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ConXtech is a California-based firm that makes a steel moment space frame system known as SMRSF for use in the construction of mid-rise residential structures.

- CHALLENGE -

ConXtech was using semiautomatic welding on its collar/beam assemblies. The company was struggling to keep up with increasing demand due in large part to the 80 minutes of weld time per finished assembly that was required.

- SOLUTION -

- Automated welding cells with Lincoln Power Wave® 455M power sources embedded with Nextweld technologies, and FANUC® 120iLB six-axis robots.
- Lincoln Electric Metalshield® MC-6 mild steel gas shielded metal-cored wire, delivered in Accu-Trak™ drum bulk packaging.

- RESULTS -

Weld time was slashed by 92 percent. Each assembly now only takes 6 minutes to weld, with excellent weld quality and weld consistency.



In fall 2000, Robert J. Simmons, a 30-year veteran of the structural concrete industry, developed a concept for constructing mid-rise residential structures using a steel moment space frame system. The system, called Simmons Moment Resisting Space Frame (SMRSF), is comprised of a proprietary bolted collar system for interconnecting columns and beams. From this concept, Simmons founded ConXtech, a company which completes all of its fabricating work in-house and then simply assembles column and beam components together on the construction site, bolting them into place.

Unlike typical structural steel construction, which usually takes seven to eight months using traditional methods, the steel moment space frame system allows ConXtech to cut structural erection time to less than two weeks.

Robotic welding systems used in ConXtech's Hayward, Calif., shop are a crucial factor to the company's success. The state-of-the-art robotic technology features two Power Wave® 455M power sources from The Lincoln Electric Company mated with FANUC® 120iLB six-axis robots for welding the beams and collar pieces together. Compared to ConXtech's earlier semiautomatic welding operations, this robotic system offers faster travel speeds, higher deposition rates and superior quality finished welds.

When welded semi-automatically, it was taking 40 minutes to weld one collar piece to a beam. Since there

are two ends to each beam, this would equate to one hour and 20 minutes of welding time per beam. With the Lincoln system and its two robotic arms, the cell is able to weld collar pieces to both ends of the beam simultaneously in only five minutes and 30 seconds.



Erection is quick using ConXtech's Simmons Moment Resisting Space Frame (SMRSF) system.

“Because of the large amount of welding required and the tight tolerances needed, our system would be economically unfeasible without the level of automation we've achieved in our shop,” says Simmons. “We believe no one in the world has successfully MIG welded structural steel with full penetration welds using a six-axis robot. We consider ourselves the most automated structural steel manufacturing facility in the world.”

The first building using the ConXtech system was erected in April 2004 in San Jose's Santana Row. This four-story residential building with retail space and a parking deck below, is

The future of welding is here.®

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significant because it was a steel reconstruction of a wood frame structure that burned down in one of San Jose's largest fires. All welding on the project was done to the AISC Seismic provision.

In addition to the bolted collar system, the Santana Row building will utilize some of ConXtech's other systems such as a concrete flooring system, a wall paneling system, an exterior wall system and a stair system.

How the System Works

The ConXtech collar connection 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 attached to the column with fillet welds. Each of the outer collar plates is machined to include a female dovetail slot contoured to the same shape as the tapered boss on the inner collar plate. The outer collar plate is also drilled along the exterior edges to receive diagonal bolts. Each outer collar plate is shop-welded to a wide flange beam.

"The quality of the Power Wave 455M arc is unmatched, while the unit's Waveform Control capabilities ensure a consistent weld. The robot system has produced impeccable quality welds typically not achievable at this level."

Field assembly is simple: slip one beam/outer collar plate assembly over the boss on the inner collar plate assembly which is on each face of the column. Once beam/outer collar plate assemblies have been located on each of the four faces 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 collar assembly that surrounds the column.

ConXtech Advantages

The advantages of ConXtech's steel moment frame system are many. As was mentioned previously, the requirement for field welding is reduced, leading to lower construction costs as compared to wood frame, concrete and steel methods.

Because of the unique bolted collar system, a building erected in this fashion is structurally superior to a wood frame structure and can better handle severe lateral loads, such as those produced by an earthquake. This is an important factor in the California bay area, where seismic concerns are a constant factor for architects, builders and construction firms.

Usually in a seismic zone, a wood structure can only be built to 50 feet, but the ConXtech system allows for much taller buildings. Even in a Seismic Zone 4, when utilizing the revolutionary collar system, an eight-story building can be erected above a podium without sheer walls, brace frames, or incurring any code-related penalties. When erecting in non-seismic zones the system can be used to build high-rise structures.

In fact, the connection system has performed successfully in 17 full scale tests at University of Arizona at Tucson's seismic test lab. It has also been scrutinized by world-class experts in the form of two peer review panels—one appointed by the cities of San Francisco and San Jose and the other representing the city of Palo Alto, Calif., where the second ConXtech building will be erected. According to ConXtech's Robert J. Simmons, these panels determined that the ConXtech SMRSF framing system qualified as an acceptable alternative to the special moment resisting space frame system and pre-qualified it for use in accordance with the 2002 AISC Seismic Provisions.

Another advantage to the ConXtech frame design is its architectural flexibility. According to Simmons, he knew he had to create something that was configurable to accommodate different designs within the architectural constraints. "We couldn't have a system that always had to be 12 feet in height. We had to have a system



The Lincoln Power Wave® 455M with Waveform Control Technology™ ensures a consistent weld.

that was infinitely variable, able to accommodate a variable number of floors and also floor-to-floor height changes," says Simmons.

"So it just came down to a joint. If we joined this whole thing together in a frame, we could have a framework that was able to do what we wanted to accomplish," notes Simmons.

Robotics Make the Difference

All the components of the ConXtech system are precisely manufactured in the shop by the company's 25 employees so that everything plumbs and aligns automatically on the construction site. Precision is an absolute and the company requires precision down to 0.004" in its steel milling, machining, cutting and robotic welding cells.

Beams, composed of A992 structural steel, arrive in the ConXtech shop as 12-inch by 19-inch or 12-inch by 30-inch rolled sections which are fabricated in an automated beam line. Simmons notes that CNC machining on the A572 Grade 50 outer collar piece is performed so that 95 percent of the configured joint's weld volume is defined by the machine part. Prior to machining, these pieces are 3" thick.

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Two six-axis robot arms perform full penetration MIG welds on structural steel—perhaps a first in the U.S.

Currently, all beams and their outer collar plate with the female dovetail are MIG welded with Lincoln Electric's Power Wave 455M. The plate requires the use of full-penetration welds on the top and bottom flanges and fillet welds on the beam's web and the back side of the flanges. The 24-inches of full-penetration welds on each beam are made in four passes, while the 64-inches of fillet welds are completed in a single pass.

The Power Wave 455M is a high performance, digitally controlled inverter which utilizes advanced Waveform Control Technology™, an element of



ConXtech obtains real-time production monitoring data for an added measure of quality control.

Lincoln's Nextweld® Technology innovations. Waveform Control Technology is Lincoln's proprietary technology platform that controls and shapes the output waveform. Since the waveform may be shaped digitally using software, rather than requiring a change in electrical components, equipment with Waveform Control Technology can deliver customized results for virtually any application, improving productivity and quality on a wide range of materials. These capabilities provide users with a versatile and upgradeable welding system.

Also, the digitally-controlled Power Wave 455M inverter power source is capable of sophisticated arc starting procedures that help to reduce the risk of starting porosity and contribute to a flat, attractive weld bead profile.

ConXtech also takes full advantage of the digital communication platform provided by the Power Wave system. Using ArcLink and DeviceNet communication protocols, ConXtech obtains real-time production monitoring of the system's performance, monitoring arc current, voltage and wire feed speed at the robotic station. In the near future, Simmons plans to tap into production monitoring via a computer network connection (Ethernet) to his laptop, which is a current capability the Lincoln Power Wave systems deliver today.

"The quality of the Power Wave 455M arc is unmatched, while the unit's Waveform Control capabilities ensure a consistent weld," explained Simmons. "The robot system has produced impeccable quality welds typically not achievable at this volume."

Fixtures, provided by Preston Easton, allow for the beam to be easily loaded and unloaded by one operator. The cell's rotating head and tail stock are on linear guides and use brackets to precisely align beams which can accommodate lengths from 8-feet to 20-feet. The end plates

themselves act as a clamp to keep beam flanges parallel. This fixturing positions the beams and outer collar components to always be within tolerance—if they are not, the robot will not function.

Not only is precision important to ConXtech, so is production speed in order for the shop to meet its goal of



The Lincoln Power Wave® 455M uses ArcLink™, DeviceNet and Ethernet to communicate digitally with other welding system components, shop systems and via the internet for remote production monitoring.

welding 80 beams and collar pieces during an eight-hour shift. Simmons reports travel speeds of 12 to 25 inches per minute and deposition rates of 13.8 lbs/ hour of weld metal. (.052" MC-6 at 400 ipm).

Consumable Selection

For its consumables, ConXtech selected Lincoln's Metalshield® MC-6 mild steel gas-shielded metal-cored wire, intended for use in applications subject to FEMA 353 guidelines. The main advantage with the 0.052-inch diameter MC-6 is that it allows multiple welding passes without interpass cleaning. This is especially helpful for the full penetration welds requiring four passes. It also produces lower fume levels and very little spatter.

"The MC-6 has proven to be very clean and capable of high deposition and high quality welds with little or no rejection due to porosity or slag inclusion," noted Simmons. "For flat and horizontal welds in a factory environment, I think the MC-6 is the most productive wire available."

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ConXtech is using an argon blend shielding gas comprised of 84 percent argon and 16 percent CO₂. The MC-6 wire is delivered in Lincoln Accu-Trak™ drum bulk packaging, which according to Simmons, works flawlessly in ConXtech's high volume application.

Other Welding at ConXtech

For now, columns and inner plates with the male dovetail are still MIG welded semi-automatically with Lincoln's DC-655 power sources and LN-10 wire feeders, but Simmons hopes to move this operation into a fully automatic, robotic station in the near future.

For operational consistency, the MC-6 metal-cored wire is used throughout the semiautomatic welding stations as well. "We are welding everything with a single type of wire to aid our quality control," notes Simmons.

Service and Training

ConXtech employees attended basic robotic training at Lincoln Electric headquarters in Cleveland, Ohio. Lincoln personnel spent four days on-site during the installation and set-up process to assist with the transition and assure that the ConXtech team was ready to ramp up productivity. "Lincoln Regional Robotic Sales Manager Chuck Murray has been incredibly supportive and has helped us achieve the necessary technical expertise to be operational," notes Simmons.

Future

For Simmons, ConXtech and the revolutionary bolted collar system is a dream come true. He hopes to expand the company worldwide as developers, builders and architects realize ways of integrating the steel moment space frame system into mid-rise residential building construction.

Featured Lincoln Products



Power Wave® 455M

For welding thicker materials in robotics, hard automation and semiautomatic applications, choose the Power Wave 455M. The Power Wave 455M features Waveform Control Technology™ for superior arc performance on a variety of material, including steel, stainless steel, aluminum and nickel alloys, and custom control of the arch for each wire type and size for consistent welds time after time. The Power Wave 455M is designed to be part of a modular, multi-process welding system in which power sources can be added or removed and still communicate with other industrial machines to create a highly integrated and flexible welding cell.



Metalshield™ MC-6 (E70C-6M)

For high quality welds that require a great bead shape, appearance and low spatter level, you can't beat MC-6! Combining the arc characteristics of MIG with the performance benefits of flux-cored welding, MC-6 is capable of fast travel speeds and high deposition rates with lowest smoke and spatter under high argon gas blends.

WHAT IS NEXTWELD?

The challenges facing industrial fabricators today are increasingly difficult. Rising labor, material, and energy costs, intense domestic and global competition, a dwindling pool of skilled workers, more stringent and specific quality demands.



Through our commitment to extensive research and investments in product development,

Lincoln Electric has established an industry benchmark for applying technology to improve the quality, lower the cost and enhance the performance of arc welding processes.

Advancements in power electronics, digital communications and Waveform Control Technology™ are the foundation for many of the improvements.

NEXTWELD brings you a series of Process, Technology, Application and Success Story documents like this one. NEXTWELD explains how technologies, products, processes and applications are linked together to answer the important questions that all businesses face:

- *How can we work faster, smarter, more efficiently?*
- *How can we get equipment and people to perform in ways they've never had to before?*
- *How do we stay competitive?*

NEXTWELD is the future of welding but its benefits are available to you today. Ask your Lincoln Electric representative how to improve the flexibility, efficiency and quality of your welding operations to reduce your cost of fabrication.

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