# Modern Steel Construction

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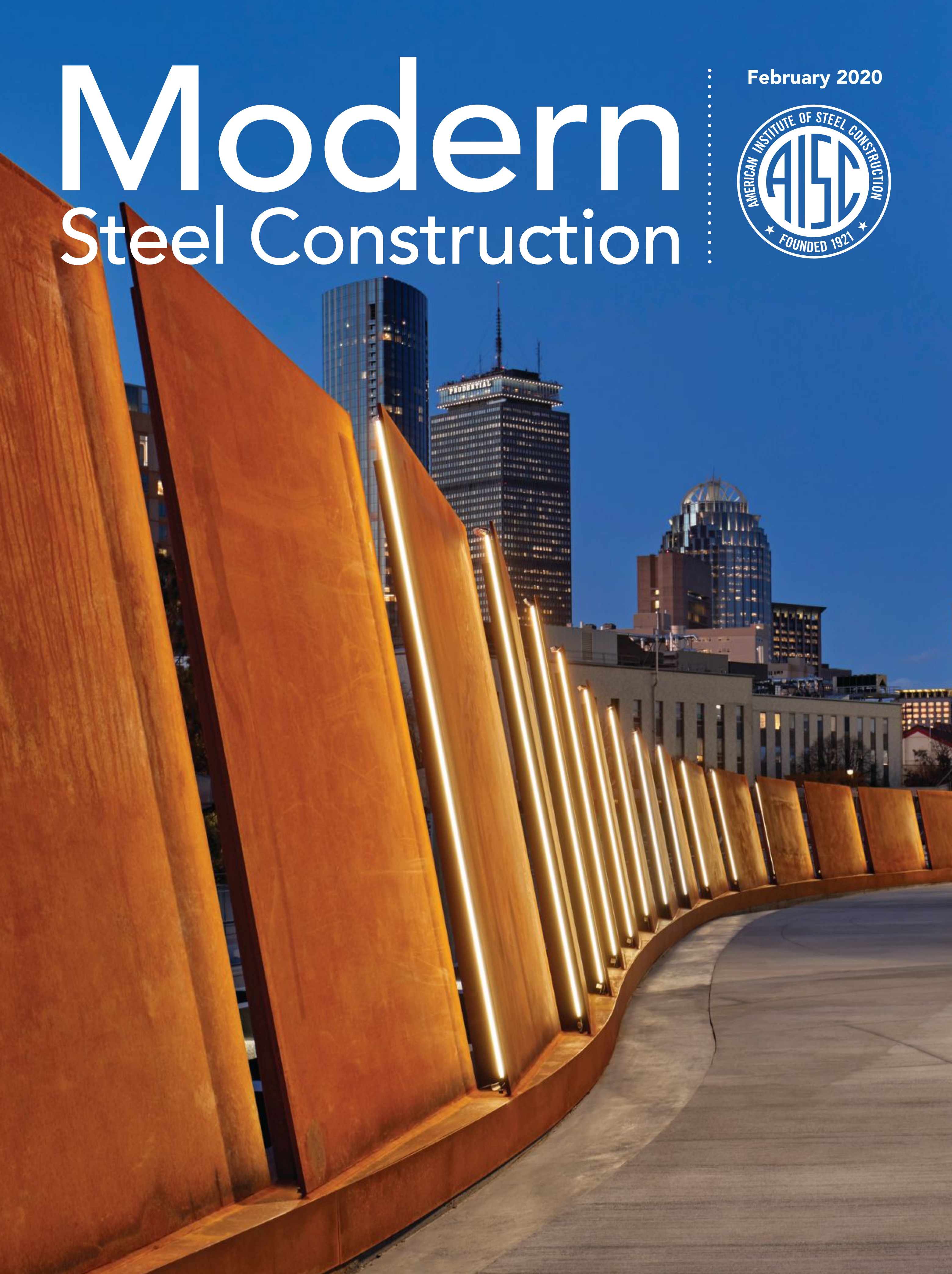


Thanks to an innovative detailing and design process, a massive new steel-framed cruise terminal in Miami will let passengers set sail in style.

All photos courtesy of Anatomic Iron Steel Detailing

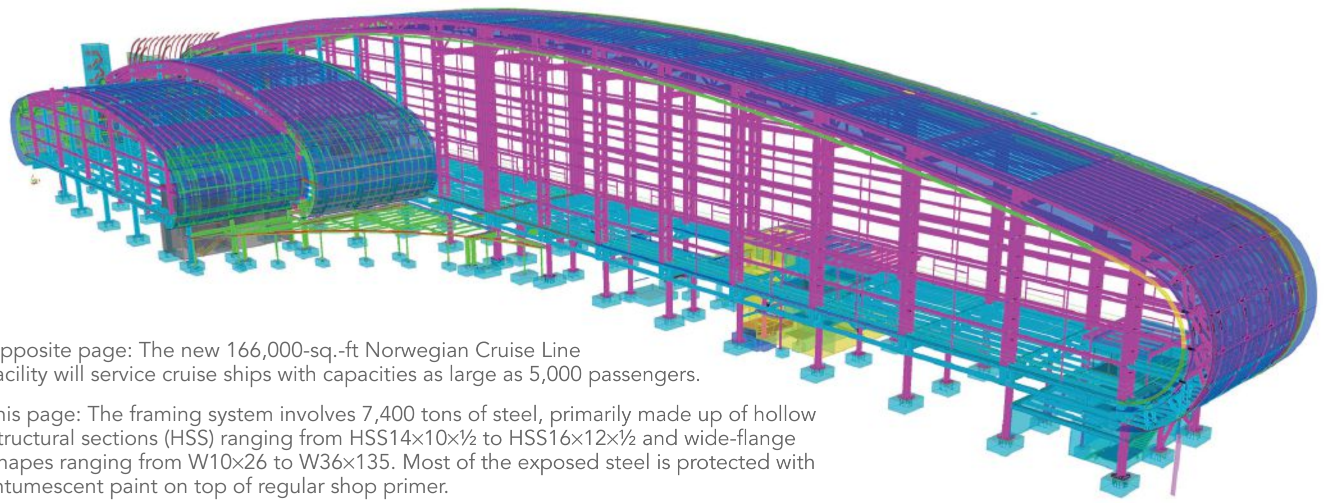
# Steel Sendoff

BY CLIFF YOUNG AND TOUAN PLANTE

**LANDLUBBERS WILL SOON** be able to embark on high-seas adventures from a curvaceous new cruise line terminal in Miami.

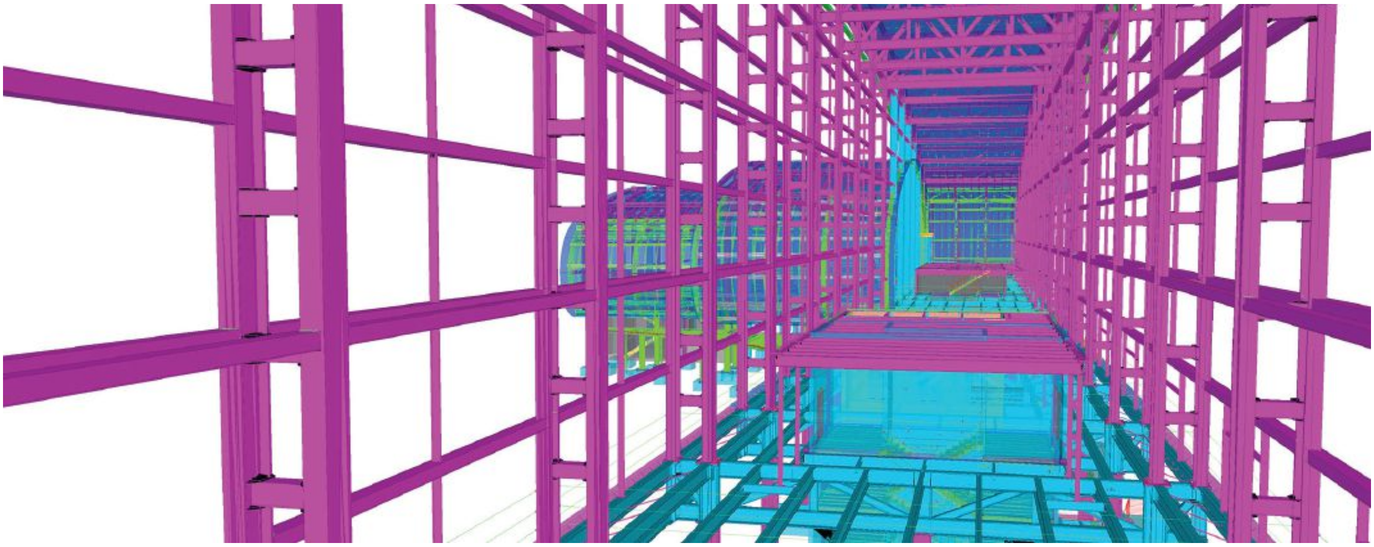
Currently under construction on Dodge Island between downtown Miami and Miami Beach, the 166,000-sq.-ft Norwegian Cruise Line facility will service cruise ships with capacities as large as 5,000 passengers. A joint venture of the Haskell Company and NV2A, the new cruise terminal's main building, adjacent to its current terminal, is composed of three unique domes, known as "pearls," positioned side-by-side and inspired by the shape of a nautilus. The curvaceous building is 128 ft tall at its peak and 800 ft long, comprising a total of 166,500 sq. ft. It's framed with 7,400 tons of steel, mostly made up of hollow structural sections (HSS) ranging from HSS14×10×½ to HSS16×12×½ and wide-flange shapes ranging from W10×26 to W36×135. (Haskell also served as the project's fabricator and transported the steel from its Jacksonville, Fla., facility to Miami via barge.)

"This is a very specialized steel project," says Mike Young, chairman of Anatomic. "The main building is very long and narrow, with massive rolled truss framing at both ends, each connecting seamlessly with the parabolic curved roof. Heavy mid-level trusses were incorporated into the design to accommodate the high loads generated by the building's dimensions and its location over the water."



opposite page: The new 166,000-sq.-ft Norwegian Cruise Line facility will service cruise ships with capacities as large as 5,000 passengers.

this page: The framing system involves 7,400 tons of steel, primarily made up of hollow structural sections (HSS) ranging from HSS14×10×½ to HSS16×12×½ and wide-flange shapes ranging from W10×26 to W36×135. Most of the exposed steel is protected with intumescent paint on top of regular shop primer.



## Detailing During Design

Construction began in September 2018 and the building is expected to open this spring. To meet this accelerated schedule, steel detailer Anatomic Iron Steel Detailing used the design detailing process—a model-based process it has developed that allows the engineer, fabricator, and architect to exchange Tekla models continually—to accelerate the delivery of fabrication and erection drawings by completing the detailing concurrently with the steel design.

The basis of the system is that the detailer works directly for the structural engineer and begins detailing when the project is only 50% designed. RFIs about steel conflicts and design issues are sent directly to the engineer inside the model via weekly GoTo-Meetings, resulting in issues that would typically become RFIs later in a traditional project instead being resolved during the design stage. In addition, the engineer approves the detailing model itself rather than issued-for-approval (IFA) drawings as the last step when the final design drawings are completed. As such, when the steel fabricator is selected, the detailer only needs to generate the for-fabrication drawings according to that fabricator's standards and thereby avoids the detailing or drawing approval process. This means the for-fabrication drawings are supplied within a matter of weeks rather than months, and fabrication thus starts months earlier.

"The terminal had to be designed, detailed, and fabricated by Haskell all at the same time, which is precisely what our design detailing process is for," says Anatomic project manager Kerry Young. "Norwegian had already scheduled cruises and if the terminal were not to open on time, the cruise ships would have no place to dock. At the beginning of the project, we were supplying advance bills of material for Haskell and determining the roof geometry and detailing based only on concept drawings that weren't yet final IFC [issued-for-construction] design drawings. Later, while it was being erected, DDA and Martin/Martin [structural engineer and connection designer, respectively] were still designing, and we were following along with the final detailing scope and final fabrication drawings."

**Cliff Young** (cliff@anatomiciron.com) is CFO and vice president of Anatomic Iron Steel Detailing, and **Touan Plante** (touan.plante@haskell.com) is a senior project manager with the Haskell Company.

As lay-down area at the site was limited on a small island bustling with cruise-related traffic, up to three cranes at a time were used to erect the steel at various points during the schedule.


According to Kerry Young, this made it much easier to solve problems and communicate throughout the project, as a design team would typically need four to eight months to design and submit IFC drawings on a project of this scope, then the detailer would need at least another eight weeks to prepare the first submittal of drawings for approval. "Under the design detailing process on Norwegian, we squashed them all together," he notes. "Thereby, the design and detailing were completed all at the same time, saving at least five months of construction time."

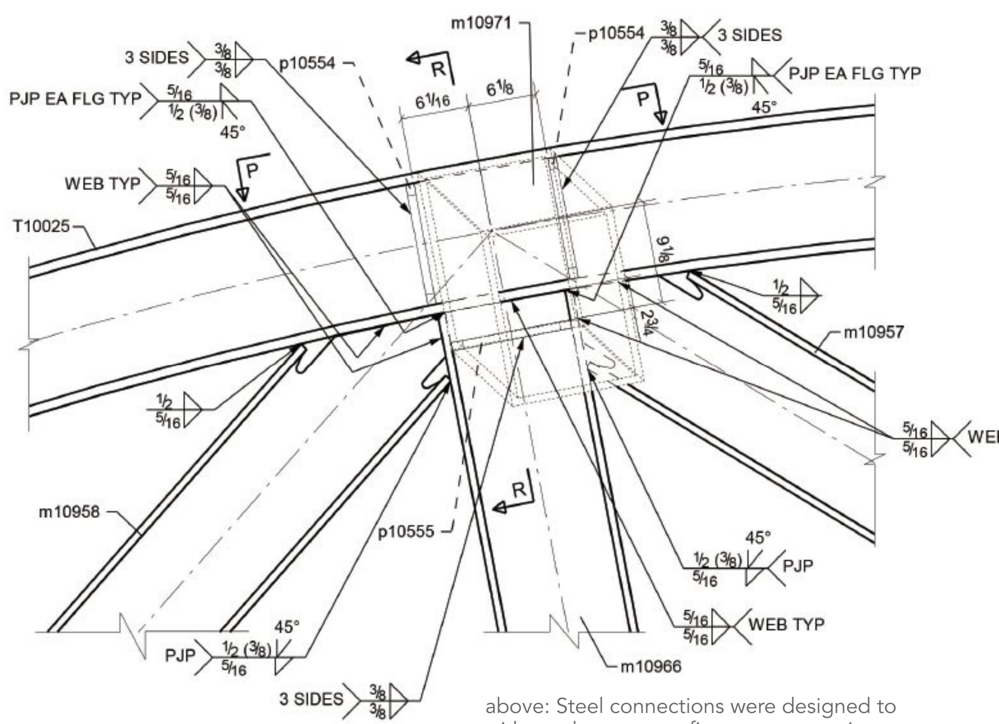
During the project, Anatomic further refined the process to help solve field issues that occur when designing and erecting a structure at the same time. Kerry Young anticipates that the design detailing process on design-build projects will be used more in the future. "If you have the detailer working directly with the design team, the direct line of communication gets easier," he says. "You can get a building standing a lot faster without dealing with RFI's which always slow the project down. We just work together as one company. We can help engineers uncover a lot of potential problems before the design drawings get to the rest of the construction team."

## Keeping the Roof on

Wind loading was determined via wind tunnel testing and analysis by the wind consultant RWDI, and the terminal uses a 3D rigid frame structure to resist hurricane-force wind loads. Both the radiused end caps and the junctions between each of the three pearls provide regions of increased strength and stiffness that were used to realize efficiencies throughout the entire structure. The combination of multidirectional loading, participation in lateral resistance by many elements, and curved geometry created numerous highly atypical connections.

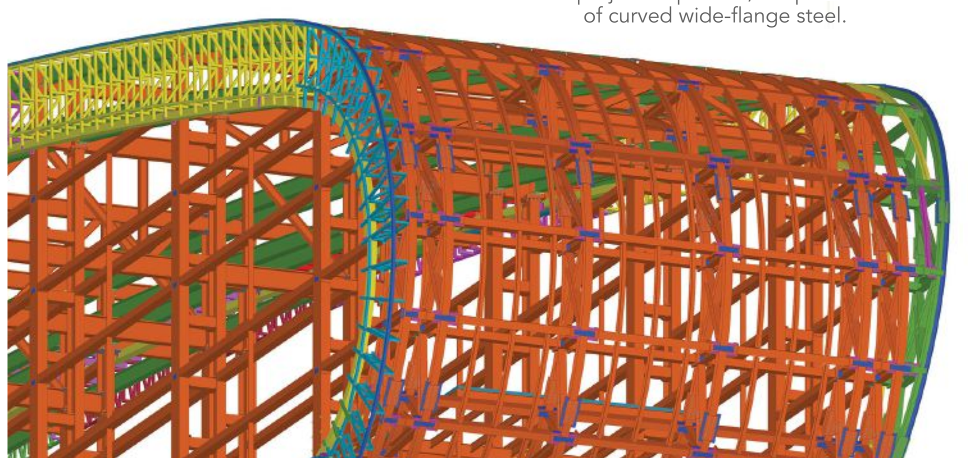
In addition, the pearls' volumes are relatively empty compared to a typical building. The main building has a single main floor plus a small VIP mezzanine 27 ft above. "The building as a whole is mostly air inside," explains Eric Sobel, an associate with Martin/Martin Engineers. "The wind load really dominates the behavior of the building."

For a large, airy glass- and architectural metal-clad building in Miami, where hurricanes and tropical storms are common, his main goal was simple.

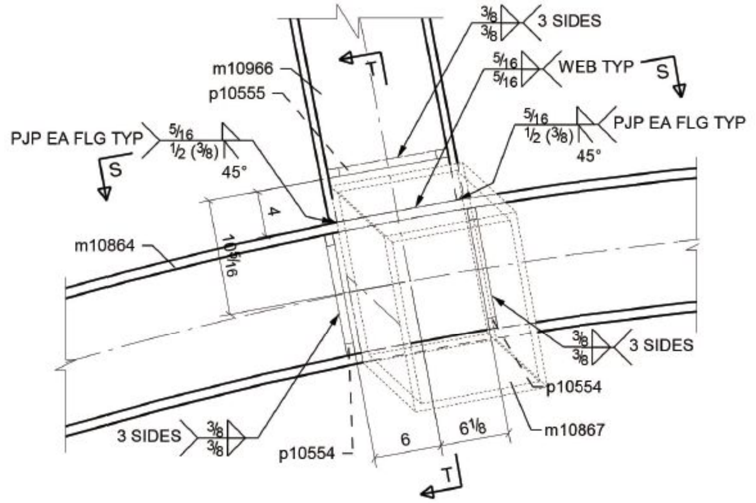


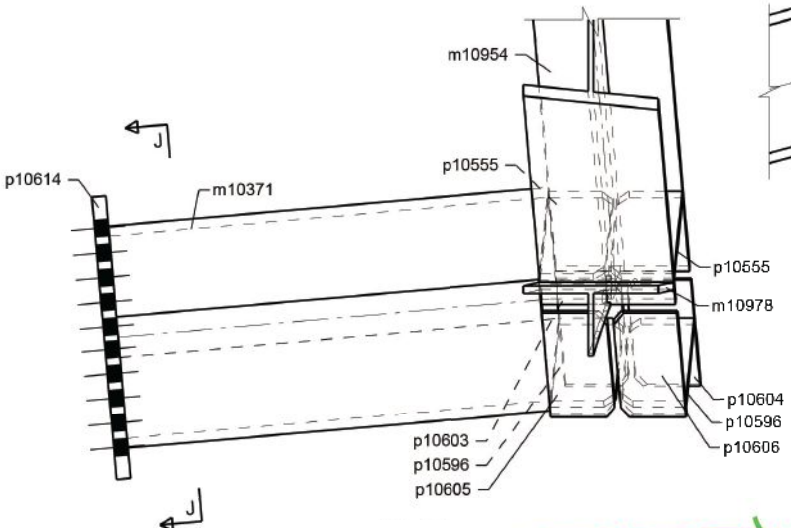

above: Steel connections were designed to withstand a category five storm, meaning sustained winds of 156 mph or greater.

below: The project required 1,500 pieces of curved wide-flange steel.

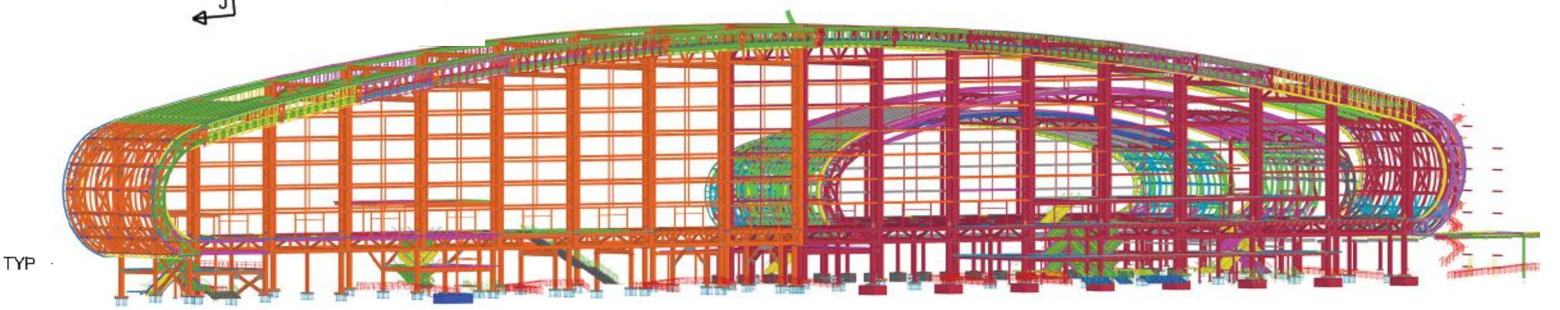


right and below:
Example connection details for some of the truss framing connections.




below: The main building has a single main floor plus a small VIP mezzanine 27 ft above. According to Eric Sobel with Martin/Martin Engineers, the building is mostly air inside and the wind dominates the structure's behavior.



"Make sure the roof wouldn't get torn off the building," he says. "Related to that, the wind exerts a force to the sides of the building. Keeping the building from cracking or falling over is another design consideration."

This required Martin/Martin to design connections that would withstand a category five storm, meaning sustained winds of 156 mph or greater.

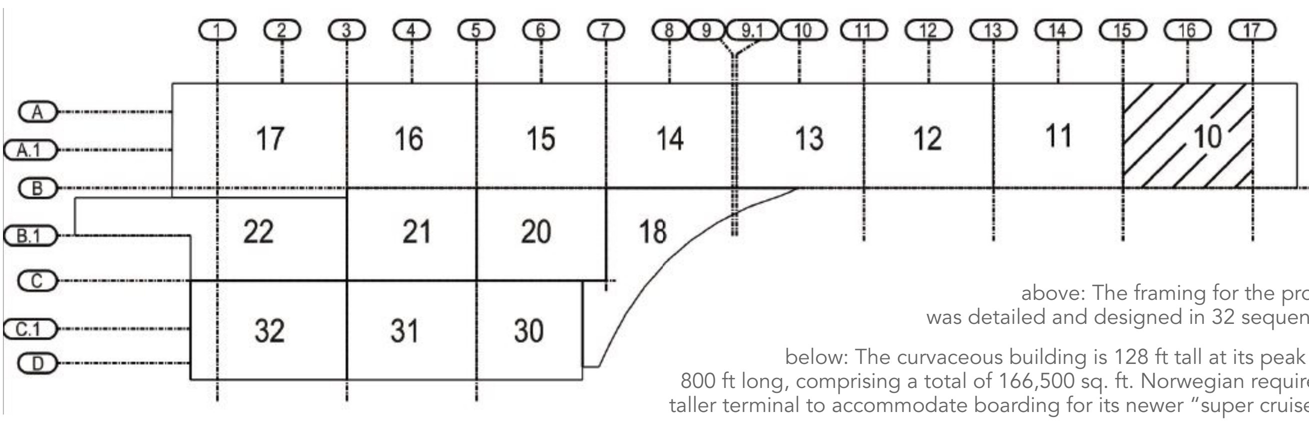
"The building has nice geometric lines to it," Sobel says. "The glass walls connect to the curve of the roof. There were a lot more details than if it was a box building or a building with fewer curves facing each other."

## By Land and Sea

Given the sheer size of the building, transporting the massive columns and trusses was challenging. Some of the columns are over 50 tons each, and the roof trusses measure 20 ft by 85 ft at 55 tons each.

These roof trusses were fabricated at Haskell's plant up the Florida coast in Jacksonville, put on barges, and shipped down the Intracoastal Waterway to Miami—two trips with four trusses each. Due to seawall issues and the fact that no cranes were allowed between the project site and the water, the barges were unloaded on the cargo side of the port, almost directly across from the project site. From there, the steel assemblies were transported to a storage yard directly across the street from the site, then brought to the site individually when they were ready to be erected.

The project also incorporated 1,500 pieces of curved wide-flange steel, which required the services of multiple bender-roller companies, including Chicago Metal Rolled Products and




above: The framing for the project was detailed and designed in 32 sequences.

below: The curvaceous building is 128 ft tall at its peak and 800 ft long, comprising a total of 166,500 sq. ft. Norwegian required a taller terminal to accommodate boarding for its newer "super cruisers."

Whitefab. As lay-down area was limited on a small island bustling with cruise-related traffic, up to three cranes at a time were used to erect the steel at various points throughout the schedule.

Now topped out, the huge yet light structure is in the final stages of construction and is expected to open in time for the summer cruise season. The eye-catching design and floating appearance will provide the perfect introduction to seafaring travelers, as the vast openness of the building's volume reflects and provides views of the open water itself.

The design, fabrication, and erection of the building were a great challenge, but all the team members pulled together to deliver a successful project to the owner and an amazing terminal from which to set sail. ■

**Owner**
Norwegian Cruise Line, Miami

**General Contractor**
The Haskell Company and NV2A, a Joint Venture

**Architect**
Bermello Ajamil and Partners, Inc., Miami

**Structural Engineer**
DDA Engineers, P.A., Miami

**Connection Designer**
Martin/Martin Consulting Engineers, Lakewood, Colo.

**Steel Team**

**Fabricator**
The Haskell Company, Jacksonville, Fla. (AISC Certified Fabricator)

**Erector**
LPR Construction Co., Loveland, Colo. (AISC Associate)

**Detailer**
Anatomic Iron Steel Detailing, North Vancouver, B.C. (AISC Detailer)

**Bender-Rollers**
Chicago Metal Rolled Products, Chicago (AISC Associate)
Whitefab, Birmingham, Ala. (AISC Associate)

above: A steel pedestrian bridge, delivered to the site in four segments, connects the new facility to an existing building.

right: Curved steel being shipped from bender-roller Chicago Metal Rolled Product's shop.

below: Support framing below one of the pearls.