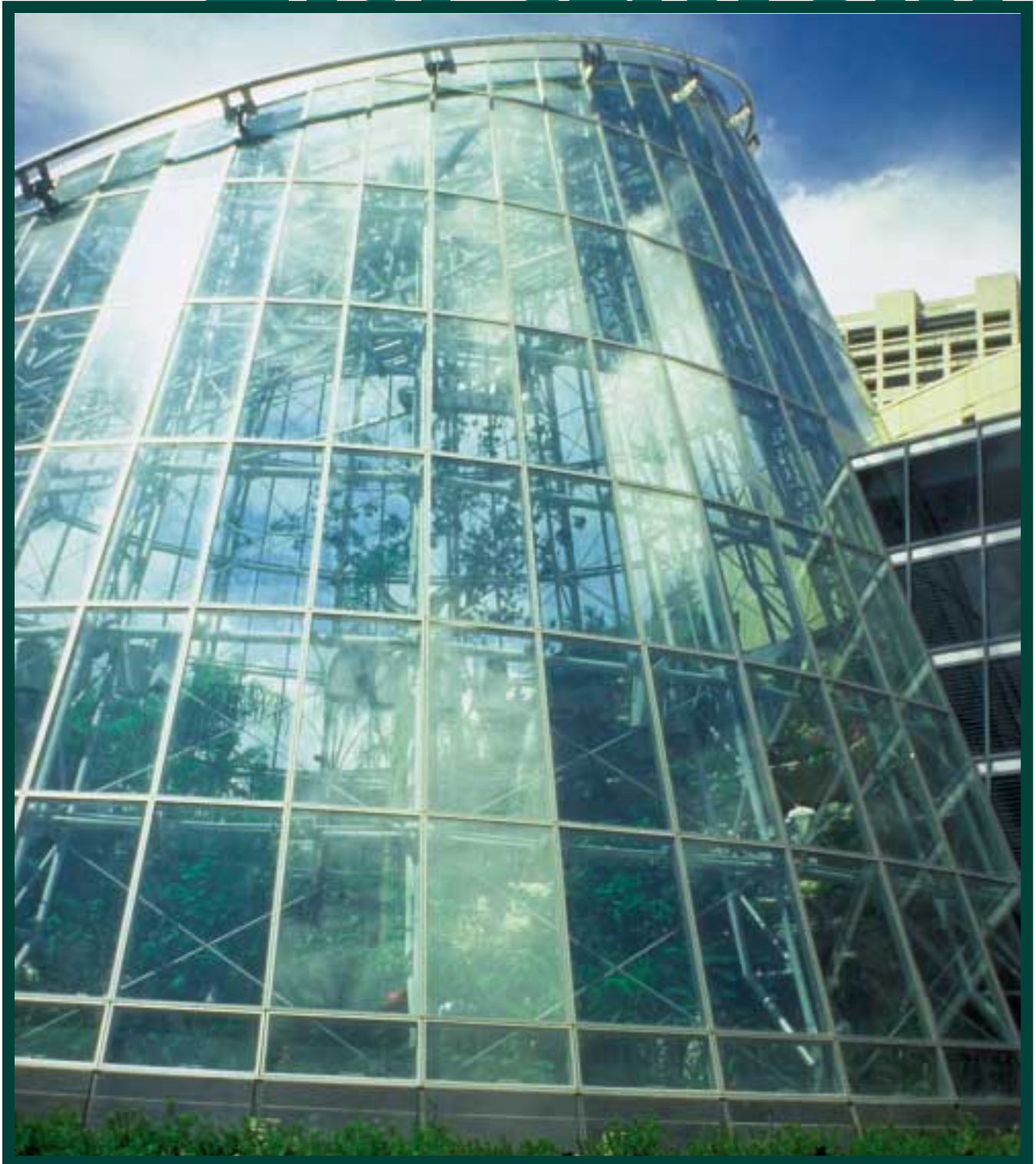
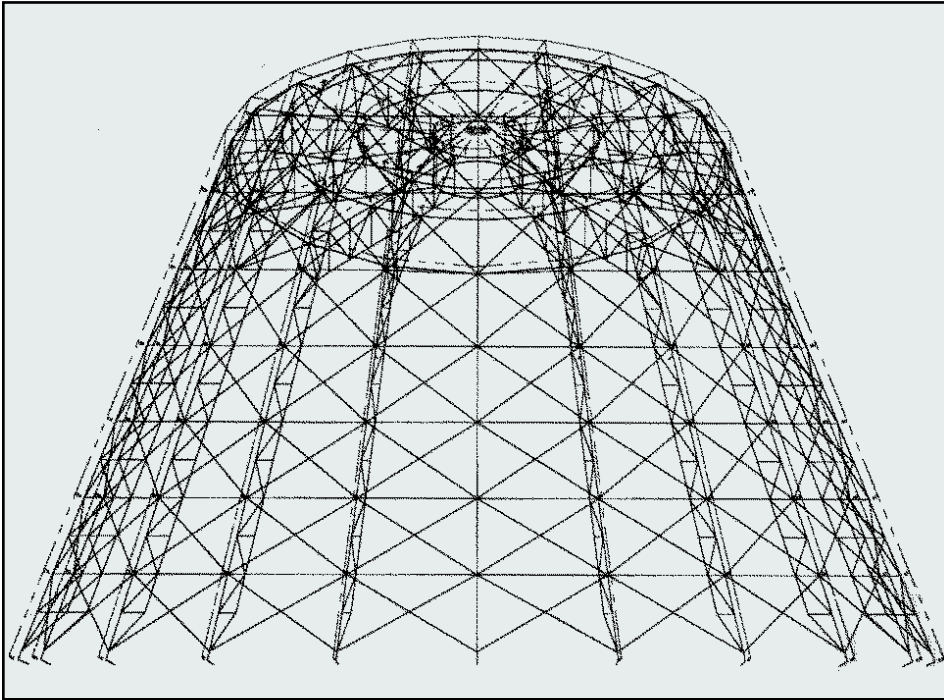


# HSS: DESIGNS FOR THE 21<sup>st</sup> CENTURY



*Cockrell Butterfly Center, Houston Museum of Natural Science, Houston, Texas*

# A TALE OF HSS AND BUTTERFLIES



## A STRUCTURE AS BEAUTIFUL AS CREATURES WHO LIVE IN IT

The designers of the Houston Museum of Natural Science's Cockrell Butterfly Center were faced with a one-of-a-kind problem.

They needed a structure that would look as delicate as the butterflies it would house; that would allow maximum sunlight and cast minimum shadow; that would simulate and sustain a fragile ecosystem 365 days a year, regardless of the local weather. And finally, they needed a structure which, for all its ethereal appearance, would stand up to the hurricane-force winds which frequently pummel Houston, Texas.

"Butterflies are incredibly delicate creatures," says Design Principal Normal Hoover of Hoover Architects, a 3D/I Company. "If you're going to build an environment exclusively for their health

and safety, you need to take into account factors which you simply wouldn't consider for any other kind of structure."

## Lots of Sunlight Important Consideration

"To begin with," he said, "butterflies are most active in bright sunlight — which is equally important for the plants which sustain them. This means using

materials which are themselves minimal, so that they cast minimal shadows. Of course, you have to use a lot of glass. But to support that glass, especially in a structure of this size, you need a material that provides excellent strength, but that is unobtrusive itself. Steel Hollow Structural Sections (HSS) filled the bill perfectly.

"And there's another bonus to the use of round HSS," adds Hoover. "Its surfaces are ideal for butterfly habitat. Why? Simply because when butterflies alight on angles or ledges, sharp corners can actually trap them and injure their wings. A circular surface is the ideal landing spot for a butterfly."

## HSS: The Ideal Frame for a Rain Forest

The Cockrell Butterfly Center, one of only two such habitats in the United States, is a 70-foot-high truncated glass and steel cone, built to withstand the Texas Gulf Coast's Class 5 hurricane winds. The structure is 105 feet wide at its base. As there are no perfect

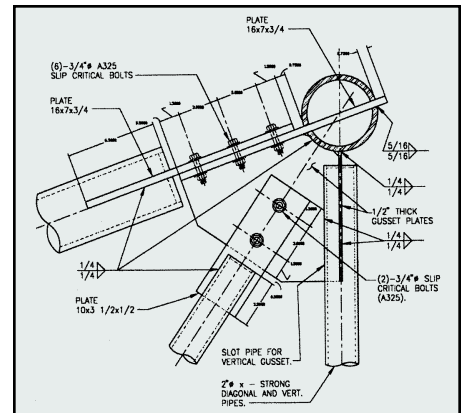
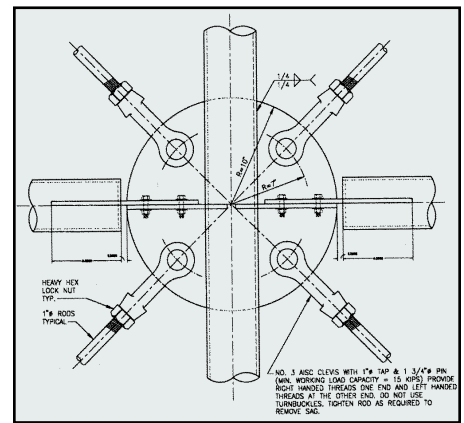




rectangles among the 588 individual panes of glass in the walls and ceiling, each pane had to be custom cut.

The building's frame is a series of vertical trusses, arranged radially

around the perimeter. The trusses, spaced on 16-foot centers, are fabricated of 4-inch diameter HSS which act as vertical chords, and 2-inch diameter HSS for web members. The trusses are reinforced with tension rods.



The structure supporting the slanted oval glass roof is integral with the overall superstructure, with sloping roof pipe trusses arranged radially to connect with the perimeter wall truss system. To minimize the depth, weight and cost of the roof, a central 10-foot diameter compression ring carries the roof loads and simultaneously provides an elegant roof pattern. Also, because the tropical humidity (kept at 80% to simulate the humidity in a tropical rain forest) that sustains the butterflies could pose a corrosion threat to the structural steel, all HSS was

specially painted—and gussets, clevises, turn-buckles and high-strength bolts were specially coated—to extend the structure's life and to minimize maintenance.

### **Center Has Attracted Over 400,000 Visitors**

The Cockrell Butterfly Center opened in 1994, and since then more than 400,000 visitors have walked along its twisting paths. Thanks in large part to the unobtrusiveness of the materials — and the excellent strength-to-weight

characteristics of the HSS — these visitors have had the rare chance of seeing an incredibly delicate piece of the natural world, protected and displayed in an artificial habitat.

Other principal participants in the Cockrell Butterfly Center, in addition to Hoover Architects, include the structural engineer, Walter P. Moore & Associates, Inc.; the contractor, SAE/Spaw-Glass Construction; and the project manager, Century Development.



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