TRANSMISSION LOSS OF ULTRA LIGHTWEIGHT CONCRETE BLOCK

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ABSTRACT

Transmission loss of ultra lightweight concrete block were measured in-situ and the FSTC (Field Sound Transmission Class) was established using the ASTM Standards.. Block wall constructions that were investigated include the untreated block, conditions with the block sealed and batt insulation installed on one side. The field STC performance was compared to earlier laboratory test results of Northwood and Monk [6] as well as predicted performance provided by National Concrete Masonry Association methods [2]. The field transmission loss of the ulta lightweight block showed that low field STC ratings are realized, due to the porous nature of the block, and that the block must be sealed to provide high field STC ratings. Further, the results showed that regression equation of Reference 2 is seen to provide an over-estimation of the STC rating for unsealed ultra lightweight block.

SOMMAIRE

Les pertes de transmission sonore d'un bloc de béton ultra léger ont été mesurées in situ et la classe de transmission sonore en conditions réelles (FSTC - Field Sound Transmission Class) a été établie en utilisant les normes ASTM. Les constructions de murs en blocs de béton qui ont été examinées comprennent un mur de blocs de béton sans traitement, un mur de blocs de béton scellés et un mur de blocs de béton avec de l'isolant en natte d'un côté. Les résultats des essais de classe de transmission sonore en conditions réelles ont été comparés à ceux d'essais en laboratoire effectués précédemment par Northwood and Monk [6] ainsi qu'à des prévisions de résultats fournies par des méthodes de la National Concrete Masonry Association methods [2]. Les pertes de transmission sonore en conditions réelles du bloc de béton ultra léger ont montré que des niveaux faibles de classe de transmission sonore en conditions réelles sont obtenus, en raison du caractère poreux du bloc de béton, et que le bloc de béton doit être scellé pour produire des niveaux élevés de classe de transmission sonore en conditions réelles. En outre, les résultats ont montré que l'équation de régression de la référence 2 se révèle produire une surestimation du niveau de classe de transmission sonore pour le bloc ultra léger non scellé.

1. INTRODUCTION

During the construction of a condominium project, the STC ratings of ultra lightweight block used between adjacent dwelling units were reviewed. These ultra lightweight blocks are being used by masonry contractors as their lighter weight reduces labour costs for the project.

For this project, the "ULTRA LITE Lightweight Concrete Block Masonry" by Richvale York Block Inc. was investigated [1]. Block weight comparisons are provided in Table 1. The ULTRA LITE Lightweight blocks are provided with nominal face dimensions of 190mm x 390mm, equivalent concrete thickness of 96.6mm, 1858 kg/m3 block density, and concrete type L2 20S. For this investigation the 15cm width, 60% solid, was used for the wall construction.

Metric Size (cm)	Block Weight Comparisons (kg)		
	Concrete	Lightweight	Ultra Lite
10	12.7	10	8.4
15	14	11.7	10.3
20	17.2	14	11.6
25	20.9	17.2	14.3
30	24.8	20.8	16.2

Table 1 Block Weight Comparison [Reference 1]

2. CALCULATED STC

Prior to testing, the calculated STC for the ULTRA LITE Block was provided by the manufacturer based on the empirical relationship shown by Equation 1.

$$STC = (0.18 \times density \times equivalent\ thickness) + 40$$

$$density = 115.9 \frac{lb}{ft^3}$$

$$equivalent\ thickness = 0.317\,ft$$

$$\therefore$$

$$STC = (0.18 \times 115.9 \times 0.317) + 40 = 46.613 \approx 47$$

Equation 1 from NCMA Tek 13-1A STC [References 2, 3]

The NCMA Tek 13-1A considers this equation to be applicable to uncoated fine- or medium-textured concrete masonry, and that coarse-textured units may require surface treatment (acrylic, alkyd latex, cement - based paint, plaster) to seal at least one side of the wall to achieve the calculated STC rating [4]. The sound ratings of concrete block walls noted in the National Building Code (Table A-9.10.3.1.A Note 3) also make reference to sealing the surfaces with at least two coats of paint or other surface finish to prevent sound leakage and achieve the stated STC ratings.

3. STC TESTING

The ULTRA LITE block was field tested in accordance with ASTM E-3365. The block wall was constructed between two reverberant rooms (concrete block construction, 2.6m wide x 4.9m long x 2.4m high, RT60 2s). Flanking paths through the doors to the rooms were sealed with batt insulation and duct tape. Sound measurements were conducted with a calibrated 2230 B&K sound level meter with 1/3rd octave band analyzer, with a white noise source. Three combinations of tests were conducted: 1) ULTRA LITE block, unsealed, 2) ULTRA LITE block with sealant on one side - Blocks were painted, but the paint was not able to provide an acceptable coating as the block soaked up the paint. As a result, Tremco Acrylic Fire Stopping Sealant was used - and 3) ULTRA LITE block with 88mm thick exposed pink batt insulation on one side. The field transmission loss data for each test is provided in Figures 1 thru' 3.

4. DISCUSSION

Table 2 summarizes the STC ratings for the three samples, which are compared to similar test results by Northwood and Monk [6], and the calculated STC from NCMA Tek 13-1A. [2]

Comparing the ULTRA LITE results with the Northwood/Monk results shows a similarity between the two sets of tests. This provides some confidence in the field test results. Further, it shows that when left untreated, the 1 5cm 60% solid

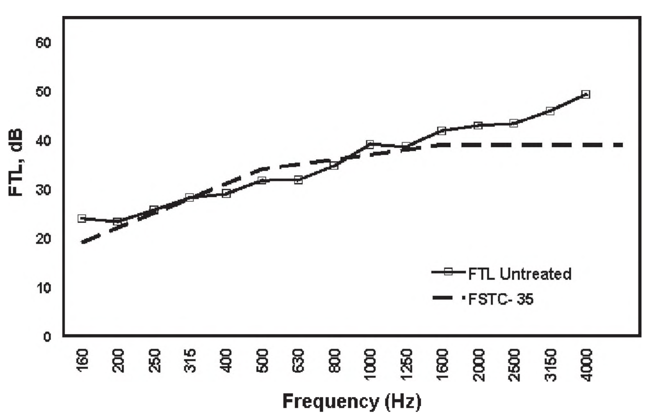

Figure 1. Ultra Lite Block, Untreated

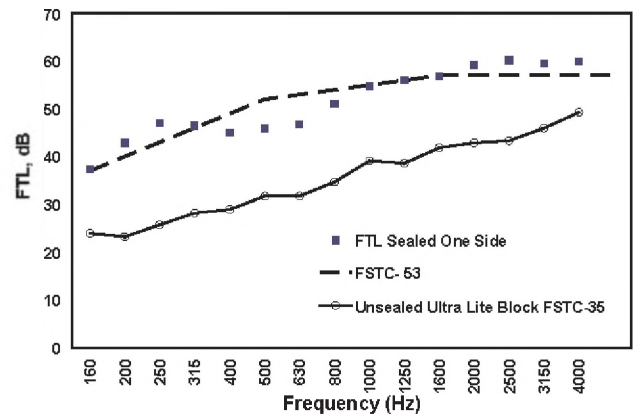

Figure 2. Ultra Lite Block, Sealed One Side

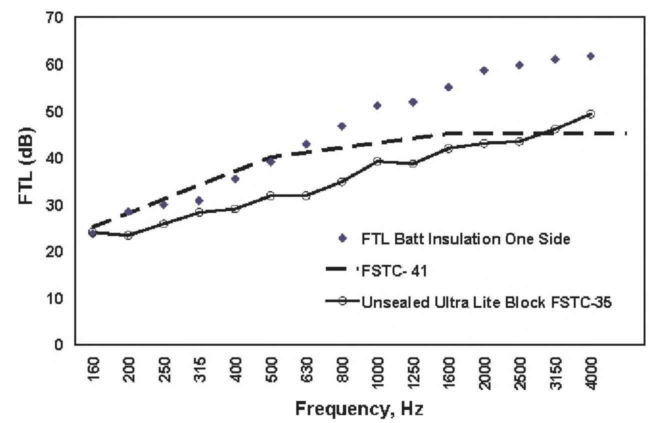

Figure 3. Ultra Lite Block, Batt Insulation One Side

ULTRA LITE lightweight block will achieve FSTC-35, and requires sealant on one side to achieve an FSTC greater than 50 since the sealant provides significant transmission loss improvement (10-20 dB) across the frequency range of interest (160 – 4000Hz) (Please refer to Figure 2).

The tested ULTRA LITE Block, when left untreated, significantly underperforms compared to the predicted Tek 13-1A rating (-12 STC points). However, with proper sealant on one side, significantly better performance (+6STC) than stated by the Tek 13-1A equation was achieved.

For normal weight concrete block walls, it is the mass per unit area and stiffness that typically governs the STC rating of the wall [7]. However, it is the porous nature, and hence low airflow resistance, of the ultra lightweight blocks that plays a significant role in determining its sound transmission loss8. With a porous material the sound waves that impinge on the wall continue their travel through the pore structure (though some of the energy is absorbed through friction). At the same time, the sound waves tend to move the wall as a whole, where this vibration is a parallel path for sound transmission (as determined by the mass and stiffness characteristics of the concrete). Both paths determine the overall transmission loss of a given wall [9].

Wall Type	No Treatment	Sealed, One Side	Batt Insulation, One Side
NCMA Tek 13-1A STC	46	46	46
ULTRA LITE Block, 15cm 60% solid	35	53	41
30cm Lightweight Block, NRC	39	51	-

Table 2. STC Comparison

With the porous ultra lightweight concrete, the transmission loss appears to be dominated by the low airflow resistance and is essentially independent of the weight or stiffness of the wall. However, once one side of the wall is sealed then the sound transmission takes place entirely by wall vibration, which then allows for higher STC ratings in the ultra lightweight block wall, as determined by the weight and stiffness [10]. Although not investigated here, research by Northwood and Monk showed that sealing both sides (versus one side) showed little improvement. Further, sealing both sides may produce reduced performance by enhancing the cavity-sealant resonance [6].

Of interest was the effect that batt insulation would have in improving the STC performance, as insulation is commonly used with block/drywall partition constructions. The results show that although the overall STC performance is improved (+6 dB) with batt insulation, this improvement is mainly in the higher frequencies, with little or no improvement below 400 Hz (Please refer to Figure 3). As sound waves pass through the porous structure of the block, some sound energy will be absorbed by the insulation after the waves pass through the block. The batt insulation is significantly better at absorbing higher frequencies than lower, and attenuates the sound energy accordingly, as is brought out in these field transmission loss results.

5. CONCLUSIONS

The following conclusions arise from the transmission loss test results presented in this paper.

a) Untreated ultra lightweight concrete block provides low FSTC ratings due to the porous nature, and hence low airflow resistance, of the block.

b) The ultra lightweight concrete block must be well sealed to provide FSTC ratings above 50.

c) The NCMA Tek 13-1A regression equation is suspect when applied to unsealed ultra lightweight concrete block, as it is significantly different than the field tested STC rating.

d) Sealing the ultra lightweight block with an acrylic sealant provides significant transmission loss improvement over the frequency range.

e) Application of batt insulation to the ultra lightweight block does improve mid to high frequency transmission loss performance, but does not provide significant benefit in the lower frequencies.

The following recommendations are based on the findings in this paper.

I. Block wall constructions utilizing the ultra lightweight concrete block must be well sealed on one side when used in critical noise applications (e.g. compliance with Building Codes)

II. Sealant should be acrylic, alkyd latex, cement - based paint, or plaster. This block is too porous for standard paint application, as the block will soak up the paint.

III. Sealant types with both one and two sides sealed can also be investigated, to determine if sealing both sides creates a cavity resonance effect with the ultra lightweight block and a specific sealant material (as was noted by Northwood and Monk for lightweight concrete).

IV. The NCMA Tek 13-1A regression equation should be revisited in light of the findings in this paper, as its use for determining STC ratings of unsealed ultra lightweight block types is suspect.

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10) H. Sabine (1960) Noise Control "Effect of Painting on Sound Transmission Loss of Lightweight Concrete Block Partitions"

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