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M E M O

TO: Paul Leef
Office of Community Planning and Sustainability
Boulder Civic Area

DATE: October 13, 2014
JOB NO.: 17167
PROJECT: Boulder Band Shell
SUBJECT: Structural Review

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Dear Paul,

At your request, JVA has reviewed the structural information and conclusions related to the building structure in the report prepared by Peak Engineering, Inc. dated October 9, 1995 regarding the Boulder Band Shell located at 1212 Canyon Boulevard. We visited the Band Shell on October 2 and October 9, 2014 to confirm the findings of the report and to perform our assessment.

Our review focused on two main objectives. First, we were asked to verify the findings presented in Peak Engineering's report and to update the findings based on the Band Shell's current structural condition. Second, we were asked to comment on the feasibility of moving the Band Shell to a yet to be determined location on the Boulder Civic Area site. This memo details the results of our independent review.

Description of the Structure

The Band Shell is approximately 50 feet wide at its open end on the south. The width tapers down to approximately 25 feet wide at the storage area at the extreme north end. The length of the structure in the north-south direction is approximately 40 feet long, including the portion of the stage that projects southward beyond the roof and including the storage room at the north. The shell roof structure, the stage floor, and the buttresses that flank the sides of the stage are wood framed. The structure is bounded on all sides by a concrete foundation stem wall that encloses the crawlspace area.

The shelter's roof structure contains five equally spaced three-point arches that vary in size. The largest, southernmost arch is 24 feet tall at the apex. Subsequent arches, spaced at approximately 5 feet, decrease in size from the largest at the front of the Band Shell to the back. There is a hinged connection at the top of each arch and a tie rod within the depth of the stage framing ties the bottoms of each arch together. The arches bear on steel saddles that are anchored to the concrete foundation wall.

The stage floor, recently reconstructed, consists of three bays of (2) 2x12 joists spaced at 16 inches on center that span in the east-west direction. Two north-south dropped steel W8 beam lines, supported on isolated concrete pedestals, divide the framing bays. Along the flared east and west sides of the building, the joists bear on a wood plate atop the foundation wall. The stage floor is sheathed in plywood.

Condition of the Structure

The stage floor framing and north storage room were severely deteriorated in 1995 as described in the report from Peak Engineering. The stage floor framing was not integrally connected to the shell roof system. The stage framing and all of the north storage room framing has been replaced. We understand that this construction may have occurred in 1996 when a permit was issued by the City of Boulder. Thus far, we have been unable to locate construction documents that describe this work.

We were unable to gain visual access to the arches but assume they remain in relatively good physical condition given the good condition of the roofing materials and the assumption that any deteriorated sections that may have been discovered during the rehabilitation were rectified at that time.



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Where the arches are in contact with the steel saddle base plates they are showing signs of minimal moisture-borne deterioration. Based on our initial observations, it should be assumed that during future rehabilitation efforts or during relocation, a small cross section at the bottom of each arch leg will need to be removed so that an air gap can be provided. The underside of the arch legs would be filled with a wood epoxy/consolidant and the legs seated on intermittent steel shims.

Also, there is one large vertical crack in the north foundation wall. If the Band Shell is to remain in its current location, the cause of the crack should be investigated and repaired accordingly.

Our analysis indicates that the arches are capable of resisting the Code prescribed snow and wind loads. The stage floor was reconstructed using conventional construction standards and the stage can safely support performance uses.

Relocation of the Structure

Although the 1995 report does not recommend moving the structure, based on our experience, we are confident that the arch/shell structure can be moved whole to another location on the site. This strategy will preserve as much historic fabric of the roof structure as possible. Given the roof structure's size, 50 feet wide by 25 feet long by 25 feet high, it will be critical to verify that there is an available pathway to the new location that can accommodate the structure and the moving rig. For preliminary planning purposes, one should anticipate an additional 6 feet of height will be required below the building to accommodate the moving carriage and wheels. Some existing site elements, such as trees, may need to be removed to afford passage.

The north storage room and the stage floor would first be dismantled so that the bases of the arches could be accessed. The arches' base plates can be released from the foundation wall and temporary moving beams, oriented in both directions, would be connected to the legs of the arches. Once the arch/shell system is relocated onto a new foundation system, the storage room, stage framing and buttresses would be rebuilt or salvaged sections of the framing be reset.

Given the lightweight and ductility of the roof structure, we expect that it can be relocated without inducing significant damage. However, the relocation of a structure is somewhat complex and we recommend that a qualified moving company be retained to discuss logistics and pricing. JVA has had success collaborating with the following outfits on previous historic building moves:

Gary DeJohn at DeJohn's House Moving
Bill Davis at Mammoth Moving & Rigging (formerly known as Rocky Mountain Structural Movers)

Once underway in the process of moving the building, there will be additional structural considerations to resolve such as determining an appropriate new foundation system. Thought must also be given to connecting the base of the shell structure in the space between the arches to the foundation wall so that lateral forces are properly transferred into the supporting soils.



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Conclusions

We generally concur with the findings of the 1995 structural analysis. Deficiencies that were identified at that time have been rectified. The structural systems are generally of sufficient strength and of adequate condition for continued use of the building. Some minor structural repairs are warranted whether the building remains in its current location or is relocated elsewhere on the site.

In regards to relocating the Band Shell, the primary shell roof structure can be lifted and reset in one piece provided that the site affords adequate clearance for the structure and moving equipment.

Locating the construction documents that describe the previous rehabilitation work will be helpful to the design team in moving forward and we recommend that you actively pursue obtaining these documents.

Thank you for reaching out to JVA's structural team and please feel free to contact us with any questions regarding our findings.

Sincerely,
 JVA, Incorporated

By *Sheri Nichols*
 Sheri Nichols, PE
 Senior Project Engineer

Reviewed By *Thomas S. Soell*
 Thomas S. Soell, PE, President
 LEED AP