

14 March 2023

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Re: oLiv Sound Isolation Study Phase 2 (Revision)
Madison, WI
KN° 3243

PROJECT UNDERSTANDING

Kirkegaard was engaged by Antunovich Associates to provide an acoustic study of the predicted sound isolation at a ten-story student housing project in Madison. Our study will focus on airborne sound isolation between bars on the first floor occupying a 15,000 sf space and residential units directly above on the second floor. We understand that Core Spaces is working on the lease and work letter and wants to understand the isolation with the current design and what details would be required for greater isolation. The potential Tenant's schematic design shows four different bar types, and each may involve different expected noise levels; the "Roxxy 2" bar has a stage and dance floor and is connected to the "Roxxy 1" bar, "Double Tap" is more arcade oriented, and the other bar is "Olive".

This acoustic study will provide and discuss:

- The estimated sound levels at peak hours in the bars based on owner-provided single-number dBA values.
- The predicted sound isolation performance of the current ceiling partition, as well as our recommendations for Good/Better/Best isolation ceiling systems below the 2nd floor slab.
- The predicted sound isolation performance of the exterior glazing with respect to the flanking path of sound out through the 1st floor windows, up the façade, and in through the 2nd floor windows (with doors and windows closed).

ASSUMPTIONS TAKEN

Bar Indoor Noise Levels

- Roxxy 1 and 2 are expected to be the loudest spaces, with a focus on amplified music.
- Double Tap, being an arcade bar, still expects moderate amplified music and arcade noises but at a lower level compared to Roxxy.
- Olive appears to be a less music-oriented bar and will be closer to typical restaurant activity noise levels.

Sound Transmission Loss

Our sound transmission calculations assume negligible airborne or structure-borne sound flanking paths (indirect weak paths for sound transmission that compromise the overall isolation performance).

The following are high-level identifications of potential flanking paths which are not studied here.

- We have assumed that the exterior glazing facade is not vertically continuous between the first and second floors.
- We have assumed that the second floor slab edge meets the exterior wall without weak points or leaks.
- We have assumed there are no holes in the second floor slab.
- We have assumed there is no structure-borne vibration transfer through any vertically continuous columns between the first and second floors.
- We have assumed that ‘crosstalk’ through ductwork is not a problem. We are assuming separate mechanical systems for the bars and residential units.
- We have assumed that the partitions at the bars (including between Roxxy and its back of house) are full height and acoustically sealed to structure. See markup.

Predicting background noise level in residential units is not part of this study. We have assumed it is neutral Room Criterion (RC) 25.

ANALYSIS & RECOMMENDATIONS

Current Assembly

- 12" normal weight concrete slab.
- This assembly has a predicted STC rating of 62.

“Good” Recommended Ceiling

- High Isolation Acoustic Ceiling Tile
- Acoustic ceiling tiles with gypsum board backer for isolation. Tiles to be CAC 40+, NRC 0.80+.
- 3" thick batt insulation resting above tiles.
- Minimum 14" airspace between ACT and bottom of structure. MEP may route above ACT.
- Note: Our recommendations assume continuous ACT ceiling and gypsum backer. If speakers are flush mounted in the ACT grid, the slab will be exposed to back-radiated noise and acoustic isolation performance may be closer to that of “Current” floor-ceiling assembly.

“Better” Recommended Ceiling

- Gypsum Board Barrier Ceiling
- 3 layers 5/8" gypsum board, hung from bottom of structure with spring and neoprene isolators.
- 3" thick batt insulation resting above gypsum board.
- Seal perimeter airtight with acoustic sealant.
- Minimum 14" airspace between barrier ceiling and bottom of structure.
- MEP serving the first floor should all be located and routed below the barrier ceiling to avoid penetrations through the gypsum board.
- Treat underside of gypsum board with minimum 80% of ceiling area of 3" thick K-13 spray for loudness control within room.

“Best” Recommended Ceiling

- High Isolation Acoustic Ceiling Tile + Gypsum Board Barrier Ceiling
- ~~Gypsum board barrier ceiling as previously defined, hung minimum 14" below slab.~~
- ~~High isolation acoustic ceiling tile as previously defined, hung minimum 14" below barrier ceiling.~~
- ~~MEP serving the first floor should all be located and routed below the barrier ceiling to avoid penetrations through the gypsum board.~~

Current Exterior Window Assembly

- 1" insulated glazing
- 1/4" glass, 1/2" airspace, 1/4" glass.

“Better” Exterior Window Assembly

- 1-1/8" laminated insulated glazing
- 3/8" laminated lite, 1/2" airspace, 1/4" lite.

PREDICTED RESULTS & RECOMMENDATIONS

The following section describes recommendations based on predicted results using assumed noise levels for various ceiling and window assemblies.

The following table lists the predicted average sound levels during peak hours based on owner-provided single-number dBA values. The estimated sound levels make up a predicted noise contour which totals to the listed dBA. Our calculations assume a -11dB drop off from 125Hz to 63Hz based on our understanding that the Tenant is willing to cut out frequencies below that point. A reduction of 11 dB is perceived as approximately half the loudness and our calculations confirm that 63Hz content is not driving the architectural sound isolation recommendations.

| Bar Space | Sound Level (dBA) | Estimated Maximum Sound Level by Octave Band (dB) | | | | | | | |
|------------|-------------------|---|-------|-------|-------|------|------|------|------|
| | | 63Hz | 125Hz | 250Hz | 500Hz | 1kHz | 2kHz | 4kHz | 8kHz |
| Roxxy | 95 | 83 | 94 | 94 | 92 | 90 | 87 | 83 | 80 |
| Double Tap | 90 | 75 | 86 | 87 | 87 | 85 | 82 | 78 | 75 |
| Olive | 85 | 65 | 76 | 80 | 82 | 80 | 77 | 73 | 70 |

With the current window assembly (1" insulated glazing unit), we predict that the flanking path through exterior glazing would be problematic for 2nd floor residential units. Currently, the 1st floor glazing has roughly the same weak resonant frequency as that of the 2nd floor glazing; noise at 250 Hz can break out and in with relative ease. This means that 250 Hz may be clearly audible and disturbing in the residential units if Roxxy is at 95 dBA and Double Tap is at 90 dBA. It would be necessary to further limit the bar sound levels to mitigate this.

We recommend upgrading the 1st floor bar windows to a 1-1/8" laminated insulated glazing assembly.

The following tables provide a quantitative and qualitative description of the estimated maximum sound level heard in the units directly above for each bar for a given ceiling and window assembly. The noise levels at 125Hz to 500Hz typically dictate the performance of a sound isolation assembly. Overages (relative to RC-25 target defined below) which are possibly objectionable are indicated in yellow, those which are likely to be a problem are indicated in orange, and those which are significantly loud are indicated in red.

| RC-25 Slightly quieter than typical background noise (e.g. HVAC running on low load with low residential activity) | Assumed Background Noise (dB) in Unit Above by Octave Band (Hz) | | | | | | | |
|---|---|-----|-----|-----|----|----|----|----|
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| | 45 | 40 | 35 | 30 | 25 | 20 | 15 | 10 |

Roxxy:

| Ceiling Assembly | Window Assembly | Estimated Maximum Sound Level (dB) Heard in Unit Above by Octave Band (Hz) | | | | | | | | Qualitative Description of Noise Heard in Unit Above |
|------------------|-----------------|--|-----|-----|-----|----|----|----|----|--|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| Better | Better | 31 | 37 | 36 | 21 | 13 | 5 | 0 | 0 | Kirkegaard's recommendation. Bass audible but likely not distracting. |
| | Current | 34 | 38 | 45 | 21 | 13 | 5 | 0 | 0 | Tonal noise at 250Hz is loud and always distracting. |
| Good | Better | 36 | 45 | 38 | 29 | 21 | 13 | 5 | 2 | Bass is somewhat loud and sometimes distracting. |
| | Current | 36 | 45 | 45 | 29 | 21 | 13 | 5 | 2 | Tonal noise at 250Hz is loud and always distracting. |
| Current | Better | 40 | 52 | 45 | 36 | 28 | 20 | 12 | 9 | Bass is loud and always distracting. Mid-frequencies are audible and sometimes disruptive to speech. |
| | Current | 40 | 52 | 45 | 36 | 28 | 20 | 12 | 9 | Bass is loud and always distracting. Mid-frequencies are audible and sometimes disruptive to speech. |

Double Tap:

| Ceiling Assembly | Window Assembly | Estimated Maximum Sound Level (dB) Heard in Unit Above by Octave Band (Hz) | | | | | | | | Qualitative Description of Noise Heard in Unit Above |
|------------------|-----------------|--|-----|-----|-----|----|----|----|----|---|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | |
| Better | Better | 23 | 29 | 29 | 16 | 8 | 0 | 0 | 0 | Bass is barely audible and not distracting |
| | Current | 26 | 30 | 38 | 16 | 8 | 0 | 0 | 0 | Tonal noise at 250Hz is audible and sometimes distracting |
| Good | Better | 28 | 37 | 31 | 24 | 16 | 8 | 0 | 0 | Kirkegaard's recommendation. Bass is audible but likely not distracting |
| | Current | 28 | 37 | 38 | 24 | 16 | 8 | 0 | 0 | Tonal noise at 250Hz is audible and sometimes distracting |
| Current | Better | 32 | 44 | 38 | 31 | 23 | 15 | 7 | 4 | Bass is somewhat loud and sometimes distracting |
| | Current | 32 | 44 | 38 | 31 | 23 | 15 | 7 | 4 | Bass is somewhat loud and sometimes distracting |

Olive:

We do not anticipate Olive to be particularly loud. At the noise levels listed in the table on page 4, we expect the noise heard in residential units above Olive to be barely audible but not distracting if there is exposed structure and virtually inaudible if there is a basic finish ceiling such as typical ACT or gypsum board.

EXTENT OF ISOLATION TREATMENT AND AFFECTED UNITS

The attached markup of isolation treatment extents includes our minimum recommendation for full-height partitions (insulated, continuously sealed to structure with full perimeter gaskets on doors). Within these isolation partitions, the extent of the “Good” and “Better” ceiling recommendations are as follows.

We recommend the “Better” treatment should cover the entire ceiling above both Roxxy spaces. After further review from our previous discussions, there is greater overlap above than originally thought (see attached markup). The reason for including the barrier ceiling below the green roof is that it is difficult to predict how sound energy might energize the concrete slab and travel horizontally into 2nd floor units (bypassing the barrier ceiling).

If the entire ceiling area is not possible, the barrier ceiling must exist at minimum in the area 2' beyond the perimeter of the residential unit footprints above Roxxy 1 and Roxxy 2. This area is indicated on the attached ceiling treatment markup. All layers of gypsum board of the barrier ceiling should continuously return to structure above and seal airtight with a soft joint. And at minimum, the rest of Roxxy and restroom corridor should have “good” ceiling type. If left untreated with only exposed slab, the noise traveling horizontally from the portion of exposed slab into 2nd floor units may be audible and somewhat loud at particular frequencies.

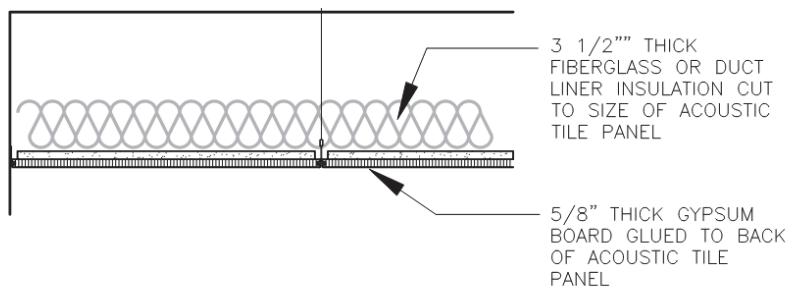
The attached markup shows our predictions for which 2nd floor units are most likely to be affected by noise from the bar spaces.

ACOUSTIC CEILING DETAILS

The following are general details and are not to scale.

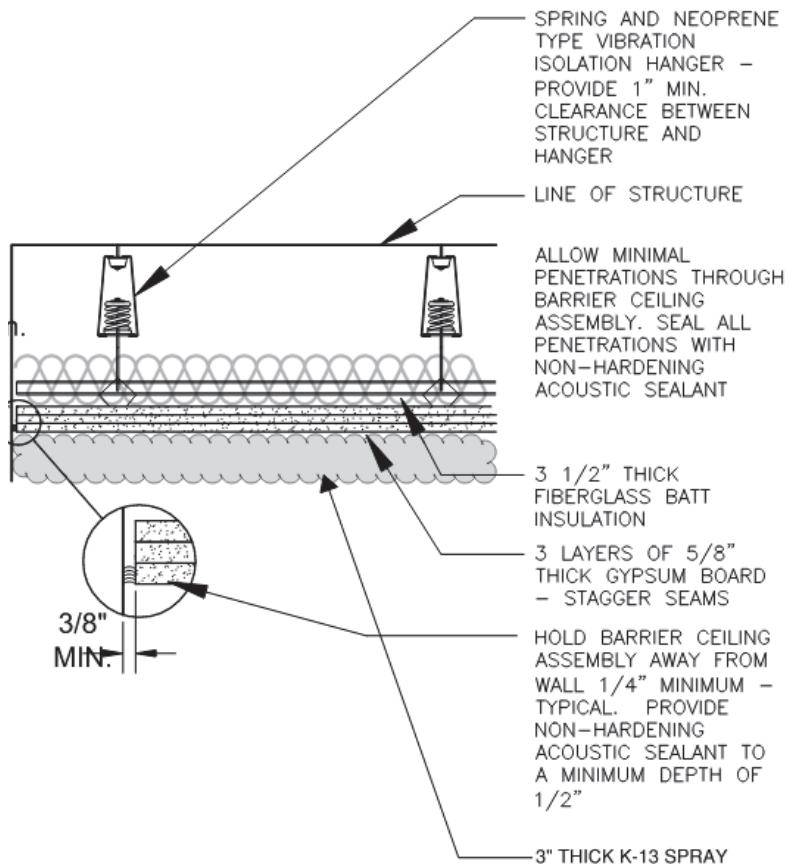
“Good” Recommended Ceiling

- High Isolation Acoustic Ceiling Tile



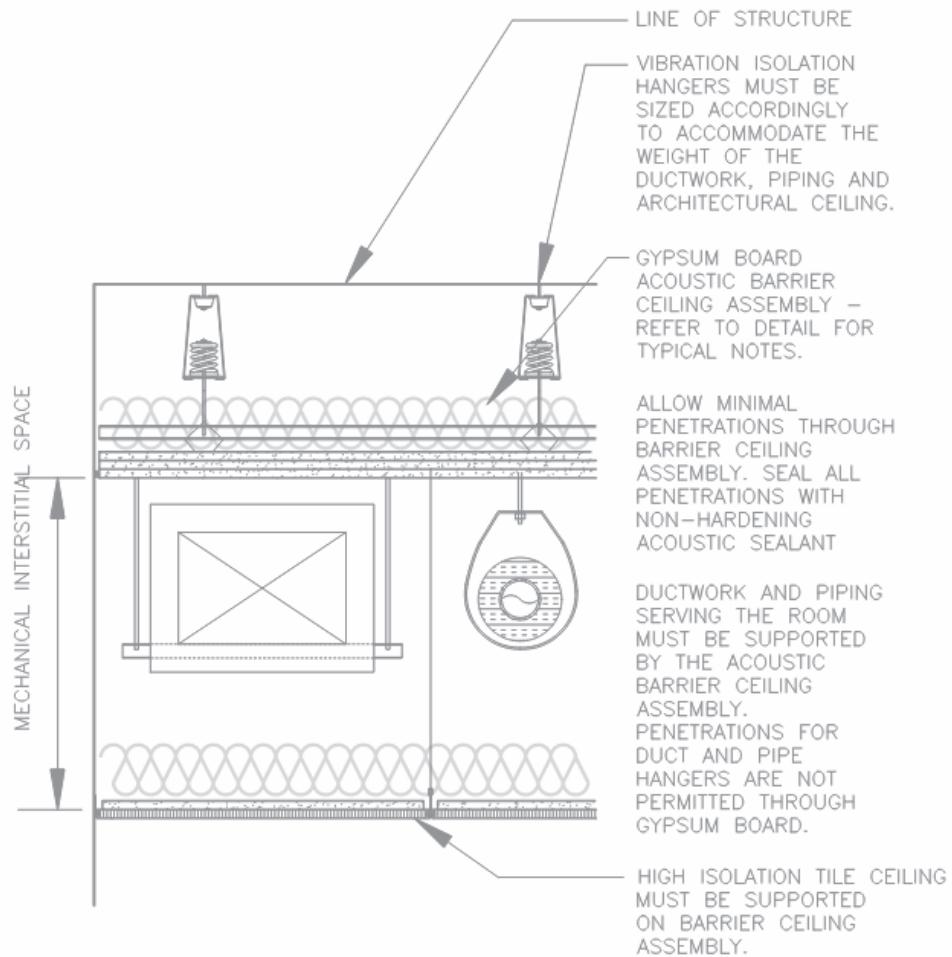
“Better” Recommended Ceiling

- Gypsum Board Barrier Ceiling



“Best” Recommended Ceiling

- High Isolation Acoustic Ceiling Tile + Gypsum Board Barrier Ceiling



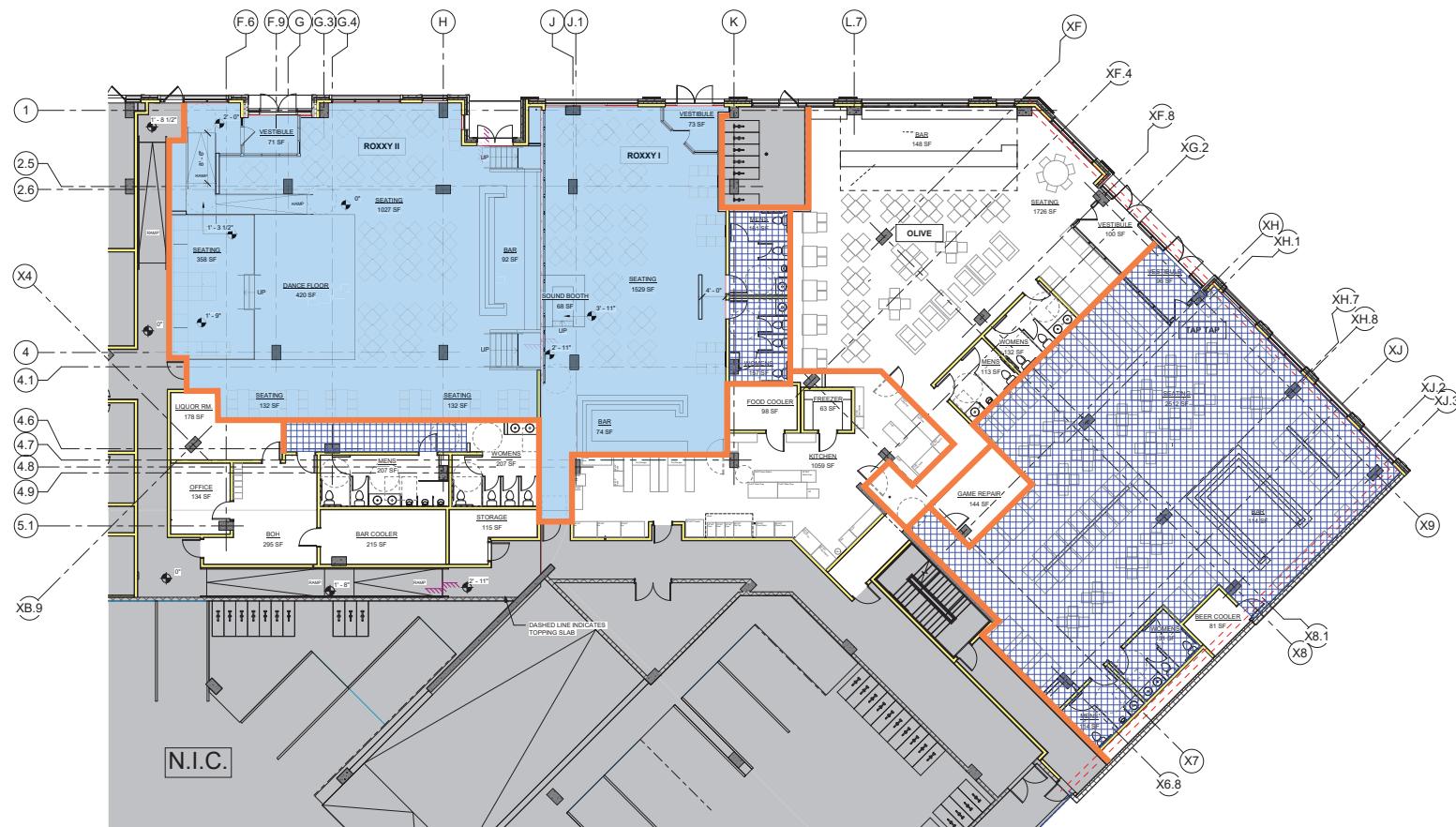
--- *End of Report* ---

KIRKEGAARD RECOMMENDED CEILING TREATMENT EXTENTS

"BETTER" GYP BD BARRIER CEILING

"GOOD" HIGH ISOLATION ACT CEILING

FULL-HEIGHT, INSULATED PARTITIONS CONTINUOUSLY SEALED TO STRUCTURE. DOORS REQUIRE FULL-PERIMETER GASKETING.



| | |
|---|----------------------|
| 1 | LEVEL 1 FURNITURE PL |
| | 1/8" = 1'-0" |

KIRKEGAARD - BAR NOISE AFFECTED 2ND FLOOR RESIDENTIAL UNITS

- █ HIGH LIKELIHOOD THAT UNIT IS DISTURBED DUE TO ROXXY NOISE IF ACOUSTICAL RECOMMENDATIONS ARE NOT FOLLOWED
- █ MEDIUM LIKELIHOOD THAT UNIT IS DISTURBED DUE TO ROXXY NOISE IF ACOUSTICAL RECOMMENDATIONS ARE NOT FOLLOWED
- █ LOW LIKELIHOOD THAT UNIT IS DISTURBED DUE TO ROXXY NOISE IF ACOUSTICAL RECOMMENDATIONS ARE NOT FOLLOWED
- █ HIGH LIKELIHOOD THAT UNIT IS DISTURBED DUE TO ROXXY NOISE WITHOUT UPGRADED BAR WINDOW
- █ HIGH LIKELIHOOD THAT UNIT IS DISTURBED DUE TO DOUBLE TAP NOISE IF ACOUSTICAL RECOMMENDATIONS ARE NOT FOLLOWED
- █ MEDIUM LIKELIHOOD THAT UNIT IS DISTURBED DUE TO DOUBLE TAP NOISE IF ACOUSTICAL RECOMMENDATIONS ARE NOT FOLLOWED
- █ HIGH LIKELIHOOD THAT UNIT IS DISTURBED DUE TO DOUBLE TAP NOISE WITHOUT UPGRADED BAR WINDOW

