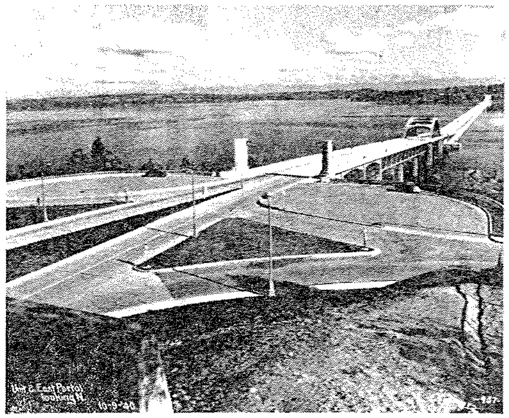
World's First Concrete Floating Bridge
Seattle—Mercer Island, Washington
Fiftieth anniversary of opening
July 2, 1940—July 2, 1990



Washington State Department of Transportation

LACEY V. MURROW FLOATING BRIDGE
Seattle-Mercer Island, Washington
HISTORICAL BACKGROUND

Open to traffic in July of 1940, the Lacey V. Murrow Bridge was the first floating bridge to be built on Lake Washington. At the time of its construction it was the largest and longest floating bridge ever built, and the first to be constructed of reinforced concrete. It was the largest single development ever undertaken by any state highway department in the Pacific Northwest, and one of the largest ever undertaken by any highway department. In contemporary publications, the Lacey V. Murrow Bridge was represented as one of "engineering's greatest triumphs," in the same category as Boulder Dam, the Golden Gate Bridge, the Moffat Tunnel, and Saint Paul's Cathedral.

As early as 1922, the necessity of completing the east-to-west transport route across Washington state became apparent. Snoqualmie Pass was the only route that remained open during the winter months, and heavy use of this route presented traffic hazards on the approach to Seattle from North Bend. Traffic was forced to detour around Lake Washington through six to seven miles of city streets and urban traffic; the route from North Bend to Seattle was then 42 miles long.

The problem focused on three main features: 1) how to cross Lake Washington; 2) where to cross Lake Washington; and 3) how to reach the city center of Seattle from the lake.

For several years the favored proposals were construction of a suspension span, or a high-span, jack-knife drawbridge from the southern end of Mercer Island to the Seward Peninsula in southern Seattle. However, the route presented additional urban traffic problems, and the cost for that time was fantastic -- between $35 million and $50 million to build a suspension span, with no precedent for such a bridge becausethe piers would have to rest in the lake's soft bottom, 400 feet below the surface.

In 1937, Homer M. Hadley, who had been a designer in a Philadelphia concrete shipyard, proposed to Lacey V. Murrow, then Director of Highways, that costs be studied for a reinforced concrete pontoon bridge crossing Lake Washington from the northern end of Mercer Island and piercing Mount Baker Ridge at its narrowest point.

The relative economy of a pontoon bridge arose from the problems presented by the lake itself: the water is 150 feet to 180 feet deep, and the soft mud on the bottom extends down nearly an equal distance. It was estimated that the pontoon bridge would be one-fifth the price of a conventional bridge structure. In addition, Lake Washington was considered favorable for pontoon construction since, unlike a river, the water level was regulated, there was no current and no drift to pile against the bridge, and there was no problem with ice.

During 1927, the comparable merits of wood, steel and reinforced-concrete pontoon structures were studied. Watertightness, low initial cost, maintenance and dead weight were evaluated. The greater dead weight of the reinforced concrete provided the advantage of greater inertia and therefore more resistance to rough surface conditions. Deeper immersion also meant a greater mass of quiet water on the lee side, which opposed any turbulence on the windward side. It became obvious that the combination of an anchoring system and the inertia of the massive structure itself would produce stability under storm and load conditions that would be far superior to that of either a fixed span or a suspension bridge.

The Lacey V. Murrow Bridge was advertised for bid in 1937 as part of the original "Lake Washington Bridge Project." The entire project was approximately six and one-half miles in length from its beginning at Rainier Avenue South in Seattle to the termination point in Factoria. It included the twin-bore tunnel through Mount Baker Ridge, the Lacey V. Murrow Floating Bridge, and the East Channel Bridge. The new route reduced the mileage from North Bend to Seattle by 14 miles, and by eliminating the urban intersections and traffic patterns provided a safer east-to-west connection.

The Lake Washington Bridge Project was broken down into 11 separate contract units, three of which (Units 3, 4, and 5) composed the Lacey V. Murrow Floating Bridge and approach structures.

By using a tied-arch design, the east and west approach structures (Units 3 and 5, respectively) were innovative for their time and -- costing nearly a half million dollars each -- were considered expensive. The tied-arch spans were more expensive to fabricate and erect than a standard span, but the design team realized their use was well justified by their overall appearance.

The absence of diagonal bracing was believed to contribute to their aesthetic appeal. The unique design of the approach structures incorporated torsionally-flexible transition spans to unite the floating pontoon sections with the column-supported structures on the lake shores. The spans were designed to withstand warping under the listing action of the floating pontoons without setting up detrimental stresses in the member of the span, or causing eccentric reactions on the floating unit supporting it. The floor beams and bottom struts of the deck were pin-connected at chord points. Two large segmental rockers (3-foot-8-inch radius) supported the trusses at the pontoon ends, which allowed for vertical movement in the pontoons as the lake level varied. A universal joint connected the segmental rockers to the trusses, allowing the transition span to follow movement in the pontoons. At the pier ends another segmental rocker (1-foot-4-inch radius) rested underneath the trusses, with a center pivot like a ball-and-socket joint at the midpoint between trusses. This system enabled the transition sections to absorb pontoon movement in all three planes.

Contract Unit No. 4 of the Lake Washington Bridge Project encompassed the most unusual and most expensive portion of the entire venture. Four contractors formed an organization to devise the ways and means of constructing and placing a floating concrete structure on Lake Washington on time and within specifications.

The 25 pontoon sections were constructed in two graving docks on Harbor Island, then owned by the Puget Sound Bridge and Dredging Company, one of the four joint-venture contractors. The docks were built side by side to enable them to be supplied from the same concrete batch plant. Outer forms were built inside the docks, steel reinforcing was placed in floors and walls, and then wooden form units were placed in the docks. Under this plan the continuous pouring operation required less than two days. Walls were stripped in 24 hours and the entire section was floated out five days later. Completed sections were towed across Elliott Bay, through the Ballard Locks, and into position on Lake Washington.

The standard floating sections were 350 feet long, 60 feet wide, and 14 1/2 feet deep. There were eight cells in 12 large, watertight compartments within each standard section. The roadway, sides and bottom slabs were eight inches thick. The adjacent ends and interior bulkheads were six inches thick.

The floating sections were rigidly connected end to end, forming a continuous box girder across the lake. Drawing up on the connecting bolts compressed a rubber gasket between the ends of the pontoons, forming a water seal. The 1-inch space between pontoons was then pumped out and grouted.

To give the bridge additional stability it was connected by cables to concrete anchors on the lake bottom. The anchor cables were attached to the pontoons with hydraulic adjustment mechanisms to accommodate changing water levels and surface storm conditions.

Three types of anchors were used: 1) on hard bottom a steel pile anchor assembly with eyebar connection, placed with a pile driver; 2) for medium hard bottom, a reinforced concrete box sunk in place and filled with gravel; and 3) in soft bottom, precast anchors with reinforced concrete shanks and palms, fitted with jet pipes so they could be deeply embedded in the muddy bottom. The second two types were placed by barges, with anchor positions located by triangulation from points on shore and radioed with shortwave equipment to the barge operators. This radio system proved convenient, and was later used throughout all stages of the bridge construction.

Before lowering the anchors into position, 2 3/4-inch galvanized, cold-drawn wire anchor cables were attached and temporarily tied off to marking buoys. The anchor cables were picked up and pulled into the pontoons when they were ready for joining, attached to the jacking castings and adjusted with the hydraulic jacks. A portion of the water ballast was pumped out to add a buoyant force, increasing stability. Once the anchor cables were stressed, final tension was put on the bolts connecting the pontoon sections.

Located near the east end of the structure, the largest of the 25 floating sections incorporated the 378-foot-long draw span. Faced with heavy maritime traffic, the original designers provided for this sliding draw span, which evolved after the engineers rejected bascule and submersible section designs. This draw span section was also constructed of reinforced concrete, and was equipped with buoyancy units to compensate for the increased weight of machinery and facilities. The 378-foot draw span operated successfully, but for traffic safety reasons was removed and replaced with fixed pontoons in 1981.

The renovation of the bridge began in February 1990 as part of Phase II of the I-90 Project. The $35.7 million renovation project includes work on the pontoons, the east and west approach structures, the bridge deck, the anchorage system and the electrical system. When the project is completed in July of 1992, the new roadway will carry the eastbound lanes of I-90 on three 12-foot lanes with shoulders on both sides.