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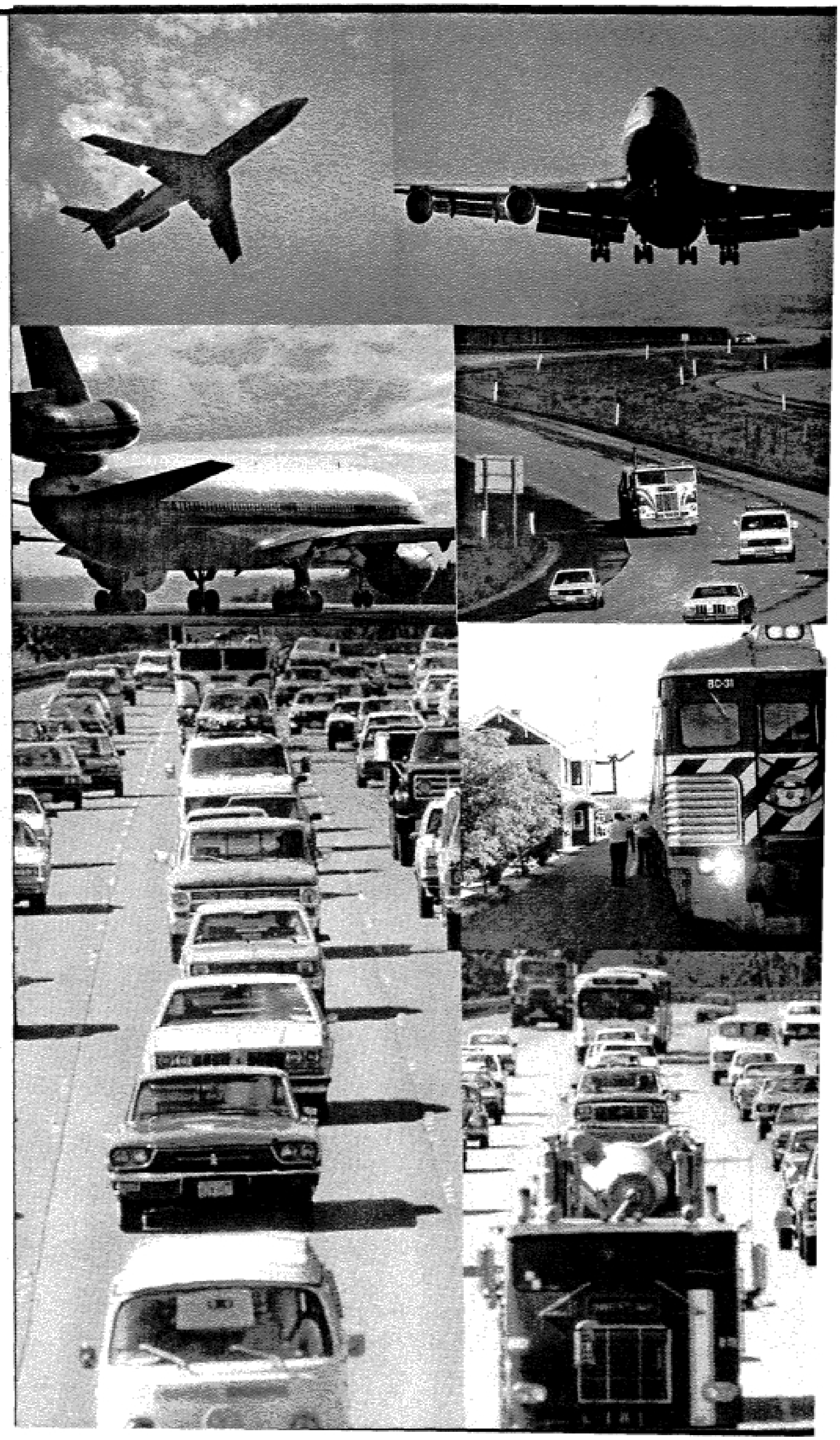


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Subscription and advertising information are shown on page 23.

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EDITOR'S CORNER

by El Angove

The Forum is Open

But it may soon look and sound more like the Colosseum. I have the feeling the games are about to begin.

Returning to our pages this issue is Ed McNair, the man who gave us "The Very High NRC Problem" opinion article in Issue No. 21, in which he stated, "The wrong ASTM test is being used." I thought for certain we'd get a lot of mail with 'attitude' on that one, but we only had light and polite response.

Oh, I had some telephone calls and a fax or two from a few of the noise barrier vendors, with some strong words about what the competition was doing, but nothing in hard copy that I could publish. I know there was a firestorm going on out there, and some mean words were being tossed around about how sound-absorptive barriers were being tested and certified, but I sure couldn't scare up a confrontational and controversialarticle with a real name attached to it.

Well, Fearless Ed McNair is back, and he's laying it on the line again. On page 13 he gives us "Parallel Barrier Engineering," a studied treatise which somewhat follows the line crafted by Rudy Hendriks in his paper "To Absorb or Not To Absorb, " which appeared in Issue No. 21. I hope that Ed's paper will draw some good responses.

It would seem to me that we should somehow be getting close to putting sound-absorptive barriers, parallel barriers and NRC ratings into some kind of standard specifications. We need to level out the sand in the Colosseum, cover up the blood, go back to the Forum, select a star panel of our best acoustics senators, and start carving the specs into stone. All hail Caesar!

Oh, Canada

I trust that all of you readers in Canada have received the note enclosed with the last issue, advising that we are once again serving you directly from here in Florida. There are so many of you down here in the winter, I could probably just ask some of them to drop off The Wall Journal at the nearest Postal Outlet. I am happy to say that the Canadian visitors are all pleasant and well-behaved, and the ladies are quite nice-looking. It must be that cold weather that preserves them so well, but you need not send any more cold weather down, thank you. The ladies, yes, but snow and ice, no.

I am slowly getting the Canada database integrated into my own, as I told you. But, I expect that The Wall Journal will reach you with each issue no later than the U.S. readers receive theirs.

A Note From Chairman Emeritus Mas

Dear El,

We were very lucky and weren't affected by the devastating floods that swept through Northern California.

One day, The Senior Magazine came to the Railroad Museum and wanted to Profile someone. I just happened to be standing in the right place at the right time. It does tell you that I am now living a new life away from the world of noise.

Vi is getting along fine and is involved in activities of her own which keeps her busy and out of my hair. That won't last too long because my hair is receding fast.

Thanks for continuing to send The Wall Journal. It helps me to keep in touch with the old world. The thing that I enjoy the most is the Editor's Corner.

Have a Happy New Year!

Mas Hatano
64 Manley Court
Sacramento, CA 95820
916 451-5000

We all miss you, Mas. Hi to Vi.

Corrections and Typos:

Issue No. 25, Page 17 — PennDOT Retrofit Noise Barrier Study (18)
(18) should be **(24)**

Issue No. 25, Page 12 — Richard G Janecek, PE, Phone 201 994-4520
Fax 201 994-7176
should be **Phone 201 267-0555**
Fax 201 267-3555

NEWS RELEASE
Thursday, January 23, 1997
New Brunswick, New Jersey

NATIONAL TRANSIT INSTITUTE ANNOUNCES ADDITIONAL SESSIONS OF NATIONAL EDUCATIONAL PROGRAM ON TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT

The National Transit Institute announces three additional offerings of its course on assessment of noise and vibration impacts of federally funded transit projects. The new locations are Seattle, Boston, and Dallas. A full schedule of remaining sessions is set out below. The three-day course, entitled *Noise and Vibration Impact Assessment* is offered free of charge.

BACKGROUND & EDUCATIONAL NEED

Noise and vibration assessments are key elements of the environmental impact assessment process for mass transit projects. To promote quality and uniformity in those assessments, the FTA recently published a guidance manual, *Transit Noise and Vibration Impact Assessment* (April 1995), to be used by project sponsors and consultants in performing noise and vibration analyses. It covers the methods and procedures for estimating the level of noise and vibration impacts resulting from most federally-funded transit projects and for determining what can be done to mitigate such impacts.

The NTI training program has been designed and developed in close cooperation with the FTA Office of Planning. The course is intended to:

- Enhance the understanding of the noise and vibration assessment approach and of the analytical methods presented in the guidance manual;
- Show how noise and vibration assessment relates to the NEPA process, the Major Investment Study Process, and other related activities;
- Present information on available noise and vibration mitigation measures and considerations for determining the need for mitigation;
- Illustrate the exercising of professional judgment in extending the basic methods of the guidance manual to situations not covered explicitly in it.

COURSE INSTRUCTORS

The program will be presented by Mr. Carl Hanson of Harris Miller Miller & Hanson Inc, a firm specializing in noise and vibration analysis, and by Mr. Abbe Marner of the Federal Transit Administration. Mr. Hanson is a principal of HMMH. He has extensive experience in noise and vibration analysis and was principal author of the guidance manual. Mr. Marner works in the FTA's Office of Planning, where he directed the development of the guidance manual.

WHO SHOULD ATTEND

The course is aimed at users of the new FTA guidance manual. It is designed for those conducting noise and vibration studies, (e.g. specialists from acoustics consulting firms engaged in federal-aid transit work) as well as management personnel of project sponsors who need a fuller understanding of the methods used by consultants in such studies. In addition, it is expected to be of interest to others in more general fields, such as environmental planners and transit project planners from local and state transit agencies.

CONTENT and OBJECTIVES

Each participant will receive a copy of the FTA guidance manual, which will serve as the course text. Substantial classroom time will be devoted to exercises applying the procedures and methods described in the guidance manual, or developed by extending the basic techniques to address conditions not explicitly covered in the manual. Personal computers will be provided for use by groups of participants in a spreadsheet demonstration. Upon completion of the course participants should:

1. Understand the basic concepts of noise and vibration and the requirements of the FTA;
2. Be able to determine when a noise or vibration assessment is required, and what level of impact assessment is appropriate;
3. Have sufficient knowledge to evaluate qualifications for producing a noise or vibration assessment for a transit project; and
4. Understand the procedures and major analytical steps of reviewing the noise or vibration report of a transit project.

Following are locations and dates of the upcoming sessions:

Seattle, WA	April 2-4, 1997
Atlanta, GA	April 16-18, 1997
Boston, MA	June 4-6, 1997
New York, NY	September 8-10, l997
Dallas, TX	December 3-5, 1997
Chicago, IL	Apr. 13-15, 1998

For further information on the course, please contact:
Susan Greenstone, Registrar
National Transit Institute
Rutgers, The State University of New Jersey
120 Albany Street, Suite 705
New Brunswick, NJ 08901

FHWA TRAFFIC NOISE MODEL, VERSION 1.0 - PART VI

A Continuing Series

By: Cynthia S.Y. Lee and Gregg G. Fleming (RSPA/Volpe Center); Robert E. Armstrong and Steven A. Ronning (FHWA)

This is the sixth in the series of articles to appear in The Wall Journal about the continuing development of the Federal Highway Administration's (FHWA) next generation highway noise prediction model, the FHWA Traffic Noise Model (FHWA TNM®). The FHWA, the Volpe National Transportation Systems Center (Volpe Center) Acoustics Facility, Harris Miller Miller and Hanson Inc. (HMMH), Foliage Software Systems, Inc. (FSS), and various other organizations have been designing, developing, and testing TNM.

Model development is in its final stages. The development team has been working to improve run-time, as well as address several remaining technical issues in the TNM. To ensure run-time is acceptable to all users, the development team, including a technical review panel made up of eight noise specialists from state highway agencies, as well as from the Ministry of Transportation in Ontario, Canada, have decided upon the implementation of further run-time improvements prior to Version 1.0 release.

A technical "brainstorming" meeting was held last August. The purpose of that meeting was to discuss further technical approaches for improving TNM run-time. During the meeting, it was decided that a final test/debug period by FSS would be imperative to ensure final product quality. In addition, the following technical approaches were decided upon: the replacement of several algorithms with look-up tables and the inclusion of "smart-code" to eliminate calculation of insignificant sound propagation paths.

It is anticipated that these approaches will achieve reasonable run-times for moderately complex studies. Specifically, the goal is to achieve a run-time of l-to-2 hours for typical studies; and the most complex studies to require no longer than an overnight run. These reasonable run-times are based upon the following recommended hardware platform:

Computer:	IBM-compatible PC
Processor:	Pentium 120 MHz
Memory:	32 MB
Hard drive:	300 MB
Monitor:	SuperVGA (1024x768), 16 colors, small fonts
Operating System:	Windows 3.1 or higher

Bi-weekly technical meetings are being held to monitor schedule and provide timely technical support and guidance throughout these final stages. These meetings will involve several critical decision points based on preliminary test results on run-time and accuracy. Each decision point will guide how next to proceed in order to achieve TNM run-time and accuracy goals.

Following final run-time improvements and extensive testing by the technical review panel and the Volpe Center, the model will undergo a final debug period by FSS prior to release. The FHWA TNM Version 1.0 is expected to be delivered to the Volpe Center by the end of August 1997. Following duplication and distribution preparation, TNM will be released to the public at the end of 1997 or early in 1998.

It is currently anticipated that FHWA will institute a 12-to-24 month phase-in period for TNM following its release. This phase-in period will allow users to update their hardware appropriately, as well as to familiarize themselves with TNM. Subsequent to the phase-in period, the use of the existing model described in FHWA-RD-77-108, "FHWA Highway Traffic Noise Prediction Model," will be prohibited by the FHWA. ■

NOISE SOURCE HEIGHT RESEARCH PROJECT COMPLETED

By Win Lindeman, Florida DOT

A two year long research project to determine the noise source height of vehicles has recently been completed. The research project was conducted by Stewart Glegg and Robert Coulson at Florida Atlantic University in support of the Federal Highway Administration's development of the new Traffic Noise Model. The results of the research have already been incorporated into the development of TNM. A 105 page final report entitled "Vehicle Noise Source Heights & Sub-source Spectra" is available through the Florida Department of Transportation's Environmental Management Office library, 605 Suwannee Street, MS-37, Tallahassee, FL 32399-0450.

This report describes a turn-key system that was developed and implemented to collect the vehicle source height database for incorporation into the new Traffic Noise Model; 'TNM.' A total of 2500 individual vehicle pass-bys were measured with this system at 16 different sites around Florida and this data is presented in the form of averaged curves for each vehicle type. The dependence of source height on speed, pavement type, road grade and acceleration state is also shown for 10 different types of vehicles. The effect of these roadway conditions on the vehicle source heights is small compared to the typical variation in the whole data set.

A recommendation is therefore made that the overall average of the data for each vehicle type be used in the TNM model and that variations with speed, pavement, grade and acceleration can be neglected. The data collection system and algorithm used to obtain the source heights is described and the accuracy is demonstrated experimentally with known sources. The measured vehicle source heights are further verified using an alternate Matched Field Processing algorithm which produced very similar results. It is also shown that the single equivalent source height model for a distribution of sources is more accurate than the two sub-source model when used in barrier attenuation calculations. ■

Summary of Noise Barriers Constructed by end of 1995

By U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning Noise Team
Report dated December 1996, submitted for publication courtesy of Robert Armstrong, telephone 202 366-2073.

Robert Armstrong

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 State highway agency (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.

Highway traffic noise should be reduced through a program of shared responsibility. State and local governments should practice compatible land use planning and control in the vicinity of highways. Local governments should use their power to regulate land development in such a way that noise sensitive land uses are either prohibited from being located adjacent to a highway, or that the developments are planned, designed, and constructed in such a way that noise impacts are minimized. It should be noted that the National Highway System Designation Act of 1995 restricted Federal participation in the construction of noise barriers along existing highways to those projects that were approved before November 28, 1995 or are proposed along lands where land development or substantial construction predated the existence of any highway.

The flexibility in noise abatement decisionmaking 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 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. Ten SHAs account for approximately seventy percent (70%) of total barrier length and cost.

This paper contains a listing of data supplied by SHAs. It should be noted that the cost data in the listing are approximate due to differing State practices for estimating costs and due to the fact that for some barriers (over thirty-six kilometers), the cost could not be estimated at all. The data represent best estimates of SHAs for barrier construction. There may be nonuniformity and/or anomalies in the data due to differences in individual SHA definitions of barrier information.

Table 1 lists the ten States with the most barrier construction by area, length, and cost, respectively.

Table 2 lists the distribution of barriers by type of material. Earth (berm), masonry block (block), brick, concrete, metal, wood, other materials (e.g., polyurethane) and combinations of materials have all been used to construct barriers.

Table 1
Noise Barrier Construction By State Through 1995
(The 10 States with the most barriers)

	Square Meters (Thousands)		Linear Kilometers
California	2529	California	701.0
New Jersey	652	Virginia	116.8
Virginia	598	New Jersey	113.9
Minnesota	476	Minnesota	99.0
New York	391	Colorado	92.4
Maryland	298	New York	90.0
Pennsylvania	291	Pennsylvania	75.2
Colorado	284	Washington	71.9
Connecticut	254	Oregon	70.2
Ohio	253	Michigan	62.6
10 State Total	6,026		1,493.0
Actual Cost (Millions)		1995 Dollars (Millions)	
California	$368.5	California	$438.7
New Jersey	141.2	New Jersey	163.9
Virginia	88.7	Virginia	106.0
Maryland	78.1	Maryland	89.6
New York	69.0	New York	78.5
Pennsylvania	66.4	Pennsylvania	76.8
Michigan	41.9	Minnesota	58.3
Florida	38.9	Michigan	52.0
Minnesota	37.3	Florida	44.4
Wisconsin	37.3	Wisconsin	43.2
10 State Total	$967.3		$1,151.4

Table 2
Total Noise Barrier Area by Material Type Through 1995

Single Material Barriers: Material	Square Meters (Thousands)	Combination Barriers: Material	Square Meters (Thousands)
Concrete/Precast	2884	Berm/Wood	278
Block	2402	Berm/Concrete	172
Wood/Post & Plank	464	Wood/Concrete	152
Concrete/Unspecified	391	Berm/Metal	133
Berm Only	298	Concrete/Block	94
Wood/Unspecified	289	Metal/Concrete	87
Wood/Glue Laminated	236	Concrete/Brick	72
Metal/Unspecified	233	Berm/Block	52
Brick	94	Wood/Metal	43
Other	81	Berm/Wood/Concrete	27
		Wood/Block	26
		Berm/Wood/Metal	16
		Other	80
Total	7,372	Total	1,232

Table 3
Type II Noise Barrier Construction By State By Total Barrier Area Through 1995

State	Square Meters (Thousands)	Actual Cost (Millions)	Cost In 1995 Dollars (Millions)
California	1079	$189.6	$230.1
Minnesota	243	18.8	33.3
Maryland	144	44.4	51.1
Wisconsin	142	22.8	26.5
Ohio	118	10.2	10.6
Michigan	107	19.3	25.5
New York	93	20.8	23.3
Colorado	83	9.0	10.5
New Jersey	79	20.3	23.3
Indiana	49	12.0	12.0
Connecticut	29	2.1	3.2
Utah	12	1.1	1.0
Oregon	10	1.3	1.5
Washington	9	1.6	1.9
Louisiana	5	0.2	0.3
Iowa	4	0.4	0.6
Georgia	3	0.5	0.6
Massachusetts	2	1.0	1.0
Florida	1	0.1	0.2
Total	2,212	$375.5	$456.5

Table 3 lists the nineteen States that have constructed at least one Type II barrier (i.e., barriers constructed for an existing highway). It should be noted that the National Highway System Designation Act of 1995 restricted Federal participation in Type II noise barriers to those projects that were approved before November 28, 1995 or are proposed along lands where land development or substantial construction predated the existence of any highway.

The nine states that have not constructed noise barriers are: Alabama, Hawaii, Idaho, Mississippi, Montana, North Dakota, Rhode Island, South Dakota and Wyoming. ■

The Wall Journal's Old-Fashioned, Easy-to-Read and Comprehend, Converted from Metric, FHWA Tables, Expressly for Marketing People Who Want a Quick Fix on What the Market in Noise Barriers Looks Like

Bob Armstrong of FHWA has been kind enough to massage the data presented in the FHWA Report "Noise Barrier Construction Trends," published in the last issue of The Journal, to produce the tables presented here, which clearly define the market areas, barrier preferences and in-place costs.

Bob was further kind enough to have their computer print out square feet of wall rather than square meters. I don't know about you, but I have sold a lot of noise barriers in my time and my dinosaur brain can only visualize in square *feet*, not in square meters.

I think we all owe Bob and his staff a huge commendation for their efforts in assembling this data in such detail and in such a concise format. Since we first published this material in Issues 14 and 15 in 1994, I have had many requests for those back issues from noise barrier manufacturers, both already in the business and those contemplating it. Many have used it in preparing business plans and market research,

Many thanks to Bob, and to Steve Ronning and the others who have made this information available to all of us. ■

Wood Noise Barriers Constructed

	Before 1986		1986 - 1990		1991 - 1995	
STATE	SQ FT	$/SQ FT	SQ FT	$/SQ FT	SQ FT	$/SQ FT
AK	45,000	$9.00	103,000	$12.00	78,000	$10.00
CA	25,000	$11.00	20,000	$16.00	40,000	$13.00
CO	892,000	$7.00	214,000	$7.00	40,000	$39.00
CT	359,000	$9.00	893,000	$14.00	633,000	$5.00
EDF	106,000	$16.00				
GA			18,000	$23.00		
IL	59,000	$19.00	342,000	$13.00	331,000	$16.00
IA	13,000	$19.00			12,000	$10.00
LA	50,000	$6.00				
MD			176,000	$33.00		
MA	71,000	$7.00				
MI	33,000	$20.00	17,000	$17.00	2,000	$7.00
MN	1,814,000	$12.00	337,000	$12.00	155,000	$14.00
MO	9,000	$9.00			10,000	$18.00
NJ	116,000	$9.00	733,000	$21.00	263,000	$24.00
NY	121,000	$19.00	550,000	$18.00	299,000	$21.00
NC	109,000	$12.00	15,000	$13.00	8,000	$4.00
OH	104,000	$12.00			294,000	$8.00
OR	3,000	$4.00	12,000	$10.00	14,000	$7.00
PA	13,000	$21.00	30,000	$30.00		
TX	152,000	$8.00				
VT			14,000	$22.00		
VA	202,000	$8.00				
WA	29,000	$17.00	83,000	$8.00	11,000	$14.00
WV					8,000	$20.00
WI	104,000	$12.00			438,000	$21.00
TOTAL	**4,427,000**	**$11.00**	**3,557,000**	**$16.00**	**2,638,000**	**$14.00**

Concrete Noise Barriers Constructed

	Before 1986		1986 - 1990		1991 - 1995	
STATE	SQ FT	$/SQ FT	SQ FT	$/SQ FT	SQ FT	$/SQ FT
AZ	267,000	$11.00	68.000	$16.00	312,000	$11.00
CA	579,000	$16.00	258,000	$13.00	688,000	$15.00
CO	7,000	$102.00	33,000	$15.00	135,000	$25.00
CT	150,000	$7.00				
FL	77,000	$19.00	174,000	$16.00	2,217,000	$18.00
GA	114,000	$14.00				
IL	224,000	$16.00			114,000	$16.00
IN					528,000	$23.00
IA	22,000	$21.00			22,000	$17.00
KY			133,000	$13.00	66,000	$13.00
LA			16,000	$8.00		
MD	133,000	$29.00	1,618,000	$26.00	993,000	$31.00
MA	59,000	$13.00	13,000	$25.00		
MI	357,000	$21.00	71,000	$18.00	230,000	$20.00
MN	365,000	$13.00	148,000	$3.00		
MO	15,000	$24.00	13,000	$16.00		
NE					85,000	$20.00
NV	111,000	$12.00				
NJ	845,000	$23.00	2,451,000	$24.00	2,036,000	$25.00
NM					84,000	$12.00
NY	80,000	$13.00	1,239,000	$22.00	646,000	$22.00
NC	60,000	$5.00	195,000	$8.00	448,000	$14.00
OH	142,000	$9.00	16,000	$14.00	1,469,000	$9.00
OK					136,000	$20.00
OR	148,000	$9.00	515,000	$12.00	433,000	$13.00
PA	70,000	$19.00	2,399,000	$25.00	356,000	$19.00
PR			10,000	$10.00	51,000	$27.00
TN	393,000	$17.00			232,000	$11.00
TX	99,000	$24.00	584,000	$16.00	1,193,000	$16.00
UT	36,000	$9.00	364,000	$13.00	938,000	$9.00
VA	611,000	$15.00	11,000	$21.00	3,741,000	$18.00
WA	265,000	$13.00	174,000	$10.00	883,000	$18.00
WI	122,000	$13.00	180,000	$24.00	1.008,000	$19.00
TOTAL	**5,351,000**	**$16.00**	**10,680,000**	**$21.00**	**19,045,000**	**$18.00**

Metal Noise Barriers Constructed

	Before 1986		1986 - 1990		1991 - 1995	
STATE	SQ FT	$/SQ FT	SQ FT	$/SQ FT	SQ FT	$/SQ FT
AK	17,000	$12.00				
CA	31,000	$14.00			24,000	$25.00
CO	17,000	$8.00				
DE	4,000	$52.00				
FL	3,000	$20.00				
GA	291,000	$11.00	197,000	$8.00	235,000	$12.00
IL	47,000	$26.00				
IN			42,000	$11.00		
IA	125,000	$10.00				
KY	41,000	$12.00			24,000	$25.00
MA	13,000	$9.00				
NJ	4,000	$13.00				
OH	115,000	$18.00	95,000	$13.00	155,000	$14.00
OR	17,000	0				
PA	5,000	$65.00				
PR					5,000	$29.00
TN	337,000	$16.00			12,000	$52.00
VA	361,000	$7.00	68,000	$18.00		
WI			193,000	$14.00	33,000	$13.00
TOTAL	**1,429,000**	**$12.00**	**594,000**	**$12.00**	**489,000**	**$15.00**

Combinations of Noise Barriers Constructed

	Before 1986		1986 - 1990		1991 - 1995	
STATE	SQ FT	$/SQ FT	SQ FT	$/SQ FT	SQ FT	$/SFT
AK	75,000	$3.00				
AZ	214,000	$9.00				
AR	33,000	$11.00				
CA	143,000	$19.00	500,000	$16.00	473,000	$2200
CO	553,000	$6.00	450,000	$9.00	451,000	$14.00
CT	285,000	$9.00	275,000	$14.00	22,000	$1700
FL					11,000	$14.00
GA			170,000	$5.00	803000	$9.00
IL	21,000	$28.00	355,000	$12.00		
IA	16,000	$13.00	5,000	$14.00		
KS					103,000	$19.00
LA	82,000	$8.00				
MD	151,000	$21.00	68,000	$37.00		
MA	105,000	$10.00			24,000	$41.00
MI	399,000	$25.00	169,000	$25.00	231,000	$26.00
MN	1,824,000	$9.00	46,000	$16.00	269,000	$11.00
NE			16,000	$10.00	8,000	$17.00
NV	92,000	$2.00	216,000	$16.00	75,000	$35.00
NJ			88,000	$16.00	61,000	$21.00
NY	177,000	$24.00	103,000	$17.00	640,000	$14.00
NC	25,000	$11.00	38,000	$6.00	19,000	$13.00
OH	177,000	$10.00			35,000	$15.00
OK	66,000	0				
OR	373,000	$8.00	9,000	$17.00	43,000	$7.00
PA	15,000	$105.00	24,000	$50.00		
PR			60,000	$20.00	11,000	$37.00
SC					165,000	$10.00
TN	225,000	$17.00				
TX					54,000	$22.00
VT	6,000	$6.00				
VA	959,000	$19.00	32,000	$24.00	441,000	$16.00
WA	10,000	$9.00	160,000	$8.00	162,000	$25.00
WI			263,000	$11.00	78,000	$19.00
TOTAL	**6,028,000**	**$13.00**	**3,048,000**	**$14.00**	**4,180,000**	**$16.00**

Berm Noise Barriers Constructed

	Before 1986		1986 - 1990		1991 - 1995	
STATE	SQ FT	$/SQ FT	SQ FT	$/SQ FT	SQ FT	$/SQ FT
AK	5,000	0	2,000	$10.00		
AZ	466,000	$4.00			23,000	0
AR	34,000	$2.00				
CA	76,000	$5.00				
CO	16,000	$5.00				
CT	111,000	$6.00				
DE					50,000	0
EDF	44,000	$7.00				
FL	11,000	$7.00				
IL	125,000	$11.00	32,000	$5.00		
IA	83,000	$3.00				
ME	7,000	$3.00				
MD	48,000	0				
MA	9,000	$24.00				
MI	70,000	$6.00	17,000	$3.00		
MN	14,000	$18.00				
NE	27,000	0				
NV			7,000	$2.00	25,000	$10.00
NH	26,000	$4.00			38,000	0
NJ					21,000	$14.00
NY	279,000	$3.00	20,000	$20.00	35,000	$9.00
NC	248,000	$2.00				
OK	20,000	0				
OR	358,000	$3.00	124,000	$3.00	33,000	$8.00
PA	79,000	0	25,000	#5.00		
TX					15,000	$4.00
UT	1,000	$1.00			8,000	$4.00
WA	465,000	$3.00	49,000	$1.00	77,000	$2.00
WV	6,000	$2.00				
TOTAL	**2,628,000**	**$4.00**	**275,000**	**$4.00**	**326,000**	**$4.00**

Block Noise Barriers Constructed

	Before 1986		1986 - 1990		1991 - 1995	
STATE	SQ FT	$/SQ FT	SQ FT	$/SQ FT	SQ FT	$/SQ FT
AZ	2,000	$1.00	48,000	$12.00	55,000	$12.00
CA	6,515,000	$16.00	8,130,000	$16.00	9,612,000	$17.00
CO			24,000	$11.00	8,000	$28.00
CT			3,000	$45.00		
FL	26,000	$14.00			11,000	$14.00
MI	41,000	$22.00	209,000	$22.00	272,000	$24.00
MN	137,000	$25.00				
NM	7,000	$22.00				
NY	7,000	$37.00				
OR	204,000	$23.00	67,000	$12.00	100,000	$16.00
PA	26,000	$38.00				
PR	9,000	$9.00				
UT	227,000	$2.00				
WA					41,000	$25.00
TOTAL	**7,202,000**	**$16.00**	**8,481,000**	**$16.00**	**10,099,000**	**$17.00**

Brick Noise Barriers Constructed

	Before 1986		1986 - 1990		1991 - 1995	
STATE	SQ FT	$/SQ FT	SQ FT	$/SQ FT	SQ FT	$/SQ FT
CO					117,000	$15.00
KY					82,000	$14.00
MI	95,000	$14.00	143,000	$24.00		
NC					465,000	$19.00
OH	67,000	$20.00				
OK	10,000	$21.00				
PA			27,000	$32.00		
UT	9,000	$17.00				
TOTAL	**181,000**	**$17.00**	**170,000**	**$25.00**	**664,000**	**$18.00**

TRB Committee A1F04 on Transportation Related Noise and Vibration

By Gregg G. Fleming, Chairman

Gregg G. Fleming

I have much to report on the TRB front (probably because I haven't written a column for several issues, having been out in the field for extended periods).

As many of you know, the TRB Annual Meeting took place in Washington, DC January 12 through 16, 1997. Not including the four A1F04 Committee meetings, there were four sessions related to transportation noise, two of which were paper sessions and two of which were presentation sessions.

On Tuesday evening, we heard about the largest aircraft noise research program ever undertaken. Bill Wilshire (NASA), Juliet Paige (Wyle Laboratories), and Sandy Fidell (Bolt, Beranek and Newman) spoke about various aspects of the $170M NASA/FAA program.

On Wednesday morning, we had two back-to-back paper sessions on transportation-related noise issues, with a focus on highway noise. A draft version of the eight papers that were presented begins on the next page. Wednesday evening, Grant Anderson (HMMH), Bob Armstrong (FHWA), and Cyndy Lee (Volpe Center) presented material related to the much-anticipated FHWA Traffic Noise Model (FHWA TNM®). A status report can be found on page 5 of this issue.

The following items were announced at the Annual Meeting as being available or soon to be available:

FHWA Video: "Highway Noise Barriers: Performance, Maintenance and Safety" (Available through NTIS, Video No. AVA19985VNB1).

FHWA Document: "Measurement of Highway-Related Noise" (Available through NTIS Publication No. PB96-147780).

Updated ANSI Standard: "Methods for Determination of Insertion Loss of Outdoor Noise Barriers" (soon to be available through the American National Standards Institute).

Other highlights of this year's annual meeting included the traditional Awards Dinner, which was held in honor of Lloyd Herman, Craig Clum, Michael Finney (all of Ohio University), and Elvin Pinckney (Ohio DOT) for their fine paper, "Perception of Traffic Noise Barrier Effectiveness: A Public Opinion Survey of Residents Living Near I-71." Lloyd, Craig and Elvin are pictured below.

At the dinner, we also mourned the passing of longtime A1F04 member Harvey Knauer, that is, the passing from the public sector to the private sector. We wish him well in his new endeavor. On behalf of the Committee, Harvey, a longtime Jimmy Buffet fan, was outfitted with the necessary apparel for his next Buffet concert (see picture below).

All in all, the entire meeting was a real success, and better yet, no snow this year!

Reflecting back on 1996, there were three fairly significant TRB-related noise activities which took place. In May, a TRB-hosted/FAA-funded workshop took place at TRB's Woods Hole, Massachusetts facility. The topic of the workshop was research needs in the area of aircraft noise modeling. The conference was widely attended by members of U.S. and foreign government, industry, and academia, including FAA, CAA, the Volpe Center, the USAF, Boeing, Douglas and many others. A document summarizing the workshop is currently being prepared by TRB.

In July 1996, Illinois DOT, Illinois State Toll Highway Authority and H.W. Lochner, Inc. hosted the TRB Committee A1F04 Summer Meeting. The meeting was well attended, with almost 100 noise professionals taking part. The technical sessions were of their usual high quality, and the tours of River-

L. to R.: Craig Clum and Lloyd Herman (Ohio University) and Elvin Pinckney (Ohio DOT) accept their award for Best Paper.

Harvey Knauer of PennDOT, soon to leave public service, beginning to acquire an appropriate wardrobe for life in the private sector.

bank Laboratories and Chicago O'Hare Airport were excellent.

And, in November 1996, TRB hosted an environmental research needs conference in Washington, DC. In the topic area of noise, three teams formulated five research statements for each of three modal areas — aircraft, highway and rail noise. A document summarizing the statements in all environmental areas is currently being prepared by TRB.

Looking ahead in 1997 and beyond, the Committee A1F04 Summer Meeting will take place in Toronto, Ontario, Canada. The meeting is scheduled for July 20 through 23 at the Delta Chelsea in downtown Toronto. All arrangements are being made by Soren Pedersen of the Ministry of Transportation of Ontario. Soren's telephone is 905 704-2291.

A couple of significant changes for this year: (1) the technical sessions will be scheduled for three full days, instead of the usual half-day on Wednesday (this will minimize the distraction of people departing on Wednesday) and (2) the Committee is introducing the first annual A1F04 Scholarship Program (see box at right).

At the Annual Meeting, Soren indicated that he is looking for a logo for the Summer Meeting. Any ideas should be forwarded to him directly. Look for more details on the meeting in upcoming issues of The Wall Journal as well as the Committee A1F04 spring newsletter.

At the TRB Annual Meeting, a proposal was made to have a dedicated rail noise session and a tire/pavement noise session for the 1998 Annual Meeting. There's no better place to "rehearse" your presentation for the Annual Meeting than at the previous summer meeting — so, get your abstracts into Soren as early as possible. ■

COMMITTEE A1F04 FIRST ANNUAL SCHOLARSHIP PROGRAM

Sponsored by
Committee A1F04
Transportation Related Noise and Vibration
Transportation Research Board

Purpose: To increase attendance at Committe A1F04 summer meetings by state DOT representatives

Eligibility: State DOT representatives who are active in transportation-related noise issues

Details: Between 2 and 4 scholarships will be awarded for the upcoming summer meeting in Toronto, Canada, scheduled for July 20-23, 1997. The scholarship will include conference registration, 4-night hotel accommodations, and up to $500.00 towards airfare. Scholarships will be awarded based on past contributions to the committee and budgetary constraints. Willingness to make a presentation will also be considered in the award process.

How do I apply? By April 30, 1997, send a brief letter describing your past contributions to the committee, your budgetary constraints, and a paper abstract for presentation (if applicable) to: Cynthia Lee, Volpe Center DTS-75, 55 Broadway, Cambridge, MA 02142.

Submissions will be evaluated and announcement of award will be made by May 31, 1997. Note: Awardees will be required to submit an expense report prior to reimbursement.

TRB COMMITTEE A1F04 ANNUAL MEETING, JANUARY 12-16, 1997
ABSTRACTS OF 8 PROFESSIONAL PAPERS (DRAFT VERSIONS)

Standards for Noise Barriers Using Recycled Plastic

Osman Hag-Elsafi*, David Elwell, Gary Glath, and Melanie Hiris, New York State Department of Transportation
*Phone: 518 457-5826

Increasing public demand for reduced traffic noise levels is generating need for more and better highway noise barriers. Those using such conventional materials as wood, steel, or concrete, deplete natural resources, and occasionally meet public criticism regarding aesthetics. Disposal of accumulating plastic waste is another environmental challenge.

Barriers that use recycled plastic thus are not only functional but also environmentally beneficial. Such barriers are proposed in this paper.

The proposed material is recycled plastic lumber, a material extruded into standard lumber sizes used by the timber industry. This material has many advantages. It is durable and requires little maintenance, can be cut and fastened like wood, provides several aesthetic alternatives in both color and texture, is highly resistant to insects and graffiti, is readily available, and is thus inexpensive compared to custom-made plastic shapes. Being denser, it should block noise more effectively than wood sheathing of similar thickness.

Wood or steel frames are proposed for structural support, with maximum span of the plastic-lumber sheathing limited to 1.22 m (4 ft). The wood or steel frames can be arranged in many configurations for aesthetic purposes, and designed to satisfy optimum cost requirements. The proposed systems are competitive with current barriers with respect to initial cost, and may have long-term economic benefits as a result of greater durability, minimal maintenance, and low life-cycle cost. ■

Laboratory Experimentation of Sound Absorbing Concrete Block Filled with Shredded Tire Rubber

Heesuk Lee*, Jinkyung Kim, Ben Moloney, Hosin Lee, and William VanMoorhem, University of Utah
*Phone: 801 585-6861

This paper discusses the use of shredded tires as filler for the sound absorbing blocks. Absorption coefficients for various noise frequencies were measured for different noise absorbing block with fillers. Absorbed frequency was higher as cavity size of the building blocks becomes smaller with more crumb rubber fillers in the cavity. A sound testing room stacked with sound absorbing blocks filled with crumb rubber showed the higher sound absorption coefficient than that of sound absorbing block or regular block. ■

Good Fences Make Good Neighbors: Highway Noise Barriers and the Built Environment

Domenick J. Billera, New Jersey* Department of Transportation;
Richard Parsons and Sharon Hetrick, Gannett Fleming Engineers
*Phone: 609 530-2834

(continued next page)

(**Papers,** *continued from page 11)*

Noise barriers have become a prominent feature on today's landscape. Unfortunately, they have also become a feature associated with insensitivity toward the built environment. Designers could avoid the negative visual impact noise barriers frequently created by increasing their awareness of aesthetics in the design process.

In an effort to improve the quality of noise barrier design, the New Jersey Department of Transportation's (NJDOT) Bureau of Environmental Analysis (BEA) altered the design process for their I-76/I-295 Type II Noise Abatement Study. The first objective of the study was to acoustically engineer a barrier that would abate the noise for residents along the affected roadway corridor. The second was to develop an architectural design that would be aesthetically pleasing to both the corridor resident and the roadway users.

Typically, architects were brought into the design process at the end to review the aesthetic impact of the wall and add architectural features. On the I-76/I-295 project, the BEA initiated a parallel process with the architectural design running concurrent with the engineering. This paper describes the architectural design process and the interfacing of this process with the engineering.

Community involvement was essential to the architectural objective of designing an aesthetically pleasing barrier. Ideas reflecting community concerns and comments were refined into final recommendations for construction of a noise barrier with gateways and a unifying corridor scheme. The noise barrier should then become a representation of the community and stand as an icon in the built environment.

Noise barriers can have a positive impact on the built environment if a commitment is made to aesthetics throughout the design process. ■

Perception of Traffic Noise Barrier Effectiveness: A Public Opinion Survey of Residents Living Near I-71

Lloyd A. Herman*, Michael Finney, and Craig Clum, Ohio University; Elvin Pinckney, Ohio Department of Transportation
*Phone: 614 593-1472

The completion of the largest Ohio Department of Transportation traffic noise abatement project in 1995 was met with public controversy over noise barrier effectiveness. A public opinion survey was designed to obtain perceptions of the residents in the project area. In a departure from most surveys of traffic noise barrier effectiveness, the coverage was not limited to the first or second row of houses, but was extended to 800 meters on each side of the roadway. It was found that the larger survey area was needed to avoid misleading conclusions. Overall perceptions of noise barrier effectiveness were found to vary with distance from the roadway and with noise barrier configuration. ■

A Simulation Approach to Traffic Noise Modeling (AAMA Community Noise Model Version 3.0)

Roger L. Wayson*, John M. MacDonald and Ronald Eaglin, University of Central Florida
*Phone: 407 823-2480

There are several models available for prediction of traffic noise levels. The FHWA promulgated model STAMINA 2.0 is the most used model in the U.S. and models free flow vehicular traffic. STAMINA 2.0 is most directly applicable to simulation of noise from highway traffic traveling at constant speeds. STAMINA 2.0 cannot directly model interrupted flow traffic, or traffic situations where traffic does not travel at a constant speed. Interrupted flow traffic can be simulated with STAMINA 2.0 using the method presented in NCHRP 311. This method is being incorporated into the new FHWA model, the Traffic Noise Model. This method is time-consuming and difficult to use. Furthermore, the STAMINA 2.0 uses average total traffic over the entire length of a defined roadway and calculates the noise produced by "segments" of the roadway. These limitations demonstrate the need for a traffic noise model that can model the acceleration and deceleration behavior of interrupted flow traffic.

The University of Central Florida developed the Community Noise Model, a traffic simulation model that determines sound levels at receivers by modeling vehicles as discrete moving point sources. The vehicles individually emit energy determined from acceleration, deceleration, idle and cruise reference energy mean emission level curves. Attenuation of energy emitted from vehicles by distance, ground absorption and user input barriers is calculated. The model sums the energy at receivers each 1/2 second from all vehicles and then calculates the L_{eq} level at the receivers.

This paper demonstrates that the CNM predicts receiver L_{eq} levels closer to measured values than the STAMINA 2.0/NCHRP311 model and the TNM model. In addition to the advantages of a real simulation model, the CNM is user friendly, allowing the user to place lanes and receivers using the mouse. A complex lane geometry can be input in a matter of minutes with the CNM graphical interface. ■

Research and Development by an Australian Road Authority Using Object Oriented and GIS Technologies: The Example of Urban Road Traffic Noise

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

It is now some four years since the New South Wales Roads and Traffic Authority (RTA) Interim Noise Policy was released. This document sets out RTA policies regarding traffic noise along with guidelines relating to assessment and control. It is perhaps the most extensive document on the topic ever produced by an Australian road authority. The underlying philosophy of the policy is the importance of noise as an issue which must be addressed in all aspects of the RTA road planning, design, construction, maintenance and operation programs. The paper commences, therefore, with a consideration of some recent advances in the traffic noise arena.

It then outlines a spatial decision support system for road planning which has been developed as part of a Australian Research Council industry collaborative research grant involving the RTA and the University of New South Wales. This is built on object-oriented programming and GIS technologies and involves a library containing models in 8 domains amounting to 33,000 lines of code. The paper describes the noise estimation procedure included in this system and how it has been adapted and implemented in an object-oriented way. It then speculates on how the prototype may be integrated into the emerging corporate responsibilities of the RTA in the area of communication and consultation.

Implementation of Proponent Mitigated Development Strategies for Traffic Noise and Land Use Compatibility Planning

Lloyd A. Herman*, Ohio University;
William Bowlby, Vanderbilt University
*Phone: 614 593-1472

Noise and land use compatibility programs which make use of Proponent Mitigated Development strategies were studied to identify critical program elements, measures of effectiveness, and the steps to be taken for program implementation. It was found that Proponent Mitigated Development strategies can be an effective complement to land use zoning in traffic noise and land use compatibility programs. ■

Stop the Whine! Narrow Band Noise Level Measurements of Three Highway Pavements

Domenick J. Billera*, New Jersey Department of Transportation;
Bela Schmidt and Wayne Miller, Louis Berger and Associates
*Phone: 609 530-2834

The origins of an annoying high pitch sound emitted by highway traffic was investigated in this study. Wayside noise levels of single vehicles passing over three different types of pavement surfaces were measured using real traffic. Data based on a statistically significant number of samples are presented for automobiles and heavy trucks. All data was collected using a real time analyzer with 1/3 and 1/12 octave band resolution. The measured data confirmed the transverse grooved pavement as the noisiest with a noticeable concentration of sound., often described as "the whine." Data for the asphalt and longitudinally grooved surfaces showed lower overall noise levels and a near absence of "the whine." ■

Newsmakers in Noise Abatement

Guy B. Le Gendre has been promoted to President of Sound Fighter Systems, Inc., of Shreveport, Fred W. Bailey, Chairman of the Board, announced today.

Le Gendre, who had been serving as general manager, will direct manufacturing operations and the marketing of Sound Fighter products. These include silencer rain caps, Sonaguard acoustical enclosures, industrial silencers and Sound Fighter propeller fans.

Principal product lines also include cast aluminum expansion joints for bridges and overpasses, as well as the well-known LSE modular acoustical noise barrier wall recently installed on Interstate 49 in Louisiana.

A native of Shreveport, the new president attended Louisiana State University and received a BS degree from Centenary College.

Prior to joining Sound Fighter Systems, Inc., in 1989, he was President of Bayou Metal Products Co., a contract fabrication firm. He began his career after college with Hycalog, Inc.

While with Sound Fighter, Le Gendre has directed several major projects including one in Bombay, India, the Seven Mile Bridge in Key West, Florida, and the Y-II-C interchange in San Antonio, Texas. He also has directed numerous installations of the LSE noise wall system throughout the United States.

Le Gendre is married to the former Rene' Hardie. They have three married children and five grandchildren.

Environmental Research Needs in Transportation

An Upcoming TRB Circular

Announcement by Jon Williams, Senior Programs Officer, Transportation Research Board

In November 1996, 140 transportation environmental specialists from around the country assembled for two and one half days at the Transportation Research Board's Washington offices and worked collegially to identify research needs. Participants formed into thirteen work groups, each group representing a different environmental topic area.

After identifying and prioritizing research needs, the groups drafted work statements for the top needs. These statements, along with resource papers developed for each topic area, will be published as TRB Circular, Environmental Research Needs in Transportation.

It is expected that the Circular will be used extensively in coming years to inform research programs sponsored by federal and state agencies, universities, and private environmental organizations. The Circular should be available in April 1997. Copies may be ordered from TRB publications / sales at 202-334-3213 or 334-3214.

(Editor's Note: Following is a list of the research needs developed by the 13 work groups, which is followed by the work statement for one particular research need concerned with sound-absorbing barrier materials.

Space was not available in this issue to print all of the work statements; they will be published in the March/April issue of The Wall Journal).

Aircraft Noise

1. Supplementary Metrics for the Evaluation of Aircraft Noise Impact
2. Technology for Aircraft Noise Control
3. Effect of Sudden Changes in Noise from Aircraft Operations on Sleep Disturbance and Annoyance
4. Assessment of Sound Insulation Modification Procedures
5. Standardized Testing Methods for Exterior to Interior Noise Reduction
6. Model Building Code Development
7. Computer Model for the Prediction of Noise from Transportation Systems

Highway Noise

1. Atmospheric Effects on Highway Traffic Noise Propagation
2. Upgrade the FHWA Traffic Noise Model (TNM)
3. Reduction of Tire/Pavement Noise
4. **Investigation / Validation of Testing Procedures for Sound-Absorbing Barrier Materials** (see next column)
5. Development of Outreach Materials to Aid in Noise Compatible Land Use Planning
6. Transportation Noise Prediction Model
7. Investigation of Sound Propagation over Irregular Terrain
8. Field Evaluation of Reflected Noise for Sensitive Receptors Across from a Non-Absorptive Barrier Surface.

Transit Noise

1. Transit Vibration Criteria Study
2. Wheel Squeal Abatement
3. Warning Signal Assessment and Control
4. Transit Vehicle In-Service Noise Emission Levels
5. Computer Module and Database for Calculating Fixed Guideway Transit Noise
6. Groundborne Vibration Prediction
7. Ballast Mat Vibration-Isolation Effectiveness
8. Source Vibration Characterization of Rail Transportation Systems

Title: Investigation/Validation of Testing Procedures for Sound-Absorbing Barrier Materials

Problem Statement: Controversy currently exists in the highway traffic noise barrier field as to the proper test procedure for determining the coefficient of absorption for barrier materials.

Proposed Research: A review of testing procedures used abroad (Europe, Japan) where sound absorbing materials are prevalent may, in itself, provide an answer. However, an important aspect of the testing procedure may currently overpredict the absorption and should be investigated. Does the frequency range of the current test match the actual highway traffic noise spectrum? Given the low frequency content of highway traffic noise and the relatively poor performance of most sound-absorbing materials at low frequencies, should weighting be employed to determine an overall absorption coefficient? The weighted absorption coefficient for any material could become a module for the FHWA TNM to allow the consideration of the spectral content of barrier reflections for sound-absorbing surfaces.

Cost: $150,000

Duration: 1 Year

Urgency and Payoff Potential: A substantial number of sound-absorbing noise barriers have been constructed or are planned for construction. The fact that controversy exists among noise experts on the value of existing test methods for noise absorption will only add to a loss of State Department of Transportation (DOT) credibility with communities seeking noise relief that are unsure of the value of State DOT proposals for sound-absorbing barriers. This can result in project delays and increased costs to satisfy the communities. This research study will help State DOTs maintain credibility and can increase the accuracy of highway traffic noise prediction. ■

PARALLEL BARRIER ENGINEERING

By Edward P. McNair

Since becoming involved with highway noise barriers in the last few years, most of the technical articles and presentations that I have read concern themselves with the justification of barrier installation in specific locations. And well they should. Any planning for noise barrier construction should not take place until the potential impact is accurately forecast; the criteria for the expenditure, such as housing density, has been met; and it has been determined that the affected community desires the barriers.

In contrast, there doesn't seem to be as much attention placed on the design and installation of the barriers themselves. Single barriers are pretty straight forward. The highway engineer is mostly concerned with their cost, height, appearance, and that they won't fall down.

However, reflections from parallel barriers cause Barrier Insertion Loss Degradation (BILD). Attempts to compensate for BILD by building the walls higher, or to alleviate it with absorptive surfaces have proved disappointing, and engineers have wondered why the actual barriers do not perform as well as predicted.

In issue 21 of The Wall Journal, Rudy Hendricks wrote an opinion article "To Absorb or Not To Absorb." In the beginning of his article he states, "We should first quantify scientifically what the benefits are of the absorptive surfaces in terms of noise reduction, and then decide if the benefits are worth the cost."

It is not "good enough" to assume that any material that is partially "absorptive" will make the BILD Problem go away because most of the time, it won't. But there are a few more mathematical calculations that can be done without the assistance of an acoustical expert that will help engineer better answers. For example, if the BILD for a pair of barriers is forecast to be 4 dB, actually absorbing 70% of the reflection would reduce it by 2.3 dB, which, in the opinion of some (I don't agree), is too small a change to be noticed.

As Paul Harvey would say, "Now for the rest of the story."

Combining Direct and Reflected Noise

Barrier Insertion Loss Degradation, or "BILD" is the sum of two or more sound energies. We know that when two noises are combined, the sound energy of one is added to that of the other. We use the decibel system for measuring noise levels based on the Bell Scale (Alexander Graham, that is) which is the common logarithm of the sound energy. Us old folks used to work with logarithms all the time, but we went to school way back in B.C. (Before Calculators).

When you add or subtract logarithms, you are multiplying or dividing the original numbers. To add or subtract two sounds, you have to convert Bells to antilogs so that sound energy can be added or subtracted, then return the result back to Bells. So, in order to calculate combinations of noises in decibels, we have to go to their

(continued next page)

(**PARALLEL**, *continued from previous page*)

antilogs. Here are two examples of how to determine noise combinations using the common logarithm - antilog function of a calculator.

Example 1:

To combine two noises of 75 dB and 80 dB;

antilog of 7.5 = 3.16×10^7

antilog of 8.0 = 1.00×10^8

Total = 1.316×10^8

log of 1.316×10^8 = 8 + .119 = 8.12 or 81.2 dB

Example 2:

If total noise is 67 dB, and one noise is 63 dB, what's the other noise?

antilog of 6.7 = 5.01×10^6

antilog of 6.3 = 2.00×10^6

Difference 5.01 - 2.00 = 3.01×10^6

Log of 3.01×10^6 = 6.48 or 64.8 dB

While it is easy to calculate these figures using a calculator that has log functions, it is quicker and more practical to use the conversion graph shown in Fig. 1. This graph is one of several formats used in textbooks over the years to show the resulting sound pressure level, in decibels, of one sound reinforcing another. While this format is not unique (this one is at least 30 years old), it should be emphasized that

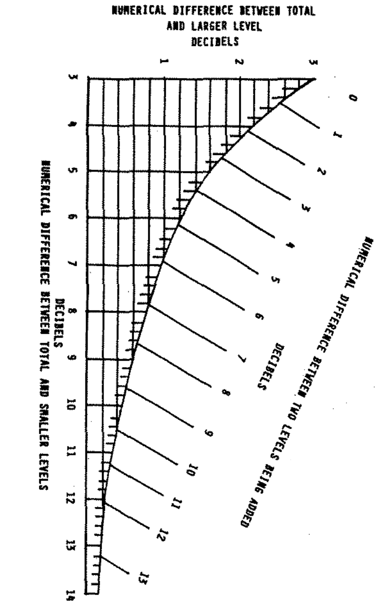


Fig. 1

the graph is not based on acoustics at all, but on mathematical conversions.

The 3 dB Rule

One advantage of this format is that it is helpful in implementing the 3 dB rule. That rule is that it is mathematically impossible for the total of two noise levels to be more than 3 dB above the higher level. When the energy of two sounds are added together, the greatest increase occurs when the their energy levels are equal. That is equivalent to doubling one noise source so that the total noise level increases by 3 dB (the log of 2 is .301). Adding together the sound energy from two unequal noise levels will always result in a noise level increase less than 3 dB above the higher noise level. Therefore, if the BILD is less than 3 dB, the direct noise is the louder noise. Conversely, if the BILD is greater than 3 dB, the reflected noise is the louder noise.

The graph shown in Fig. 1 has been constructed by following the procedure described above for adding the antilogs and plotting the logs of their sums in dB. Because of the 3 dB rule, BILD appears on the horizontal scale when it is greater than 3 dB and on the vertical scale when it is less than 3 dB.

Here is an example of how the graph can be used:

> Lets say that it has been determined that parallel barriers should be built along a section of new highway and that the FHWA's Traffic Noise Model

has computed a parallel barrier degradation of 4 dB (see The Wall Journal, Issue No. 22, page 17).

In this case, the direct noise is the smaller level, so enter the graph along the bottom line at 4 DECIBELS and read up to the slope to find a difference between the two levels of 1.8 dB. That means that the reflected noise is 1.8 dB higher than the direct noise. Reading to the left we see that the total noise is 2.2 dB higher than the reflected noise.

If an absorptive surface whose coefficient of absorption for the central frequencies of the octave bands being considered is .7, then it will reduce the reflected noise for that band by 5 dB (the reflection is only 30% of its previous value and the log of .3 is -.52). It's the same 5 dB less if the original noise level is 55 dB or 85 dB.

Subtracting the 5 dB from the 1.8 dB yields a difference of -3.2 dB. Since the result is negative, the direct sound is now the larger sound. Reading to the left horizontally from 3.2 dB on the slope shows that the BILD would be reduced to 1.7 dB for that frquency, an improvement of 2.3 dB.

Similarly, we find that if the BILD is 6 dB, a 70% absorptive surface would reduce it by 3 dB. If the BILD is 4 dB, this same surface would reduce it by 2.7 dB, and 3 dB of BILD would be reduced by only 1.8 dB.

The figures that I chose for this illustration were arbitrary, but not unreasonable. 4 dB of BILD will happen more often than 5 or 6 dB of BILD. If you want to try this exercise using different rates of absorption, 60% absorption reduces the reflection by 4 dB, 80% absorption reduces the reflection by 7 dB.

Thus, if the cost for an absorptive barrier over a reflective barrier is substantially higher, and the criteria selected by a state D.O.T. to justify that extra cost is a minimum of a 3 dB improvement, a material that actually absorbs only 70% of the sound energy will not meet that performance criteria.

The above calculations were based simply on total reflections, but the higher BILD situations are the result of a combination of a single and multiple reflections and the latter term is used with regard to parallel barrier degradation. We really don't care what kind of reflections cause BILD except if it significantly changes the above calculations. The reflections start with a single reflection. We are talking about highly reflective vertical walls, so attenuation of the reflections is a function of Width X Height. If the Width X Height ratio is high enough, multiple reflections are too low to be audible and their sum will not add to the BILD.

As the Width X Height ratio becomes lower, say less than 15:1, the subsequent reflections can be described as behaving like a geometric progression whose ratio Is less than one. When the ratio is less than one, the equation for the sum of a geometric progression when the number of terms is increased indefinitely is:

$$s \rightarrow a/(1 - r) \quad \text{as } n \rightarrow \infty$$

In this case, s = sum of the energy of multiple reflections; a = energy of the 2nd reflection, r = coefficient of the amount of energy reflected each time, and (1 - r) would be the decay rate.

But, in situations that we are concerned with out on the highway, as long as each succeeding reflection has less than half the

(continued next page)

(**PARALLEL**, *continued from previous page)*
energy of its predecessor, in these calculations, the sum of multiple reflections will change more slowly than a single reflection will change, and the calculations used for determining the alleviation of BILD will apply. In the Width X Height ratio, the maximum width is determined by the right of way, and the minimum height of each of two parallel barrlers has to be the same as for a single barrier. Increasing the height of the barriers beyond that is probably the most unattractive and expensive way to compensate for BILD. If the Width X Height ratio were low enough that each succeeding reflection had more than half the power of its predecessor then the walls are too high, and the cure has become worse than the disease.

It's important to remember that these examples are based not on acoustical theory, but on mathematical calculations: specifically. the relationship between loqarithms and their antilogs.

Picking the Right Coefficient

The calculations show that partial absorption can yield marginal results, even when it is assumed that the materials will actually reduce the reflections by these amounts in the frequency ranges that have the highest noise levels; therefore, it becomes important to accurately determine what the absorption rate is in real life situations.

Paragraph 4.2 of ASTM Test C 423 - 90a states, "the sound absorption coefficient of a surface ... is ideally defined as a fraction of the randomly incident sound power absorbed by the surface,.... The relationship between the theoretically defined and the operationally measured coefficients is under continuing study."

Obviously, if tests of highway sound barrier materials yield absorption coefficients of 1.3 or more for some frequency bands, the operationally measured coefficients do not come close to the theoretically defined coefficients.

We also have the question of normal incidence noise vs. random incidence noise which I discussed in my opinion article, "The Very High NRC Problem" in Issue No. 21 of The Wall Journal.

Picking the Right Frequencies

When calculating the performance of the absorptive material, I also kept it simple by assuming that the material actually reduced the reflection in the frequency ranges that are the loudest. Without a barrier, highway noise levels are pretty uniform from around 75 Hz to 4000Hz, but low frequencies are diffracted more than high frequencies, so beyond a barrier, the highest noise levels are in a frequency range below 1000 Hz.

You can check this out for yourself. Like the human ear, a noise meter registers the loudest noise, regardless of frequency. With a basic noise meter at an existing barrier, take readings using the dB A scale and the dB C scale. Since the dB A scale and the dB C scale are the same at and above 1000 Hz, a higher reading on the dB C scale indicates that the loudest noise is below 1000 Hz. In fact, if you examine the graph of Fig. 2 showing the dB A curve and the dB C curve, you will probably conclude that the loudest frequencies are below 500 Hz.

The dB A curve approximates how people hear different frequencies when the sound pressure is at 40 dB. The dB C scale does the same at the 100 dB level. Above 55 dB people actually hear low frequencies bet-

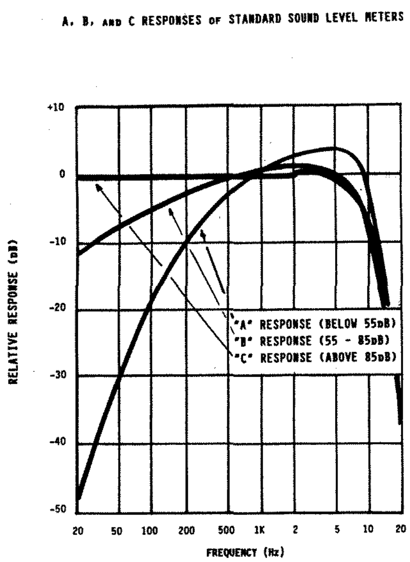


Fig. 2

ter than the dB A scale indicates. The whole purpose of sound barriers is to mitigate the impact of noise on the people in the adjacent community. While the dB A scale is universally accepted as the standard for noise control purposes, from the point of view of giving the community the best barrier for the buck, the state environmental engineers might wish to take the difference into account. Indoors, 1000 and 2000 Hz noise may be as significant as 250 and 500 Hz noise, but that doesn't make them valid for evaluating highway barriers.

ASTM Test C423 - 90a requires that the center of frequencies be selected from the series 125, 150, 500, 1000, 2000, and 4000 Hz to determine coefficients of absorption, with all six frequencies required for a standard test. Any proprietary absorptive material with a NRC rating will also have this information available. So if the frequency range that causes the noise is well below 1000 Hz, why not consider the three lowest coefficients of absorption required by the test in calculating performance?

A Solution to the Dilemma

That leaves us with a dilemma. Whenever BILD is above 3 dB, the reflected noise beyond the barrier is higher than the direct noise. But even if most of the noise heard beyond the barriers after their installation will be reflected noise, considering how little performance improvement can be gained, it is seldom worth a lot of extra expense to reduce the reflection.

Parallel barriers shouldn't be built any higher or cost any more than single barriers. Low cost absorption is a good thing, but the only way to be sure that you are getting a good value is to not preclude the consideration of other types of barriers. Exclusively specifying absorptive barriers in bids isn't cost effective.

A better solution would be a "belt and suspender" approach of parallel barriers having inclined faces, and comprised of monolithic panels of conventional light weight concrete that has some porousness but that remains dense enough to meet the requirements for strength and sound transmission loss, would minimize BILD at little or no extra cost. ■

(Ed McNair received his B.S. in Engineering from West Point in 1954. He worked in Plant Engineering and Manufacturing Management for 16 years. Since 1973, he has been a management consultant in Industrial Engineering. In 1995, he developed and patented the ***Whisper Walls*** *vertical sound barriers with multiple inclined faces. Ed, who lives in New Jersey, says that he got interested in the field of highway sound barriers "because they were there.")*

Letters to the Editor

OFFICE OF THE ENVIRONMENT PROTECTION AUTHORITY
Adelaide, South Australia

!6 December 1966

Dear El,

Just dropping you a note to wish you and your family the very best for Christmas and hope you have a safe, prosperous and healthy New Year.

Your publication is very much appreciated here in the antipodes. Keep up the good work!

Please don't feel disappointed that we haven't contributed anything to The Journal yet, but it is high on our agenda and as soon as we consider that we have an issue worth sharing we will be in touch.

Once again, the very best to you all.

Marco Ciccozzi
Noise Control Engineer

Ed. — Many thanks, mate. I look forward to publishing your paper.

EDWARDS AND KELCEY, INC.
Morristown, New Jersey

November 20, 1996

Dear El,

In The Wall Journal issue No. 25, you provide a list of subscribers names, addresses and telephone numbers. I was very happy to see a long list of names including mine; however, as you are well aware engineers always tend to be nitpickers, and just to bring back old memories I have redlined the corrections in my listing.

I would also just like to take this opportunity to tell you to keep up the good "work" you are doing. However, it does sound like you are having too much fun to call it work.

Sincerely,
Richard Janecek, P.E.

Ed. — Rich, we've been friends for many years. It pains me to see you writing poison pen letters to me at this late date.

SKELLY and LOY, Inc.
Monroeville, Pennsylvania

January 10, 1997

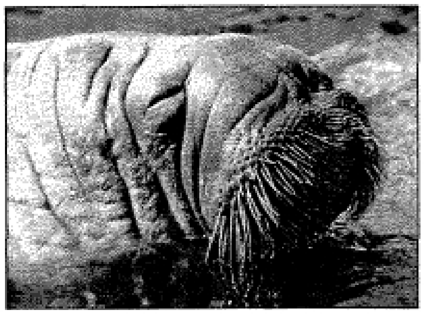
Dear Mr. Angove,

In your Editor's Corner from the Nov/Dec 1996 issue, you asked about principal interests for The Wall Journal. My interests are generally with the case histories for either completed or on-going noise abatement studies for highway use and currently any information related to the FHWA's TNM. Additionally, I've completed some noise-related work in conjunction with future Go-Cart Race Tracks. Is there a possibility of articles related to this area occurring in a future issue of The Wall Journal?

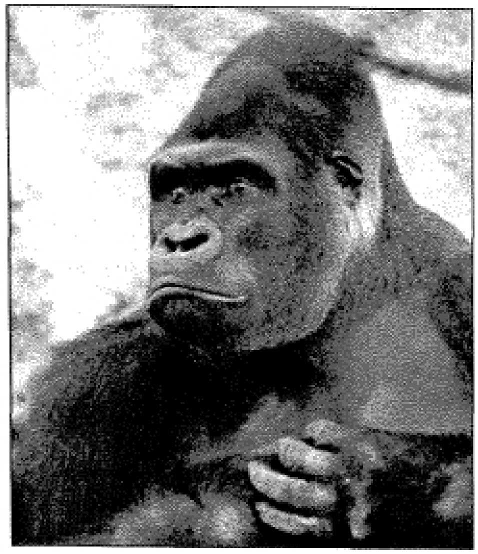
Linda S. Zug
Noise Specialist

Ed. — Linda, let's see if we can get a response from some of our readers. Linda's telephone is 412 856-1676.

In the Back Issue Room with The Walrus and Gus the Gorilla



"Hello again, Gus. You don't seem too happy to see me back from my vacation. I've had a wonderful time, and I can't thank you enough for taking care of filling the back issue orders for me while I was gone. I really appreciate it, and after I rest up from my vacation I'll try to do something nice for you. Cheerio, old friend.



"Listen, you waterlogged glob of fat, if I knew where your eyes were, I'd punch out your lights. I've been busting my cheeks doing all your work and my collection work too. I'm tired and I'm mad! Now, get your fat, lazy carcass up out of the water and start helping ME, or I will pound your ugly body to pulp and melt it down to axle grease. MOVE!!"

In the Back Issues:

- 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
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- Construction Trends in Noise Barriers
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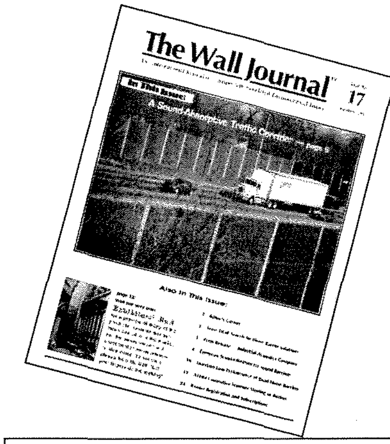
- Materials Test Standards
- Rail Transit Noise Control
- And a Bunch More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The Off Ramp

This space used to be called "The Last Word." I thought it was clever for a while, until I paused to think about it, and discovered that I had very seldom had the last word about anything in my life.

Since this publication is mostly about highways, it seems appropriate to end a journey along highways through the pages of this journal with an exit also known as the off ramp.

When I worked in the Washington, DC area before I retired, I got on I-95 at about 6:00 pm and headed south for 43 miles, always in stop-and-go traffic, which was more stop than go. By the time I got to the exit at the Quantico Marine Base, I was 92% vegetable.

BUT, the next exit south was the town of Stafford where I lived. And, when I got on the OFF RAMP, I became animal again, my spirits soared, the road opened to my house, life was good again, the front door opened and my beautiful wife greeted me with a kiss and a hug, and a pitcher of martinis (stirred, not shaken). Old Shep brought my slippers, and I slipped into paradise, thanks to the OFF RAMP from Hell.

More on The Off Ramp next time. ■

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