

COMPARATIVE FIELD TEST EVALUATION OF THE IMPACT INSULATION CLASS (IIC) OF ROOFS

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1. INTRODUCTION

As urban density is increasing, the use of rooftops to regain exterior private and/or public spaces is escalating. Rooftop use for outdoor recreation, urban agriculture and restaurant seating are examples of this increment.

Additionally, green roofs are being introduced to rooftops at an exponential rate to support occupancies and for environmental benefits. The impact noise created by users on green roofs must now be considered.

Sound tests were performed to determine how well roof/ceiling assemblies insulate against noise created by impact and airborne vibration. Where airborne sound transmission loss of green roofs has been quantified [1], it is almost unknown if green roofs perform as well as resilient deck to isolate concrete and wood decks and decrease impact noise.

Impact Insulation Class (IIC) measures the ability of the assembly to isolate impact noise like foot fall or objects being dropped or dragged. For impact sound, the nature of the surface finish plays an extremely important role in determining what is transmitted through the assembly [2]. Other factors determining impact sound isolation of an assembly include damping, stiffness and decoupling [3]. It was hypothesized that green roofs would provide a high level of impact sound isolation.

2. METHODOLOGY

The tests were performed at British Columbia Institute of Technology, Centre for Architectural Ecology's Green Roof Research Centre. The Research Centre had three independent roofs: one conventional and two green roofs. The building was 14.5m long, 6.0m wide and 7.0m high, for an approximate interior volume of 970 cubic meters. The internal temperature and relative humidity were controlled at a constant.

The dimensions of each roof were approximately 4.5x6.0m for an area of 27 square meters each. From bottom to top, the reference roof was composed of: 51x305x406mm O.C. wooden deck, vapor barrier, 38mm extruded polystyrene insulation, 6mm overlay board, torch-on modified bitumen base sheet and torch-on modified bitumen cap sheet (SBS).

The two green roofs were constructed identically as the reference roof with the addition of a drainage layer, filter cloth, growing medium substrate and plants. The two green roofs differed only by the depth of substrate. One green roof had 75mm depth of substrate and the other one had 150mm depth of substrate. The plant communities were fully

established and included the following species: *Sedum spurium*, *Sedum hybridum*, *Sedum forsterianum*, *Sedum floriferum*, *Sedum acre*, *Sedum album*, and *Sedum divergens*. The green roofs had a soft impact surface in comparison to the other roof types.

The test method is fully described in the ASTM standard E1007 "Field Measurement of tapping machine impact sound transmission through floor-ceiling assemblies and associated support structures." The standard states that the source room can be an exterior location on a roof or a deck [4]. The standard specifies that a standard tapping machine be placed at four prescribed positions on the roof to generate impact noise [4]. One-third octave band sound pressure levels were recorded at the source and at the receiver over a duration of 60 seconds. Four measurements were averaged to determine the average sound pressure level in the receiving room.

ASTM Standard E989 "Standard Classification for Determination of Impact Insulation Class (IIC)" was used to determine the IIC or FIIC. Spatially-average sound pressure levels measured in the receiving room below were adjusted for room absorption and compared to standard values to obtain an overall rating in the frequency range 40 Hz to 6300 Hz [5].

The reference roof (exposed SBS) and the following five roofs were evaluated:

- 60cm x 60cm x 5cm concrete pavers with plastic pedestal spaces directly on the SBS membrane
- 60cm x 60cm x 5cm concrete paver with rubber pads on the SBS membrane
- A wood deck with 38 x 64mm dimensional lumber on 38mm extruded polystyrene insulation providing a continuous separation from the SBS membrane
- 75mm substrate green roof with sedum cover
- 150mm substrate green roof with sedum cover.

3. RESULTS

The Impact Insulation Class (IIC) is a single figure rating scheme intended to rate the effectiveness of roof-ceiling assemblies at preventing the transmission of impact sound generated by the standard tapping machine. The higher the value of the rating, the better the roof performance.

Wooden deck and concrete pavers over conventional roof showed some improvement when using absorbent materials (polystyrene and rubber pads). The plastic pedestals used with the concrete pavers allowed for a direct transmission of the impact to the roofing structure; thus they

had almost no effect in mitigating impact sound transmission.

The wooden deck and the concrete pavers generated higher perceptible levels of air borne noise when using the tapping machine. For this reason, flanking noise would be expected inside the receiving room and lower IIC values would be obtained.

The results of the tests are summarized in Figure 1, Figure 2, and Table 1. The green roofs clearly outperformed the other roof types.

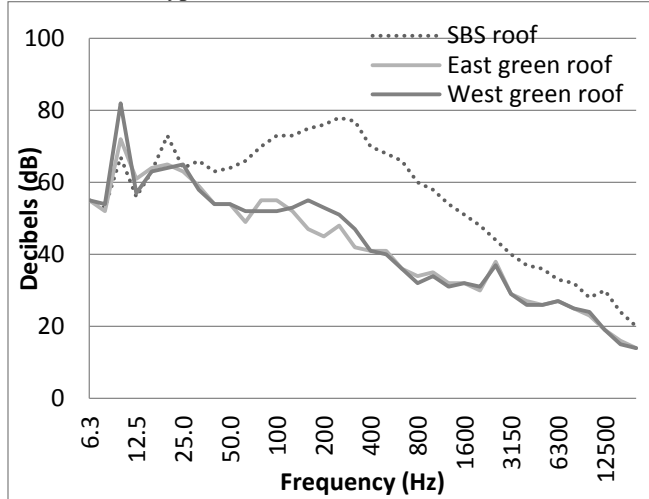


Figure 1: Comparison of SPL in receiver room under reference SBS roof and green roofs.

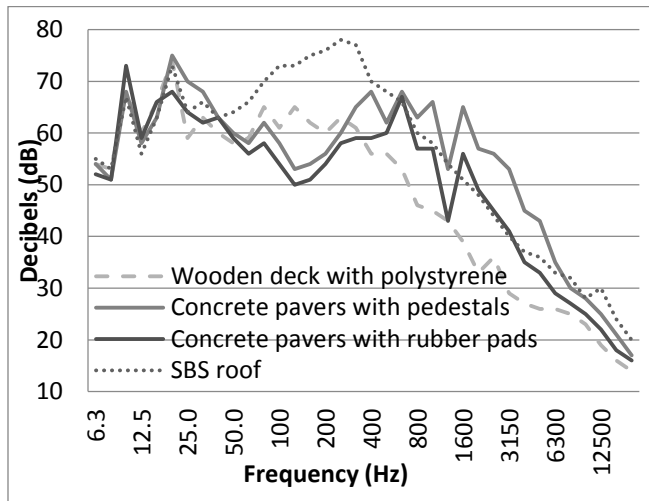


Figure 2: Comparison of SPL in receiver room under reference SBS roof and non-green roof types.

Table 1: IIC of the various tested roof assemblies

SBS roof (reference)	IIC 41
Concrete pavers with plastic pedestals	IIC 44
Concrete pavers with rubber pads	IIC 50
Wooden deck with polystyrene insulation	IIC 55
Green roof with 75mm substrate	IIC 64
Green roof with 150mm substrate	IIC 64

4. CONCLUSION

International Building Codes requires a minimum IIC of 45 for field test in new constructions for floor-ceiling assemblies. Assuming the same criteria for occupied roof top ceiling assembly, the SBS roof over wooden deck and the same roof with concrete pavers and plastic pedestal did not comply.

Some acoustical consultants define the following qualitative values based on IIC rating of floor-ceiling assemblies in new homes:

- FIIC 50 for low income or affordable (minimum quality)
- FIIC 60 for average or mid-range (medium quality)
- FIIC 65 for luxury or high end (high quality)

Under this consideration, the bare SBS roofs with concrete pavers were in the minimum quality category. Wooden deck with polystyrene was in the medium quality category. Both green roofs performed as high end or high quality roofs and outperformed the other roofs tested.

REFERENCES

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