Innovating with Steel

By Nandu K. Shah

Design-build and structural steel “bring good things to life” in this corporate learning center in Cincinnati.

Executives at General Electric Transportation had a vision for a learning center that would employ innovative design to capture the attention and imagination of visitors while reflecting the company’s innovation.

GE commissioned The Haskell Company to design and build the new two-story, 45,000 sq. ft learning center in Cincinnati. The center aids in engineering, marketing, and technology training and acts as the GE campus’s main entrance and greeting center for guests and employees.

The facility houses several classrooms and conference rooms, a business center, a café, and an auditorium that accommodates 375 people. Aircraft engines are displayed on the floor or hung from the exposed roof structure of the museum, which exhibits decades of GE’s history. Outdoor areas include a beautifully landscaped courtyard, which is used for outdoor functions and is equipped for audio/video presentations.

Flexible Framing

Decisions related to space planning changed as the needs for various departments and systems were identified. During preliminary design and planning, it became obvious that the framing system must be flexible.

Haskell’s team worked very closely with the owner throughout the project. In the early stages of the project, several “design charette” meetings were held involving the architect, structural engineer, and construction manager to evaluate various framing schemes for cost, efficiency, and appropriateness, including:

1. Structural steel with bar joist/beam framing for the floor and roof
2. Structural steel with composite beam framing for the floor and joist/beam framing for the roof
3. SMI SmartBeam® system for floor framing
4. Poured-in-place concrete

In addition, the following exterior wall schemes were also evaluated:

1. Structural steel with synthetic stucco over metal studs with glazing
3. Structural steel with CMU, brick, and glazing
4. Structural steel with precast and glazing
5. Structural steel with metal panels and glazing
6. Load-bearing, site-cast tilt-up wall panels

The key factors considered in the selection of the systems were flexibility, ease of modification for possible changes, floor vibration, schedule, cost, and aesthetics.

The structural system selected consists of structural steel, composite floor beams, bar joist/beams for roof framing, architecturally exposed structural steel (AESS), and AESS X-bracing. The exterior wall system features strategically located precast concrete wall panels, glazing, and metal panels, as well as brick.

The composite floor system consists of 2½” of normal weight concrete over 1½”, 18 ga composite deck. The primary floor beams are W18×40 and secondary floor beams are W18×35. The roof framing is 1½”, 22 ga deck on bar joists and beams. Over 320 tons of steel were used for the project.

The geometry of the building made it impossible to develop a consistent column grid. The architect and structural engineer worked closely to develop an economical column grid layout and to locate the lateral bracing. The column spacing in one direction is approximately 23’ and varies in the other direction. The lateral system consists of X-bracing in both directions.

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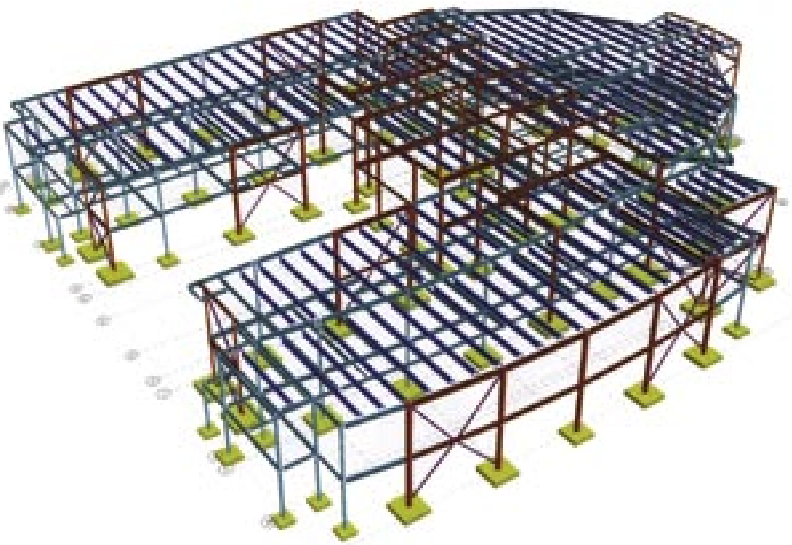

The decision to enlarge the semicircular auditorium (shown in the upper right of this RAM Structural System model) was made during the shop-drawing review process. The steel design easily accommodated the changes.

A key design feature is this exposed HSS bracing detail that features shop and field-welded connections. Many of the braces are outside the building envelope.

The semi-circular auditorium presented a challenge for locating X-bracing in inconspicuous areas due to large supply and return ducts, large open spaces, and expansive interior and exterior glazing. Also, the architect wanted to express the X-bracing as a design feature. The solution was to terminate the bracing 2′ above the base, adding moment to the column design. RAM Structural System software was used for the lateral load analysis, as well as the gravity load analysis.

The floor-to-floor height is 13′-6″, which required close coordination of various systems. The ceiling height varied from 8′-6″ to 11′-0″. In some areas, the depth of primary beams was reduced to accommodate other trades. Coordination of the floor framing, ceiling height, HVAC, electrical, A/V systems, and fire protection helped minimize field problems.

The exterior precast panels were intricate, with many different conditions of geometry and supports. The structural engineer developed suggested details and provided forces and loading information to the precast manufacturer. The precast subcontractor developed the shop drawings. Coordination meetings were held involving the structural engineer, architect, construction manager, and the precast system engineer. These valuable meetings helped avoid many potential field problems.

Accommodating AESS

AESS was used at strategic locations, with many of the interior columns exposed. However, the key AESS design feature is the X-bracing with shop and field-welded connections. In some cases, AESS X-bracing is outside the building.

Haskell's steel fabrication shop developed a mock-up sample of the center section and end section of the X-bracing in accordance with the specification issued by the structural engineer for the AESS steel. The architect, structural engineer, construction manager, and QA coordinator inspected the mock-up sample. The acceptable weld locations were marked and a standard for acceptance was established. The fabricator was directed to grind the welds and/or re-weld, meeting the standard of acceptance. In a second inspection, the AESS mock-up was approved, and the sample was shipped to the project site.

A meeting with the client, structural steel erector, structural engineer, QA coordinator, construction manager, and superintendent was held at the job site. The AESS mock-up sample was inspected and expectations were defined for the AESS members and the field welds. This was a great success, as very little rework was required in the field for the AESS sections.

Sculpture Supports

A three-dimensional element designed to simulate an engine blade sits on the top of the front entry wall. This architectural feature is known as "the banana" or "the eye brows," and was constructed with structural steel, metal studs, and metal panels to create the engine blade's shape.

The design and geometry of the structural framing, supports, and the structural stud framing to support the fascia were very challenging. The architect, structural engineer, steel fabricator, steel erector, and construction manager decided to use HSS sections for the framing. Due to the curved nature of the members and complexity of erection, it was decided to fabricate these sections in one full length. Understanding the fabrication and erection difficulties, the architect developed the design to accommodate the 65′ shipping limitation and to avoid splicing.

The design solution for support of the framing required more collaboration. The obvious, simple solution would have been to add full-height steel columns to support the engine blade framing; however, the team decided to take advantage of the precast elements to support it. Embed plates were cast at the top of the precast panels to which stub columns were field welded, which in turn supported the entire engine blade feature. The structural engineer provided gravity load and lateral load information to the precast engineer to design the embed plates. The full-length, curved assembly of the engine blade beams was lifted in one piece and welded to the stub columns. Dimensional verification in the fabrication shop, as well as field measurements, made erection a smooth operation without any adjustments.

Last-Minute Changes

As the foundations were being poured, Phase I structural steel for the east wing was under fabrication, and the structural engineer was reviewing the shop drawings for the Phase II semi-circle auditorium area, the owner realized seating capacity needed to be increased in the auditorium and the seating arrangement had to be changed. This challenged Haskell's design-build team to develop schemes and solutions without affecting the occupancy date. The architect and engineer reviewed numerous schemes to minimize the impact on the systems already constructed or fabricated and presented them to the client with a budget estimate. The solution was to move the exterior curved wall of the auditorium by 9′, as well as to perform some modifications to the balcony areas. Very few field modifications were required. Most of the already-fabricated steel sections remained unchanged or were used with slight modifications. While the architect, engineer, and owner were finalizing the changes, the entire construction team moved to Phase III, the west wing, without slowing down. ★

Owner
General Electric

Design-Build Team
(Architect, Structural Engineer, Fabricator, Detailer, and General Contractor)
The Haskell Company, Jacksonville, FL, AISC member

Engineering Software
RAM Structural System
Enercalc

Detailing Software
Xsteel

Erector
SOFCO Erectors, Inc., Cincinnati, NEA member