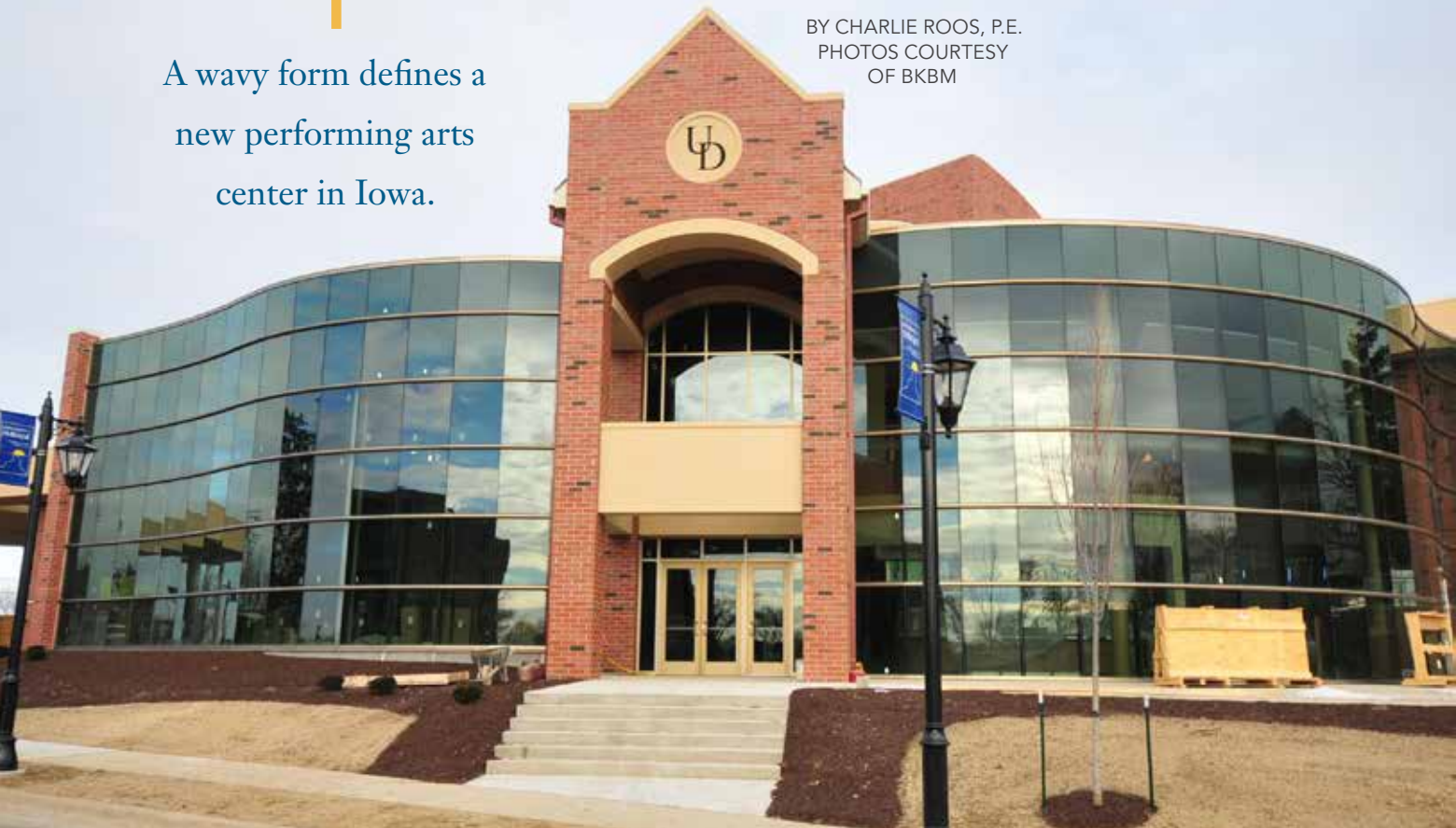


# Liquid MOTION

A wavy form defines a new performing arts center in Iowa.

BY CHARLIE ROOS, P.E.  
PHOTOS COURTESY  
OF BKBM



## SURF'S UP IN DUBUQUE.

The University of Dubuque's new Heritage Center—colloquially known as “the Wave,” thanks to its curved form—is part classroom space, part performance hall and part art gallery. The 80,000-sq.-ft structure not only plays host to music but also expresses it in its design, as the building's curved envelope imitates a treble clef turned on its side.

From the exterior, the roof profile sets the Wave apart from its fellow campus buildings with multiple long-span convex and

concave roof joists and beams, further reinforcing the musical theme while also supporting an extensive labyrinth of catwalks. The focal point of the Wave, the Main Hall, employs 50-ft joists (interrupted by a 90-ft joist girder), and joists in the black box area span up to 39 ft, 3 in.

The towering radial curtain wall wrapping much of the exterior is laterally supported by exposed curved HSS8×8×<sup>3</sup>/<sub>16</sub> girts. In the main lobby, the curtain wall is canted outward 10°, creating a space between these columns and the glazing, which is filled with sections of HSS rolled in the shape of, yes, a musical note.



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## Sonic Temple

The 1,000-seat Main Hall offers unobstructed views of the stage from every location. The tiered seating of the main level is built of composite deck on top of a light-gauge steel platform to allow HVAC to be routed beneath the floor and distributed via diffusers beneath the seats. When it came to the balcony, the original design called for a cast-in-place assembly. However, since several trades were required in the Main Hall simultaneously due to scheduling purposes, such a balcony scheme would have been inefficient, requiring shoring and elevated concrete work and subsequently closing off the space to other trades for several weeks.

As such, inquiries were made to regional steel suppli-



◀ ▼ The University of Dubuque's 80,000-sq.-ft Heritage Center—part classroom space, part performance hall and part art gallery—is characterized by its wavy form.



➤ The completed lobby.

- ◀ The roof profile uses multiple long-span convex and concave roof joists and beams.
- ▼ Steel framing for the main lobby.



ers shortly into the schematic design phase (once it became apparent that the construction schedule would play a large role in the design) as to the availability and cost of obtaining and fabricating wide-flange members—with favorable results. The end product is a balcony built of composite deck supported on wide-flange raker beams on a radial grid. The raker beams are moment connected through a rolled W36 ring girder (64-ft, 9-in. radius) near the low end with an 11-ft cantilever to the bottom edge of the balcony. The raker beams are supported by an intermediate concrete bearing wall (also on a radius) and at the upper end by another rolled W36 ring girder (96-ft., 7-in. radius). Each rolled W36 ring girder arrived in two to three pieces and was spliced together

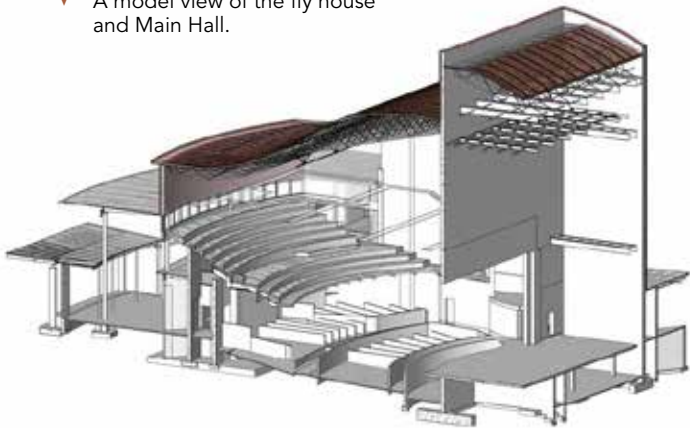
in the field in order to achieve the approximate 90-ft horizontal dimension of the Main Hall. The lower ring girder is supported at each end via embed plates in the cast-in-place walls and twice near mid-span via 48-in.-deep plate girders that cantilever out 10 ft to support the ring girder. The plate girders are tapered at the ends to maintain clean ceiling lines under the balcony. Overall, the lower edge of the balcony is cantilevered 21 ft past the nearest support, which maintains the requirement of zero visual obstructions in the Main Hall. The majority of the balcony steel was sized to keep vibration within the acceptable ranges for rhythmic movement. A dynamic analysis model was created for the balcony framing for the recommended design criterion for the rhythmic intensity



- ▲ Joists supporting the undulating form of the room.
- ▼ Steel orders were broken down into many smaller submittals to limit the amount of on-site storage that would be required.



- ▼ A model view of the fly house and Main Hall.



of a lively concert. The fundamental frequency of the entire balcony was limited to be above 7.0 Hz in order to stay well within the recommendations of AISC Design Guide 11: *Floor Vibrations Due to Human Activity*.

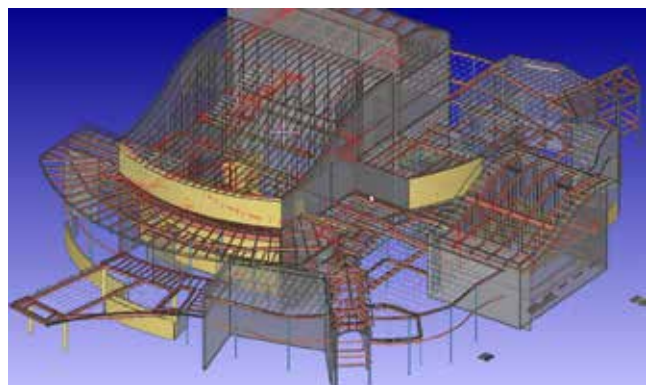
### Raising the Ceiling

The classroom, office, practice and third-level mechanical spaces are largely constructed with hollow-core precast plank floors supported by wide-flange steel beams. Many of the

- ▼ Balcony framing in the building's performance hall.



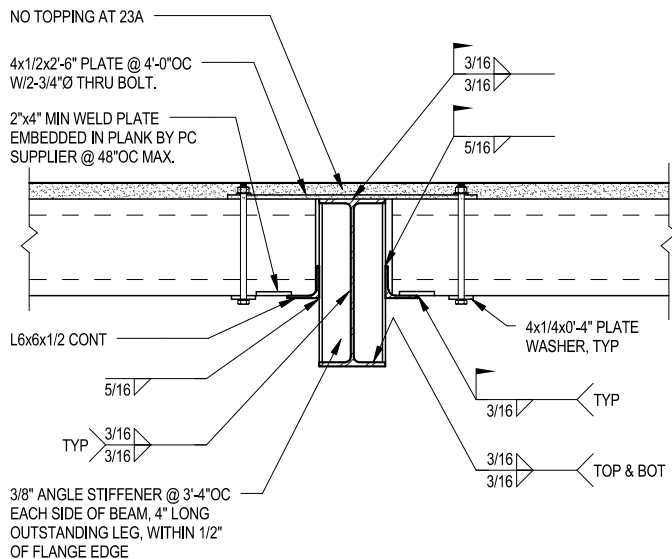
- ▲ Framing for the performance hall's balcony.
- ▼ The focal point of the Wave, the Main Hall, employs 50-ft joists interrupted by a 90-ft joist girder.



beams span large distances, some up to 35 ft, which drove the structural depth up and increased covered ceiling space. These beams were “upset” to match the top of steel to the top of precast plank. The plank is supported from steel angles that attach to the beam web, thus saving 12 in. of space that would have otherwise been occupied by the plank and creating additional space for routing ductwork. The lobby and commons areas connecting the Main Hall with these other spaces are largely two-story spaces, much of which are framed with shallow wide-



- ▲ The Main Hall seats 1,000.
- ▼ The entrance canopy to the main lobby.



- ▲ In some areas, the tops of the steel beams match the top of the precast plank, thus decreasing the structural depth by as much as 1 ft.
- ▼ Framing at the back of the performance hall.



flange shapes moment connected through their girders. The balcony overlooking the main lobby cantilevers past the framing line to create a “floating” look from the main level.

The Wave also boasts an extensive fly loft area behind the stage and a black box practice area. The fly loft area consists of multiple levels of steel framing to support very large vertical and horizontal rigging loads as well as an iron grid level for stage hands to manipulate this rigging. The framing consists of the beam and steel plate pin rail gallery on each side of the stage (at approximately 28 ft above stage level), the full iron grid walking surface level framed with 12-in. channels and flat 3-in. channels hung from the rigging beam level above (approximately 69 ft above the stage with the supporting rigging level at 77 ft above stage) and “bowstring” profile joist roof framing above the rigging level. The black box area is a two-story space with a less extensive catwalk system supported by convex and concave wide-flange roof purlins that match the profile of the Main Hall.

A tight construction schedule paired with a small project site and laydown area required a building material that could not only be installed quickly, but also collaboratively alongside other trades—plus, the building’s curvaceous design required

structural elements that could take on not-too-common geometry. The steel framing system accomplished these goals and did so in a way that enables and articulates the building’s architectural intent. The end result is a new icon for the University of Dubuque that radiates artistic creativity and resonates with music as well as the community. ■

#### Owner

The University of Dubuque

#### General Contractor

Conlon Construction

#### Architect

Straka Johnson Architects

#### Structural Engineer

BKBM Engineers

#### Steel Team

##### Fabricator and Detailer

Design Build Structures 

##### Bender-Roller

Chicago Metal Rolled Products