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"Exodermic Bridge Deck on Movable Bridges - A Project Update"

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Exodermic Bridge Deck on Movable Bridges – A Project Update

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ABSTRACT

Several movable bridges with Exodermic decks have been completed. Others are under construction or in design. This paper will review the designs and construction experience on the Main Street Bridge in Green Bay, Wisconsin and two bridges in Florida: the 17th Street Causeway Bridge in Ft. Lauderdale and the Hallandale Beach Bridge. In addition, the design for the Exodermic deck for the Royal Park Bridge, now in final design, will be examined. Royal Park will see the first use of the revised Exodermic design on a movable bridge.

The Exodermic design provides a highly efficient, lightweight bridge deck. It provides bridge owners with a closed deck and reinforced concrete riding surface, without the expensive weight penalty of standard, full depth, reinforced concrete decks.

Although the Exodermic design dates to the early 1980's, in the last few years, a simplified and lower cost Exodermic design has been introduced, and is in use on a number of major structures. This paper will also explore the changes to the Exodermic design.

MOVABLE BRIDGES

Over the last ten years, there has been a strong trend away from the use of open grid decks on movable bridges in order to:

- Reduce noise
- Provide a better ride quality for the traveling public
- Protect the steel superstructure and machinery of the bridge from water, debris, and deicing salts.

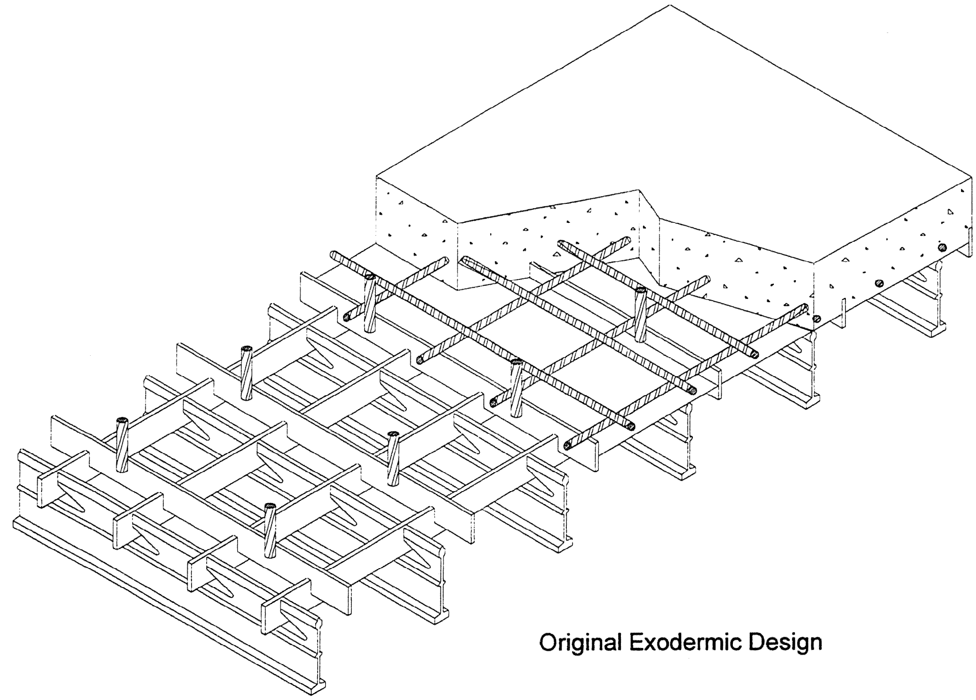
Concrete is the riding surface of preference. Reinforced concrete decks, with normal weight and lightweight aggregates have been used, but are substantially heavier, adding tremendously to the complexity and cost of the bridge. In addition to an excellent ride quality, reinforced concrete decks can be designed for the large tensile forces seen by the decks of movable bridges. Over-filled half-filled grid decks are an option offering the same ride quality of a reinforced concrete deck, with a significant weight savings – typically on the order of 40%. The Exodermic design offers the same concrete riding surface, the same (or better) weight savings of a half-filled grid – but with the appropriate choice of reinforcing in its concrete component, can be designed for tensile forces in the same way a reinforced concrete deck can.

Three movable bridge projects with Exodermic decks have been completed or are under construction. All three are already carrying traffic. In all three projects, the structural efficiency of the Exodermic design allowed the bascule leaves to be designed without stringers. Framing consists of main bascule girders, floor beams, and (for some of the projects), a bottom lateral bracing system. In this regard, all three bridges are similar. All three are double leaf bridges (two projects consist of twin, double leaf bascules). However, the three projects differ in substantial ways. The Main Street Bridge in Green Bay, Wisconsin is a Scherzer rolling lift design, with plate main girders; the 17th Street Causeway Bridge in Fort Lauderdale is a trunnion type bascule with open box main girders; The Hallandale Beach Bridge, eight miles south of the 17th St. Bridge is also a trunnion bascule, but uses plate girders for the main bascule girders.

A fourth movable bridge project with an Exodermic deck is the Royal Park Bridge, in West Palm Beach, Florida. This structure returns to the conventional superstructure framing of main girders, floor beams and stringers. The Royal Park design will include the first use of the revised Exodermic design on a movable bridge.

EXODERMIC DECK DEFINED

Described in the AASHTO LRFD code as “unfilled grid decks composite with reinforced concrete slabs”, an Exodermic deck combines the advantages of reinforced concrete with a fabricated steel grid, providing a light weight deck system that can be rapidly erected and which has substantial structural benefits. In this type of deck, a reduced depth concrete component, typically 4" to 4½" thick is cast on top of an unfilled steel grid. The two components are made composite by the embedment in the slab of a 1" portion of the grid which act as shear connectors. Another way of thinking about an Exodermic deck is that it is like a standard reinforced concrete slab in which the bottom half of the slab has been replaced by a steel grid, saving approximately 40% of the dead load.



Original Exodermic Design

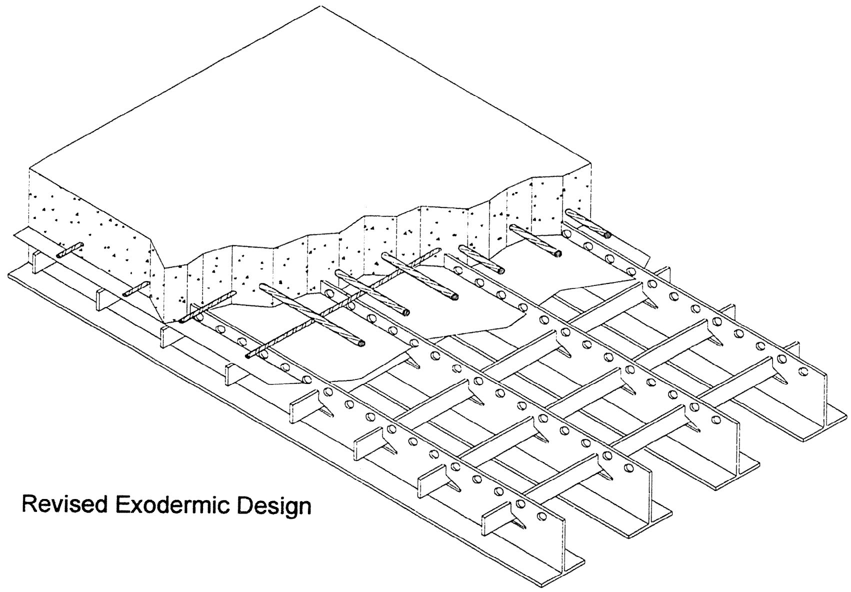
With this design, the neutral axis is located near the top of the grid, reducing the stress range at the fatigue prone welds and punchouts inevitable in a fabricated steel grating. Fatigue should always be checked in these type of decks, but rarely will control in an Exodermic design.

An Exodermic deck can be designed for substantial negative moments such as found on long, continuous spans or at deck cantilevers, by appropriate choice of reinforcing steel. Grid bar size and spacing, rebar size and spacing, and concrete thickness can all be varied to give a cost effective result for a specific job.

The efficiency of the Exodermic design results in a stiff section. Decks are configured to provide deflections of less than L/800, the criterion in most jurisdictions.

In the original Exodermic design, which dates back to the early 1980's, shear transfer between the slab and grid was effected by "tertiary bars", rectangular bars extending 1" into the slab to which ½" diameter studs were welded at regular intervals. The tertiary bars were welded to the distribution or "cross" bars of the grid, which in turn were welded to the main bars of the grid.

In the revised Exodermic design, inverted structural T's are used as the main bars of the grid and tertiary bars are eliminated. Instead, the top 1" of the main bars (the stems of the T's) are directly embedded in the slab. ¾" holes are punched on 2" centers in the top one inch of the main bars. When the concrete slab is poured, concrete "dowels" are formed through these holes and provide the required horizontal shear transfer mechanism.



Revised Exodermic Design

Research conducted at Clarkson University confirmed the viability of this approach, and included pull out tests, beam tests, full scale panel tests to ultimate, and a full scale, two span continuous fatigue test.

On the Main St. Bridge in Green Bay, the 17th St. Causeway bascule bridge, and the Hallandale Beach Bridge, the original Exodermic deck design was used, with 5 $^{3}/_{16}$" (132 mm) main grid bars and a 4½" (114 mm) reinforced concrete slab for an overall depth of 9 $^{11}/_{16}$" (246 mm).

On the Royal Park Bridge, the revised Exodermic design is being specified.

Exodermic decks have been used on a wide variety of bridges, on both new construction and in rehabilitation. The Exodermic design can be applied where all the concrete is cast-in-place as is the case on the projects discussed in this paper, or precast, where only small closure pours need to be made in the field. Precast Exodermic decks lend themselves well to rapid, often overnight, construction.

Some project examples include:

- The Interim Viaduct over Albany Street, a 1700 ft. structure carrying I93 traffic in Boston during the construction of the Central Artery/Tunnel project.
- The nighttime redecking of the Tappan Zee Bridge over the Hudson River, keeping all seven lanes of the bridge open to traffic during the day.
- The redecking of the main spans of the Eads Bridge over the Mississippi in St. Louis.

THE 17TH ST. CAUSEWAY BRIDGE

Light weight, speed of construction, and design efficiency are the most important reasons designers choose an Exodermic deck. In the case of the replacement for the 17th Street

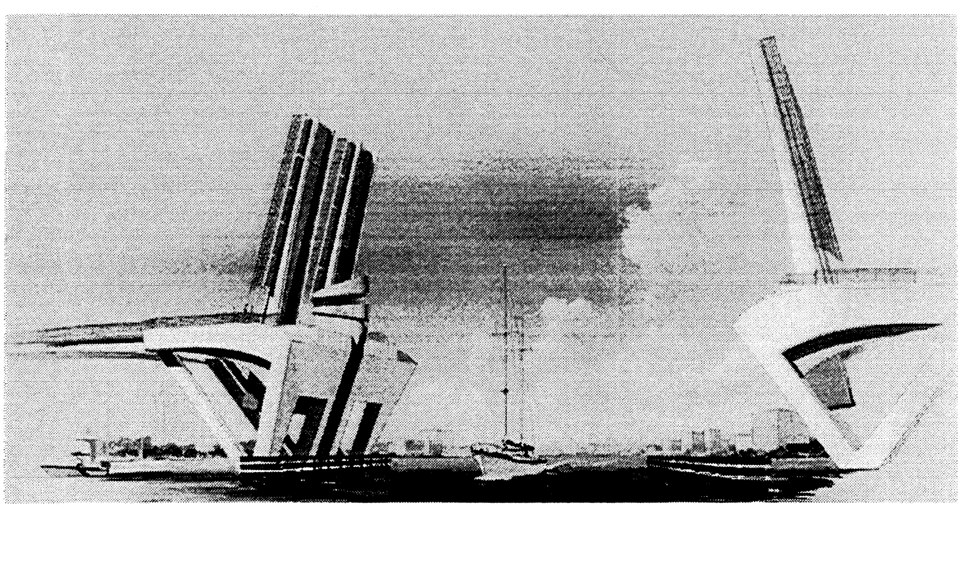
Causeway Bascule Bridge in Fort Lauderdale, Florida, aesthetic considerations were a driving factor as well.

A light weight deck for a bascule bridge is especially critical in that weight savings in the deck is multiplied by weight savings in the counterweight. One pound per square foot saved on the deck translates into 3 pounds/square foot saved overall in the moving portion of the bridge. This, in turn, reduces the capacity required of the mechanical equipment, and leads to further savings in the construction of the piers and substructure. The Exodermic deck on this bridge weighs 68 lbs/sf, substantially reducing dead load.

Speed of construction is important for the vehicles normally using the bridge, but perhaps even more so for marine traffic which may have no alternative route to destinations. It is critical to minimize the amount of time that a bascule leaf is in the closed position during construction. Because the steel grid component of an Exodermic deck acts as the form work for the concrete portion of the deck, construction time is significantly shortened.

The efficiency of the Exodermic design aided the 17th Street Bridge project in other ways besides reducing the deck dead load. The long span capacity of the chosen deck configuration allowed the elimination of stringers; the deck spanned longitudinally, and was continuous over the floor beams. With this orientation, because the deck was made composite with the top flanges of the main bascule girders, the main bars of the grid and the main reinforcing (#6 rebar at 4 inch centers) participated with the main girders. Because negative bending controls in the design of a bascule leaf, the participation of the substantial amount of steel in an Exodermic deck with the top flange of the main girders has significant structural benefit. In fact, the amount of steel contributed to the effective top flange of the composite main girders by the Exodermic deck is equivalent to adding 3" of additional steel thickness to each flange of the box girders.

For the new 17th Street Bascule Bridge, the aesthetics of the design were given considerable emphasis. Called out specifically for funding in the 1991 Federal ISTEA legislation, the new structure was intended to be Ft. Lauderdale's "signature" bridge. With this in mind, engineers at E.C. Driver & Associates, Inc. ("E.C. Driver") developed an innovative design that has resulted in a strikingly attractive new bridge.

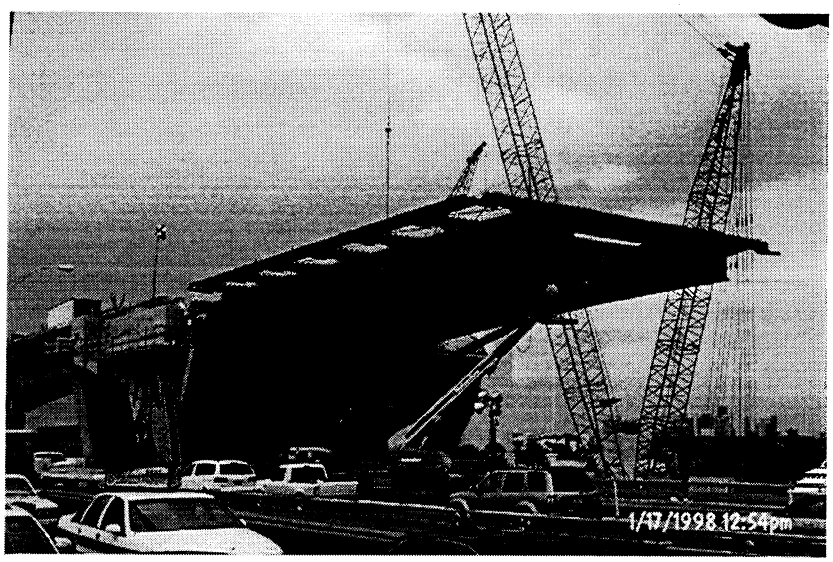


A major aesthetic goal of E.C. Driver was simple and clean lines. This philosophy is seen in the V shaped "Carina" bascule piers, and in the design of the bascule leaves themselves. Framing for the leaves consists of open box girders and floor beams. The inherent efficiency of the Exodermic design allows it to span the 14.4 feet (4.4 meters) between floor beams without stringers. Thus the underside appearance of the leaf, seen numerous times per day, is clean and uncluttered.

Eliminating stringers has other benefits besides the structural and aesthetic, of course. The cost and construction time required for stringers is eliminated. Bascule leaf weight is lowered, giving additional savings, and future maintenance costs reduced.

The 17th St Causeway Bascule Bridge spans the Atlantic Intracoastal Waterway and serves as the "Gateway" to this important navigational channel from Ft. Lauderdale northwards. Ft. Lauderdale is the busiest yachting center in the United States. The old 17th Bascule Bridge opened 30 times per day on average due to its low 25 foot navigational clearance. Even with 55 feet of clearance, the new bridge will be operating 10 times per day on average, a clear testimony to the number of large sailing craft in the area.

Construction by contractor Traylor Brothers began in 1998, with the erection of a temporary, Dutch-style overhead counterweight bascule bridge as part of the maintenance of traffic plan.



The new structure consists of long, segmental concrete approaches to twin, double leaf bascule bridges. Each double leaf bascule bridge spans 210 feet (64 meters) between trunnions, and is 53.5 feet (16.3 meters) wide. The first of the bridges opened for traffic in the spring of 2000.

In evaluating deck types, E.C. Driver sought to reduce the overall weight of the bascule leaf, reduce traffic noise (ruling out an open grid), provide a good quality riding surface, improve skid resistance, and reduce future maintenance requirements, while using conventional materials. They studied four alternative designs in depth:

1. Reinforced concrete on stringers
2. Half-filled grid with integral over pour, spanning transversely on stringers
3. Full depth grid spanning longitudinally across floor beams
4. Exodermic deck spanning longitudinally on floor beams.

For all cases, 115 pounds per cubic foot lightweight concrete was assumed, with the deck composite with its supporting beams. The Exodermic deck weighs 68 pounds per square foot.

An Exodermic deck was chosen because of its superior structural efficiency. The ability to specify size and spacing of the reinforcing steel in the Exodermic deck was particularly important. This allowed the deck to span further between supports with minimal additional weight. In turn, the number of required supports was reduced. Of the alternatives studied, the Exodermic option provided the lowest overall weight and cost.

The Exodermic deck, manufactured by licensee IKG Greulich for this project, is continuous over the floor beams. The Exodermic deck design employed uses the original Exodermic design, with $5\ {}^{3}/_{16}$ inch main bars on 6 inch centers, and separate tertiary bars acting as shear connectors between the 4½ inch reinforced concrete slab and the grid. Overall deck thickness is approximately 9¾ inches. The deck was made composite with both the floor beams and the flanges of the main box girders, significantly stiffening the overall structure and limiting stress levels and deflection. The leaf was torsionally quite stiff as well. Diagonally bracing was only required during erection, and was removed once the deck concrete had cured.

During construction, some difficulty was encountered in achieving a consistent concrete weight of the targeted 115 pounds per cubic foot. Measured weights for the first two leaves ranged from 118 to 121 pounds per cubic foot. With lightweight concrete, the final weight of the concrete would be two to three pounds lower per cubic foot. The approved mix design had 60% ground blast furnace slag as a percent of total cementitous material, and yielded 28 day strengths of over 7,000 psi (55 MPa), well in excess of the 5500 psi required by the specification.

A number of ½ inch round studs welded to the tertiary bars were knocked loose from the grid panels during erection. One of the advantages of the revised Exodermic design is the elimination of the need for these studs.

The second of the twin bridges is under construction and is scheduled to open by the end of 2001.

HALLANDALE BEACH

Florida has the largest number of bascule bridges of any state in the nation. Many of these bridges span the Intracoastal Waterway, and are located in prime residential and vacation locations. As the older bascule bridges are replaced, the aesthetic qualities of the replacement bridges have become more and more important to the communities in which they are located.

As do their colleagues in other states, the Florida DOT prefers to use closed decks on movable bridges where ever practical. A concrete riding surface reduces noise, keeps debris and water off of superstructure steel and machinery, enhances ride quality, and reduces maintenance costs.

For the residents of Hallandale Beach, reduced noise and a high level of aesthetics were at the top of their wish list when the aging bascule bridge on Route 858 came up for replacement.

Engineers at consultant Reynolds, Smith and Hills evaluated bascule leaf designs with reinforced concrete, half-filled grid, and Exodermic decks. An Exodermic deck was chosen because it provided the lowest cost option for the overall design. By not requiring stringers, and by making the deck composite with the main girders and floor beams, using an Exodermic deck saved a substantial amount of structural steel. In addition, by not requiring stringers, the Exodermic deck option provided an uncluttered under deck appearance – an important consideration on a bridge expected to open frequently to heavy recreational sailboat traffic.

One unique aesthetic aspect of the bridge is the use of tinted glass blocks for a portion of the structure housing the electrical equipment. Lighted from within at night, these lights will make a striking sight for local residents, and people traveling by road or water.

Each of the double leaf bridges spans 187 ft (57 meters) trunnion to trunnion. Main bascule girders are plate girders, and are composite with the Exodermic deck, as are the floor beams. A bottom lateral bracing system is employed. The Exodermic deck design specified uses the original Exodermic design, with 5 $^{3}/_{16}$ inch main bars on 6 inch centers, and separate tertiary bars acting as shear connectors between the 4½ inch reinforced concrete slab and the grid. Overall deck thickness was approximately 9¾ inches. Exodermic licensee IKG Greulich supplied the steel grid portion of the deck, which spans 14.6 feet (4.46 meters) across floor beams, and was made continuous using a bolted detail.

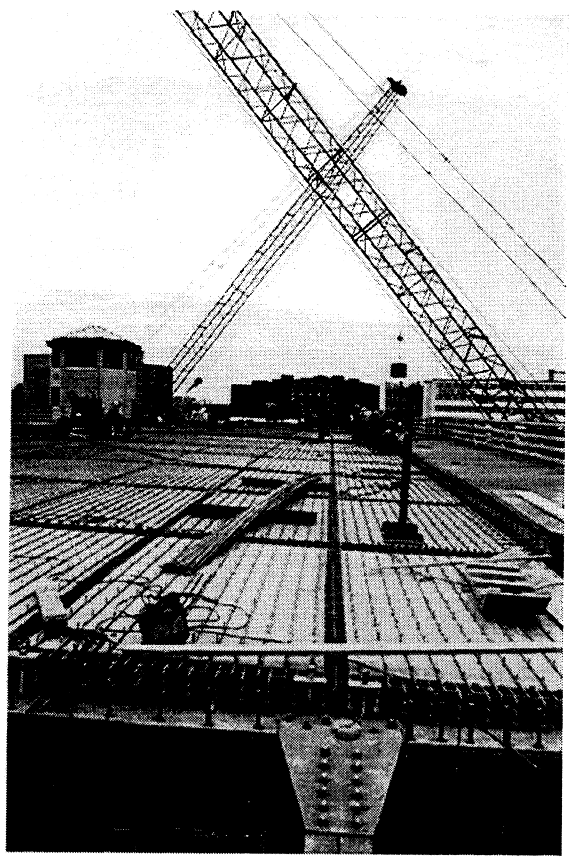
On this project, the contractor and their concrete supplier were unable to meet the specified 28 day concrete strength of 5500 psi, despite the fact that this was easily achieved on the 17th Street project, which is located less than 10 miles away (the concrete specification was the same). Florida DOT relaxed the strength requirement to 4,000 psi, and permitted a change in the curing requirement from a two week wet cure and 50% of design strength before opening the leaf, to a three day wet cure and 3000 psi before moving the leaf.

The concrete portion of the Exodermic deck on the first of the twin, double leaf bascule bridges was placed by contractor GLF in June of 2000. The deck received a 5 day wet cure before the leaf was opened, and no cracking problem has appeared. Deck weight is 67 pounds per square foot. The first of the twin bridges will open to traffic in the early autumn of 2000.

MAIN STREET BRIDGE, GREEN BAY, WISCONSIN

The Ray Nitschke Memorial Bridge, carrying Main Street over the Fox River in Green Bay, Wisconsin replaced a 1929 structure of similar type. The double leaf, Scherzer type of rolling lift bridge was chosen because of site constraints, aesthetic appeal, and because other bascule bridges in the district are Scherzers, simplifying future maintenance. In other regards, this bridge is similar to the 17th St. Causeway Bridge and the Hallandale Beach Bridge in that framing consists of main bascule girders and floor beams, without the need for stringers. Longitudinal cross frames and "K" type bottom lateral bracing brace each leaf on the Green Bay bridge. This project saw the first use of an Exodermic deck on a movable bridge.

Parsons Brinckerhoff Quade & Douglas (PBQD) designed the replacement bridge, which is 171 ft. (52 meters) centerline pinion to centerline pinion. Main bascule girders are plate girders, 57'9" (17.6 meters) apart. Floor beams frame into the main girders, the top flanges of which are above the top of the finished roadway, at the level of the raised sidewalks. Floor beams are spaced at 13.5 foot (4.1 meter) centers.



The main bars of the Exodermic deck are oriented in the direction of traffic, parallel to the main girders, and are made continuous over the floor beams through a bolted splice detail. Reinforcing steel in the Exodermic is continuous across the bridge in both directions, with standard lap splices as required. Main bearing bars of the deck are 5 $^{3}/_{16}$"

bars on 6" centers. Top reinforcing steel is #6 bars at 5" centers. Overall deck thickness is approximately 9¾" (246 mm). Because of the use of normal weight aggregate, deck weight is 78 pounds per square foot. The deck is composite with the floor beams, but because of the layout of the superstructure framing, the deck does not extend over the main girders.

Aesthetic considerations were given due weight on this project. The tender house is octagonal and incorporates a clay tile roof and other details that had been used in the bridge being replaced. Accent lighting makes the view of the bridge at night particularly dramatic.

PBQD considered three deck types during the study phase of the project: open grid, half-filled grid, and Exodermic. An Exodermic deck was chosen based on cost (both first cost and future maintenance cost) and on its suitability for longer spans, which simplified structural framing significantly.

A significant difference between this project and the projects in Florida was the concrete used. Normal weight concrete was used on this project, as Wisconsin DOT prefers it to light weight concrete. The state's standard bridge deck mix design was specified, including the use of larger coarse aggregate than the $^{3}/_{8}$" maximum size recommended by the grid industry on all types of grid decks.

Contractor Lunda Construction erected the deck in two stages. First, the grid panels were attached to the leaves as they were erected in the down position. The leaves were then pulled open as other work progressed during the winter of 1997-98. The leaves were pulled closed on April 10, 1998. Counterweights were poured as miscellaneous forming and rebar placement were completed.

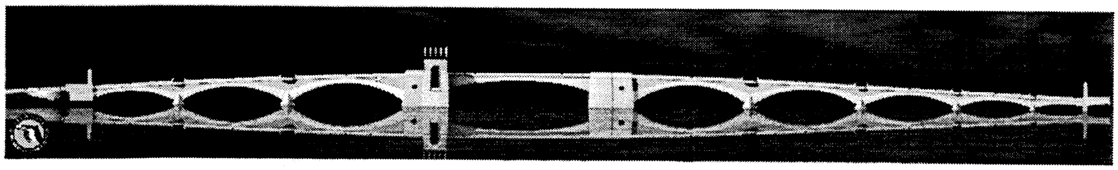
Exodermic licensee L.B. Foster fabricated the 5 $^{3}/_{16}$" grid for the Exodermic deck, as well as orthotropic sidewalk panels for the lift span.

Several problems concerning the deck were encountered on this project. Concrete was placed during cold weather in April of 1998 using conveyors, and working from the tail to the toe of the first leaf, then continuing on to the second leaf, toe to tail. One leaf was considerably heavier than planned, and balancing both leaves required substantial changes to the counterweight. After a seven day cure in cold weather, the leaf was opened. Cracks in the concrete were seen on one of the approaches and on the bascule leaf deck as soon as curing covers were removed. The approach deck was standard reinforced concrete, and used the same mix as the Exodermic deck. While the exact causes of the cracking have not been determined, some factors were the mix design, with larger coarse aggregate than normal; cool ambient temperatures during the concrete placement; and the cold weather experienced during the seven day wet cure period (temperatures dropped into the 30's or lower on all but two nights).

The Ray Nitschke Memorial Bridge was selected for a merit award by the National Steel Bridge Alliance at the April, 2000 Prize Bridge Competition.

ROYAL PARK BRIDGE

Florida has been placing a high level of emphasis on the aesthetic appeal of its bridges. The planned Royal Park Bridge in West Palm Beach will add considerably to Florida's reputation for beautiful bridges.



As is often the case, aesthetic decisions may drive overall structural design to a certain extent. On the Royal Park project, overhangs on the bascule span were minimized in order to emphasize the arched look of the precast concrete approaches. For this reason, engineers E.C. Driver & Associates chose to frame the four bascule leaves on this twin, double leaf bascule bridge project conventionally, with main girders, floor beams, and stringers. The lack of a sizeable overhang meant that a smaller width of the Exodermic deck would have participated compositely with the main girders if the deck had spanned floor beam to floor beam as on the projects described above. Overall leaf weight was reduced by using 3 widely spaced stringers and a lighter Exodermic deck.

The Royal Park Bridge will be 184 feet (56 meters) trunnion to trunnion. Main girders are 38.4 feet (11.7 meters) apart, with floor beams on 24.6 foot (7.5 meter centers). "X" type bottom lateral bracing will be used.

The revised Exodermic deck is specified, with WT 6x7 (WT155x10.5 metric) main bars at 12" (304.8 mm) spacing. The top inch of the main bars will be embedded in the 4½" structural slab to assure internal composite action within the deck. Top reinforcing in the concrete component of the Exodermic deck will be #6 bars at 6" centers. Deck weight, using sand lightweight concrete, will be 58 pounds per square foot.

Attention to detail meant that E.C. Driver was able to layout the deck panels for the bridge using only two different size grid panels, reducing overall project cost.

With the deck spanning transversely to traffic, the engineers were able to mount span locks within the traffic barrier, easing access for maintenance and avoiding the need for under bridge access platforms.

Construction of the Royal Park bridge is expected to begin in 2001.

COST COMPARISON

Three large bascule bridges were designed and bid at approximately the same time in Florida: 17th Street, Hallandale Beach, and a "third project". All three are roughly the same size, and cross the same waterway – the Intracoastal. All designs placed a strong emphasis on aesthetic qualities. The first two projects we've already discussed. The "third project" was constructed using conventional floor beams and stringers, supporting an over-filled half-filled grid.

Project	Dimensions	Bascule Leaf Cost per square foot
17th Street (Box Girders, Exodermic deck)	171.6' between pier faces x 106.9' wide. Twin, double leaf	$375.48
Hallandale Beach (Plate Girders, Exodermic Deck)	150.7' between pier faces x 116.1' wide. Twin, double leaf	$413.66
Third Project (Through Plate Girders, Stringers, Half-filled grid)	148.6' between pier faces x 54.8' wide. Double Leaf.	$463.09

E.C. Driver & Associates

LESSONS LEARNED

These projects provide a number of lessons worth considering:

Mix Design

1. Do not design for high early strength to shorten the cure period.
2. Keep coarse aggregate size to the recommended maximum of $^3/_8$"
3. Carefully pre-qualify and test mix designs. There is no good reason why the concrete supplier could not meet the spec for Hallandale Beach while less than 10 miles away, another supplier was able to meet the spec for 17th St.

Concrete Placement

1. Pay attention to environmental conditions and place concrete properly and quickly. On 17th St., the contractor took 3 hours to place the first 14 feet of concrete on the first leaf. Although there is no evidence of problems on this project, early age drying and shrinkage can have an impact on concrete durability.
2. Properly consolidate concrete around grid bars, rebar, shear studs, connections between panels, and in haunches.
3. Make sure the crew size is adequate. On the Ft. Lauderdale project, Parsons Brinckerhoff inspectors had to jump in to help with the vibrators on the first pour.

Concrete Curing

There is tremendous pressure on the owner and contractor to minimize the amount of time the leaf is in the down position potentially interfering with marine traffic. However, many studies have shown that proper wet curing of concrete is essential in minimizing shrinkage cracking. Because of the reduced thickness of the concrete portion of an Exodermic deck, proper curing is essential. Where possible, a two week wet cure is highly recommended, with one week considered a minimum. There was a marked difference in curing between the Green Bay project and the two Florida projects. 17th Street received a seven day wet cure, while Hallandale Beach received a five day wet cure. In addition, environmental conditions in Florida were typically warm and humid. In sharp contrast, the seven day curing period in Wisconsin was cold and much less humid. Measured in *effective* curing days, the Wisconsin curing period was clearly too short; there were only two days in which the temperature did *not* drop below 42 degrees, the criterion for determining whether or not a day counts as a "curing day". In some jurisdictions, 45 degrees is the cutoff temperature.

Global Design
The deck of a bridge does not exist on its own; it is an integral part of the superstructure. On long spans, where main superstructure members are substantially larger and stiffer than the deck, the deck is really 'along for the ride'. While it will strengthen the superstructure, it cannot resist large negative moments on its own. In other words, to minimize the chance for flexural cracking of a concrete deck – which sees large negative moments in a bascule bridge, the overall leaf must be designed as a system, with careful checks for crack width control as part of the design methodology.

The Devil Is In The Details
On the 17th Street project, there was insufficient room for both shear studs and bolts between the floor beams and box girder top flanges. The engineers carefully detailed the stud layout, and extended a number of bolts so that with additional nuts, they could do double duty as both fasteners and shear studs. Care in detailing assured that panels would fit without interference between studs, bolts, splice plates, and grid bars.

On one of the other projects, a hatch was shown in the roadway portion of the deck as a black rectangle. The only information provided was that the hatch should be 0.75 meters by 2.0 meters. It was intended to serve as access for replacing the 'maintenance-free' span locks. Detailing the hatch and its support was left to the contractor and his deck fabricator. Many hours were spent trying to find a way to support the hatch and the deck that was interrupted part way across the long span between floor beams. A frame could have been fabricated from channel sections, but would have then interfered with access to the span locks. Finally, a decision was made to eliminate the hatch and substitute ladder access from the side of the bridge. This type of detail should be thought out and clearly specified in the design plans.

CONCLUSIONS

An Exodermic deck provides significant weight savings and structural benefits to bascule bridge design. Savings in steel and fabrication and erection costs are realized by making the Exodermic deck composite with the bridge superstructure. Weight savings on the leaf are multiplied throughout the structure in cost savings in machinery, counterweight, and substructure. Lightweight concrete in an Exodermic deck can reduce dead load even further when compared to a conventional reinforced concrete deck.

Careful detailing is important to avoid conflict between welded headed shear studs and the bars of the grid, particularly where the deck is spanning longer distances and grid main bars must be closer together. Attachments to the deck such as hatches, scuppers, railings, and joints should be detailed on the plans.

Concrete specification, placement, and curing must be done correctly to maximize the quality of the resulting concrete component of an Exodermic deck.

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