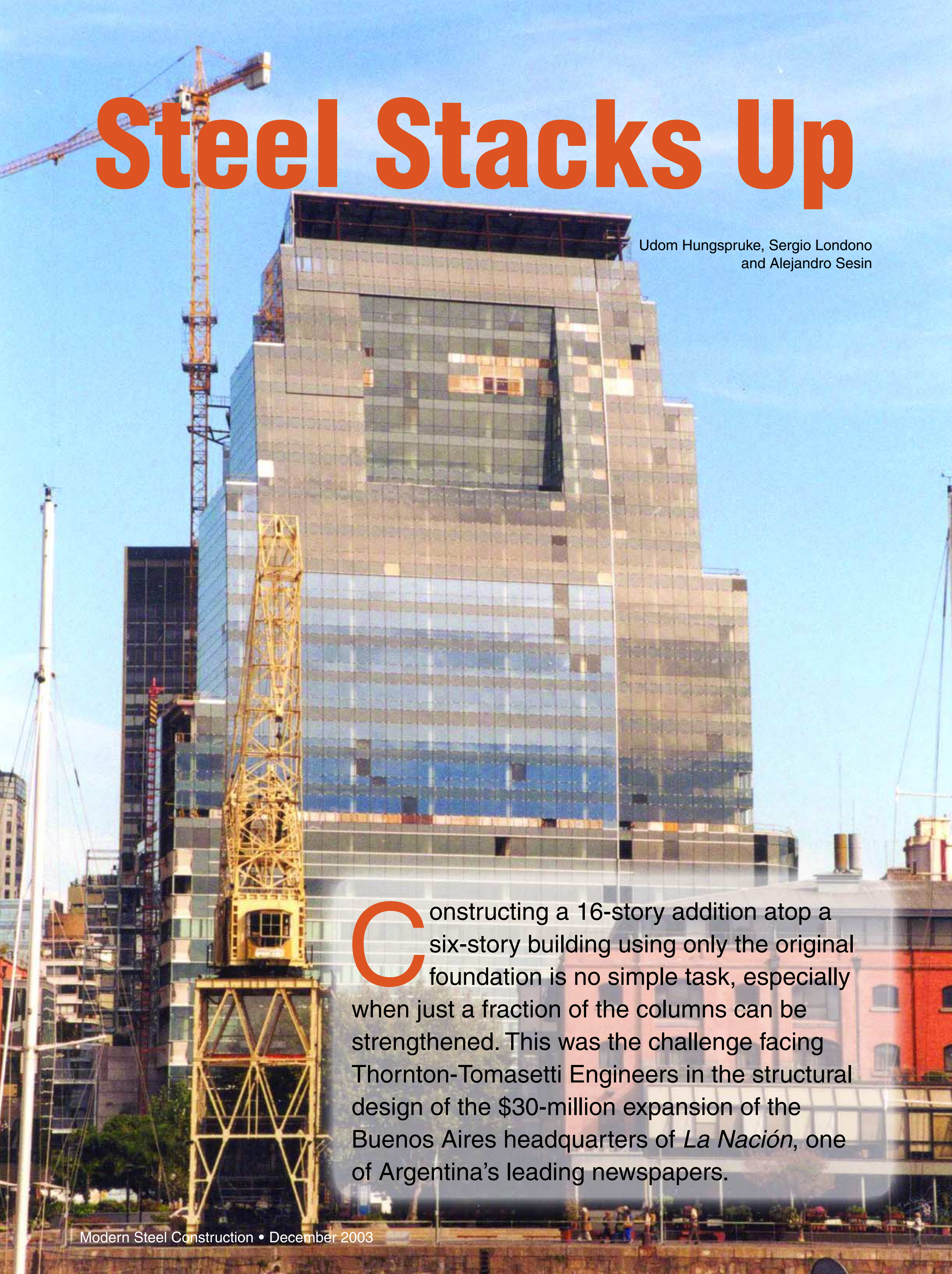

Steel Stacks Up

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Constructing a 16-story addition atop a six-story building using only the original foundation is no simple task, especially when just a fraction of the columns can be strengthened. This was the challenge facing Thornton-Tomasetti Engineers in the structural design of the $30-million expansion of the Buenos Aires headquarters of *La Nación*, one of Argentina's leading newspapers.

The original *La Nación* building occupied a city block in downtown Buenos Aires. The existing building was a classic reinforced-concrete structure with an exposed brick and concrete façade. Its industrial design accommodated large live loads. Three below-grade levels were used for printing equipment and parking. The ground floor incorporated a newspaper distribution center and reception area, while the second and third floors served as storage areas for paper rolls and printing material. Newsrooms and offices filled the third through sixth floors.

An addition to the building, originally considered in the late 1960s, became a reality in 2001. The owners of *La Nación* chose to expand the building on condition that the paper's day-to-day operations would not be interrupted. As a result, any structural reinforcement of the existing concrete columns was limited to the newsrooms and offices of the top three floors of the building. Buenos Aires-based design-build contractor Techint Compañía Técnica Internacional (Techint) accepted the challenge.

The design-build method was chosen to ensure that quality, cost and schedule requirements could be met under the project's demanding conditions. Techint's coordination of the design team kept the project moving on time and in budget.

The structural steel members for columns, beams and girders are ASTM A572 Grade 50 steel. All connections are designed as bolted connections using high strength A-325 and A-490 bolts. The column and truss members at the transfer floor system are W14s.

THE STEEL ANSWER

Steel was the only feasible structural system for the 16-story addition because of its light weight. To unify the entire structure, the exterior of the concrete portion was refurbished to blend with the addition. The façade features a low-emissivity glass curtain wall that slopes inward on the upper part of the building face, offering a commanding view of the Rio de La Plata port. This design, by St. Louis-based Hellmuth, Obata + Kassabaum (HOK), was driven by the need to avoid blocking the light in the streets below with a tall monolithic structure. Twelve elevators are located in the core, which is constructed of reinforced concrete shear walls that extend the full height of the building. The walls share the same foundation slab as the concrete columns.

The floor system of the original structure consists of concrete slabs and columns with large capitals. The shear walls of the reinforced-concrete core provide the primary lateral-load resisting system for the building. The foundation is composed of a series of 39″-wide by 71″-thick foundation beams, located directly below column rows. A 20″-thick reinforced concrete mat spans between the foundation beams.

FOUNDATION REUSE

While a 16-story addition to an existing structure is uncommon, it's even less common to re-use the existing foundation without modifications. In this case, the large addition was possible because the existing building had been designed to hold the heavy live loads of the newspaper's printing presses—and the new, taller structure would be used only for offices. *La Nación*, like many urban newspapers, transfered its printing operations to a less congested site. Also, the original foundations, columns and shear walls had been constructed with reserve capacity for three additional floors that never were built.

During the conceptual design phase of the project, studies of the existing building included structural analyses using simple models, soil studies of the surrounding areas and testing of concrete from columns and shear walls.

To determine the actual in-place compressive concrete strength of the existing concrete, core samples from the slabs, column shafts, column capitals and shear walls were tested.

Ultrasonic tests were performed on all the existing concrete columns to determine their actual strength by relating these test results with results of previous destructive tests on concrete samples. Gamma-ray testing confirmed the location of the steel reinforcement as depicted on design drawings for the original building.

Based upon the test results, the actual column capacity was evaluated and compared against the superimposed loads from the new building. The studies indicated that some of the existing columns would require strengthening.

On the office floors, column reinforcement consisted of continuous vertical corner-bent steel plates. The corner-bent plates were attached with horizontal strap plates, spaced at 12″ on center. Column strengthening was confined to the top three floors of the original building. To strenghten the columns of the basement floors, vertical rebar and ties were added and covered with shotcrete. The foundation structure was strengthened by retrofitting the concrete mat and transforming it into an 80″-thick post-tensioned slab.

STEEL DESIGN

When choosing the structural system for the new building, a key consideration was the overall building weight because of the inherent load-carrying-capacity limits of the older building. Because minimizing dead loads was essential to the feasibility of the project, steel, with its inherent weight advantage, was the best choice. Comparisons of various structural systems showed that steel framing supporting composite floor slabs met dead-load, architectural and mechanical requirements.

The column grid for the new addition was designed for modern commercial uses and did not match the layout of the existing columns—fewer columns were acceptable in the new addition. The transfer system between the new column layout and the existing building consists of a system of transfer trusses, configured so the design of the truss members could be fine-tuned to distribute the new superimposed load according to the available strength in each existing column. By controlling the magnitude and location of the new superimposed loads, the strengthening of existing columns could be minimized.

The transfer truss system is 12′ high and is located on top of the original building, at what would become the new 7th floor. The transfer structure was designed using wide-flange shapes and ASTM A572 Grade 50 steel. SAP 2000 software was used for the analysis of the transfer-system structure.

The design of the structural steel was in accordance with the requirements of the 1993 AISC *LRFD Specification*, ANSI/ASCE 7-95, and the CIRSOC, the Argentine Standards Building Code.

The sloping columns along the slanted façade added horizontal force components to the steel framing. The forces are transferred by the composite floor system acting as a diaphragm to the concrete core.

The structural floor system consists of 3000 psi 2.5″ lightweight concrete slabs on 3″-deep steel deck supported by steel framing. The typical beam and girder sizes are W18. Engineers used RAM Structural System software for the analysis and design of the floor framing.

The structural steel members for columns, beams and girders are ASTM A572 Grade 50. All connections are designed as bolted connections using high strength ASTM A325 and A490 bolts. Slip-critical bolt connections were specified for all column splices, truss connections, all connections of beams to columns, and all moment connections. Column and truss members are W14s.

The design live load of a typical floor in the new addition was for office occupancy of 50 psf. The mechanical penthouse at the 24th floor was designed for a live load of 100 psf.

LATERAL LOADS

The lateral wind loads used in the design were specified to meet the requirements of CIRSOC 102, the Argentine Standards Building Code, and the results from wind-tunnel studies performed by Cermak, Peterka & Petersen of Fort Collins, CO.

Based on CIRSOC 102, the design wind pressure ranged from 26 psf to 32 psf. The shear force at the transfer floor was 900 kip for the short direction of the building and 1,000 kip for the long direction. The wind-tunnel analysis was performed for several load case scenarios for a 50-year period, using a damping ratio of 2%. Even in the worst-case scenario, the wind-tunnel studies produced smaller forces than the ones prescribed by CIRSOC 102 for the transfer level of the building. However, a decision was made to use the CIRSOC 102 wind loads.

Although Buenos Aires is located in a region free of earthquakes, wind loads are demanding for high-rise buildings. The design team decided that lateral stiffness of the new addition would be provided through the continuity of the concrete core within the new steel tower. The lateral-load resisting system, designed by Argentine engineering firm Estudio Lavallaz-Yentel, was achieved by extending the existing concrete shear walls of the core to the top of the 16-story addition. Based on the lateral-load analysis and design of the overall shear-wall system, strengthening the existing shear-wall core was not required. At the transition between the new and existing concrete shear walls, the steel reinforcing bars were spliced with full-tension mechanical couplers.

The concrete core was extended upwards parallel to the steel-structure erection. During the concrete placement, pockets were left in the walls to receive the steel beams, which would later be embedded in concrete. Embedded plates were left in the concrete walls at the core corners to be used for connecting steel elements with clip angles. The function of the new concrete core was essentially the same as that of the existing core: to provide the lateral strength to resist the wind loads transferred from the façade through the floor system.

Although the structure was designed solely for office use, the building's dynamic response is such that the structure also meets residential standards. By exceeding the requirements for stiffness and flexibility, the design team provided the office occupants with the bonus of a more comfortable working environment, less subject to perceptible accelerations.

CONSTRUCTION

Construction started in July 2001 and is near complete. Structural steel erection started on October 2001 and was completed in September 2002, with a three-month interruption due to the Argentine political crisis from December 2001 to February 2002.

The delivery and erection of the transfer trusses in downtown Buenos Aires was one of the biggest challenges of the project. Most of the work on the transfer level was done during weekends, when there was less traffic, allowing for a continuous flow of materials without interruption of crane operation.

Protected-access paths were provided for construction-material delivery and for the crew. Safety measures were extreme to prevent accidents within the building and the surrounding streets. The boom of the construction tower cranes were guyed down during work breaks and non-working time, because of the new structure's proximity to adjoining buildings. There were no accidents during the construction period.

Noisy tasks, such as foundation and column reinforcements, were done during times that were not disruptive to the newspaper's operation. Additionally, structural-steel corner-bent plates were a quick and tidy way of reinforcing the existing columns. Cast-in-place concrete reinforcements would have entailed a larger working area, more construction time, more clean-up, and more disturbance.

THE FINAL OUTCOME

The total weight of structural steel for the 16-floor addition, including the transfer truss system, was 1,300 metric tons (about 1,430 U.S. tons). Despite logistical limitations of the congested downtown area, structural steel was erected on schedule with no major difficulties. The success of the *La Nación* project is a credit to the design and construction firms who coordinated their efforts across international boundaries.

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ENGINEERING SOFTWARE

SAP 2000, RAM Structural System