AMERICAN CONSULTING ENGINEERS COUNCIL'S

AFFILIATE

HEAVY MOVABLE STRUCTURES, INC.

4TH BIENNIAL SYMPOSIUM

NOVEMBER 10TH - 12TH, 1992

SHERATON DESIGN CENTER
FT. LAUDERDALE, FLORIDA

SESSION
WORKSHOP NOTES

#41 Author: William E. Nyman
Hardesty & Hanover
"Erection of Bascule, Adjacent To Operating Swing Bridge"

SOUTH SLOUGH BRIDGE

ERECTION OF A NEW BASCULE ADJACENT TO AN OPERATIONAL SWING SPAN

Willaim E. Nyman, Hardesty & Hanover

Introduction

Built in the 1930's, the swing bridge at the crossing of Cape Arago Highway over the South Slough of Coos Bay on the south coast of Oregon served the travelling public well. Over the previous fifty plus years it opened over 200,000 times to allow commercial fishing vessels to pass from the South Slough out into Coos Bay and the Pacific in search of their share of the salmon, cod and other species bountiful just off the scenic coastline. This heavy usage made the South Slough Bridge the most frequently opened bridge in the State. But, a combination of frequent openings of the span, long vehicular traffic delays during peak summer tourist periods and harsh environmental factors made the bridge ready for replacement by the 1980's.

Design

After initial studies by the Oregon Department of Transportation, a replacement movable span on an alignment just north of the existing alignment was determined to be most desirable. The firm of CH2M-Hill of Corvallis, Oregon was retained to design the structure along with Hardesty & Hanover Consulting Engineers of New York City as a subconsultant responsible for design of the movable span. Since an eighty foot channel was found necessary for marine traffic, either a single or double leaf bascule would have served well. Hardesty & Hanover found, however, that the double leaf bascule would be more economical since it could be built with much smaller open backed piers without counterweight pits. In addition, considerable cost and time savings could be achieved by use of precast raised footings only possible with the double leaf scheme. The shorter overall leaf length meant working lower to the Slough level which reduced floating construction equipment size requirements. The symmetry of a double leaf bascule also generally makes it more aesthetically pleasing than a single leaf bascule and the two open leaves of the double leaf bascule offer improved safety as they serve to block vehicles from driving off of the end of an open bridge.

In order to allow continued crossing of the Slough by vehicular traffic and avoid a twenty six mile detour, the existing swing span had to be left in service during construction. The marine traffic also could not be interrupted except during a six week mid-winter period. With the close proximity of the old and new bridges and limitations caused in maintaining marine and vehicular traffic, the most viable scheme was erection of the bascule leaves in the open position with the existing swing span being allowed to swing below the open leaves during construction (see Figure 1).

The final design was completed in February 1988. After some delay required to secure funding, the project was awarded to General Construction Company of Seattle Washington in September 1989 at a total bid of $13.3 Million. Of this total bid, $7.7 million was for the bascule span including machinery, electrical controls, superstructure and substructure.

Bascule Pier Construction

Construction of the bascule piers and span would be on the project's critical path due to the generally complex nature of the work. The precast concrete approach spans would be erected quickly using conventional methods. With the bascule span being approximately 800 feet from the west shore of the slough and 600 feet from the east shore, work using land based equipment would be impossible. Work from the existing span was not allowed as this would hinder the flow of vehicular traffic. Therefore, the contractor was left with the option of either constructing a temporary work bridge or using waterborne equipment to access the area where the bascule span was to be built and keep the project on schedule. Waiting for the approaches to be constructed before starting construction of the bascule piers would have extended the schedule. The shore ends of the approach spans were over environmentally sensitive mud flats and had to be erected from temporary work bridges. With the remote location of the project, early dedication of expensive and potentially underutilized waterborne equipment to the project would have been uneconomical. Hardesty & Hanover's scheme of providing floated-in precast raised footings for the bascule piers not only reduced basic material and labor costs but it further reduced costs by allowing later mobilization and more efficient use of waterborne equipment in completion of the bascule span construction. The bidders were given an option of using deep footings at the bascule span. The deep footings would have been constructed using conventional methods including cofferdams with tremie seals. However, only one of the six bidders selected this option and they were not the low bidder. His bid was twelve percent higher than the average of the three low bids.

The raised footings consisted of one open topped rectangular concrete box for each of the two bascule piers (see figure 2). Each box is roughly 30 feet by 60 feet by 13 feet tall with 1'-0" thick walls. The bottom of the boxes are ribbed for strength and provided with thirty two 2'-6" diameter knock out plugs in the bottom to accept 24" octagonal piles (forty two piles were used at the east pier to accomodate the control house.)

The raised footing boxes were precast sequentially on a barge adjacent to the project site. The barge with the box on it was floated to a dry dock where the barge was sunk and the box floated off. A tugboat was then used to bring the box back to the project site. At the project site, the contractor had already erected temporary supports to hold the box roughly nine feet above the slough bottom. The contractor-designed support system consisted of a series of pipe piles lining the long sides of the box and underslung beams suspended from the box with allthread bars. This system allowed room to bring the box in from one end and allowed for ease of vertical adjustment. The box was moved onto the supports at slack high tide. The seating of the box on the supports was aided by the opening of two tide drain holes in the sides of the box. This assured uniform flooding of the box. As the box flooded, it came to rest on the supports. The knock-out plugs on the bottom of the box at the pile locations were then removed and the piles driven through the holes using the box as a guide. The bottom of the box was then sealed with a 2'-6" thick tremie and pumped dry. The footing reinforcement was placed in the dry and the piers constructed. Upon completion of the first pier, the temporary supports were reused for the second pier.

Steel Fabrication and Erection

With the leaves being erected in the open position, the possibility for misalignment of the leaves was increased. The actual mating of the leaves could not be verified until the steel erection was largely complete and the leaves lowered. Erection in the open position also called for simplified details which would allow easy assembly of the steel components in the awkward seventy degree open position. Tight fabrication and erection tolerances were necessary in order to assure success of the project. Complete shop assembly of the leaves was specified. This would allow verification of the alignment and fit of all components prior to shipping to the field.

The structural steel was fabricated by Oregon Iron Works in Clackamas, Oregon. The bascule girders were then shipped to Steward Machine Company in Birmingham, Alabama for assembly and alignment of the trunnions and racks. This careful shop assembly of the mechanical components to the girders resulted in an excellent alignment of trunnions, racks, pinions and other mechanical components at final assembly in the field. The girders were then shipped back to Oregon Iron works for complete shop assembly and shop application of the three coat paint system. The operating machinery was shop assembled to a common base and shipped to the field as a unit thus minimizing the time required for field installation and making it easier to achieve a proper alignment of mechanical components.

At the job site, the details designed to ease erection in the open position paid off. The bascule girders had no splice, reducing the chance for misalignment. After erection and alignment of the bascule girders, the counterweight box was installed with minimal effort by lowering it in from above and seating it on connection plates projecting from the counterweight box. All floorbeams were also easily lowered in from the top. Because the spans had been completely shop assembled and match-marked, the stringers and grating panels were easily erected with the span in the open position. The only major activities necessary during the six week mid-winter channel closure were installation and alignment of the lock machinery, welding grating panels together and placement of the epoxy mortar in the deck grating. A combination of good weather, a motivated work crew and adequate planning lead to a timely and successful completion of the project. The project was completed and opened to traffic in March 1991 six months ahead of schedule (see figures 3 and 4).

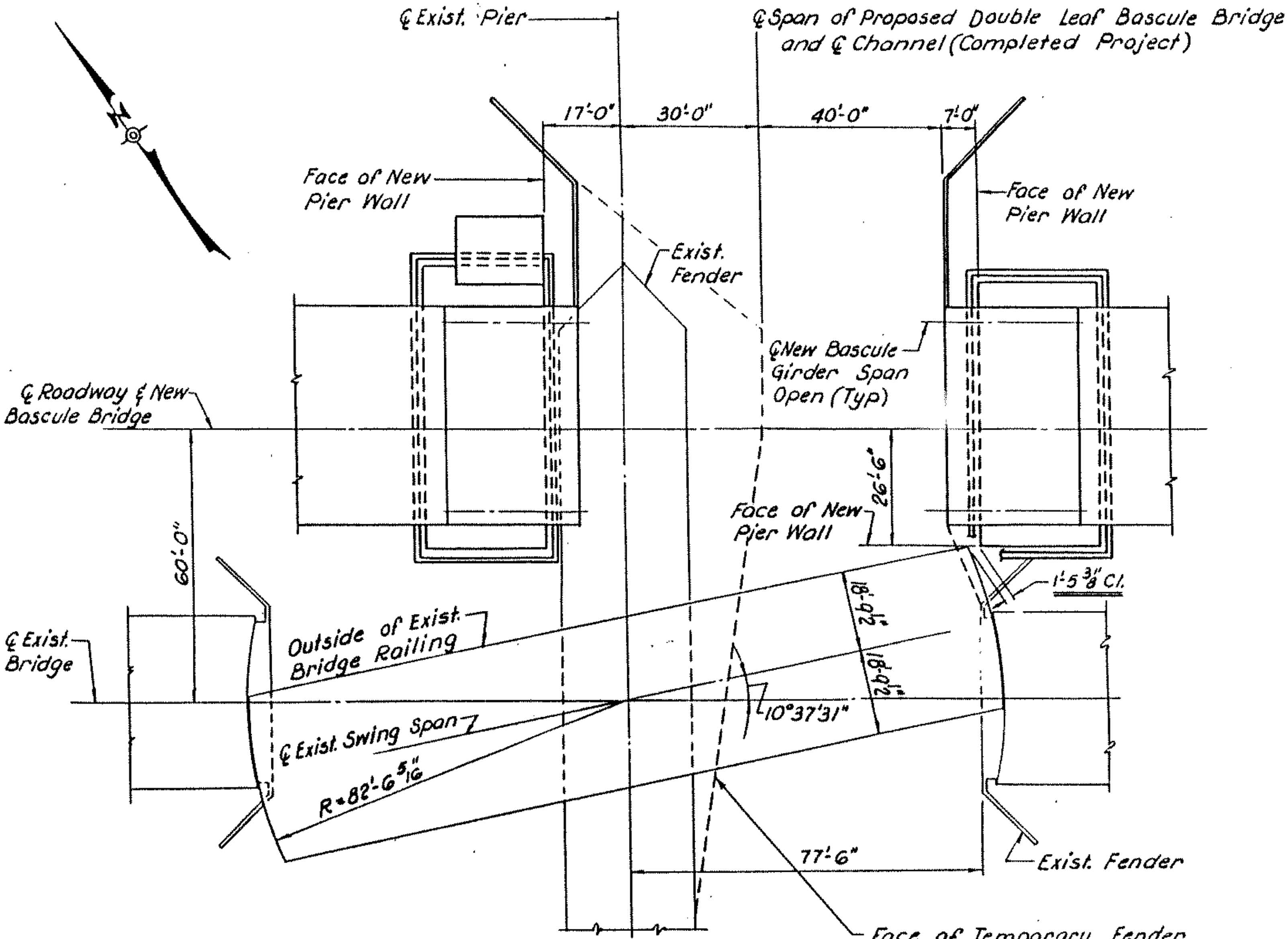
Movable Bridge Features

The new South Slough Bridge provides two twelve foot traffic lanes with eight foot shoulders and a single five foot sidewalk. The movable span is a double leaf simple trunnion type bascule with two tapered steel bascule girders and four floorbeams per leaf. The center to center distance between trunnions is one hundred twenty six feet. A forward live load bearing reduces the cantilever moment and deflections in the bascule girders under live load. The roadway deck is a half depth epoxy filled grating with a 1/2 inch thick epoxy grit overlay. the roadway deck is carried by eleven steel wide flange stringers. The sidewalk deck consists of steel orthotropic plates topped with an epoxy grit surface. The trunnions are supported on bearings with spring loaded caps mounted to concrete filled welded steel box columns. The spring loaded caps allow the uplift force caused by heavy loads to be transferred to the anchorage girders at the heel of the girders rather than being transferred to the bearing caps. The steel columns minimize the trunnion length, reduce the amount of intrusion of the column legs into the counterweight area as the span opens and simplify machinery alignment. A one inch thick welded steel counterweight box filled with concrete and scrap metal was mounted to the heel of each leaf. The bascule span provides a twenty two foot vertical clearance in the closed position and an unlimitted vertical clearance over the eighty foot channel in the open position. The flanking spans consist of tapered steel plate girders with steel floorbeams and stringers and a concrete deck. The flanking span floorbeam closest to the bascule span serves as an anchorage for the bascule girders under full live load. The bridge was designed using the load factor method to carry a HS-25 loading.

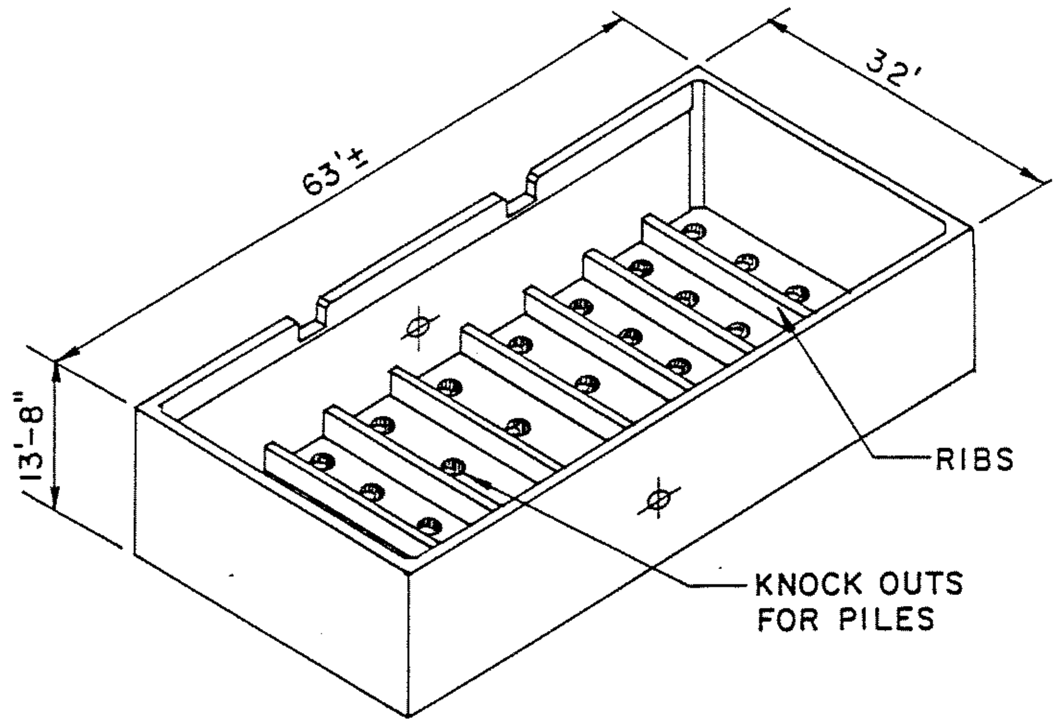
The bridge operating machinery consists of a single main reducer per leaf with shafting connected to the pinions. This simplified machinery allowed ease of fabrication and assembly. The electrical controls were made as simple as possible so that they would be familiar to crews operating and maintaining ODOT's older movable bridges in the area. The secondary resistance type controls were supplied by United Pacific Controls of Portland, Oregon.

Conclusion

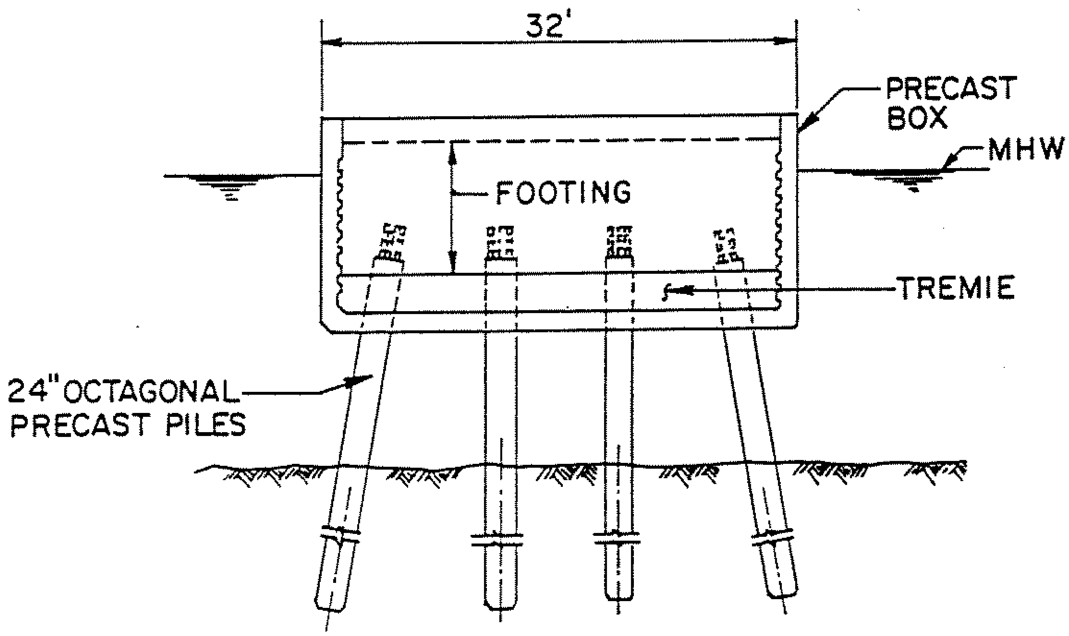
Disruption of local businesses and marine traffic was extremely limited during the year and one half construction period. This drew nothing but praise from the Charleston residents and businesses. The bridge operators, though sad to see the old swing span go, have been quite pleased with the ease of operation of the new bascule. Careful attention to architectural detail also paid off as the new South Slough Bridge provides a focal point for the Charleston community. The bascule girders deepen uniformly from midspan to the bascule piers where they meet the flanking span girders. The flanking span girders then taper uniformly to meet the approach spans. The lines of the approach span deck are gracefully carried around the bascule piers to meet a fascia weldment on the bascule span. Similar horizontal lines are incorporated in the control house to provide a simple yet pleasing appearance.



PLAN OF EXISTING SWING BRIDGE AND NEW BASCULE DURING CONSTRUCTION
(SWING SPAN PARTIALLY OPEN)

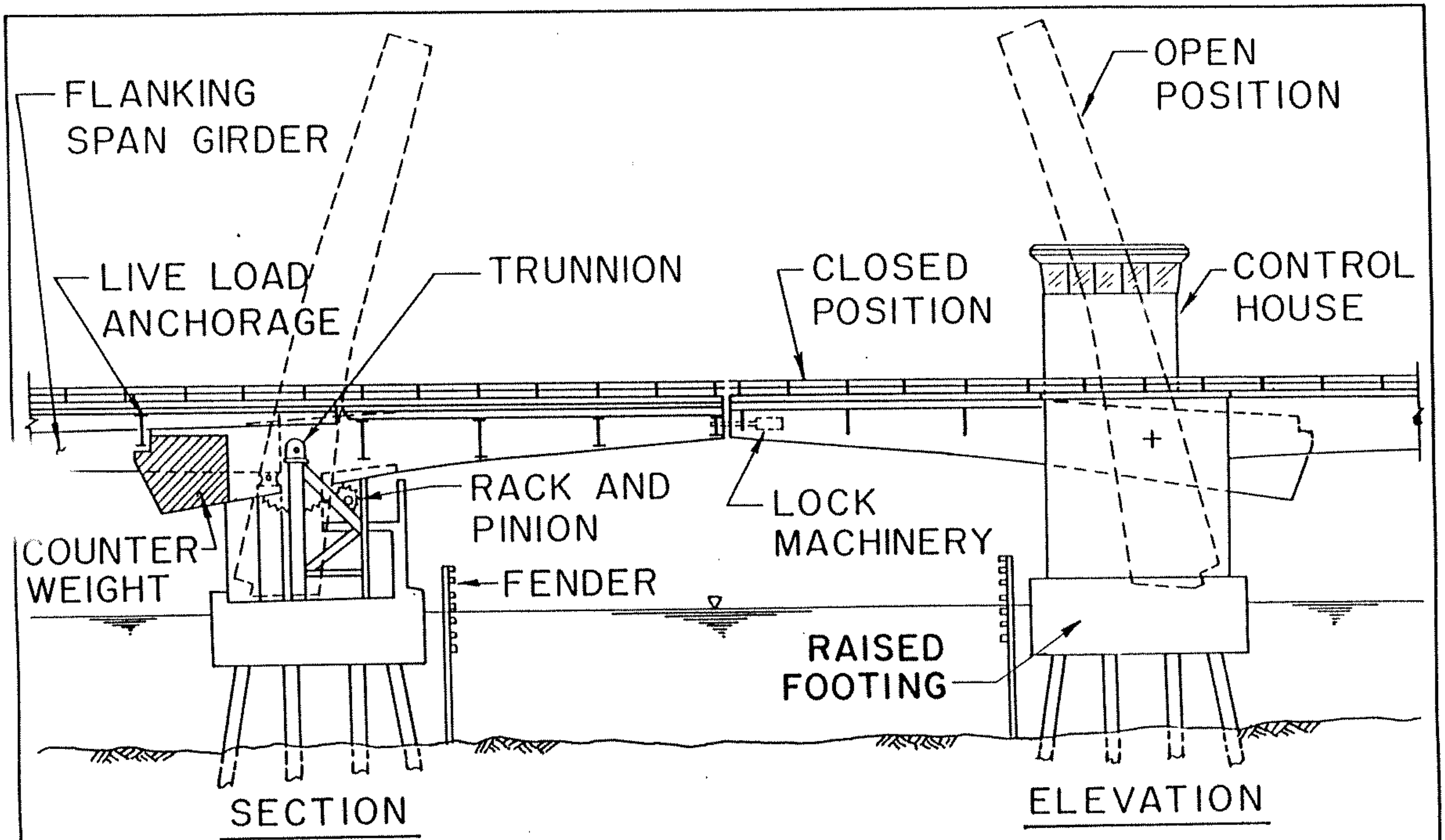


PRECAST BOX



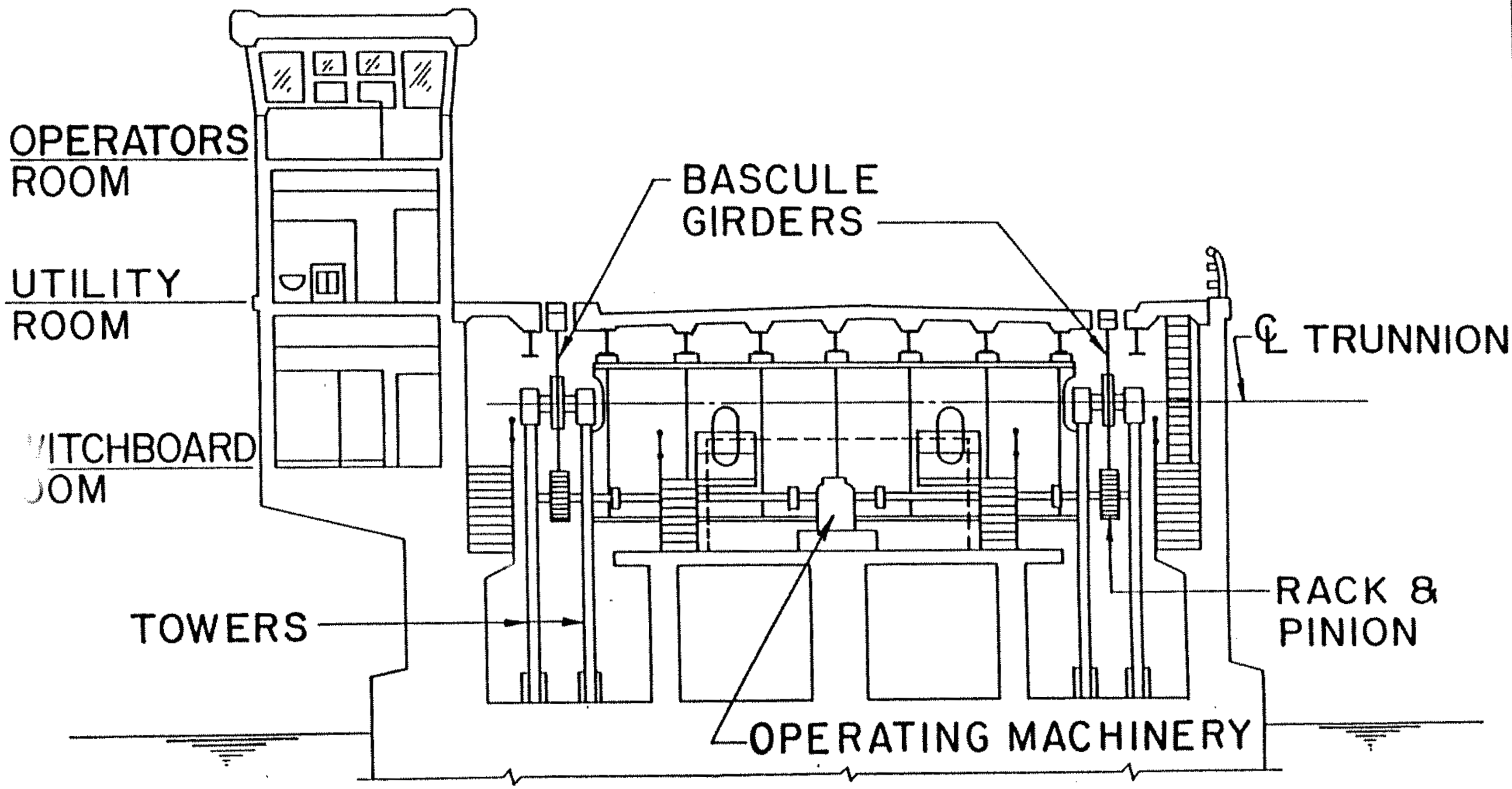
RAISED FOOTING

FIGURE 2



SOUTH SLOUGH BRIDGE

FIGURE 3



SECTION

SOUTH SLOUGH BRIDGE

FIGURE 4