Cast Steel Best Choice

To go from concept to reality required tubes and nodes that provided the necessary properties at reasonable cost. The first thought was to use carbon steel elements coated with corrosion-resistant paint. But then the building would be subject to periodic inspection, which the client feared would discourage prospective tenants. Weathering difficulties precluded the use of cladding methods and various special materials. The choice finally fell on stainless steel.

Initially, two alloys seemed to qualify: a cast alloy with a nominal composition of 25 Cr, 5 Ni, 2 Mo, and a wrought alloy, AISI 316 (nominal composition: 18/10/3). The cast alloy, with its tailor-made “recipe,” was chosen over the standard wrought alloy for two reasons. One was the unfavorable coefficient of thermal expansion of AISI 316—the cast alloy’s coefficient is less than two-thirds that of the wrought alloy—which would aggravate the problem of differential thermal movement. The main reason, however, was the fact that the casting process makes it easy to obtain tubes of many different diameters and wall thicknesses, as well as almost two dozen sizes of nodes. Fabrication of these components would have been lengthy and very expensive.

Lattice-Work

The lattice is composed of 44 prefabricated diagonal assemblies plus nine columns. Each column consists of two welded lengths of tubes, connected by welded crossbars. The tubes have outside diameters of about 7/8, 12 1/2, and 20 inches (194, 324, and 512 mm) and wall thicknesses ranging from approximately 1/8 inch (6 mm) in the small tubes to 2.5 inches (64 mm) in the columns at the diagonal joint connections. They were cast centrifugally; yield strength at 0.2% offset is 58,000 psi, tensile strength is 105,000 psi, elongation is 35%, and impact strength (Charpy V-notch) is 33 ft-lb at -4 F.

The architects’ design of the nodes was modified by the foundry to insure directional solidification and structural integrity without compromising the required performance. Varying in weight from 80 to 650 pounds (36-295 kg) depending on size, the nodes were cast to shape. Yield strength at 0.2% offset is 56,000 psi, tensile strength is 98,000 psi, elongation is 30%, and impact strength (Charpy V-notch) is 22 ft-lb at -4 F.

Assembled, the lattice columns weigh up to 14.3 tons; diagonal assemblies weigh up to 4.4 tons. Compression forces on the bottom of the columns reach about one million pounds (5000 kN) and 100,000 pounds (500 kN) at the K-joints connecting the columns to the diagonals. As it now stands, Bush Lane House is about 115 feet long and 52 feet wide. The elevator core, above ground, is a long, narrow, load-bearing element that supports the building on one side. Two columns support the building on the other side—and between the columns and the core is the required clear space. The plantroom rests conventionally on the core and columns and supports the lattice; and the lattice supports the rest of the building.

Constructing the Building

The very tight tolerances among the lattice, the curtain wall, and the floor frames required construction methods as unconventional as the design. The approach was to erect the floor steelwork first and then attach the lattice. The floors rose on temporary posts; the lattice frames were hung from the floors until assembly was complete. The tubes and nodes were shop-welded together to form the main assemblies, and bolted to each other at the site. Only after all the lattice joints and welds had been made was the load transferred to it.