Innovative Connections

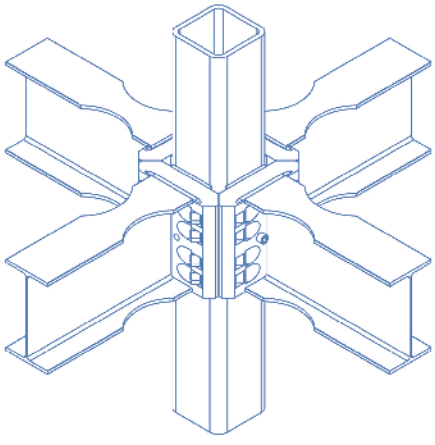
By Bree Renz

ConXtech's systemized approach to steel construction streamlines and transforms traditional design and construction processes.

Terrance Reimer

ConXtech is a systemized approach to steel construction that encompasses a suite of standardized structural components, including boltless base plates, an exterior wall panel system, a stair system, a rooftop davit system, and a concrete floor system. ConXCAD™, a parametric modeling software suite, allows architects to easily adjust structural grid dimensions, even late in the design process.

Founder Robert J. Simmons had long envisioned a concept that would streamline traditional building processes. He wanted to create a building system that would enable mass customization of high quality, mid- to high-rise residential buildings and that would be faster and more cost effective than conventional wood, concrete, or steel-framed methods.



The Simmons Moment Resisting Space Frame connection is integral to the ConXtech structural framing system. (US patent No. 6,837,016. Other patents pending.)

Simmons originally selected concrete for his concept but found that formwork costs and lack of architectural flexibility made steel a more practical solution.

By January 2001, Simmons had developed several new concepts for a steel moment space frame using a self-aligning, gravity stabilized joint that required no field welding. He collaborated with Walid Naja, S.E., to further develop and refine the Simmons Moment Resisting Space Frame™ (SMRSF), a bolted collar system for interconnecting columns and beams.

Structural analysis by Constantine Shuhaibar, Ph.D., led to the use of the RBS (Reduced Beam Section) concept as an energy dissipating component to ensure the SMRSF qualified as a special moment frame under the latest FEMA and AISC provisions.

"When it became clear a building comprised of all SMRSF joints would be cost prohibitive, Walid suggested using a gravity connection for the perimeter of the structure," Simmons said. Simmons designed a simple "drop and click" self-aligning gravity stabilized connection that could be utilized around a building's perimeter, known as the ConX Gravity Joint.

Structural Frame

ConXtech reduces the structural frame to a few common components: HSS 8×8 and HSS 4×4 columns, 12" wide-flange beams, and two joints—the SMRSF full moment joint and the ConX Gravity Joint.

The SMRSF joint assembly is comprised of four inner and four outer collar plates. Each of the inner collar plates is machined to include a male dovetail and is welded to each face of the HSS 8x8 column at floor to floor increments. Each outer collar plate is machined to include a female dovetail slot contoured to the inverse shape of the male projection on the inner collar plate. The outer collar plate is mitered and drilled along the exterior edges to receive diagonal bolts. Outer collar plates are robotically welded to the ends of the 12" wide-flange beams.

Field assembly is simple: drop one beam/outer collar plate assembly over the male projection on the inner collar plate assemblies on each of the four faces of the HSS 8×8 column. Once the beam/outer collar plate assemblies have been located on each face of the column, high strength bolts are inserted into the diagonal holes in the adjoining outer collar plates and pre-tensioned to form a rigid moment collar assembly that surrounds the column.

The ConX gravity connection is plasma cut with a simple flange cope and hook in the web of the beam that drops into a receptacle piece on the HSS 4×4 column and is later bolted. Similar to the SMRSF full moment resisting connection, the gravity connection is self-aligning and gravity stabilized.

ConXtech's interlocking joints drastically reduce erection time, site generated waste, and overall risk because all components are fabricated in a highly automated factory environment. In the field, iron workers simply "drop and click" beams

to columns, wall panels to the building exterior, and stair system assemblies into place. The connections are bolted only after the floors are in place.

Seismic Advantages

In high seismic zones, the ConXtech system allows for much taller buildings than could be constructed in wood and can have substantial design, time, and cost advantages over concrete or conventional steel.

The SMRSF joint has been subject to extensive in-house testing, as well as 17 full-scale tests conducted at the University of Arizona's seismic testing laboratory. It has also been scrutinized by engineering experts through peer reviews required by the cities of San Francisco, San Jose, and Palo Alto.

"The panel determined that the SMRSF frame system qualified as an alternative to the Steel Special Moment Resisting frame system contained in the 1997 *Uniform Building Code* and also is pre-qualified for use as a fully restrained, Special Moment Resistant Framing connection in accordance with the 2002 AISC *Seismic Provisions*," said Raymond Kitasoe, P.E., ConXtech's vice president of engineering. "We were extremely fortunate to have world class experts peer review the system and serve as a seismic advisory committee."

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Day 1 of erection of Building 1 at Santana Row (see sidebar). ConXtech's interlocking joints drastically reduce erection time.

Manufacturing the System

All ConXtech components and assemblies are manufactured at the company's facility in Hayward, CA. Key to manufacturing is ConXCAD software, which integrates the design and manufacturing process by immediately reflecting dimensional modifications on the architect's desktop in the manufacturing output without the need for manual data re-entry or updating shop drawings. ConXCAD

ConXtech Debuts: Santana Row

In August 2002, the residential core of the nearly complete mixed-use development Santana Row, in San Jose, CA, was devastated by a 13 alarm fire. The highly anticipated project was just weeks from celebrating the grand opening of its high-end retail component. Five acres of wood-framed, three-story townhouse style apartments—atop four levels of retail and parking— went up in flames in a matter of hours.

Robert J. Simmons' concrete firm had initially placed all of the structural concrete at the Santana Row site on a design-build basis. As plans to rebuild what had been destroyed by fire progressed, Simmons was tapped to explore the feasibility of replacing the wood structures that had burned with the fledgling steel-framed ConXtech system.

"We were not quite ready to go 'prime time' with the system at that point," Simmons said. "In fact, we hadn't even figured out exactly how or where we were going to manufacture."

Simmons accelerated plans for his manufacturing facility. "It was a leap of faith on both the owner's part, as well as our own," he said.

Within three months of getting the green light, ConXtech was operational and producing its first ConX components.

Assembly of structural steel at Santana Row began in late April 2004. The structures were completed by November 2004. A total of seven wood-framed buildings were replaced by only three steel-framed buildings with four residential levels above the original four parking levels.

With steel, the fuel-load was drastically reduced on the podium, appeasing the San Jose Fire Department. Steel also made it possible to build fewer structures higher, leaving ample space for a clubhouse and swimming pool that were not part of the original plans. Using the ConXtech system, the Santana Row buildings were completed under budget and over a year ahead of schedule.

ConXtech's steel frame system was quickly erected at Santana Row directly above a bustling outdoor dining and shopping area. Because construction with the system generates little noise, site generated waste, or disruption, the system provided an advantage over conventional methods in the demanding urban environment. ★

Courtesy MBH Architects

imports AutoCAD-based architectural files and converts that data to manufacturing code. In fact, the last three ConXtech buildings erected were effectively manufactured and assembled without any shop, fabrication, or erection drawings.

Precision manufacturing is an absolute requirement. Precise fit up assures plumb and level buildings. To accomplish this, ConXtech requires precision down to 0.006" in its steel milling, machining, cutting, and robotic welding cells. "Go/no-go fixturing" is also used to check tolerances as the components make their way through the manufacturing process. With go/no-go fixturing, as a steel component makes its way through the factory from process to process, it will not physically fit into the next fixture unless it is precisely in tolerance. This ensures that all components fit as designed when they are assembled in the field.

Wide-flange beams are cut to specific lengths on a Ficep automated drill/saw line. The line also plasma cuts holes for plumbing, HVAC, and electrical and stamps each individual component with a unique address previously generated and assigned by ConXCAD. The machine code that controls the CNC machining comes directly from ConXCAD.

Robotic welding is essential to the economic viability of the system. ConXtech's state-of-the-art robotic technology features power sources from The Lincoln Electric Company mated with FANUC® six-axis robots for welding the beams and collar pieces together. Compared to previous semiautomatic welding operations, robotic gas metal arc welding (GMAW) offers faster travel speeds, higher deposition rates, and superior-quality finished welds.

Semi-automatically welding one collar piece to a beam can take 40 minutes. With two ends to each beam, welding time per beam equals one hour and 20 minutes. The fully automated system's two robotic arms are able to weld collar pieces to both ends of a beam (comprised of 24" of multi-pass full penetration welds and 64" of fillet welds) simultaneously in only five minutes and 30 seconds.

ConX Components

In addition to the ConXframe composed of columns, beams, and connectors, the ConXtech solution is based on a suite of manufactured assemblies which are sequentially delivered to the building site for integration into the building. Components include;

- ConXfloor—Comprised of a corrugated metal deck and concrete fill, this floor has similar characteristics as floors in a typical concrete building.
- ConXwall—Panels which form the wall and substrate for the exterior envelope of the building, as well as the edge stop for the concrete on the metal deck.
- ConXstair—A factory-manufactured exit stair system that employs a drop-in, self-seating gravity connection allowing permanent stairs to be erected to the roof of the structure within the first few days of erection.
- ConXdavit—An integrated, re-sealable davit receptacle integrated into the top of columns at the perimeter of a building. This receptacle provides a secure and solid base mount for a portable, lightweight davit (outrigger) that can be used in lieu of scaffolding during construction. It can also be used for window washing and exterior maintenance over the life of the building.

According to the company, the system has shown a substantial savings over conventional steel construction—between 25% and 30%. ConXtech performed a cost comparison against conventional systems that included direct construction costs (materials, labor, etc.), as well as costs for the additional elements ConX offers but that are not typically included in traditional steel buildings. The comparison also included soft cost savings such as insurance, construction time, and related carrying costs.

ConXtech recently finished its fifth structure. Although the ConXtech system is privately owned, the company's goal is to broadly deploy it by enabling other fabricators, engineers, and erectors to build with the SMRSF and ConX components. Currently, SMRSF and the ConXtech system have not been licensed to others, but the company is working with several potential licensees. ★

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