

HSS: DESIGNS FOR THE 21st CENTURY



Cedar Point's new Millennium Force coaster uses 5,000 tons of HSS.

HSS HELPS GIVE CEDAR POINT COASTER RIDERS A 'MILLENNIUM' THRILL

Strength, Flexibility Make Newest Coaster a Real Record-Setter

Cedar Point—the giant amusement park and resort on Lake Erie near Sandusky, Ohio—is greeting the new Millennium with a new roller coaster that's a record-setter—even for a park that bills itself as America's Roller Coast®.

The Millennium Force is higher, faster and longer than any of Cedar Point's 13 other coasters. But the bottom line—as it is with all the park's rides—is safety. And that relies on the strength and smooth surface of steel Hollow Structural Sections (HSS).

The Millennium Force adds a new dimension to the Cedar Point skyline that's visible from miles away.

The new coaster's lift hill towers 310 feet above the flat, northern Ohio countryside. "It's a truly a dominating feature," says Monty Jasper, the park's Vice President, Maintenance. "There are only two other structures that are as high as 300 feet—our Power Tower and Space Spiral rides. And the Millennium Force really dwarfs some of our other coasters."

The Millennium Force was designed by a Swiss firm, Intamin, which has a U.S. operation headquartered in Maryland. The



coaster's ride is 6,000 feet long, and it hits a top speed of 92 mph. Its trains are pulled to the top of the ride's opening hill by a unique, elevator cable-type lift mechanism, then go into a precipitous, 80° drop that powers the remainder of the ride.

'HSS Helped Us to Do What We Wanted to Do'

Cedar Point's Jasper is enthusiastic about the use of HSS in coasters. "HSS helped us do a lot of the things we wanted to do with the Millennium Force," he says. "We wanted a ride that topped 300 feet in height, one that would be truly colossal in appearance and record-breaking in performance. HSS let us do that.

"The high strength-to-weight ratios of HSS let you go higher than you could with wood—the other traditional material for

coasters. The highest hills on wooden coasters are between 150 and 200 feet, and from my experience, that's probably pushing the envelope for wood. And HSS is more economical. With the strength of steel, you can do more with less."

Jasper says that the flexibility of HSS was also a factor in the design of the Millennium Force. "The variety of shapes HSS is made in lets you be very flexible in how you construct the towers and support columns. It's a material that's very easy to design and build with."

HSS is used for all of the rail on the coaster, and in its support columns and towers. In all, there are about 5,000 tons of hollow structural sections in the ride. There are 229 sections of track, each weighing upwards of 8 tons, and 2,413 HSS supports.

Track Designs Provide Strength as It's Needed

Jasper notes that three different track configurations were used, depending on the stresses involved in various parts of the ride. The simplest is two-pipe track—two running rails formed by 5" round HSS with walls 3/8" thick, connected by 6" square HSS "bents," or cross-members.

"We also have three-pipe track," he says. "In these, the two running rails are supported by a 'backbone' of round HSS, as large as 5" in diameter, beneath them. All are cross-hatched together into a triangular truss structure using sections of square HSS.

"The strongest design," he concludes, "combines the two running rails with two 'backbone' tubes connected by square HSS to form a rigid square truss that provides an extremely strong platform for the trains to travel on."

Sections of the coaster up to 100' in height are supported by single large HSS columns. Above that height, truss-work towers of round HSS and other structurals provide the support. Overall, the support structure has the strength to withstand G-forces in the range of 3-4



maximum generated by the coaster's operation. It's also designed to withstand winds of up to 75 mph.

Smooth Riding Surface Another HSS 'Plus'

Jasper says another big advantage of HSS in coasters like the Millennium Force is the smooth surface it provides for trains. "You can make the ride very, very smooth, if you want to," he says. "And you get a consistently smooth ride, year-in and year-out."

HSS for the Millennium Force was fabricated in the U.S., Germany and

Switzerland in sections that could be trucked to the park on the final leg of their journey. While these sections of HSS were shop welded, all of the connections done at the site were bolted which, Jasper says, makes erection easier and less expensive.

Even the sections of rail are bolted together. They're made with male and female elements that slide together and are bolted in place. Then the joints are hand-ground to a smooth surface that lets the coaster's trains fly along them.

