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The St. Johns River bridge for Duval County, Florida

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THE ST. JOHNS RIVER BRIDGE FOR DUVAL COUNTY, FLORIDA

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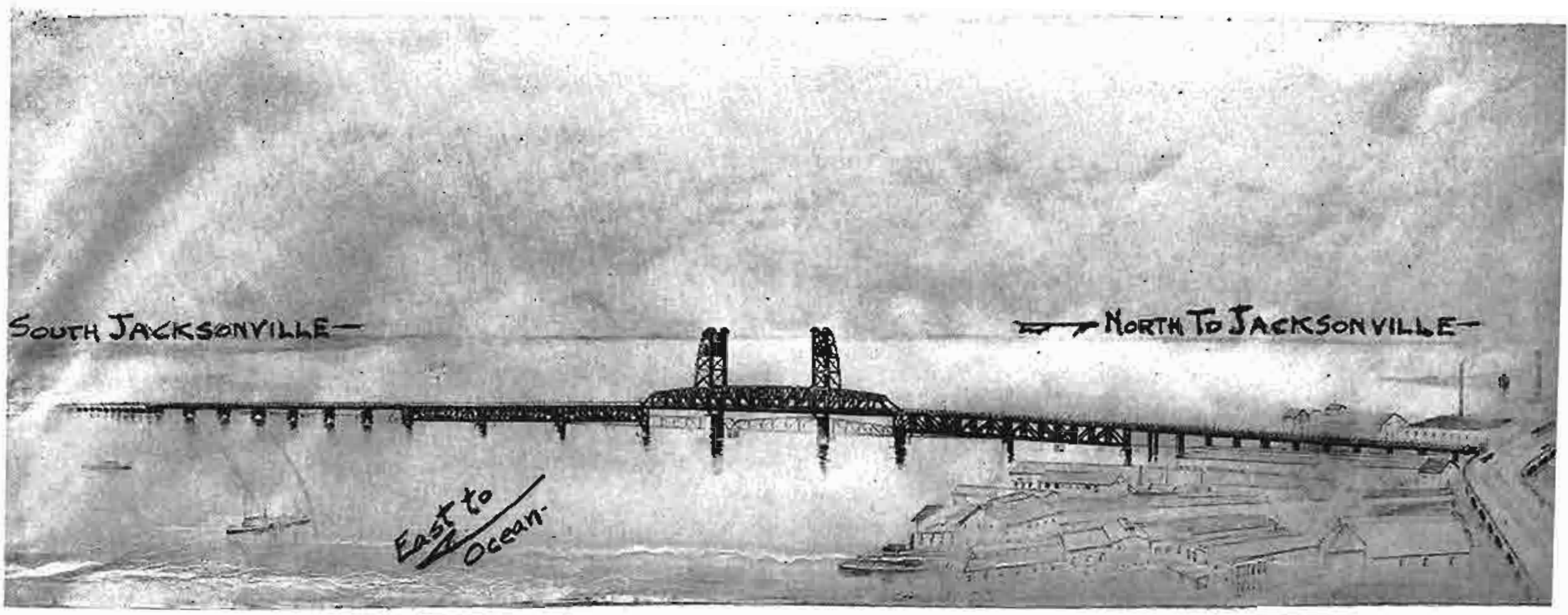

THE ST. JOHNS RIVER BRIDGE FOR DUVAL COUNTY, FLORIDA.

"Of all inventions, the alphabet and the printing press alone excepted, those inventions which abridge distance have done most for the civilization of our species. Every improvement of the means of locomotion benefits mankind morally and intellectually as well as materially and not only facilitates the interchange of the various productions of nature and art, but tends to remove national and provincial antipathies, and to bind together all the branches of the great human family."

Macaulay.

As man, through necessity, through quest of wealth, and through love of adventure and exploration, pushes forward into new and undeveloped country, and as this new territory becomes peopled and gradually built up into one of a more highly cultivated state, correspondingly must grow and become more efficient the means of transportation and communication between the older and newer countries so related - With respect to transportation facilities, both for railway and highway systems, possibly the chief individual structures are those which bridge chasms or bodies of water, the least easily surmounted obstacles which nature has placed in man's way as he makes his journeys from land to land. It is a matter of history that the choice of a site for such a bridge, the expense and difficulties involved in its placement, and likewise the period in a country's life in which such a needed crossing is obtained, have all proven of vital moment in the growing life of many sections of this and every other land. Thus in making a few statements of more or less general interest regarding the bridge now being built over the St. Johns River at Jacksonville, Fla., a reference to the country as a whole which will be served by this structure, and to the causes and needs which brought about this construction, should be well in point.

The State of Florida, being the southermost of our United States, is, generally speaking, a long narrow strip of very low lying land which forms the eastern limit of the Gulf of Mexico, as separation is made for this body of water from the Atlantic Ocean. Marshes, swamps and lakes are extensive, and the soil is of the most sandy nature. The climate is such that tropical fruits of the citrus variety may be grown throughout the whole state, while in the southern part of the state tropical vegetation of nearly every variety finds conditions suitable to growth. It is not a densely populated territory by any means, as large stretches of jungle wilderness are not uncommon; and at least fifty percent of the inhabitants are of the negro race. Though its shores were of the first touched by the early explorers of our continent, and though the City of St. Augustine is credited with being the oldest city in the United States, the development of Florida as a whole has beenvery slow. Practically all growth has been along the east and west coasts, and in those limited sections of the interior where soil and drainage conditions have been most favorable to agricultural development. This growth has been more pronounced in recent years, as the warm winter months have attracted an increasing number of winter visitors, and as the agricultural possibilities of the lands have proven responsive to the intelligent studies and investigations which have been spent upon them.

In the north-eastern part of the state is its largest city, Jacksonville, of a population approximately one hundred thousand. This is the so-called hub of the state, as all of its railway lines enter the Jacksonville Station. This city is also a sea-port of some consequence. It is located on the St. Johns River, some eighteen miles from the Atlantic Ocean. For many years past there has been a railway bridge over the river at this point serving the Florida East Coast Railway with its line to Key West. Highway traffic has been forced to rely on a ferry for crossing the river, and with the growth of an extensive system of paved roads down the state, particularly along the east coast, and the resulting increase of traffic, this service has become congested, slower than the needs demand, and generally unsatisfactory in many ways. As a means of relieving this condition, together with the development of the agricultural districts immediately south of Jacksonville, the need of a first-class highway bridge over the St. Johns River has become an important one indeed.

The St. Johns River is not a true river in the stricter sense of the word. More properly, it is an arm of the ocean extending many miles inland, with a waterway, which is much more than ample to provide for the carrying off of the rain-fall over its drainage area. It is one of the few rivers of our country whose general direction of flow is to the northward. In the vicinity of Jacksonville the water movements are principally tidal, the flow reversing in direction twice each day and being practically as swift with an incoming tide as with an outgoing tide. At times this current seems easily to be at the rate of four miles per hour. Generally speaking a two foot tide seems to be the rule, with very little variation except as the tidal movement is affected by high winds. A five foot tide is the maximum recorded. The river is strictly non-silt bearing and at this point the water is only slightly brackish as a general thing. Widths and depths of the river are variable indeed and in many cases extreme. A five mile width is not unusual and a depth of from seventy to ninety feet is known to exist at many points.

At the point on the river where the Florida East Coast Railway Bridge is located, the river is approximately but a half mile wide, this being by far the narrowest point on the river for many miles either up or down stream. It is stated that as the Indian Tribes of the east coast of Florida pursued their journeys to and from the north, long years ago, their ferrying point over the St. Johns River was naturally at this same place, and consequently we find one of the reasons why the City of Jacksonville was originally built upon its present site.

Agitation to procure a highway bridge over the St. Johns River at Jacksonville began possibly some thirty years ago. The expense of such a structure was the chief reason for the failure of its accomplishment in the beginning. In more recent years advocates of the bridge became more numerous and determined, and likewise opposition to its construction became more crystallized, this opposition coming principally from the naturally unprogressive of the community, from special interests which would be affected by its building, and from others whose antipathy to the project arose from political motives. However, a bill was finally passed by the State Legislature empowering Duval County, through its Board of County Commissioners, to bond itself for the amount of money required to assure the building of the bridge, this bill specifying that these bonds should be taken up by the funds accruing from the collection of the tolls charged for all passages across the bridge; until all such bonds are taken up, at which time the bridge becomes a free one. A hard fought bond election was then held by the county which resulted in the issuance of these bonds being authorized, and which opened the way for the actual bridge planning and building to begin.

The firm of Harrington, Howard & Ash, consulting engineers, was first engaged by the county to prepare the bridge plans and specifications and to represent the county's interests in the actual building operations as well as in the contract letting. These plans were prepared, and in June 1919 contracts were awarded as follows: construction of substructure and approaches to the bridge to be done by the Missouri Valley Bridge and Iron Company; furnishing of superstructure metal and erection of same to be done by the Bethlehem Steel Bridge Corporation. Contracts were let on the basis of unit prices for all items, and monthly estimates to be rendered to the contractors for materials on hand and work done, these estimates being payable from funds procured by the selling of the county's bonds before the beginning of the work.

The features governing largely the type and design of this bridge will now be presented. The site selected for the bridge is not the most desirable one, speaking from the standpoint of how the main business section of the city might be most directly served. However, the railway and navigation interests had sufficient influence to fix the location so that the new county highway bridge must be but seventy-five feet from and parallel to the present Florida East Coast Railway bridge; the argument in favor of this location being that the large vessels entering this port would be hampered in their movements in the river harbor if the two bridges were separated more than the minimum reasonable distance. This restriction then fixed the type of movable span which would reach across the navigable channel of the river, as the present railway bridge has a swing span which must not be interfered with in its operation, and any type selected must allow a navigable channel with clearances as fixed by the U. S. War Department and to conform with the present channel. The railway bridge is a low-level structure, consisting for the main river portion of a series of through truss spans.

To meet these conditions a lift span over the channel was decided upon, this span being placed high enough so that in the down position the swing span of the railway bridge could swing around beneath it safely. This meant that the crown of roadway of the lift span must be sixty-five feet above the water, but this also would permit ordinary river craft to pass under this span without the necessity of operating the lift span. The War Department required that a vertical clearance of 165 feet over the water should be provided over the navigable channel, in order that tall-masted schooners might freely operate on the river. This requirement meant that the normal lift of the movable span should be 108 feet. The lift span itself was of course made a through truss span, and the adjacent spans each way were made through truss spans in order that proper support might be made for the lift span towers. Thus we find a few of our restrictions, especially as regards navigation, provided for.

In the main river portion we find water to a depth of seventy-two feet at the deepest point. Deck truss spans were selected for this portion because of the excessive costs of foundation piers. Where the water is from five to thirty feet deep, plate girder spans were adopted. In all we have a total of nineteen spans over the water, there being four 71 foot girder spans, seven 100 feet girder spans, three 178 foot deck truss spans, one 136 foot through truss span, one 188 foot through truss lift span, one 136 foot through truss span, and two 178 foot deck truss spans; the above enumeration being in order, beginning at the south end of the bridge.

The south approach to the bridge is to be an earth embankment about 900 feet in length. The north approach is to be a reinforced concrete viaduct about 500 feet long. The south approach leads to ground level, while the north approach makes connection to a concrete arch-span viaduct now existing. The grade on the north approach will be about three and three-fourths per cent grade up to the level of the lift span, 65 feet above the water. South of the lift span the grade falls on a three and one-half per cent grade down to the beginning of the earth embankment for the south approach, the grade along this approach being not far from level.

It was desired that the roadway should be thirty feet in width, providing for two lines of traffic in each direction. Two street car tracks are also to be provided and a seven foot sidewalk on each side. A two inch bitulithic pavement will be laid upon the roadway deck, which is a thin reinforced concrete slab, 5¼" thick. This slab is supported directly by 8" steel I cross-beams, 36" centers, which bear upon longitudinal stringers of 28" I-beams, 9'-0" centers. These stringers go into the floor beams, which are built up plate girders 60 inches deep, and which are 27 foot centers, being located at the panel points, of course, for the truss spans. The sidewalks are carried on steel brackets outside of the bridge trusses or main girders. Altogether it may be said that a light, strong and economical floor system has been developed, the use of the concrete slab being justified by the fact that it is thin, strong, fireproof and permanent. The structure throughout has been designed to provide for the modern, heavy standard highway loadings. The influence of the recent war and the accompanying war-time prices was felt all through the design of this bridge, and a very pronounced effort was made to secure an economical but thoroughly satisfactory structure.

The reinforced concrete approach at the north, or Jacksonville, end of the bridge will consist of twelve 40 foot concrete girder spans supported on two-column bents which go to concrete footings resting on timber piles driven to rock, some twenty-five feet below water level.

The lift span raises vertically 108 feet.

To carry the steel ropes which lift this span are the steel towers resting on the fixed spans at each end of the lift span. The weight of the lift span is counterbalanced by a concrete block at each end weighing about 1,400,000 pounds. Each counterweight is connected to the span by sixteen plow steel wire ropes 2¼ inches in diameter, these ropes passing over cast steel sheaves, twelve feet in diameter, placed at the tops of the towers. Since these loads are counterbalanced quite closely, only that force is required to operate the lift span which is necessary to overcome friction, and provide rapidity, ease and certainty of operation under all conditions. This force is supplied by one 120 H. P. - 3 phase-60 cycle motor, 600 R.P.M., which operates the up-haul and down-haul cables. By this means the span can be raised or lowered in about two minutes. Electric power is obtained from the 2200 volt transmission line of the city and transformed for operation of the motor to 440 volts, and to 110 volts for roadway, signal and other lights. In case the electric motor is out of commission for any reason, an auxiliary means of operation is provided by a 6 H. P. marine gas engine connected through a James Speed Reducer. This device requires about 50 minutes to complete the lifting or lowering of the span. These motors are enclosed in the machinery house which is located at the center of the lift span above the roadway clearance line and below the top chords of the trusses. The operation of this machinery is made as nearly "fool-proof" and certain as is possible, limit switches and such devices being used extensively. For the present, it is not expected that the lift span will have to operate more than once a day upon the average, nearly all of the present river craft being able to pass under it in the down position. Future conditions may be different however, and in this connection it may be said that similar lift spans on other bridges are required to operate fifty or more times per day.

The erection of the steel superstructure for this bridge has not yet begun. A large part of the metal required has now been fabricated at the Bethlehem Steel Bridge Corporation's Mills at Steelton, Pa., and shipments of this material are soon expected to begin arriving here. It is planned to use a minimum amount of falsework in the steel erection. The steel girder spans will all be floated into position on barges, the generally constant level of the river permitting this. The steel truss spans over the extremely deep water will be erected mainly by the cantilever process, since falsework costs for this portion of the erection would be so excessive. The navigable channel must not be closed for any considerable length of time, and so we will find the lift span either floated into position completely assembled all ready for attachment to the counterweight cables, which procedure will occupy but a few hours; else we will find the lift span assembled in place in the up position. Either method presents nice problems in construction, but it is probable that the latter method will be chosen because of the height at which the floor level of the lift span must be placed above the water level.

The piers of this bridge, of which there are twenty in all, are of the same type generally speaking. Each pier is made up of two cylinders of concrete reaching from bed rock to the surface of the water. Upon these cylinders and bridging across between them are constructed the concrete pier shafts, which extend from the surface of the water to the point where they are to receive the superstructure steel. These cylinders range in size from eight to eleven feet in diameter, depending on the loads which they are to carry, and extend from twenty-eight to thirty-five feet below the water. The deeper pier bases become rectangular in section, some being sixteen feet square and others eighteen feet square. Two of these piers have their bases extending about forty feet below the water surface, while the three deep piers for the bridge will extend to a depth of between ninety-five and a hundred feet below the water surface. All piers are being sunk by the pneumatic process. This work is in process at the present time and the sinking of cylinders for eleven of the twenty piers have been completed. This sinking work is being handled from barges, the constant water level making this procedure highly satisfactory. The air compressor plant is complete on one barge, the concrete mixing plant complete on another, and in addition there are two derrick and pile-driver barges. Materials are towed out to these barges as needed upon the various material lighters. Owing to the present high prices of steel, a wooden cylindrical shell is framed to receive the concrete as poured for these bases. This is quite a departure from standard practice, as steel shells are quite the customary thing.

These wooden forms have proven quite satisfactory, although they are not exactly inexpensive, considering the high current lumber prices and the labor costs for framing them. The cylindrical forms are mainly framed in the yard on shore and then placed in position in the pile dock or stall which has been prepared for them at the pier site. As concrete is poured into them, they are then lowered in the water until they rest on the river bottom. The concrete pouring is then completed and sinking by compressed air is ready to begin. These cylinders are sunk in pairs, and as a rule they require from four to six days to outfit them for air, sink them down onto and into the foundation rock, and finally to seal with concrete the working chambers and man-shafts.

Sinking progress has been somewhat slower and more expensive than originally anticipated because of the unusual nature of the materials encountered in sinking. Speaking from a geological standpoint, this part of the country is young or new. Rock outcropping above the ground is practically an unheard of thing, a fine beach sand usually overlying all rock to a depth of twenty-five feet or more. It is the formation of this rock which is so unusual. Beyond a doubt it is "young". Only an occasional thin layer is found which is dense and hard enough to compare with a firm limestone. The upper portions of these rock beds are composed mainly of large slabs or boulders of very porous, fossilferous and hence soft limestone. Mixed with these may be found a fine sand or a white clay. Then occasionally we find large beds of this same porous shell rock which more resembles a bed of packed shells. All of this material requires more or less blasting in order that it may be excavated expeditiously. Beneath this conglomerate just described, we find a fairly dense shell limestone, which is not hard, as rock is usually described, but it is found in quite extensive beds and is amply good for the load of 5 tons per square foot, which it is asked to carry. It is in this bed of rock that our piers are being landed, and the extent of the bed landed in is always investigated by drilling three or four test-holes into the bed beneath each cylinder before the working chamber is sealed. From the rock borings taken at each pier site it was planned that it would never be necessary to pass through more than three feet of boulders and loose and soft rock before foundation rock would be reached. However, it has been found necessary to excavate to a depth of as much as ten or twelve feet in this material before sealing can be accomplished. This condition has made the sinking work slower and more expensive than anticipated, but it was a condition impossible to foretell, since no similar work has gone on in this part of the country since the construction of the Florida East Coast Bridge, and records of its building were either lost, or withheld, or at least unavailable.

Regarding the concrete materials used in this structure, it may be interesting to note that the crushed granite aggregate is shipped from South Carolina, a distance of about 150 miles, while the concrete sand comes from the Lake Weir deposit, over a hundred miles distant in Florida. The geologic nature of this locality, as previously spoken of, readily explains this condition.

Labor conditions in this work have been quite satisfactory on the whole, especially during the past winter season. The shutting down of work in local ship yards caused a surplus of labor to be created last fall, and the coming winter caused the men to be loath to move northward and leave homes established. An open shop is being maintained, and the wages paid rank with the most reasonable being paid in the larger American cities. For instance, common labor receives from thirty to forty cents per hour, carpenters receive sixty-five cents per hour, and sand-hogs are paid $5.00 per eight hour shift. All other than sand-hogs work nine hours per day, and in no case is an increased rate allowed for overtime. The efficiency of labor is markedly inferior to that of the pre-war period. It is a current statement that the late war work resulted in a great many inefficients being placed in a position to call themselves skilled mechanics, that a large number of really good mechanics were positively spoiled, and that it is a source of ever-increasing wonder that so many foremen and timekeepers and checkers could have been created.

Shipments of freight by railway have of course been erratic at all times, but no serious stoppage of work has yet resulted from failure to receive materials as expected, and so it may be said that this work has fared well in that respect, considering the present condition of the railroads.

The base-line which is used for pier locations on this work is one established along the center line of the present Florida East Coast Bridge, the new county bridge piers being located simply by a right angle and distance from the base line established. This makes all location work very direct and positive, and avoids the use of the customary complex triangulation system, which in this instance would have been very difficult and involved, because of the low-lying country and the extent to which the river-fronts are built up.

It is estimated that this new St. Johns River Bridge will cost about $1,200,000; it is planned that it shall be opened for traffic by March 1921; the river portion of the bridge will be about 2400 feet long, and the approaches about 1400 feet long, a total length of about 3800 feet; the tops of the lift span towers will stand 228 feet above the river level and the deepest pier will reach 97 feet below the water; if all the materials for the bridge were in one train, each car loaded to capacity, the train would be approximately ten miles in length.