An AISC member steel producer goes bigger than ever with its new coil mill in Texas.

Texas-Sized Steel

BY GEORGE R. BATCHA, IV, AND MICHAEL T. KEMPFERT

STEEL DYNAMICS, INC. (SDI) has built a Texas-sized new facility.

The AISC member producer's new steel mill in Sinton, Texas, roughly 10 miles north of Corpus Christi, is a sprawling complex that produces flat-rolled steel coils. At a cost of $1.9 billion, the new campus represents the largest construction project the company has ever undertaken. Consisting of a melt shop, hot mill, and cold mill complex, the mill was designed to greatly expand SDI's capacity to manufacture sheet steel.

When SDI approached CSD Structural Engineers to design the structures that would house and support their cranes and equipment, the latter's experienced team saw the project as an exciting opportunity.

"Engineers in our field have the chance to work on a project like this maybe once or twice in a career," said Mike Ryer, CSD's president. "It's a very interesting project full of big, complicated stuff—like putting a puzzle together in record time."

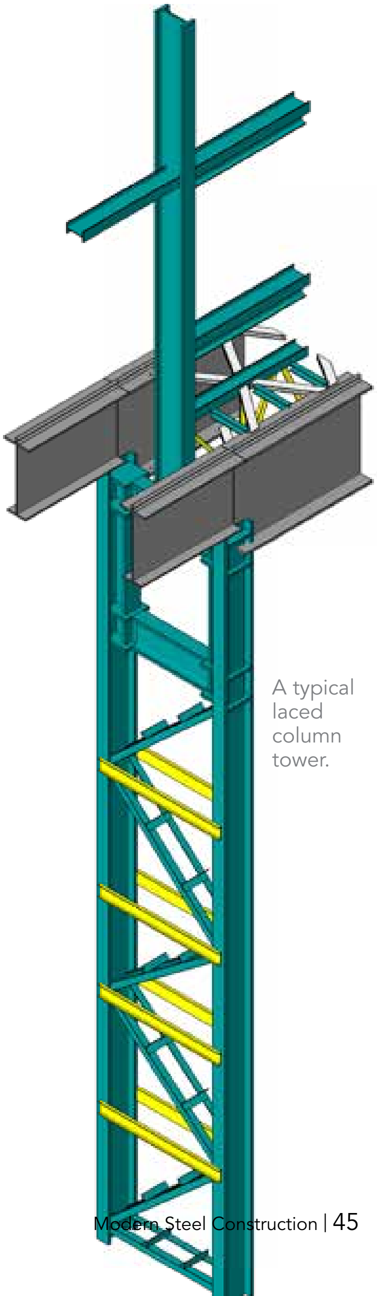
The project represented a collaboration of steel experts, both on the producing side and the structural design side. While SDI and CSD had collaborated on several projects in the past, the new mill presented an unprecedented challenge that pushed the engineering and project coordination expertise of the combined team to its limits. With a high level of complexity and an extremely aggressive schedule, it would take expertise, ingenuity, and the exceptional capabilities of structural steel to ensure the success of the project.

Building Geometry and Loads

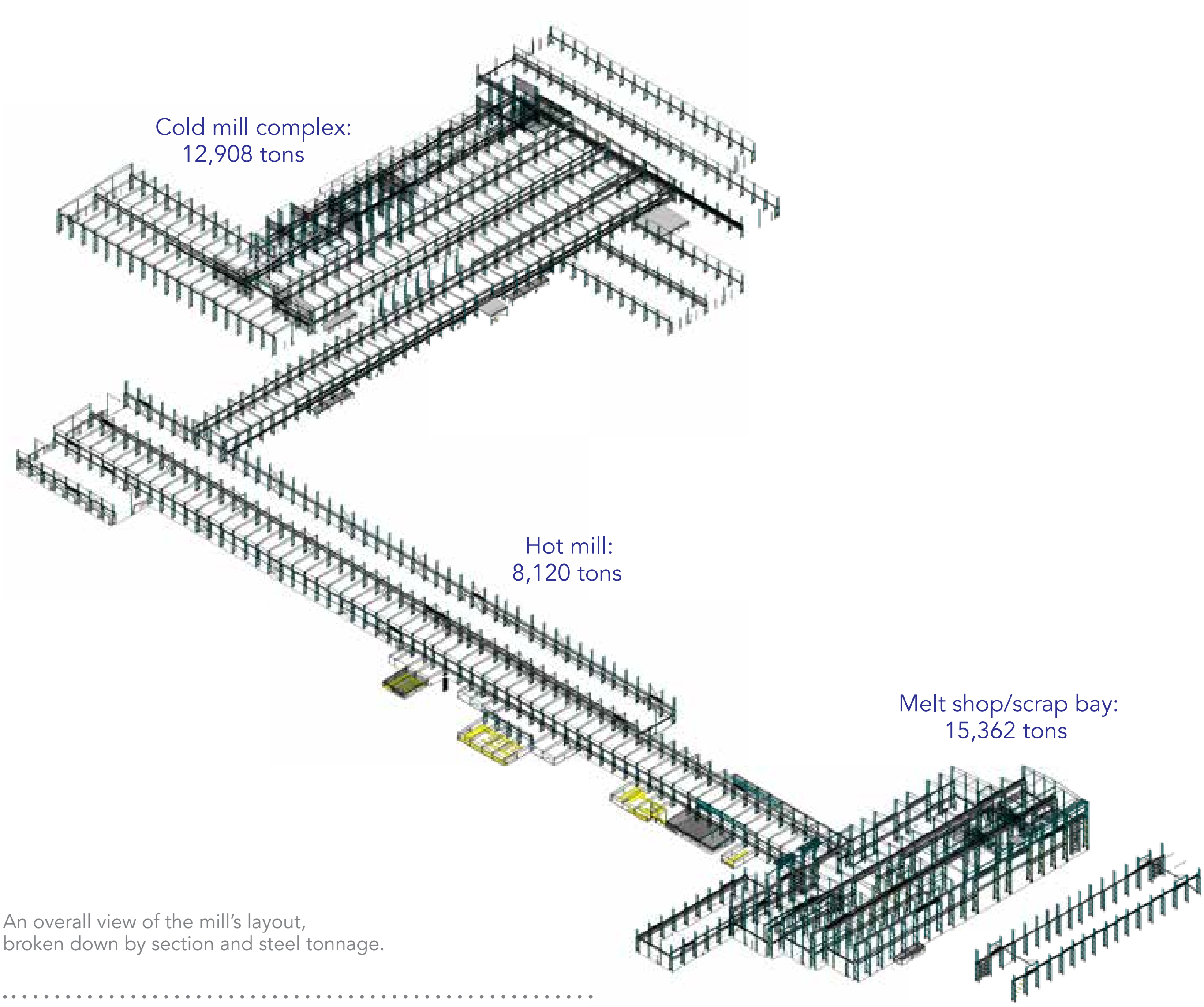
With over two million sq. ft under roof and building heights approaching 175 ft, the scale of the buildings alone is staggering. Mill buildings are essentially shells to support crane runways and provide shelter for the manufacturing process. As a result, they are largely open with no interior columns and open aisles typically over 100 ft wide. For this project, the cranes travel on elevated runways up to 125 ft above the mill floor, with crane bridge spans up to 115 ft.

The new mill contains more than six miles of crane railway.

The entire mill is framed by more than 36,000 tons of structural steel.



A typical laced column tower.



An overall view of the mill's layout, broken down by section and steel tonnage.

There are nearly 50 cranes in the complex, ranging from 10-ton maintenance cranes up to 500-ton capacity cranes in the melt shop, the latter being capable of lifting the entire lower section of an electric arc furnace (EAF). In such facilities, crane runways must be designed for vertical loads from the weight of the crane and lifted loads, dynamic lifting forces, side thrusts transverse to the structural framing, and horizontal forces along the length of the runway. Deflection and drift requirements for crane runway structures are generally more restrictive than standard buildings, both to protect operations and to prevent maintenance issues with the cranes and runway structures. In addition, the exposure to hurricane-force winds inherent in the facility's location near the Gulf of Mexico presented unique loading challenges to the design of the buildings.

Also unique to this type of project are the design considerations for the extreme environment. Molten steel, hot gas, corrosive elements, and heavy mobile equipment are just a few of the items that cause damage and deterioration in the structures. While deterioration can't be avoided completely, the facility's design must help prevent such issues as much as possible.

Crane Runways

The project contains over six miles of crane runway girders and rail. Typical runway girder spans were 40 ft, but in some cases ranged up to 90 ft to accommodate the requirements of the steelmaking process. For lighter cranes (less than 50-ton capacity) in the 40-ft bays, rolled wide-flange shapes (W27 to W36 weighing up to 178 lb per ft) were used for the runway beams, although in many cases, reinforcing angles were required at the beam top flange. This combination of wide-flange beams with reinforcing angles allowed SDI to construct a large percentage of the crane runways using steel shapes produced at its Columbia City, Ind., steel mill.

For longer spans and heavier cranes, it was necessary to use fabricated plate girders for the runway. Many of these were asymmetrical sections with different top and bottom flange sizes to provide an efficiently designed section while still ensuring that performance demands were met. Even so, the largest runway girders were 11 ft deep, used plates up to 3 in. thick, and weighed over 1,600 lb per ft.

The tolerances for crane runways are much more stringent than those typical for structural steel construction. This is necessary to minimize crane maintenance issues that can be caused by a runway structure with too much variation from theoretical horizontal and vertical alignment. Strict fabrication and erection controls are necessary, starting from the ground up to ensure that a crane runway can be properly aligned. Industry documents such as AIST Technical Report #13: *Guide for the Design and Construction of Mill Buildings* can supplement the AISC *Code of Standard Practice for Buildings and Bridges* (ANSI/AISC 303, **aisc.org/specifications**) for certain tolerances to help achieve this goal.

Building Framing

Mill buildings require open access throughout their length so that the overhead cranes can travel freely along the runways. As a result, there is no opportunity to brace across the building width, and the buildings are too long to only brace at the end walls. As such, frame lines for the SDI project were typically spaced at 40 ft, and the frames are comprised of a double column on each side. The inside column supports the crane runway gravity loads along with part of the building loads, while the outside column supports building loads, and both columns are laced together to provide lateral support for the crane and building horizontal loads. These columns are spaced with a gauge equal to approximately 8% to 10% of the building height, and being laced together allows the whole system to act as a fixed base cantilever from the foundation.

In the hot mill and cold mill buildings with medium heights and lighter cranes, the laced column towers are built using W24 shapes in the 12-in.-flange series. The melt shop building has the most severe loading conditions as it contains the 500-ton capacity cranes operating at 100 ft above the mill floor, with runway spans extending to 80 ft. In addition, this building structure provided support for piping and electrical utilities, alloy storage and conveying systems, and emission control ductwork up to 22 ft in diameter. These loads required one of the heaviest rolled shapes produced in the U.S. today: W36×652. In some cases, the loads were so high that even these massive columns required the addition of 4-in.-thick cover plates to provide additional strength. CSD coordinated with SDI to use reinforcing plates on available steel wide-flange shapes to avoid more expensive fabricated built-up columns from plates.

Platform Structures

Another prominent use structural steel was the dozens of platform structures throughout the facility. While most primary equipment is supported directly on concrete foundations, many pieces of equipment that support the process, such as control pulpits and maintenance equipment, are supported on steel platforms. In addition, steel walkways and stairways can be seen in almost every area of the mill.

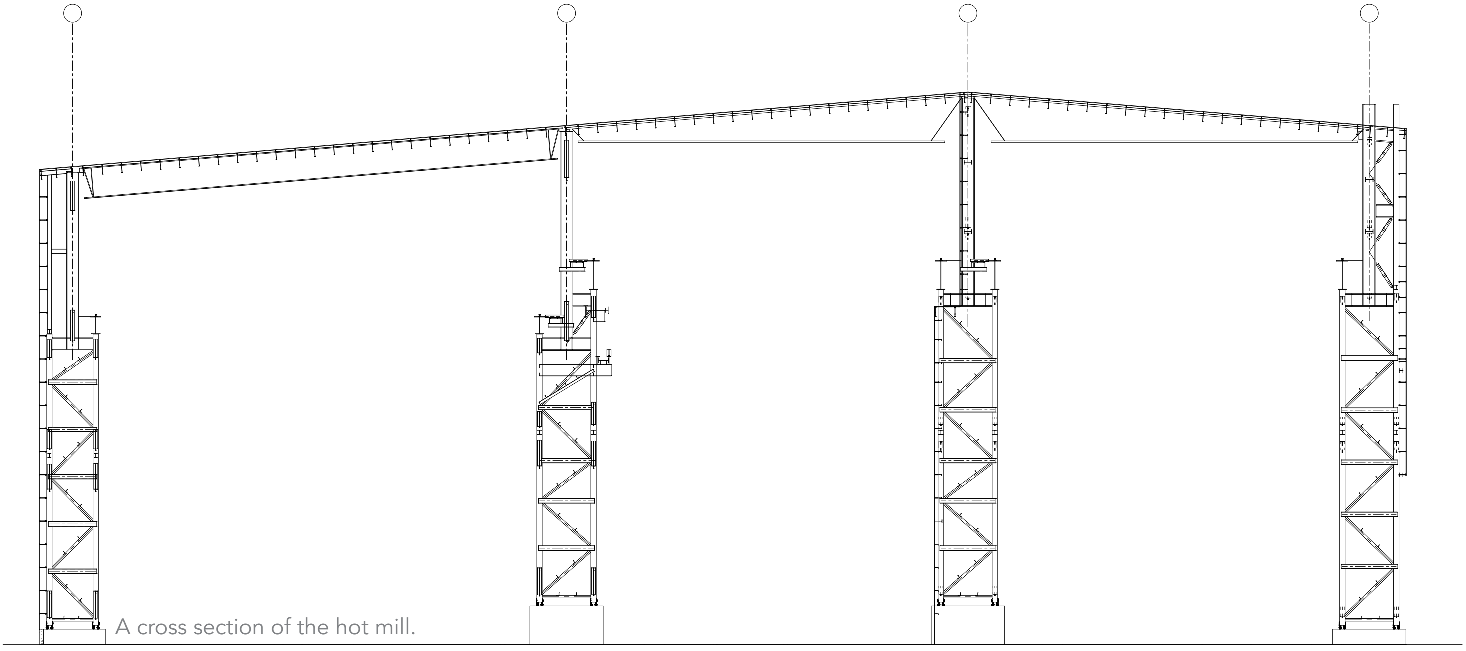
In the melt shop, large multi-level platforms provide access around the furnaces as well as support for the many materials and processes necessary to operate these key pieces of equipment. The combination of heavy floor loading, up to 750 psf, in conjunction with depth restrictions on framing members (due to clearances with processing equipment) required complex framing schemes with heavy, relatively shallow members.

In the cold mill complex, coating lines that apply paint or galvanizing to finished coils employ numerous large platform structures to support the dozens of pieces of equipment. These platform structures are of a scale similar to typical buildings but are deliberately kept independent from the main structure so that environmental loads do not affect the stringent tolerances necessary to meet the quality requirements of the process lines. The layout and design of all platform structures had to be closely coordinated to meet SDI's and all equipment vendors' requirements to precisely support the equipment and provide necessary clearance around both it and the foundations that penetrated through multiple levels.

Connection Design

CSD's expertise in steel connection design was also showcased at the new Sinton mill. By providing a complete structural design, which included all connection designs, CSD ensured that the project's fabricators and erectors had accurate information from the bid stage until steel erection began. Using standard AISC connection designs while also incorporating fabricator preferences allowed for a streamlined process for shop drawing review and fabrication in the shop.

CSD's experience in both heavy industrial crane buildings in conjunction with connection design paid the highest dividends when outside the scope of what would be considered standard connections. These include connections of heavily loaded members, laced columns, crane runway girders, and crane runway girder tie-backs to the columns.



A cross section of the hot mill.

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Structures of this size supporting loads of this magnitude and built within this schedule are only possible with steel. A steel producer expanding its capability to produce more steel with the help of a team of expert structural engineers makes for a great case study for structural steel design, detailing, fabrication, erection, and end performance—and, given the industrial nature of a mill, also puts it on full display. SDI's new flat roll steel mill stands as one of the world's premier steel production facilities and is supported, protected, and enabled by the very material the company produces. ■

Visit the Project Extras section at ***www.modernsteel.com*** *for drone footage of the project during construction.*

Owner and General Contractor
Steel Dynamics, Inc.

Structural Engineer and Connection Designer
CSD Structural Engineers

Steel Team

Fabricator
FabArc Steel Supply, Oxford, Ala. (Hot Mill)

Erector
Bracken Construction Company, Inc., Ridgeland, Miss.

Detailer
S. P. International, Inc., Kansas City

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