

ATLAS TUBE KEEPS AMERICA ON TRACK

When engineers were designing a steel bridge over a busy railway, **Atlas Tube's Jumbo HSS and Shuriken® bolted connection system** were the right choices to support a highly ambitious design.

The railroad passing through Corona, California, has bolstered the local citrus industry for an entire century, earning Corona the nickname "Lemon Capital of the World." However, that same rail infrastructure that connected Corona to the rest of the world also divided it from itself as it snaked through the very center of the city. For drivers on McKinley Street, long waits for freight and passenger trains to clear the grade-level crossing became customary.

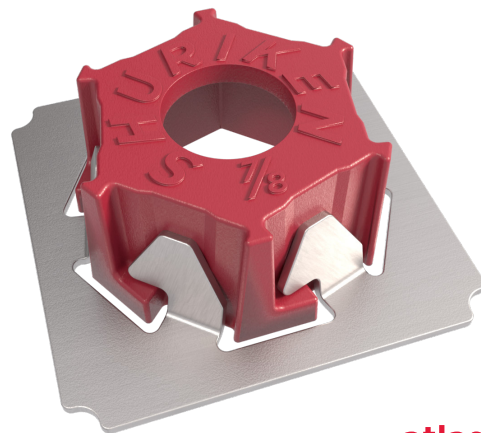
In 2018, the City of Corona began the environmental and final design phases to build a new bridge over the railway and the open-channel drainage canal that runs beside it. The new bridge would not only shorten commutes, but would also improve safety at the crossing that had claimed five lives since 2000.

Initial concepts proposed a concrete bridge with columns placed between the railway and the canal. The project engineer, Biggs Cardosa, quickly identified challenges with the proposed concrete spans: limited access to the railroad right-

of-way made a cast-in-place concrete solution difficult to construct, and the placement of a central column would require temporary rerouting of the canal.

Biggs Cardosa's solution was simple: go big with steel. By spanning the entire 291-foot gap over the railway, canal, and access roads, any conflicts with the drainage canal were eliminated. Utilizing a lightweight steel span meant that the bridge could be constructed adjacent to its final location and then lifted into place, minimizing railway disruption. In this case, an arch design was the perfect solution.

Shuriken simplified fabrication and erection for the McKinley Bridge team.



The structure that emerged from the design process was an eye-catching inclined arch with network suspenders. Using interlaced “network” suspenders to support the deck reduced moments imposed on the arch ribs when compared to vertical suspenders, allowing the arch ribs to be lighter, more slender, and more aesthetically pleasing. Initial designs included wide-flange X-bracing between the arch ribs, but those members were switched to parallel 22x22x7/8” Jumbo HSS members from Atlas Tube due to their ease of constructability and cleaner aesthetics.

“The geometry is difficult to detail when you have two inclined members coming into each other at a connection point,” says Austin Emrich, Engineer at Biggs Cardosa. “Additionally, when a member is subjected to both vertical and horizontal loads, biaxial bending occurs, requiring adequate strength in both principal directions.” Atlas Tube’s 100% domestic Jumbo HSS helped Emrich avoid the obstacles presented by wide-flange beams.

“There are also the aesthetic implications of X-bracing going along the entire structure. The Atlas tubes provide a more sleek and open feeling,” says Emrich. The near-immediate availability of Atlas’ Jumbo HSS provided the benefits of closed sections without fabricating additional built-up boxes for the structure.

Walsh Construction, the largest bridge builder in the country, was chosen as the general contractor, and they assembled an all-star team to make the project a reality. Thompson Metal Fab (TMF), with 85 years of history in oil and gas, marine structures, and transportation, fabricated the geometrically complex structure. Walsh Construction would self-perform the steel erection.



Overall shot showing the various structural elements.



HSS22x22x7/8 stubs being set for attachment to the built-up arch ribs. The inclined ribs made for complex geometry with tight tolerances.

TMF's expertise was critical as the project included several heavy weldments with complex geometry, especially at the joint where the arch rib connects to the tie girder. According to TMF, Atlas Tube Jumbo HSS made a difficult job possible. "We build boxes for a living, and we know how to do it," says Alex Berlin, Project Manager at TMF. "With Jumbo HSS, you don't have to splice four corners and try to make a box square. You're getting a well-manufactured product."

However, Atlas' domestic Jumbo HSS was not the only innovation that made the bridge a reality. While the tie girders were large enough to allow ironworkers to reach the interior of the bolted splices, the arch ribs, tie beams, and support diaphragms were not. A new technology at the time, Shuriken® by Atlas Tube, was a logical answer to this challenge. Shuriken allows the installation of A325 and A490 bolts from one side and was the perfect solution to the connection conundrum confronting the team.



An HSS 22x22x7/8 set up for a bolted splice using Shuriken.

Shuriken is a one-time-use wrench that holds a nut in place on the inaccessible side of a connection. It is strong enough to resist the torque imposed by bolt pretensioning, but flexible enough to allow the nut to move laterally. This preserves erection tolerance and allows bolts to be installed even when they are not perfectly aligned. By mounting the nuts on the interior of the HSS and box members, splices could be bolted up from the exterior.

This bridge was a monumental test for the efficacy of the brand-new Shuriken, and it passed with flying colors, supporting a piece of critical infrastructure with over 12,000 units. "We did extensive testing on Shuriken to verify its performance and reliability in the field, and it was great to see it stand up to immense pressure to perform and succeed in the largest project we've done up to this point," says Ted Goldstein, Business Development Engineer at Atlas Tube and the inventor of Shuriken.



The simplicity and robustness of Shuriken turned awkward connections into straightforward ones. Walsh's Senior Superintendent, James Neeley, a member of the RCSC Bolt Council, made sure the team was prepared, even holding a "bolt-a-palooza" event beforehand that brought together all companies and personnel contributing to bolting operations:

- St. Louis Bolt - Hardware Supplier
- Applied Bolting Technology - Maker of DuraSquirt® DTI
- GWY - Torque wrench supplier
- Skidmore-Wilhelm - Bolt Tester Manufacturer
- Walsh Construction - bolting crews
- City of Corona
- Atlas Tube - Manufacturer of Shuriken

Assembly and bolt-up went smoothly. The built-in lateral flexibility of Shuriken preserved erection tolerance, while DuraSquirt DTI washers from Applied Bolting Technologies made accurate tensioning and inspection easy for the slip-critical A490 bolts.

During the project, other lessons were learned about working with Shuriken. "One thing I took away from this project is that when we have another job with Shuriken,



[TOP] Support diaphragms being set for connections to the tie girder using Shuriken.
[BELOW] A completed bolted splice using Shuriken. The orange media from DuraSquirt DTI washers helped crews and inspectors verify that the bolts are tight.

I would put four holes in the corners of each splice plate so that you could drive barrel pins through [to make alignment simpler],” says Les Hancock, Superintendent of Steel Erection at Walsh.

The use of Shuriken and Jumbo HSS weren’t the only innovative design decisions made by the team. To avoid tension and fracture-critical connections, post-tensioned tendons were run within the tie girder at the bottom of the arch for the bridge’s full span. In addition to putting the tie beam in compression, this approach added redundancy to the bridge’s design.

Additionally, to prevent corrosion on the interior of the arch ribs and tie beams between the ribs, which were too small to allow access for inspection, the interiors were filled with expanding polyurethane foam. This approach has been used extensively in maritime applications but is new to transportation projects.

All these innovations came together to give Corona a beautiful, efficient new bridge as well as a safer and better-connected community.



An arch rib with Shuriken being lifted into place. Walsh prepared complex rigging to lift the tilted arch ribs in the proper orientation.



A “knuckle” of the bridge, where a support diaphragm, arch rib, and tie girder come together. The anchorages for the four post tensioned cables are visible.

About Atlas Tube

Atlas Tube, a Zekelman company, produces a wide range of steel tubular products and is the leading provider of hollow structural sections (HSS) in North America. Other offerings include engineering support, HSS Design Tools, and straight-seam electricresistance weld (ERW) pipe piling.



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