Creative dunnage placement in one rooftop's "demilitarized zone" keeps everyone cool.

Small Steel,

BY MARCO SHMERYKOWKSY
PHOTOS BY SHMERYKOWSKY CONSULTING ENGINEERS

DUNNAGE MIGHT NOT BE THE SEXIEST use for steel, especially not amongst the towering glass and steel skyscrapers that consume ever more building sites on the island of Manhattan. It certainly doesn't make headlines. And as common as it is to engineers, the word's definition escapes all but the most informed layperson. For New York-based Shmerykowksy Consulting Engineers, a team as well known for its new high-rise design as for its renovations, the word is less remarkable for its obscurity than for its evocation of a particularly ingenious work of structural engineering.

The job seemed simple enough—design a structural steel dunnage platform capable of supporting two air-conditioning units, weighing a combined 20,000 lb, on the roof of an old cast iron, timber, and brick building. No problem. This is New York. We do it all the time. This late-19th century vintage building had seen its share of renovations, and a previous dunnage platform still sits on the roof.

This time, however, all involved were concerned about placing too much weight on the aged roof and, naturally, about disrupting the business of existing tenants. Our client, a new tenant, had to meet current expectations about the indoor climate, and thus required a more advanced and far weightier set of units.

The initial design called for the two air-conditioning units to be installed on separated platforms at the far east and west ends of the roof surface. The existing structural supports were cast-iron columns reaching up to a broad timber roof girder along which wooden joists ran perpendicular, spanning from wall to wall. Not a bit of steel in the whole place.

The complications involved in this initial design were massive. It would have taken a host of penetrations into the existing roof framing and a convoluted dunnage network on either end on the surface. The scheme also added up to more money for materials and labor and more time in construction.

Furthermore, alternatives were hard to come by, in part because sight lines from the windows of adjacent residential buildings, which loomed over the rooftop, could not be compromised. On early diagrams, wide circles surrounded the roof representing those inviolable sight lines, acoustically protected zones, and existing roof elements. Locations for our sizable air-conditioning units were limited.

Our team had considered all of this.

Knowing how the superimposed loads could be supported, and after decades of dealing with the encyclopedic New York City building codes, we proposed a single dunnage platform that could hunker down into the narrow permissible construction zone left after we accounted for field constraints.

Our team began to refer ironically to this isolated island of roof as the "Demilitarized Zone" or "DMZ"—and it stuck.

Opposite page: Two W27 girders 33 ft apart span from parapet to parapet, transferring the load directly into the brick bearing walls. They support an upper level of steel upon which the new air-conditioning units are mounted.

Below: To accommodate the nearly 4-ft change in elevation between the parapets, one end of the platform required vertical posts and lateral bracing. Also note the upper level steel cantilevering 7 ft beyond the girder.

BIG City

While the initial design challenge may have been vexing, the Shmerykowsky team couldn't help but sympathize with nearby residents. As New Yorkers who have lived cheek by jowl with industrial and commercial buildings, our engineers know all too well what can happen when designers fail to consider the burden of a project falling on adjoining spaces if they leave a living room window facing a brick wall or a heating duct clamoring relentlessly through the night. Our DMZ solution was clearly one of those moments when one's personal and professional sympathies aligned.

Our final design called for using the building's brick bearing walls on the north and south perimeters as the bearing points for the new platform. This concept benefited from the fact that each perimeter wall was solid brick and continuous to the building's foundation. There were no penetrations or transfers to affect the load path from the roof level. Moreover, by bridging the 50-ft distance with one clear span, the dunnage steel would avoid routing new superimposed loads into the building's cast-iron columns and timber framing.

From Theory to Reality

The first step in turning the design concept into reality centered on another examination of the existing conditions. Although the new mechanical units themselves could be placed within the DMZ, the supporting structural steel would have to thread its way past roof obstructions including stair bulkheads, skylights, and abandoned chimneys. Additionally, the existing parapets sloped downward from west to east. With these constraints, it became apparent that any new platform would be limited to a total of four support locations on the existing brick walls. In order to accommodate the nearly 4-ft change in the elevation between the parapets, one end of the platform would require vertical posts and lateral bracing for stability.

The next constraint was related to the length of the mechanical units themselves. When placed in a straight line with the required

Marco Shmerykowsky is a principle engineer at New York-based Shmerykowsky Consulting Engineers.

clearances between the units, a 47-ft-long platform was required.

Yet the space between the two 50-ft support girders was limited to 33 ft. We could take advantage of the inherit strengths of continuous structural steel, however, by placing the dunnage rails that support the mechanical units on a second level. This would allow one continuous section of steel to cantilever the required 7 ft beyond the supporting girder on either end without the need for costly moment connections.

Once these general parameters were addressed, the design of the platform became straightforward. Four 47-ft-long, continuous W14 sections composed of ASTM A992 Grade 50 steel were arranged in the north-south direction. The inner two beams were aligned with the vibration isolators mounted along the east and west edges of the new mechanical units. Two additional W14 sections were placed parallel to these beams to form the outer supporting edge of the maintenance access catwalk, which parallels both sides of the units. To provide lateral stability to this level of steel, a set of horizontal 4-in. by 4-in. double-angle diagonal bracing members were added. This upper level platform is supported by two W27 girders, also consisting of ASTM A992 Grade 50 steel, which span from parapet to parapet. The girders were sized so as to limit vertical deflection due to the superimposed loads from the mechanical units. These girders also needed to accommodate the superimposed loads due to lateral wind loads. Additional horizontal diagonal bracing was added to the lower level steel to provide stability.

Finally, in order to engage adequate bearing area at the support points along the brick wall, a pair of ⅜-in.-thick gusset plate wings were added at the ends of the W27 girders. The northern support points could rest directly on the parapet walls. The southern ends required vertical posts consisting of 10-in. by 8-in. hollow structural sections. Diagonal vertical braces were added at both post locations in both directions to provide lateral stability.

Although the majority of the dunnage installation was accomplished with minimal penetrations into the roof membrane, the design team was forced to consider its component parts when determining the placement of the air-conditioning units' attendant air ducts. As mentioned above, the building itself was framed by a series of iron columns running up to a wide timber girder, which spanned from the east to west

Four 47-ft-long, continuous W14 sections form the upper level. Two inner beams are aligned with the vibration isolators mounted along edges of the new mechanical units. The other two beams form the outer supporting edge for the steel grate maintenance access catwalk that parallels both sides of the units.

sides of the roof structure. A series of joists stretched perpendicular to the girder and delimited the spaces through which the air ducts could be introduced. Luckily for the engineers, there were no existing mechanical components to cause additional complications, and the four proposed ducts were easily sized and fitted between the joists. The platform's central location on the roof surface proved to be a boon for the design team as a whole, as the ducts could be installed so as to provide the floors below with optimal air flow and distribution. In the end, the DMZ, regardless of sight lines or acoustical zones, proved to be the ideal location for the dunnage platform. Somehow, New York City building codes actually made the final product more efficient to construct and easier to sustain.

Though far exceeding the average dunnage platform in both complexity and scope, the project remains a point of pride for other reasons, as well. Structural engineers, in most cases, don't get many chances to unleash their creative imagination in the design process. Often we are called upon simply to review and approve a design, not to devise radical solutions. In this case, we got that opportunity and we nailed it.

The triumph might seem modest and the project small, but examining these less ostentatious uses of steel can sometimes widen one's perception of the sheer variety of its uses. Structural steel not only frames the most innovative, breathtaking skyscrapers of our day, but also allows less eye-catching structures, the legacies of our predecessors, to live on.

They might not make headlines, they might not shout from the covers of our daily tabloids, but make no mistake—projects like these preserve and enrich New York's multi-generational cityscape. In such a big city, the little things matter, too. MSC

Structural Design
Shmerykowsky Consulting Engineers, New York

Architect
Gensler, New York

The finished installation: a single, efficient dunnage platform hunkered down into the narrow permissible construction zone.