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Hearst Headquarters: Innovation and Heritage in Harmony

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Bart Sullivan

Bart Sullivan, P.E. is Vice President and Director of WSP Cantor Seinuk, Dubai Office. Mr. Sullivan has managed the design and construction of a variety of high rise residential and office buildings throughout the world. He has been involved for many years with 3-dimensional computer analysis and design of lateral bracing systems. His experience includes work in new concrete and steel structures, as well as rehabilitation of existing structures. Currently, Mr. Sullivan is managing WSP Cantor Seinuk's Middle East operations at our Dubai office.

Mr. Sullivan is Project Manager for the Two World Trace Center, the second commercial tower to be built at the World Trade Center and also the Seven World Trade Center, New York.The first building to be reconstructed at the World Trade Center. Further projects are the Al Asima Tower, Kuwait City, Kuwait, a 3 million square foot mixed-use development; the Burj Dubai, Site 30 & 31, Dubai City, Dubai, two towers A & B linked together at the base by a low level podium structure and car park; ALM Tower, Dubai, United Arab Emirates, for a 175 m tall concrete framed tower that will be located in the Business Bay district of Dubai and several other projects.

Mr. Sullivan is a member of the American Society of Civil Engineers, the American Concrete Institute, the Council on Tall Buildings and Urban Habit, the Structural Engineering Association of New York and was part of the ASCE/FEMA committee investigating the response of buildings to the collapse of the World Trade Center.

1993, Mr. Sullivan graduated with high honors in Engineering, Bachelor (BS) from the Rutgers College of Engineering, New Brunswick, NJ and in 1994 in Engineering, Master (MEng) with honors from the Cornell Universtiy, Ithaca, NY. He maintains a proficiency in a number of software packages including ETABS, SAP2000, Ram Structural Systems, PCA design modules, RISA, AutoCad, and Microsoft Office components. Abilities in C/C++ programming are also held.

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Abstract

The new $500million Hearst Corporation headquarters is a 46-story, 600 ft tall, glass and steel skyscraper that rises from a 6-story base landmark art deco building. The client's goal was the preservation of the existing façade and the incorporation of a new tower providing architectural character of the highest standards. This paper describes the challenges met in preserving the façade and how the choice of a diagrid system - a highly efficient triangulated truss tube structure – met the engineering and architectural requirements for the tower. Furthermore, the innovative solutions incorporated to meet the associated challenges inherent with such a structural form are described in detail.

Completed in September 2006 on time and on budget, the first diagrid high-rise building in The Americas is an iconic and welcome addition to the New York City skyline.

Keywords: Innovation, Diagrid, Savings, Nodes, Preservation

Introduction

At 959 Eighth Avenue, Manhattan, New York, an iconic tower is the new $500million landmark headquarters for the Hearst Corporation. The 46 story glass and steel skyscraper rises from the 6 story base of a landmark art deco building and opened in September 2006 (see Figure 1a & b).

The original masonry façade building, completed in 1928, was commissioned by the magazine owner, William Randolph Hearst, as the first stage of a corporate headquarters for his vast publishing empire (see Figure 2). Designed in 1926 by Joseph Urban and George P. Post & Sons, the building was intended to accommodate seven additional floors, which were never built. With its limestone façade featuring columns and allegorical figures representing music, art, commerce and industry, the building was considered an "important monument in the architectural heritage of New York", and was designated as a Landmark Site by the Landmarks Preservation Commission in 1988.

Figure 1a & b. Completed Hearst Headquarters

Photo Credit: The Hearst Corp

In 2001, the team of Foster and Partners Architects and WSP Cantor Seinuk Structural Engineers were hired by the Hearst Organization to design its new headquarters at the site of its existing building located at Eighth Avenue between 56th and 57th Street. The new 856,000 ft ^{2} office tower is 600 ft tall and incorporates two underground levels.

Preserving New York's Heritage –The Landmark Facade

An important design specification was the preservation of the existing landmark façade and its incorporation into the new tower design.

The new design requirement necessitated the demolition of the interior of the existing building but the retention of its 6 story façade at the three exterior faces on 56th and 57th Streets and Eighth Avenue.

On plan, the original six story building had a horseshoe shape with an approximate footprint of 200' by 200'. The design for the new tower, however, required a footprint of 160 ft. by 120 ft., and to be situated on new foundations behind the landmark façade. Furthermore, the client also requested a new, 95 ft. high, interior atrium to be formed by the existing façade and the tower above.

By removing the existing support structure for the landmark façade, a new design requirement was necessary due to the larger unbraced height condition of the façade. Therefore, a new framing approach was incorporated for the structural stability of the existing wall, in order to address the new design condition as well as construction phase issues. Furthermore, the existing façade was reinforced and upgraded for the new seismic requirement of the current New York City Building Code.

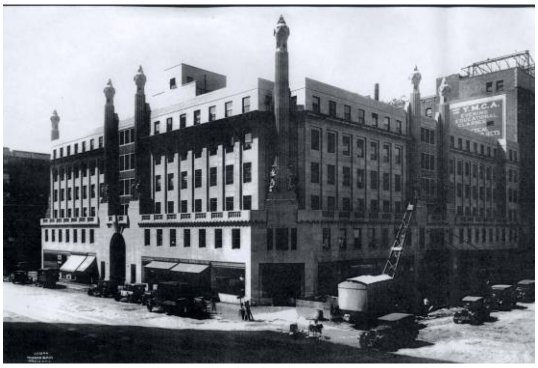

Figure 2. Original masonry façade building

Photo Credit: The Hearst Corp

Figure 3. Illustration of existing façade prior to the addition of new tower

Photo Credit: Foster and Partners

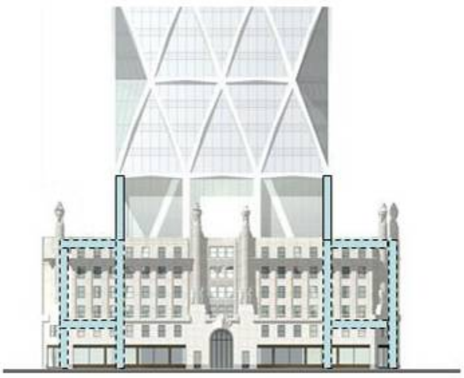

Figure 4. New lateral support of existing façade

Photo Credit: Foster and Partners

The supporting perimeter steel columns and spandrel beams of the original building were also maintained. They provide full vertical support for the façade system. However, an additional grid of vertical and horizontal framing was provided behind the façade following lateral stability and seismic requirement studies. Furthermore, the new and existing framing are in turn laterally supported by the new tower's 3rd floor framing system as well as the new skylight framing system at the seventh level which coincides with the top of the existing façade (see Figures 3 and 4).

Two Types of Foundation

There is a sharp drop in elevation of suitable ground bearing rock at the site, varying from a few feet to 30 feet below basement level. Therefore, the foundation solution was for almost half of the tower to be supported on spread footing whereas caissons of equivalent strength embedded into the respective deeper rock levels were necessary for the other half of the building.

Structural Layout

The tower has two distinct zones, with the office zone starting at 110 ft above street level from the 10th floor to the top of the building. Composite steel and concrete floors with 40 ft interior column free spans were utilized for open office planning (see Figure 5). The other zone below 10th floor contains entrance at street level and lobby, cafeteria and auditorium at the 3rd floor with an approximately 80 ft high interior open space. The tower is connected to the existing landmark façade at the seventh level by a horizontal skylight system spanning approximately 40 feet from the tower columns to the existing façade.

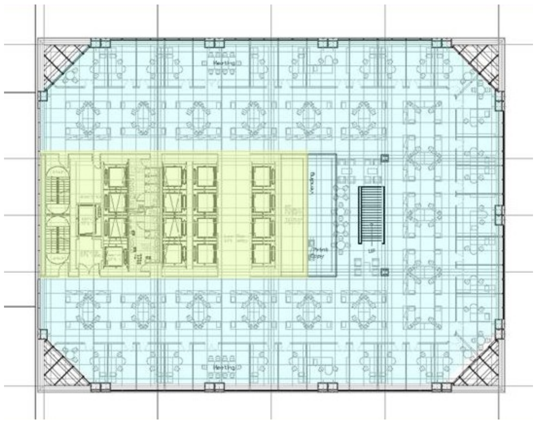

Figure 5. Typical office floor layout

Photo Credit: Foster and Partners

Choice of Efficient Structural Form Specific for the Project

For interior layout efficiency, the service core zone was placed asymmetrically toward the west side of the tower as this is the only side of the building that is not open to the surrounding streets and in fact shares a common lot line with an existing high rise building. Naturally, the eccentric core position reduces its structural benefit as the main spine of the tower. Therefore, the design team decided to focus on the opportunities that the perimeter structure could provide in order to address the overall stability of the tower. This led to an evolutionary process in the conceptual design of the tower by evaluating the effectiveness and benefits of various structural systems. Finally a diagrid system was proposed that would wrap around all four sides of the tower due to a number of benefits specific for the project.

Diagrid - A Highly Efficient Triangulated Truss Tube Structure

The diagrid creates a highly efficient tube structure by being composed of a network of triangulated trusses which interconnect all four faces of the tower. The diagrid system is inherently highly redundant by providing a structural network allowing multiple load paths. This provides a higher standard of performance under extreme stress conditions that national and international codes are striving to achieve.

This provides an inherent lateral stiffness and strength and therefore results in a significant advantage for the general stability requirement of the tower under gravity, wind and seismic loading. Furthermore, this highly efficient structural system was constructed with 20% less steel than an equivalent conventional moment frame structure would have used for the project. This, together with the fact that over 90% of the project's structural steel contains recycled material contributed towards Hearst Tower becoming the first building to receive a Gold LEED certified rating for "core and shell and interiors" in New York City.

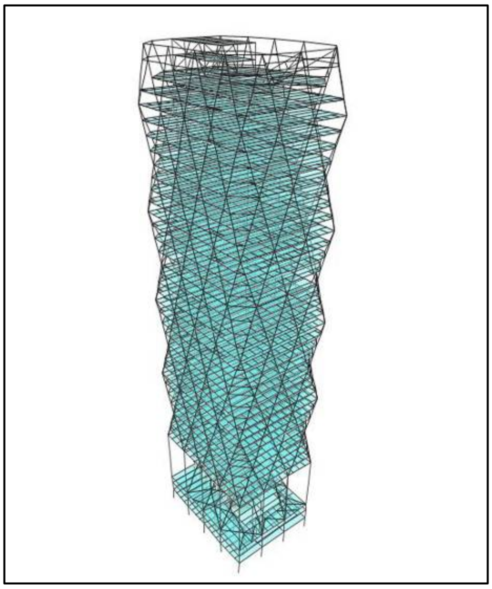

Figure 6. 3D FEA model of structure

Although diagrid systems have inherent strength and stiffness comparable to conventional moment frames, it was necessary to brace the diagonal elements at the floor level between the nodal levels, as the height from node to node spans a whole four floors. This approach necessitated a secondary lateral system connected to the common diaphragm floors. The design of this secondary lateral system addressed the stabilizing requirements considering the total gravitational loads at each level and inter-story construction tolerances. A braced frame at the service core area was incorporated to provide this secondary lateral system.

The main dimensions for the diagrid system were based on its nodes being set on a 40 ft module and placed at four floors apart. A natural evolution of the refinement of the structural and architectural options led to chamfered corner conditions referred as "birds' mouths" (see Figure 7). This not only accentuates the aesthetic character of the diagrid in this project but also solves an otherwise structural vibration concern of having 20ft cantilever conditions at every eight floors at each corner of the tower.

Typically wide flange rolled steel sections were used for the diagrid members with all nodes being prefabricated and installed at the site using bolted connections.

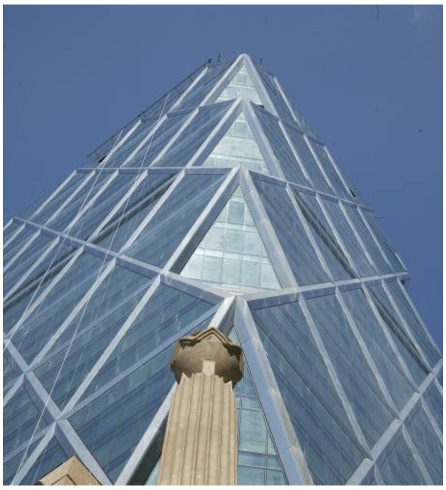

Figure 7. Birds' mouths

Photo Credit: Michael Ficeto/The Hearst Corp

Nodes – Innovative Detail

The diagrid nodes are formed by the intersection of the diagonal and horizontal elements. The nodes, from both a structural and architectural viewpoint, were one of the key design elements in the project. Structurally, they are acting as hubs for redirecting the member forces. Architecturally, they were required to not be larger than the cross dimension of the diagrid elements in order to maintain the pure appearance.

There are two types of nodes; the interior and corner nodes, with the former being planar and transferring loads in two dimensional space, whereas the latter transfer loads in three dimensional space and thus form a more complicated arrangement (see Figure 9). As the dimensions of the nodes could have a significant effect on the viability of the overall concept in respect of cladding, aesthetics, and ultimately the structural system, it was decided that the nodes were to be designed early on during the Conceptual Design phase instead of the more usual Detail Design phase.

Nodes – Back to Basics with Model Making

Even with modern computer software to hand (see Figure 6 and 10), the time tested method of model making was utilized for alternate studies of the corner nodes (see Figure 8). The key was to have a less labor intensive node design even at the cost of marginally increased material.

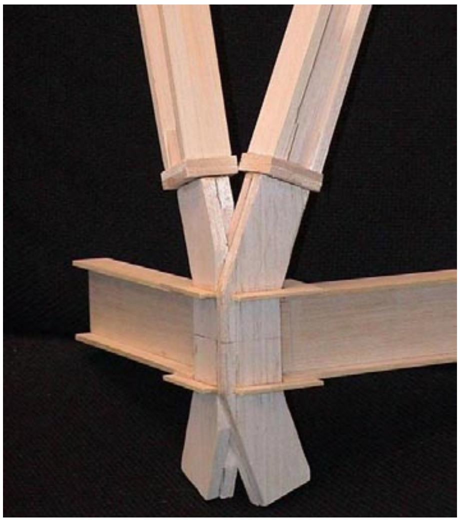

Figure 8. Handmade model of corner node

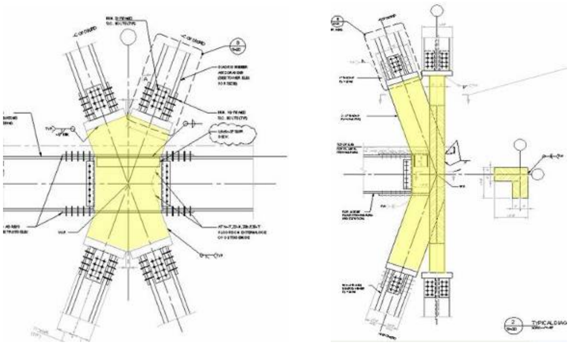

Figure 9. Typical diagrid interior and corner node details

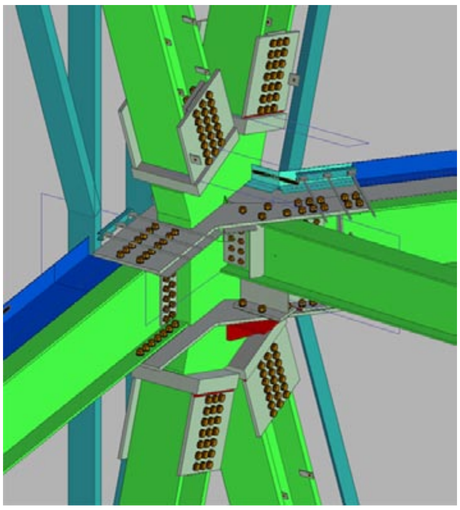

Figure 10. X-steel model of corner node connection

Photo Credit: Mountain Enterprises

The outcome satisfied not only the structural and architectural requirement but also the fabrication requirement in such a way that the design concept was wholly accepted by the steel fabricator (see Figure 11)

Figure 11. Installation of 6 ton node connector

Photo Credit: Michael Ficeto/The Hearst Corp

Mega Columns

A series of perimeter mega columns support the diagrids at the 10th floor and are continued down to the foundation (see Figure 12). The lateral system below this level is provided by a robust composite core shear wall comprised of steel braced frames encased in reinforced concrete walls. Two sets of super-diagonals further enhance the core wall lateral stiffness.

It is this same 10th floor at 110 ft. above ground where the typical office tower starts. Below, the requirement was for an interior open space between Ground and 10th floor with a maximum height of 95 ft. The mega column system positioned around the perimeter of the tower footprint was utilized to give this part of the building's structure the appropriate stability for such a large unbraced height.

Mega columns are primarily made out of built-up steel tube sections and strategically filled with concrete. In order to create the interior open space for the lobby, two of the tower interior columns are also transferred out to the perimeter mega columns of the tower via a series of mega diagonals below the 10th floor. The horizontal component of the load in the mega diagonals intersecting with the mega columns, is resisted through in-plane ring beams and trusses located around the 3rd floor lobby opening that interconnects all the thrust points.

Figure 12. Mega columns and super diagonals

Photo Credit: The Hearst Corp

Construction

The existing façade, in its final condition, has been laterally reinforced, and furthermore has been laterally supported at its 3^{rd} and 7^{th} levels - the 7^{th} level correlating to the top of the wall by the new tower structure. However, the façade had to be temporarily stabilized as its existing internal structure was removed in order to construct the new tower (see Figure 13).

Figure 13. Temporary bracing system of existing landmark facade

Photo Credit: Turner Construction Corporation

This was achieved by temporarily keeping the first bay of the structure all around the perimeter including its columns and floor framing as a ring element. This also provided a working platform for existing façade wall reinforcing. However, the analysis of the one bay ring structure under the temporary loading condition showed that it also required temporary lateral stiffening. Therefore bracing members were placed within the temporary remaining one bay ring structure prior to removal of the balance of the existing building.

These temporary bracings remained in place until the major permanent structural work was completed up to the 10^{th} floor and the final stability of the existing façade wall was restored.

Conclusion

Steel erection was completed in February 2005 and Hearst Headquarters opened in September 2006 on time and on budget. Through the incorporation of innovative engineering techniques, a new iconic tower in harmony with its heritage below has provided a new gem on the Manhattan skyline for the 21^{st} Century

Figure 14. View from 8^{th} avenue entrance

Photo Credit: Michael Ficeto/The Hearst Corp

Ahmad Rahimian, Ph.D., PE, SE, is the President and Yoram Eilon, PE, is an Associate at WSP Cantor Seinuk in New York.

Credits:

Owner: The Hearst Corporation
Developer: Tishman Speyer
Architect: Foster and Partners, Adamson Associates
Structural Engineer: WSP Cantor Seinuk
Construction Manager: Turner Construction Corporation
Steel Fabricator: Cives Steel Company, Gouverneur, NY
Steel Erector: Cornell and Company, Woodbury NJ