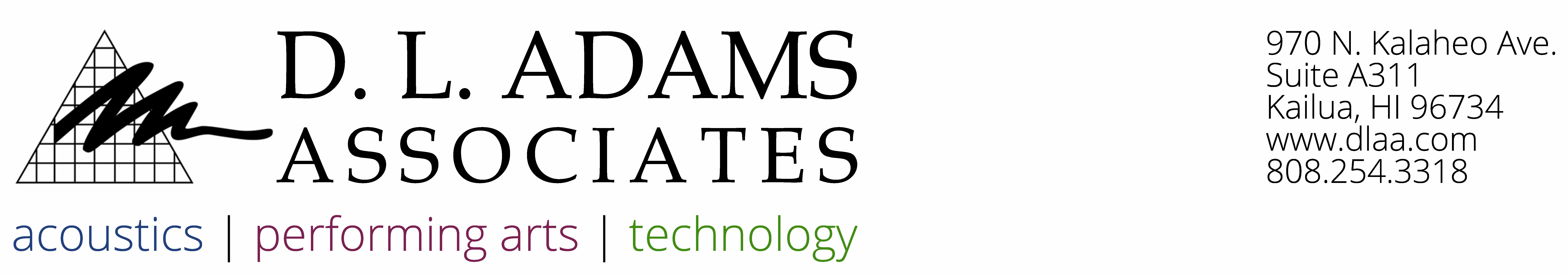
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June 1, 2021

The Ironwoods AOAO

1 Ironwood Lane

Lahaina, HI 96761

Attention: Mr. Jeff Roberts

**RE: The Ironwoods Floor/Ceiling Assembly Renovations Acoustical Study Report– (DLAA #21-011)**

Dear Mr. Roberts:

DLAA has completed a study of the issue of floor/ceiling acoustical performance at The Ironwoods in Lahaiana, HI. The assessment included review of renovated floor/ceiling assemblies, field testing, study of available as-built structural drawings, and review of existing house rules related to vertical sound isolation. This document reports our findings and recommendations to help the AOAO determine an updated strategy for addressing the issue of floor and ceiling renovations moving forward.

**ACOUSTICAL CONCEPTS**

**Impact Noise**

The Impact Insulation Class (IIC) is a single-number rating which grades how well a floor/ceiling assembly attenuates impact noise, such as footsteps. The higher the IIC rating, the more efficient the partition is at reducing impact noise between spaces. It should be noted that the IIC rating is limited in that it does not address low frequency noise below 125 Hz. Very low frequency “thuds” and “thumps” are not addressed by the IIC metric. These sounds are unavoidable in lightweight wood-frame structures. For this reason, DLAA advises against marketing any wood-framed residences as luxury and disclosing these acoustical limitations to all prospective buyers. Field measurements of impact noise are classified as Apparent Impact Insulation Class (AIIC) ratings. AIIC ratings are typically allowed to be 5 points lower than the corresponding laboratory rating. For example, an assembly tested to IIC 55 in a laboratory and AIIC 50 in the field would be considered roughly equivalent acoustically.

**STC**

The Sound Transmission Class (STC) is a single-number rating which grades how well an assembly attenuates airborne noise, such as conversation. STC is measured according to ASTM E90 and classified according to ASTM E413. The higher the STC rating, the more effective the partition is at reducing airborne noise between spaces. STC is only determined in a laboratory where all paths by which sound could travel around the test subject assembly are strictly controlled ensuring the measured sound is only that which travels through the test specimen. Field ratings of airborne sound isolation are measured according to ASTM E336 and classified according to ASTM E413. According to ASTM E336, the “Standard Method for Measurement of Sound Isolation in Buildings”, measurements of a partition in the field include all elements in the assembly, that would otherwise be absent in a laboratory. The effects of site-specific field conditions are included in the field metric Apparent Sound Transmission Class (ASTC). The ASTC rating of a construction element is typically specified 5 points less than the corresponding laboratory rating. For example, an assembly tested to STC 55 in a laboratory and ASTC 50 in the field would be considered roughly equivalent acoustically.

**Flanking Transmission**

The need for different field and laboratory ratings arises from a phenomenon called “flanking” transmission. Sound in buildings travel to adjacent spaces by all possible paths, such as over the ceiling, through the floor structure, adjacent walls, windows, mechanical systems etc. In laboratory conditions these alternate paths are intentionally suppressed or removed from the study. However, in practical applications these alternate paths are unavoidable and care must be taken during construction and renovation to minimize their effects on sound transfer.

**HOUSE RULES**

**HUD vs. Modern Standards**

The current house rules are based on achieving Grade 1 sound isolation performance presented in the Housing and Urban Development’s “A Guide to Airborne, Impact, and Structure Borne Noise – Control in Multifamily Dwellings” dated September 1967. For floor/ceiling assemblies the minimum criteria for Grade 1 construction are STC 55 and IIC 55.

Grade 1 is the highest performance criteria specified in HUD’s 1967 document, indicating STC and IIC 55 may have been considered a high performing sound isolation criteria at the time. Since then, the International Code Council has published the International Building Code (IBC) which sets absolute minimum allowances at only 5 STC and IIC points below HUD 1967’s “Grade 1” Performance. More recent HUD guidance states that STC and IIC 55 would be considered “mid-grade” quality, while top tier, luxury quality acoustical isolation is typically categorized as a minimum of STC 60 and IIC 60 in modern industry.

Based on discussions with Ironwoods personnel, continuation of the minimum IIC 55 and STC 55 criteria is desired moving forward, which corresponds with a mid-grade market level acoustical performance.

**ANALYSIS**

DLAA analyzed five floor/ceiling assemblies to evaluate the performance on the as-built structure of The Ironwoods. The core structure is described as follows:

* 1-1/2” light-weight concrete
* 3/4” plywood
* 2” x 10” wooden joists, spaced 12” On Center
* Resilient Channel
* 5/8” Gypsum Ceiling

The five scenarios were selected to study the effects of various alterations to the original as-built condition. Scenarios 1 through 4 were field tested on May 26, 2021. These scenarios and their tested results are described in Table 1. Full test reports are attached. Units 71 and 32 have multiple ceiling heights in the receiving space due to renovations to enclose lanais, soffits, etc. The client advised the ceiling height in Unit 61 represents the as-built condition. The client has not reported insulation in the ceiling cavity of any units. Scenario 5 is a hypothetical scenario with floor/ceiling modifications and is discussed further in the **Recommendations** section.

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| --- | --- | --- | --- | --- | --- | --- |
| **Table 1.** Field Tested Floor/Ceiling Acoustical Performance at The Ironwoods | | | | | | |
| **Scenario Number** | **Units Tested (Source/Receive)** | **Floor Finish** | **Underlayment** | **Ceiling Mounting** | **Field Result** | |
| **AIIC** | **ASTC** |
| #1 | 63 MBR/61 MBR | Carpet | 5/16 padding | Resilient Channel | 76 | 57 |
| #2 | 73 MBR/71 MBR | Laminated Wood | 5 mm rubber | Resilient Channel | 42 | 49 |
| #3 | 34 Kitchen/32 Kitchen | Stone Tile | 5 mm rubber | Hat Channel | 40 | 50 |
| #4 | 34 MBR / 32 MBR | Laminated Wood | 5 mm rubber | Hat Channel | 45 | 48 |

**Flooring Type Analysis**

This section discusses the results of the desktop and testing analysis in terms of potential alterations to the floor surface material.

*Carpet Flooring*

The original carpet and pad and ceiling construction achieve the IIC 55 and STC 55 goal, as proven by calculation and measurement.

*Engineered Wood Flooring with 5mm Rubber Underlayment*

Field tests indicate the building code minimum of ASTC 45 is typically met with engineered wood finishes, however the AIIC 45 minimum criteria may not be achieved depending on the conditions of ceiling renovations. Additional mitigation is required to achieve the proposed IIC 55 and STC 55 Ironwoods criteria with engineered wood flooring.

*LVT/LVP Flooring*

Calculations indicate typical vinyl products with existing ceiling and structure would not achieve the IIC 55 and STC 55 goal. Additional mitigation would be required to achieve IBC minimum criteria and the proposed IIC 55 and STC 55 Ironwoods criteria with vinyl flooring.

*Stone/Ceramic Tile Flooring*

Tests of unit 34/32 comply with the international building code minimum and proposed Ironwoods ASTC criteria. IBC and ironwoods AIIC criteria are not achievable with stone tile. Additional mitigation is required to achieve IBC minimum criteria and the proposed IIC 55 and STC 55 Ironwoods criteria with tile flooring.

**Testing Subjective Evaluations**

In addition to objective measurement results according to the ASTM standards, DLAA performed a subjective analysis of each tested unit to determine potential flanking paths. This section lists subjective observations and notes regarding each specific unit.

*63/61*

* Ceiling lights rattle with loud impact and airborne noise from upstairs neighbor
* Open ceiling return grilles in bathroom adjacent to Unit 61 bedroom may be a flanking spot for airborne noise.
* Carpet and pad provide IIC rating as expected, no impact noise “weak” spots.

*73/71*

* Airborne and impact noise appear to be concentrated toward the area of the enclosed lanai in the bedroom of Unit 71.
* Upon inspection, the ceiling grille above the adjacent bathroom does not appear to include sound isolation.
* The ceiling of the enclosed lanai is not uniform and includes areas with a relatively small ceiling cavity, which may be a primary flanking path for both airborne and impact sound between these units.

*34/32*

* No clear flanking paths observed in either the kitchen, living room, dining area, or hall.
* Some loud sounds may be transmitted via the large kitchen windows, however this transmission is not a function of the floor/ceiling assembly design.
* Airborne noise in the enclosed Unit 32 Bedroom lanai/study area appeared slightly louder than the rest of the bedroom.
  + This is expected, lanai structures are not usually designed for sound isolation; maintaining the acoustic isolation of the rest of the structure may require deeper changes to the enclosed lanai ceiling.

**RECOMMENDATIONS**

**House Rules Modifications**

DLAA recommends simplifying the house rules to reference standards typical of modern industry. Suggested house rule language is provided as an attachment for review and coordination with the building’s attorney prior to adoption into building standards.

**New Renovation Requirements**

The results of the study indicate the following alterations to the core structure would increase the IIC and STC ratings. These alterations qualify as Scenario 5 of the analysis scope. Mitigation options are presented in terms of either flooring renovation only, ceiling renovation only, and both floor and ceiling renovation. Note that it may not be possible to achieve the STC and IIC 55 goals with floor-only renovations without significant change to floor height. The absence of insulation in the ceiling cavity severely limits the acoustical performance of the as-built floor/ceiling assembly.

*Flooring Only Renovation – Estimated IIC 52 and STC 53*

* Hard Flooring Finish (LVT, Wood, Tile)
* Rubber Acoustical underlayment
  + LVT – 2mm
  + Wood – 5mm
  + Tile – 10 mm
* Gypsum concrete subfloor
  + 1-1/2" thick for dimpled Rubber underlayment; or
  + 1” thick for wire mesh underlayment
* Acoustical Interlayer
  + 25mm dimpled rubber interlayer (Pliteq Geniemat or Regupol Sonus); or
  + Premium wire mesh underlayment (0.4” MT for Keene QuietQurl, 1/4" Premium for Maxxon AcoustiMat)
* Additional layer 3/4" of plywood

*Ceiling Only Renovation – Estimated IIC 55 and STC 62*

* Add mineral wool insulation between all floor joists – thickness to fill minimum 80% of the ceiling cavity.
* Use two (2) layers of gypsum at the ceiling

*Flooring and Ceiling Renovation – Estimated IIC 65 and STC 56 (bold text indicates added material)*

* Engineered or Hard wood
* ***5mm rubber Underlayment***
* Minimum 1.5" light-weight concrete
* ***5mm dimpled rubber interlayer***
* ***3/4” plywood layered 90 degrees to below***
* 3/4" plywood
* 2”x10” wood joists, 12” O.C.
* ***Fiberglass batt insulation filling 80% of joist cavity***
* Resilient Channel
* 5/8” Gypsum Board
* ***5/8” Gypsum Board***

**Mitigation Options for Already Renovated Units**

There is no substitute for a correct floor/ceiling assembly renovation, however DLAA is often asked to advise on how to address situations where owners have already altered the as-built floor/ceiling assembly. Usually retrofit solutions are limited to requiring area rugs, furniture pads, and enforcing strict adherence to noise nuisance bylaws, to be determined by the Board based on their applicable situation. The ultimate solution for Ironwoods depends on non-acoustical considerations and policies to be determined by the Ironwoods Board.

**General “Best-Practices” Recommendations for Floor/Ceiling Renovations**

Flanking transmission has the potential to reduce the sound isolation performance of floor/ceiling assemblies even with high IIC and STC ratings. Typical flanking paths in floor/ceiling assemblies are comprised of mechanical or electrical penetrations into the system. DLAA recommends the following to reduce the amount of flanking transmission during renovations:

* All recessed ceiling lights and speakers should be enclosed in a two-layer gypsum board enclosure.
* All mechanical equipment suspended within ceiling cavity, including associated plumbing and ducts, should be installed with vibration isolation according to the 2015 ASHRAE Guidebook Chapter 15 “Noise and Vibration”.
* Externally lag all ceiling mounted duct/piping with 2” mass loaded vinyl such as Kinetics KNM-200AL

The ceiling mounting method has an impact on acoustical performance. Ceiling mounting methods should be restricted to resilient channels or resilient clips. Acceptable resilient mounting materials are as follows:

Resilient channel: Clark-Dietrich RC-Deluxe only.

Resilient isolation Clips: Kinetics Isomax, RSIC-1, GenieClip, SonusClip

Although not required to achieve project minimum criteria, there are more expensive ceiling constructions which would provide more sound isolation, such as spring hangers and other proprietary methods such as the Kinetics Wave Hanger.

**CONCLUSIONS**

The original construction of The Ironwoods was built to achieve the 1967 HUD Guideline criteria as adopted in the current AOAO house rules. While the 1967 HUD guidelines for “Grade 1” quality no longer align with industry “luxury” acoustical standards, maintaining a criteria of IIC 55 and STC 55 would allow the most seamless transition to modern design aesthetic.

It is not possible to comply with the updated STC 55 and IIC 55 standard, or even IBC minimums without carpet and pad (of comparable quality to the original construction) and the original ceiling construction. To maximize sound isolation flooring modifications will require adding several layers of materials above the existing plywood decking: plywood, acoustical interlayer and thicker concrete finishes in addition to the already typical 5mm rubber underlayment. Even with this approach, changes to the ceiling would be required to bring the floor/ceiling assemblies up to the building standards with hard surface flooring. All ceiling joists should be filled minimum 80% of the cavity depth with mineral wool insulation, and every ceiling should use two layers of gypsum board.

Finally, DLAA notes that the proposed house rule criteria, the allowance of non-carpet flooring finishes and the fact that the structure is a light-weight wooden joist structure all prohibit the possibility of a “luxury” experience at The Ironwoods in terms of acoustical sound isolation. DLAA strongly advises avoiding the term “luxury” in all sales materials and notifying prospective buyers of this inherent limitation.

DLAA’s recommendations are aimed at achieving acoustical objectives only. All recommendations should be reviewed by appropriate professionals for compliance with building code, fire code, etc. prior to implementation.

Please feel free to contact us if you have any questions or comments.

Sincerely,



Lucas Johnson

Senior Consultant