



MITCHELL PARK HORTICULTURAL CONSERVATORY DOMES

Investigation of Structural Concrete Framing for Explosion Damage

Milwaukee, Wisconsin



April 7, 2009
WJE No. 2008.3876

Prepared for:
The ASU Group
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Prepared by:
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A handwritten signature in blue ink, appearing to read 'Kevin A. Nichols', positioned above a horizontal line.

Kevin A. Nichols
Licensed Professional Engineer
Wisconsin No. 36297 - 006

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INTRODUCTION

As authorized by the ASU Group in connection with ASU File 008-07-20343-I (1342), Wiss, Janney, Elstner Associates, Inc. (WJE) performed an investigation of the three concrete frame dome structures at the Mitchell Park Horticultural Conservatory in Milwaukee, Wisconsin. The investigation was requested to evaluate if the concrete frames of the domes were damaged by an explosion that occurred on December 6, 2006 at the Falk Corporation plant that is located approximately one-half mile northwest of the conservatory.

The Mitchell Park Horticultural Conservatory complex, commonly referred to as “The Domes”, consists of three large domes, a central lobby area, and a transitional greenhouse. Each dome contains a distinct microclimate and exhibits plants in a naturalistic setting. The Show Dome is used for changing seasonal horticultural exhibits, while the microclimates of the Tropical Dome and Arid Dome remain constant year round. The domes are conoid-shaped glass-covered structures that are 140 feet in diameter at their base and 85 feet high. Structural framing consists of reinforced concrete members arranged in triangular patterns to form a conoid-shape dome. Concrete members were precast on-site, erected on temporary shoring, and joined by welded connections. The dome framing is supported on a circular, reinforced concrete foundation wall. The glass facade is supported by an aluminum framework that is connected to the concrete frame via stainless steel connection posts. Construction of the complex began in 1959 and proceeded in stages with the Show Dome opening in 1964, the Tropical Dome in 1966, and the Arid Dome in 1967. Overall views of the complex are shown in Figures 1 and 2. An exterior view of the aluminum-framed glass exterior is shown in Figure 3 and an interior view of the concrete structural framing is shown in Figure 4.

The WJE investigation was limited to the concrete frame superstructures of the three domes above their concrete foundation walls and included a site investigation, review of provided documents, and preparation of this report.

SITE INVESTIGATION

Kevin Michols of WJE performed a site investigation of the three domes on August 19, 2008. The conservatory was closed at that time due to renovation of the lobby area. Access into the conservatory complex was provided by John King of Belfor Property Restoration. Mr. King indicated that inspection of the glass facade after the explosion revealed newly cracked glass panes that were attributed to the explosion. He indicated that approximately 750 cracked glass panes were replaced after the explosion. Mr. King was not aware of any structural concrete repairs being performed after the explosion.

The WJE site investigation included visual inspections of each of the three domes from both the exterior and interior. Exterior inspections were made from grade around each dome and from the roof of the lobby area. Overall visual inspections from the exterior did not indicate any readily discernable out-of-shape deformation of the domes. Interior inspections were made from the walkway paths throughout the domes and the maintenance catwalks around the perimeter of each dome. These vantage points, in

combination with using binoculars to view higher sections, allowed the concrete frames in most areas to be visually inspected. Observations from interior inspections are summarized below for each of the three domes.

Show Dome

Overall, with the exception of many areas of water staining and some peeling paint, the Show Dome concrete framing appeared in generally good condition with no abnormal cracking, displacements, or deformations noted. General observations included cracks along some joints between precast sections, small concrete spall areas at a few concrete joints, and fine-width, transverse-oriented cracks spaced along the length of some members. Cracks were typically highlighted by dirt, peeling paint, and raveled edges suggesting they are old and have existed for a long time. Both the cracking at joints and transverse cracking are attributed to normal concrete shrinkage and/or stresses associated with normal structural behavior. Representative views of the Show Dome concrete framing are shown in Figures 5 through 10.

Arid Dome

Condition of the Arid Dome concrete framing was comparable to the Show Dome and included similar water staining, peeling paint, cracks at some joints, and fine-width, transverse oriented cracks. The Arid Dome concrete framing appeared in generally good condition with no abnormal cracking, displacements, or deformations noted. Representative views of the Arid Dome concrete framing are shown in Figures 11 through 14.

Tropical Dome

Overall, the Tropical Dome concrete framing exhibited more water staining and peeling paint as compared to the Show and Arid Domes. In addition, some localized concrete spalls with exposed corroded reinforcing bars were noted. The concrete spalls are attributed to corrosion of embedded reinforcing bars with shallow concrete cover. The Tropical Dome concrete framing appeared in generally fair condition with no abnormal cracking, displacements, or deformations noted. Representative views of the Tropical Dome concrete framing are shown in Figures 15 through 20.

DOCUMENT REVIEW

The following documents were provided to, and reviewed by, WJE:

Graef, Anhalt, Schloemer Associates, Inc. (GASAI) letter to Mr. Chuck Ward of Milwaukee County dated December 14, 2006:

This letter indicated that GASAI performed a visual inspection of the structural concrete framing for each of the three domes on December 6, 2006 after the explosion had occurred. Access for their inspection consisted of walking around the inside perimeter of each dome on the maintenance catwalk. The letter indicated, "From this near at grade position, there were no unusual concrete frame displacements observed in any of the domes, and no concrete cracking was observed that was noticeably different than that observed during previous Show Dome inspections."

County of Milwaukee Inter-Office Communication from Mahmoud (Mack) N. Malas, PE to Dennis Dietscher, County Safety Coordinator dated February 12, 2007:

This memo indicated that the author completed a walkthrough inspection of the Domes' glass structures on January 15, 2007 and visually inspected the basement walls and other structural components on February 7, 2007. The memo indicated, "No evidence of structural damage was observed during my

visual inspection of the facility.” and “Although, no apparent structural damage was observed, it is very evident that the facility experienced large forces causing movement and glass damage.”

Graef, Anhalt, Schloemer Associates, Inc. (GASAI) report submitted to the Milwaukee County Department of Transportation and Public Works Architecture, Engineering and Environmental Services Division entitled, “Show Dome Façade Study and Lower Level Façade Study” and dated October 10, 2008:

GASAI performed an existing condition survey of the Show Dome in September and October of 2006, which was several months prior to the December 6, 2006 explosion. Results of their 2006 condition survey are indicated in their October 10, 2008 report. The report indicates that cracks, small concrete spalls, peeling paint, and staining were present in the precast concrete dome framing. The 2006 pre-explosion condition descriptions included in the GASAI report are consistent with the 2008 post-explosion conditions observed by WJE.

CONCLUSIONS

Based on the investigation described above, the December 6, 2006 explosion at the Falk Corporation Plant did not cause damage to the structural concrete framing of the three domes. WJE did not observe abnormal concrete cracking, displacements, or deformations that would indicate strength or serviceability impairment of the structural framing. Observed minor concrete cracking and spalling of the concrete framing are consistent with normal structural behavior and long-term exposure to the environments within the conservatory. Also, the cracking and spalling conditions observed by WJE post-explosion were similar to those described by GASAI pre-explosion, which indicates that these conditions were pre-existing to, and not caused by, the explosion. The dome concrete framing appears serviceable at this time, but is in need of some minor concrete repairs and re-coating for protection against its environmental exposure.

ATTACHMENT A - FIGURES



Figure 1. Overall view of the front of the conservatory complex (looking east).



Figure 2. Overall view of the rear of the conservatory complex (looking northwest).



Figure 3. Aluminum-framed glass exterior.

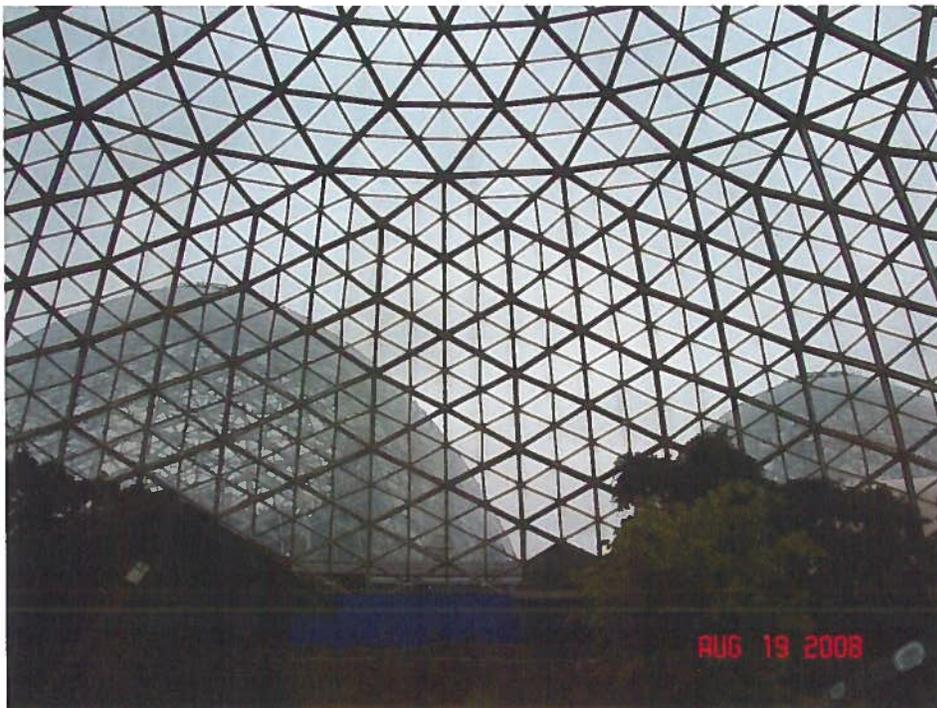


Figure 4. Arrangement of reinforced concrete structural framing members.



Figure 5. Representative condition of concrete framing in Show Dome from interior.



Figure 6. Representative condition of concrete framing in Show Dome from exterior.