# 2017 AWARD OF MERIT: ADAMS PRECAST SEGMENTAL TOWER POST-TENSIONED PRECAST SEGMENTAL TOWERS FOR HIGH WIND TOWERS

Large-scale commercial wind farms are a significant source of energy generation today in the United States and internationally. The initial cost of construction typically determines the competitiveness of wind energy in comparison to the energy sources of others. The costs associated with transporting large steel tower sections between the tower fabricator and the jobsite are high and often require modifications to existing roads and bridge infrastructure to accommodate. A utility-scale wind farm project commonly has 60 or more towers installed. This creates the opportunity for on-site industrialization in production of the precast segments and significant savings in tower transportation costs. This industrialized approach to constructing wind towers on site provides many of the same benefits found in the construction of large precast segmental bridge structures, where many standardized segment geometries also exist. Wind Tower Technologies (WTT) developed a patented precast segmental tower system for high wind towers in 2011. The company licensed the tower technology to Siemens Energy in 2013 and formed a commercial partnership together with Siemens to bring it to market with a focus on North and South America.

The Adams County precast tower (Fig. 1) is the highest tower constructed in the United States in steel or concrete. The hub height is 377 ft (115 m) and supports a 2.3 MW turbine and 354 ft (108 m) diameter wind blades, resulting in a total height of 605 ft (169 m). The new tower system was fabricated on site, eliminating the disruptions and costs inherent with transporting large steel tower sections over roads and bridges from remote locations to the project site. Using on-site concrete fabrication, the tower base diameter is nearly unrestricted, thereby providing the height of the tower to be limited only by zoning permits and erection equipment.

The significance of taller towers is higher energy production in many geographic markets where increased and more sustained wind speeds exist with height. The

*Fig. 1—Adams County precast tower.*

market opportunity for concrete wind towers in North and South America is high as the wind market trends towards taller towers.

*Fig. 2—On-site segment precasting.*

*Fig. 3—Precast segments are match cast.*

## ON-SITE SEGMENT PRECASTING

Besides the removed limitation on the base diameter and corresponding tower height, additional benefits to on-site concrete precasting includes the use of local labor and locally sourced materials such as reinforcing steel, aggregates, cement, and admixtures. Further cost-saving opportunities can exist when the foundation contractor and concrete tower contractor can coordinate to source materials from the same batch plant.

To achieve the required speed of construction, the concrete tower segments are match cast together, resulting in a tight fit between segments when installed. The geometry of the tower is therefore largely set in the casting yard with minor provisions for alignment adjustments during erection.

## CAST-IN-PLACE FOUNDATION

The cast-in-place foundation for the tower incorporates an annular pedestal wall that enables the precast tower to connect to the foundation using a grouted joint to provide a uniform transition of forces across this joint. The connection, located close to ground level, is the only grouted joint in the tower.

The concrete tower weight exceeds that of a steel tower for the equivalent load-carrying capacity, thus reducing

*Fig. 4—Cast-in-place foundation.*

overturning moments and resulting in a reduction in foundation quantities for a concrete tower in comparison to that for a steel tower. The precast tower system is installed onto the foundation's pedestal wall and secured to the foundation using post-tensioning. This connection has benefits over steel tower connections, whereby mechanical anchor bolts through the steel flange plates, reducing future maintenance of these mechanical components.

## INSTALLATION OF TOWER SEGMENTS

With wind towers increasing in height and carrying larger rotors and turbines, innovative concrete tower designs and construction techniques are becoming increasingly important.

The precast segmental tower solution is changing the wind industry's landscape. During the development of the WTT/Siemens solution, the importance of construction speed is critical. The use of match-cast segments greatly expedited the stacking of segments (Fig. 5).

The concrete tower design was stepped to optimize the use of formwork. The transition from concrete to a steel tip adaptor near the top of the tower allows for a standardized steel top section for the yaw attachment and cabling platforms.

## POST-TENSIONING

The 19-strand external tendons located around the perimeter of the tower run the full height of the concrete

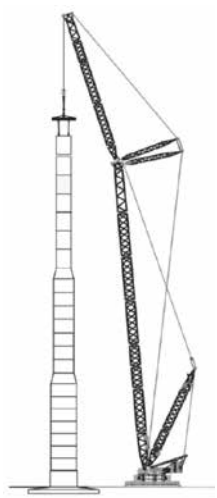

*Fig. 5—Precast segmental tower erection.*

*Fig. 6—Stepped concrete tower design.*

*Fig. 7—Nineteen-strand external tendons around perimeter of tower.*

*Fig. 8—Prefabricated tendons shipped to site ready for installation.*

tower. This configuration provided the design team and contractor with the ability to stack all segments prior to installing and stressing the tendons. Taking this operation off the critical path resulted in significant savings of time and took the post-tensioning off the critical path of the crane activities.

Each tendon was prefabricated offsite and delivered to the wind farm protected from the environment and ready to install and stress (Fig. 8).

## VIEWS FROM THE TOP OF TOWER

**Location**: Adams County, IA
**Owner:** MidAmerican Energy Company
**Architect:** Wind Tower Technologies, LLC
**Engineer:** Wind Tower Technologies, LLC
**Contractor:** (1) Siemens Wind Energy (2) Baker Concrete
**PT Supplier:** Schwager Davis
**Other Contributors:** EFCO Forms, Thornton Tomasetti Engineers, International Bridge Technologies
**Submitted by:** Wind Tower Technologies, LLC

**Jury Comments:**

- This project displays a unique and potentially game-changing use of post-tensioning for wind tower applications.
- This project has the potential to shed some light on a new market for post-tensioning in wind towers.
- This is a trend-setting structure in the United States.