The power of OPEN BIM in the face of tight deadlines

Architect: Douglas Muir | Structural Engineer: Mark Flamer

Urban plan for Taichung City in Taiwan

In 2010, Taiwan approved a new urban plan for Taichung City. Part of this plan included a new landmark in the form of a building tower. Designers from all over the world entered the Taiwan Tower International Design Competition in the hopes of winning the commission. The design team of architect Douglas Muir, RA, BArch, NCARB and structural engineer Mark Flamer, PE decided to take part in this competition even though they were up against a tight deadline and larger competitors.
Mega project with a tight deadline

The guidelines included a construction budget of US$220 million. The structure was to include a city museum at the ground level, an observation deck, a restaurant, and an environmental monitoring station at the top level. It was required that the structure be the tallest in central Taiwan; therefore, the minimum height requirement was 300m (984 feet). This included designing for typhoon level winds of +499.2 kg/m², -748.8 kg/m² at the top of the tower. The deadline for this submission was just four weeks, and neither of the team members could dedicate full-time to the project.
OPEN BIM approach

Because of the tight project deadlines and the close coordination the project required, the team choose an Open BIM design approach. Open BIM is a model-based design approach based on the Industrial Foundation Class or IFC model exchange format. Choosing an Open BIM approach meant that Flamer and Muir could choose to use whatever software they felt would work best for their respective part of the design process, and not be forced into a single vendor’s software program. Exchanging models as IFC files made it easy for Flamer to leverage Muir’s architectural model into engineering, and pass it back to Muir, who optimized Scia Engineer structural models that he could incorporate into the final design in ArchiCAD. It also made it easy to manage design changes, which was important for Flamer and Muir, who worked incrementally all the way through to the final design. Despite the complexity and the large size of the files, they did not experience any problems with the structural-architectural collaboration. The entire final project documentation, including rendering images and drawings of the structural system, was created by the architect.
Driven by inspiration

Using GRAPHISOFT’s ArchiCAD, Muir’s design merged science and art. His inspiration for the project was drawn from both mathematical forms as well as floral shapes. Sustainability was also an important component. The shape was conducive to providing smooth airflow to harvest wind energy. The team investigated various configurations for the structure of the tower’s shaft and discovered that the five-tube configuration provided the best combination of permeability, integral shafts, and structural support. Coiled tubes were to wrap the core in one complete, 360 degree rotation.

Dimensions of the tubes were determined by the requirements of the egress stairs, elevators, and structural components. The structural system was primarily comprised of four steel framed tubes, 7 meters in diameter, which spiral around an 8 meter circular concrete core. Each tube was composed of round steel pipes in a diagrid pattern rotated around the core, completing a full 360 degrees of rotation over 240 meters of rise in elevation. Outrigger trusses would transfer lateral loads from the central core to the exterior tubes for the full height of the tower. Using the exterior tubes in conjunction with the concrete core greatly increased the lateral stiffness. Torsion induced on the core would be offset by a continuous truss, which connected the tubes to each other and allowed the four individual tubes to work as a single unit. The base would consist of five occupied floors, and the top would consist of seven occupied floors supported by composite slabs on a steel beam and girder system. A mat slab on drilled piers provided the foundational support.
Unique workflow

It is typically the architect who builds the initial model and sends it to the engineer for design of structural elements. However, the exposed steel and the complexity of the tower required that the structure be modeled first. "Without the flexibility and scalability of Scia Engineer, we would not have been able to meet this deadline," Flamer said. He was able to analyze and design for gravity loads and seismic loads including dynamic analysis, and wind loads. After optimizing the model, he sent it to the architect via IFC. Muir was then able to use ArchiCAD to complete the architectural design and detailing. While Muir and Flamer did not win this competition, they took collaboration to new heights and truly worked as a team. Using Open BIM allowed them to create a unique 3D workflow, collaborate on the complex design, and integrate architecture and engineering. Muir and Flamer met the requirements of the competition and made the deadline. They submitted their design in just three weeks.

Design Competition Details:

- City museum on the ground level
- Restaurant, observation deck and environmental monitoring station at the top level
- 300m minimum height (984 feet)
- Typhoon Level Wind = +499.2 kg/m2, -748.8 kg/m2.
- US$220million budget
- Three-week deadline

Mark Flamer, PE
Mark Flamer has worked in the AEC industry for over 15 years. He is a General Building Contractor and Registered Engineer. Mark now works for Vectorworks as a software engineer, leveraging his AEC experience to create software for the design of smarter, more efficient buildings.

Douglas Muir, RA, BArch, NCARB
Mr. Muir has been practicing architecture in New York for over twenty years. His experience includes Healthcare, Education, Commercial, Residential and Cultural work. Notable projects in recent years included involvement with the renovation and addition to Alice Tully Hall and Julliard School of Music at Lincoln Center in Manhattan with FXF and DS+R and a 500-bed hospital in New Jersey.

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