STEEL going STRONG

Georges Axmann

The move towards higher strength steels has made structural shapes in ASTM A913 Grade 65 increasingly popular.

Over the last few years, ASTM A913 Grade 65 has been used in more than 70 projects throughout the United States. The trend toward steels with yields of 50 ksi and higher is reducing building material and construction costs—and making steel a more economical material. Depending on the application, the weight reduction for using 65 ksi material relative to 50 ksi is generally between 10 percent and 30 percent. For columns, weight saving is on average 15 percent; for trusses it is usually more than 20 percent, and can go as high as 35 percent. Thus 65 ksi shapes are used predominantly as columns in multi-story structures, as beams in short- to medium-span bridges and as diagonals and chord members in trusses.

For seismic applications, high yield strength steels offer an additional advantage: They allow structural engineers to optimize the design of the "strong column-weak beam" concept by using columns in 65 ksi material and beams in 50 ksi material. This can help the engineer implement the relatively new concept of "clean columns"—that is, choosing "stocky" columns that eliminate costly web reinforcing in the panel zone of moment connections. With clean columns, any cost increase due to the use of heavier column shapes (or in the case of 65 ksi material, heavier and stronger column shapes) is minimal compared to the fabrication time and cost savings from the elimination of web doubler plates.

Several case studies follow, illustrating the use of 65 ksi is recent projects.

RELIANT STADIUM

In August 2002, the United States' first retractable-roof football stadium opened its doors in Houston, TX. The 956' by 385' roof covers the 1.9-million-sq.-ft Reliant Stadium. The retractable roof is supported by super-trusses of A913 Grade 65 steel, and is covered with teflon-coated fiberglass fabric in order to reduce weight and overall cost of the roof. The primary roof consists of 14 trusses each 385' long, totaling 2,900 tons of steel. The retractable portions of

Opposite page: 199 Fremont Street, San Francisco, CA.

Left: 5 Times Square, New York, NY. (Featured in the December 2001 issue of *Modern Steel Construction.*)

Below: Reliant Stadium, Houston, TX. (Read more about Reliant Stadium's retractable roof in the November 2002 issue of *Modern Steel Construction.*)

Photo by Russ Anadorka

the roof consist of two sections of five trusses each, which come together at the 50-yard line. The retractable sections ride on rails supported by super-trusses that run parallel with the sidelines of the field and support the entire retractable roof. The two super-trusses have a length of approximately 1000' and are built with 7,100 tons of exposed structural steel comprised mostly of high-strength A913 Grade 65 shapes. Each super-truss, with a depth varying from 50' to 75' along the span of nearly 650', rests on two reinforced-concrete super-columns composed of 13 ksi concrete. The super-trusses cantilever 136' beyond each super column, creating four "armrests" for the retracted panels. Two barrel-vaulted trusses of 1,100 tons brace the super trusses outside the retracting roof area. The project incorporated 3,000 tons of W14×90 to W14×283 in A913 Grade 65.

5 TIMES SQUARE

Ernst & Young's 38-story, 5 Times Square building is located in the heart of Manhattan. It is surrounded on three sides by subway stations and adjacent to a landmark theater on Fourth Avenue. These space restrictions led the team to choose 40 12"-diameter caissons for introducing the load into the soil. A modified perimeter tube system and a braced core constitute the lateral wind-resisting system. The perimeter tube features two C-channels at the north and south faces. According to Thornton-Tomasetti Engineers, the braced system tends to be more cost saving in fabrication and erection when compared to a moment-frame system. By moving the lateral system to the perimeter, the leased space was maximized. On the eighth floor, the steel structure features a full-story-high, 90'-long transfer truss to pick up the load from three of the tower's bustle columns located on the west side of the building. The truss was needed to transfer the columns as well as the gravity and lateral loads to another part of the structure, due to a profile change of the building and the space below the eighth floor. A similar system was used between the second and third floors. The project incorporated 5,100 tons of structural shapes, of which 900 tons were A913 Grade 65 shapes up to W14×730.

745 SEVENTH AVENUE

Morgan Stanley Dean Witter (MSDW) set a fast-track schedule for a 32-story building at 745 Seventh Ave. in Midtown Manhattan: 25 months from the start of the foundations to occupancy. To stay on track, the project was executed by a negotiated team that bypassed the bidding process. The steel structure, comprising 12,000 tons of steel, was erected in only eight months. The lateral system consists of a braced core that is approximately 65' by 55' at the upper levels of the building and enlarged to 95' by 55' on the lower floors. Floor heights range from 13'-6" to 16'-6". Engineers solved torsion problems caused by the location and wind effects by placing larger steel columns in the corners of the core so the system could resist torsion by acting as a closed tube. The steel-framed structure has typical spans of 35' to 40'. The structure's hor-

AVAILABILITY OF A913 GRADE 65

Readily available	Available (check first)
W14 × 90 thru 730	W12 × 65 thru 230
W36 × 150 thru 439	W24 × 84 thru 370
W40 × 167 thru 503	W27 × 102 thru 129
W44 × 230 thru 335	W30 × 108 thru 148
	W33 × 130 thru 169

izontal framing and most core columns were 50 ksi steel, but gravity columns used A913 Grade 65 steel. The project incorporated 900 tons of shapes in A913 Grade 65 shapes up to W14x730.

199 FREMONT STREET

Bechtel's 199 Fremont Street Building is a Class A, high-rise office building located South-of-Market in downtown San Francisco. The 29-story, 510,000-sq.-ft building was completed in 2000, and is one of the first high-rise structures to be constructed in San Francisco since the late 1980s. Lateral-load resistance is achieved via a dual structural system, which includes a moment-resisting perimeter frame with an eccentrically braced frame core. The structural frame is configured to maximize the column-free space in the lower stories through several nine-story-high Vierendeel trusses in the perimeter frame. The design of the skyscraper incorporated wind-tunnel testing of a scale model to determine wind pressures on the structure. It also included structural testing of full-size beam-column joints for compliance with FEMA 350, the latest seismic design criteria for new buildings. The FEMA seismic design guidelines recommend A913 Grade 65. This high strength steel allows the optimization of the established "strong column-weak beam" design concept. By increasing the strength of the beams from A36 to A992 Grade 50, a strengthening of the column beyond that of the beam is required.

ASTM A913 also covers Grade 50, which is available with a yield strength capped to 65 ksi. Some advantages of A913 Grade 50 are superior toughness, ductility and weldability. A913 grades are generally weldable without preheating prior to welding—and are prequalified as such in the Structural Welding Code AWS D1.1.

The team detailed the beam-column connections with "dog-bone," reinforced reduced beam sections (RBS), which force the plastic hinge in beams during a quake. These solutions achieved large clear areas, material cost savings and earthquake safety. The project incorporated 2000 tons of structural shapes in A913 Grade 65 shapes up to W14×730. ★

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