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CUSTOM DESIGNS

September 9, 2019

Property: **Crescent Beach Condominium Association, Inc.**
Property Address: **100 N. Collier Boulevard**
Marco Island, Florida 34145

Attn: **Mrs. Sheelah Yahwitz**

RE: FLOOR COVERING SOUND TRANSMISSION STUDY

SCOPE OF WORK

At the request of Mrs. Sheelah Yahwitz, with Crescent Beach Condominium Association (client), Joyce Engineering, LLC was retained to provide professional engineering opinions related to the transmission of sound through alternative floor coverings (i.e. wood flooring and ceramic tiles) at presently carpeted areas of the to the adjacent units. Joyce Engineering, LLC has performed multiple on-site visits to the subject property, but did not perform acoustic testing at the subject property and was outside the scope of this assignment. Therefore, the information and opinions presented within this document are based on research and review of industry leading testing data, review of the general conditions at the subject property, and professional engineering judgment. This report was not prepared for use in a real estate transaction. It was prepared for the scope of work indicated herein, and for the client indicated above. Any and all usage or reliance upon this document by parties other than the owners is expressly prohibited.

GENERAL DISCUSSION

Excess or unwanted sound is defined as ***noise***. Depending on the source, type, and properties of the sound, in conjunction with the materials used within the building, noise can have a significant negative impact on the occupants within the building. Sound is created from numerous sources within a building. In general, there are two primary types of sound paths: **airborne sound** and **impact sound**.

Airborne sound (both interior and exterior) radiate from the source (interior and exterior) into the air. Examples of airborne sounds created by ***interior*** sources include: voices, music, mechanical equipment, etc. Examples of airborne sounds created by ***exterior*** sources include: vehicular traffic, aircrafts, construction activities, etc.

Impact sound, commonly referred to as "structure-borne sound" is sound that travels through solid building materials. Examples of impact sounds include: foot traffic on floors (footsteps) with hard-soled shoes, movement of furniture, dropped objects, furniture, door knocks or slams, washers and dryers, mechanical and plumbing equipment vibrations, exercise equipment/activities, etc.

There is some commonality among factors that influence the attenuation of airborne sound and impact sound; however, impact sound is by far the more complicated to measure, rate, and control. Acoustic ratings are measures of sound transmission in building assemblies and materials. The two types of acoustic ratings that are of particular interest in this study are **sound transmission class (STC)** and **impact insulation class (IIC)**.

Sound transmission class (STC) is a measure (in decibels) of how much airborne sound a floor or wall assembly blocks. Studies indicate that an increase of 10 in the STC translates roughly to a decrease in the perceived noise by one-half. In general, adding mass to the assembly improves the STC rating. The following tables give typical STC ratings for various wall and roof/ceiling assemblies.

Wall Assembly	STC (dB)*
Wood stud wall (2 × 4 in. studs spaced at 16 in. on center with ½ in. gypsum board on each face screwed to the studs)	34
Metal stud wall ($3^{5}/_{8}$ in., 25 gauge studs spaced 24 in. on center with a single layer of $^{5}/_{8}$ in. gypsum board on each face screwed to the studs)	39
8 × 8 × 16 in. lightweight CMU (28 lbs/block)	45
Common brick mortared together with ½ in. gypsum/sand plaster	50
6 in. normal-weight concrete wall (75 psf)	55

Roof/Floor Assembly	STC (dB)
0.036-in.-thick corrugated galvanized steel roof deck	23*
2 × 10 wood joists spaced 16 in. on center with $^{5}/_{8}$ in. subfloor glued to joists and nailed 12 in. on center, ¼ in. particle board glued to plywood, ½ in. parquet wood flooring glued to particle board, and ½ in. gypsum board ceiling screwed to joists 12 in. on center	42†
8 in. lightweight hollow core concrete slab (57 psf)	50†
6 in. normal-weight concrete slab (75 psf)	55†

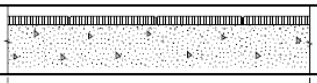
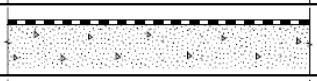
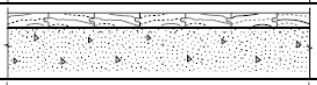
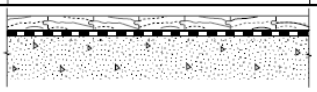
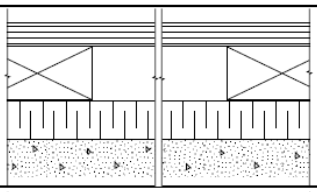
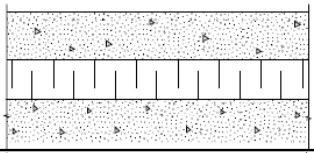
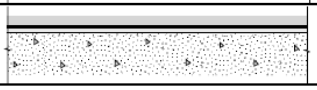
Impact insulation class (IIC) ratings measures how much structure-borne sound is blocked in the floor/ceiling assemblies. IIC ratings are greatly influenced by the surfaces and areas under the floor and the IIC rating can be significantly enhanced by the addition of underlayment, insulation, or by floating the floor. The "loudest" floor is stone or tile laid directly over concrete. Basically, the higher the IIC value, the better the floor/ceiling assembly is at blocking or dampening the impact noise. IIC is greatly influenced by the surfaces and areas under the floor and the IIC rating can be significantly enhanced by the addition of underlayment, insulation, or by floating the floor. The "loudest" floor is stone or tile laid directly over concrete. The following table provides typical IIC values for various roof/ceiling assemblies.

Floor/Ceiling Assembly	IIC (dB)*
8 in. lightweight hollow core concrete slab (57 psf)	28
6 in. normal-weight concrete slab (75 psf)	34
2 × 10 wood joists spaced 16 in. on center with $^{5}/_{8}$ in. subfloor glued to joists and nailed 12 in. on center, ¼ in. particle board glued to plywood, ½ in. parquet wood flooring glued to particle board, and ½ in. gypsum board ceiling screwed to joists 12 in. on center	37
6 in. normal-weight concrete slab (75 psf) with $^{1}/_{2}$ -in.-thick wood fiber board, carpet, and padding	81

In general, an **IIC 50 or less** has the least impact sound absorption quality. While this may be appropriate for ground floors, it would be unsatisfactory for most on a high floor without a great deal of insulation in the area between the floor and the ceiling below. ****Most stone and tile floorings will fall into this category.*** **IIC 60** indicates a "medium" impact sound absorption quality and encompasses floorings such as wood, laminates, and some vinyl coverings. **IIC 65** is a "high level" of impact sound transmission absorption and includes superior sound reduction materials, such as carpet and cork.

EFFECTS OF FLOOR FINISHES/TOPPINGS

Concrete slabs, similar to that at the subject property, finished with a hard surface such as ceramic tile, marble, or hardwood flooring have low IIC ratings and are invariably perceived as unacceptable for multi-story buildings unless adequate insulation or dampening materials are utilized between the concrete slab and floor topping. Soft or cushioned layers play an important role in determining impact sound attenuation. Basically, the softer and thicker the floor covering, the better the IIC value (such as carpet). Impact sounds must be dampened or "cushioned" by a resilient upper surface or a floating floor to prevent intolerable impact noise. The following table provides approximate IIC ratings for a 6-inch concrete slab with various types of floor toppings:

	Topping	IIC
	None, or ceramic or marble tiles	28
	Vinyl flooring	35-40
	Hardwood flooring	30-35
	9-mm-thick hardwood on 6-mm-thick resilient layer	45-50
	16-mm plywood or OSB on 40- x 90-mm wood strapping on 25-mm mineral fibre board	50-55
	35-mm concrete on 25-mm mineral fibre board	60-65
	Carpet and underlay	75-85

Based on the test results provided by the Institute for Research Construction (IRC), it was determined that hard-finished flooring materials, such as **ceramic tiles**, adhered directly to the concrete slab did not improve upon the impact sound attenuation achieved by the concrete itself.

Concrete slabs finished with only **wood flooring** only slightly improved the IIC values. Slight increases in the IIC values may be achieved by the adhesive used to attach the wood, although without the addition of a resilient layer under the wood flooring, the impact insulation will not be adequate. The IIC value for wood flooring is primarily dependent on the resilient (dampening) material used, such as rubber, cork, fiber board, plastic, etc., and the thickness of the layer.

Carpet flooring with cushioned underlay provides very high IIC ratings given that the impacts and sounds are well cushioned or dampened. Carpet flooring or floor toppings providing a minimum IIC value greater than 60 are recommended for occupant comfort in multi-story residential buildings constructed of reinforced concrete, although lower IIC values are permissible by the Florida Building Code.

FLORIDA BUILDING CODE REQUIREMENTS

Section 1207 – Sound Transmission in the 2017 Florida Building Code, 6th edition provides the following requirements for air-borne sound (section 1207.2) and structure-borne sound (1207.3):

1207.2 Air-borne sound. *Walls, partitions and floor/ceiling assemblies separating dwelling units and sleeping units from each other or from public or service areas shall have a sound transmission class of not less than 50, or not less than 45 if field tested, for air-borne noise when tested in accordance with ASTM E90. Penetrations or openings in construction assemblies for piping; electrical devices; recessed cabinets; bathtubs; soffits; or heating, ventilating or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings. This requirement shall not apply to entrance doors; however, such doors shall be tight fitting to the frame and sill.*

1207.3 Structure-borne sound. *Floor/ceiling assemblies between dwelling units and sleeping units or between a dwelling unit or sleeping unit and a public or service area within the structure shall have an impact insulation class rating of not less than 50, or not less than 45 if field tested, when tested in accordance with ASTM E492.*

CONCLUSIONS

Based on the observed conditions at the property, review of the original Architectural Plans and available documentation, and research and review of industry leading testing data, Joyce Engineering, LLC provides the following professional opinions and recommendations related to the alternative floor toppings (wood and ceramic tile) at the presently carpeted areas:

1) Impact sounds or noise will significantly increase at the adjacent units if carpeted areas are replaced with wood flooring or ceramic tile directly adhered to the concrete slab. Studies indicate that IIC ratings double (wood flooring) or almost triple (ceramic tile) as opposed to carpet flooring.

2) It is my professional opinion that replacement of the presently carpeted areas with wood flooring or ceramic tiles including a resilient or insulating layer, will still increase the impact sounds/noises transmitted to the unit(s) oriented directly below.

3) We do not recommend replacing any carpeted areas unless a minimum IIC value of 60 or greater can be achieved for occupant comfort.

4) *Acceptable* noise levels (dependent on occupant's personal comfort level) at the adjacent units *may* be achievable with the installation of a sufficiently thick and appropriate type of resilient layer or floating floor system installed between the wood or tile flooring and the underlying concrete slab in strict accordance with the manufacturer's installation requirements. However, height limitations may be presented when adding a floating floor system or resilient layer due to the thickness of the presently installed floor finishes, such as transitions between differing floor finishes (e.g. carpet-to-tile, wood-to-tile, etc.) and architectural trimwork.

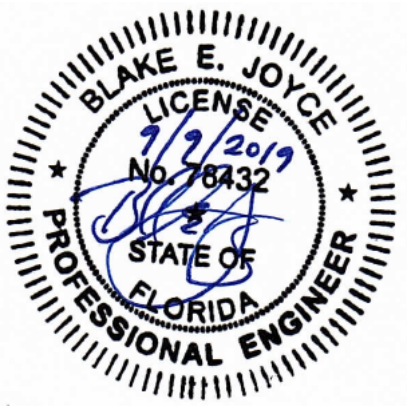
5) If alternative floor finishes/toppings are to be utilized at the previously carpeted areas, we strongly recommend installing a minimum of three (3) "sample areas/rooms" at differing units and locations within the building to ensure occupant satisfaction prior to performing a large-scale replacement of the floor finishes.

LIMITATIONS

The opinions presented herein are based on the observed conditions at the site, measurements recorded, verbal and/or written documentation, prior experience and professional engineering judgment. It should be noted that the scope of work was limited to providing professional engineering opinions related to the transmission of sound through alternative floor coverings (i.e. wood flooring and ceramic tiles) at presently carpeted areas of the to the adjacent units. Joyce Engineering, LLC has performed multiple on-site visits to the subject property, but did not perform acoustic testing at the subject property and was outside the scope of this assignment. Therefore, the information and opinions presented within this document are based on research and review of industry leading testing data, review of the general conditions at the subject property, and professional engineering judgment.

This document has been prepared for exclusive use of the client and/or owners indicated above. No unauthorized distribution, reproduction or re-use of this document, or portions of this document, shall be permitted without prior written consent by Joyce Engineering, LLC. In the event that additional information becomes available that could affect the conclusions reached and/or opinions presented herein, Joyce Engineering, LLC reserves the right to review all new information, and, if required, revise, and/or amend some, or all, of the statements presented herein. Please feel free to contact me with any questions.

Respectfully submitted,



Blake E. Joyce, P.E., LEED AP
Principal Owner & Professional Engineer

JOYCE ENGINEERING, LLC
"YOUR SWISS ARMY KNIFE OF ENGINEERS!"

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