SOUND ISOLATION UPGRADE OF EXISTING PERFORMING ARTS CLASSROOMS – DESIGN CHALLENGES AND THE PUSUIT OF SOUND FLANKING PATHS

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1. INTRODUCTION

A new performing arts program was established within an existing urban high school to promote continuing education for dance, music and drama. To satisfy the immediate demand for space, an old industrial arts section of the school was converted by dividing the total floor area into three separate, but adjacent rooms using 190mm concrete block walls. Simultaneous activities within this new Dance/Music/Drama facility resulted in a high degree of sound interference. This author did an initial investigation in the Fall of 2005, providing recommendations with limitations due to budget constraints. The project did not proceed.

With a new and expanded budget, the project was recalled in January, 2011. A review was done of existing conditions and recommendations were revised to provide all the necessary elements and details to ensure optimum sound isolation.

2. EXISTING ROOM CONDITIONS

The old industrial arts section of the school was a large, open space with a total, approximate floor area of 43 meters by 18 meters. The floor consists of a monolithic concrete slab on-grade. The exposed structural roof is a concrete T-beam system. The height to the underside of the roof slab is approximately 7.5 meters. Two demising walls were constructed using 190mm concrete blocks, painted and sealed at all junctions and penetrations. The resulting rooms, excluding the built-in offices and storage have the following physical characteristics:

Dance Studio V= 2060 cubic meters; A = 275 square meters
Music Room V= 1610 cubic meters; A = 229 square meters
Drama Room V= 1630 cubic meters; A = 197 square meters

Each common block wall area is approximately 137 square meters (18.3m X 7.5m).

The existing sound isolation was measured and classified in terms of Noise Isolation Class (NIC) as follows:

Dance Studio to Music Room: NIC = 40
Drama Room to Music Room: NIC = 39

The corresponding level differences and lab-measured transmission loss values for a 190mm concrete block wall are compared in Figure 1.

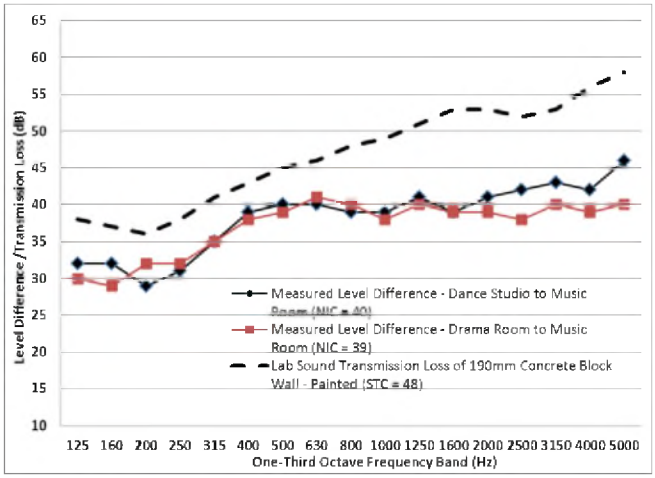

Figure 1. Original Sound Isolation

3. ACOUSTIC UPGRADE

One side of each concrete block wall was built-up using steel stud and gypsum board construction. Ideally, this additional wall system should be structurally separate from the existing block wall. However, the wall height of 7.5 meters did not allow construction of an unsupported wall. Steel hat channels were used to tie the new wall system back to the existing block wall. The amount of ties was limited to provide as much structural isolation as possible. Also, resilient channels were used to attach the gypsum board to the metal studding. The estimated Sound Transmission Class rating for the new composite wall system is STC 65.

A primary concern was the common floor slab and its' potential to flank sound underneath the new wall systems. With the Music Room located between both the Dance Studio and the Drama Room, an isolated floor system was placed within the Music Room. The installed floor system consists of the roll-out floor isolation system; Model RIM by Kinetics Noise Control Inc.

Specific concerns were addressed during construction that related to mechanical/electrical attachments and penetrations, as well as construction within and around stairs, bulkheads and storage areas.

4. POST CONSTRUCTION RESULTS

An initial, subjective evaluation of the sound isolation improvement indicated that the construction between the Dance Studio and Music Room is now optimized. However, the sound isolation between the Drama Room and Music Room still had significant sound flanking. At the top of the common wall and on the on the side of the new construction, the wall face is about 50mm from the T-beam web structure. The acoustic seal at the top of the new wall to the structure underside was questionable due to the limited access. Additional details were provided to seal this construction junction. Sound isolation tests at this point confirmed that significant sound flanking still existed. Results of the measured sound isolation for each room pair is as follows:

Dance Studio to Music Room: NIC = 61
Drama Room to Music Room: NIC = 47
The sound isolation improvements are shown in Figures 2 and 3 for the two room pairs.

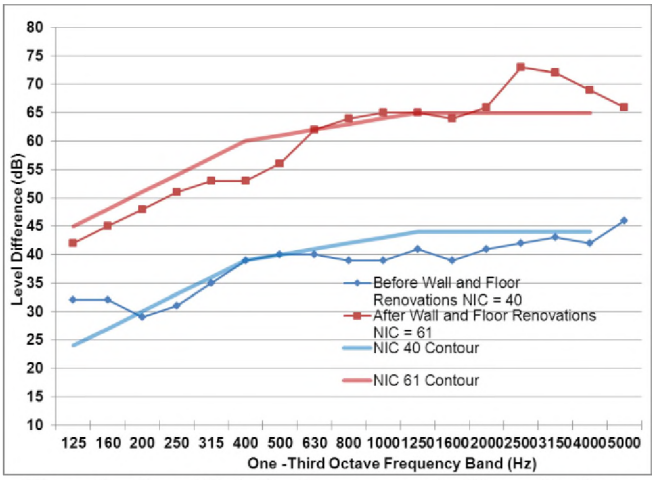

Figure 2. Sound Isolation Improvement – Dance Studio to Music Room.

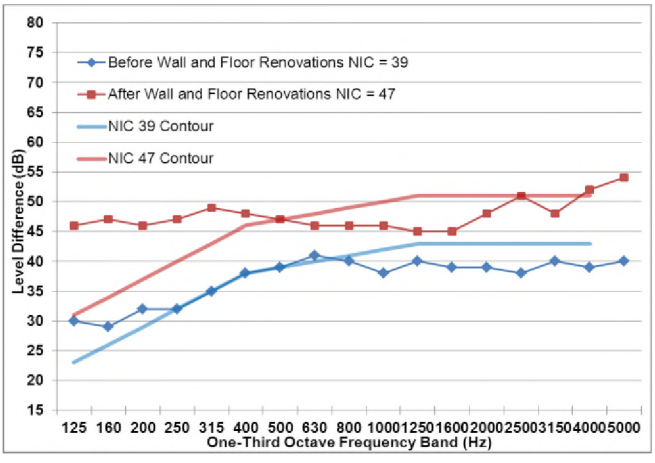

Figure 3. Sound Isolation Improvement – Drama Room to Music Room.

5. STEEL BEAM INVESTIGATION

The sound flanking investigation now focused on an array of steel hoist support beams that remained from the days when the area was used as an industrial arts shop. This steel beam array is common to both the Music Room and Drama Room, and penetrates the wall at five separate locations. All penetrations were sealed well and did not exhibit any sound leakage. However, it was surmised that the airborne sound was creating sufficient vibrations within the beams and radiating into the adjacent room from the web surfaces.

To validate the correlation of beam vibration to the receiving room sound pressure, pink noise was generated within the Drama Room at an overall, average level of 97 dBA. Using a two channel analyzer, simultaneous measurements were taken within the Music Room (receiving room). One channel measured the vibration velocities on the steel beam web, and the other channel measured the sound pressure levels within the room. Figure 4 shows a comparison of the two measurements. The correlation coefficient for the beam vibration velocities and the room sound pressure levels is 0.815 within the one-third octave frequency bands from 250Hz to 5000Hz.

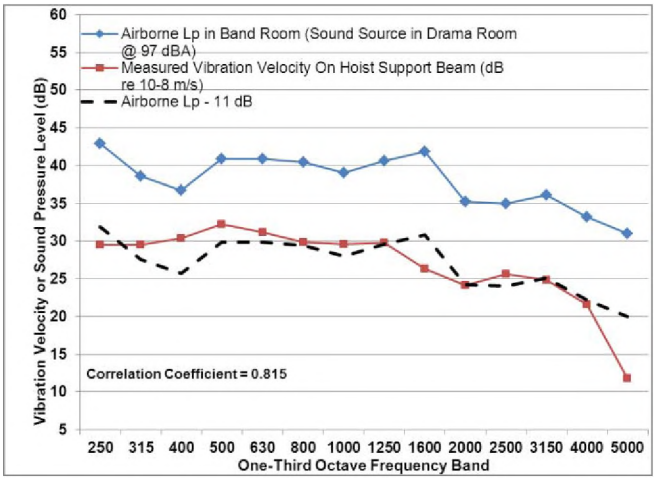

Figure 4. Simultaneous Beam Velocity and Room Sound Pressure Level Measurement

6. CONCLUDING REMARKS

The high sound isolation required for performing arts classrooms demands careful consideration in the acoustic design and the elimination of all structural sound flanking paths. All elements common with and penetrating through the sound-rated construction must be evaluated for their sound flanking potential.

ACKNOWLEDGEMENTS

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