

## Section 9: Analysis #4 - Bolted Vs. Welded Glulam Arch Connection

### **9 - 1 Problem:**

In the natatorium of the Pearland Recreation Center and Natatorium a glulam structural system is used, including 14 glulam arches. These glulam arches are connected to the concrete footers using bolts. The bolted connections of these arches were difficult due to the small tolerances of the glulam arches. In hind sight, the contractor suggested that a welded connection would have been more constructible.



**Figure 9-1.1 - Glulam Arches** (Courtesy of Structural Mag)

### **9 – 2 Goal:**

The goal of this research is to identify the feasibility of using welded connections instead of the as-built bolted connections for the 28 connections (2 per arch) of the 14 glulam arches to the concrete footers.

### **9 – 3 Analysis Method:**

- 1) Determine the cost of using a welded connection.
- 2) Identify the time required to construct a welded connection.
- 3) Compare the cost and time duration for a welded connection with that of a bolted connection.
- 4) Consider the durability of a welded connection versus a bolted connection.
- 5) Research the availability of qualified welders in the geographic area.

### **9 – 4 Resources:**

- 1) Welding contractors
- 2) Pearland Recreation Center and Natatorium project team.
- 3) Glulam contractors
- 4) RS Means Cost Data
- 5) MS Project

**9 – 5 Feasibility/Constructability Analysis:**

A welded connection would be easier to construct. The greater Houston area has ample availability of qualified welders. However, connecting dissimilar materials might create problems with the weld.

**9 – 6 Design Analysis:**

As designed, each connection had (12) 1” diameter stainless steel anchor bolts. This is the equivalent of  $12 \times 3.14 \times (0.5")^2 = 9.42 \text{ in}^2$  of steel connection. To create a weld of equivalent strength, it would be necessary to have  $75.36 (9.42\text{in}^2/(1/8\text{in}))$  linear inches of 1/8” weld. This would require about 38 inches of 1/8” weld on each side of the connection.

**9 – 7 Cost Analysis:**

To analyze the costs associated with this connection, it is necessary to identify what would be removed and added. **Table 9-1.2 – Items Added and Removed per Connection** lists these items.

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<b>Added</b>	<b>Removed</b>
75” of 1/8” weld	(12) 1” Anchor Bolts
Metal plate embedded in concrete footer	(12) holes for bolts
	Careful alignment of columns during erection.
	Extra labor to align anchor bolts with holes during erection.

It can be assumed that the material costs associated with the removal of the 12 bolts and the addition of the plate that would be casted into the concrete footer would cancel each other out and could be ignored. Similarly, the labor costs required to insert the plate in the concrete would likely be less and certainly wouldn’t be more than the cost to place and brace the anchor bolts during the concrete pour. It is very difficult to properly brace anchor bolts while pouring concrete.

It can also be assumed that the costs associated with field welding the steel plates would be equivalent to the costs of cutting the bolt holes in the steel and the additional labor that would be required to align the anchor bolts with the holes in the steel plate on the base of the glulam column.

**9 – 8 Schedule Analysis:**

Analyzing the schedule implications of this connection modification is also important. Assuming a 60" long 1/8" weld could be done in 1 hour, .8 connections could be done per hour. The total of 28 connections would only add 35 man hours. Therefore, the schedule implications of this change could be ignored since it would be no more than the time required to set the anchor bolts prior to pouring concrete and aligning the columns with the bolts during glulam erection.

**9 – 9 Conclusions and Remarks:**

As designed, the bolted connection between the glulam columns and the concrete footer is very difficult to construct. Modifying to a welded connection would eliminate the tedious process of aligning the baseplate of the glulam column with the anchor bolts without increasing the schedule or cost of construction; in fact, it could possibly result in a cost reduction.