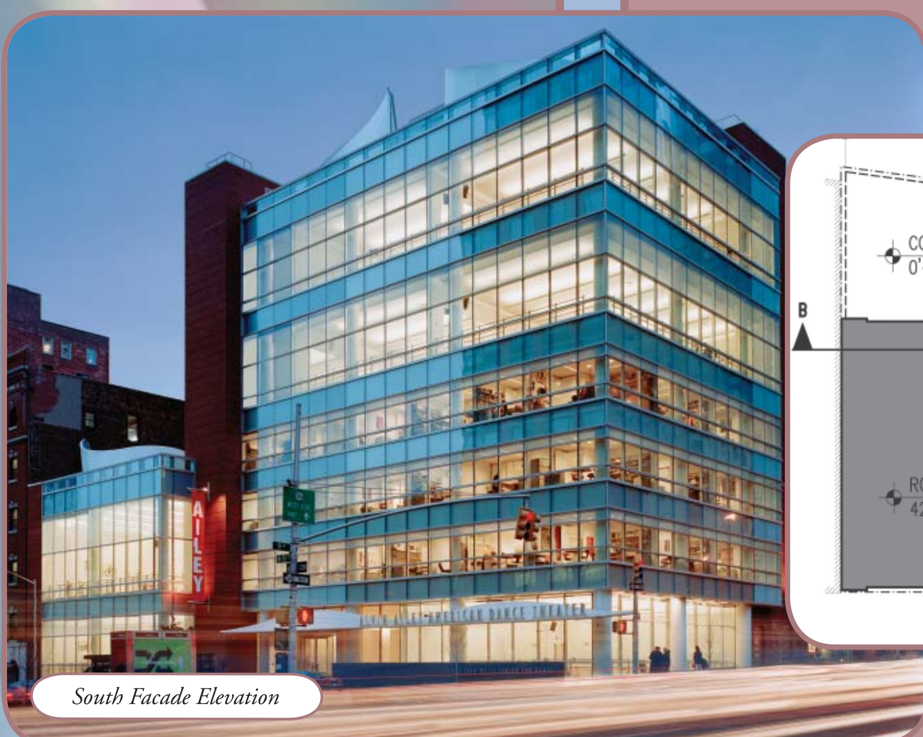
Revelations

the Joan Weill Center for Dance

By Rebecca Harting and Pablo Bruno, P.E.

The new home of nationally acclaimed Alvin Ailey Dance Foundation, on the corner of West 55th Street and 9th Avenue in Manhattan's Clinton District, is a modest glass and brick structure designed to reveal the dancing within. Located between Lincoln Center and Times Square, it is also within walking distance of Fordham University, which partners with The Ailey School in a BFA program. To ensure that the new building would be striking and meet all the needs of its various programs, the Foundation hired modernists Iu + Biblowitz, Architects for the design. Gilsanz Murray Steficek was contracted for the structural engineering.

Completed in 2004, the building has six stories, two basement levels, and an area of 77,000 square feet. Due to zoning constraints, the building is actually two volumes sharing a central elevator and utilities core. The eastern volume is larger and taller than the western volume (Figure 1) and creates a private courtyard in the northwestern corner of the lot.



South Facade Elevation

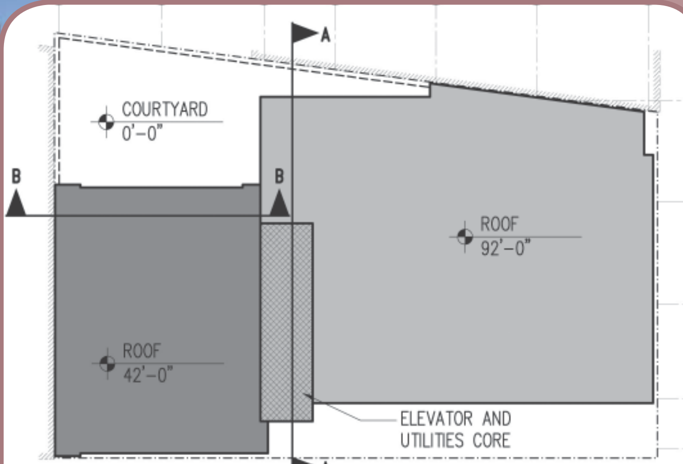


Figure 1

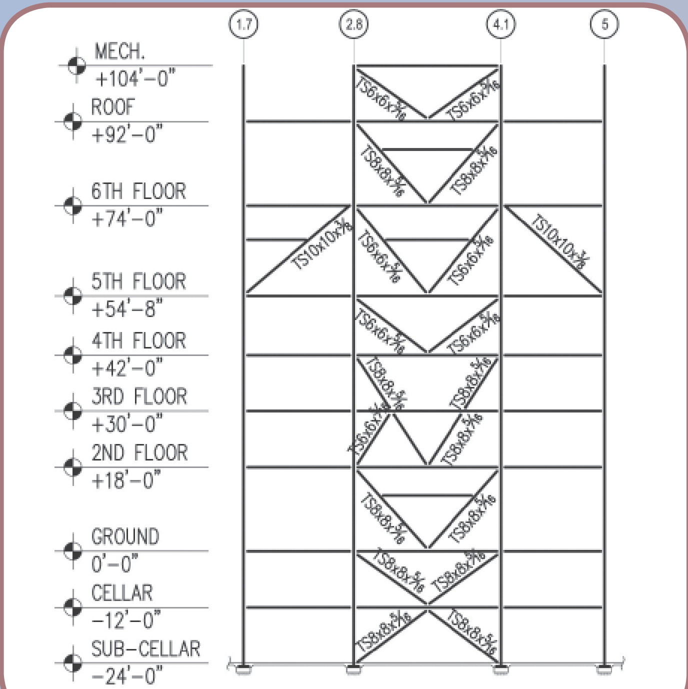


Figure 2

The eastern and southern facades are almost exclusively glass in long horizontal lines. From the street the building is a stage, the large open studios unobscured to pedstrians. The concrete and steel structure contains a dance theater, school, studios, support activities and administration. The building's gravity framing system had to accommodate the large open spans and the vibration requirements from the intended combined dance and office use.

Gravity Truss Elevation

The building's mixed use posed a tricky design problem. The minimum required natural frequency for a similar building occupancy ranges from 6 Hz to 10 Hz, with a normal range of acceleration between 2% and 6% g. The Client and the Architect agreed on a minimum floor natural frequency of 7 Hz and a maximum 5% g floor acceleration. The gravity framing system was required to be lightweight in order to bridge the long spans of the dancing spaces, and have the mass and stiffness to reduce the amount of vibrations and accelerations expected from the dancing activity.

According to the *AISC Steel Design Guide Series 11* "Floor Vibrations from Human Activity," the dynamic rhythmic activities tend to be too large and the resonant vibration is generally too great to be reduced only by increasing the damping and/or mass. This means that, for design purposes, the natural frequency of the structural system *fn* must be made larger than the forcing frequency *f* of the highest harmonic that can cause resonant vibration, and to avoid matching the occupants excitation harmonics with the natural frequency of the structure. The natural frequency (stiffness) of the structure has to be increased to reduce the effects of resonance from activity accelerations. The floor effective mass ratio is also increased, requiring more participants to induce the overall mass to vibrate in a noticeable manner.

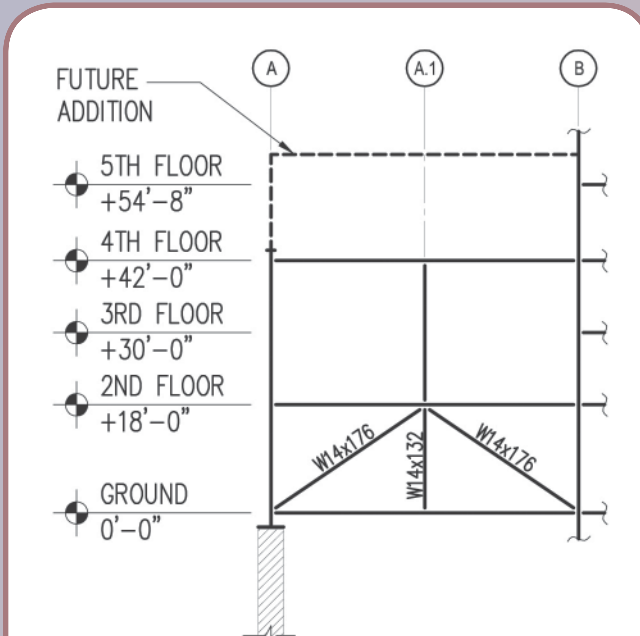


Figure 3

Increasing the natural frequency (stiffness) of the floor was achieved by using steel beams in composite action with the concrete slab on top of the metal deck. The floor stiffness, as well as the floor weight, depends heavily on the concrete slab section selected. As the structural slab thickness is increased, the floor stiffness and weight increases; however, the floor's natural frequency is adversely reduced by this increase in slab weight. The floor slab section selected consists of 6 inches of concrete over a 3-inch metal deck for a 9-inch overall thickness, thus optimizing the concrete section by reducing the amount of concrete in the location where it is least effective, below the composite section neutral axis. This maintained the stiffness and reduced the self weight.

To accomplish the Client's idea of a stage to the community, the lateral system selected consists of concentrically braced steel chevron (inverted V) bracing at the interior framing locations (*Figure 2*) and ordinary steel moment frames at the south and east exterior facades. The exterior wall moment frames allowed the installation of curtain walls, permitting the dance studios to be visible without obstruction from the street. The acoustic and fire protection requirements for the curtain wall system mandated the insulation of the space between the curtain wall, slab edge, and spandrel beam area.

The black box theater, located at the west side of the lot and stretching under the courtyard to the northwest property corner, required 50 foot clear spans. Composite steel beams could not be used to achieve the natural floor frequency required for the dance studio above. Instead, two gravity trusses were installed (*Figure 3*) with a vertical member at the middle of the span and diagonal members from the interior high point connecting to the outer ends of the bottom member. This minimized the vibration problem using the inherit stiffness of the truss gravity system, while keeping a reasonable compromise on the floor system stiffness and mass.

Two passenger elevators and one service elevator cover the demand for the mobility of dancers and equipment between all the floors. Two pre-cast scissor stairs on the building's north side provide emergency egress. The school uses five studios on the first and second floors, another below street level, and a performance theater that can be converted to two more studios. The administrative offices are on the third and fourth floors. The first and second companies have studios on the fifth and sixth floors.

A 14-foot floor-to-ceiling clear space was required for all dance spaces, much greater than needed by the administrative areas. The varying story heights demanded precise coordination of the architectural, structural, and mechanical requirements by all parties involved.

To resist lateral soil pressure in the two levels below grade, the foundation was constructed of reinforced concrete walls, with concrete pilasters to support the steel columns. The horizontal soil reactions were transmitted from the foundation walls to the floor diaphragm.

The governing design for the isolated interior footings was concrete two-way shear. The concrete footings bear on Class 1-65 rock, described as sound hard rock with a capacity of 60 tons per square foot.

South Building Facade During Construction

East Facade

The client and the community required minimal disruption to the neighborhood routine. The rock depth varied from 6 feet to 25 feet below grade, and was excavated without the use of dynamite. A pneumatic hammer was used to break up the rock. Neighboring buildings were laterally shored using temporary outriggers.

The Alvin Ailey American Dance Theater has performed for two presidential inaugurations, won national and international awards and toured the world extensively, including Africa, China, Cuba, and the Soviet Union. Today the AADT is the residential dance company of the City Center, with two primary troupes and 3,500 students. Their new state-of-the-art permanent home, the Joan Weill Center for Dance, is the largest facility devoted entirely to dance in the United States. Designed to reveal the art of dance to the community, this vibrant and frenetic structure was achieved using hard, cold engineering knowledge.▪

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