MIAMI AVENUE OVER THE MIAMI RIVER

by

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It would seem appropriate to give a reader an appreciation of the setting in which this bridge is located and thus the importance for the design features implemented.

The Miami Avenue crossing of the Miami River is located in the central business district of the City of Miami. It is one of three major north-south collector-distributors feeding the central business district; the other two being Brickell Avenue-U.S. 1 and S.W. 2nd Avenue.

Over the past series of years, the downtown area of Miami has undergone significant change with considerable construction taking place. With the completion of the first phase of the Dade County MetroRail System, the Downtown People Mover now nearing completion, and the construction of numerous public and private highrise office buildings, convention centers, parking facilities and condominiums, the architecture and skyline of the City of Miami has undergone significant change. With the local County Government being the owner, one major concern was the operating system and its reliability and ease of maintenance for the bascule span. With this considered, one can then realize the concern and attention given to the bridge and its approaches during both the design and construction phases.

The players involved in this project are as follows:

- Metropolitan Dade County - the Owner
- Florida Department of Transportation - Plans Review and Construction Administration
- FHWA - Funding
- United States Coast Guard - Permitting
- Kunde, Sprecher, Yaskin & Associates, Inc. - Design Consultants
- Capelletti Brothers, Inc. - the Prime Contractor
- Sheffield Steel - Steel Fabricator
- Signal Construction, Inc. - Electrical Systems
- Circuit Engineering and Rexroth - Hydraulic Subcontractor
- Steward Machine - Trunnions, Trunnion Bearings, Buffers, etc.
- Ebsary Foundation - Coffer dam, Seal, Fender System
- VSL Corporation - Retained Earth Walls

Project design requirement was to connect one-way pairs both north and south of the river at a common point, providing a six-lane facility over the Miami River. The Coast Guard required a 90' horizontal clearance with the river skewed at 40°, and 21' of vertical clearance at the fenders. With this significant amount of channel skew it was decided to design twin bridges side by side providing for northbound traffic on the east half and southbound traffic on the west half. This allowed the designer to separate the bascule piers and leafs staggering them to minimize the span length for each bascule span. Even so, the distance between face to face of bascule piers is 174 feet and a centerline trunnion to a centerline trunnion distance of 195'-0". The effect of this is to create two, double leaf bascule bridges, or four nearly identical bascule leaves. It should also be noted that the resulting center line vertical clearance to Mean High Water was 27'-10". In addition to providing clearance for marine traffic, the bridge is extended both north and south to provide on the north side, for the riverfront walkway to pass beneath the bridge and on the south side to provide for southeast-southwest 5th Street to pass under the bridge.

The cost of the project will exceed $14 million when completed. The price tag for the bascule span including the four bascule leaves, bulkhead, fender system, control tower, bascule piers is in excess of $5.5 million or approximately $220 per square foot. The project, was designed and constructed in four phases. Phase One the removal of the existing bridge. Phase Two the construction of the bascule span. Phase Three the construction of the approaching bridge and retaining wall section. Phase Four the approaching roadway.

To give the reader an idea of the magnitude of this project, the following quantities of materials for the bascule span were required.

1) 1,150,000 pounds of structural steel, A36 or A588

2) 6,812 cubic yards of concrete

3) 500,000 pounds of epoxy coated reinforcing steel

4) 15,000 feet of steel H-pile.

The total weight of each of the four leaves is approximately 1,500,000 pounds when fully assembled.

Significant Design Features

Aesthetics was of major concern in the selection of the bridge structural system and details. Dade County was committed to having a local architectural review board review plans and aesthetic features. They had an obligation of obtaining approval from the Miami City Commission, the Dade County Commission and the Miami River Marine Council for the bridge appearance.

Since the bridge approaches were totally behind bulkheads, a 20" deep poured-in-place concrete flat slab superstructure was selected as the spanning system for the approach spans. Span lengths were set at 42 feet. Each half of the bridge was supported by two, 2-foot wide 8-foot long columns with pier caps partially recessed and poured integrally with the superstructure. The superstructure was designed and constructed as a 3, 4, 5, and 6 span .ontinuous element depending on location. The net result was to provide a beamless, flat surface when viewed from below with an uncluttered appearance due to the relatively few columns. The bottom edges of the slab was rounded and a concrete parapet, 2'8" in height, was poured atop the slab with a 10" high aluminium handrail above. Pier caps cantilevered 12-14 feet. At the face of the columns the pier cap extended below the superstructure slab approximately 2'-4' feet. The bottom surface of the pier caps was then tapered so that at the edge of the superstructure the pier extended below the slab 6". In some instances, pier caps were extended beyond the face of the parapet to support light poles, safety gates, and warning signs. Thus, in profile, the bridge provided an exposed surface of approximately 4'-4" with an aluminium handrail above. The approaching roadway was confined between retaining walls. Retaining walls were constructed utilizing the retained earth propriatary wall system. The slab and parapet configuration was continued off the bridge and down the approachs atop the retaining walls. The exterior face of the retaining walls were recessed approximately 6" inside the exterior face of the parapet. In addition, the parapet configuration of the approaching superstuctures was carried across the bascule leaf. This was accomplished by attaching curved steel plates to the exterior of the bascule leaf. To further enhance the appearance of the bridge and to provide for the continuity of the bridge parapet when viewed in profile, starting with the retaining walls continuing across the bridge approach spans and finally across the bascule leaves, an applied finish coating will be utilized. The finish coating would be applied in two textures, each texture in a different color. A beige color was selected for the fine textured surfaces which included the parapet surface and under bridge surfaces, including the steel plates across the bascule leaf. The second texture will be a medium (coarse) texture in a dark brown color. This is applied to the recessed retaining wall surfaces, pier cap and pier column surfaces, which would thus highlight the beige fine textured surfaces. The structural steel behind the parapet surfaces of the bascule leaves are to be painted black - again to highlight the parapet surfaces.

As an additional aesthetic feature, an isolated idependently supported control tower was designed. Past convention has been to cantilever the control tower structure off of one of the bascule piers. In this instance, cost studies showed the independently supported structure to be more economical. The overall appearance of the control tower is similar to that of an airport control tower. Bronze glass and mullions and a bronze metal roof is utilized and fit quite nicely into the color scheme of the overall bridge.

The next significant design feature was the selection of hydraulics as the prime system for operating each of the four leaves. Four 8" cylinders are used to operate each of the four leaves.

Each bascule leaf is provided with its own hydraulic system. In the original design and the contract documents, a closed loop hydraulic system was indicated. The contractor and his subcontractor, Circuit Engineering, proposed the use of an open loop system, which was submitted as a value engineer alternative. While no substantial cost reduction was obtained, it was clear that approximately a 50% reduction in hydraulic components would be realized. This indicated a substantial cost savings over the life of the structure with fewer components to maintain.

As a measure of safety, the system was designed to operate at low pressures and the system fabricated using high pressure components. Each system is equipped with two c-face style, 25 horsepower electric motors and two variable displacement open loop axial piston bent axis design Rexroth pumps. Motor and pumps are mounted on vibration absorption supports and pumps are connected to rigid piping with flexible hose in an effort to minimize noise and the potential for fitting leaks. Pumps were required to provide constant horsepower control. Each system was also equipped with a 5 horsepower gasoline engine and pump as an alternate manual emergency method of bridge operation.

The hydraulic system was bid as a separate item with the total price tag for all four systems being $326,000. The design consultant, in evaluating this cost as opposed to the mechanical type system, believes the uses of hydraulics represent a cost savings in excess of $1 million. The horsepower control feature, a design requirement, yields a constant horsepower output from the electric motor and pump. This means that under all conditions of loading, be it starting friction, inertia, or wind, the system will continue to develop a constant 50 horsepower and when loads are high the pumps will automatically ramp themselves to a slower speed of operation. When loads are low the pumps will automatically ramp to their highest speed of operation. This is a perfect application and compliance with AASHTO design requirements, where under normal light load conditions the bridge is required to open in what is called "normal time of operation", usually 60 to 75 seconds. When loads are higher, such as a high wind load, the bridge is allowed to operate at a lower speed, not to exceed twice the time of operation. Automatic ramping controls are also provided which allows handsoff acceleration and deceleration of bridge when opening and closing.

Additional features provided by Circuit Engineering and Rexroth are as follows:

1) Hydraulic tanks were factor cleaned and sealed. Tanks are then shipped to the field and can only be filled through the system filters. Since fluid contamination is of utmost concern in any hydraulic system, this insures that tanks do not become contaminanted and that the system starts off with filtered fluid.

2) Manifolds were fabricated from steel blocks. Hydraulic components, such as meal valves, relief valves, counterbalance valves, guages, are subplate mounted to the manifolds. Manifolds are machined to accept these components and eliminate the extensive amount of rigid piping that would be necessary to interconnect each of them. This ultimately will reduce maintenance and eliminate the multitude of pipes and fittings which are areas of potential leaks.

3) Hyraulic cylinders are mid-trunnion supported cylinders. One would normally think and expect cylinders to be end mounted with a clevis type device. The idea of front trunnion or mid-trunnion supports reduces the long column effect of the hydraulic cylinder when fully extended. Front trunnion cylinders have been tried on other bridges and require extremely accurate alignment procedures. We have found that the mid-trunnion allows a more tolerable alignment situation while still reducing the long column effect.

Some redundancy has been built into the hydraulic system. We use two cylinders under each girder, four per leaf, two 25 horsepower motors, 2 hydraulic pumps and naturally two sets of controls. During the design process it became evident that load condition C, which includes the 10 pound wind force, was to control the maximum horsepower requirements for the bridge, with the wind load being 5 times greater than load condition A. It became obvious that a single, 25 horsepower motor was more than adequate to operate the bridge under normal load and time requirements.

All bascule bridges are susceptible to maintenance and repair problems and it can be anticipated that during periods of repair and maintenance bridges will be placed out of service, most likely in the open position, closed to vehicular traffic. The system has therefore been designed to provide the capability of removing one motor and pump and even removing two cylinders and still provide the owner with an operable situation. The bridge should operate in the normal time of operation when the loads fall into the normal category, and should continue to operate even when higher than normal loads are encountered without overloading pump or motor since horsepower control is provided.

Miami Avenue Bridge should be completed within the year and will provide its owners, the motoring public and the boating public with a highly reliable facility. Its appearance should enhance the Miami area and may even entice development in the immediate vicinity. The bridge is the second new major bridge in the state of Florida to utilize hydraulics as the operating system. There is a third bridge under construction in the Palm Beach area, a fourth on the drawing boards, and two existing state bridges for which plans for renovation include alternate hydraulic systems. It is hoped that by the next bridge symposium this paper can be updated with some operating history that will justify the effort put forth by all parties concerned.