C. Core Investigation Areas

C.1 Introduction

Detailed analyses of technical building systems and construction methods have been selected and investigated. The three main challenging areas on the Wellington Condominiums Project are detailed in the following sections below.

C.2 Hambros Joist Composite Deck System ~ *Acoustical Breadth*

Figure 1: First Floor Hambros Joist Composite Deck System

The Hambros Joist Composite Deck System for the Wellington Condominiums has been analyzed and is broken down as followed:

C.2.1 Problem Statement

Is the Hambros Joist Composite Deck System a correct decision to be utilized on the Wellington Condominiums Project? Would a traditional composite deck system be a better alternative to the Wellington Condominiums Project? What type of construction project would best benefit from using the Hambros Joist Composite Deck System?

C.2.2 Proposed Solution

Analyze and compare the Hambros Joist Composite Deck System to other typical composite deck systems. The main breath will look at the acoustical properties of both systems and see what system would be recommended through a design and constructability perspective. The acoustics is mostly of concern due to the fact that the Hambros Joist Composite Deck System can be as thin as 2.5". Being that thin of a deck and having high end condominiums, the vibration and sound transfer between floors become of great interest and importance. Manufacturers and Suppliers have promoted the fact that this system is excellent by industry standards for minimal vibration and sound transfer. It is up to this research to examine if this claim is true and if any parts of the system, i.e. the acoustical properties, are not as expected then recommendations would be provided to correct the problem.

C.2.3 Analysis Steps

1. Learn in more detail how the project team selected the use of the Hambros Joist Composite Deck System. What are the initial advantages and disadvantages of this system on the Wellington Condominiums Project?
2. Perform an acoustical analysis to determine if the Hambros Joist Composite Deck System performs up to typical composite systems.
3. Compare and contrast each system and come up with a logical rational as to decide if the Hambros Joist Composite Deck System was the correct choice for this project.
4. If areas of the Hambros Joist Composite Deck System are seen to cause problems what can be done to improve the system during the construction phase.
5. Make recommendations as to where this system would be best utilized for a given project. Identify some key areas that a project team must focus on when deciding to use this product.

C.2.4 Analysis Result Overview

The research results concluded that the Hambros Joist Composite Deck System has its advantages; but it might not be what is suitable for the Wellington Condominiums Project. The Hambros Joist Composite Deck System is a new product that has been a problem for the project team during construction. Issues have risen to the surface and questions have been researched about whether or not this system fits well with the Wellington Condominiums Project. It is through this investigation, as detailed in the following sections, to create a logical and systematic approach as to see if this system was the correct decision to be utilized on this project.

C.2.4.1.A Overview of the Hambros Joist Composite Deck System

The Hambros Joist Composite Deck System was utilized on the Wellington Condominiums Project to provide a new means of floor-ceiling assembly construction.

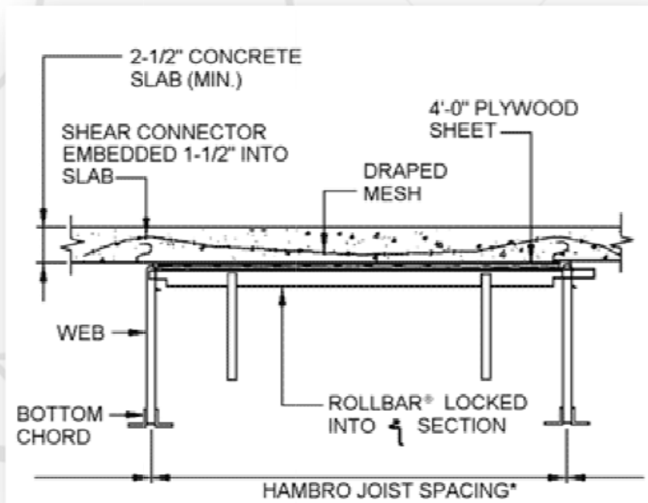


Figure 2: Hambros Joist Composite Deck Section

The system, as shown in Figure 2, utilizes a concrete slab through the support of 4’-1/4” spaced Hambro Joists. Some of the unique features of utilizing this floor-ceiling assembly are: the concrete slab can be as thin as 2-1/2”, utilize minimum reinforcing through the application of welded wire mesh, 4’-0” plywood sheets can be removed the day after a concrete pour, and no shoring/re-shoring is required for this system.

The process at which to utilize this system is very straight forward and is outlined as followed:

1. **Spreading Joists:** Spread Hambro joist at 4’-1 ¼” on load bearing walls
2. **Placing Roll bars:** Roll bars are to keep uniform spacing while providing lateral and tensional stability
3. **Installing Plywood Forms:** Installing the plywood forms a working surface and forms a rigid diaphragm during construction
4. **Mesh In Place:** Mesh over top chord of joist creates a way of reinforcing concrete
5. **Pouring Concrete:** No shoring is required with this system when pouring concrete. The minimum thickness requirement is 2 ½”. The Wellington Condominium project makes use of 3” slab thickness.

6. **Stripping Formwork:** When concrete reaches strength of 500 PSI (usually the day after the pour) the plywood forms can be taken out. When the concrete reaches strength of 1000 PSI (usually within 48 hours) the deck is ready for other trades and the formwork can be removed for future re-use.

C.2.4.1.B Advantages and Disadvantages of the Hambros Joist Composite Deck System

Through the experience of the project team on the Wellington Condominiums Project and manufacturer's specifications, a list of the advantages and disadvantages have been compiled as followed:

Advantages

Fire Ratings: U.L. Fire Ratings for 1, 2 and 3 hours and can eliminate the need for fire dampers.

Composite Design: Provides a floor that is 2-3 times more rigid, with 1/3 the deflection of a typical bar joist assembly. Hambro also provides 4' joist spacing without bridging and bracing. Typical bar joist assemblies are spaced at 2' or 2'-6" on center and require bridging, bracing, and a metal deck.

Cost Savings: No Shoring or Re-shoring required. Less concrete and reinforcing are needed which decreases material cost. Overall the Hambro Composite Deck System is in the same price range as other floor-ceiling assemblies.

Slab Penetrations: Is relatively simple using sleeves, Styrofoam, or wood blocking prior to concreting. No tendons and fewer joists offer flexibility. Slender 3,000 PSI slab makes coring simple, if necessary.

Schedule Savings: Typically after one or two days the formwork can be stripped and work can begin on the next level without the need of shoring or re-shoring. Total construction per floor can reach levels of less than 5 days with experienced crew members.

Mechanical Interfacing: Features open web configuration, no bridging and 4' to 6' joist spacing accommodates mechanical distribution within the joist plenum. Hambro permits full-length ducts and pipes, and virtually eliminates dropped ceilings and sofits.

Disadvantages

Acoustical Properties: Hambro has an STC 52 and IIC 26 for a 2 ½" slab and 1 layer of ½" drywall. The IIC rating is very low due to the composite systems thin concrete slab.

Special consideration to what floor material is applied to the system must be carefully analyzed.

Bearing Systems: Hambro works well for a variety of bearing systems. One of the biggest problems with this system through the utilization of load bearing metal stud walls is that it is dependent on a flat concrete surface for panel bearing. If there are any bumps or high spots in the concrete where the panels bear on the slab, then the panel needs to be shimmed, and that area of the building gets taller. If the panels stacked on top of each other and the slab butt into the side of the panel (perhaps bearing on an angle or recess in the panel), then the concrete flatness and accuracy would be less of an issue.

Labor Intensive: Only two or three companies specialize in the installation of this system professionally in the eastern United States. The system tends to be very labor intensive due to moving the Hambro Joists into place. A lot of time is spent by crews stripping the formwork from the joist assembly for the next floor level.

Installation: Increase in schedule and budget can result if not familiar with the system and its components. System is unlike other floor-ceiling assemblies and requires different planning during construction.

Versatility: Hambro is well-suited to a variety of projects but is very difficult to use when walls are not repetitious and linear.

Quality Control: Measures must be in place to control any seepage of concrete from the formwork system during pouring. After stripping the formwork, a special crew may be needed to come back through to properly finish the surface of the concrete assembly. Additional costs to the contractor may be inherited due to this situation.

C.2.4.1.C Project Team Selection of the Hambros Joist Composite Deck System

The Wellington Condominiums Project Team selected the Hambros Joist Composite Deck System by the design team to initially speed up the construction process. Through consultation of the manufacturers and engineers, the project team was able to then utilize the Hambros Joist Composite Deck system on the Wellington Condominiums Project.

C.2.4.1.D Original Estimate and Schedule

The Wellington Condominium's original composite deck system estimate and schedule are detailed as followed:

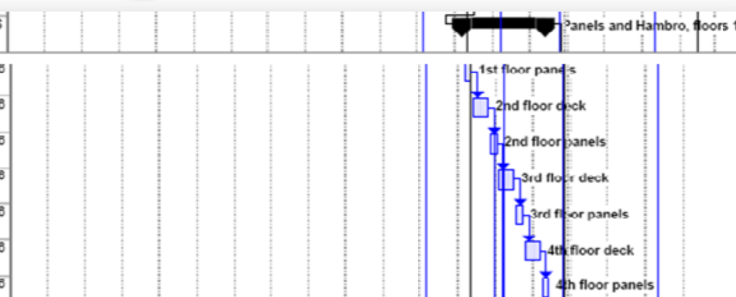
Original Estimate:

Hambro Joist System and Components					Superstructure						
Qty	CSI Number	Description	Crew	Daily Output	Labor Hours	Unit	Bare Mat.	Bare Labor	Bare Equip.	Total
Division 5 Metals										
25526.54	54204100550	Floor joist, galv CF steel, 12 ga x 12" D, incl jois				L.F.	153,159.24	0.00	0.00	153,159.24
2,700.000	54204101550	Floor joist, galv CF steel, 12 ga x 12" D, incl fas	2 Carp	30	0.533	Ea.	0.00	46,305.00	0.00	46,305.00
		Totals					$153,159.24	$46,305.00	$0.00	$199,464.24
				ENR Building Cost Index Inflation from 2005 to 2006 Allentown, PA Location Factor already in calculations					(3.9% Total Cost Escalation)	
										$207,243.35

~See Attached Appendix for Detailed Structural Takeoff~

Original Schedule:

Panels and Hambro, floors 1-4	50 days	Mon 8/7/06	Fri 10/13/06
1st floor panels	5 days	Mon 8/7/06	Fri 8/11/06
2nd floor deck	10 days	Mon 8/14/06	Fri 8/25/06
2nd floor panels	5 days	Mon 8/28/06	Fri 9/1/06
3rd floor deck	10 days	Mon 9/4/06	Fri 9/15/06
3rd floor panels	5 days	Mon 9/18/06	Fri 9/22/06
4th floor deck	10 days	Mon 9/25/06	Fri 10/6/06
4th floor panels	5 days	Mon 10/9/06	Fri 10/13/06



Total: **50 Work Days = 10 Weeks**
Mon 8/7/06 – Fri 10/13/06

~See Attached Appendix for Full Schedule~

C.2.4.2.A Architectural Acoustical Breadth Analysis of the Hambros Assembly

An acoustical analysis was performed to determine if the Hambros Joist Composite Deck System performs up to other conventional steel joist and deck systems. This breadth analysis will explore:

1. What acoustical properties are used to rate a floor-ceiling assembly? How is a floor-ceiling assembly created?
2. The manufacturer Swirnow Building System's claim that the Hambro D500 acoustical properties are excellent as compared to other floor-ceiling assemblies.
3. Identify areas of the Hambro Joist Composite Deck System that are of need of further improvement based on the Wellington Condominiums Project specifications.
4. Suggestions for acoustical performance improvement on the Wellington Condominiums Project.
5. Recommendation of what floor-ceiling assembly should be utilized on a project based on acoustical properties.

C.2.4.2.B Architectural Acoustical Background Information and Example Calculation

The main acoustical properties that are used to rate floor/ceiling assemblies are the sound transmission class (STC) and impact isolation class (IIC).

STC, according to *Architectural Acoustics* by David Egan, is defined as: a single-number rating of airborne sound transmission loss (TL) performance of a construction measured at standard one-third octave band frequencies. The higher the STC rating, the more efficient the construction will be in reducing sound transmission within the frequency of range of the test.

The STC rating method and procedures are specified in the American Society for Testing Materials (ASTM) annual book of standards. The following floor-ceiling assembly was utilized as an example to the steps required in calculating the STC value:

❖ Conventional Steel Joist & Metal Deck with 1 5/8" Concrete and 5/8" Gypboard

Step 1: Calculate or look up TL data based on the floor-ceiling assembly chosen.

Building Construction	Transmission Loss (dB) 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	STC Rating	IIC Rating†
31. Construction no. 30 with 5/8-in gypsum board screwed to resilient channels spaced 24 in oc perpendicular to joists	30	35	44	50	54	60	47	39
32. Construction no. 31 with 3-in glass-fiber insulation in cavity	36	40	45	52	58	64	49	46
33. 4-in reinforced concrete slab (54 lb/ft²)	48	42	45	56	57	66	44	25
34. 14-in precast concrete tees with 2-in concrete topping on 2-in slab (75 lb/ft²)	39	45	50	52	60	68	54	24
35. 6-in reinforced concrete slab (75 lb/ft²)	38	43	52	59	67	72	55	34
36. 6-in reinforced concrete slab with 3/4-in T&G wood flooring on 1 1/2 by 2 wooden battens floated on 1-in glass fiber (83 lb/ft²)	38	44	52	55	60	65	55	57
37. 18-in steel joists 16 in oc with 1 5/8-in concrete on 5/8-in plywood under heavy carpet laid on pad, and 5/8-in gypsum board attached to joists on ceiling side (20 lb/ft²)	27	37	45	54	60	65	47	62

Figure 3: Transmission Loss Data for Common Building Elements

Step 2: Plot the measured TL values against the frequencies ranging from 125 to 4000 Hz.

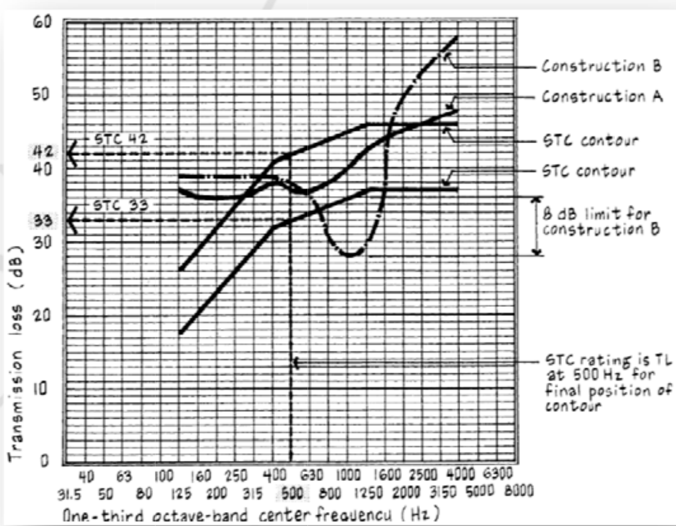


Figure 4: Example of Plotted Transmission Loss with STC Contour

Step 3: The STC rating, as shown in Figure 4, can be graphically determined by using a transparent overlay on which the STC contour is reproduced. The STC contour, as defined by ASTM, is shifted vertically relative to the plotted curve of test data to as high a final position possible according to the following limiting criteria:

- The maximum deviation of the test curve below the contour at any single test frequency shall not exceed 8 dB.
- The sum of the deviations below the contour at all 16 frequencies of the test curve shall not exceed 32 dB.

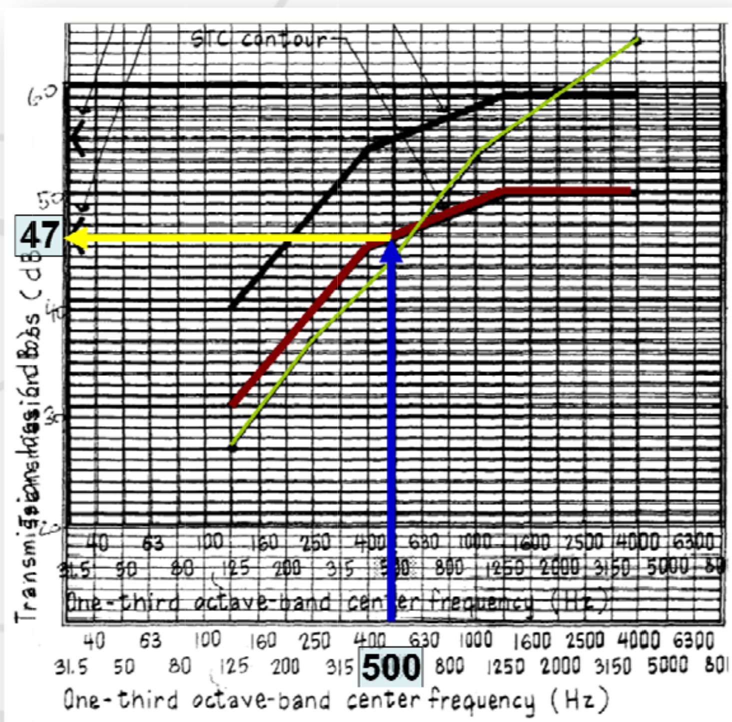


Figure 5: Conventional Steel Joist & Metal Deck Overlay

Step 4: Once the criteria has been met as shown in Figure 5, a vertical line is drawn from the 500 Hz frequency to the STC contour and then horizontally to the TL scale. The number read from the TL scale is the STC for that assembly. For this example, a conventional steel joist & metal deck overlay has an STC rating of 47.

Note: STC 50 is the minimum required for apartments and condominiums and must be in accordance with ASTM-E336 and ASTM-E90-70. If STC 50 is not reached further noise control parameters must be done.

IIC, according to *Architectural Acoustics* by David Egan, is defined as: a single-number rating of the sound transmission loss performance of a floor-ceiling construction measured at standard one-third octave band frequencies. The higher the IIC rating, the more efficient the construction will be in reading impact sound transmission within the frequency range of the test.

In the United States, the IIC rating method is recommended by the Federal Housing Administration (FHA) as a rating of impact sound isolation effectiveness for floor-ceiling assemblies. The same procedure used for calculating STC is applied for IIC. The only differences are listed as followed:

- Instead of measuring TL data, the Impact sound pressure level is measured in relation to the floor-ceiling assemblies.
- The Impact sound pressure level is plotted against the frequencies ranging from 100 to 3150 Hz. The IIC contour is applied utilizing the ASTM criteria as described in the STC procedure.
- The IIC rating is read off in similar fashion as shown in Figure 6 below.

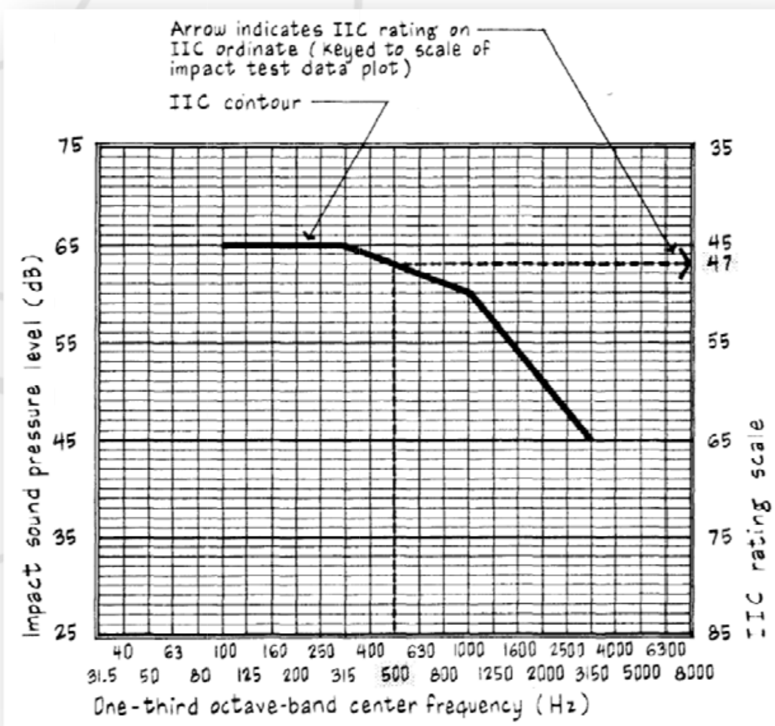
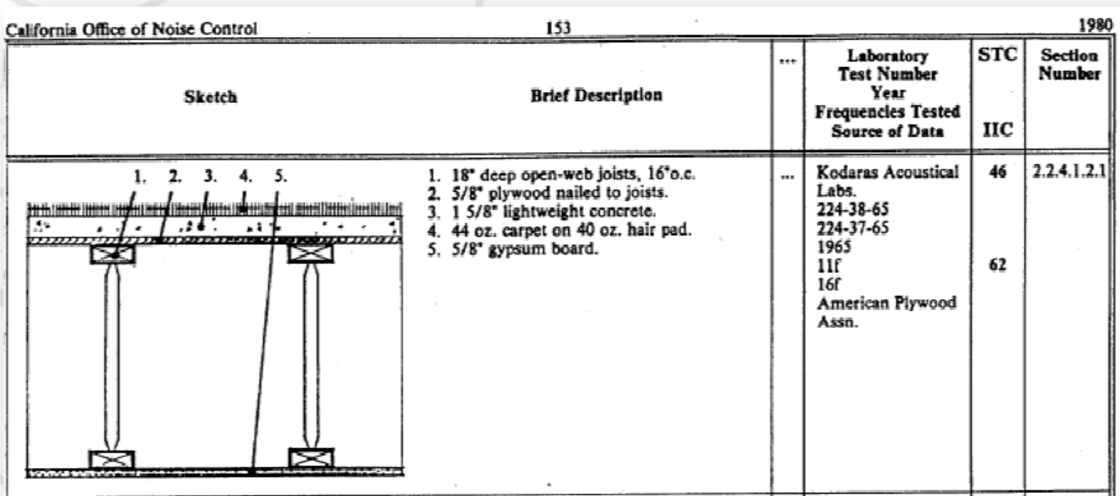


Figure 6: Example of IIC Rating Graph

The STC and IIC ASTM rating procedure has been performed numerous times and administrations like the California Department of Health Services have compiled a catalog of accepted STC and IIC ratings for Wall and Floor-Ceiling Assemblies. An example of what you would find in the catalog of STC and IIC Ratings for Wall and Floor-Ceiling Assemblies is as followed:



California Office of Noise Control 153 1980

Sketch	Brief Description	...	Laboratory Test Number Year Frequencies Tested Source of Data	STC / IIC	Section Number
1. 2. 3. 4. 5.	1. 18" deep open-web joists, 16"o.c. 2. 5/8" plywood nailed to joists. 3. 1 5/8" lightweight concrete. 4. 44 oz. carpet on 40 oz. hair pad. 5. 5/8" gypsum board.	...	Kodaras Acoustical Labs. 224-38-65 224-37-65 1965 11f 16f American Plywood Assn.	46 62	2.2.4.1.2.1

Figure 7: Catalog of STC and IIC Ratings for Conventional Steel Joist & Metal Deck

Important Observation: From the following information provided, you can see that the STC and IIC data are consistent for Conventional Steel Joist & Metal Deck:

Figure 3: TL Data for Common Building Elements
- STC: 47
- IIC: 62

Figure 5: Conventional Steel Joist & Metal Deck Overlay
- STC: 47

Figure 7: Catalog of STC and IIC Ratings for Conventional Steel Joist & Metal Deck
- STC: 46
- IIC: 62

C.2.4.2.C The Manufacturer's Claim

The manufacturer Swirnow Building systems have made the claim that the Hambro D500 has the acoustical properties of reaching an STC 57 and IIC 30. The manufacturers have provided a chart below to show the relationship between the Hambro D500 and other floor-ceiling assemblies.

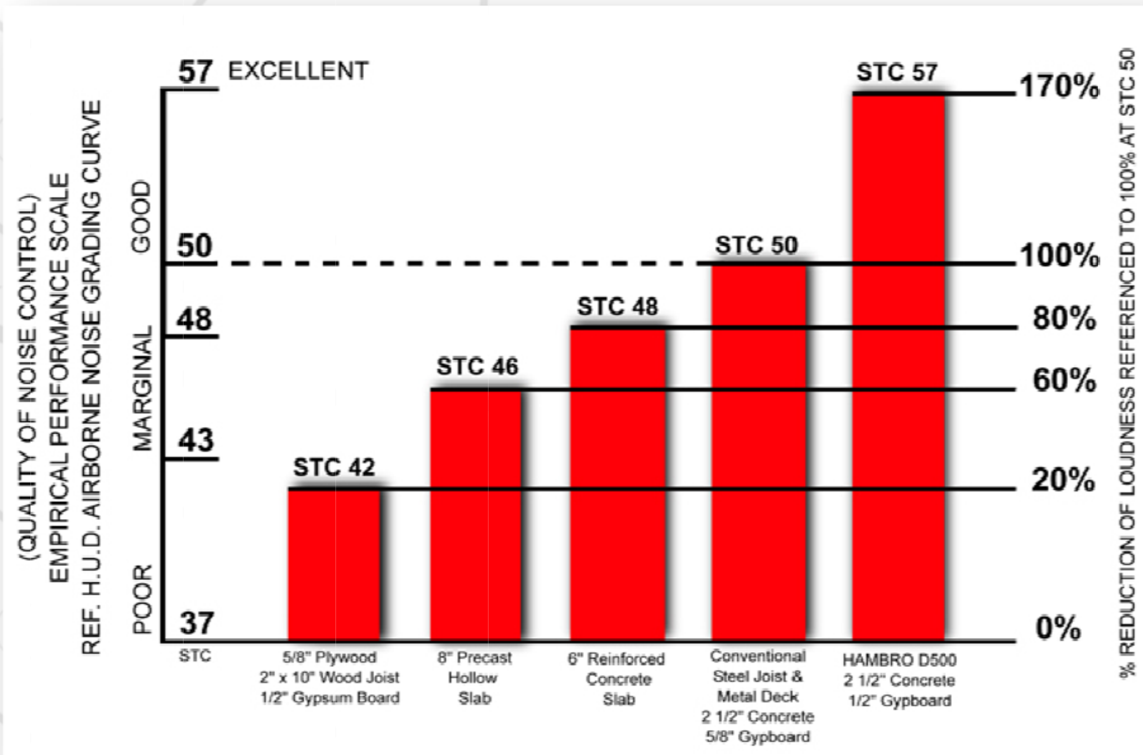


Figure 8: Manufacturer Swirnow Building Systems Comparison Chart

This chart as shown in Figure 8 shows that the Hambro D500 has a STC 57 and is considered excellent to the quality of noise control. Other floor-ceiling assemblies are compared as listed in the chart. But further investigation into this chart and other data reveals that this data is misleading to the normal viewer.

HAMBRO SOUND INFORMATION

Hambro Assemblies	STC	IIC
2 1/2” slab, 1 layer 1/2” drywall	52	26
3” slab, 1 layer 1/2” drywall	57	30
4” slab, 1 layer 1/2” drywall	58	32
4” slab, 2 layer 1/2” drywall	60	36

Figure 9: Acoustical Property Specifications for the Hambro Assemblies

From Figure 9 we can see that the Hambro Assembly with a 2 ½” slab has a STC 52 and not STC 57 as specified in Figure 8.

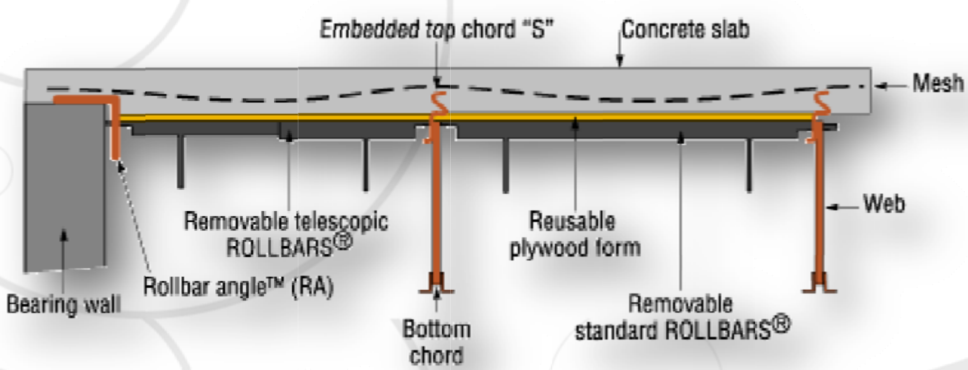
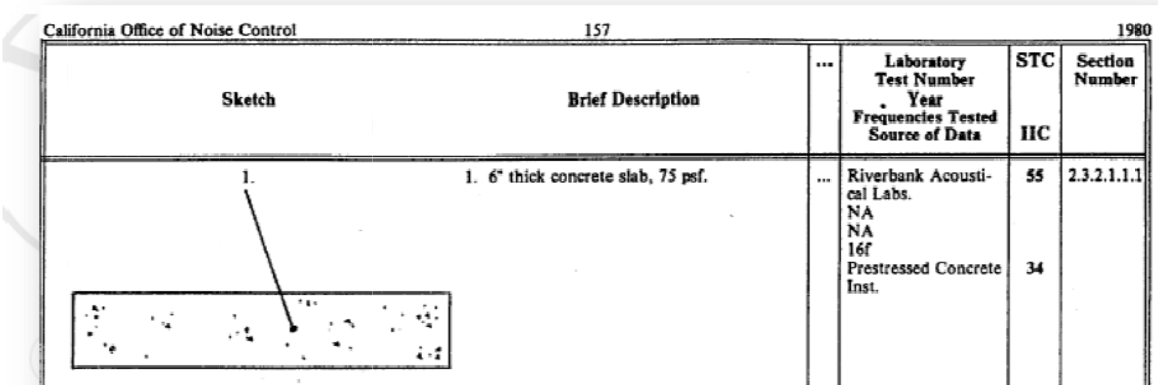


Figure 10: Hambro D500 Floor-Ceiling Assembly

From the above “Important Observation” it was concluded that Conventional Steel Joist & Metal Deck reached a maximum value of STC 47. In Figure 8, the manufacturers specify an STC 50.

In Figure 11 below; for 6” thick concrete slab a STC 55 is achieved. The manufacturers specify that 6” thick concrete slab achieves a STC 48.

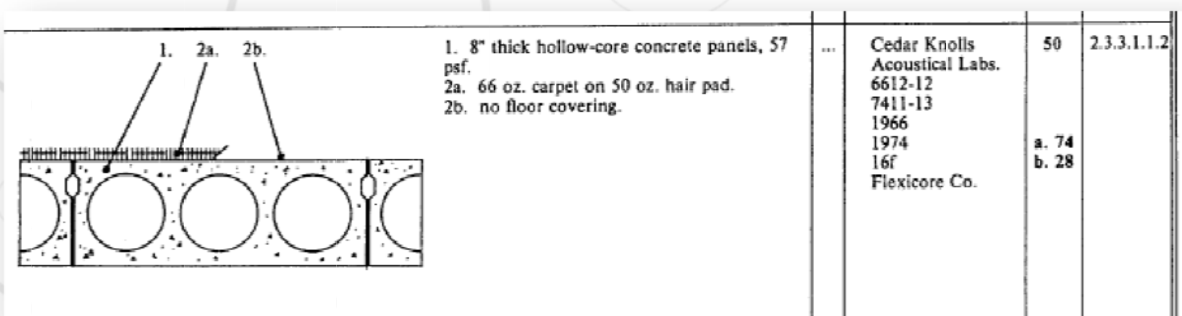


California Office of Noise Control 157 1980

Sketch	Brief Description	...	Laboratory Test Number • Year Frequencies Tested Source of Data	STC / IIC	Section Number
1.	1. 6" thick concrete slab, 75 psf.	...	Riverbank Acoustical Labs. NA NA 16f Prestressed Concrete Inst.	55 / 34	2.3.2.1.1.1

Figure 11: STC and IIC Ratings for 6" Thick Concrete Slab

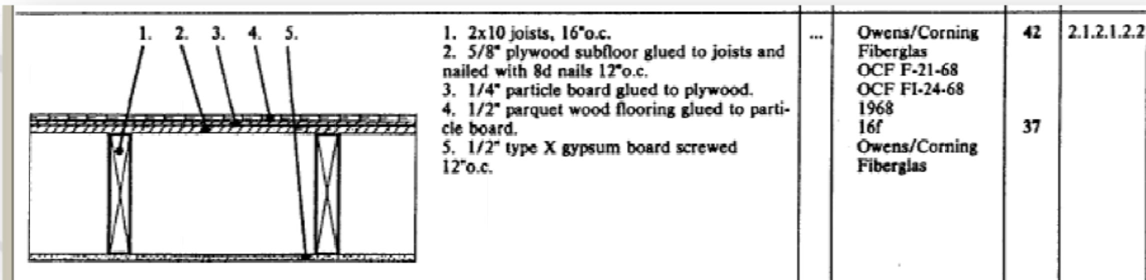
Figure 12 below indicates that for 8" thick hollow slab a STC 50 is achieved. The manufacturers specify that 8" thick hollow slab achieves a STC 46.



1. 2a. 2b.	1. 8" thick hollow-core concrete panels, 57 psf. 2a. 66 oz. carpet on 50 oz. hair pad. 2b. no floor covering.	...	Cedar Knolls Acoustical Labs. 6612-12 7411-13 1966 1974 16f Flexicore Co.	50 a. 74 b. 28	2.3.3.1.1.2

Figure 12: STC and IIC Ratings for 8" Hollow Slab

For a 2 x 10 Wood Joist Floor-Ceiling Assembly an STC 42 is achieved by the California Department of Health Services as indicated in Figure 13. The manufacturers Swirnow Building Systems have claimed that an STC 42 is achievable.



	1. 2x10 joists, 16"o.c. 2. 5/8" plywood subfloor glued to joists and nailed with 8d nails 12"o.c. 3. 1/4" particle board glued to plywood. 4. 1/2" parquet wood flooring glued to particle board. 5. 1/2" type X gypsum board screwed 12"o.c.	...	Owens/Corning Fiberglas OCF F-21-68 OCF FI-24-68 1968 16f Owens/Corning Fiberglas	42 37	2.1.2.1.2.2

Figure 13: STC and IIC Ratings for 2 x 10 Wood Joist Floor-Ceiling Assembly

With all that information at hand updated versions of the floor-ceiling assemblies STC ratings have been compiled in Figure 14.

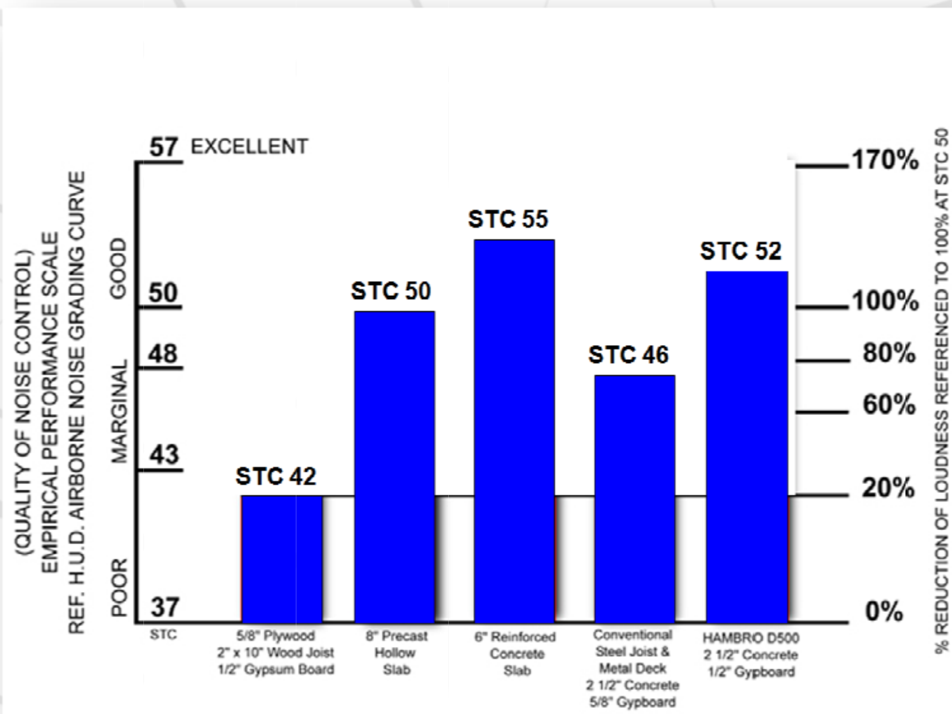


Figure 14: Updated Chart for STC Ratings for Floor-Ceiling Assemblies

Figure 14 now represents a clear picture of what floor-ceiling systems should be recommended based on STC rating. As it currently stands the 6" reinforced concrete slab achieves the highest rating for reducing apparent loudness of transmitted airborne noise such as speech, radio, TV, and music.

STC RATINGS: WHAT THEY MEAN

STC Rating	Practical Guidelines
25	Normal speech easily understood
30	Normal speech audible, but not intelligible
35	Loud speech audible, fairly understandable
40	Loud speech audible, but not intelligible
45	Loud speech barely audible
50	Shouting barely audible
55	Shouting Inaudible

Figure 15: What Does It All Mean?

By having a STC 52 for the Hambro D500 System this indicates that if shouting were to occur in an apartment or condominium above the sound would transfer through the floor-ceiling assembly.

C.2.4.2.D Further Improvements to the Assembly

Therefore on the Wellington Condominiums Project adjustments were made to minimize the sound and vibration transfer between floor-ceiling assemblies. Figure 16 is a floor-ceiling assembly detail that illustrates what the project team did to improve on architectural acoustics.

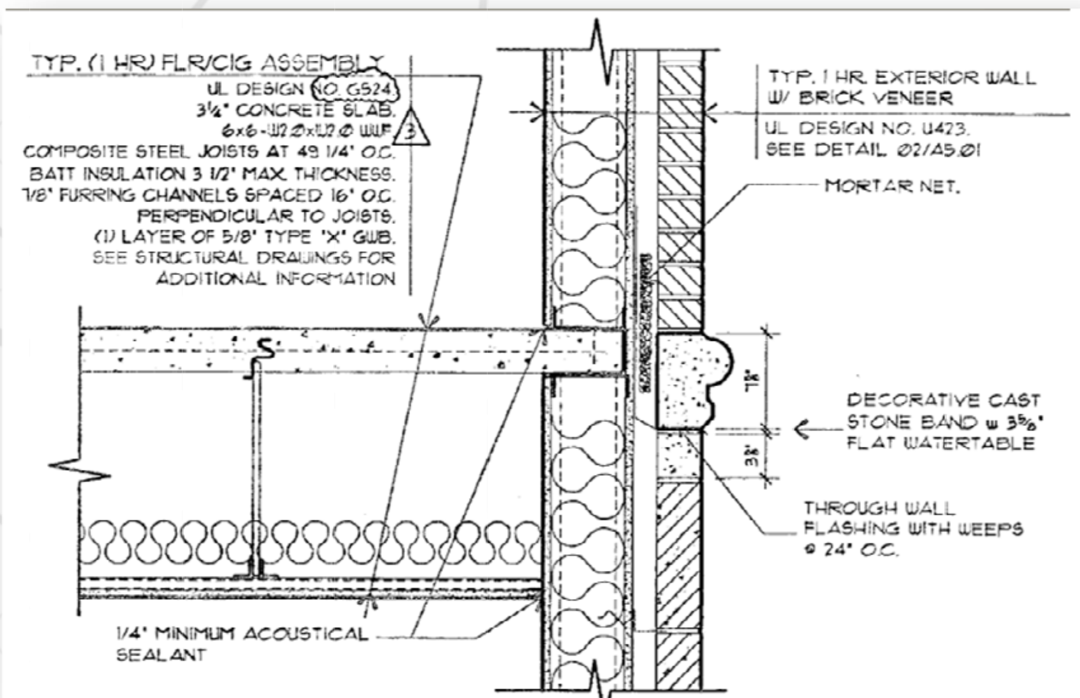


Figure 16: Wellington Condominiums Project Floor-Ceiling Assembly Detail

The following initial change that the Wellington Condominiums project team made is as followed:

- ❖ Went with 3 ¼" thick concrete slab

From this information, the Wellington Condominiums Hambro Joist Composite Deck System thru the utilization of the Hambro D500 floor-ceiling deck assembly will have an STC 57 and IIC 30.

The STC 57 achieved through the utilization of the Hambros Joist Composite Deck System meets IBC requirements of having at least STC 50 rating. With an STC 57, it means that all sound transmission will be isolated between floors. Shouting will be inaudible and create an atmosphere that luxury condominiums demand.

Source room \ Receiving room	Bedroom	Living room	Kitchen	Bathroom	Family room	Corridor
Bedroom	50	50	50	50	50	50
Living room	55	50	50	50	50	45
Kitchen	55	50	45	45	45	40
Bathroom	55	55	50	50	40	40
Family room	55	50	45	45	40	40
Corridor	50	45	40	45	35	-

Figure 17: STC Recommendations for Dwellings

Figure 17 indicates the STC level recommendations that should be achieved for a level of comfort for occupants. The highest STC rating achieved for dwellings occurs at STC 55 with a bathroom being the source room and a bedroom being the receiving room. Since an STC 57 is achieved on the Wellington Condominiums Project, no further analysis is needed due to sound transfer.

Source room (located above) \ Receiving room (located below)	Bedroom	Living room	Kitchen	Bathroom	Family room	Corridor
Bedroom	52	52	50	-	48	-
Living room	57	52	52	-	50	-
Kitchen	62	57	52	-	52	-
Bathroom	-	-	52	50	-	-
Family room	62	60	58	-	-	-
Corridor	62	57	52	-	-	48

Figure 18: IIC Recommendations for Dwellings

The current IIC 30 rating provided creates an issue when compare ratings to Figure 18. In Figure 18, the recommendations for dwellings are shown to indicate acceptable levels of impact noise between floor-ceiling assemblies.

Improvement must be made to prevent impact noises caused by walking, rolling carts, dropped objects, shuffled furniture, and slammed doors. On the Wellington Condominiums Project the project team did the following to prevent impact noises from transferring between floors:

- Added batt insulation with 3 ½” maximum thickness
- ¼” minimum acoustical sealant

IIC AND STC IMPROVEMENTS FROM MODIFICATIONS TO FLOOR-CEILING CONSTRUCTIONS

The table shows modifications to floor-ceiling constructions along with the corresponding estimated improvements in IIC and STC ratings. Floated floors can be more effective when installed on concrete slabs than on wood-joist flooring because concrete slabs provide more rigid support.

Modifications to Basic Construction	IIC Improvement	STC Improvement
Wood Joist		
Resiliently suspended ceiling	8	10
Floated floor	8	10
Sound-absorbing material in airspace of resiliently suspended ceiling	7	2 to 4
Concrete Slab		
Resiliently suspended ceiling	8	10 to 12
Floated floor	15 to 20	10 to 12
Sound-absorbing material in airspace of resiliently suspended ceiling	>5	>3
Wood flooring ($\geq 1/2$ in thick) set in mastic	7	0
Wood Joist or Concrete-Slab		
Vinyl tile	0 to 5	0
Linoleum (3/32 in thick)	3 to 5	0
Carpet on foam rubber underlay (use higher end of IIC range for concrete slab systems)	20 to 40	0

Figure 19: IIC and STC Improvements to Floor-Ceiling Constructions

Figure 19 indicates that if a sound-absorbing material is added an IIC and STC improvement of 5 and 3 results respectively. Therefore a STC 62 and IIC 33 results due to the improvements listed in Figure 19. With an IIC 33 more improvement is still needed to isolate impact noise between floors.

For the Wellington Condominiums Project to ensure proper impact noise isolation a STC 62 should be reached. Therefore 29 additional points should be achieved to ensure occupants the luxury grandeur of the condominiums promised.

Impact of Floor Finishes & Hambro Floor System

Floor Finishes	Additional IIC Points
Carpet and Pad	24
Homasote 1/2" comfort base under wood laminate **www.homasote.com**	18
6 mm cork under engineered hardwood	21
Dodge Regupol 4010 10 mm underlayment under ceramic tile **www.regupol.com**	20
Quiet Walk underlayment underlaminate flooring **www.mpglobalproducts.com**	19
Insulayment under engineered wood **www.mpglobalproducts.com**	20
1 1/2" Maxxon gypsum underlayment over Enkasonic sound control mat with quarry tile over Noble Seal SIS **www.maxxon.com**	28
1 1/2" Maxxon gypsum underlayment over Enkasonic sound control mat with wood laminate floor over silent step **www.maxxon.com**	29
1 1/2" Maxxon gypsum underlayment over Enkasonic sound control mat w/Armstong Commissions Plus Sheet Vinyl **www.maxxon.com**	27

Figure 20: Additional IIC Points

Figure 20 indicates additional IIC points that can impact the Hambro floor system. The IIC rating is strongly effected and dependent upon the type of floor finish for its resistance to impact noise transmission. To achieve high ICCs, the use of soft floor surfaces (carpet and pad), suspended ceilings, floated floors, and isolator hangers should be utilized. To gain the additional IIC Points necessary the 1 ½" Maxxon gypsum underlayments over Enkasonic sound control mat with wood laminate floor over silent step should be utilized. The utilization of this product will ensure total impact noise isolation for occupants. Other methods can be done in other areas that would not require such high IIC ratings. For example: The bedroom over bedroom in Figure 16 has an IIC rating recommendation of 52. Utilizing carpet and pad for this area will create an IIC 57 which is acceptable. But caution must be taken when a kitchen is over a bedroom because an IIC 62 is required and if utilize ceramic tile in the kitchen an IIC 53 results. This will create impact noises to the bedroom below and make the room unacceptable to current standards.

C.2.4.2.E Suggestions for Improvement

Therefore it is recommended that in order to achieve maximum sound and vibration isolation between floor-ceiling systems an STC 55 and IIC 62 should be achieved. The Hambros Joist Composite Deck System can achieve this if the following is done to the original assembly:

- Increase concrete slab thickness of 3 ¼"
- Add batt insulation with 3 ½" maximum thickness
- Apply ¼" minimum acoustical sealant
- Utilize 1 ½" Maxxon gypsum underlayment over Enkasonic sound control mat with wood laminate floor over silent step (This can be used with other materials but caution must be made.)

C.2.4.2.F Architectural Acoustical Recommendation

Important Observation: A quick comparison to Conventional Steel Joist & Metal Deck:

STC 47:

- Add floated floor or increase thickness of concrete slab
- Apply ¼" minimum acoustical sealant
- Results in STC 57

IIC 62:

- Already achieves IIC requirements of impact noise

Conventional Steel Joist & Metal Deck require less to improve acoustics of the assembly therefore could be an alternative to the Hambros Joist Composite Deck System.

C.2.4.3.A Compare and Contrast other Floor-Ceiling Assemblies

The Hambros Joist Composite Deck System is just one of the many floor-ceiling assemblies that are currently being utilized in the industry today. To fully understand if the Hambros Joist Composite Deck System was the correct choice for the Wellington Condominiums Project, a matrix chart was compiled to compare and contrast three similar systems. The three systems analyzed were: the Hambros Joist Composite Deck System, Conventional Steel Joist and Composite Deck System, and Epicore MSR Composite Floor System. The Hambros Joist Composite Deck System was explored in **Section C.2.4.1** while the other two systems are investigated as detailed below:

C.2.4.3.B Conventional Steel Joist and Composite Deck System

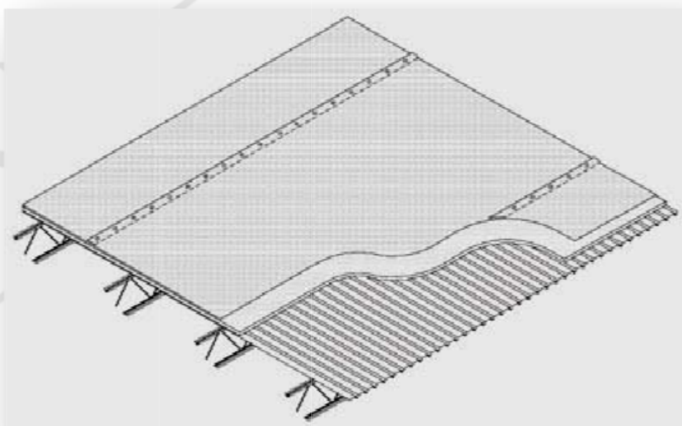


Figure 21.A: Conventional Steel Joist and Composite Deck System

As indicated in Figure 21.A, the Conventional Steel Joist and Composite Deck System utilize steel joists, metal deck, and concrete slab to forming the floor-ceiling assembly. The main difference with this system as compared to the Hambros Joist Composite Deck System is that the metal deck replaces the need for formwork. No formwork, shoring or re-shoring is required but bracing may be necessary during construction. Utilizing this system beneficially removes the need to remove any formwork and have an additional crew to finish surfaces.

UL Design No.	Rating (hr)	Slab Thickness (in.)	Ceiling	Beam Rating
G003	2	2 ½	Suspended Panel	-
G213	2	3	Suspended Panel	2
	3	4	Suspended Panel	3
G227	2	2 ½	Suspended Panel	3
G228	2	3 ¼	Suspended Panel	2
G229	2	3	Suspended Panel	2
	3	4	Suspended Panel	3
G524	2	2 ½*	Gypboard ½	2
	3	3 ½*	Gypboard ½	3
G525	3	3 ¼	Gypboard 5/8	3
G702	1-2-3	Varies*	Spray On	-
G802	1-2-3	Varies*	Spray On	-

* Note normal and lightweight concrete.

Figure 21.B: Conventional Steel Joist and Composite Deck System Fire Ratings (www.ul.com)

In Figure 21.B, the fire rating for a conventional steel joist and composite deck system is shown to indicate a 2 or 3 hour fire rating which exceeds the requirements of 1 hour.

C.2.4.3.C Epicore MSR Composite Floor System

Figure 22.A: Epicore MSR Composite Floor System (www.infinitysystems.com)

Infinity Structural Systems developed a floor-ceiling assembly that is similar in idea to the Conventional Steel Joist and Composite Deck System without metal joists. This system utilizes an Epicore MSR Deck which spans on top of pre-panelized load-bearing metal stud walls. Similar to the Hambros Joist Composite Deck System but requires no formwork due to the Epicore MSR Deck. The only disadvantage to this system as compared to the other systems is that shoring and re-shoring is required. The main advantage to this system is that it saves on formwork and the labor intensive placement of steel joists. It is up to the project team to decide on what system works best for the given situation at hand.

U.L. Fire Ratings

U.L. Design Number D938

Restrained* Rating Required	Total Slab Depth (Inches)	Type and Weight of Concrete (pcf)
1 hour	4	RW (147)
1 hour	3¾	LW (110)
1½ hour	4½	RW (147)
1½ hour	4	LW (110)
2 hour	5	RW (147)
2 hour	4¼	LW (110)

* For unrestrained rating, refer to Underwriters Laboratories, Inc. Fire Resistance Directory.

NOTES:
RW - regular weight concrete
LW - lightweight concrete

Figure 22.B: Epicore MSR Composite Floor System Fire Ratings (www.infinitysystems.com)

Also shown in Figure 22.B are the fire ratings for Epicore MSR Composite Floor System without any other material such as gypboard, spray on, or suspended panels. This has by itself a rating of 1 hour which matches the fire rating for the Wellington Condominiums project requirement.

C.2.4.3.D Main Comparison and Contrast between Systems

The main comparison factors are listed as followed between the three systems:

- Hambros Joist Composite Deck System:

Joists: Required
Formwork: Required
Shoring and Re-shoring: Not Required

- Conventional Steel Joist and Composite Deck System:

Joists: Required

Formwork: Not Required
Shoring and Re-shoring: Not Required

- Epicore MSR Composite Floor System:

Joists: Not Required
Formwork: Not Required
Shoring and Re-shoring: Required

Interviews from numerous industry members confirm that one of the controlling factors in the selection of floor systems is labor. Specifically, how much labor is required to construct the system to the project specifications? The most labor intensive systems of the same level of specifications are not highly recommended by most industry members. Therefore by initial comparison of the systems, it can be seen that the Hambros Joist Composite Deck System requires the most labor involvement while the Epicore MSR Composite Floor System requires the least labor involvement. This is primarily due to the labor intensity of joist layout during construction and formwork placement and stripping.

To confirm that the Epicore MSR Composite Floor System may be the best assembly for the project team; each floor-ceiling assembly was broken down into 12 categories of interest and rated on a scale based on how well the system performs for the Wellington Condominiums Project.

Note: The schedule and cost estimate for each of these systems are very similar and fluctuate greatly from project to project. When talked to manufacturers the ranges ranged greatly and therefore are not a major comparison factor in the analysis.

~See the Attached Appendix for Comparison of Systems~

C.2.4.3.E Conclusion

From the analysis we can determine that for the Wellington Condominiums Project the selection of the Epicore MSR Composite Floor System would have been best. Even though the Hambros Joist Composite Deck System scored an "Okay-Good" rating, the Epicore MSR Composite Floor System scored a "Good-Great" rating. One of the reasons for this is due to labor. Labor is a controlling factor and dictates what the schedule and budget will be for a given project. Due to the project team's inexperience with the Hambros Joist Composite Deck System and its related properties; the Epicore MSR Composite Floor System may have been an overall better solution to the Wellington Condominiums Project.

C.2.4.4 Improvements when Constructing Hambro

The project team ran into problems that caused delays and change orders. One of the problems project managers were having on the project site was the labor intensity of installing the Hambros Joists. These joists had to be moved into position by hand and then aligned accordingly. If the project team was able to use a crew or brought on a consultant that had experience with the system; delays and change orders would not be a high probability of occurrence. Other improvements such as acoustics should be taken into consideration when constructing a floor-ceiling assembly such as the Hambros Joist Composite Deck System.

C.2.4.5 Projects Best Suited for Hambros Joist Composite Deck System

From the analysis, it can be determined that for the Wellington Condominiums Project the utilization of the Hambros Joist Composite Deck System could have been better suited for other projects. Some of the issues that have arisen during construction that have made the Hambros Joist Composite Deck System unpractical for the Wellington Condominiums Project are due to: the project team's inexperience with the system, highly labor intensive system, acoustical demands for the living spaces, constraints of the formwork system selection process, and non-repetitive joist spacing layout.

From industry interviews it was determined that the following points of reference be utilized when considering the implantation of the Hambros Joist Composite Deck System:

- Repetitive Joist Spacing and Uniformity Throughout
- Sound Vibration not a critical factor in the building design
- Have highly skilled labor
- Recommended Use: Factories, Stores, Warehouses, Malls, Airports
- Not Recommended Use: Retirement Homes, Hospitals, Hotels, and Luxury Apartments and Condominiums