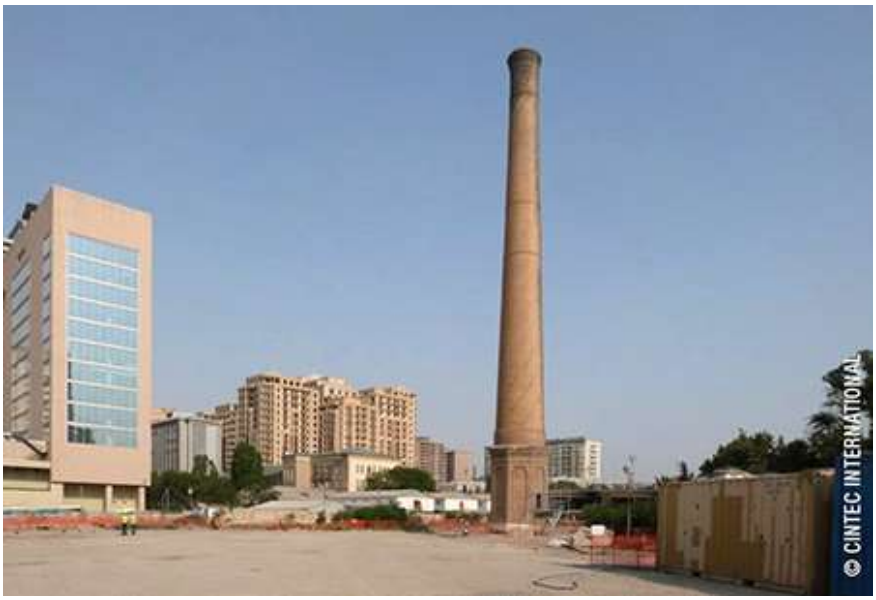
Civil Engineering

THE MAGAZINE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Surgical Engineering Preserves Chimney in Azerbaijan

By Kevin Wilcox

A historical industrial chimney in Azerbaijan has been structurally bolstered and preserved to eventually serve as the centerpiece of a new mixed-use development.



The 180 ft tall brick chimney, rescued from demolition and carefully preserved, will be the centerpiece of a twin tower development. © CINTEC International

January 5, 2016—The Azerbaijan capital of Baku is one of the largest and oldest ports on the Caspian Sea. The metropolitan area's approximately 4 million residents can trace the rich history of the region back to the Bronze Age, and several prominent and preserved buildings in the city date to the 12 th and 13 th centuries. So it comes as no surprise that as the oil-rich area undergoes a dramatic urbanization leaders seek to maintain connections to an industrial past.

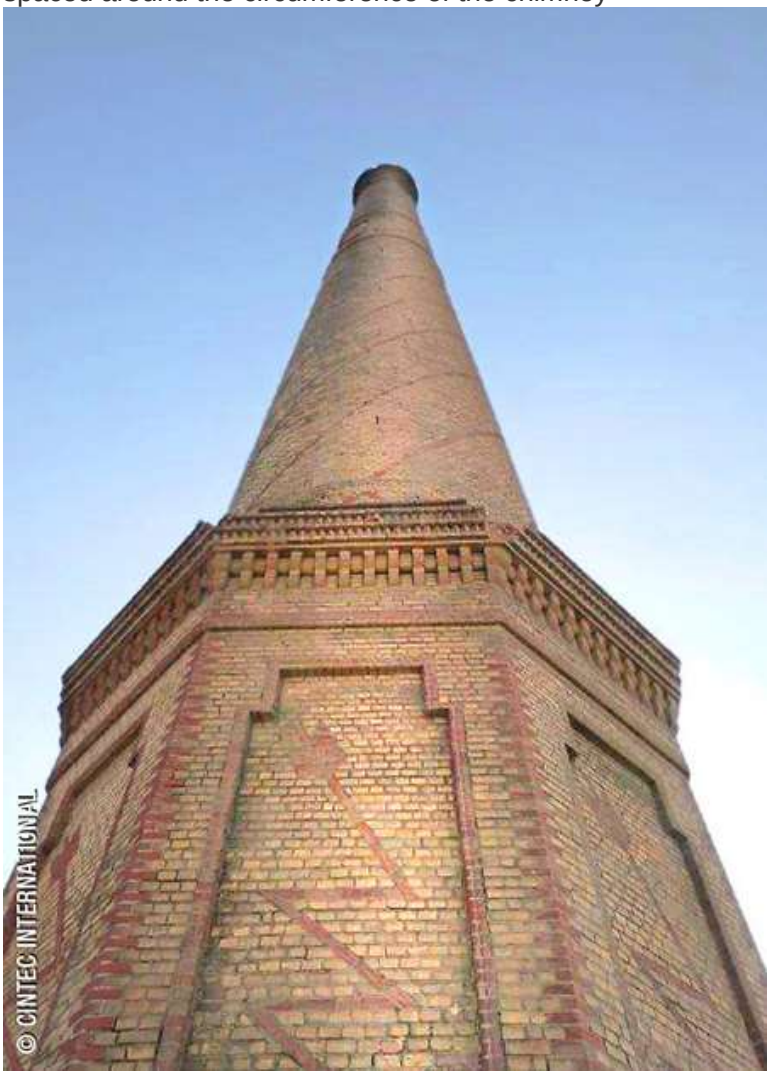
One such project is nearing completion as a construction team installs the final masonry anchors in a historical industrial chimney near the sea. The 180 ft tall brick structure was at one time slated for demolition to clear the site for a large mixed-use complex—in the form of an asymmetrical pair of

sweeping office towers connected by shared lower levels of retail space—but was spared by President Ilham Aliyev.

The chimney is about 16 ft 3 in. diameter at the base, tapering to 9 ft. 6 in. at the top. The chimney bears on a thick octagonal foundation of local Baku stone, similar to portland stone. Portions of the chimney interior are heavily glazed and brittle—scars from decades of use in the steel and iron industry. There is also residual damage from an earthquake.

Although the chimney is structurally robust, there are portions with damaged or missing bricks. Preserving it to serve as the centerpiece of a modern development required a dedicated team that included Pasha Construction, a division of Pasha Insaat, headquartered in Baku; the engineering firm Ramboll, headquartered in Orestad, Denmark; and CINTEC International, a structural masonry expert headquartered in Newport, Wales, United Kingdom.

"To do the work, we had a robust steel frame go on the outside of it, all the way up to the top, which was designed to hold the chimney in the event of a seismic event. We also used it for control and for marking out the position of the anchors," says Peter James, the managing director of CINTEC. "We had a variety of [potential] positions and shapes for the anchors and the drilling, but eventually we chose the [simplest] one." That plan called for eight steel anchors, approximately 78 ft long, evenly spaced around the circumference of the chimney



The chimney is structurally robust, but did exhibit some areas of damage following an earthquake and decades of use in the steel and iron industry. © CINTEC International
Because of a choke point in weak brick at the chimney's corbel, the team reduced the planned drill bore size from 101 mm to 85 mm, while maintaining the originally specified 27 mm thick steel anchors. James refers to the installation process as surgical engineering, beginning with boring holes that are slightly deeper than the anchors to be installed within extremely tight tolerances.

After the holes are bored through the brick, the anchor is inserted, surrounded by a special fabric tube that serves several purposes during the process. "It's a special sock woven in such a way that [when] we inject the grout at three bars, it expands radially, but it doesn't then contract. These are specially woven so that we don't lose any dimension," James says. "[It] retains the fine aggregate but allows the surplus water to permeate into the substrate. When we put the sock on the anchor body, we have plastic spacers on the bar so we can keep it centralized all the time."

With the bar installed and centered, a high-strength microconcrete grout is injected into the gap between the bar and the sock. The injection pipe is inserted for the full distance of the bore hole and removed slowly as the space fills with grout.

"We use a microconcrete grout made specifically for us," James explains. "The cement is very fine. Its strength can be 55 Newtons, [but] we can vary it."

The sock is only used for about 10 seconds, he says, while the grout is applied. "After that, it really is redundant," he says. "The water that takes the grout in, then permeates through the holes in the sock into the substrate to give you a better fix and keys it in."

Once all of the vertical reinforcement is installed, the team plans to install much shorter horizontal anchors between that reinforcement in the specific areas that have been weakened by exposure to extreme heat or damage from an the earthquake.

With the chimney project slated from completion early this year, the mixed-use development can proceed. To provide stability during the preservation and minimize any impact from the new building construction, a ring of 20 large secant piles were installed around the chimney's foundation and then joined by large concrete beams. This system will provide protection while the area surrounding it is excavated to a depth of roughly 50 ft to accommodate underground parking for the new development. These bolstering elements will then be incorporated into the new structures.

CINTEC has reinforced a vast array of high-profile structures—from the Pyramid of Djoser in Egypt to Windsor Castle and Buckingham Palace in England and the St. Alphonsus Church in Baltimore, Maryland. What are the differences between those august edifices and this more industrial one? "None whatsoever," James says. "In 30 years, we have specialized in looking at distressed structures, one way or another." And the chimney in Baku, he says, is "a lovely structure to reinforce."