Totally Tubular

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Images: Pueblo

An innovative modular HSS construction system for the multi-story residential market touts time and money savings.

IN AN AGE WHERE LABOR ISSUES ARE ON THE RISE AND GENERAL CONDITIONS COSTS WEIGH HEAVILY ON PROJECTS, the speed of construction is as important as ever. The more that can be done off-site to reduce the total amount of on-site work, the more financially successful a project can become.

A modular system can help meet these goals of cost-effectiveness and construction speed—as well as that of design flexibility. Modular construction is on the rise, and the applicability of HSS in the multi-story residential market is a very practical and viable solution. With HSS being readily available in a short amount of time from both service centers and HSS producers, this option is now an easy win for fast-paced projects that would typically not be designed in structural steel. With small columns that can be buried within the walls of the structure, the architectural flexibility is also a huge bonus.

One such HSS modular system, geared toward the four-to-12-multi-story residential market, is the Pueblo Building System. Developed by two principals from Pueblo Building Technologies, San Francisco—Tom Graf and Jorge de Quesada—the Pueblo system uses prefabricated vertical trusses comprised of vertical and horizontal HSS members, light-gauge prefabricated floor panels, and poured-in-place concrete floors. The core component is the proprietary structural system; a Pueblo structure consists of shop-fabricated tubular steel frames of standard design. Once erected in the field, the frames are connected with secondary tubular beams, forming a 3D building skeleton. The tubular frame supports prefabricated floor panels using light-gauge cold-rolled steel joists with attached corrugated steel deck. The floor panels then receive a 2-in.-thick lightweight concrete topping reinforced with steel mesh. After the placement of the concrete topping, the structure is ready to receive the finishing trades.

Framing and Flooring

Ladder frames for the system are composed of vertical and horizontal welded HSS members, forming assemblies similar to a ladder and extending up to six stories in height. For buildings with more than six stories, the ladder frames can be stacked and field-welded; they are intended to support vertical loads only. The system's braced frames are of similar construction and maximum dimensions as those of the ladder frames, but with additional HSS diagonal members. Secondary connecting beams, also consisting of HSS sections, serve to connect the ladder and braced frames to complete a 3D structural cage.

For the flooring, prefabricated panels, comprised of lightweight "C" joists with an attached corrugated light gauge steel, form floor assemblies with a maximum width of 10 ft (to allow for normal road transportation) and lengths equal to the full span between supporting HSS members.

Starting off in San Francisco

At this time, the Pueblo system has only been designed for typical residential loading, with the possibility of reworking it for other types of structures in the future. The first building to incorporate a Pueblo-manufactured framing system was a four-story, 47,000-sq.-ft loft condominium building on Harrison Street in San Francisco, utilizing approximately 230 tons of HSS. The project consisted of four levels of condos over one story of concrete framed parking. Six-inch square HSS was used for the ladder and braced frames comprising the vertical assemblies. Shop assembly added to the cost savings of this project due to the fact that the modules were easily fabricated, stacked, and transported. In general, the Pueblo system readily lends itself to the jig systems used to form the ladder and braced frames in the shop. Because of their reduced weight,

This loft condominium project in San Francisco (also pictured under construction on the previous page) was the first structure to use the Peublo modular framing system.

The Washington Street (San Francisco) project, scheduled for completion later this year, integrates the Pueblo system with conventional construction.

the HSS assemblies are easy to handle and inexpensive to erect, since smaller-capacity cranes can be utilized on the job site.

A second project using Pueblo is currently under design, with construction starting later this year: a nine-story project on Washington Street in San Francisco consisting of two lower levels of standard concrete construction for parking, six upper condo levels using Pueblo framing, and an upper floor and mechanical penthouse using standard light gauge steel construction. The Pueblo system was chosen due to the huge cost and schedule savings over competing materials. Savings on the order of $12 per sq. ft are being anticipated, due in considerable part to the shortened construction period. When comparing this project to a concrete system, 16-18 weeks was estimated for the concrete alternate as compared to six weeks with Pueblo, for a schedule savings of two to three months.

The Washington Street project, designed by KPFF, is in seismic zone 4 with a R = 5.6 for the longitudinal direction and a R = 4.2 for the transverse direction, on account of the use of moment frames at the front and rear elevations and the large bay window openings at the end of the building. Steel for the project came in at around 7.21 psf for the HSS and 3.68 psf for the moment frames, which are comprised of wide flange sections. All columns are HSS 6×6 with wall thicknesses varying from ¼ in. to ⅝ in., depending on the loads. The beams use HSS 10×6, with thicknesses typically at ¼ in.

One Step Further

With the Pueblo system, Graf and de Quesada have taken the modular concept one step further, with the integration of mechanical, electrical, plumbing, and air conditioning into the structural frame. They have also developed additional time- and cost-saving elements, such as stackable prefabricated bath and kitchen units, sectional stair units, and prefabricated wall panels, creating, in essence, a complete modular structural steel system for the multi-story residential market. Graf and de Quesada plan to promote the future growth of their patented technology by licensing it to fabricators and contractors.

Says de Quesada, "The new frontier in building construction resides in the increased use of standardized, factory-built components and building modules able to be incorporated into a wide diversity of designs." MSC

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