History Meets High-Tech: The Griffith Observatory Expansion and Renovation

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Abstract

This paper is a discussion of structural aspects of the Griffith Observatory Expansion and Renovation. The year 2006 will mark the reopening of Los Angeles historic Griffith Observatory after a four-year, $93 million renovation program. Highlights of this ambitious project, designed by Miyamoto International Structural Engineers, include the creation of 40,000 square feet of space below the main exhibition floor, installation of a new Planetarium star projector on a disappearing platform, and new stairs and elevators connecting the basement level to the rooftop viewing terrace. Virtually the entire expansion is subterranean, constructed around and below the existing building and required that the existing structure and foundation be extensively modified while leaving the historic fabric of the building undisturbed.

Introduction

Since its opening in 1935, the Griffith Observatory has been one of the most cherished cultural icons of the City of Los Angeles. Perched on the south face of Mount Hollywood and overlooking nearly the entire Los Angeles basin, the Observatory hosts more than 2 million visitors a year and is a leading venue for informal scientific education for both children and adults. This paper describes the first major renovation of the Observatory since its original construction. The current project, designed by Martin & Huang International (now the Los Angeles office of Miyamoto International), was begun in 1997 and is scheduled for completion in the fall of 2006.

Historical Background

The original Observatory was the brainchild of Col. Griffith J. Griffith (1850-1919), the wealthy Los Angeles landowner who also donated the land for the surrounding 3,015 acre park which bears his name. His concept was to create a public park with educational facilities that would “make science accessible to everyone.” As initially planned, the Observatory was to feature an astronomical telescope open for free public viewing, a Hall of Science which would display the latest discoveries in the science of astronomy, and a motion picture theatre that would show educational films on all topics. Scientists from the California Institute of Technology and the Mt. Wilson Observatory, most notably George Ellery Hale and Robert A. Millikan, lent their advice and assistance to the planning process. Initial sketches were developed by architect and astronomy enthusiast Russell Porter of MIT (see figs. 1 and 2).

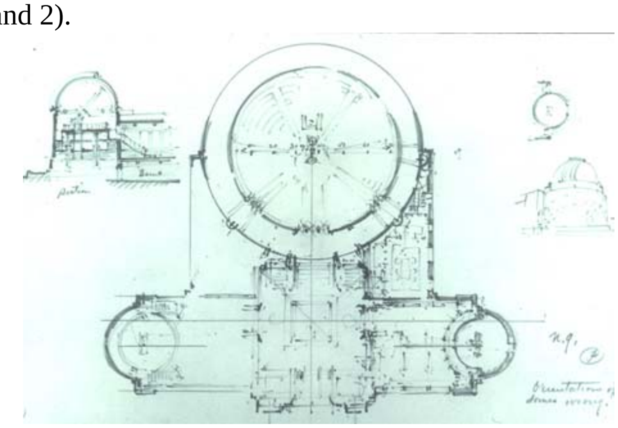

Figure 1:
Concept sketch by Russell Porter

As planning continued over the following decades, the motion picture theater was dropped in favor of a Planetarium Theater, however many of the concept's original features were retained. The final design contract was awarded in November 1931 to architects John C. Austin/Frederick M. Ashley, who developed a facility very close to the original Porter sketches. Ground was broken on the project on June 20, 1933 by the William Simpson Construction Company, and the facility was opened to the public on May 14, 1935 (see figs 3 and 4).

In plan, the Observatory as designed was "T" shaped, with the domed Planetarium theater dominating the south wing while the east and west wings were dedicated to science exhibits. Visitors to the facility would enter an elaborately-decorated central rotunda, topped by a low octagonal dome and featuring a Foucalt Pendulum swinging in a central pit. A raised lobby to the south led to the Planetarium theater and also housed a large plaster model of the surface of the Moon. To the east and west of the rotunda, the science exhibits were contained in a series of vaulted niches. Both east and west wings terminated in a small rotunda over which was mounted one of the facility's two astronomical instruments, a 12-inch refracting telescope on the east end and a ceolostat, or solar telescope, on the west.

The structural system of the Observatory was relatively advanced for the day, consisting of a riveted steel moment-resisting frame combined with reinforced concrete joists and walls. The Planetarium dome was composed of a welded steel framework covered with a thin reinforced concrete shell. The foundation of the building consisted of concrete pad footings bearing in bedrock, connected with reinforced concrete grade beams. Because the building was located over the slope of Mt. Hollywood, the foundations beneath the Planetarium step down rapidly, descending two stories from the Hall of Science to the southernmost edge of the Planetarium dome. The building's ornate interior was constructed using travertine panels hung from cold-formed metal studs. Below the Planetarium, a partial basement contained workshops, storage rooms, and other support functions.

A major change to the Austin/Ashley design was the deletion of the building's heavily articulated terra cotta cladding. In lieu of cladding, the concrete walls were thickened and the articulation was made part of the

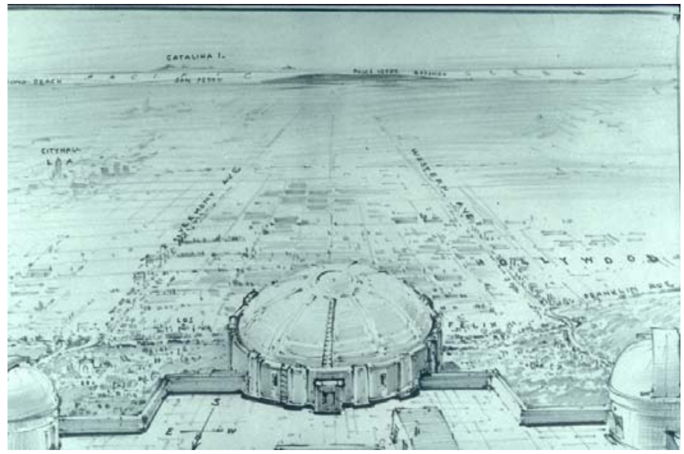

Figure 2:
Russell Porter sketch showing views from the planned Observatory

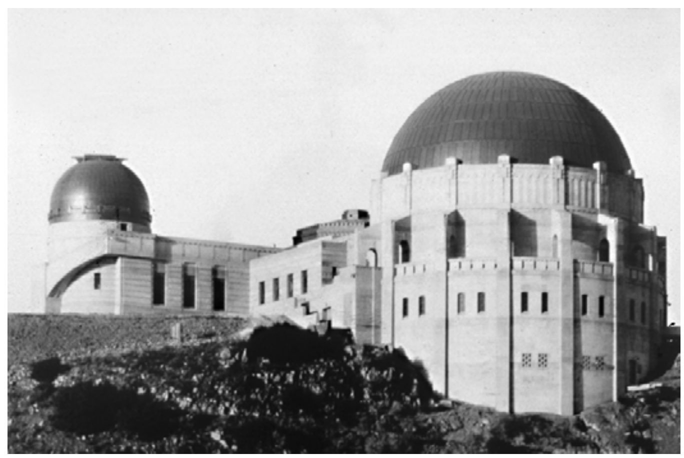

Figure 3:
Original Observatory as viewed from the Southwest

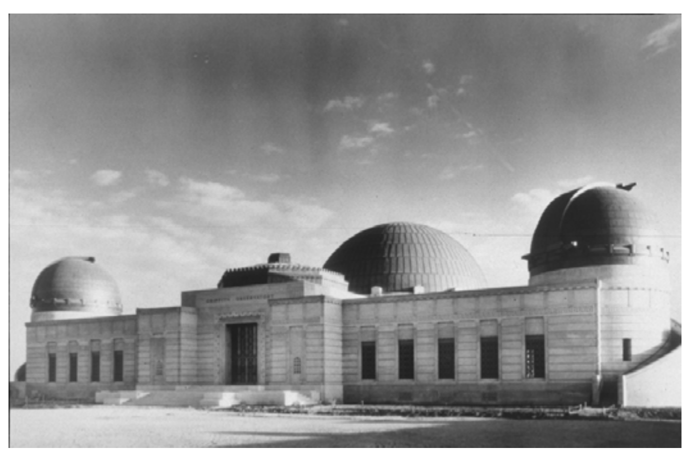

Figure 4:
Original Observatory as viewed from the Northwest

structural walls. This change was specified in the aftermath of the 1933 Long Beach earthquake, and vastly improved the seismic behavior of the building. Another change involved the construction of a copper dome in lieu of the planned tile dome. Otherwise, the building was constructed essentially in conformance with the plans, and went nearly unchanged until the late 1990's.

Renovation Design

By the 1990's it was clear that the building, although in good condition, was approaching functional obsolescence. Building systems and planetarium equipment were outdated, additional exhibit space was required, and the building was too small to contain the modern amenities expected in a public facility. The planetarium shows still attracted large audiences, however queuing for the shows would often extend well into the Hall of Science, making circulation extremely difficult. The architectural firm of Hardy Holzman and Pfeiffer (now Pfeiffer Partners) in association with Brenda Levin and Associates, was therefore engaged to design a thorough expansion and renovation of the facility. Because of the Observatory's historic status, it was essential that renovations not alter either the interior or exterior appearance of the building; therefore, it was determined that nearly the entire expansion would have to be placed underground. The plan as finally adopted involved 40,000 square feet of new space, including exhibit, retail and dining spaces on the north and west sides of the building; and new workshops and mechanical equipment rooms to the south (see figs. 5 and 6). Queuing issues were resolved by adding a new lobby in the basement level, communicating with the Planetarium via a grand staircase and new internal elevator. The Planetarium itself features a new star projector on a retractable platform, and a new ceiling dome. Additional features of the design include:

- New meeting rooms and classrooms, including a 200-seat auditorium/lecture hall,
- An outdoor dining terrace overlooking the west slope of Mt. Hollywood,
- New administrative offices beneath the Planetarium theater,
- A "wormhole" or tunnel beneath the center of the building, connecting the new exhibit space with the basement lobby;
- An outdoor mechanical platform on the east face of the mountain, hidden from public view.

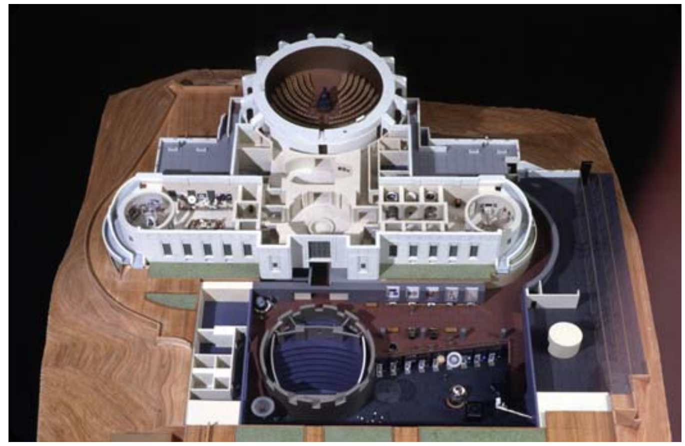

Figure 5:
Model of the expansion, with roof removed and lower level exposed

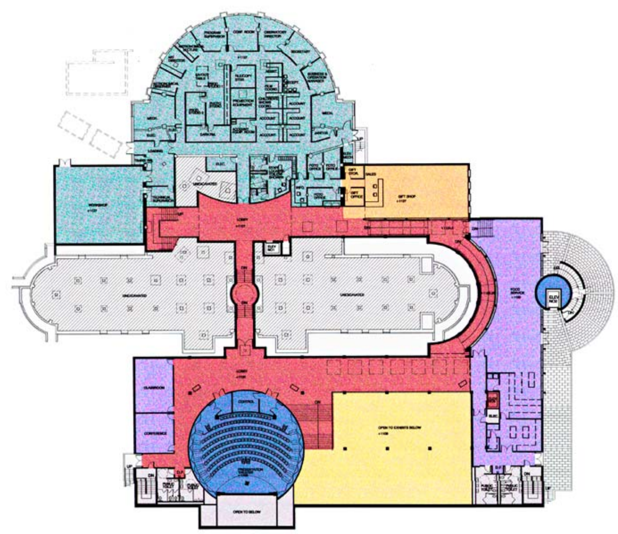

Figure 6:
Expansion lower level plan

Structural Challenges

The governing code for the project is the California State Historic Building Code, which places a premium of preserving the historic fabric of the existing building. The challenge facing the engineering team was the need to simultaneously provide new space around and below the existing facility, accommodate new building systems, and maintain structural integrity and seismic safety, all while disturbing the existing structure as little as possible. Each portion of the project involved a unique set of challenges, which are described below:

North Underground Expansion: The largest component in the project is the north underground expansion, a two-story deep, 15,000 square-foot space beneath the front lawn of the observatory (see fig. 7). This area contains two exhibit levels, the new auditorium, classrooms and other support facilities.

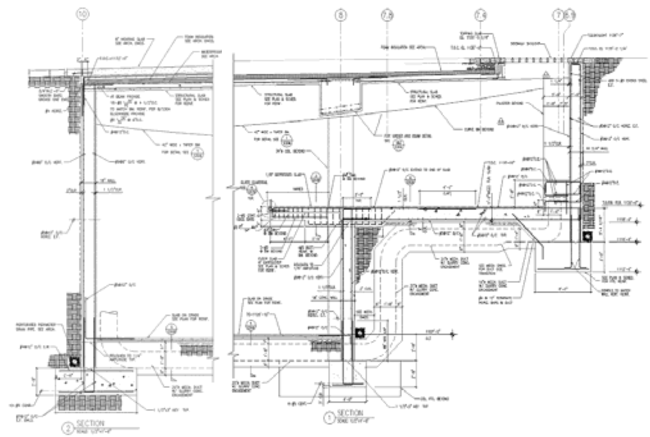

Figure 7:
Section through underground expansion, looking East

At its lowest, the floor of the expansion is approximately 30 feet below grade and 35 feet below the main floor of the Observatory. To avoid surcharge loads from the existing building and minimize the need for underpinning, the expansion is stepped in cross-section, however underpinning was still required beneath the existing main entrance, which comes to within two inches of the new construction (see fig. 8).

Figure 8:
Existing building showing underpinning at entrance

Because of the seeming paradox of an underground structure dedicated to exploration of space, the architect made every effort to create a sense of openness in the exhibit hall. The main exhibit area, dubbed the Depths of Space, features 55-foot clear spans and a floor-to-ceiling height of 25 feet. MII engineers worked with the architect to develop the roof framing system, which consists of a series of exposed, gently curved beams supported by circular columns (see fig. 9). The circular auditorium, designed to echo the shape of the planetarium directly to the south, is heavily soundproofed and is framed with a combination of concrete beams and concrete masonry bearing walls. Because the upper level balconies are subjected to unbalanced lateral earth pressure, they are designed as diaphragms with heavy chord reinforcing along their interior edges.

Figure 9:
View from the Depths of Space

West Expansion: Designed to take maximum advantage of available views, the west expansion contains a gift shop and restaurant, observation deck and outdoor dining terrace. The foundation of the structure consists of CIDH piles founded in bedrock at sufficient depth to provide a ten-foot setback from the hillside. The dining terrace overhangs the hillside at its south end, and is framed with a structural concrete slab spanning between concrete grade beams. To enhance the open feel of the expansion, maximum use is made of both exterior and interior glazing, and steel, rather than concrete, columns are used to minimize obstruction of the views.

Basement Lobby and Administrative Offices: The basement lobby and administrative offices are located directly beneath the south wing of the existing building, in an area that had previously been an unfinished crawl space over a bare granite slope. Adequate headroom could only be achieved by deepening the crawl space, which in turn led to extensive foundation work. A complex construction sequence was used for this area, as follows:

1. Soil and bedrock was removed from between the existing footings. This operation was closely observed by the Geotechnical Engineer and was limited due to the presence of slippage planes in the existing bedrock (see fig.10).
2. Steel shoring was installed to support the existing floor and unload the footings.
3. Temporary concrete underpinning was installed beneath the columns.
4. After the underpinning had cured, shores were removed and the excavation proceeded to its full depth (see fig. 11).

At this point, construction could begin on the new lobby. Where possible, existing walls and columns were extended downward and placed on new foundations, however numerous existing columns had to be removed and replaced by transfer beams. Construction of the transfer beams was complicated by a small floor-to-floor height and by the fact that the rooms above were finished with brittle travertine and terrazzo panels. Deflection of the existing floor had to be minimized to the greatest extent possible; however there were severe limits on beam depth. It was therefore decided to construct the transfer beams from concrete and to preload them using the following sequence:

1. Prior to placement of the transfer beams, a steel jacking frame was constructed around the existing column. This frame consisted of two components, an upper frame which bolted to the column, and a lower frame which could slide up and down along the

Figure 10:
Excavation around existing column footings

Figure 11:
Column footing supported on temporary underpinning

Figure 12:
Column with jack frames in place, prior to the construction of the transfer beams

column and which was to be suspended by rods from the transfer beams (see fig 12).

2. The transfer beams were constructed around, but structurally separate from, the existing column. Rods for the lower frame were embedded in the beams.
3. Hydraulic jacks were installed between the upper and lower frames.
4. The jacks were pressurized, forcing the two frames apart, using the dead load from the column to pull down on the transfer beam. When the jacks reached a predetermined load which was nearly equal to the column dead load, the jacking was stopped. At this point, the existing column was essentially unloaded.
5. The original and new structures were joined together using nonshrink grout and dowels.
6. The jacks were released and removed, and the column could be cut off (see fig. 13).

Results from this procedure were very good, and no cracking or deflection of the floor above was reported.

The new lobby is connected to the Underground Expansion by two pathways: the first, a long passageway which curves around the west side of the existing structure, is named the "Cosmic Corridor," while the second, a concrete tunnel which passes directly beneath the center of the Observatory, is appropriately dubbed the "Wormhole" (see figs. 14 and 15) Access to the Planetarium is via a grand staircase placed in an opening on the east side of the first floor lobby, in the location of the former Moon Model. The staircase is comprised of individual cast-in-place concrete treads and stringers, and glass-block risers. A new concrete drag strut was installed in the first floor to compensate for the loss of diaphragm caused by the creation of the stair opening. Finally, a new elevator provides handicap access from the basement to both the main floor and the rooftop observation deck.

Planetarium Renovations: Programmatically the most critical element in the renovation project was

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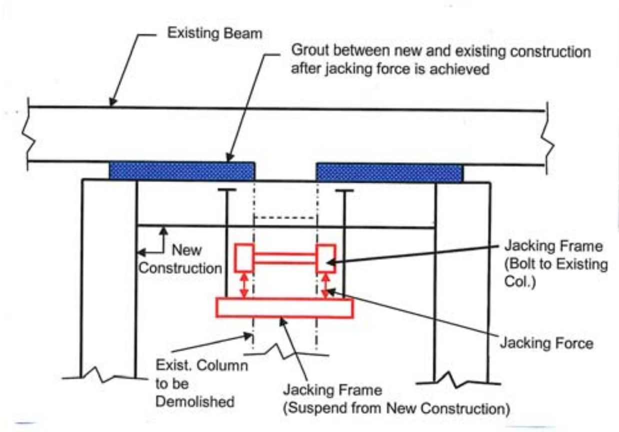

Figure 13:
Preloading Scheme

Figure 14:
Wormhole under construction

Figure 15:
Finished wormhole structure

replacement of the existing planetarium star projector and ceiling dome The existing projector was over 40 years old and in serious need of replacement. It also was mounted high above a fixed platform in the center of the planetarium floor, dominating the room and making it unusable for any other purpose. It was therefore decided that the new projector would be mounted on a movable platform, upon which it could be lowered into the basement when not in use. A large opening was cut in the center of the planetarium floor for this purpose, however because the hole was located directly over an existing column, extensive reframing of the floor, including the construction of new columns and footings, was required. The new platform is mounted on four vertical guiderails, and is raised and lowered using electrically-powered screw jacks. When the projector is retracted, the opening is covered by steel doors and the room can then be used as a lecture hall.

Replacement of the existing planetarium ceiling was complicated by the fact that the aluminum dome selected by the Owner could not be supported in the same manner as the original plaster one. Instead of being hung from splay wires extending from the roof dome, the new ceiling had to be supported along its lower edge. A new circular steel ring beam and catwalk was therefore designed and mounted to the inside face of the roof dome to support the ceiling, and to provide mounting points for loudspeakers, lights and other equipment (see fig. 16).

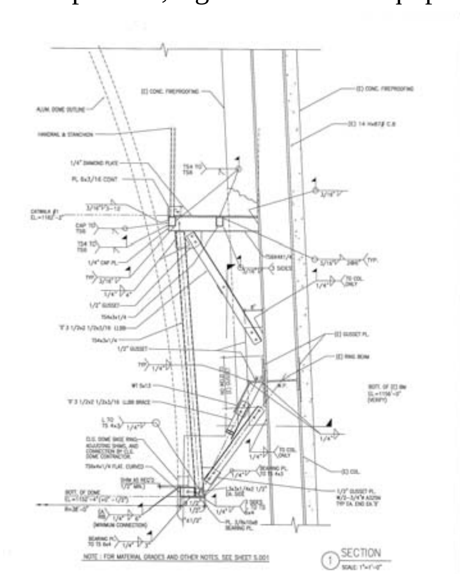

Figure 16
Section through Planetarium ring beam

Conclusion:

Renovation of the Griffith Observatory, while neither the largest nor most expensive project of this sort undertaken by the City of Los Angeles, could very well be among the most important in terms of its impact on the cultural life of the community. More than any other single building, the Observatory has belonged to the people of Los Angeles. Generations of visitors have come to learn about the universe, to enjoy the planetarium and laser shows, to gaze at the stars, or to simply enjoy its unmatched views of the City. It is hoped that this project will make the Observatory more meaningful to future generations and insure its usefulness for decades to come.

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Historical Information on the Griffith Observatory was obtained from the Observatory Website: www.griffithobservatory.com.