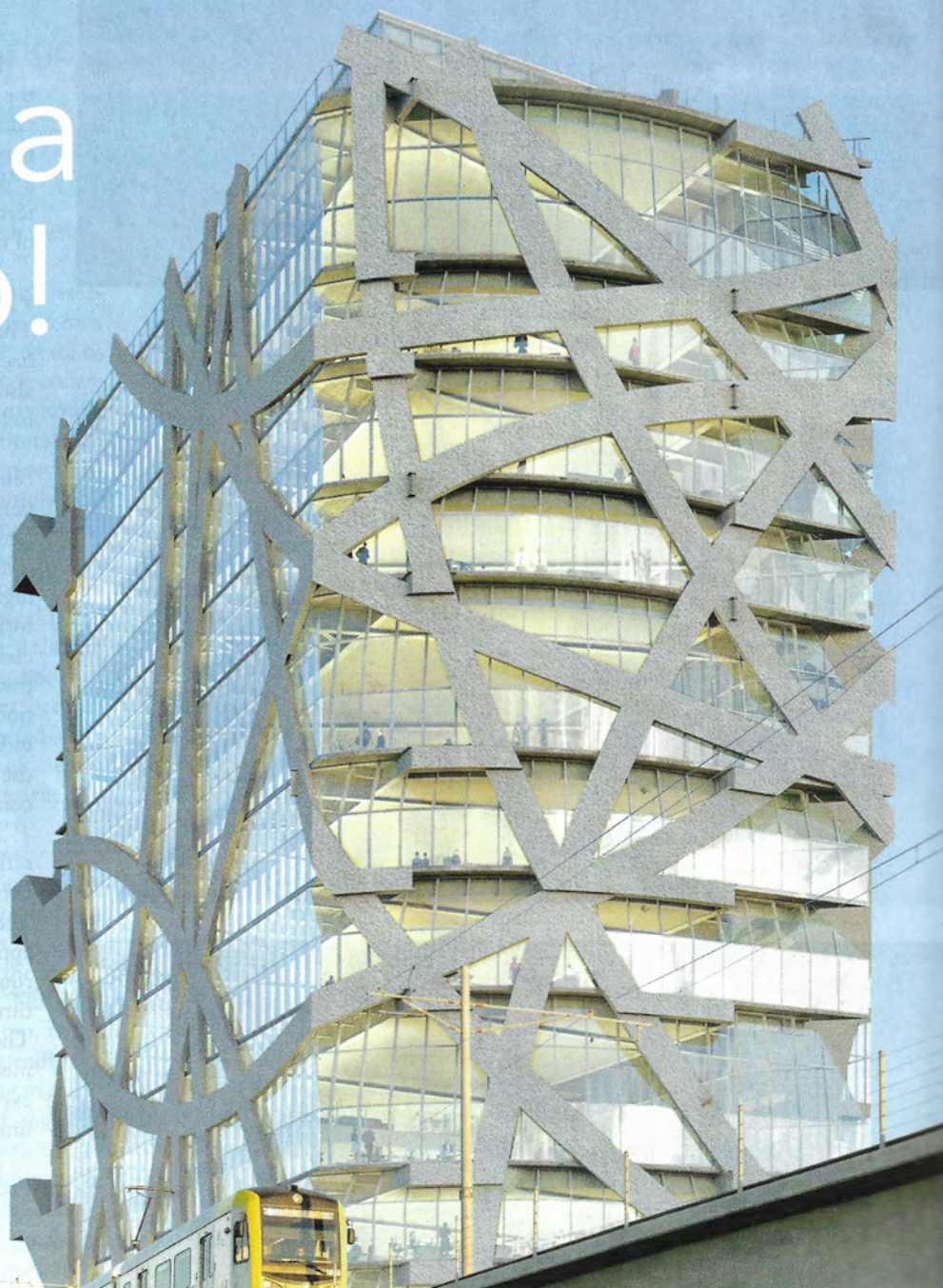


That's a (W)rap!

BY TYLER HOLKE, PE, AND
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Steel bands define and
support a new Southern
California office tower.



opposite page: The 17-story (W)rapper office tower in Los Angeles is defined by its steel helical band exoskeleton.

below: The typical exterior band is a built-up box section with a continuous intermediate longitudinal stiffener.



All images courtesy of Hassett Engineering unless otherwise noted.

THE (W)RAPPER in Los Angeles certainly lives up to its name.

Designed by Eric Owen Moss Architects and structural engineer Arup, with MATT Construction and Stegeman and Kastner providing general contractor/construction management services, the 17-story office tower is, well, wrapped by a helical band exoskeleton made from built-up steel box sections that are coated with a cementitious fireproofing. The project employed a design-assist project delivery methodology, which was particularly important thanks to the complicated design and erection methodology. Scheduled to be completed in September, the structure was permitted as a performance-based design and went through a peer-review process due to the unconventional band frame system, which was designed as part of the seismic force-resisting system, and the use of base isolators.

Building Design

Steel doesn't just wrap the building's exterior but also its core. It employs a special steel plate shear wall (SPSW) core that connects to the slab-on-metal-deck floors via steel girders and horizontal bracing, resulting in column-free tenant space; the core is approximately 60 ft by 60 ft, and the typical floor size is 60 ft by 185 ft. The structure is also base-isolated, supported at 20 locations on triple-pendulum bearings manufactured by Earthquake Protection Systems. The west end of the building hangs from the band continuity above, arranged in such a way that rendering the structure self-supporting only after it was completely erected and welded.

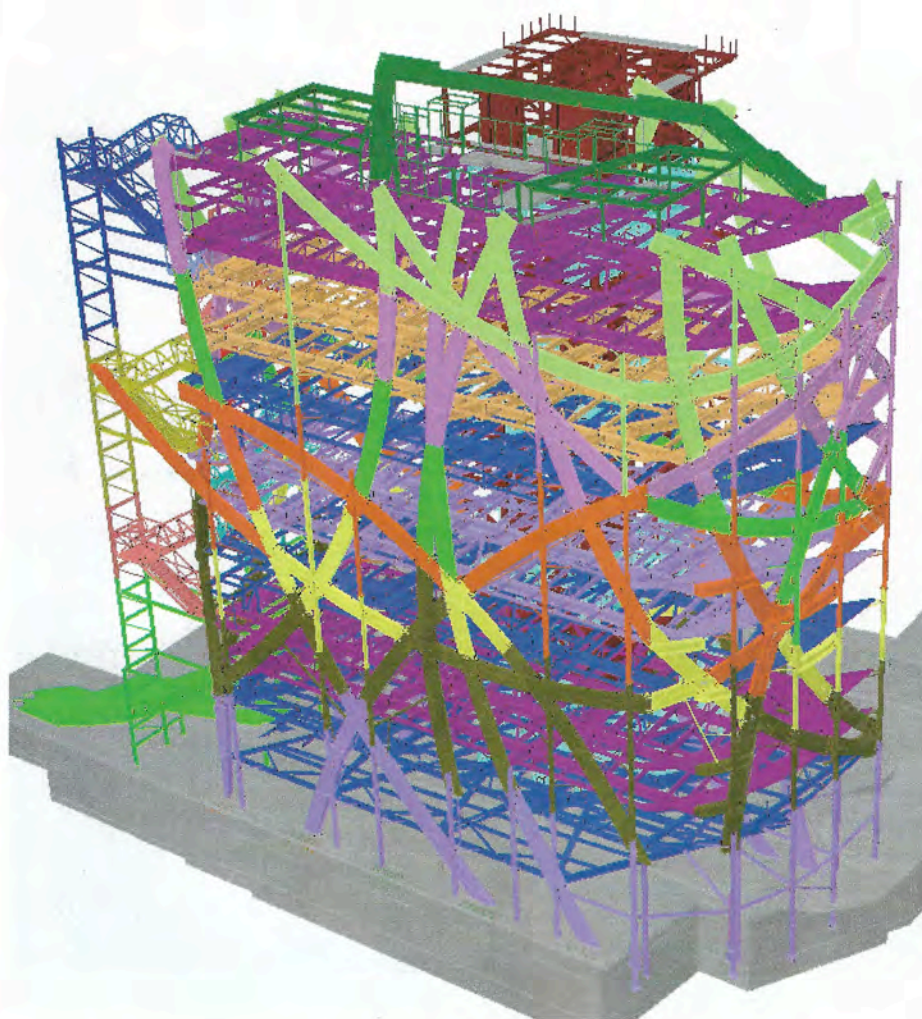
The typical exterior band is a built-up box section with a continuous intermediate longitudinal stiffener. The box cross sections

are 24 in. by 60 in. up to the second level and 12 in. by 60 in. above, with wall thickness varying from 1 in. to 2.5 in. The intersections of the bands at the building's corners, known as "spines," are framed with solid 12-in.-thick plates that accommodate the connections with bands joining from orthogonal sides. The tallest spine—64 ft—required both a shop and field splicing due to its weight (34 tons) as well as erection logistics. The building uses more than 6,300 tons of structural steel in all.

Erection Planning

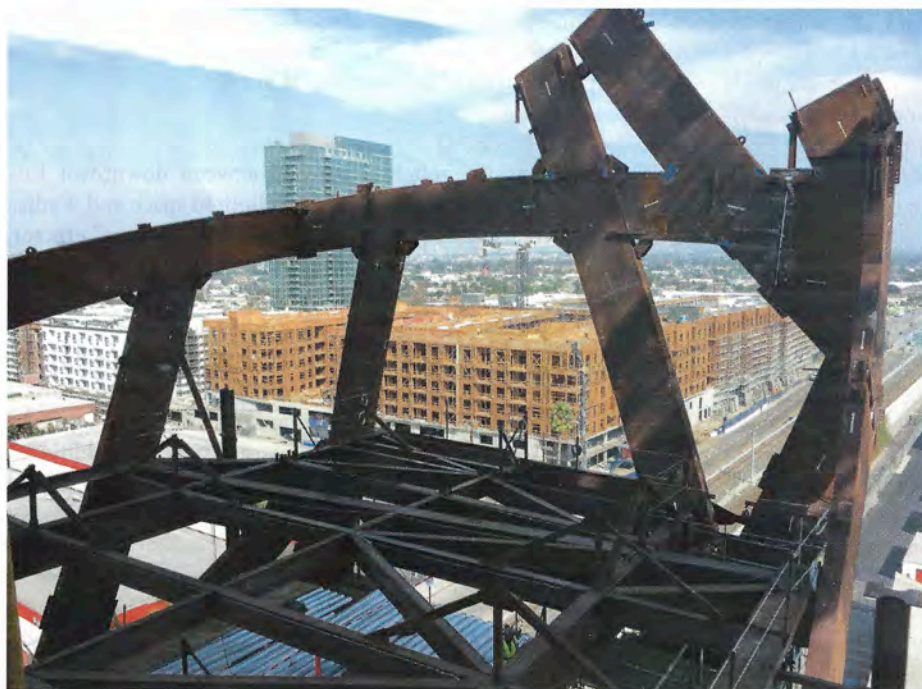
The building site, roughly halfway between downtown Los Angeles and Santa Monica, has relatively limited space and is adjacent to busy streets. SME, the project's steel fabricator and erector, selected a Wolff tower crane to pick and set the heavy band segments, and multiple assist cranes were used to construct the tower crane as well as for setting particularly heavy and far-reaching assemblies (the most critical lift spanned 130 ft and weighed 44 tons). Erection engineer Hassett Engineering performed analysis for the multiple hydraulic cranes moving in and out on the ground floor podium slab and designed slab reinforcement and additional shoring so that a 500-ton Grove crane and other cranes could be driven onto the site's parking garage and operate in a mega-wing configuration (a boom attachment that provides increased capacity) to assemble the tower crane.

The team knew from the outset that the structure would need to be supported by temporary framing until it was nearly completed. The exoskeleton had to be completely constructed for the load path to be established and the structure to be stable. The challenge



above: A 3D model indicating final and temporary structural members colored-coded by erection sequence.

below: Band erection at levels 8 through 11 on the east side of the building.



for Hassett and SME was to strategically place the temporary framing and sequence the erection to minimize the number of temporary supports. The band segments that support the office floor framing are sloping and nonuniformly spaced and do not follow a conventional grid—and without shoring, many of the band segments would be unstable during erection until connected to the neighboring bands, some of which had not yet been erected.

Therefore, the temporary supports were dictated by the locations of the band splices. These splices were proposed by Hassett, reviewed by SME for weight and shipping constraints, and confirmed acceptable by Arup. The constructability and acceptability review took place for every splice on all 145 band assemblies, and the ideal splice location for one party was not always approved by the others. Certain bands could not be spliced at intersections due to the primary load path, and other band splices had to be welded on-site prior to lifting due to shipping limits and erection stability requirements. To minimize fit-up problems during erection, SME fit up the band segments in its shop and preassembled them as part of the fabrication process. Following preassembly, the erection planners directed the detailers to locate survey targets to be placed by the shop at the band intersections and on each face at each end of each band segment. The coordinates of the targets were then used to monitor locations at the time of erection as well as subsequent phases of erection.

Early in the planning phase, Hassett established the erection procedure as a two-story, tier-by tier scheme, with the slabs of the two erected floors being poured and cured prior to erecting the subsequent tier. This procedure stabilized the bands against significant lateral displacement after welding. Further, the team performed surveys after each tier floor slab was placed, allowing the erection crews to make fine adjustments to the erection of the subsequent tier of bands. Additionally, having the floor slab in place gave SME a platform for its boom lifts, which provided safe access to the band splice connections and temporary columns and beams prior to releasing the members from the crane.

Hassett's erection bracing drawings included 3D renderings of the partially

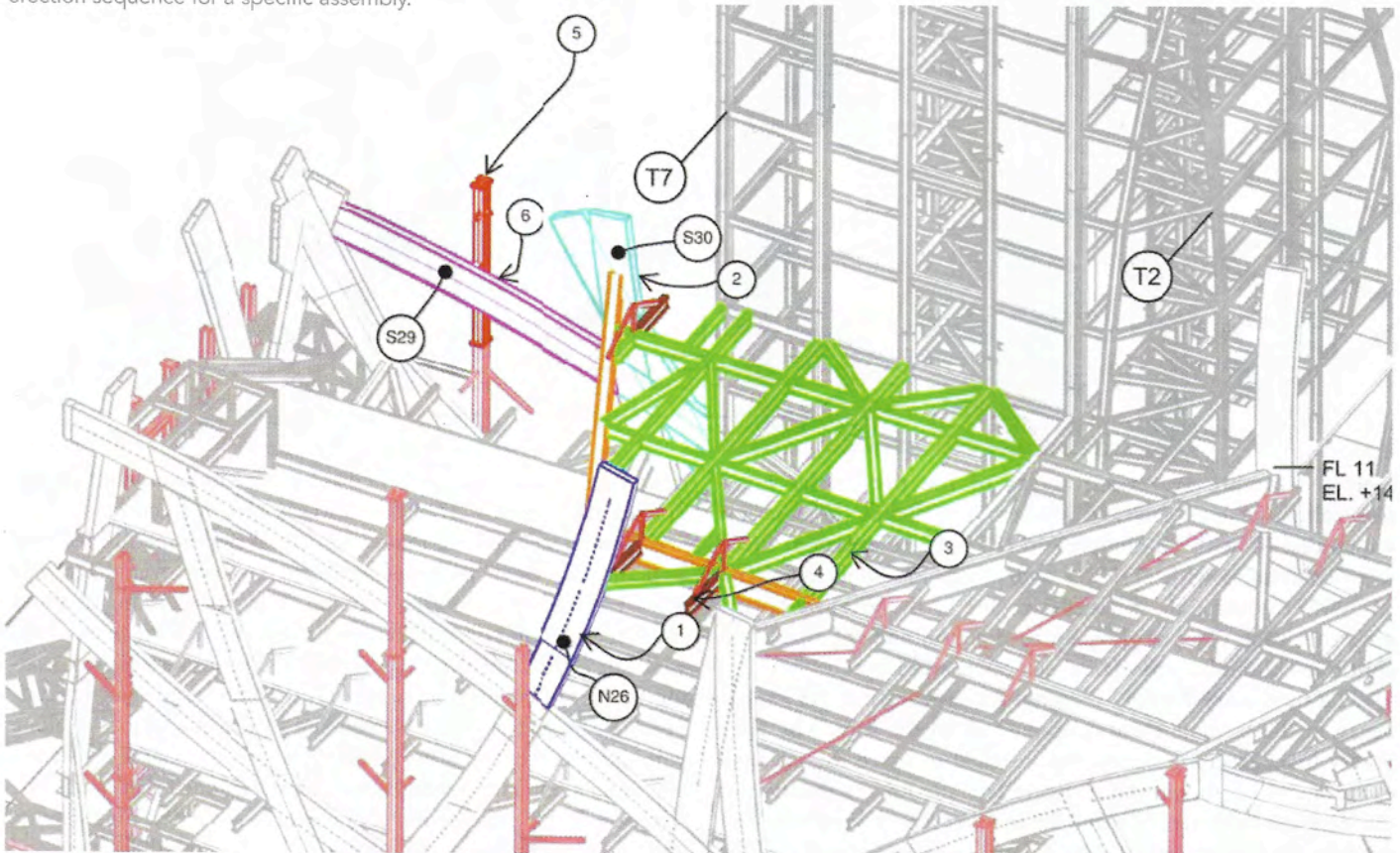


above: Lifting a band assembly, the heaviest of which was 44 tons.

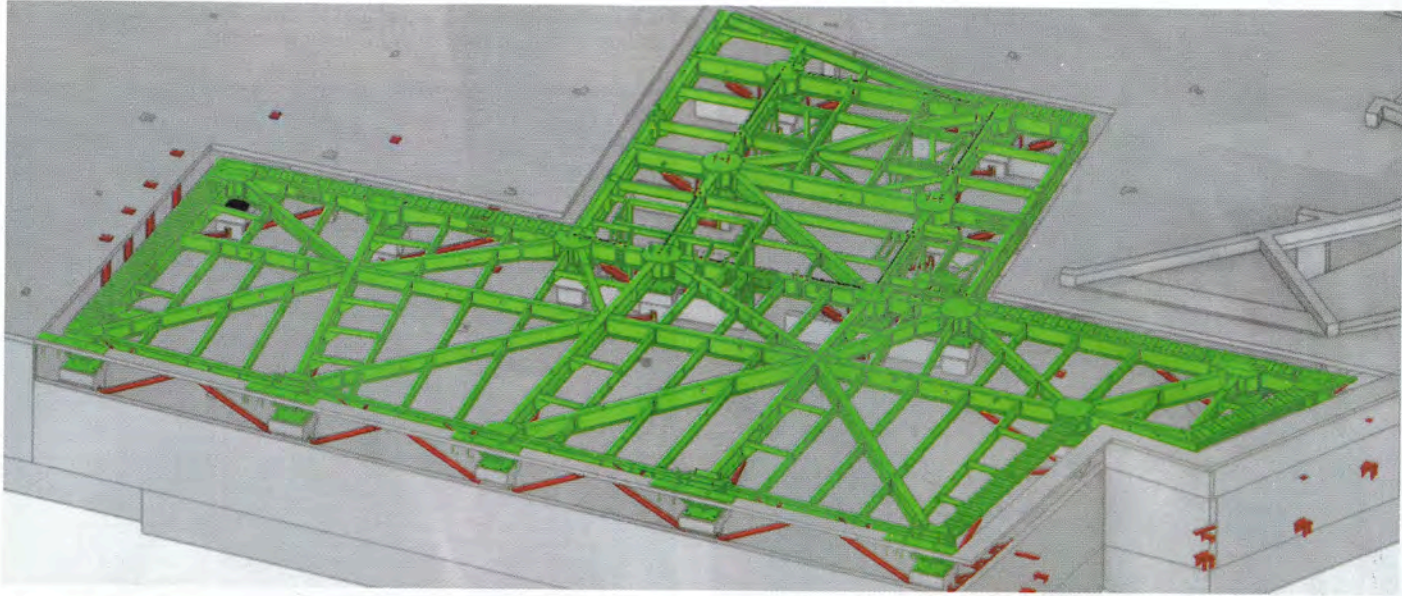
below: An erection model showing temporary columns and the erection sequence for a specific assembly.



above: A "birds beak" band assembly erected onto temporary columns on the west side of the building.



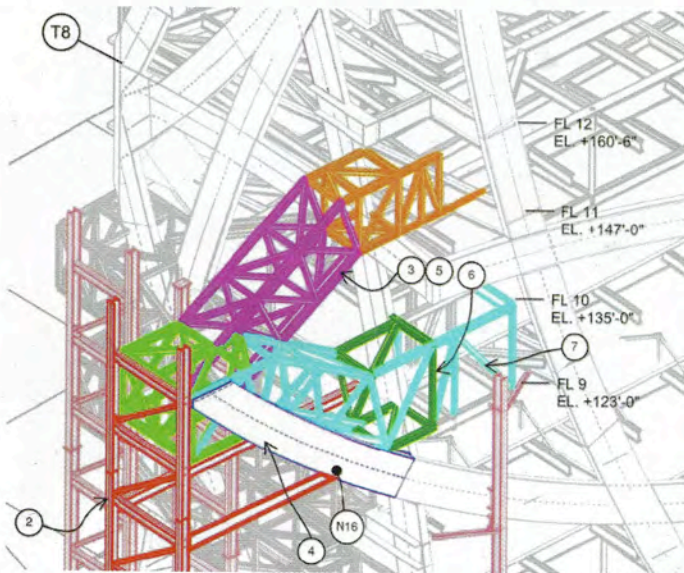
opposite page: Band assemblies and temporary shores on the building's north side.



above: Base level framing and isolator bracing (the latter is shown in red).

right: A temporary column jack. The jacking system allowed for the synchronized lowering of the structure in predetermined stages.

below: A model of the stair erection sequence and shoring from Hassett Engineering's erection procedures.



the field construction crews were more confident in the engineered bracing plans, resulting in minimal delays (after confirming no negative effects from either earthquake) before resuming construction.

To resolve the gravity demands, the team implemented 14 temporary columns to keep stable elevations while erecting the bands. These temporary columns were erected in two- to three-floor tiers along with the structure and continued up the structure as required to support band segments. Five temporary columns supported the hanging west side of the structure, with the remaining nine temporary columns holding the sloping bands at the correct elevation and location until the surrounding bands could be erected. These temporary columns, with the heaviest being a W14×311, were attached to the exterior face of the band using extended shear plates with long slots. These slots allowed for adjustments to be

made at the connection of each individual band to the temporary columns during erection without needing to jack the entire column, and the shores remained in place and attached to the bands for the duration of steel erection. In addition to the temporary framing, six "ladder frame" shores were used to erect the east stair, which cantilevers as much as 37 ft outside the primary structure. These shores also were continuous and connected to the stair cantilevers with typical shear tabs.

De-shoring Procedure

Once erection and welding were completed and the slabs were poured, the temporary column shores were sequentially lowered from their bases and disconnected from the bands in stages. SME accomplished de-shoring by using two digital hydraulic manifolds



left and below: Early in the planning phase, Hassett established the erection procedure as a two-story, tier-by tier scheme, with the slabs of the two erected floors being poured and cured prior to erecting the subsequent tier. This procedure stabilized the bands against significant lateral displacement following welding.



that controlled 26 jacks at 13 ground level temporary column bases. This jacking system allowed for the synchronized lowering of the structure in predetermined stages, and the de-shoring process used the extended shear plate connections to release selected band-to-temporary-column connections at specific stages of jacking down. Each shear connection was to be released when the shear load predicted by Hassett's SAP2000 analysis model was at a minimum, and the bases of the temporary columns were predicted to deflect between $\frac{3}{8}$ in. to 2 in. After complete unloading, the actual magnitudes were very close to the predicted values.

Owners Frederick and Laurie Samitaur Smith, founders of Samitaur Constructs, had a vision to create a building that coupled innovation with a column-free office space supported by an unorthodox and visually stunning exterior bracing system—and the design and construction team delivered. Thanks to this effort, L.A. now has a new A-list tower that draws the eye and demonstrates a sculptural and practical use of steel framing. ■

Owner

Samitaur Constructs

General Contractor

MATT Construction

Construction Manager

Stegeman and Kastner, Inc.

Architect

Eric Owen Moss Architects


Structural Engineer

Arup

Erection Engineer

Hassett Engineering

Steel Fabricator and Erector

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