple occasions for failure to uphold its legislated responsibilities under the Noise Control Act, so far unsuccessfully. This has led University of Kansas Law Professor, Sydney Shapiro, in his 1991 report to the Administrative Conference of the United States on "The Dormant Noise Control Act and Options to Abate Noise Pollution" to conclude in short: "The NCA is by any measure a public policy failure."[6]

What limited authority the EPA retains over environmental noise, it gets from Section 109 of the Clean Air Act. Responsibility for review of noise issues within all environmental assessments and impact statements produced by other Federal agencies is now handled by the Office of Air and Radiation. Initial document review takes place at the regional level where there is little or no expertise in noise; that is followed by headquarters review where just two staff have a working knowledge of noise, and only a part-time responsibility for it. Further cuts are expected. How can an Agency in this predicament ever hope to fulfill its legislative mandate, much less promulgate reasoned public policy?

A BRIGHTER OUTLOOK?

Though EPA is unlikely to recover any of its former purview over noise control, other agencies appear to be maintaining much stronger positions. For example, the FHWA is nearing completion of a major upgrade to its traffic noise prediction software. The new program, known as the Traffic Noise Model, or TNM, runs on MicroSoft Windows and provides new graphical views of both input and output using NMPLOT, a plotting package that is also being incorporated into other prediction models under development by the FAA and U.S. Air Force. This is but one example of the coordination that is now occurring between agencies having common interests. TNM will also permit the importing of roadway geometry through .dxf files generated by other CAD programs, and it will incorporate an entirely new database of 1/3 octave band "reference energy-mean emission levels" from comprehensive measurements of automobiles, medium and heavy trucks, buses, and motorcycles. Improved prediction algorithms will permit detailed barrier, double barrier, and terrain effect calculations. Release of the program is expected by mid-summer, 1996, at which time it will become the new standard for highway noise modeling.

Other agencies are faring equally well. The Federal Transit Administration (FTA) is examining new criteria for assessing the noise impacts of urban and commuter rail systems, trolley systems, transit bus routes, and related facilities. Findings will be reported in a new Guidance Document currently in printing. Future goals include development of the transit noise model as a module to the FHWA' s TNM—again, a prime example of agency coordination. There are additional signs of problem-solving between the Department of Defense and the FAA on Part 150 studies at joint-use airfields where the military has been found to produce a significant proportion of the noise and participates willingly in the development of operational abatement measures though it is under no obligation to do so.

Lastly, probably the best example of on-going agency coordination is the Federal Interagency Committee on Aviation Noise, or FICAN. Formed in 1993, the committee includes senior technical representatives of the Department of Defense (U.S. Air Force, U.S. Navy, and U.S. Army), the Department of Interior (National Park Service), the Department of Transportation (FAA), the Department of Housing and Urban Development (HUD), and the EPA and NASA. The committee holds regular meetings two to four times per year to discuss on-going research by member agencies; it conducts public forums to obtain input for future research; it solicits input from the technical and aviation community through conference participation; and it publishes a compendium of approximately 60 projects currently underway with the member agencies. Some of the more significant research topics include:

- **Noise Reduction Technologies**—In work funded jointly by NASA and the FAA, and with full participation by engine manufacturers, new low-noise engine designs are being examined that increase bypass ratios by a factor of 2 and include swept, low-speed fan blades, plus active sound absorbers in the nacelles and actively controlled rotor-stator interaction. The goal is to achieve a 10 dB improvement over 1992 technology through improved engine and air frame design and from improved flight procedures incorporating Global Positioning Satellite (GPS) inputs.
- **Land Use Compatibilities and Background Noise**— Under a pair of projects (the first sponsored by the National Park Service, and the second by the Air Force), work is being carried out to determine the nature and scope of visitor reaction to aircraft noise over National Parks and wilderness areas with the aim of resolving conflicts over the impairment of visitor enjoyment.
- **Community Reactions to Aircraft Noise**—Under a contract funded jointly by the Air Force, NASA, the Army and the FAA, a sleep disturbance study is currently underway to resolve disparities between recent field and laboratory studies of peoples' propensity to waken in the presence of aircraft noise.
- **Noise Effects on Animals**—The Air Force and Army are jointly studying various effects of aircraft noise on animals including effects on domestic, grazing, and wild animals, effects on birds of prey, and effects on nesting and roosting eagles.

THE FUTURE OF FEDERAL ACTIVITIES IN NOISE CONTROL

Together, these recent signs of cooperation and coordination among Federal agencies are promising. Even in the rather discouraging specter of major budget cutting efforts, transportation continues to have the overall support of the U.S. Congress which should be reasonably good news for those involved in aviation, rail, and highway noise issues, and cooperative efforts should make dwindling funds go further.

There are even some potential signs of expanding markets: signs that some transit systems may initiate sound insulation programs modelled after those implemented widely at airports; signs that aviation noise is improving significantly but not going away, especially at the country's most noise-sensitive airports; signs that new land use compatibility criteria for parks and open space will create new areas of impact; signs that new military aircraft will not only not be any quieter, but will continue to need low altitude airspace in which to conduct training; signs that residential development will continue to encroach on airports and significantly erode the benefit of reduced noise exposure that is (was?) expected to result from a 100 per cent Stage 3 fleet. In sum, none of the country's aviation, highway, and rail problems has been completely solved, but key Federal agencies have certainly taken significant steps toward improving our environment and ought to be recognized for that. ■

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[3] *Airport Noise Report,* edited by A. H. Kohut (Ashburn, VA, 3 May 1995), Vol. 7, No. 9, p. 66.

[4] Federal Highway Administration, Office of Environmental Policy, Noise and Air Quality Division, *Summary of Noise Barriers Constructed by December 31, 1992* (Federal Highway Administration, Washington, DC, July 1994).

[5] U.S. Environmental Protection Agency, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety,* EPA Report 350/9-74-004 (U.S. EPA, Washington, DC, March 1974).

[6] Sidney A. Shapiro, "The Dormant Noise Control Act and Options to Abate Noise Pollution," Administrative Conference of the United States, November 1991, page 45.

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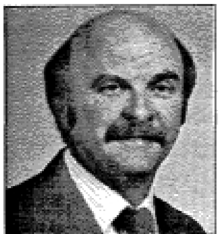
Highway Traffic Noise Barrier Construction Trends

A Report compiled by the Federal Highway Administration

Submitted for publication by Robert Armstrong, Highway Noise Team Leader, FHWA Office of Environment and Planning



Robert Armstrong

INTRODUCTION

The Federal-aid highway program has always been based on a strong State Federal partnership. At the core of that partnership is a philosophy of trust and flexibility, and a belief that the States are in the best position to make investment decisions that are based on the needs and priorities of their citizens. The FHWA noise regulations give each SHA flexibility in determining the reasonableness and feasibility of noise abatement and, thus, in balancing the benefits of noise abatement against the overall adverse social, economic, and environmental effects and costs of the noise abatement measures. The SHA must base its determination on the interest of the overall public good, keeping in mind all the elements of the highway program (need, funding, environmental impacts, public involvement, etc.). Congress affirmed and extended the philosophy of partnership, trust, and flexibility in the enactment of ISTEA.

The flexibility in noise abatement decision-making is reflected by data indicating that some States have built many noise barriers and some have built none. Through the end of 1995, forty-one State highway agencies (SHAs) and the Commonwealth of Puerto Rico have constructed over 2,120 linear kilometers of barriers at a cost of over $1.2 billion ($1.4 billion in 1995 dollars). Nine States and the District of Columbia have not constructed noise barriers to date. A detailed listing of noise barrier data may be found in "Summary of Noise Barriers Constructed by December 31, 1995." The paper that follows presents a brief analysis of the data contained in the detailed barrier listing.

It should be noted that the data represent best estimates supplied by SHAs on barrier construction. There may be nonuniformity and/or anomalies in the data due to differences in individual SHA definitions of barrier information and costs. However, some trends are evident.

NOI8E BARRIER CONSTRUCTION

Tables 1-8 provide data on barrier construction, height, materials, and unit costs (all cost information is in 1995 dollars). The following points may be made concerning noise barriers:

1. Expenditures in the last ten years comprise over seventy-five percent (75%) of the total for more than 25 years of recordkeeping.

2. Through the end of 1995, the overall average unit cost, combining all materials, is $174 per square meter. The average unit cost, combining all materials, for the last ten years is $187 per square meter.

3. Approximately sixty-nine kilometers of barriers have been built with highway program monies other than Federal-aid.

4. Overall, approximately seventy-five percent (75%) of Federal-aid barriers have been Type I (a barrier built on a highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes).

5. Nineteen States have constructed at least one Type II noise barrier (a barrier built along an existing highway) at a total cost of over $456 million.

6. The following States have not constructed noise barriers to date: Alabama, Hawaii, Idaho, Mississippi, Montana, North Dakota, Rhode Island, South Dakota, and Wyoming.

7. Ninety-four percent (94%) of barriers that have been constructed range in height from 2-6.9 meters. Two percent (2%) of barriers are less than 2 meters tall and four percent (4%) are more than 6.9 meters tall. The overall average barrier height is 3.7 meters.

8. Barriers have been made from materials that include concrete, masonry block, wood, metal, earth berms, brick, and combinations of all these materials. Concrete and block represent almost two-thirds of total material usage [thirty-eight percent (38%) and twenty-eight percent (28%), respectively] and wood eleven percent (11%). Metal, berm, and brick together account for seven percent (7%) of the total. Fourteen percent (14%) of all barriers have been constructed with a combination of an earth berm and a wall; two percent (2%) have been constructed with other materials, such as recycled materials, plastics, composite polymers, etc.

9. Average unit costs for all years for all barrier materials range between $137-206 per square meter, except for earth berms which average only $43 per square meter. Concrete has been the most popular material; however, its cost, $202 per square meter, has been almost that of brick, $206 per square meter. Overall average costs for wood, metal, and combination barriers are approximately the same ($145, $137, and $152 per square meter, respectively).

10. There are no block or brick barriers over 6.9 meters tall or metal barriers over 7.9 meters tall. A wooden barriers has been constructed to a height of 17.7 meters, a berm/metal combination barrier to a height of 12.0 meters, and a cast-in-place concrete barrier to a height of 11.9 meters.

11. Unit costs for barriers do not always appear to increase as the barrier height increases (Note: This may be due to nonuniformity and/or anomalies in the data reported by SHAs).

SUMMARY

The most notable trend in highway traffic noise barrier construction is a dramatic increase in the amount of construction starting in 1986. SHAs have averaged spending over $113 million annually. Over seventy-eight percent (78%) of the spending has been for Type I projects.

Most barriers have been made from concrete or masonry block, range from 3-5 meters in height, and average $175-200 per square meter in cost. ■

(Editor's Note: The tables referenced in the text above are printed on the following pages. FHWA published the data in metric form as do most government agencies.

However, I have converted the metric data to American to make the information readily understandable to those readers unaccustomed to metric usage.

If you prefer the metric version, I am sure Bob Armstrong could make it available. He may be reached by phone at 202 366-2073 or fax at 202 366-3409.

In the next issue, we will publish a further breakdown of the data, as we did in Issue No. 15 for the data published in Issue No. 14).

TABLE 1
NOISE BARRIER CONSTRUCTION BY YEAR

YEAR	MILES	ACTUAL COST	1995 COST
Unknown*	5		
1970	1		
1971			
1972	1	500,000	1,000,000
1973	2	500,000	1,000,000
1974	14	5,000,000	12,000,000
1975	21	6,000,000	12,000,000
1976	6	1,000,000	2,000,000
1977	14	7,000,000	16,000,000
1978	60	28,000,000	49,000,000
1979	60	26,000,000	37,000,000
1980	44	23,000,000	28,000,000
1981	43	27,000,000	35,000,000
1982	26	19,000,000	26,000,000
1983	40	30,000,000	42,000,000
1984	53	42,000,000	56,000,000
1985	43	36,000,000	43,000,000
1986	65	70,000,000	85,000,000
1987	56	49,000,000	60,000,000
1988	93	107,000,000	122,000,000
1989	104	112,000,000	127,000,000
1990	65	82,000,000	92,000,000
1991	101	125,000,000	142,000,000
1992	140	158,000,000	184,000,000
1993	85	99,000,000	112,000,000
1994	61	68,000,000	72,000,000
1995	114	141,000,000	141,000,000
1970-1995	**1,317**	**$1,262,000,000**	**$1,497,000,000**

TABLE 2
NOISE BARRIER CONSTRUCTION AVERAGE UNIT COST BY YEAR

YEAR	SQUARE FEET	COST IN 1995 DOLLARS	COST PER SQ FOOT
Unknown	441,000		
1972	65,000	1,000,000	15.38
1973	108,000	1,000,000	9.26
1974	775,000	12,000,000	15.48
1975	1,249,000	12,000,000	9.61
1976	291,000	3,000,000	10.31
1977	1,001,000	16,000,000	15.98
1978	3,983,000	49,000,000	12.30
1979	3,735,000	37,000,000	9.91
1980	2,939,000	28,000,000	9.53
1981	2,411,000	35,000,000	14.52
1982	1,722,000	25,000,000	14.52
1983	2,648,000	42,000,000	15.86
1984	3,218,000	56,000,000	17.40
1985	2,702,000	43,000,000	15.91
1986	4,166,000	85,000,000	20.40
1987	3,778,000	60,000,000	15.88
1988	6,415,000	122,000,000	19.02
1989	7,363,000	127,000,000	17.25
1990	5,511,000	92,000,000	16.69
1991	8,245,000	142,000,000	17.22
1992	10,495,000	184,000,000	17.53
1993	6,265,000	112,000,000	17.88
1994	4,887,000	72,000,000	14.73
1995	8,202,000	141,000,000	17.19
ALL	**92,615,000**	**$1,497,000,000**	**$16.16**

TABLE 3
TYPE I AND TYPE II NOISE BARRIER CONSTRUCTION BY YEAR

	TYPE I Miles	TYPE II Miles	TYPE I % of Total	TYPE II % of Total
Unknown	6	0	100	0
1970 - 79	104	71	60	40
1980	37	7	83	17
1981	22	21	51	49
1982	18	6	74	26
1983	29	9	77	23
1984	39	16	71	29
1985	29	14	66	34
1986	41	24	63	37
1987	35	17	67	33
1988	83	8	91	9
1989	89	8	92	8
1990	45	20	69	31
1991	79	20	80	20
1992	112	19	85	15
1993	60	22	74	26
1994	41	16	73	27
1995	78	31	71	29
ALL YEARS	**947**	**329**	**74**	**26**
TOTAL TYPES I & II		**1276**		
TOTAL ALL OTHER TYPES		**43**		
TOTAL ALL TYPES		**1319**		

TABLE 4
NOISE BARRIER CONSTRUCTION BY HEIGHT

HEIGHT	NO. of MILES	% of TOTAL
Under 7'	24	2%
7' - 10'	153	12%
10' - 13'	435	33%
13' - 16'	410	31%
16' - 19'	148	11%
19' - 22'	97	7%
Over 22'	49	4%
ALL HEIGHTS	**1316**	**100%**

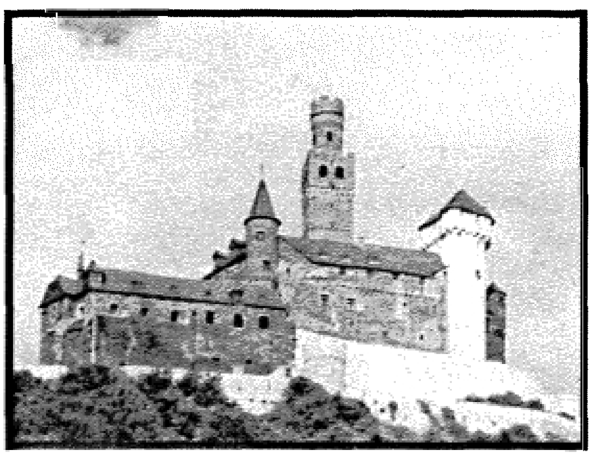
NOTES TO TABLE 3

A Type I barrier is one built on a highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes.

A Type II barrier is one built to abate noise along an existing highway. This type of abatement, commonly referred to as retrofit abatement, is not mandatory and is constructed at the option of the SHA. Nineteen (19) States have constructed Type II barriers.

TABLE 5
NOISE BARRIER CONSTRUCTION MATERIAL BY YEAR

YEAR	CONCRETE SQ FT	BLOCK SQ FT	WOOD SQ FT	METAL SQ FT	COMBINATION SQ FT	BERM SQ FT	BRICK SQ FT
Unknown	226,000			140,000	75,000		
1985 & Prior	5,134,000	7,180,000	4,424,000	1,281,000	5,942,000	2,605,000	183,000
1986	1,238,000	1,335,000	570,000	140,000	764,000	65,000	22,000
1987	980,000	1,798,000	280,000	140,000	538,000	0	32,000
1988	3,035,000	2,196,000	280,000	54,000	517,000	22,000	11,000
1989	3,154,000	1,432,000	1,485,000	269,000	743,000	140,000	108,000
1990	2,303,000	1,733,000	947,000	0	495,000	43,000	0
1991	3,509,000	2,217,000	657,000	43,000	1,539,000	11,000	258,000
1992	5,630,000	2,960,000	764,000	151,000	807,000	43,000	43,000
1993	3,444,000	1,873,000	355,000	11,000	312,000	86,000	118,000
1994	2,411,000	1,292,000	667,000	22,000	183,000	86,000	140,000
1995	4,198,000	1,841,000	205,000	258,000	1,346,000	108,000	97,000
ALL Known Years	**35,262,000**	**25,857,000**	**10,634,000**	**2,509,000**	**1,3261,000**	**3,209,000**	**1,012,000**



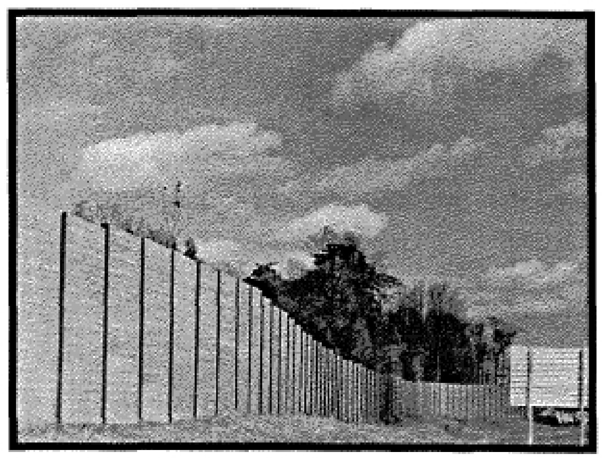


TABLE 6
NOISE BARRIER CONSTRUCTION MATERIAL
AVERAGE UNIT COST BY YEAR

YEAR	CONCRETE PER SQ FT	BLOCK PER SQ FT	WOOD PER SQ FT	METAL PER SQ FT	COMB. PER SQ FT	BERM PER SQ FT	BRICK PER SQ FT
1986	21.55	21.74	23.41	13.01	15.32	8.18	25.92
1987	19.04	14.68	12.73	14.59	15.42	6.22	31.03
1988	23.32	14.03	11.43	13.66	17.28	6.78	25.92
1989	20.81	15.24	15.89	10.41	12.82	3.25	23.97
1990	20.25	15.24	15.05		9.85	0.19	
1991	19.04	18.30	18.21	19.70	10.96		15.33
1992	18.86	15.79	16.91	17.19	14.96	10.13	18.77
1993	17.28	18.86	17.47	58.90	21.65	4.74	19.51
1994	15.61	14.86	7.34	22.67	22.67	3.81	24.53
1995	17.56	15.61	8.18	12.36	20.35	2.23	13.84
All	**$18.86**	**$16.26**	**$13.47**	**$13.47**	**$14.21**	**$3.99**	**$19.14**

TABLE 7
NOISE BARRIER CONSTRUCTION MATERIAL
BY HEIGHT

HEIGHT	CONCRETE SQ FT	BLOCK SQ FT	WOOD SQ FT	METAL SQ FT	COMB. SQ FT	BERM SQ FT	BRICK SQ FT	ALL SQ FT
Over 32'	151,000		312,000		807,000	43,000		1,313,000
32'	237,000		43,000		312,000	32,000		624,000
29'	323,000				161,000			484,000
26'	2,583,000		947,000	75,000	571,000	280,000		4,456,000
23'	4,607,000	312,000	1,894,000	334,000	2,799,000	151,000		10,269,000
19'	10,118,000	291,000	1,830,000	151,000	506,000	75,000	172,000	13,218,000
16'	9,419,000	11,657,000	2,756,000	1,152,000	4,499,000	603,000	129,000	30,807,000
13'	6,028,000	11,550,000	1,884,000	657,000	2,659,000	1,453,000	269,000	24,757,000
10'	1,593,000	1,927,000	861,000	108,000	936,000	452,000	312,000	6,081,000
7'	194,000	118,000	118,000	22,000	11,000	118,000	129,000	603,000
ALL HTS.	**35,253,000**	**25855000**	**10,290,000**	**2,499,000**	**13,261,000**	**3,132,000**	**1,011,000**	**92,612,000**

TABLE 8
NOISE BARRIER CONSTRUCTION MATERIAL
AVERAGE UNIT COST BY HEIGHT

HEIGHT	CONCRETE PER SQ FT	BLOCK PER SQ FT	WOOD PER SQ FT	METAL PER SQ FT	COMB. PER SQ FT	BERM PER SQ FT	BRICK PER SQ FT	ALL PER SQ FT
Over 32'	25.92		4.27		8.73			9.48
32'	22.95				7.90	1.60		12.63
29'	13.29				11.61			12.73
26'	23.23		19.42	16.35	11.24	2.23		19.51
23'	20.62	15.7	11.43	9.10	11.98	1.58	16.26	15.70
19'	18.49	20.81	16.35	14.40	18.95	4.18	19.14	18.30
16'	18.58	15.24	14.86	12.17	16.43	5.02	17.65	16.26
13'	16.44	17.28	10.03	14.40	13.75	3.62	19.79	15.33
10'	17.19	15.79	13.19	16.44	4.92	4.92	24.43	15.33
7'	16.35	10.31	29.26	35.12	7.80	7.80		12.91
ALL HTS.	**$18.77**	**$16.26**	**$12.73**	**$14.12**	**$11.80**	**$3.99**	**$19.14**	**$16.16**

Note that there are 872,000 square feet of noise barriers constructed with other materials, costing approximately $25.83/sq ft.

TABLE 9
NOISE BARRIER CONSTRUCTION BY STATE — AVERAGE HEIGHT AND AVERAGE UNIT COST

STATE	AVERAGE HT	$1995 PER FT^2	STATE	AVERAGE HT	$1995 PER FT^2
ALABAMA	0		MONTANA	0	
ALASKA	3.5′	10.87	NEBRASKA	14.0′	15.61
ARIZONA	10.2′	11.06	NEVADA	10.8′	15.70
ARKANSAS	13.1′	6.50	NEW HAMPSHIRE	11.8′	12.45
CALIFORNIA	11.2′	12.28	NEW JERSEY	17.1′	25.27
COLORADO	9.8′	13.01	NEW MEXICO	9.8′	16.44
CONNECTICUT	16.4′	11.61	NEW YORK	13.5′	23.04
DELAWARE	13.8′	17.56	NORTH CAROLINA	15.4′	12.45
DIST. OF COLUMBIA	0		NORTH DAKOTA	0	
EASTERN DIR .FED.	11.2′	14.40	OHIO	14.4′	12.26
FLORIDA	12.8′	22.85	OKLAHOMA	9.5′	16.35
GEORGIA	12.8′	11.43	OREGON	9.8′	9.66
HAWAII	0		PENNSYLVANIA	11.5′	26.11
IDAHO	0		PUERTO RICO	14.0′	21.46
ILLINOIS	11.8′	16.17	RHODE ISLAND	0	
INDIANA	12.5′	16.63	SOUTH CAROLINA	14.8′	11.52
IOWA	13.5′	14.77	SOUTH DAKOTA	0	
KANSAS	15.0′	19.23	TENNESSEE	14.4′	21.00
KENTUCKY	13.8′	15.33	TEXAS	11.2′	17.37
LOUISIANA	11.8′	11.52	UTAH	10.8′	9.85
MAINE	9.8′	3.44	VERMONT	6.2′	14.40
MARYLAND	17.0′	30.57	VIRGINIA	15.0′	13.38
MASSACHUSETTS	8.9′	15.05	WASHINGTON	9.8′	13.19
MICHIGAN	11.5′	21.83	WEST VIRGINIA	11.5′	10.41
MINNESOTA	15.7′	12.82	WISCONSIN	16.7′	16.82
MISSISSIPPI	0		WYOMING	0	
MISSOURI	11.5′	17.75			

NOTICE TO ADVERTISERS

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Letters to the Editor

(I would rather have letters like these than money from home. Thanks to all of you for the kind words. — Ed.)

Please continue the Highway Authority's subscription to The Wall Journal. Your publication has been a great source of information, in a consolidated format, which assists the Highway Authority in the Implementation of our sound barrier policy.

Mark B. Bernard, P.E.
Structural Engineer
New Jersey Highway Authority
Woodbridge, New Jersey

Please continue my free subscription to The Wall Journal. A sound barrier using materials described in your publication is in use in Hammond, Indiana along I-80/94 and has proven to be effective. This Department is also looking at requiring the use of such barriers adjacent to certain business operations such as 24 gasoline service stations that are directly adjacent to residential areas. The Journal is helpful in providing options for reducing noise in our community.

Ronald L. Novak, Director
Hammond Department of Environmental Management
City of Hammond, Indiana

Please change my address to that noted in the letterhead above. Thank you.

By the way, we here in Sacramento County hate soundwalls! In fact, because they are imposed on virtually every project we do, we are considering changing our name to the Transportation & Soundwall Division.

There is some hope however. We have successfully mitigated noise problems associated with road widening projects without constructing soundwalls, by overlaying the pavement with rubberized asphalt concrete.

The noise component on these projects was primarily from tire wash. By placing the crumb rubber in our overlays, "Where the rubber meets the road" has become, "Where the rubber meets the rubber" and we have achieved a 5dB reduction. On projects with marginal sound reduction needs this technique has saved the expense of construction, right of way, and maintenance of soundwalls. These results have been verified with before/after noise studies and is used where the traffic will remain fairly consistent. We don't win them all though.

On one project, we were widening a road on the opposite side of a subdivision that had installed a 6 foot soundwall many years previous. When our project came out of environmental review it required that we had to raise the wall to 9 feet. It seems to me that the original wall was installed to the standard that was enforced at the time and our project was not bringing the traffic any closer to the receptors. Is this double jeopardy? The existing wall was owned by the residents and we had to get their permission to come onto their property to demo the existing wall and erect the new one. Ironically, many of the residents did not want the higher wall because it would block their view, but for continuity we had to construct a continuous wall of uniform height. Some residents had landscaping on the existing wall that they wanted to remain, so we left their portion and built the new wall immediately behind.

On other projects, we have built notches into walls for tree plantings that break up the appearance of the wall. These look quite nice. Unfortunately, these notches have proven to be an attractive shelter for the homeless. We have now modified the depth and shape of the notch so that it is not so protected and inviting.

These are but a few examples of the fun and excitement we enjoy at the Transportation and Soundwall Division. I wish you well

Theron Roschen, P.E.
Senior Civil Engineer
Sacramento County Public Works Agency

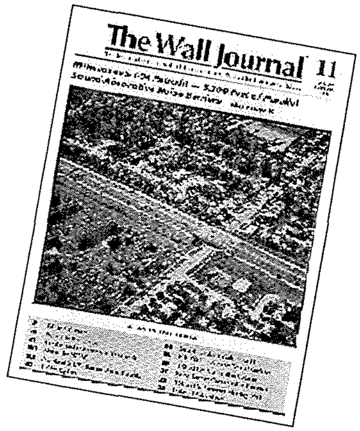
Merry Christmas
We'll see you in 1997

Editor's Note: The Walrus went crazy on Thanksgiving and overstuffed his already overstuffed hot-air balloon-sized body. He can't come back to work for a while — his belches are topping 90 dB and his breath is really fouling the environment.

Bob Bullmoose is on leave to help out with Santa's Xmas deliveries.

Some of the good stuff you might want to read again, now and then:

- Noise Barrier Construction Forecast
- Summaries of Professional Papers
- Noise Barrier Project Reports
- Fundamentals of Sound
- New Product Press Releases
- TRB A1F04 Committee Meetings
- State DOT Noise Barrier Programs
- FHWA Noise Model Updates
- Noise Abatement in Other Countries
- Airport Noise Control
- Construction Trends in Noise Barriers
- Product Approval Process
- FHWA History of Barrier Construction
- Materials Test Standards
- Rail Transit Noise Control
- And a Bunch More



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The Last Word

I've been good, Santa. Really I have. I know that you have an awful lot on your mind, especially at this time of the year. Ordinarily, I wouldn't bother you, but I'm afraid that you may have somehow forgotten all about me.

Otherwise, why haven't you brought me those things I've been asking you for all these years. You know how badly I wanted that boat. I lived inland most of my life, and now that I live near the water in Florida, I really, **really** do need to have a boat. A **large** boat.

And, when one retires in Florida, you should know that it is absolutely essential that you have a great big white Lincoln Town car, or a great big white Cadillac, at the very least.

And, two years ago, I asked for a sweet old lady with a lot of money to live with me in my autumn years.

Well, Santa, I'm Fedexing this issue to you, and I hope that you will do the right thing. This is your last chance.

Merry Christmas,

El (a good man) Angove

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