2.0 Depth Structural Proposal

2.1 Building Codes

Before redesigning the museum's structure with glued-laminated timbers, the proposed design must be confirmed with a current code to establish if the building can be safely framed with heavy timber. The museum was designed with the Southern Building Code (SBC) 1994 and is being redesigned with the new International Building Code 2000 (IBC). The museum has several diverse occupancies and building materials. IBC 2000 classifies the proposed structure as an Assembly Type III with Type IV heavy timber construction. The museum is a four story structure with an average height of 76 feet and a maximum floor area of 47,670 square feet. The number of floors and square footage exceeds IBC 2000 requirements for A-III, Type IV construction and is rejected. None the less, by incorporating sprinklers and frontage, which the building is so equipped, IBC 2000 grants an additional floor and 275 % square footage thus now approving the museum to be constructed as A-III, Type IV construction. IBC 2000 dictates minimum requirements and the city of Nashville, TN, may have a superior hierarchy of codes, but for simplicity, this report will use IBC 2000. Knowing that IBC 2000 will consent in allowing the museum to be designed as heavy timber, an assessment now can be made as what structural members will enhance the interior of the museum to the desired effect upon redesigning to glued-laminated timbers. It has been determined that the *Hall of Fame* will obtain a redesigned glued-laminated framed roof and the museum will obtain glued-laminated roof trusses and a glued-laminated floor frame. The timber design will follow the NDS 2001 Edition and allowable strength design (ASD) guidelines. Table 2.1 on the following page compares Type I SBC 1994 and Type IV IBC 2000 for this building.

Table 2.1 (Code Assessment: SBC 1994 & IBC 2000 for A-III, Type IV Heavy Timber Construction)

Governing Codes	SBC 1994	IBC 2000	IBC Modifications	NFPA	NOTES	
Occupancy Classification						
Primary Groups	A-1	A-3				
Other Groups	B (Business)	B				
	M (Mercantile)	M				
	S (Storage)	S-2				
Building Height						
Max Height Allowed	80	65	85		**Sec 504.2**	
Average Height	76					
Max Number of Stories	No Limit	3	4		**Sec 504.2**	
Actual Number of Stories	4				**Sec 506**	
Building Area					*506.3*	
Max Sq Ft Allowed	Unlimited	15,000 / floor	+ 41,250 / floor		Is	200.0%
Designed SQ FT					*506.2*	
Basement	4,824	15,000			F/P	1
First Floor	47,670	15,000	56,250 *(506.2)*		W/30	1
Second Floor	33,103	15,000	45000 *(506.3)*		If	75.0%
Third Floor	21,701	15,000	45000 *(506.3)*			
Fourth Floor	23,285	15,000	45000 *(506.3)*			
Zoning Requirements						
Present Zoning	CF					
Site Set-Backs						
Front	10					
Side	0					
Rear	20 = W					
Max Floor Area Ratio	5					
Fire Limits						
A. Building is in a municipal						
B. Fire Limit restrictions						
Construction Type	Type II, Sprinklered					
Travel Distance	250	250 *(1004.2.4)*	X	200		

The following are the proposed changes for the three spaces:

FIG 2.1 HALL OF FAME (TUCK HINTON ARCHITECTS)

2.2 Hall of Fame

The Hall of Fame is a dramatic concrete, stone and steel-topped structure that is positioned close to the street in front of the museum. Its round form sets an egalitarian tone where all of the inductees to the Hall of Fame stand on equal footing. Natural light in the rotunda comes from above through windows that are patterned after the original museum building. Four concentric circles representing the 78-, 45- and 33-rpm records and the compact disc together create the shape of the Hall of Fame's stair-

stepping roof. . A replica of the W.S.M. (*We Shield Millions*) tower, which has broadcasted the *Grand Ole Opry* to the nation for more than sixty years and established country music as a radio staple, pierces the rotunda roof and hangs from the 60-foot ceiling of the round hall. The proposal for the *Hall of Fame* is to redesign the stair steeping roof members with either exposed dimensional rough saw or glued-laminated timbers.

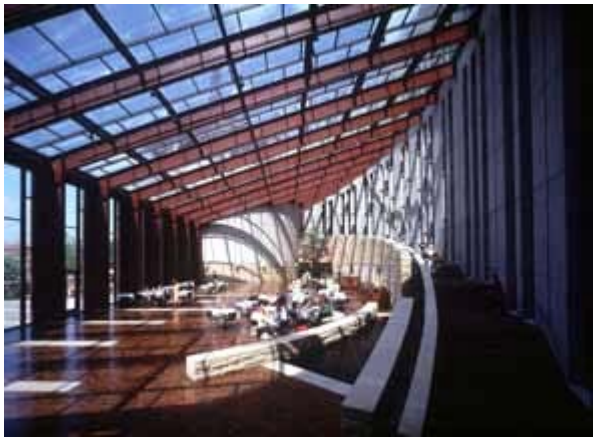

Fig 2.2 Upper: Interior of the Conservatory
Fig 2.3 Middle: Exterior of the Museum)
Fig 2.4 Lower: Interior of the Museum seen from the 3rd Floor (Tuck Hinton Architects)

2.3 Conservatory

The 11,000 square foot Conservatory architecturally anchors the museum's entrance, seen in the upper right picture (Fig 2.2). The conservatory is a steel frame of columns, rafters, and purlins, curtained with glass. The architects drew inspiration for its heavy steel frame from railroads and bridges that connect the small towns where country music came to life. Because of the steel's symbolization there will be no changes to this structure. This will remain the only exposed steel structure in the facility seen by visitors.

2.4 Museum

This building's first and most obvious musical reference is the giant keyboard formed by the series of vertical windows positioned like ebony keys across the dominant, curved front façade (Fig 2.3). The tail fin of a '57 Chevy inspired the dramatic end of the concrete wall that rises above the street corner. The structural emphasis for the museum will be redesigning the museum's interior structural steel composite frame to glued-laminated timbers.

The museum's existing frame is a steel composite structure with braced lateral frames. The

proposed design is to keep the existing second floor steel frame and all of the exterior steel columns and build the upper, interior frames with structural glued-laminated timbers. The first floor contains non-public spaces and combustible areas (mechanical rooms and a commercial kitchen). The second floor's concrete slab will be kept as a fire barrier between the first and upper floors. The second and third floors are public exhibit spaces and the topmost floor are administrative offices. The two upper most floors have an exposed steel structure and this is what will be redesigned with glued-laminated timbers. In summary the museum will be a one story steel frame composite structure with the steel exterior columns and lateral frames extending to the roof and an upper two-story glued-laminated interior frame sheltered by a glued-laminated heavy timber truss roof.

Most of the interior columns are non-continuous from floor to floor due to overhanging beams and the short length won't be a concern for the design of glued-laminates. The exterior columns are continuous and extend from the foundation to the roof with an intermediate splice part way and the side exterior columns are in lateral braced frames. To achieve the rear columns with glued-laminates, the column sizes will be considerable greater than the steel columns and slenderness and thermal and moisture movement will have a major involvement. In the side exterior columns, lateral braced frames are possible with wood using diagonal tension rods or shear walls. But more important is story shear transfer at the second floor. If the upper exterior columns are glued-laminates, the wood to steel connection at the second floor would be a pinned connection and this type of connection would need to be as strong as a continuous piece of steel or steel splices. To achieve story shear transfer would require a heavily reinforce connection which can be very costly. Thus the exterior columns will be kept to steel as originally designed and the interior columns will be redesigned with glued-laminates. As for what is being achieved in the museum, only one side of the exterior steel column will be seen, and by masquerading the exposed side with a dimensional board will conceal the steel. In between the exterior and interior columns, the steel studs with gypsum board will be kept unchanged .

The interior girders and joists will be designed using normal glued-laminates. In areas of high tension experimental fiberglass reinforced plastic glued-laminates will be assessed. Fiberglass reinforced plastic glued-laminates, or FiRPs, are manufactured with one or more thin layers of a fiber reinforced panel. The reinforcing consists of high-strength fibers embedded in a matrix and are strategitically placed between certain laminations to increase beam strength and stiffness. Three types of reinforcing are currently approved for use in FIRP beams: Aramid, Carbon, and Fiberglass.

The addition of reinforcing generally permits a reduction in beam width reducing the volume of wood fiber used. The FiRPS will be designed under accordance with ICC Evaluation Service, Inc. published supplement, PFC 5100, Division 06-Wood & Plastic, reissued May 1, 2003. One important concern when redesigning the floor system is that the framing layout is to keep the original design to avoid any new MEP coordination.

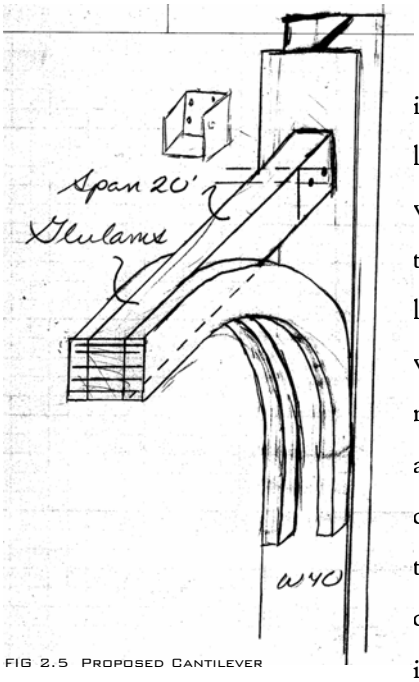

FIG 2.5 PROPOSED CANTILEVER


FIG 2.6 AN ARCH BRIDGE (O.D.O.T.)

One of the structural impediments in the museum is the cantilevered walkway located on the third floor. The cantilevered walkway has a twenty foot span with a thirty feet spacing and a 100 psf short-term load. Glued-laminated timber don't perform well as cantilevers chiefly due to the moment connection required, so other alternatives had to be devised. Alternatives were to sustain the cantilever at the free end with either a column or a tensed rod but there is a strong desire to preserve the drama of the cantilever and other alternatives were sought after. The proposed design (*Fig* 2.5) is influenced by the construction of arch bridges (*Fig* 2.6). The curved glued-laminates will carry the bending to bearing into the steel column while the horizontal piece will act as beam-column resisting tension and bending carried over. Most arch bridges start in two phases, they start at the ends and join in the middle where it is joined. If half an arch can support itself alone then this would seem viable for the cantilever walkway in the building. If the design works the only disquiet is clearance height for the floor below which is not an issue. Floor to floor height is approximately 17 to 18 feet and the curvature of glued-laminates will be governed by a Southern Pine minimum radius (18 feet) which will be sought after to reduce clearance restrictions.

2.5 Roofs

The last redesign in the museum's is the 2-1/2 : 12 mono-sloped roof. The mono-sloped roof is supported by a series of forty-eight inch open web joists which are intended to be replaced with glued-laminated timber trusses. The loads that exist on the roof are: short-term load, wind loads (including uplift) and mechanical loads (duct work and wenches). The mechanical wenches will be excluded from the design, due to only a visual observation and unavailable documented information.

2.6 Decking

The floor decking will be a tongue and groove decking acting as formwork with light weight concrete for stiffness and a laminated decking for the wearing surface (Fig 2.7). The roof decking will be existing with the exception of laminated roof decking (Fig 2.8).

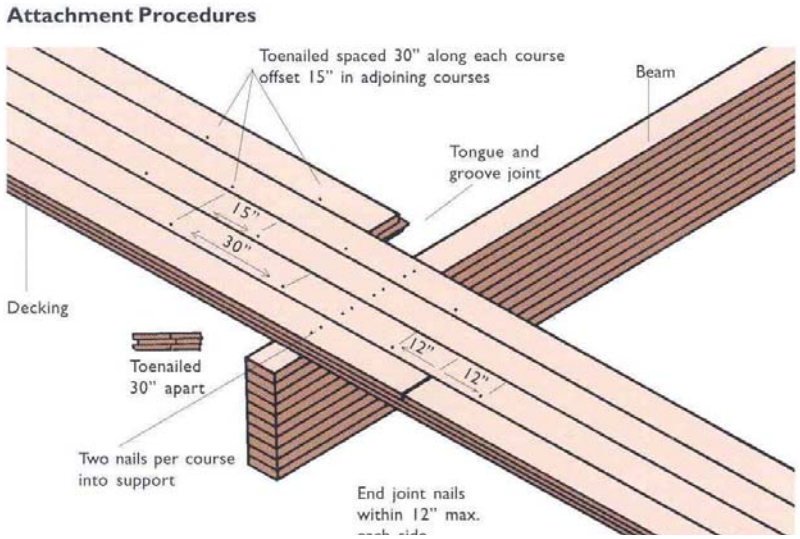

FIG 2.7 TONGUE & GROOVE DECKING (RIGIDPLY RAFTERS)

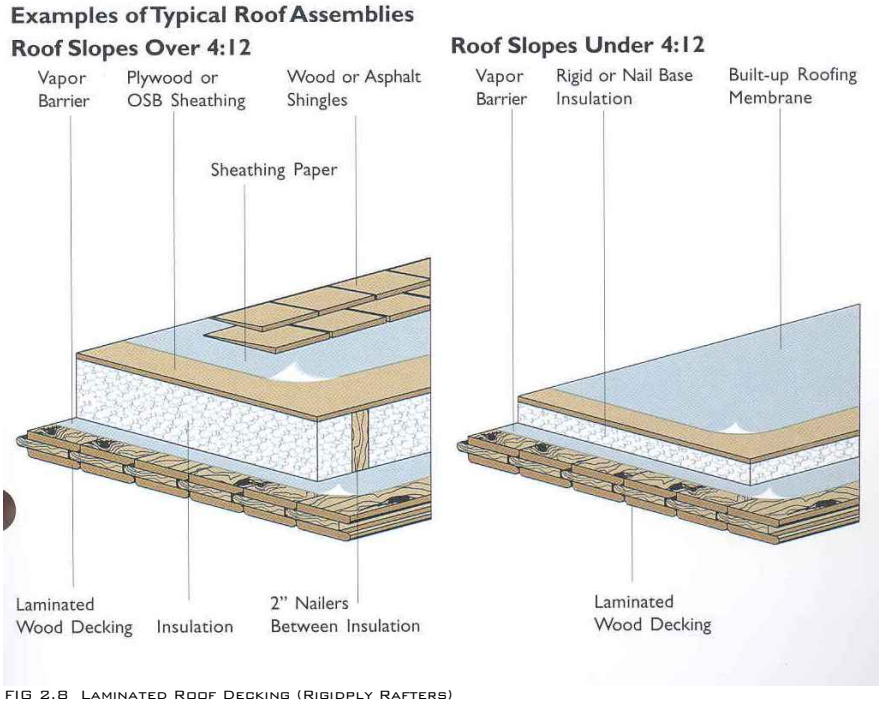

FIG 2.8 LAMINATED ROOF DECKING (RIGIDPLY RAFTERS)