NOISE REDUCTION POTENTIAL OF GREEN ROOFS

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1. INTRODUCTION

Green roofs on top of the commonly used roofing system design are becoming mandatory in major cities around the world[1]. One of the potential benefits of green roofs is touted to be the noise reduction of the added mass of the green roof structure. The transmission class of the green roofs has become a major research project in acoustics[2,3]. There are also skeptics who question the noise reduction potential of green roofs[4].

A model of an extensive green roof was investigated as to its noise reduction potential as part of an undergraduate thesis. Details of green roof types are presented in Lagstorm[4]. The noise reduction of different layers of the green roofs was measured in a mock-up 2 m X 2 m green roof model. The results of the noise measurement are presented in this paper.

2. THE EXPERIMENT

The green roof mock-up is shown in Figure 1. A cube of two metres is built as a box with a parapet to include green roof details on the top. An access door is also built into the side of the box to place a sound source within it. Images of the different layers that constitute green roof body are also shown in Figures (b) and (c).

The two base cases of the set-up consist of a typical roof over the plywood roof-deck. Base case 1 consists of a 2" thick extruded polystyrene insulation, water proofing membrane and ½" thick gravel. Base case 2 increases the insulation to 4" thick extruded membrane.

2.1 Green Roof Details

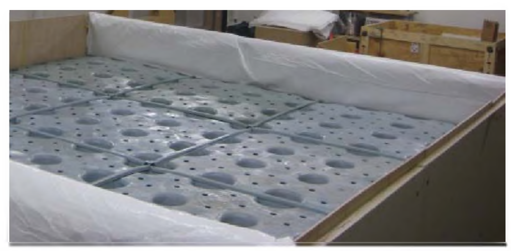
Three configurations of the extensive green roofs were tested in the current experiment. The green roof consists of: 2" retention panels (Figure 1b); bio-void, bio filter cloth (Figure 1c); 2" (or 4" or 6") layer of Bio-Mix Ecoblend soil. The green roof details are shown in Figure 2. Only two of the three extensive green roof configurations are shown in Figure 2.

2.2 Test Procedure

A boom-box DVD player was used as a sound source. A pink noise audio file was played through the DVD player. The sound levels within the box at three heights in one third octave bands were measured using Hewlett-Packard HP3569A real time analyzer. The sound levels at nine locations on top of the gravel (base case) or on top of the soil (green roof cases) were measured. The noise reduction in each third-octave band is given by the Equation (1) below:

$$NR = \left\{\left[\frac{1}{3}\sum_1^3 SPL_{i\,inside}\right] - \left[\frac{1}{9}\sum_1^9 SPL_{j\,top}\right]\right\}, dB \quad (1)$$

(a)

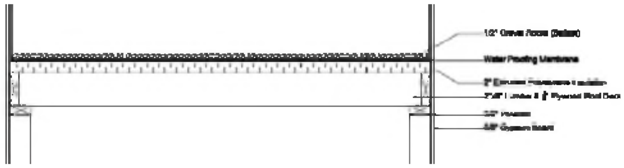


(b)

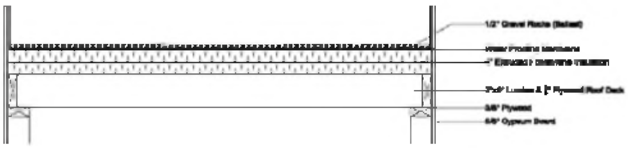
(c)

Figure 1. Details of Green Roof mock-up.

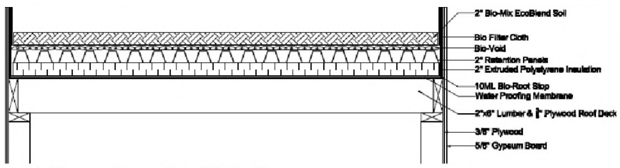
It must be pointed out that the current investigation measured only the noise reduction of the green roof configurations. No attempt was made to measure the TL (Transmission Loss) of the constructions in the same way as references 3 and 4 following a standardized procedure. The box construction was made sufficiently strong so that the noise propagation was the strongest through the roof.



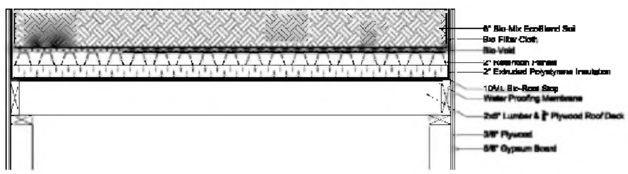
(a) Base Case 1



(b) Base Case 2



(c) Base Case 1 + 2" Soil



(d) Base Case 1 + 6" Soil

Figure 2. Details of Extensive Green Roof.

3. RESULTS AND DISCUSSION

The results of the Noise Reduction, NR, of the various configurations are presented in Figure 3.

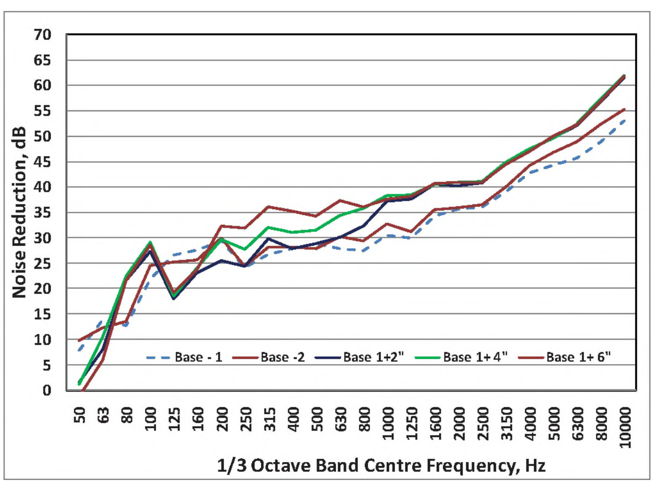


Figure 3. Noise Reduction of Green Roofs.

The first observation of the measured data is that there is hardly any difference between the two base cases. Actually, by adding another layer of insulation decreased the NR value at low frequencies for Base Case 2. This can be attributed, perhaps, to stiffness effects of the insulation materials.

The results for the three Green roof configurations were also presented in Figure 3. Two main observations were obvious from the test results: a) adding more layers of soil produce increased noise reduction in the mid-frequency range of 250 to 500 Hz; b) the thickness of the soil has no influence on the noise reduction in the high-frequency range. The reason for the low high-frequency performance is due to the leakage through the porous soil topping of the green roof construction. The performance in the high frequency range can get better due to the plant growth which was not considered during the current experiment.

The results show that the maximum additional noise reduction potential of a green roof is around 5 dB in the high frequency range and between 3 to 10 dB in the mid-frequency range. The test results of the current experiment are similar to the Transmission Loss values reported in References 2 and 3. Lagstrom[4] experiments also showed similar noise reduction of extensive green roofs.

4. CONCLUSIONS

A simple experiment was conducted as an undergraduate thesis project to evaluate the noise reduction potential of extensive green roofs. The results show that green roofs can provide around 5 dB of additional noise reduction. The results also showed that the thickness of the top soil has minimal influence on the high frequency performance of the green roofs.

REFERENCES

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