Another aerial view of the cable-stayed bridge as it enters the Salesforce Transit Center. Photo: Steve Proehl.

Innovative Structural Arrangements

The cable-stayed bridge is a side-by-side deck, single-tower structure. The main span consists of a 146.17-ft cantilever span over a park above the future underground train station. A 52.25 ft drop-in span over a local street was used to further reduce the weight imposed by the bridge on the SCT's supporting columns. The 127.17-ft-long back span is positioned over Howard Street. To limit live-load deflection of the cantilever span, a 91-ft-high concrete tower (from the deck to the top) is used with a single plane of cables along the centerline of the bridge deck.

The ladder-frame system of the bridge deck was constructed from two concrete box girders rigidly connected by a series of concrete link beams. To provide sufficient torsional rigidity of the ladder frame, the spacing of the link beams is set at 15 ft in the back span and 16.5 ft in the cantilever span.

The tower and the end pier are monolithically connected to the deck. This arrangement not only minimizes future maintenance work in this area but also enhances torsional rigidity of the ladder frame, which provides additional resistance to unbalanced live load and lateral seismic load in the transverse direction of the bridge.

The tower is supported on two 200-ft-deep slurry walls founded on bedrock. The end pier is supported on four 5-ft-diameter drilled shafts. Post-tensioned bars are used in the end pier columns to resist tension from the stay cables during different loading conditions.

Technical Challenges

The structural isolation of the cable-stayed bridge from the STC added complexity to the design of the expansion joint between the cable-stayed bridge and the drop-in span. The expansion joint should allow for movement in all directions, and the free end of the bridge is expected to move more than 2 ft in the transverse direction during a seismic event. A modular type of expansion joint with dovetail-shaped joist boxes was chosen so that the free end can move in both longitudinal and transverse directions.

AESTHETICS COMMENTARY

by Frederick Gottemoeller

According to the project profile, the Salesforce Transit Center is intended to be a visionary project that will transform downtown San Francisco. Thousands of people will be moving through the center every day on foot, or by bicycle, car, or bus on their way to or from their bus or train. The quality of their experiences will be an important factor in whether they judge the center to be a success. They will be moving through sidewalk and street spaces whose "ceiling" is the underside of the bus ramp bridge. Therefore, the bridge's appearance from below is its most important aesthetic feature.

The designers have recognized this fact in both their overall conception of the bridge and in the structure's details. The choice of a cable-stayed structural system was driven largely by the limited space for foundations, but it also constrained the number of vertical supporting elements below the bridge. That keeps open the sight lines through the structure, making the area below seem safer and more spacious. The concrete box girders conceal all of their internal bracing and provide a smooth, light-colored reflective surface overhead, while their curved outer webs allow daylight to penetrate under the bridge. The curved webs also make it difficult to judge the actual depth of the structure, so the bridge seems thinner than it really is. Finally, using cable saddle boxes instead of individual stay anchorages at the tower keeps the tower relatively thin and in proportion with the rest of the bridge.

But the designers' real stroke of genius was leaving the median open and exposing the ladder-frame system of the bridge deck. This design brings daylight into the space under the bridge, while showing off the structural elements of the system. The role of the tower in supporting the stays and the roles of the stays in supporting the deck are crystal clear. The elegant stay-link beam intersection and simple stay-anchorage detail make their roles even more obvious.

Inserted among numerous 50-story skyscrapers, and adjoining the five-block-long Salesforce Transit Center, the bus ramp bridge can't compete with its neighbors on size. However, by borrowing from the curved-surface vocabulary of the transit center, the bridge's dramatic and carefully detailed shape certainly competes on elegance. The bridge will become a well-known and popular landmark in this urban scene, and a captivating lesson on how bridges work.