

WHAT MAKES COWBOYS STADIUM NEWSWORTHY

Five Key Design Highlights

1. The stadium features **two monumental arches**, soaring 292 feet above the playing field, which support a retractable roof. As the longest single-span roof structure in the world, each arch box truss is 17 feet wide by 35 feet deep. Weighing 3,255 tons each, these impressive structures span 1,225 feet—nearly a ¼ mile—in length.
 - The arches are more than twice the length of the Gateway Arch in St. Louis. If the Empire State Building were to be laid down beside one of the arches, the arch would fall just 25 feet shy of the base of the building's famous spire. If the Statue of Liberty were positioned at the event level, the flame of her torch would lick the apex of the roof, 292 feet above the field. (*Illustration attached*)
 - Each 17-foot wide by 35-foot deep arch truss weighs 6.5 million pounds (the equivalent of twenty Boeing 777s) and is comprised of special high-strength Grade 65 steel (radius = 1024.25 ft) imported from Luxembourg.
 - Wide flange sizes up to W14 x 730 (730 lbs. per foot) -- the heaviest structural steel shape rolled in the world -- will be used.)
 - 50,000 bolts will be used
 - The south arch truss erection began in July of 2007 and was completed in October of 2007; the north arch truss erection began in November and was completed in late February 2008.
 - The 64,000 pound steel arch pin assembly is cast in a special sand mold, fabricated in Michigan and milled in Massachusetts.
 - Arch truss slurry wall foundation:

Each of the four abutment foundations bears the brunt of a 19 million pound thrust reaction. The foundations appear massive above the ground as a 25-foot by 11-foot solid concrete thrust block column launches out of the ground to receive the end of the arch. The real enormity lies hidden below the surface of the ground as the other side of the thrust block column is anchored to a series of concrete walls creating a buried box measuring 18 feet wide, 176 feet long, and 71 feet deep. Each foundation relies on the 3,400 cubic yards of concrete (or approximately 377 concrete ready mix truck loads) that comprise the box of subterranean 30-inch thick trenched slurry walls to transfer the thrust into the surrounding soil. This force transfer is accomplished through the bearing and friction resistances that grip the concrete mass holding it firmly in its place.
2. The **expansive retractable roof** is the largest of its kind in the world and measures approximately 661,000 square feet. When closed, the roof encompasses 104 million cubic feet of volume, making it the largest enclosed NFL stadium.
 - Two bi-parting mechanized roof panels – each measuring 290 feet by 220 feet (63,000 square feet) – will be driven by a rack-and-pinion drive system consisting of 64 7.5 HP electric motors, making it the first of its kind in the world. (Mechanization system designed by Uni-Systems)

The roof's 128 motors (32 per roof quadrant) each power a pinion that eases the operable panels down 328 feet of rack that is permanently attached to the arch trusses. As the moving roof progresses downhill, the slope becomes more dramatic as the arches maintain their constant radius curve. Twelve minutes later - when the two roof panels are parked in the opened position to reveal the iconic roof opening, the final slope endured by the rack and pinion drive system is 23 degrees.

The rack and pinion drive system must also power the retractable panels back into the closed position, conquering this 23 degree slope in the uphill direction. (Each of the 128 motors produces 7.5 horsepower, making the 960 horsepower required to close the roof roughly equivalent to four Ford Mustang engines.)
 - The roof is doubly symmetric, which aided economy. In addition, even though each of the 35 planar fixed trusses in each doubly symmetric quadrant of the structure are of different lengths, the segments between splice points have been modularized to allow fabrication of repeating segments of trusses. Each end segment, however, is unique to accommodate the unique length.
 - The roof is designed specifically to emulate the current Texas Stadium opening which is recognized around the world. From directly above, the entire playing field can be seen and the opening itself is visible from an elevation of five miles.
3. The stadium features the largest retractable end zone doors in the world.
 - Each has a five-leaf, clear, retractable opening measuring 120 feet high by 180 feet wide.
 - The five 38-foot panels take only 18 minutes to open or close.
 - By using clear glass for the door panels, spectators experience panoramic vistas from within, and the operability provides air circulation during game-day and non-game-day events.
4. One of the most compelling architectural features of the stadium design is the **canted glass exterior wall**.
 - The 86-foot high glass, curtain-wall surface slopes outwardly at a 14 degree angle to create a luminescent glow day or night.
 - A fritted glass system transitions up the elevation to create a dynamic, ever-changing aesthetic depending on the time of day. At night, a series of internal lights washes the glass wall to create a glow across the façade.
5. Within the seating bowl, Cowboys fans will be provided with a one-of-a-kind feature unlike any other in the world, a **center-hung video board**.
 - Hanging approximately 90 feet above the field from the roof structure, the innovative video center spans between the 20-yard lines and features four individual boards—two facing the sidelines, 160 feet wide and 72 feet tall, and two facing the end zones, 53 feet wide and 30 feet tall, totaling over 25,000 square feet of display area
 - All four boards are angled toward the stands for optimal viewing. The stunning combination of these boards will immerse spectators with video imagery, creating a premium on upper level seats and presenting the game in a way never before experienced.

Innovative solutions to additional design challenges:

- **COMPLEXITY OF LONG SPAN + RIGGING + VIDEO BOARD**

Inherent in the design of any covered stadium is the complexity of conquering the long span over the bowl and event area without obstructing views. Adding the owner's desire to make a bold design statement with the main roof span resulted in perhaps the central challenge of the design: the 1,225-foot twin arch box trusses that will support the longest single-span roof structure in the world upon completion.

Commanding such a span to efficiently defy gravity given its own weight and the weight of a "simple" fixed roof is difficult enough, but add a moving roof to the equation, and the span begins to object. Now add show rigging loads at the arches' center and the trusses' protests gain intensity. Finally, request that the twin arches permanently support the world's largest center-hung video board.

Even with the arch trusses themselves placated, the structural design team was still left with the responsibility of getting the 19 million pounds of thrust generated by the arch trusses at each of the four supports into the ground.
- **EXTREME LOADS**

The nearly quarter-mile span of the twin arched box trusses represents a substantial structural challenge under any loading scenario, but the extreme loads and the variable conditions generated by a moving roof augments the task.

Along with the fixed side roof and fixed roof over the end zone seating areas, the trusses permanently support the 1.2 million pound center-hung video board. In the instance of an event requiring show rigging, the arches must carry an additional 200,000 pounds that can be placed in dozens of unique configurations. The variability of the placement of this load added dozens of load combinations to the structural analysis, but these changing loading scenarios did not complicate the design as much as those imposed by the operable roof.

The fixed side roof and fixed roof over the end zone seating areas are held aloft with planar trusses that are oriented so that they always remain perpendicular to the curving surface of the roof. This varying cant always matches the radial configuration of the arch truss creating an elegant sweeping structural system. The arch trusses feature an argyle pattern of web members along each vertical side – one of the world's most ancient three-dimensional spacing patterns.

Each 17-foot wide by 35-foot deep arch truss weighs 6.5 million pounds. For a span of 1,225 feet, a 35-foot structural depth is actually quite diminutive. Use of the arch, however, yielded an effective depth of arch action of 225 feet. Leveraging this concept allowed this monstrous network of steel to gracefully and efficiently carry the extreme loads imposed upon it through a combination of bending and axial arching action down to colossal abutment foundations at each support.
- **VIDEO BOARD BOX TRUSSES**

The 72-foot tall center-hung video board with over 25,000 square feet of video displays looms over the football field in an enormous "I-shaped" plan that extends from 20-yard line to 20-yard line. The structural design team created essentially a 72-foot tall steel structure that contains a ten-level network of catwalks and is clad on all sides with video displays. Behind this dynamic cladding lie full-height trusses that carry the entire gravity load to the video board's support points.

The entire video board assembly weighs in at 1.2 million pounds. Three-inch diameter steel cables grip each end of the video board structure's "I" shaped plan and extend vertically up toward the opening in the roof. In one of the best examples of blending modern and traditional design for the Cowboys' new venue, the cables are tethered to large steel box trusses that span the 256 feet between the twin arch trusses. The inclusion of these video board box trusses reflects the traditional box trusses that sweep across the opening at the Cowboys' original home, Texas Stadium.
- **COWBOYS ICONIC HOLE IN THE ROOF**

While repeating the soaring cross spans from the original stadium was significant, retaining the "hole in the roof" - the iconic feature of Texas Stadium and an integral component of the Cowboys brand - was one of the most important design features to the owner. A firm desire also existed, however, to completely enclose the stadium to protect spectators from the blistering Texas heat and other weather phenomena. The design team accommodated both of these seemingly mutually exclusive desires with the sleek bi-parting retractable roof.