INTERNATIONAL MOLYBDENUM ASSOCIATION
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Innovative bridge uses stainless steel

Iconic bridges that combine cutting edge technology and aesthetic beauty are increasingly used to create visual focal points in city centers, but very few are constructed on modest budgets and ahead of schedule.

When a 100-year old Ft. Worth vehicular bridge was beyond rehabilitation, the engineers at the Texas Department of Transportation (TxDOT) designed a very special replacement – the world's first precast concrete network arch bridge. The 12 nearly 50 meter long and 7 meter high arches, each weighing 284 tonnes, are believed to be the world's largest precast concrete arches transported to a bridge location. The structural molybdenum-containing stainless steel hanger bars within them are also believed to be a first.

The 299-meter-long, multi-award winning, four-lane West 7th Street bridge was completed in 2013. This vehicular bridge also provides a walkable gateway between the downtown area and museums designed by some of the world's most famous modern architects. It offers spectacular views of the river, downtown and the museum district. Lights within its graceful arches highlight the gleaming angled stainless steel bars. The sidewalk's position, right next to the arches, encourages pedestrian interaction with them, so this sculptural bridge appears frequently on social media. The bridge was opened a month ahead of schedule, and its US $25.9-million cost was under budget and well below the typical cost per square meter for a high-profile bridge. ›

The West 7th Street Bridge in Ft. Worth, Texas USA uses angled 2205 duplex stainless hanger bars in its structurally innovative precast concrete network arch design. © Liam Frederick Photography

On-site placement of a bridge arch.
© Liam Frederick Photography

Light gleaming off the 2205 duplex stainless steel hanger bars adds the sculptural look of this beautiful bridge. © Liam Frederick Photography

The key feature of a network arch bridge is its angled hangers. These hanger bars connect the 'tie', which holds the arch ends at the bottom of the arch together, to the top of the arch. The combination of the tie and hanger system creates a truss-like behavior where the hangers transmit loads from the deck through the tie and into the arch. In contrast to a traditional vertical hanger system, the angled bars reduce bending in the arch when vehicles and people pass over the bridge. This system is structurally highly efficient. Most network arches use steel box arches, whereas the West 7th Street Bridge uses precast, prestressed concrete arches.

In total, nearly 100 tonnes of stainless steel were used for the very visible inclined hanger system at the center of the 12 arches. These large, 44.5 millimeter diameter bars are made of 2205 duplex stainless steel, containing 3% molybdenum, and are up to 8.2 meters in length. The link plate, pin and hanger tube components were manufactured from 2205 duplex stainless steel plate, and the cast clevises were CF8M stainless steel (cast Type 316). This molybdenum-containing stainless steel alloy combination was selected for its corrosion resistance and structural performance during TxDOT mock-up testing.

Traditional bridge replacement can take two to three years, causing significant traffic and business disruption, but this innovative design used arches which were cast off-site and required the bridge to be closed for less than five months. The construction and its unique challenges were documented in the award-winning US public television documentary, the 'Arc of Innovation'.

Charles Walker, P.E., Senior Associate, Walter P. Moore and Associates (formerly of the TxDOT) played a key role in the structural design of the stainless steel elements of this special bridge. When asked about stainless steel selection, he said that, "the combination of stainless steel and concrete in compression takes us towards infinite durability of the network arch elements because stainless steel does not require the coatings and maintenance that would have been necessary for carbon steel hangers." "Infinite durability" is a big phrase for any bridge engineer to use, but with the proven longevity of molybdenum-containing stainless steel, he may be right. (Catherine Houska)

While the angled 2205 duplex stainless bars stabilize the bridge, their location beside the sidewalk makes them a lovely place to pose for photos. © TxDOT