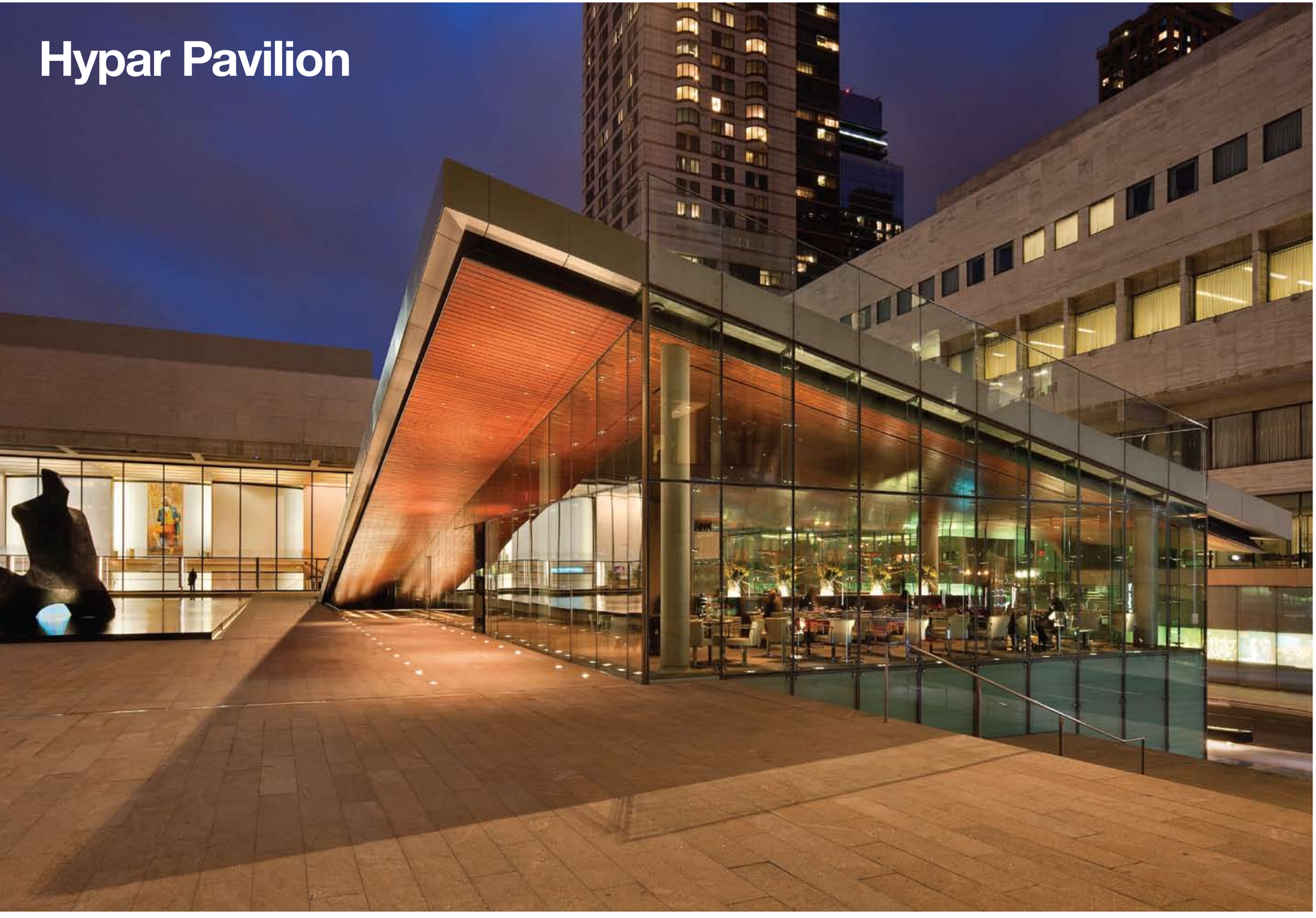
# Hypar Pavilion



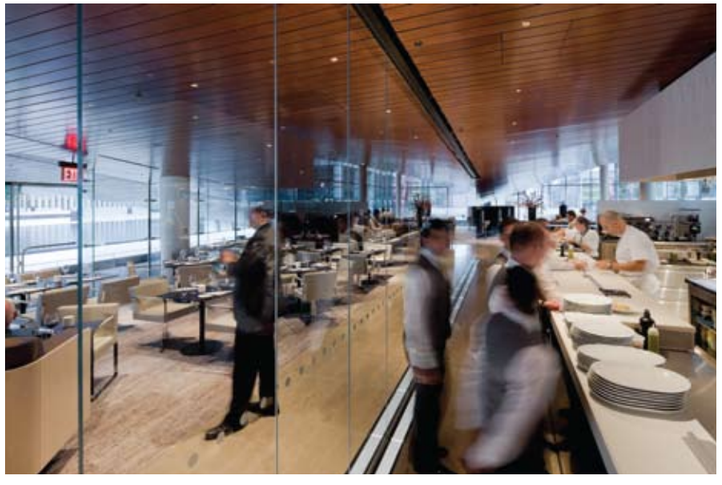
**Lincoln Center's new restaurant and rooftop lawn relies on structural steel to create a valuable public space and a reinvigorated campus.**

THE HYPAR PAVILION, A slanted green roof that shelters a glass-enclosed restaurant below, is a crucial piece of Lincoln Center's move to reunite the north edge of its campus with the surrounding neighborhood. The design, by Diller Scofidio + Renfro in collaboration with FXFowle, is focused on "engagement, transparency, bringing life from complex to street and from street to complex," says Heidi Blau, the partner in charge of Lincoln Center Redevelopment for FXFowle.

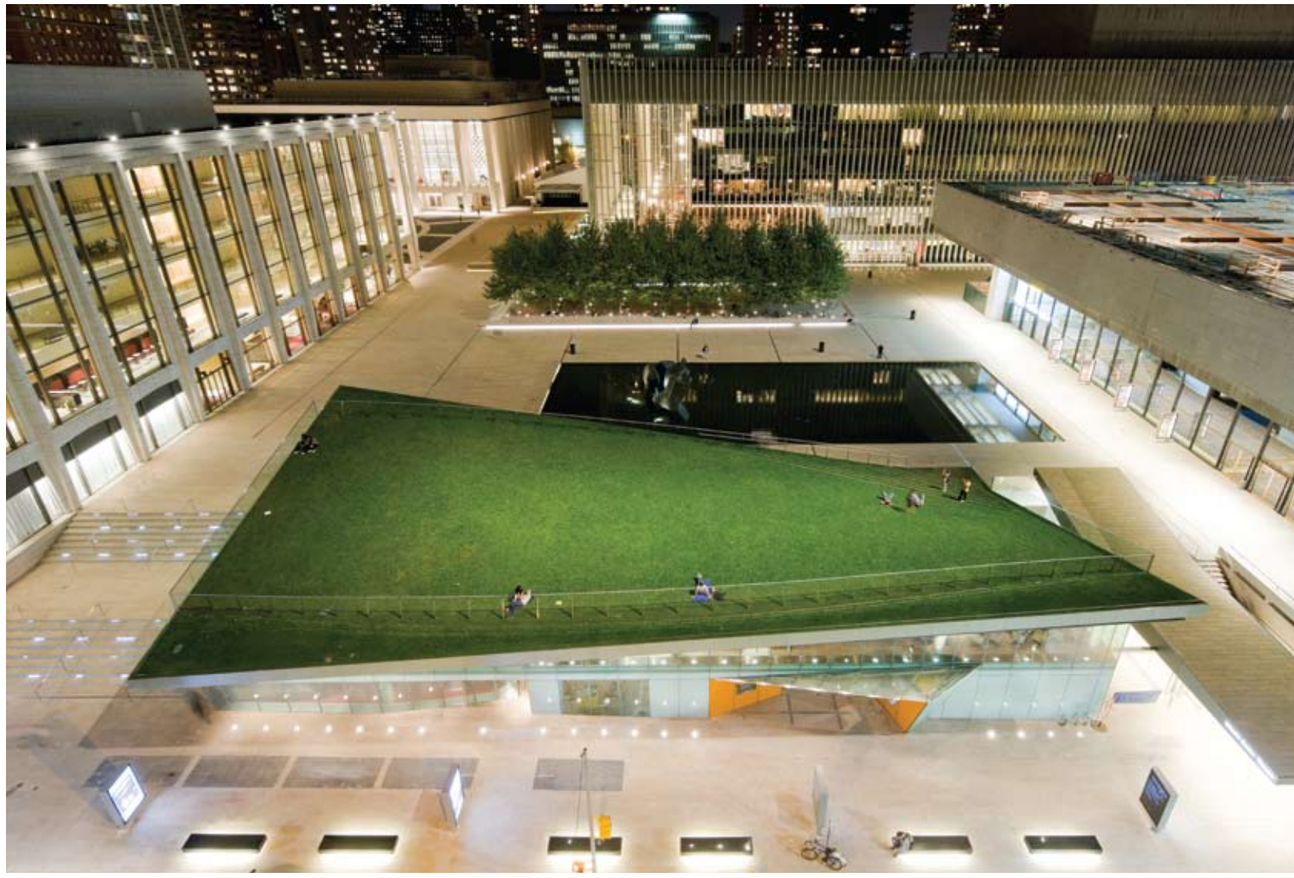
With a roof that "tilts and peels upwards," describes Blau, the 7,200-square-foot pavilion lawn, officially named the Laurie M. Tisch Illumination Lawn, appears to be made of a single curved plane. Although the design team considered using thin-shell concrete to create the hyperbolic paraboloid form, they chose instead to construct the shape using straight steel members. "Steel seemed to be more economical," says Blau. "And we could keep a very sleek profile through the edge of the shape. We wanted the lawn to hover and not look like it was attached to the plaza. Main beams were tapered on the edges to maintain the structural portion's vertical height, which we couldn't have achieved with concrete."

In addition to allowing tapered edges, the steel beams accommodated web through-cuts for the rooftop drainage systems and Lincoln Restaurant equipment and ductwork. Steel was also a lighter-weight solution when compared with the amount of concrete that would have been needed to support a foot of soil and growing medium atop the roof. "The weight of a structural concrete member would have added tremendously to the weight of the structure," says Blau.

"The thoughtful rationalization of the architectural form simplified fabrication and enabled rapid



**This page** Lincoln Restaurant's ceiling, a continuation of the exterior soffit, emphasizes the hovering plane of the pavilion roof.
**Previous spread** A tilted structural steel frame creates the roof of the restaurant.



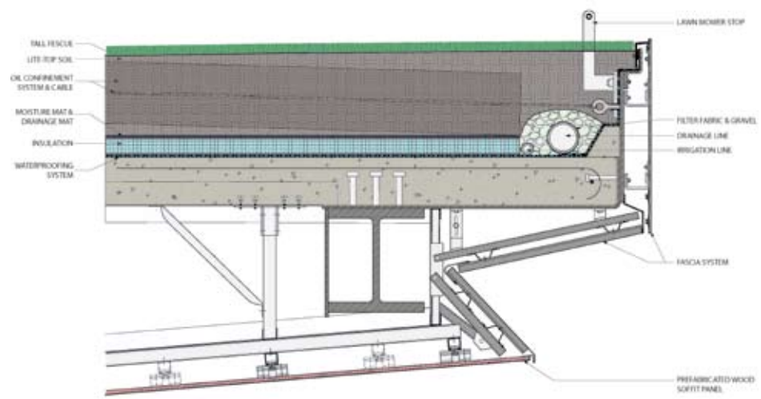
**Above** A hyperbolic paraboloid-shaped roof forms the Laurie M. Tisch Illumination Lawn.

Previous spread: Chris Cooper; this spread: Iwan Baan

construction of the pavilion," explains Markus Schulte, structural engineer and principal-in-charge for all of Arup's work at Lincoln Center. "The steel structure solved the challenge of building atop Lincoln Center's existing podium and its densely packed network of existing columns and mechanical spaces." Sharing 3-D models with project SMEP engineer Arup along with steel contractors further facilitated interdisciplinary coordination between the trades and sped up fabrication.

Though design and construction activities related to the project were carefully scheduled and sequenced over a period of five years—first renovation of the existing underground mechanical plant, then work for the center's new subterranean Film Society space—the steel erection happened quickly. "The steel hypar was put in place over the course of three weeks because all of the members were fabricated and delivered to the site ready to be installed," says Schulte. Maintaining the correct sequence of activities and staying within the allocated tight time frames was critical, as Lincoln Center was to remain open during the entire design and construction phase.

"The steel beam grillage is composed of W12 and W24 sections, A992 Grade 50 beams, ranging from 27 to 32 feet in length, approximately 150 tons overall," explains Schulte. Beams spaced approximately 10 feet apart were field-bolted to W12 columns using high-strength A325 and A490 bolts. The steel superstructure of the hypar transfers vertical loading into the existing concrete columns below. Additional heavy transfer beams, built-up out of steel plates, transfer the load around the new movie theaters and an existing mechanical plant. At the west end the hypar dives down, transferring lateral load into the existing plaza, while at the 10-foot cantilevered south end of the pavilion, braced




**Left** A soil confinement system, a honeycomb-like web, is stretched over the roof to stabilize the soil until roots are established.
**Below** A section of the typical Illumination Lawn shows the roof's waterproofing systems and roof assembly installation.

frames transfer lateral loads into the concourse level underneath.

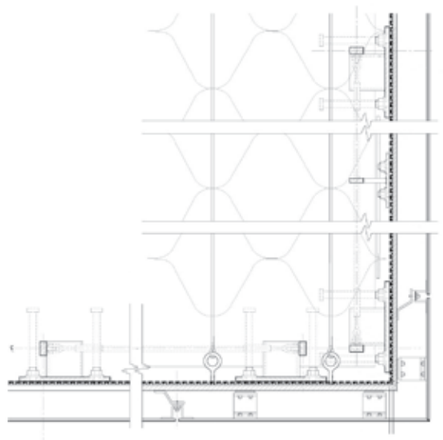
The lawn-edge fascia was crucial to maintaining the pavilion's appearance of weightlessness. The steel beams were chamfered along the edge to reduce their height and to achieve the architect's vision. A bird's-mouth finish Grade A316 stainless steel shoe sits above the roof soffit. It is field-bolted to the roof's edge beams with A315 bolts. Below, tempered insulating glass units (IGUs) span from street level to the soffit, or on the east, west, and part of the north sides, past the rooftop to act as a guardrail. The system is laterally supported by 12-inch-deep glass fins attached with point fittings on the interior, maximizing the curtain wall's transparency. "The effect that we were going for was pure glass, uninhibited," says Blau.

Detailing the roof guardrail was equally important to the public lawn's appearance, as well as its safety. Atop the roof's waterproofing membrane are two ½-inch-thick painted and galvanized base plates to which the ¾-inch stainless steel rail stanchion is fastened using stainless steel bolts and neoprene spacers. Vertical grain stainless cable mesh infill is stitched to the 1¼-inch-diameter stainless steel pipe rail welded to the top of the stanchion. All of the stainless steel is Grade 316. The mesh is anchored above the grass by a continuous 12mm, 1x19 stainless strand cable, fastened to the base plate with cable brackets and stainless bolts. Though the angle between the mesh and stanchion is constant, the angle of the stanchion and the lawn surface varied due to the hypar's shape, making precise detailing even more important to achieve the desired appearance.

Now that the restaurant and rooftop have been open for several months, it is difficult to imagine the campus without it. Crowded with lunchtime visitors enjoying the sunshine, the tilted lawn has already achieved its purpose of unifying the Lincoln Center campus with the city around it. "It was incredibly rewarding to help reshape these spaces for Lincoln Center and create a place where a lot of people enjoy visiting," says Blau.

This spread: FXFOWLE

**Right** The completed steel frame is covered with a concrete deck; zigzag elements are future "check-dams" that divert storm water to strategically located drains.
**Below** The roof geometry called for straight steel pieces to be rotated against one another to create the hyperbolic paraboloid form.

**This page** The lawn's stainless steel rail and mesh infill required precise detailing because the angle of the stanchion to the lawn surface varied between points.

**Above** The pavilion rises next to the Paul A. Milstein Pool and Terrace. The light-weight steel structure allowed the design team to build atop Lincoln Center's existing podium and columns.

**"The steel structure solved the challenge of building atop Lincoln Center's existing podium and its densely packed network of existing columns and mechanical spaces."**

**Markus Schulte, Arup**

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## HYPAR PAVILION

Location: **Hearst Plaza and 65th Street, New York, NY**
Owner: **Lincoln Center for the Performing Arts**, *New York, NY*
Developer: **Lincoln Center Development Project**, *New York, NY*
Architects: **Diller Scofidio & Renfro**, *New York, NY*,
in association with **FXFOWLE Architects**, *New York, NY*
Structural and Mechanical Engineer: **Ove Arup & Partners**, *New York, NY*
Construction Manager: **Turner Construction**, *New York, NY*
Curtain Wall Consultant: **R.A. Heintges & Associates**, *New York, NY*
Structural Steel Erector: **Capco Steel Co.**, *Providence, RI*
Miscellaneous Iron Erector: **Capco Steel Co.**, *Providence, RI*
Architectural Metal Erector: **Permasteelisa North America**, *Windsor, CT*
Curtain Wall Erector: **Tower Installation**, *Windsor, CT*
Metal Deck Erector: **Capco Steel Co.**, *Providence, RI*