IBANA - Insulating Buildings Against Noise from Aircraft

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INTRODUCTION

IBANA is a new research project to develop a computer-based procedure for designing the sound insulation of a building against aircraft noise. Work in the 1970s led to a design guide [1] that has been widely used in Canada to design the sound insulation of residential buildings against aircraft noise. Unfortunately it is now very much out of date. Aircraft noise has changed, construction techniques have changed and it is now possible to produce a more accurate and a more convenient computer based procedure. This paper is a status report of this ongoing new project.

There are three main components to this project: (1) laboratory measurements of sound transmission loss (TL) of building façade components, (2) field measurements of TL, and (3) development of the computer software for sound insulation calculations. Laboratory measurements of TL are made for approximately diffuse field conditions and are more precise than field measurements. However, aircraft noise is incident on building facades from particular angles of incidence. It is known that TL varies with angle of incidence and it is intended to derive corrections for the laboratory TL results so that they are representative of the reduction of aircraft noise by real buildings. This will be accomplished by systematic comparisons of laboratory measurements with those in a simple test structure at Ottawa airport.

LABORATORY MEASUREMENT PHASE

The laboratory measurements of a large number of exterior wall and roof constructions are now complete and will be compiled into a data report. There are many combinations of construction details to be found in exterior walls and roofs of buildings near Canadian airports. The list of constructions to be tested was developed with advice from Canadian consultants (See acknowledgements). The focus of these measurements was on common types of residential constructions. However, a few tests related to commercial buildings were also included.

Table 1 lists the construction variables that were considered for four basic types of roof-ceiling systems. Not all possible combinations were tested but a total of 43 different roof-ceiling systems were measured. Both 2" by 10" wood joist and 14" wood truss systems were tested where the outer and inner surfaces were parallel as in flat roofs and cathedral ceilings. The raised heel wood truss (RHWT) was a sloping roof as illustrated in Figure 1. The steel deck roof systems were representative of light-weight commercial roof systems.

Type	Outer layer details	Insulation	Inner surface
2" by 10" wood	Shingles	None	1 gyp
14" wood truss	Steel sheet	R20	2 gyp
Raised heel wood truss (sloping)	Roofing - membrane	R40	RC+1 gyp
Steel deck	Roof vents		RC+2 gyp
	Ridge vent		

Table 1. Roof Construction Variables

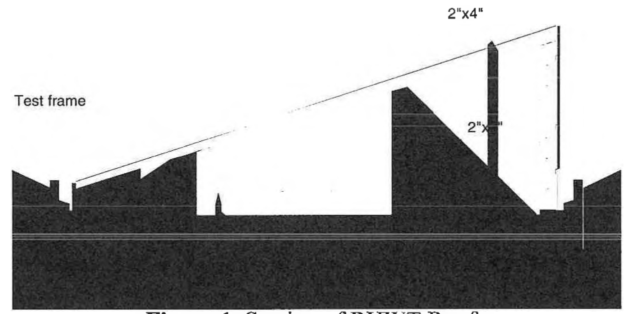

Figure 1. Section of RHWT Roof.

Figure 2 is one example of these roof-ceiling system tests and illustrates the effects of various ceiling treatments for the roof illustrated in Figure 1. Increased layers of gypsum board and the addition of resilient channels (RC) both have the expected effects on the measured TL. Figure 3 shows the change in measured TL for this same roof system with the addition of roof vents. The effect of the roof vents is quite dependent on the amount of attic insulation.

Table 2 summarises the construction details that were considered for the wood stud exterior walls tested in the laboratory. Although most walls were built using 2" by 6" wood studs at 406 mm (16") spacing, tests also included 610 mm (24") spacing and 2" by 4" stud constructions. A total of 29 different exterior wall constructions have been tested. In addition 6 different conventional windows have been tested, some both with and without an additional storm window. The windows included aluminum, wood, vinyl and vinyl clad wood frames and the double glazing units from the windows were also tested separately to help to identify the effects of the different window frame constructions.

As an example of these measurements, Figure 4 compares the effects of three different types of resilient channels (RC) when added to a wood stud wall construction. The differences among the different designs of RC are much less than the average effect of adding the RCs.

Table 2. Wall Construction Variables

FIELD MEASUREMENTS

The project will include two different types of field measurements. The first is intended to make it possible to derive conversions from laboratory TL measurements to the attenuation of aircraft noise by real buildings. A simple test structure has been constructed at

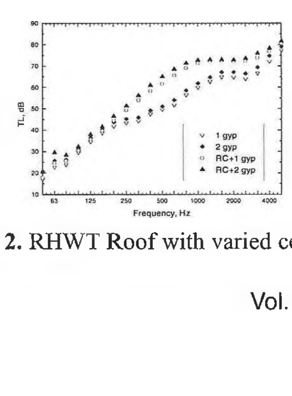

Figure 2. RHWT Roof with varied ceiling treatment.

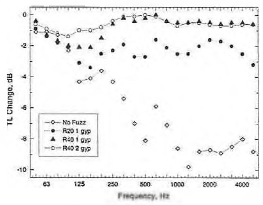

Figure 3. Effects of roof vents on RHWT roof.

Ottawa airport and a systematic series of tests will compare the TL of a number of constructions obtained for aircraft noise with results from the same constructions tested in the laboratory. Measurements in the test structure are recorded using two exterior microphones and 3 microphones in each of the two receiving rooms. All equipment is battery powered. The plan of the test structure is illustrated in Figure 5 showing a configuration that includes windows.

The second type of field measurements that are planned will consist of sound insulation measurements in homes near a major airport. The purpose is to validate the complete computer based design procedure under completely realistic conditions. The same measurement equipment and procedures as used at the Ottawa airport test structure will be used.

Outer layer	**Outer insulation**	**Ext. Sheathing**	**Insulation**	**Inner layer**
Vinyl	none	OSB	Glass fibre	1 gyp
Aluminum	air	Fibre board	Cellulose fibre	2 gyp
Brick	glass fibre		Mineral fibre	RC+1 gyp
Stucco (cement)	Styrofoam			RC+2 gyp
Stucco (acrylic)				

TABLE 2. Wall Construction Variables.

COMPUTER PROGRAM

The computer design software is intended to perform quite simple calculations but in a very convenient manner so that the design process is both more accurate and more efficient. The program is written in Visual Basic and is intended to have the look and feel of typical Windows based software. Users first select details describing the type and level of the source. They then calculate a sound

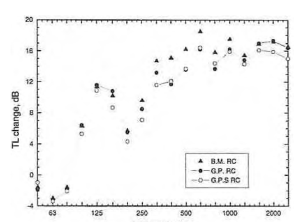

Figure 4. Incremental effects of 3 types of RCs.

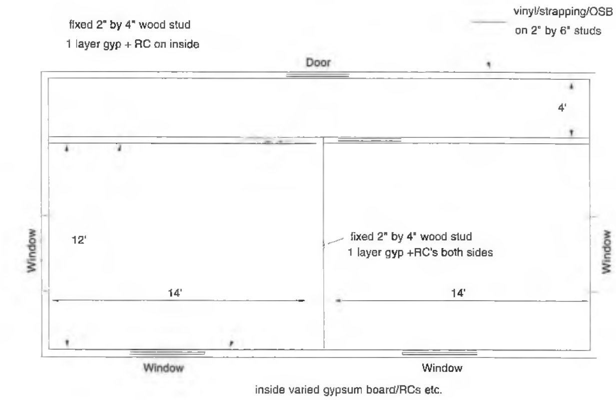

Figure 5. Plan of Ottawa airport test structure.

insulation scenario by selecting combinations of façade elements from lists. Calculations are performed for all 1/3 octave band frequencies from 50 to 5000 Hz and the expected indoor sound levels are determined. Multiple scenarios can be compared so that the user can rapidly determine the desired combination of façade elements to meet the design goals. The program will include a data base of TL measurements including those obtained as part of this project. The software has been beta tested and its development is now mostly complete.

CONCLUSIONS

It is hoped that the data base, field measurements and design software will be complete and available for use by the summer of 2000.

ACKNOWLEDGEMENT

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REFERENCES

[1] Anon, "New Housing and Airport Noise", Canada Mortgage and Housing (1981).