THE ENGINEERING DESIGN AND MUNICIPAL PROCEDURE EMPLOYED IN THE CONSTRUCTION OF SEVENTH STREET BRIDGE OVER SHUNGANUNGA CREEK IN THE CITY OF TOPEKA, KANSAS

A thesis submitted to the faculties of The School of Engineering and the Graduate School of The University of Kansas

For

THE DEGREE OF PROFESSIONAL ENGINEER

By

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Preface

The writer has thought for some time that, while there is plenty of material available in book form for the technical study and analysis of engineering construction of all kinds, there is not available much material for the use of the younger and less experienced engineers, and students, covering the preparation of the necessary procedure, whereby a program of public works may be followed logically, from personal ideas and public necessity to completed projects forming the tasks and meeting the needs and conveniences of those who are required to pay for the same.

In the thesis herein presented an attempt will be made to introduce in order, those items, as are required by statute law: Sound Engineering Design, Contract Letting, and Standard Municipal Procedure, as involved in the conception, administration, and construction of a bridge for the public use in a city of the first class in the state of Kansas, based upon the experience of the writer, as a city engineer.
Table of Contents

The Bridge Location

a. The existing street intersections
b. Possible future street intersections
c. Creek location
d. Explanation of the need for replacement of existing structure

Authority for Procedure

a. Statutes governing
b. Commissioner of Public Works
c. District Drainage Board

Preliminary Design

a. Loads and spans
b. Roadway and sidewalks
c. Foundations and channels
d. Approval by Drainage Board

Final Design

a. Technical study of arch rib
b. Technical study of abutments
c. Detailed plans

Preparation of Project for Contract Letting

a. Instructions to Bidders
b. Estimate of Quantities
c. General Stipulations
d. Specifications
e. Contract forms
f. Bond forms

Presentation of Detailed Project to Governing Body of the City

a. Approval of Plans and Specifications
b. Setting of Date for reception of public bids
c. Certified Check
Engineer's Estimate of Cost

a. Computation of Quantities
b. Computation of cost, determination of unit prices, lump sum

Contract Letting

a. Reading of Engineer's estimate
b. Opening of bids
c. Awarding of contract

Construction

a. Engineering supervision
b. Contractor's monthly estimate
c. Contractor's final estimate

Conclusion
THE BRIDGE LOCATION

The theme of this thesis is located on east Seventh street over Shunganunga Creek in the City of Topeka, Kansas. At this point Hancock street forms an intersection with east Seventh street, on the left down stream bank of the creek, and Chestnut street terminates at the right down stream bank of the creek.

The bridge spanning the creek forms a junction for these three streets and is located and arranged that east Seventh street in the future may be brought in along the right down stream bank from the East, to the junction with Chestnut street forming a through traffic way on Seventh street, which has never been possible heretofore.

The channel of the stream at the bridge location approaches from the South, and makes an almost right-angled turn to the east under the bridge, which necessitated a skew of the pier and the bridge abutments, to an angle of Sixty-Five degrees with the center line of the arches, instead of the usual ninety degrees. Sheet number Four of the detailed plans shows these conditions quite plainly, also the
possibility of later bringing in Seventh street from the East.

There has been a bridge at this place for the past thirty years, the old bridge was a common four bent pile bridge with wooden stringers, and plank floor, for both sidewalk and roadway. The spans were too long for modern loads, and although the wooden stringers had been reinforced with steel rolled I-beams still the danger of collapse was gradually growing greater all the time until the abandonment of the old structure became a necessity. Another feature of the old bridge was its plank roadway, these planks under the action of rain, sun, and traffic, checked and splintered so as to continually threaten automobile tires and thus give grounds for frequent complaints from the traveling public.

AUTHORITY FOR PROCEDURE

In 1911-12 a general survey of the bridge needs of the city was made, and a bond election to provide funds for the reconstruction of all bridges spanning the Shunganunga Creek was called. In this proposed bond issue, the sum of $14000 was set aside for the
construction of a new bridge at Seventh street. However, these bonds failed to receive the necessary majority of the electorate, and the matter was then dropped. In 1913, largely through the efforts of Mr. W.G. Tandy, the Commissioner of Streets and public improvements of the city at that time, a bill was passed by the state legislature authorizing a maximum levy of 1/2 mill upon all the taxable property of the city, at the option of the City Commissioners, for the general construction, repair and maintenance of bridges in the city. This statute reads as follows:

Revised Statutes of 1923, Section 13-1058, Levy for Bridges:-

That all cities of the first class are hereby authorized to levy a tax each year of not to exceed one half of one mill on the dollar, on all taxable property in such cities, for the purpose of paying the cost of building, rebuilding and repairing bridges.

L-1913, ch. 93, Section 1, March 10.

Under Section 13-1025 of the Revised Statutes of 1923, we have a statute covering the construction of bridges in this state, which statute while possibly applicable in this case requires a vote of the people before a structure costing more than $10,000 can be
built, but since the statute is in conflict with the above mentioned statute, Topeka has elected through its city officers to use the former statute, and therefore, no elections are held for the permission to spend money for bridges in Topeka, the funds for all bridge work being obtained and spent under the authority of statute 13-1058 exclusively.

The full levy permitted under authority of this statute has been made by the City Commissioners each year since its enactment, and from the funds so obtained, bridges within the city have been built as follows:

Kansas Ave., Fifteenth St., East Sixth, Lincoln St., The Drive, Topeka Ave., Twenty-first St., Eighth St., Fourth St., Lake St., Seventh St., Walker Ave., Roosevelt St., Wagner St., Ripley Park Suspension, Chandler St.

Under the Commission form of Government, funds must be in the treasury before any contracts may be let for public improvements. Under this rule it was necessary at times to permit the accumulation of the bridge fund without any new construction since the levy made for a single year was not enough of itself to pay
for the construction of some of the larger bridges. Early in 1922, the Commissioner of Streets and Public Improvements, Mr. W.S. Hancock, obtained authority from the City Commissioners to authorize the City Engineer to proceed with the necessary surveys and plans for the construction of a suitable bridge at Seventh street. These instructions specifically stated that the new structure should have a twenty foot roadway, between curbs, with a five foot sidewalk on each side of the roadway, and so located as to meet as far as possible the necessity for a junction between Chestnut street on the south, and Hancock street on the north and west, another instruction was that the plans for the structure meet the approval of the District Drainage Board, before final plans were studied.

As an explanation of the District Drainage Board, it may be said, that under authority of statute 2R-401-480 there may be created what are called local drainage boards which boards are formed for the purpose of improving drainage conditions within the boundaries of the district as formed, and to which boards are delegated almost unlimited authority regarding main water channels, the straightening and widening of the
same and the control of all structures spanning the same. These boards are at times somewhat unreasonable in their demands being usually composed of non-technical men, who refuse to see any possible solution of a problem other than that which may have originated in their own minds. The funds for the support of these boards in their construction programs which they undertake within their districts are raised from taxation of the property in the district. But for the improvement of structures spanning the stream, such as railroad and highway bridges, the owners of the structures must stand the expense of all the requirements of the board. The activities of these boards concerning the conditions of the stream channel within their district boundaries, are sometimes very discouraging; islands are allowed to accumulate in the stream bed together with dense growths of willows and such encroachments by riparian owners upon the stream beds as said owners are able to get past a friendly board, are also often permitted. But when new bridge construction is proposed, the requirements of these boards are severe as to spans and clearance above flood water lines.
In taking up the study of this problem I first met with the East Side Drainage Board which has jurisdiction over the Shunganunga at the site of the Seventh Street Bridge, and we discussed the problem in hands. The old wooden bridge then in service was not only rapidly becoming unsafe, but was also so located that the piling offered considerable obstruction to the current and caused accumulation of drift during high water. By reference to the plans sheet the location of the old bridge may be seen shown by dotted lines.

At the meeting a single arch bridge and a two arch bridge was discussed, then later a three span job. I pointed out to the board that while a single arch would give an unobstructed main stream channel, the abutments would be so located as to cause considerable obstruction to the stream during the flood water period. A single arch bridge for this location would require a span of not less than 125 feet between soffits, and with a rise of the arch so as to pass at the crown point the flood water heights. Such a structure would have to be an open spandrel type bridge and require rather heavy abutments for its support. A two span bridge at this location would require a pier
located somewhat in the main stream channel, this is usually objectionable, but such a type permits of shorter arch spans which in turn might or might not permit of the elimination of open spandrel construction and also permit of the raising of the arch crowns with the consequent less amount of dragging of the arch soffits at the abutments. A third type of structure, that of two piers and three arches was discussed. Such a type fits fairly well for this location, the piers could be so placed as to have one located on each side of the main stream channel, and the abutment arches would be short and high providing more actual effective water way during flood periods than either of the other types could provide; however, it is also true that these two piers would easily collect enough rubbish during high water as to cause the construction of a dam across the stream, which means the loss of a large amount of the effective waterway during floods, and a doubtful construction to employ where a creek makes practically a right angle turn as this one does at this point.

A survey of the Shunganunga Creek Bridges within the city limits was made under the direction of the
district drainage board covering this stream in 1913. The Engineers making this survey reported among other things that in their judgment an effective waterway of not less than 1250 square feet was required as a bridge opening across this stream at Seventh street. The board approved this report, and passed to me as their first requirement the proposed structure should have not less than this amount of waterway between the flood water height and the normal low water level. The board further decided that while it preferred no piers in the stream channel at all, it would grant me one pier and two arches as a limit, but that two piers and three arches would not be considered. I drew up tentative plans showing on the one elevation a single and two arch job, a single arch of 125 feet span, and a pier and two arch job of sixty foot clearance for each arch. Owing to the skew required of the pier and abutments to better fit the stream line, and the necessity of bringing Hancock street onto the bridge with as open a corner as possible, which it could be readily seen would place the east curb of Hancock street well up on the spandrel wall of the west arch if used, I decided it would make for much easier
construction and far less consideration of indeterminate stresses if I would use two arches of small span rather than one arch of relatively large span. The reader at this point is invited to refer to the plans of the bridge where on sheet number 4 & 5 is seen a layout of the problem. Here may easily be seen the complications arising from the use of the single arch, and while the same complications exist in the use of two arches, the strength of the structure is not nearly so much involved, and the use of lighter abutments is made possible. I decided to use as a basis of final design for the bridge a pier and two arches, the arches to be of 60 foot span each, with crown heights at the flood water level of the bridge, and a rise of the arches of ten feet each. I was then ready to pass to a general consideration of the problem of the bridge proper.

PRELIMINARY DESIGN

In beginning a study of this kind, it is well to start at the top of the structure and work downward I believe. One of the first matters to receive attention was the subject of the bridge paving to be used.
Seventh street which approaches the bridge from the west is paved with brick, a three inch repressed brick laid on a five inch concrete base with one inch sand cushion and Asphalt Filler. Hancock street which comes in from the north is not paved. Chestnut street which comes on the bridge from the south is paved with Asphalt, two inch wearing surface on a six inch concrete base. The nature of the traffic in this vicinity is more of the commercial type than pleasure or light load nature, and since the Asphalt type of paving requires the use of an asphalt plant for its final wearing surface, which is equipment not usually found in the ordinary bridge contractor's plant due consideration must be given to the type of wearing surface required on the bridge paving. Usually bridges when completed are at once thrown open to traffic, and such was the requirement at this bridge. The construction of this bridge was going to cause considerable interference with business interests at this point, and speed of construction was a requirement of the specifications. Brick paving requires no special equipment by the average bridge contractor, and his construction crew can lay the brick paving as soon as the concrete
work is ready to receive the same. It appears therefore the paving should be of brick for this job rather than Asphalt, and since settlement of the approach fills always occurs at bridge abutments, resulting in the loss of the paving over the same, it is better to use brick as a wearing surface rather than asphalt because the brick may be salvaged, while the loss of the base is acknowledged in either case. I decided to use for this job a three inch brick laid on a six inch concrete base, with one inch of sand cushion and asphalt filler for the brick.

The width of the roadway between curbs for use in this bridge became the next matter for consideration. The other bridge previously built over this stream in the city have the uniform width of twenty feet between the curbs. There is no particular justification for this width, in fact to study it from the number of lines of traffic which it can accommodate, it is somewhat uneconomical; however for the sake of uniformity, I decided to make this bridge of the same width as the others, and twenty feet between curbs will be used.
The sidewalks for the bridge are next to be considered. The width of these walks is fixed at five feet at once since the same is the standard width of all sidewalks other than on principal business streets in the city. There is to be a sidewalk on each side of the roadway, guarded by suitable handrails. The support of these sidewalks is a matter of bridge design, which might be briefly considered at this time. Two methods of support are used for these sidewalks, one is to build the arch rib of such width as to support both the roadway and the two sidewalks. Such a plan would call for an arch rib of width in this case of 20 plus 5 plus 5, plus the thickness of two spandrel walls or not less than a total width of 32 feet. Such a width of arch rib would call for abutments and pier to support the same, and since the foundations of any bridge are usually the more expensive part of the structure, it is not well to compel any greater width of these elements than actually necessary to sustain the loads. A second method of support for these sidewalks is to bracket out from the arch rib and spandrel wall a sufficient distance to carry the width of walk desired. It will be at once
seen that this method would make for far less construction costs, since the saving of added abutment widths is gained entirely, and the problem resolves itself into one of safe design of the same and adequate distribution of the loads back to the arch rib. Likewise a very material improvement in the appearance of the structure is obtained by the use of the brackets as it eliminates the heavy massive appearance of the bridge when the arch rib is carried of width to support both the roadway and sidewalks. The use of brackets also provides means for the breaking up of the appearance of the spandrel walls, since the brackets may be of pleasing design and of such depth as the nature of the arch rib at the point in question will permit. The attention of the reader is invited in this design to this feature of the structure where the use of two deep brackets at the pier makes the whole appearance of the bridge both attractive and of great strength.

The load thrown upon the brackets in this type of structure is severe and the spandrel walls must be reinforced by pilasters connected into the arch rib or connected to each other across the top of the arch rib.
at the bracket points by straight beams. Just how far this idea of supporting a part of the bridge load upon brackets attached to the arch rib may be carried out is a matter for the bridge designer to decide. On highway bridges where no sidewalk is required the piers and abutments are cut down as to width and part of the roadway of the bridge is cantilevered out, this makes for very material savings in costs and if properly designed is perfectly safe. In our bridge a part of the roadway as well as the walks may have been carried on the brackets, in fact in the design of the Lake Street Bridge I did carry the walks and the curb and gutter on the brackets but such loads on brackets calls for heavy bracket construction and heavy brackets call for considerable depth of spandrel walls at the arch crowns because the brackets cannot extend below the arch soffits, therefore in this design with two arches I had very little depth of spandrel wall at the crown points available and I decided to support only the sidewalks and the handrailing upon the brackets. Another feature to which attention should be called at this point is the matter of providing light on city bridges, and also provision for public
utilities such as gas and water pipes across structures of this kind. Gas and water pipes are subject to necessary repairs at times and if buried in the roadway of a bridge, result in practically a suspension of the bridge while the roadway is torn up for the repairs necessary. By employing the bracket type of sidewalk construction space is provided under the walk and on top of the brackets for numerous pipes, conduits and cables with little inconvenience for their installation, and after once in place provided with a better housing of the utilities than if the same was buried. I have employed this type of construction in nearly all of the designs I have made for this city, and the same have measured up admirably to the requirements of both usage and repairs, it is undoubtedly the type of construction to employ where the conditions to be met are the same as required in this city. Where open spandrel wall construction is employed, these brackets are placed on the division walls of the bridge and their depth can then be made such as required for most any load desired to be placed upon them. The spacing of the brackets along the spandrel wall is largely a matter of choice, they
are usually spaced uniformly with no bracket at the crown of the arch. The span between brackets on closed type of arch filling, may be as desired, it will be seen the posts in the handrailing are made to come over the bracket points, and few rather than many brackets are desirable in the appearance of the design.

Another matter for consideration at this point is the loads to be supported by the bridge in addition to the weight of the bridge itself. These loads are known as the "Live Loads" and the moving vehicle loads of present day traffic present some interesting points in bridge design. The bridge must be studied from a consideration of a uniformly distributed load rather than for a concentrated load since we are employing earth filled arches wherein the load on the pavement is carried to the arch rib proper through a small earth fill between the arch rib and the paving slab.

The ordinances of the city permit of a gross load of 25,000 pounds on a four wheeled vehicle. The maximum load per inch width of tire is fixed at 600 pounds. And not more than one-third of the gross load is permitted to be on any one wheel. We might
therefore have a maximum load of 8400 pounds on a wheel to account for in our load design, which load under city ordinance might be required to have not less than a fourteen inch tire. In considering loads of this kind however, it is safe to say a tire of this width is seldom found in service. In the first place hard rubber tires are rapidly going out of service since the vibration on the truck through the use of such tires has been found to be too destructive to warrant their continued use. For heavy loads the double pneumatic is now more generally found and the future I think is tending towards the use of four wheels on the rear instead of two using the balanced mechanism of load distribution on the wheels. Furthermore, the percentage of loads of this character as compared with the general traffic is found to be in the neighborhood of one per cent of the entire traffic unless in a wholesale district where heavy loading is the rule rather than the exception. In the bridge we are now considering we expect to have an earth fill over the arches, upon which will be laid a concrete base supporting the paving. When this type of construction is employed there is no necessity for
consideration of special wheel loadings since the load is transmitted through the paving slab into the earth fill and thence to the arch rib where the concentration is removed and distributed in such a manner as to be beyond the need of serious consideration for the reason that in truck loading the size of the truck bed is also to be considered. To follow up the above consideration we find that the size of a truck bed is in some cities limited as well as the axle load. I find in the Borough of Manhattan, in New York City, the size of the bed of the truck is limited to eight feet wide by twenty-eight feet long. Such a bed would occupy an area in the street of 224 square feet, which would allow for no room whatever between the vehicle and other moving traffic. Suppose we consider the actual limit of the vehicle, and assume that we will design the arch rib for a live load per square foot on the paving instead of for a concentrated load; assuming this live load at 200 pounds per square foot, we would have as a live load on the area occupied by this truck 200 x 224 or 44800 pounds which is seen to be almost twice the load allowed on the truck under consideration, namely 25000. This difference of total
live load permits of two further considerations, first, a greater allowable load on the truck in question. I examined a number of city ordinances in the larger cities of the country concerning this subject and found great discrepancies among them, some cities allowing larger loads, others smaller. The largest truck load ordinance I found considered by any city was a gross load of 50000 pounds with a maximum load on the rear axle of 24000 pounds. For this loading no prescribed size of the truck bed was given but a comparison of this load with our assumption of a live load of 200 pounds per square foot on the roadway still leaves ample margin for still greater loads. Since the location for this bridge is in Topeka, and at a point where large wholesale developments are not probable, I think we have established beyond a reasonable doubt that 200 pounds per square foot should be used in design of the arch span, and the same will be used. Even the usual 20-ton roller produces but 140 pounds per square foot.

We now pass to a consideration of the loads to be carried on the sidewalks of the bridge. These walks are five feet in width and so designed that only
four feet six inches of the load would be actually off of the arch rib proper, however this is not material at this time. The greatest load imposed on the average sidewalk of a bridge is at a time of high water in the stream where concentration of the foot traffic occurs. A number of experiments have been made of crowds of people to determine the greatest load human life can reasonably impose on the supporting floor. In bridge work the concentration upon a sidewalk will not exceed four feet thick on the stream side, with a moving load on the remainder of the walk. This concentrated load is found to be very nearly 100 pounds per square foot, while the moving load will not exceed 40 pounds per square foot. There is however one other possibility, and that is a moving vehicle may leave the roadway and mount the sidewalk. In the design of this bridge we shall have the protection of a seven inch curb against this possibility, and even though the same should occur, but one wheel of the load will be on the sidewalk area in all probability. As a matter of safety however we will use 125 pounds per square foot as the live load on the sidewalk area.
Our dead and live loads for the bridge computations now shape themselves into the following.

Live load on roadway, 200 pounds per square foot.
Live load on sidewalk, 125 pounds per square foot.
Earth filling, 120 pounds per cubic foot.
Concrete, 150 pounds per cubic foot.

Brick paving, including the brick, filler and sand cushion but not the base, 300 pounds per square yard.

With these data presented, which of course might be further elaborated upon, but which I consider irrelevant if so presented, I shall pass now to the consideration of the channel conditions to be met, since the use of the above data will present itself again in the technical study of the arch rib proper.

For foundations to support this structure, borings were first made with a common 2" auger as is used for timber work. A soft mushy soil for about 5 feet below low water level is supported on blue clay which extends to a point 20 feet below low water where solid rock is encountered. It is true that for arch foundations rock is usually sought and I might have felt in this case some inclination to connect the arch thrust with the rock, but since I have already built
several larger arches than this on this creek, all of which had the same foundation conditions, no hesitancy need obtain as to the method of procedure. Piling is depended upon to carry the entire load of the arches. These piling obtain a wonderful hold in this clay which seems to carry a layer of schist just above the rock line. Some of the piling at the beginning of the driving penetrate to the full length of the pile - 20 feet - but as additional piles are driven the clay tightens and at the end of the driving in the pits about four feet has to be sawed from each pile. This is true in the pier and also in the abutment foundations.

By reference to the sheet of the plans an idea may at once be obtained concerning the stream conditions of the bridge to be met. It was not desirable to place a pier in the low water channel and a study was begun with this idea in mind. Some years ago the lot adjacent to the creek on the south and fronting on Chestnut Street had been sold for taxes to the City. It was found in the preliminary studies that if an additional lot (25 feet) could be secured adjacent to the lot already owned by the City a much improved setting
for the bridge and improvement of the stream channel could be consumated; this the city decided to do, and I now had ample ground on the Chestnut street end of the bridge to improve my intersections and channel, for the stream. A pier could be placed on the left bank of the low water channel, and the channel widened by channel excavations on the newly acquired ground, making the active waterway at least twice what it was formerly, and materially improving the angle of the stream at this point. Such a bridge layout, permitted of two arches, each sixty feet from pier to springline, providing when finished an effective waterway from low water to highest flood water level of 1450 square feet. This waterway met the requirements of the District Drainage Board, also the height of the arches was held above the highest known high-water, which together with the improvements shown made in the stream channel, won the approval of the plans for the bridge from the Drainage Board, as shown by the following.
Topeka, Kansas
August 10 - 1923

Mr. W.E. Baldry
City Engineer

Dear Sir:-

At the last meeting of the East Side District Drainage Board, your general layout plans for the construction of a bridge over Shunganunga Creek at Seventh street were approved, which we understand will provide a pier and two sixty foot arches, the crown of the arches to be at high water level, and to provide a waterway of more than 1250 square feet.

Signed, W.A. Voight, Sec.
M.T. Watson, Pres.

FINAL DESIGN OF THE BRIDGE

Having obtained approval of the Drainage Board for the construction of the bridge as to size and location, and the disposition of the location of the pier, the skew of the pier and abutments, together with the acquisition of the necessary adjacent land upon which to build the bridge, we were ready to take up the technical study of the arch ribs and prepare the plans for a contract letting of the improvement.
The following is not intended to provide a thorough technical study of arch bridge design, since this thesis is not written with that thought in mind, but rather to present an average example of the studies made before offering for bids a bridge of this character in municipal work. In this structure we do not have excessive span lengths to provide for, and therefore it is not necessary that some of the computations be carried out as far as should be done if the spans were excessive. We have here a rather novel setting for a bridge, wherein as will be seen from the plans, the old bridge occupied an awkward position for modern day traffic, and where a new type of structure presents conditions much more desirable from the surface, but also complicated matters of the stream channel.

It will be observed from a study of the plans, the arch is so twisted due to the skew of the pier and abutments, the crown of the arch rib under the up stream spandrel wall is nearly opposite the quarter point of the rib under the down stream spandrel wall. These skew conditions in an arch undoubtedly invite stresses which we have not attempted to analyze, nor do I think I could without making an extended study
which is beyond the time I have in which to get out the plans. To overcome these conditions we protect the bridge in several ways, particularly in the amount of steel in the arch rib. Your attention is invited to the two lines of one and one-eighth inch steel used in this structure, where as a matter of simple arch requirements, considerably less steel might have been used.

Such technical studies as were made are as follows, and the reader is referred to "Reinforced Concrete Construction" by Hool, volume three, as a guide and text for the development of the formulas used.

COMPUTATIONS OF DEAD LOADS

Total weight per lineal foot of bridge:-

Paving, (taken at 300 pounds per square yard)
\[
\frac{300 \times 17}{9} = 567 \text{ Lbs}
\]

Paving Base, (Six inches thick)
\[
.5 \times 17, \text{ is square feet} = 8.5
\]

Curb & Gutter, (7" Curb, 18" Gutter)
\[
5' \times .5' \text{is, (two lengths)} = 2.5
\]

Sidewalks, (Considered 5'-6" wide)
\[
11 \times .42, \text{ is} = 4.62
\]
Handrails, 
2 x 1 x 3, is - - - - - - - - 6.0

Sidebeams, 
2 x .75, is - - - - - - - - 1.5

23.12 Square feet x 1 x 150 pounds per cubic foot, - - - - - - 3468 Lbs

Constant, - - - 4035 Lbs

Constant per lineal foot of arch ring is then 4035 or 183.4 pounds per lineal foot

Spandrel walls and fill overarch, (Fill at crown to under side of paving base taken at 14 inches)
19.5 x 120 pounds per cubic foot for earth fill, - - - - - - - - 2340
2.5 x 150, - - - - - - - - - - - - 375
22) 2715

Weight per foot of height, - - - - - - 123.4 Lbs

Load No. P-1 P-2 P-3 P-4 P-5 P-6 P-7 P-8
Height 7.38 5.68 4.28 3.15 2.28 1.70 1.31 1.20
Wt. Walls and Fill 911 701 528 399 281 210 162 148
Add Constant, 1094 884 711 572 464 393 345 331
4 x Above 4366 3536 3844 2288 1856 1572 1380 1062
Arch Ring 2010 1380 1008 910 780 750 750 375

Total Loads 6376 4916 3852 3198 2636 2322 2130 1037
COMPUTATION OF ARCH RING WEIGHTS

These weights were used on the opposite page, and are obtained as follows:

The arch ring is divided into equal spaces, horizontally beginning at the spring line, using in this case, SEVEN EQUAL spaces, and the eighth space just ONE HALF a space, thus each full space is represented by four feet, and the half space by two feet. Thus we have for four feet of arch ring, weighing 150 pounds per cubic foot, 4 x 150 or 600 pounds. The DEPTH of the arch ring measured vertically, at the center of the space, is taken as the average thickness, and at this point the weight of the arch barrel is presumed to be concentrated. We have then the following:

P-1, 3.35 x 600 or 2010 Lbs.
P-2, 2.30 x 600 " 1380 "
P-3, 1.68 x 600 " 1008 "
P-4, 1.35 x 600 " 910 "
P-5, 1.30 x 600 " 780 "
P-6, 1.25 x 600 " 750 "
P-7, 1.25 x 600 " 750 "
P-8, 1.25 x 300 " 375 "

LIVE LOADS PER FOOT OF ARCH RING

We estimate the live load on the paving should be computed on the basis of 200 pounds per square foot,
and on the sidewalks at 125 pounds per square foot.

Along the 22 foot width of arch barrel there is distributed the total load on the structure, the live load then being,

\[
\begin{align*}
20 \times 200 & \text{ or } 4000 \\
10 \times 125 & \text{ or } 1250 \\
22 & \text{ or } 5250 \\
\sum & \text{ or } 238.6 \text{ or say 240 pounds along each horizontal foot of the arch ring.}
\end{align*}
\]

Since then each load division is represented by four feet, the total live load on each division would be \(4 \times 240\) pounds or 960 pounds, for each full division, and \(2 \times 240\) or 480 pounds for each half division.

<table>
<thead>
<tr>
<th>P-1</th>
<th>D.L.</th>
<th>L.L.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>6380</td>
<td>960</td>
<td>7340</td>
</tr>
<tr>
<td>P-2</td>
<td>4920</td>
<td>960</td>
<td>5880</td>
</tr>
<tr>
<td>P-3</td>
<td>3850</td>
<td>960</td>
<td>4810</td>
</tr>
<tr>
<td>P-4</td>
<td>3200</td>
<td>960</td>
<td>4160</td>
</tr>
<tr>
<td>P-5</td>
<td>2640</td>
<td>960</td>
<td>3600</td>
</tr>
<tr>
<td>P-6</td>
<td>2320</td>
<td>960</td>
<td>3280</td>
</tr>
<tr>
<td>P-7</td>
<td>2130</td>
<td>960</td>
<td>3090</td>
</tr>
<tr>
<td>P-8</td>
<td>1040</td>
<td>480</td>
<td>2000</td>
</tr>
</tbody>
</table>
MOMENT THRUST and SHEAR at CROWN

Dead Load Only

\[ H-c = 10 \times 2 \times 1,818,127.2 - 2 \times 508,136.4 \times 14.5 \]
\[ = \frac{2(10 \times 51.14 - 14.5 \text{ squared})}{2 \times 10} \]
\[ = +35,588 \text{ pounds} \]

\[ V-c = \text{zero} \]

\[ M-c = 2 \times 508,136.4 - 2 \times 35,588 \times 14.5 \]
\[ = -790 \text{ foot pounds} \ (e = .0194) \]

Dead Load plus Live Load on Right Half

\[ H-c = 10 \times (1,818,127.2 + 2,655,632.1) - (508,136.4 + 764,456.0) \times 14.5 \]
\[ = 607.70 \]

\[ V-c = \frac{9,836,613.2 - 14,547,937.0}{2 \times 1751.9} = \text{minus 1348} \]

\[ M-c = \frac{508,136.4 + 764,456.0 - 2 \times 43,253 \times 14.5}{2 \times 10} \]
\[ = +913 \]
\[ (e = .0211) \]

Dead Load plus Live Load on Left Half

\[ H-c = 43,253 \]

\[ V-c = \frac{14,547,927.9 - 93,6613.2}{2 \times 1751.9} = +1348 \]

\[ M-c = +913 \]
\[ (e = .0211) \]
Dead Load & Live Load on Whole Span

\[ H-c = \frac{10 \times 2655632.1 - 2 \times 764456.0 \times 14.5}{2(10 \times 51.41 - 14.5 \text{ squared})} = +50919 \]

\[ V-c = \text{zero} \]

\[ M-c = \frac{2 \times 764456 = 2 \times 50919 \times 14.5}{2 \times 10} = +2613 \]

Temperature (+50°)

\[ H-c = \frac{0.097 \times 0.00006 \times 50 \times 10 \times 62 \times 288000000}{607.7} = +8550 \]

\[ M-c = -8550 \times 14.5 = -12400 \text{ foot pounds} \]

RIB SHORTENING

"A" (For D.L. & L.L. on L1/2 Rise of Temp. and rib short.)

<table>
<thead>
<tr>
<th>Load</th>
<th>14500</th>
<th>22500</th>
<th>32000</th>
</tr>
</thead>
<tbody>
<tr>
<td>+Temp</td>
<td>7000</td>
<td>8200</td>
<td>8550</td>
</tr>
<tr>
<td>Short</td>
<td>2500</td>
<td>3060</td>
<td>3060</td>
</tr>
<tr>
<td>Total</td>
<td>24000</td>
<td>33760</td>
<td>44610</td>
</tr>
</tbody>
</table>

"B" (For D.L. & L.L. on L1/2 Drop Temp. and rib short.)

<table>
<thead>
<tr>
<th>Load</th>
<th>14500</th>
<th>22500</th>
<th>32000</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Temp</td>
<td>-7000</td>
<td>-8200</td>
<td>-8550</td>
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<tr>
<td>Short</td>
<td>1450</td>
<td>1770</td>
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</tr>
<tr>
<td>Total</td>
<td>8950</td>
<td>16070</td>
<td>25220</td>
</tr>
</tbody>
</table>

For "A" Condition

\[ H-c = \frac{0.097 \times 34120 \times 62 \times 10}{607.7} = -3380 \text{ pounds} \]

\[ M-c = \frac{3380 \times 14.5}{10} = +4901 \]
For "B" Condition

\[ H-c = 0.097 \times 16750 \times 62 \times 10 = -1660 \text{ pounds} \]
\[ 607.7 \]

\[ M-c = \frac{1660 \times 14.5}{10} = +2407 \]

**MAXIMUM COMpressive STRESS**

Extrados at crown for D.L. & L.L. Whole Span & -Temp.

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loads</td>
<td>+2613</td>
<td>50919</td>
</tr>
<tr>
<td>-Temp</td>
<td>+12400</td>
<td>-8550</td>
</tr>
<tr>
<td>Rib Short</td>
<td>+2410</td>
<td>-1660</td>
</tr>
<tr>
<td></td>
<td>+17423</td>
<td>+40709</td>
</tr>
</tbody>
</table>

\[ F-c = \frac{17423 \times 12}{0.1315 \times 12 \times 1.25 \times 144} = 735 \text{ pounds per square inch} \]

\[ F-s = 15 \times 735(13.5 \times 1) = 3420 \text{ pounds per square inch} \]

**MAXIMUM TENSION STRESS**

Extrados at springline D.L. & L.L. on L/2 drop Temp.

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loads</td>
<td>44383</td>
<td>+54320</td>
</tr>
<tr>
<td>Drop T.</td>
<td>-65918</td>
<td>7000</td>
</tr>
<tr>
<td>Rib Short.</td>
<td>-12796</td>
<td>-1360</td>
</tr>
<tr>
<td></td>
<td>123097</td>
<td>+45960</td>
</tr>
</tbody>
</table>

\[ t = 3.65 \]
\[ e = \frac{.735}{t} \]

(e = 2.68)
Maximum tension stress, Continued

\[ t = 3.65 \quad e = 0.735 \quad \frac{d'}{d} = 0.046 \]

\[ l = 0.098 \quad K = 0.31 \]

\[ P_o = \frac{1.988}{12 \times 12 \times 3.65} \quad e = 0.0038 \]

\[ f_c = \frac{123097 \times 12}{0.098 \times 12 \times 3.65 \text{ squared} \times 144} = 654 \text{ pounds per square inch} \]

\[ f_s = 15 \times 654 \left(\frac{3.4}{3.6 \times 0.31} - 1\right) = 19600 \text{ pounds per square inch} \]

EXAMINATION OF PIER PILE FOUNDATION

Since the pier supports one end of each arch, and since each abutment has more piling than the entire pier has, it is only necessary so far as support is concerned, that we examine the pile foundation of the pier to see if the piling are over-loaded. As a matter of fact, there is a shale bed under this entire bridge which the piling penetrates somewhat, and which resists any further penetration of the piling, and I have no doubt but what these abutment and pier foundations would support a very much greater load than is upon them. However, in the preparation of plans for the structure, matters of this kind are not thoroughly
known, and we proceed on the basis of the foundations being only of nominal ability to support loads.

On pile foundations, we expect the piling to support a load of twenty tons to each pile. Our first design of this abutment called for twenty-four piling in the pier foundations, so we proceed to see if sufficient piling has been chosen for the work as follows:

Arch ring weights,

| P-1, 2010 pounds | P-5, 780 pounds |
| P-2, 1380 " | P-6, 750 " |
| P-3, 1008 " | P-7, 750 " |
| P-4, 910 " | P-8, 375 " |

Total load of 7963 pounds or call it 8000 pounds per foot of arch, and since the arch barrel is twenty-two feet wide, and an arch on each side of the pier, we have a load of 8000 \times 2 \times 22 \text{ or } 352000 \text{ pounds}.

To this load should be added the earth fill transmitted to the pier, by way of the arch rib and the weight of the pier itself. The earth load over the pier was calculated, and found to be 6960 cubic feet, which taken at 120 pounds per cubic foot, is 835200 pounds for the total earth fill load on the pier, the spandrel walls, 127800 pounds, and the pier shaft and base, 184350, and 118800 pounds respectively, or a total load on the piling of 1638150 pounds or about 819 tons.
As above stated it was first proposed to carry this load with twenty-four piling, or about 34 tons per pile. The design was then changed to give the pier foundation 39 piling, or a load of 21 tons per pile. We feel, knowing the conditions as we do, this is perfectly good designing.

EXAMINATION OF ABUTMENT FOUNDATIONS

In the study of this bridge, I first planned an abutment that was smaller than this and found the same inadequate for the loads. This first abutment was planned to be twelve feet wide, with only one foot extension of the base on each side of the shaft. The following was designed after this first abutment was tried out and found deficient.

Concrete:

EFG' = \(\frac{(14 \times 2)}{2}\) 150# = 2100 Lbs. The Center of gravity of this section is 4'-6" left of "F"

DEG'G = (14 x 2)150# = 4200 Lbs. The Center of gravity of this section is 7'-0" left of "F"

BCHK = 3.75 x 10 = 37.50 x 150# = 5625 Lbs. The center of gravity of this section is 7' from "F"

RAMK = two triangles, 
RAM is \(\frac{(17 \times 3.67)}{2}\) 150# = 4679 Lbs. C.G. 2' left of "F"
Accompanying a Thesis Submitted to the Faculties of the School of Engineering and the Graduate School of The University of Kansas, for the Degree of Professional Engineer.
By W.E. Baldry, Topeka, Kansas June 1926.
BKM is \( \frac{10 \times 6.25}{2} \times 150 \frac{\#}{2} = 4687 \text{ Lbs.} \) C.G. 3.25 feet left of "F"

From this we get the C.G. of the abutment concrete to be

\[
\begin{align*}
4200 \times 7.0 &= 29400 \\
5625 \times 7.0 &= 39375 \\
4779 \times 2.0 &= 9558 \\
4687 \times 3.25 &= 15232 \\
\hline
21291 &+ 102815 = 21291 "X", \text{ or C.G. is} \\
\hline
4.83 \text{ left of } "F" &
\end{align*}
\]

Dirt:

Small Rect. section, \( 2 \times 20 \times 120 = 4800 \text{ Lbs.} \) C.G. 13 feet left of "F"

\[
\frac{16 + 7.25 \times 16.25}{2} \times 120 = 22680 \text{ Lbs.} \) C.G. 4 feet left of "F"
\]

Combining the earth and concrete, we have with moments about "F"

\[
153120 + 102815 = X(21291 + 27480) \]

whence \( X = 5.24 \) left of "F"

By referring to the detailed plans it will be seen how these forces have been combined with the dead and live loads to obtain the resultants on the abutment foundations.

The concrete load as above shown is 23391 pounds per foot of arch, while the earth load is 27480 pounds per foot, making a total dead load of 50900 pounds per foot. Under the most adverse possible conditions of loading, we have a total dead load on the abutment foundations of 1119800 pounds or about 560 tons.
In the abutment pit area of 14 x 22 feet, there will be 40 piles to carry this load, or about 14 tons per pile, so that our abutments are very ample as to foundation spread.

PREPARATION OF PROJECT FOR CONTRACT LETTING

DESCRIPTION OF THE STRUCTURE

The structure proposed to be built under these plans and specifications consists of a double reinforced concrete arch bridge of sixty foot spans each, a five foot cantilevered sidewalk on each side and twenty foot roadway. There will also be built in connection with this bridge the necessary retaining walls, to control the creek, pavements, etc., to make the job complete, to fit in with the surrounding conditions.

There will have to be preparation made by the contractor for the disposition of these materials, for the bridge construction the bridge site will be closed, but Chestnut street must be kept open as far north as the bridge, in order that the streets and shops there may continue to do business. The Seventh and Hancock intersection must be kept open so that a one way line of traffic may be open to the public and also, a road
way maintained with an outlet on Seventh and Hancock intersection along the north bank of Shunganunga Creek, or if not feasible to do this to provide some other means of taking care of this traffic.

Excavated materials will be disposed of as the Contractor sees fit, you will not be allowed to deposit any materials in the stream or creek channel unless you have the specific permission of the District Drainage Board, and you will be required to remove any and all such material from the creek channel at the conclusion of your work.

The bridge will be an earth filled structure so that ultimately ample disposition of surplus material may be made on the site of the work. The contractor is required as a part of this contract to construct across the creek a foot bridge and to maintain the same until the new bridge is open to travel, the said foot bridge to be four feet wide between the handrails, and to have a handrail on each side of the walk, 36 inches high, above the floor of the foot bridge, and to be suitably braced and made secure, and to be closed against the possibility of children falling through the same, by side rails properly spaced as pier pales for
the same. The foot bridge is to be made safe, serviceable, secure and satisfactory, and to be located where it will be out of the way of the new bridge construction and afford suitable means of approach. Until such time as the old bridge must be removed, the public may use it as a footbridge.

The old bridge will remain the property of the city, and it is to be taken down by the Contractor, and the material piled on the parking on the south side of Seventh street and west of Hancock street, the material will be preserved and not unnecessarily destroyed, and none of the material is to be used by the Contractor in his bridge construction. The piling now supporting the bridge will be sawed at the low water level by the Contractor, so that no interference to the flow of the stream will remain. The cost of the old bridge removal will be included in the Contractor's bid for the new bridge complete.

ENGINEER R'S ESTIMATE OF QUANTITIES

The following quantities are given the bidder only as a guide to him concerning the various amounts of work to be done. These quantities are NOT GUARANTEED and the bidder is advised to check them and use
his own conclusions as to their accuracy -- they do not however contain any known errors. If the bidder finds errors in these quantities, he should take the matter up with the Engineer at once before submitting his bid.

PILING
207 Piles - 18 feet long - 12" butts
Extraction Total
Wet 538 Cubic yards
Dry 1194 Cubic yards

CONCRETE
1-3-5 - 452 Cubic yards
1-2-4 - 538 " "

STEEL
Structural - 1218 - Reinforcing 55000

FOOT BRIDGE
To be erected and then removed after completion of new bridge.

HANDRAILING - 313 Lineal feet
CURB & GUTTER - 390 " "

BRICK PAVING - 512 Square yards
ASPHALT PAVING - To cut and replace 34 Square yards

INSTRUCTION TO BIDDERS

NAME: - Proposals under different names will not be received from one firm or association.

RIGHT TO REJECT BIDS: - The Mayor and Board of Commissioners of the city of Topeka reserve the right to reject any or all bids, or parts of bids the rejection of which may be deemed advantageous to the city.
CERTIFIED CHECKS REQUIRED:

Each bid must be accompanied or have filed with the city Clerk a certified check made payable to the City of Topeka in the amount of $1000.00 and given to the city by the bidder as a guarantee that the bidder will file all bonds required and enter into a contract with the city for the construction of the bridge if awarded the contract within ten days from the date of the award, and should the successful bidder fail to file approved surety bonds or enter into the contract, with the city, then, at the option of the city, the certified check shall become forfeited as liquidated damages, and the money realized therefrom shall be turned into the treasury of the city.

NAME AND ADDRESS:

Each bidder will be required to state in his proposal the name, place of residence, exact post office address, and also the names and addresses of all persons or parties interested or associated with him therein. Anyone signing a proposal as agent for another, or otherwise, must file his authority to do so, with the proposal.

ACCEPTANCE OF PROPOSAL:

No proposal will be accepted from any person who is in arrears to the city of Topeka on debt or contract, who is in default as surety or otherwise on any obligation to the city or who has failed in previous contracts to comply with the requirements of the specifications or to fulfil his contracts.

SPECIFICATIONS TO BE ENFORCED:

Bidders on this work should take into consideration the fact that these specifications will be enforced and that an inspector will be present at all times on the work to see that the same is properly and faithfully performed.

OPENING BIDS:

Bidders are invited to be present at the opening of their proposals. All proposals are made and received with the express understanding that the bidder accepts the terms and conditions contained in these Instructions to Bidders, Contract, Specifications and Bonds referred to herein, and bound herewith.
CANVASSING BIDS:

All bids will be canvassed upon the approximate quantities designated upon the Bidding Forms, and the lump sum bid for the structure complete as per plans. The lowest bid will be determined upon the basis of the aggregate cost.

PROPOSAL TO BE COMPLETE:

The proposal shall be a lump sum for the bridge complete ready for traffic, which sum shall also include the removal of the old bridge, the channel work required to be done, the raising or lowering of any manholes, flush tanks, waterlines, sewers, or the carrying of any sewers through the structure to an outlet in the creek. The laying of the new pavements from the end of the present Seventh street paving to the new bridge, the connecting of the sidewalks as now exist to the new structure, the connecting of the Chestnut street paving to the new bridge, and any incidental work not specifically herein mentioned, but necessary to make the job complete are also to be included in the lump sum bid for the job. The temporary foot-bridge called for in the preceding paragraph under "Description of the Structure" and the removal of the same after the new bridge is placed in service, is also a part of the lump sum bid for the work.

Where additional items are presented in the "Proposal" for which unit prices are asked, the same is intended to be used in case unforeseen conditions arise in the prosecution of the work requiring prices for extra work not otherwise provided for in the lump sum bid. Any or all of these extra items may be omitted if construction conditions permit of the same; likewise, any or all of these items may be used if required, and in larger or smaller amount than as appears in the "Proposal." However it is to be understood the contract price will be paid the contractor regardless of the use of these unit price items. It is to be understood however that extra work will not be paid for by the city under these unit prices for work required to be done by reason of carelessness of the contractor, or results obtained by his operations in the bridge construction.
CLOSING OF STREETS:

No streets will be closed due to this bridge construction but the contractor will be permitted to reduce the roadway in the Seventh and Hancock street intersection to a one way passage and he must leave an opening in front of the business houses on Chestnut street. Any private property which may be used will have to be arranged for by the Contractor, and paid for at his expense.

TIME OF COMPLETION:

This bridge must be completed and ready for traffic and all construction matters finished by December 1st, 1923.

GENERAL:

The city reserves the right to question any successful bidder as to his competency to construct works of this kind. The contractor will encounter difficulties in the construction of this bridge, due consideration of which he should give in order that he may prepare for this construction. You will encounter water mains, gas mains, which may be removed out of the way during construction if the companies controlling the same can figure out a way to do so; and it is expected at this time this will be done.

In the matter of materials for the bridge it is the idea of the department that upon award of the contract, the contractor will at once arrange for the shipment of his piling and his steel and in the meantime start clearing away for his excavations, finding a place for the storage of materials and a place for his excavated materials, in order that the same may be used for filling over the arches at the completion of the bridge.

In the matter of crushed rock for the bridge, he may contract for this material wherever you like, but let it be understood this job will not be allowed to lag for rock when we are ready to pour concrete. It has been the experience of the department, in the summer when building operations want rock, our bridge work has not been furnished, for the reason the bridge contractor had contracted for his rock in the winter.
season, and at a less price than the prevailing price in the summer season, and since the builders can use about all of the rock that can be produced, rock for the bridge operations has not been forthcoming. The city hereby reserves the right to order rock shipped to the job or brought to the same from any available source of supply, at any time local rock as contracted for is not being promptly supplied. It is the intention of the department this job must move and we will allow no delay because of the fault of some subcontractor, likewise, there must be sufficient force on the work to make it move, and we will not allow it to drag along because there may be time left in which to possibly complete the same before the expiration date named in the contract. The time specified is the limit, and we want the bridge in operation as much before that time as it can be done and work to advantage with your forces. We do not however expect more force on the work than can be profitably be employed. Understand you will not be allowed to place any materials from your excavations in the creek channel unless you have the consent of the District Drainage Board, filed with this office.

The piling lengths shown on the plans, should carry the foundations to rock or hard shale, according to the boring that has been made, and you will encounter in the pier excavations particularly, and possibly in the abutments, considerable old cobblestones and rubbish which has been placed along the creek banks in times past to preserve the same. All the cobblestones recovered will be allowed to be placed in the foundations, as rubble concrete, they shall however before being placed in the concrete be cleaned, and if more rock of this nature is encountered than can be used in the foundations, they will be preserved for later filling at advantageous places on the work.
PROPOSAL

Topeka, Kansas

To The Mayor & Commissioners,  
City of Topeka, Kansas.

Gentlemen:

The undersigned hereby proposes to furnish all the labor and material of every description, necessary to construct the bridge provided for under these plans and specifications, the same to be built across Shunganungac Creek, at Seventh Street, in the City of Topeka, Kansas, complete in all respects, and acceptable to the City Engineer, and board of City Commissioners, in accordance with the written and verbal instructions given for the work, and to have the same ready for traffic, by December 1, 1923, including the removal of the old bridge, the building of a new foot bridge and the maintenance of the same during construction of the new bridge, the removal of the foot bridge after completion of the new bridge, the channel work required, paving, retaining walls, etc., for the sum of ________________

The undersigned further proposes to furnish all labor and materials necessary for the following extra items which may or may not be required to be used in the construction of this bridge, which items are not a part of the general contract above provided for, but which are to form a basis of costs for work necessary to be done but which are unforeseen items in the general contract, and when extended will help determine the lowest bidder for the work and set aside funds with which to meet the same.

100 Cubic yards of extra excavation below elevation anywhere on the job, including sheeting, bracing, pumping, bailing, etc., per cubic yard.  

__________________________

25 Cubic yards of extra excavation below elevation anywhere on the job, per cubic yard  

__________________________
15 Cubic yards of 1-3-5 concrete, including forms, but no reinforcing steel, per cubic yard


25 Cubic yards of 1-2-4 concrete, including forms, reinforcing steel, per cubic yard


10 Lineal feet of extra wooden piling furnished and driven for foundations, as required, per lineal foot


The undersigned makes the above statements, and proposals with the understanding that there are to be no deductions made from the lump sum bid for the general contract as planned, but that the amount of quantities above shown for which unit prices are asked may be decreased or increased as the necessity requires for the proper security and completion of the structure, and the unit prices herein made are to be used regardless of the final quantities.

The undersigned further agrees to enter into a contract with the city of Topeka for the construction of the above public improvements, and to furnish approved surety company bonds for all bonds required in the specifications.

Signed
GENERAL STIPULATIONS

CONTRACTOR TO LOOK OVER PROPOSED WORK:—

The public improvements contemplated under these specifications shall be built of the dimensions and materials and to the grade, locations, and lines provided by the Engineering Department of the city, and in conformity with the general layout scheme, accompanying the plans for this work, approved by the Commissioners of the city, January 16th, 1923, and the Contractor is admonished to look over the site of the job, that he may be fully informed of the nature of the work, and the conditions under which the same is to be accomplished.

MATERIALS SUBJECT TO APPROVAL:—

All materials furnished and work performed which in the opinion of the Engineer is not in accordance with the specifications, plans, etc., for the work, or which does not meet the standard tests for the materials in question, shall be immediately removed from the work and other materials furnished and work done which shall conform thereto.

EXECUTION OF THE WORK:—

Work under this agreement is to be carried on with such force of labor and machinery and to be of
such workmanship, and in such order as will insure the completion of the job by the time specified, and acceptable in all its parts to the city officials.

REGULATIONS, LABOR, FOREMEN, SUBCONTRACTORS:

The contractor shall comply under this contract with all the rules and regulations and ordinances of the city, pay all necessary fees, licenses, and take out proper permits, together with the giving of proper notices to all individuals, firms or corporations whose interests may in any manner be affected by his operations. He will not be permitted to sublet without the approval of the city authorities, and part of this contract of a construction nature. He shall at all times have upon the work a competent foreman, to whom directions may be given as required, and all employees upon the work may be dismissed from the same for good cause upon the demand of the City Engineer. The employment of labor shall be from the available supply of the city, and from regular residents therein and other things being equal they shall have the preference over other labor which might be desired to be used upon the work by the contractor.
TRAFFIC AND DRAINAGE: -

The contractor shall provide under this contract a footbridge for foot passengers across the creek, as set forth above in the "Description of the Structure" which shall be out of the way from construction materials, and the execution of the work, and he shall provide the necessary safety measures to prevent the public from falling into the work in any way or from being hurt in approaching these facilities. The usual drainage and water courses must be maintained open and ready for use at all times.

The contractor shall properly protect the public from all open work with suitable barricades, red lights, and watchmen as the needs of the same demand. He will be held responsible under his bond for any damages which any parties may sustain in consequence of neglecting the necessary precautions in prosecuting his work.

IMPERFECT WORK: -

No work will be considered as acceptable which may be deficient in any of the requirements of these specifications, in consequence of the neglect of the engineer or inspector to point out such defects during
the construction of the work, and the contractor will be required to make good any defective work whenever the same is discovered before the final acceptance of the job.

PROTECTION OF NEW WORK:

All new work must be protected, and no wheeling or walking upon it shall be allowed. Any work injured before completion of the whole job must be rebuilt by the contractor without extra pay for the same.

PRESERVATION OF STAKES:

The contractor shall preserve all stakes set to mark lines or levels in their proper positions until authorized by the engineer to remove them. Any stakes removed or intentionally torn out shall be reset at the expense of the contractor, and the cost of the same if necessary shall be taken from his final estimate of the work.

ESTIMATES:

The monthly estimates to be made the contractor, during the progress of the work, shall be made on or about the twenty-fourth to the twenty-sixth of each calendar month and ninety per cent of the completed work shall be allowed the contractor, ten per cent
being retained from all monthly estimates until the final estimate shall have been written. An estimate of seventy-five per cent of the cost of the materials of construction on the ground will also be allowed in addition to completed work with the monthly estimates. Each monthly estimate will show the amount of completed work done to date, and from this will be deducted the amount of the previous payments made. The engineer will be allowed to use his discretion in the amount of material payments to be allowed, in view of the amount of the general contract.

FINAL ESTIMATE:

The final estimate will be made at such time as the contractor has fulfilled his entire contract to the satisfaction of the engineer and it has been accepted by the Mayor and Commissioners. Ten per cent of the entire contract as shown by the final estimate will be withheld and shall not be due the contractor until thirty days after completion of the work and the final acceptance and passage of the final estimate by the City Commission; this is done to comply with the law in such matters.
CONTRACTOR RESPONSIBLE FOR DAMAGE:—

The contractor will be held liable for damages to houses, fences, yards, sidewalks, trees, parks, shrubbery, water, gas, sewers, heating pipes, or other property which he may in anyway injure or destroy of grading, teams hauling materials, or other wise, and such contractor shall settle with the property owners for any such damage, and in case of failure to make such settlement within thirty days after the bill has been filed in the office of the City Engineer, the city may settle for the same and deduct the amount thereof from the next estimate allowed the contractor, and in case of claim or suit for damages is presented or brought after the final estimate is given the contractor, then the contractor's sureties will be held for the damages on the bond provided for herein.

SANITARY CONVENIENCES:—

Necessary conveniences, properly secluded from observation for the use of the laborers on the work, shall be erected and maintained by the contractor under the direction of the engineer and to the satisfaction of the Department of Health of the city.
TELEPHONE:

The contractor is required to maintain a telephone and an office whereby he may be reached at any time day or night if needed.

TIME:

Time being an essential element of this contract, and it being desired by the city that this work shall progress as rapidly as possible, it is hereby stipulated that at the option of the Commissioners, the contractor shall forfeit the sum of ten dollars per day for each and every day after the expiration of the contract time, during which this contract is not fully completed and accepted. In considering this clause of the contract, due account must be taken of the provision made in the preceding pages relative to the working days of the contract and the availability of materials; this clause is to apply as liquidated damages unto the city by reason of culpable negligence in the completion of his contract by the contractor.

BOND FOR PERFORMANCE OF WORK:

The contractor will be required to furnish the city with and sufficient surety company's bond to be approved by the Mayor and Commissioners, in the amount
of the contract price, conditioned for the faithful performance of the contract, and such bond shall also indemnify the city against any loss or damage which the city may sustain or suffer on account of injury to persons or property or property rights, caused or permitted by the Contractor or his employees. The surety company furnishing the bond must have a local representative.

**BOND FOR PAYMENT OF BILLS:**

Contractors will be required to furnish a good and sufficient surety company bond to the state of Kansas in an amount equal to the total amount of the contract conditioned that such contractor shall pay all indebtedness incurred for labor or materials furnished in the making of these public improvements. This bond shall be filed by the Contractor in the office of the Clerk of the District Court of Shawnee County, Kansas.

**PAYMENTS:**

Payments will be made in cash on or about the seventh of calendar month, based upon the estimates of the engineer as provided for above.
HANDLING OF MATERIALS, CLEANING UP

Materials must be so dumped so as to be readily recollected, and no materials are to be dumped in mud or dust. After completion of the work, the contractor will be required to remove all left over materials, rubble, etc., of whatever nature, clean up all street parkings which have been in any way used, and leave the job in the same clean condition as when he went on the work, also the stream channel will be required to be cleaned up in a workmanlike manner, all timbers left in the foundations to be neatly cut off, all construction wires, braces, stakes, deadmen, anchorage, etc., must be entirely removed. The piling of the old bridge will also be required to be left smooth with the water level.
GENERAL SPECIFICATIONS.

Portland Cement:

All Portland cement shall be of the best grade, and shall be delivered and stored at some suitable point for the inspection of the City Engineer, who shall be informed and given access to the same at least ten days before it is required for use, so that he may make such tests of the same as necessary in his opinion to insure a proper product. Any work in which rejected cement has been used will be rejected altogether.

The manufacturer's certificate of plant tests for each car of cement delivered upon the work or any part of the car must be mailed directly to the Engineer by the manufacturer at the time the car is loaded. The cement shall be packed in strong bags having printed on the outside of the bag the brand of the cement, and the name of the manufacturer. Only one brand of cement will be allowed to be used in the casting of any particular surface, both for the effect of the color and the strength. In this work the tests for the cement will be those current in the American Society of Testing Materials, and for mastic the boiling test will be used.
Portland Cement, Continued.

The parts in the steam test shall remain sound without signs of checking, distortion or cracking. The cement shall show initial set within one hour, and final set within ten hours; briquettes will be formed, stored, and tested in accordance with the requirements of the specifications of the American Society of Testing Materials and they must meet these tests the values of strength prescribed in those specifications. The methods of tests will be those by the special committee of the American Society of Civil Engineers and American Society of Testing Materials.

Sand:-

Sand shall be clean Kaw River sand and not more than five per cent shall pass the 200 sieve, and not more than 30% shall pass the number 50 sieve. Briquettes of a 1-3 mix by weight at age of seven days shall show a tensile strength and compressive strength with 1-3 mortar of standard Ottawa sand.

Broken Stone:-

All broken stone shall be of the best quality of crusher run limestone, none of which shall exceed one
Broken Stone, Continued.

inch in diameter or along its greatest dimension, i.e., it must pass a one-inch ring in any direction.

Joplin Chats:

For the sidewalks, and curb and gutter construction, Joplin screened chais are to be used of the mixture 1-2-4, in which the amount of sand to be used may be varied to meet the requirements of a first quality mixture. The use of local stone for this work is not recommended, and if used the contractor will be required to give the city a satisfactory maintenance bond for one year, conditioned that he will replace any of the same regardless of cause within that time if the same goes bad, and he is not to set up as a reason for the nonfulfillment of this clause that vibration or similar conditions are the cause of the failure and not the materials. The experience of the engineer teaches that local stone is not advisable to be used in small or thin sections of concrete.

Reinforcing Steel:

The reinforcing steel bars to be used for this job shall be rolled from new billet stock, and such bars shall comply with the standard specifications for the same
Reinforcing Steel, Continued.

as in force at the date of testing, of the same as adopted by the American Society of Testing Materials.

In the event of the use of any re-rolled steel for the manufacture of these bars, they shall be rolled from standard tee rails of a tensile strength of not less than 80,000 pounds per square inch with a yield point of not less than 50,000 pounds per square inch. The elongation in eight inches, shall in per cent be not less than a million divided by the tensile strength, except for bars over ¼ inch in diameter; and the other details of this steel shall be in conformity with the specifications for the same, as found in the specifications of the American Society for Testing Materials. The bending of these bars to fit the job, if this steel is selected, must be accomplished, and no broken bars will be used and patched up because of this fact.

Paving:

The paving will be of the class as shown on the plans, and the contractor in this will be obliged to conform to the standard specifications of the city current at the time of his laying this pavement.
Broken Stone for Curb or Walk:-

The largest fragment of J oplin flint, crushed granite, or native limestone shall not exceed $\frac{3}{4}$ inch, in its greatest dimension and the same shall be free from dust, dirt, and such fine material as will pass a #10 sieve.

General Bridge Construction:

Soundings; The contractor may be required to make a boring in the pier abutments, or wing foundations, to determine the bearing power of the soil, and the nature of the equipment required to be used for the bridge construction.

Excavations; All excavations are to be carried to the depth shown on the plans, and deeper if the stability of the structure requires. The Engineer will personally inspect the foundations before any concrete is poured in them. In the excavations the contractor will be expected to remove at his own expense all loose rocks, boulders, logs, or other materials as the same shall be encountered, without extra compensation from the city. No extra payment will be made unless additional work over that shown on the plans
is required to be done. All sewers, conduits, drains, or other channels for the flow of water, must be left unobstructed, or and provision made for their continuance through the work.

Cofferdams; Cofferdams will be so constructed as to permit of placing dry concrete in the foundations. No concrete will be deposited under water without special apparatus for doing so. All sneeeting left from cofferdams must be cut off smooth at the completion of the work.

Adjacent Structures; Foundations of adjacent buildings or embankments shall be securely braced so as to hold the same to prevent injury to property. The contractor will be held liable on this matter.

Foundation Concrete; In pouring the first four feet of the abutments for this bridge, the concrete must flow tight against the excavations, so there will be no possible chance for the arches to move on their foundations when the forms are struck.

Surplus Material; Surplus material from the excavations must be removed from the stream channel, and any excavated materials placed in the stream must be done only on the consent of the Drainage Board. In this con-
struction, the excess material will largely be used in the fills over the arches.

Centering; The contractor shall desiging the centering for the arches, pier, and wingwall forms, and submit them to the Engineer for his approval. All forms shall have sufficient strength to support the materials in them until it sets up, and when centering is removed all supports must be leveled to the water edge at low water flow. If the arch centering shows any signs of distress in loading, crown loading may be resorted to to prevent such distortion.

Forms; Forms for all exposed surfaces shall be dressed and smooth, the arch lagging is to be made non-absorbent by the use of oil or paraffine. Upright forms must be securely wired or clamped, and upon removal of the forms all wires must be neatly turned in and the wall left smooth. All corners are to be fitted with a triangular moulding nailed into the same not less than one inch on a side so that upon removal of the forms the corners will present a neat appearance. Panels will be formed by nailing also a triangular moulding to the forms of suitable size to harmonize with the size of the panel to be created.
Concrete: Concrete will be mixed to a uniform mixture and color, in a concrete mixer of approved pattern capable of being controlled as to the amount of water in each batch, and the length of the time the batch is in the mixer drum. The method of charging the mixer must be up to date and capable of complete control. The concrete when placed in the forms must be spaded, tamped, and worked to produce even, true surfaces, free from honey-combed spots, and to the satisfaction of the Inspector in charge. Concrete will be proportioned by volume measurement, and mixed in the following ratios.

In the abutments, pier and wing footings, and up to the spring line level of the arches, and the underside of the coping in the pier, the concrete will be mixed in the ratio of 1-3-5 and above the footings in the wing walls, the arch barrels and all other construction on the bridge except the paving base, curbing, sidewalk, etc., the mixture ratio will be 1-2-4. In the railing sections where the use of stone is impractical, gravel or coarse sand may be used in the proportion of one part of cement to three parts of sand. Sufficient clean water from the city water mains, will be used to make the mixture plastic, so that it may be readily spaded and worked into the
forms. The contractor is to pay the city water department for all water used at the rates and manner prescribed by that department.

Loose concrete, sawdust, or other debris, shall all be removed from the forms before concrete is poured. Boulders or hard quarry limestone, may be buried in the heavy footings, abutments, and away from any forms, or steel. No stone thus used shall be larger than twelve inches in its largest dimension, and must be imbedded in at least four inches of concrete. No retempering of concrete will be permitted, and no concrete will be poured in freezing weather, unless special arrangements are made for the same.

Division of the Arch:-

The arch rings will be poured in sections parallel to the cement line of the roadway, and they shall not exceed approximately five feet in width. Proper forms shall be built for these sections and the cross steel of the arch will be run through the vertical wall forming the side of the ring, so as to properly tie the various sections of the arch ring together. Each section will be required to be completed when begun, from spring line to spring line;
These rings must be run straight, so that the appearance of the sortit lines will be parallel to the spandrel walls. The outside rings will be concreted monolithic with the spandrel walls, brackets, etc.

Pouring of Beams:-

Beams or girders are to be poured in one run and are not to be cut in sections. Should circumstances arise requiring the cutting of a beam, the division shall be made at the center, transverse.

Expansion Joints:-

Expansion joints must be provided at all points where temperature changes might cause unsightly cracks. Expansion joints should be provided in the railings, at not greater intervals than twenty feet. These expansion joints will be worked out at the panels members in the handrailins.

Drains:-

Drains consisting of vitrified tilei ng, shall be run through the arch barrel at or near the spring line, so as to properly drain the fills over the arches. In the pier and abutments drains must also be provided so that the filling behind the same may be kept reasonably dry. These
drains are to be covered with large stones first, to create a sump for the collection of the water.

Forms, Finish, etc.:

Coping shall be built with special care to show true and straight lines, and camber. The forms for coping shall be aligned after supporting walls have been completed and the coping itself shall be subsequently added. Forms which do not support loads may be removed as soon as the concrete has taken its final set. The forms from coping and railings and spandrels is to be removed as soon as possible. Immediately after removal of the forms all cavities in the surface shall be filled with dry cement mortar from which the surface film must be removed before it sets. All surface shall have a smooth finish produced by spading the concrete near the lagging, to flush the cement near the surface. The finish of all parts above the lower line of the sidewalk will preferably be inner and more decorative than the balance of the work. Great care must be used to secure smooth surfaces, and after early removal of the forms, the surfaces will be brushed with clean water to remove the cement, lime and sand; then grout will be applied to the entire surface of the struc-
ture above the ground line, and to this also will be added something in the nature of hydrated lime to produce a white finish to the structure.

Hydrated Lime:-

In addition to the regular amount of cement required, to be used in making all concrete for this work, above the ground line eight per cent of hydrated lime, by weight, is to be added to the cement, that is, 8% of the amount of the cement used, but no deduction of cement is to take place by reason of the addition of this lime hydrate.

Plastering:-

No plastering will be permitted except on surfaces covered by earth filling. Panels where used may be accentuated by triangular casting, and by tooing, or bush hammering.

Filling:-

Filling over the arches of the bridge must be done under the direction of the engineer, and to the satisfaction of the Inspector on the work. The arch must be loaded with special care, and equally from each side. The
abutments will be built and filled first before the construction of the arch rings.

Walks & Curbs:-

Cement walks, curbing and paving will be made to conform in all cases to the city's standard specifications current at the time of the letting of the bridge contract.

Opening of the Bridge:-

The bridge will not be opened to travel earlier than twenty days after completion of the supporting members nor without the consent of both parties to the contract.

Removal of Centering:-

The contractor shall strike centers at such time as shall be determined by both parties, but no longer than sixty days after completion. The centers or supports must not be removed until after the fill has been substantially completed over the arches, except upon written permission of the engineer.

Railing Construction:-

The railing will be built after the arch centers have been removed. This construction must be done with care and by competent mechanics. The spindles must be evenly
spaced, set plumb, and pointed up with neat cement, around base and top. Proper expansion joints must be provided throughout the railing and these will be specifically pointed out by the Engineer at the time of the construction of these railings. The height of the railing, and the size of the various members will be as detailed upon the plans.

Name Plates:

The contractor will provide two name plates, one to be set on each side of the bridge and bearing the following legend and set in the end pedestals of the hand railing. These plates will be bronze castings and will not be less than 14 x 21 inches outside measurements. One of these plates will carry the names of the City Commissioners, the year of erection, and the name of the designing and erecting Engineer. The other plate will carry the name of the contractor who built the bridge. These plates will be set flush with the surface of the panel in which they are placed.

Conduits, Water Mains & Utilities.

Conduits when required in the structure will not be furnished by the Contractor, but where called for will be set by him where directed, but the Engineer, with-
out additional expense to anyone. Public utilities, such as gas mains, telephone, telegraph, steam, water, etc., when encountered shall be maintained, and the owner thereof notified, and if it is decided to maintain the same in their present positions, the contractor will build the necessary forms about the same, so that they may be removed in the future without injury to the bridge or the utility. Work of this kind, unless it involves any decided additional material will be done without expense to the city or owner, by the contractor. In any event of this kind, where it is obviously necessary that the utility must be removed, the city will arrange for this work to its best ability and with as little delay as possible to the contractor.

Street to be Left in Original Condition:

The contractor will be required to repave, remacadamize, or recinder any road to replace, rebuild, or relay any sidewalk, fences, curbs, gutters, bridge, or flagstone; and to replace with new material any which have been injured or destroyed by the execution of the work; to leave the surface of the street or alleys in all respects equal to their original condition and to the satisfaction of the Engineer.
Piling:

Wooden piling supporting the arches proper, shall be of round burr oak, cypress, red cedar, green yellow pine, or other material that will successfully resist the blows of the hammer; Piles must be cut from round trees, be close grained and solid, free from defects as wind shakes, decays, loose knots, etc., that will impair their stability and durability. They must be cut above the ground swell, have a uniform taper from butt to tip, and must not contain short bends. A line drawn from center of butt to center of tip must lie within the body of the pile. All knots must be trimmed close to the body of the pile, and all bark removed. The butt of the piling should be as near twelve inches as can be commercially obtained. The tip shall be of such size as usually obtains with this size of butt, and approximately six inches. These piling shall be eighteen feet long.

Concrete Pile Shafts:

Under certain conditions of foundation to insure the safety of the arches, concrete piers or shafts will be built from the base of the abutment downward to suitable subgrade; these shafts will be approximately four feet square, made of 1-3-5 concrete, and a few stubs of steel will be inserted therein to tie the shafts to
the abutment proper; these shafts when required will be paid for as required in the bidding blank. The prices will include the necessary bracing for such pits:

Blasting:

Blasting where required shall be conducted in accordance with the city ordinances covering the same.
CONTRACT

ARTICLES OF AGREEMENT

Names of parties to this contract

Between - - - - - - - - - - - - - - - - a firm
composed of - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - part____ of the first part and the City of Topeka,
party of the second part.

This agreement made and entered into this ____
day of _____________ of _____, part____ of the first
part, and the City of Topeka, a municipal corporation or-
ganized under the laws of the State of Kansas, party of
the second part.

AGREEMENT

Witnesseth, That the said part____ of the first
part for and in consideration of the covenants and agree-
ments of the said party of the second part hereinafter
make and contain for ____ heirs, administrators and
assigns, hereby covenants and agrees to and with the said
party of the second part, that ________________, the
said part____ of the first part shall and will furnish all
material and all the work of whatever kind necessary to
construct and complete in accordance with the specifica-
tions bound herewith, and made a part hereof, and accord-
ing to the plans and drawings on file in the office of the
City Engineer of the City of Topeka, Kansas which are also
a part of this contract, the following public improvement
in the said City of Topeka, Shawnee County, Kansas, to wit:

The construction of a reinforced concrete, earth
filled, three arch bridge, consisting of 12 piers and two
abutments, with wing walls, twenty foot roadway between
curbs, and two five-foot contilevered sidewalks, together
with the paving of approaches between the end of the pav-
ing now there and the new bridge; the construction of
suitable foot bridge during the progress of the work, at
the grade of the connecting creek banks, and necessary
channel work, supplying materials for the filling over
the arch and all other work incident to the construction
of the bridge as per plans and details for the same.

All the said work to be done and all the said
material to be provided and furnished in conformity with
the specifications therefor, bound herewith, and the plans
for the same on file in the office of the City Engineer,
reference to which is hereby made, also all the written
and verbal instructions and directions and orders of the
Engineer, given for the complete fulfillment or explan-
nation of the said plans, or specifications as the Engineer shall from time to time make and give during the progress of the work, and it is hereby expressly agreed and understood that all such written and verbal directions shall be made, performed and accepted by the party of the first part as though the same had been fully written herein and all explanations of said plans or specifications for such work shall be considered as final and conclusive.

BEGINNING AND COMPLETION OF THE JOB:

The said party of the first part further covenants and agrees that said work shall be commenced within twenty days from the date of this agreement, and shall thereafter be constantly and vigorously prosecuted, and that the same shall completed to the entire satisfaction of the City Engineer and Board of Commissioners in accordance with the plans and specifications therefor, as aforesaid, by the first day of December, 1923.

AMOUNT TO BE PAID:

The said party of the first part doing and performing all and singular the items and conditions of this agreement herein by him agreed to be done and performed, and said party of the second part, having accepted
the work of the party of the first, the said second party agrees to pay to the said party of the first part, or his legal representatives, the following prices, respectively for the various materials furnished and labor performed, to wit:

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To bridge complete according to plans and specifications on file as above mentioned, as per proposal filed</td>
<td></td>
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<tr>
<td>100 Cubic yards of extra excavation below elevation 2.0 anywhere on the job, including sheeting, bracing, pumping, bailing, etc., per cubic yard</td>
<td>100</td>
<td></td>
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</tr>
<tr>
<td>25 Cubic yards of extra excavation above elevation 2.0 anywhere on the job, per cu.yd.</td>
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<tr>
<td>15 Cubic yards of 1-3-5 concrete, including forms but no reinforcing steel, per cu.yd.</td>
<td>15</td>
<td></td>
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<tr>
<td>25 Cubic yards of 1-2-4 concrete, including forms, reinforcing steel, per cubic yard</td>
<td>25</td>
<td></td>
<td></td>
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<tr>
<td>10 Lineal feet of extra wooden piling furnished and driven for foundations, as required, per lineal foot</td>
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<td></td>
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</table>

MATERIAL TO BE FURNISHED BY CONTRACTOR:

All labor and material necessary to complete the work provided for in this contract shall be furnished by the contractor at his own expense.

NO MATERIAL TO BE USED UNTIL INSPECTED:

No materials of any kind shall be used until they
have been examined and approved by the Engineer who shall have full power to condemn any work or materials not in accordance with this specification; and to require the contractor to remove any work or materials so condemned.

NOT FINAL UNTIL ACCEPTED BY MAYOR AND COMMISSIONERS:

It is a part of this contract that the acceptance of work and material will not be final and conclusive in any respect until the completion of the work and the Engineer's final estimate is approved by the Mayor and Board of Commissioners.

PORTIONS MAY BE OMITTED:

The right is expressly reserved to the Mayor and Board of Commissioners of the City of Topeka to order the omission of any portion of the work or materials called for by the plans and specifications, or to order any additional thereto or to make any alterations whatever in the nature of the work or materials called for therein, provided said order be in writing and the amount of the consideration to be added or deducted from the contract price, for such addition or omission shall be determined and fixed by written agreement between the contractor and the Mayor and Commissioners; and in case they should fail to
agree upon the amount to be added or deducted, then the amount shall be determined by the Engineer of said City of Topeka, whose decision in writing shall be accepted as final and binding upon both parties, and it is expressly agreed and understood that such alterations, additions or omissions shall not in any way violate or annul the contract; and the contractor hereby agrees not to claim or bring suit for any damages whether by loss of profits or otherwise, on account of not being allowed to do such work or furnish such materials.

FAILURE TO EXECUTE AND COMPLETE IN TIME, CITY MAY COMPLETE AT CONTRACTOR'S EXPENSE.

It is also understood that in case of failure to execute the work or furnish material in accordance with the specifications to the satisfaction of the City Engineer, Mayor and Board of Commissioners of said City, or to proceed with the same rapidly enough in the estimate of the City Engineer, Mayor and Board of Commissioners to secure its completion within the time allowed by the contract, then it shall be lawful for the Mayor and Board of Commissioners of said City, after giving three days written notice of their intention to do so by serving the
notice on the contractor or his agent or foreman on the work, and if there be more than one person contracting to do said work, then by such service upon each of them, to employ any person or persons either by contract, days work or otherwise, to proceed with said work and to complete the same; and to charge all sums paid such person or persons as so much money paid to the contractor; and if the sums so paid shall exceed the sum due the contractor under his contract, the said contractor shall become liable to the City for any sum by which the expense of doing the work shall exceed the sum due under his contract as liquidated damages and not by way of penalty and the Mayor and Board of Commissioners may annul and terminate the contract, which thereupon shall become null and void except to any right of action which may accrue to said City by reason of the neglect of the contractor to do the work in the manner and time prescribed by the contract and these specifications; nor shall such action in any manner annul, vitiate or in any manner and time prescribed by the contract annul, vitiate or in any manner affect the validity of the bond given by said contractor; said contractor further agrees that all work heretofore done at the time of the contract is so declared void, shall at once pass to and become the property of the
City without any payment therefor and covenants that he will not make any claim or bring any suit for the value of such work or materials.

**NO SUB-CONTRACT OR ASSIGNMENT UNDER ANY CIRCUMSTANCES:**

The contractor will not be allowed to sub-let the whole or any part of his work, or make an assignment of his contract, or any moneys to be paid to him; and should this provision be violated, said assignment or sub-contract shall be void and sufficient cause for the Engineer, Mayor, and Board of Commissioners at their option to end and terminate this contract.

**PRICE MUST INCLUDE EVERYTHING:**

It is also agreed that the price stated in the bid of this contract must include all labor and materials, pumping and bailing, with all other costs incidental to the proper completion of the work; it is the intention that there shall be no extra bills of any nature whatsoever associated with the perfect construction of the public improvement herein contracted for; the contractor and his sureties will not be released from any liability until thirty days after the final estimate to the Engineer is given and the work accepted by the Mayor and Board of Commissioners.
In case the contractor after five days written notice by
the Mayor and Board of Commissioners, shall refuse to
keep his work in repair, while the same is progressing and
prior to the completion of the contract as above specified
the City shall have the right to make the repairs by day
labor or otherwise at the contractors expense and the cost
of said repairs shall be recoverable from the contractor
or his said sureties as liquidated damages and may be
deducted from any moneys due or become due under this con-
tract.

IF NOT COMPLETED IN TIME, MUST PAY INSPECTORS:

It is also agreed that if the contractor fails
to complete the work as herein specified within the time
named, he shall be liable for the wages of the inspectors
on his work from the above specified time to the date of
the Engineer's final estimate made after the completion
of the work; and the amount of such wages shall be deduct-
ed from any moneys due him from this City on the final
estimate; or if no money shall be so due him from the City
then the said amount shall be recoverable from the contract-
or or his sureties.
WORK AT CONTRACTOR'S RISK:

It is understood and agreed that the whole of the work under these specifications and this contract is to be done at the contractor's risk and he is to assume the responsibility and risks of all damages to the work which may be occasioned by floods, backwater, caving of streets, settling of foundations of buildings or from any other cause whatsoever; to hold the City harmless therefrom and any damages or suits for damages for which the City may become liable shall be secured to the City by deducting the amount from the next estimate of the Engineer or from any money due for work performed under this contract or from the contractor, or his sureties.

WILL PAY UPON COMPLETION OF THE TERMS:

Said party of the second part further agrees that upon the entire and complete fulfillment of all and singular the terms and conditions of this agreement by said part of the first part and the entire completion of said work and upon acceptance of said work by said party of the second part as provided in the specifications bound herewith, the said party of the second part will pay to the said part of the first part as aforesaid all balances or balance due for the said work as herein provided.
IN WITNESS WHEREOF: The said part__ of the first part has__ hereunto set ___ hand_ and the Mayor of the City of Topeka hereunto signed this agreement on behalf of said party of the second part as such Mayor and said Party of the second part has caused these presents to be attested by its clerk and the seal of the said City to be attached hereto this ___ day of ______ 1923.

__________________________

__________________________

Part__ of the first part.

THE CITY OF TOPEKA
Party of the Second Part,

By____

Mayor of the City of Topeka____
BOND

KNOW ALL MEN BY THESE PRESENTS:

That we, ______________________________________

a firm composed of ______________________________________

as principal, and ______________________________________
as Surety are held and firmly bound unto the City of
Topeka, a municipal corporation organized and existing under
the laws of the state of Kansas, in the sum of ___________

__________, Dollars, lawful money of the United States
well and truly to be paid to the City of Topeka, its suc-
cessors, or assigns, to which payment we hereby bind our-
selves, heirs, executors, administrators, successors or
assigns, jointly and severally, firmly by these presents,

THE CONDITIONS, of the above obligation are such
that whereas the said, _______________________________
ha__ on this ___ day of ____, 1923, entered into a
written contract with said City consisting of ____

which public improvements are specially described and
designated in said contract and are to be constructed
in strict accordance with the terms and conditions of
said contract and specifications bound herewith and the
plans and drawings therefor on file in the office of the
City Engineer.

Now, therefore, if the said ________
shall honestly and faithfully discharge, perform and ful-
fill all and singular, the terms and conditions of said
contract and specifications bound herewith and shall save
and hold harmless the City of Topeka from any and all costs,
charges, liens for labor and materials, loss arising from
fraud and overcharges and damages of every kind and nature
whatever arising out of said contract in any manner then
this obligation shall be void; otherwise, it shall be and
remain in full force and effect.
IN WITNESS WHEREOF, We have hereunto set our names this __________ day of ________________, 1923.

________________________________________
Principal:

________________________________________
Surety

ATTEST:

________________________________________
By____________________________
PRESENTATION OF PLANS AND SPECIFICATIONS

to

BOARD OF CITY COMMISSIONERS

In Journal "JJ" of Commissioners Proceedings of the City of Topeka, Kansas, for the year 1923, we find this notation:

"Commission Chamber, Topeka, Kansas, Tuesday, January 16, 1923.

"The City Commission met in regular session at 9:30 A.M., with the following Commissioners present:

Commissioners Hancock, McGiffert, Stanfield, and Stevens, - - - 4. Mayor Corwing in the chair.

"Plans and specifications for the construction of a double reinforced concrete arch bridge across Shungamunga Creek at Seventh Street were presented and explained by W. E. Baldry, City Engineer. The construction of the project was approved by the following vote: Ayes, Commissioners Hancock, McGiffert, Stanfield, Stevens and Mayor Corwing----5. It was further decided that upon the recommendation of the Engineer, the structure be required completed ready for use by December 1st, 1923.

"Upon motion of Commissioner Hancock, the City Clerk was instructed to advertise for bids for the construction of the bridge, all proposals to be filed with the City Clerk not later than 9:30 A.M., January 30, 1923, and to be accompanied by a certified check made payable to the City Treasurer of the City of Topeka, in the amount of $1000.00; the motion prevailed".

The above sets forth clearly the procedure incidental to the launching of a project of this kind by the governing body. We have here those items attended to required by law to be
done. In the first place the plans must be drawn by a competent engineer; second, the plans must be approved by the governing body; third, a date must be set for the reception of bids; and fourth, the amount of a certified check required to accompany each bid must be determined upon.

The amount of the certified check is an arbitrary amount but is usually based on about 5% of the estimated cost of the work. In this case, however, only about 3% of this estimated amount was asked for. When the award of the contract has been made, these checks are immediately returned to the unsuccessful bidders, the only check retained being the check of the successful bidder, which is retained until he has given to the City all required surety bonds for the work which are required to be given in the specifications.
COMPUTATION OF QUANTITIES.

Piling: -

In west abutment, - - - - - - - 88
In east abutment, - - - - - - - 80
In pier, - - - - - - - - - - - 39

Total 207

These piling should be purchased eighteen feet long and in order to have some on hand in case additional piling may be needed, 210 piles should be ordered for the work.

Excavations: -

Pier,
This pit will be 8' x 35' in area, depth from zero to 6.0, making an average depth of 6.0 desirable to use for this work. Whence, \(8' \times 35' \times 6'\) or 62 cubic yards, all \(\frac{27}{27}\) of which should be classed as wet excavation.

East Abutment,
We estimate 18 feet of the depth of this excavation will be dry, and the balance wet, or 7 feet of wet excavation purposes is taken \((15' \times 45')+(23' \times 10')\) or 905 sq/ft. whence for the dry excavation we have, \(905 \times 18\) or 630 cubic yards, while for the wet excavation we have an area of 883 square feet, 7 feet deep, or 230 cubic yards.

West Abutment,
We estimate this pit at 16 feet dry, and 7 feet wet. \((15' \times 46')+(26' \times 10')\) is 950 sq. ft, which at 16 feet deep is 564 cubic yards. Also 950x7' is 246 cubic yds. of wet excavation.

Totals,
Wet excavation, 62+230+246 is 538 Cubic Yds
Dry excavation, 630+564 is 1194 Cubic Yds.
Concrete:

Southwest Wing, 7th St.:-
Footing, \((23' \times 7.4' \times 4') + (1' \times 3' \times 4)\) over 27, is \(26\frac{1}{2}\) cubic yards.

Northwest Wing, 7th St.:-
Footing, \((25' \times 7.4' \times 4') + (1' \times 3' \times 4)\) is 28.3 cu. yds.

Southwest Wing, Chestnut St.:-
\[
\left\{ \frac{(23.7' \times 29.3') \times 7.4}{2} \right\} + \frac{4.0 + 4.0(11.5 \times 6.25)}{2} \right\} \text{ is 34 cu. yds.}
\]

Southwest Wing, Chestnut St.:-
\[
\frac{(1.3 \times 7.4 \times 4.0) + (1 \times 3 \times 4)}{2} \text{ is 15 cubic yards.}
\]

Wing Wall Concrete:

Southwest Wing, 7th St.
Approximately 22' long, 19' high, and 12'' top, 3.37' bottom.
\[
\frac{22 \times (1.0 + 3.37)}{2} \times 19 \right\} \text{ is 34 cu. yds. and 2 pilasters are } \frac{16 \times (1.0 + 3.0)}{2} \text{ or } 2.4 \text{ cu. yds.}
\]

Northwest Wing, 7th St.
\[
\frac{24 \times (19 \times (1 + 3.37))}{2} \times 19 \} \text{ is 37 cu. yds. and 2 pilasters are } \frac{16(1+3)}{2} \text{ is } 2.4 \text{ cu. yds.}
\]

Southeast Wing, Chestnut St.
Length taken at 27 feet.
\[
\frac{27 \times (1 + 3.37) \times 19}{2} \text{ is 41.6 cu. yds. and 1 pilaster is } \frac{(1+3)16}{2} \text{ is } 1.5 \text{ cu. yds.}
\]

Southwest Wing, Chestnut St.
\[
\frac{12 \times (1 + 3.37)}{2} \times 19 \right\} \text{ is } 18.5 \text{ cu. yds. and 1 pilaster is } \frac{(1+3)16 \times 1}{2} \text{ is } 1.5 \text{ cu. yds.}
\]
Abutment Footings
7th St. Abutment and Chestnut St.
\[
2 \times (22 \times 14) \times (2+4) \times \frac{2}{27} = 68.4 \text{ cubic yards}
\]

Abutment, Concrete up to level of back haunching
\[
\frac{(3.75 \times 10 \times 24) \times 2}{27} = 66.7 \text{ cubic yards}
\]

Abutment, Concrete up to spring line
\[
\frac{(16 \times 9.5) + 5.5 \times 24}{2} \times \frac{2}{2} = 142, \text{ and } \frac{142 \times 24}{27} = 126.2 \text{ cu. yds.}
\]

Pier Concrete:
Footing is, \[
\frac{7.33 \times 4 \times 31.72}{27} = 34.44 \]

Shaft is \[
\frac{(5.33+4.5) \times 9.8 \times (14' - 7\frac{1}{4}'' )}{2} \times 2 = 48.17 \times 29.40 = 1416.2 \text{ cu.ft. or 52.4 cu.yds.}
\]

Coping is \[
\frac{5 \times 5.5 \times 30.4}{2} = 83.60 \text{ cu. ft.}
\]

Pier Snoot, is included in the above

Arch Barrel
\[
\left\{ \frac{16.4 \times (1.25+1.42)}{2} \right\} \times 24 + 16.4 \left\{ \frac{1.42+3.8}{2} \right\} \times 24 = 4 \times 2101.4 \text{ cu.ft.} + 4109 \text{ cu.ft. or 230 cu. yds.}
\]

Chunk in between the arches
\[
\left\{ \frac{4.5 + 1.0}{2} \right\} \times 3.5 \times 24 = 231 \text{ cu. ft.}
\]

Spandrel Walls
From crown to abutment these walls are as an average, 34 feet long. From crown to pier they average 32.25 feet long. Batter 1" in 12"
Spandrel Walls (Continued)

\[
4 \left\{ 39(1.237)(5.53) \right\} \text{ is } 4 \times 267.54 \text{ is } 1070 \text{ cu. ft.}
\]

Also \[
4 \left\{ \frac{32.25(1+1.17)}{2} + \frac{(1+1.25)}{2} + \frac{(1+1.83)(1.25+3.17+10)}{3} \right\}
\]
equals \[
4(1.21 \times 32.25 \times 4.81) \text{ or } 750.7 \text{ cu. ft.}
\]
total \(67\frac{1}{2}\) cu. yds. in spandrel walls.

Pilasters inside the spandrel walls

One of these on each bracket \[
\left\{ \frac{(1.42 \times (1+1.25) \times 1.0)}{2} \right\} 8
\]
or \[
\left\{ \frac{9.25 \times (1.75+2.79)}{2} \right\} 2 \text{ or } 6.75 \text{ cu. yds.}
\]

Brackets \[
\left\{ \frac{2+8.3}{2} \right\} \times 1.0 \text{ is } 196.3 \text{ cu. ft. or } 7.3 \text{ cu. yds.}
\]

Pier Brackets

\[
\left\{ \left( \frac{.83 \times 1.0}{2} \right) + \left( .83 \times .83 \times 1.17 \right) + \left( 7.5 \times 7.5 \right) - 3.14 \times 7.5 \right\} \times 4
\]
is \(4(4.15+2.87+50.3) \text{ or } 229 \text{ cu. ft. or } 8.5 \text{ cu. yds.}
\]

Corbels \[
\left( \frac{1+3}{2} \right) \text{ high } \times 1.0 \text{ thick} \text{ is } 62 \text{ cu. ft.}
\]

Beam between brackets

These are about 6 feet long, since brackets are 9'-3" center to center, whence,

\[
(6 \times .5 \times 1.0) \text{ is } 393 \text{ is } 14\frac{1}{2} \text{ cu. yds. } \times 2 \text{ is } 29 \text{ yds}
\]

Special Pier Corbels

\(7.5 \times .5 \times 1.0\) 4 is say 1 cubic yard

Sidewalk Concrete

\(5.75 \times .43)(156+157.5) \text{ is } 782.5 \text{ cubic feet or } 29 \text{ cu. yds.} \)
Concrete, Continued

Slab over the gap from north spandrel wall to the northwest wing, or the east wing of the Hancock St. return:

\((18 \times 18) \text{ (1)}\) or 162 cu. ft. or 6 cubic yards.

\(\frac{2}{2}\)

Summary of the Concrete

1-3-5 Mix

<table>
<thead>
<tr>
<th>Description</th>
<th>Cubic Yards</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.W. Wing footing at 7th St.</td>
<td>26.5</td>
</tr>
<tr>
<td>N.W. Wing &quot; at Chestnut St.</td>
<td>34.0</td>
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<tr>
<td>N.W. Wing &quot; at 7th St.</td>
<td>28.3</td>
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<tr>
<td>S.W. Wing &quot; at Chestnut St.</td>
<td>15.0</td>
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<tr>
<td>Abutment &quot;</td>
<td>68.4</td>
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<tr>
<td>Pier &quot;</td>
<td>34.4</td>
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<tr>
<td>Abutment up to spring line,</td>
<td>126.2</td>
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<tr>
<td>Abutment at haunch</td>
<td>66.7</td>
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<td>Pier Shaft &quot;</td>
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1-2-4 Mix

<table>
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<tr>
<th>Description</th>
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<tbody>
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<td>S.W. Wing, 7th St.</td>
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</tr>
<tr>
<td>S.W. Wing, &quot; &quot;</td>
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<tr>
<td>N.W. Wing, &quot; &quot;</td>
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<tr>
<td>N.W. Wing, &quot; &quot;</td>
<td>2.4</td>
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<tr>
<td>S.E. Wing, Chestnut</td>
<td>41.6</td>
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<td>S.E. Wing, &quot; &quot;</td>
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<tr>
<td>S.W. Wing, &quot; &quot;</td>
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<tr>
<td>Pier Coping, &quot;</td>
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<td>Arch Barrels, &quot;</td>
<td>230.0</td>
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<td>Chunk in between arches,</td>
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<tr>
<td>Spandrel Walls,</td>
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<tr>
<td>Pilasters &quot;</td>
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<tr>
<td>Brackets, &quot;</td>
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<tr>
<td>Pier Brackets, &quot;</td>
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<tr>
<td>Ornamental supports over brackets,</td>
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<td>Beam between brackets,</td>
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<tr>
<td>Pier Bracket Corbels</td>
<td>1.0</td>
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<tr>
<td>Sidewalk</td>
<td>29.0</td>
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<tr>
<td>Slab from wing wall to spandrel wall</td>
<td>6.0</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>538.0</strong></td>
</tr>
</tbody>
</table>
COMPUTATION OF PAVING OVER BRIDGE PROPER, AND APPROACHES:

It is 181.5 feet from the Seventh Street paving; center of header to where the center line of the bridge hits the header of Chestnut Street. We have then $\frac{5 \times 17 \times 181.5}{27}$ giving 57 cu. yds. of concrete in the base and 343 sq. yds. of paving.

Also, pave the Hancock St. wing, 40' - 6" from header along center line of wing, to where it hits bridge curbing produced, 40 + 1.5 is 42 feet.

$$\frac{42 \times 5 \times (30' - 3)}{27}$$

is 21 cu. yds. or base, or 126 square yards of paving.

Also pave the triangle formed on the east side of wing where it connects with bridge proper, $\frac{10 \times 18}{2}$ is 10 sq. yds. of paving, or 9

$$\frac{90 \times .5}{27}$$

is 45 cu. ft. or $1 \frac{2}{3}$ cu. yds. of base.

Also radius on the N.W. Corner of 7th St. and Hancock, between wing paving and bridge paving, already computed above,

1 Rectangle, $16(4 + 1.5)$ is 88 sq.ft. paving
1 Triangle, $16 \times 12$ is 96 sq.ft., making a total of 20.4 sq.yds. for these two items, or 3.4 cu.yds. of base.

Also on S.W. Corner of 7th and Hancock, one triangle omitted from bridge proper, $\frac{5 \times 16}{2}$ or 40 sq.ft., or 20 cu.ft. of base.

Also one triangle at the S.E. Corner of Chestnut, not included in the bridge proper, $\frac{17 \times 9}{2}$ or 77 sq.ft. or 39 cu.ft. of base.

Summary: From the above, we have $343 + 126 + 10 + 20.4 + 4.4 + 8.5$, or a total of 512.3 sq. yds. or paving involved in the construction. Since the paving is carried in
Summary, Continued:-

The estimate on a square yard basis which includes the base as well as the wearing surface, it really is not necessary to compute the base in cubic yards.

Combined Curb & Gutter:-

The curb and gutter is carried in the estimate on a lineal foot basis, the north side length is 187 feet while the south side length is 170 feet, and there is also 33 additional feet on the northwest corner of 7th and Hancock, making a total of 390 lineal feet.

Handrailing:-

Including the solid portions, the length of the handrailing is 157 feet on the north side, and 158 feet on the south side, making a total length of 313 lineal feet.

Steel:

**Arch Rib Bars**

Top bars are actually 96 feet long and allow for four laps, gives 112 feet.
Bottom bars are actually 93 feet long, and allow for four laps, gives 109 feet.

\[(112+109) \times 2 = 22 \times 2 \text{ arches, gives } 9724 \text{ lineal ft.} \]

However, this provides too much steel from the arches going into the pier, and we must subtract from this one-half of the steel in the pier from the coping down, or \(10 \times 44\) gives 440 feet, and 9724 less 440 is 9284 feet at 3.38 lbs. per foot or 31379 pounds.

\(\frac{1}{2}\) inch bars @ 24" centers, over arch bars, 
\(21(66) \times 2 \text{ arches, or } 2772\text{ ft. @ } .67\text{ lbs. or } 1857\text{ pounds.}\)

**Arch Shear Bars**

These are 7/16", and connect the upper tier of arch bars with the lower tier, thus we have 48 ft. @ 22 x 2 arches, or 2112 lineal feet at .51 pounds per foot, or 1077 pounds.

1-60 pounds per yard, railroad rail, 250 pounds.

**Spandrel Walls**

The average length will be 4 @ 39 feet and 4 @ 32 feet, total 284 feet; and the average height is 5.5 feet.
Spandrel Walls, Continued.

These walls have ¼" bars @ 12" c.c. and ½" bars 18" c.c. then we have 2-rows @ 284 ft. or 568
bars @ 5.5 ft., making 3124 ft. @ 1.5 lbs. per
foot, or 4686 pounds.
And the ½ bars will be four rows, at 39-32, or
284 feet per row, or 1.56 lineal feet of steel, at .67 lbs. per foot, giving 761 lbs. We estimate
the weight of material will provide material
for the stirrups required.

Brackets

There will be 26 standard brackets, 4 pier brack-
ets and 1 special bracket. Each standard brack-
et is figured at 14 feet of steel in each bar,
giving 3x14 or 52 feet of steel in each bracket.
52 @ 1.50 pounds per foot is 78 pounds.

3 stirrups, at 6 feet each, gives 18 feet of ½"
@ .67 pounds per foot, or 12.6 pounds, and 78+
12.6 gives 91 pounds of steel in each standard
bracket or 26 x 91 gives 2366 pounds.

4 pier brackets; these are taken at 20 feet of
steel in each bar, or 3 x 20 @ 1.5 pounds per
lineal foot, gives 90 pounds. Also we estimate
20 pounds will take care of the necessary stir-
rups, thus we have 90 +20 or 110 lbs. x 4, gives
440 pounds.

One Special Bracket

1-12 inch-I-beam, 18 feet long, @ 50 pounds per
foot, - - - - 900 pounds
1-8 inch I-beam, 12½ feet long, @ 20 pounds per
foot, - - - - 318 pounds.

Total of bracket steel,
2366+440, or 2800 pounds of reinforcing
steel and 1218 pounds of structural steel.

Pilasters

There are 3 bars in each pilaster, ¾ inch
round is used, and from scaling the drawings
we find the length of the bars required will be
about as follows, (8x1.5)+(8x2.75)+(8x5.5)+
(4x7.75)+(2x9.25) or 128 lineal feet in each
bar, whence we have 128 x 3 @ 1.5 lbs. per
foot, is 576 pounds.
Wingwalls

The length of these wingwalls is taken at 22+24+27+12, or 85 lineal feet.

85x19x2 is 3230 lineal feet of \( \frac{1}{4} \) inch bars @ 1.5 pounds per lineal foot, or 4850 pounds.

Also 6 pilasters on these wings, (3x6)19, or 342 feet @1.5 pounds per foot, 513 pounds. Also there are 20 lines of \( \frac{1}{2} \) bars, or 20x85x.67 or 1139 pounds.

Spindles

There are 170 spindles, each bar is 20 inches long.

1.7x170, is 289 ft. @ .38 lbs. per ft. is 110 lbs.

Handrail

There are two \( \frac{1}{2} \) bars in handrail, total 313 ft. long.

313 x 2 is 626 ft. @ .67 lbs. per ft., or 419 lbs. Also 2 7/8 inch bars in the spindle beam, 2 x 313 is 626 ft. @ 2.04 lbs. per ft., or 1277 pounds.

Sidewalk

The sidewalk bars are 3/8 inch, at 8 inches centers 313x12 gives 470 bars, each 6.3 feet long or 470x6.3 @ .38 pounds per foot, total 1184 pounds. Also the beam under the walk between the brackets has 1 bar, 313 @ .67, or 219 pounds.

Summary of the Steel.

| Arch Rib Bars | 31379 | lbs. |
| " " " | 1827 | " |
| " " " | 1077 | " |
| Tie bars through pier | 568 | " |
| Railroad Rail | 220 | " |
| Spandrel Walls | 4686 | " |
| " | 761 | " |
| Standard Brackets | 2366 | " |
| Pier " | 440 | " |
| Structural Steel | 1218 | " |
| Pilasters | 576 | " |
| Wing Walls | 4850 | " |
| Wing Wall Pilasters | 513 | " |
| " " Horizontals | 1139 | " |
Summary of Steel, Cont.

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<th>Quantity</th>
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<tr>
<td>Spindles</td>
<td>110 lbs.</td>
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<tr>
<td>Handrail</td>
<td>419 &quot;</td>
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<tr>
<td>Spindle Beam</td>
<td>1277 &quot;</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>1184 &quot;</td>
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<tr>
<td>Beam between brackets</td>
<td>219 &quot;</td>
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<tr>
<td><strong>Total</strong></td>
<td>54889 &quot;</td>
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CONSIDERATION OF FORM CONSTRUCTION
AND COSTS

There are one or two methods of computing the cost of form work. Sometimes these costs are obtained by simply adding an amount to the price of concrete per cubic yard, determined by experience; and again by a thorough analysis of the work to be done, and the cost actually arrived at. For the rapid study of the cost of form work, one or two empirical rules are employed which have been found to be practical; one of these rules is quoted thus: "Multiply the number of square feet of form work required by two to obtain the amount of lumber required in thousands of board measure, which amount will include sheathing, studding, and braces". Thus, to form a plain wall, both sides ten feet high and one hundred feet long, we would have two thousand square feet of forms to build, and the lumber order would be 2 x 2000 or 4000 board feet. Let us examine this rule further. In the wall consider the studding 2"x4" spaced 16" center to center; it would therefore actually require, using a studding at each end, 76 pieces, which is 1520 lineal feet of 2"x4" or 1014 board feet; also we would have 20 pieces 100 feet long or 2000 board feet of inch material for the wall forms, making our requirements a total of 3014 board feet. We would still
need some large general bracing material for this work, and since this wall is a very plain wall, as compared with the loss of lumber due to cutting for forms on an arch bridge job, it would seem that the rule was approximately correct as a rough gauge of the amount of material required. In bridge work also it is necessary to have around the job about 25% more lumber than is actually required to be used for such temporary work as crossing the stream, bracing up excavations, etc. Heavy bracing lumber for foundation work runs into board measure rapidly.

Another rough rule for ascertaining the cost of form construction is to base the same upon the number of square feet of forms to be built. A third rule is to use the number of board feet of form lumber required as the basis of the cost of building the forms. For this study, however, we shall make an actual computation of the amount of form lumber that could possibly be required to form this bridge, using the same later as a basis for the estimate of cost of the bridge. It should be remembered, however, that different contractors will proceed far differently in the actual method of constructing a bridge of this character, and the following provides for, we believe, the greatest amount of forms that anyone would wish to construct before actually pouring concrete.
The method of form construction for the arches is a series of pile bents spaced equal distance apart, built to proper grade, with floor beams resting upon the bents, and upon the floor beams, arch soffit lagging. Assuming the pier previously constructed, one pile bent is driven adjacent to the previously constructed abutment and the distance between these two bents is now divided into four equal parts, making in this case 6 bents required for each of the foot arches.

Each bent is constructed of 5 piles capped with a 10"x10", 26 feet long, or the actual width of the arch barrel, thus allowing the cap to extend over two feet on each end. The length of piling to be used for these bents is estimated at 26 feet, with 8" butt and 6" tip. Upon the caps are laid 4"x12" floor beams on edge, each 14 feet long, extending from one bent to another, or parallel with the center line of the arch. There is to be one of these floor beams at each outer edge of the arch rib, and the remainder set at two feet center to center. Upon these floor beams are set on edge, 2"x10"x14' additional floor beams which have been previously cut to the curvature of the arch barrel, the 4"x12" floor beams are not cut, but serve only as reinforcement for the 2"x10", thus the heavy floor beams become 100% salvage for use on other
work. On the 2"x10" floor beams the arch laggering forming
the sofit of the arch is laid, which is formed of 2"x6"
material, and extended beyond the face of the spandrel
wall, on each side of the arch rib, two feet, to provide
working room and bracing for the construction of the
spandrel walls. Both arches are formed alike, and with
this explanation the following is developed, as the re-
quirements in form lumber for the bridge construction.

Arch Forms, (2 Arches)

Piling, 6 bents, 5 plies each, 26' long,
equals 1560 lineal feet of piling, recaps,
6-10"x10" square caps, 26' equals 2604
Board Feet of heavy dimension lumber.

Floor-beams, 12x2"x12"x14' (5 spans) equals
6620 board feet of heavy dimension lumber.
12x4"x10"x14' (5 spans) equals
2800 board feet of light dimension lumber.
Soffit-laggering, (Taken at 75 feet along arch
barrel) 2"x6"x26' or 75' is 164 pieces,
whence we have (26x164)(2arches), equals
8528 board feet.

Pier Forms:-

For the piers we use 1"x12" sheeting with
2"x4" studding 16" on centers. The length of
the pier is taken at 30 feet, height 10 feet,
width 7 feet. Whence (30x2)+(7x2) equals 74
feet around the pier. Lay the sheeting horiz-
ontal, whence we have 120'/+ 11½ which gives say 11
pieces @ 74 feet is 814 board feet for sheeting
and for the studding, we have (74x12)+16, equals
56 pieces @ 10 feet is 560 lineal feet of 2"x4"
or 375 board feet, giving a total board feet in
the pier forms of (375+814) or 1189 board feet.

Spandrel Wall Forms:-

Use 1"x12" sheeting, 2"x4" studding. Assume
the average height of the spandrel walls as five
feet, form both sides and the length of the wall along the edge of one side of the arch rib is taken at 75 feet. Whence, for both arches we require 4x75, or 300 linear feet, and form both sides requires 600 linear feet of forms; lay sheeting horizontal will require 6 pieces of 1"x12" x 600 feet or 3600 board feet. Also for the studding, we require 600x12 divided by 24 or 300 pieces of 2"x4" @ 5 feet each, or 1500 feet or 1000 board feet. Total board feet for the spandrel wall forms 4600 board feet.

Pilaster Forms: -

Use 1"x12" for sheeting, and 2"x4" for studding.

We assume 32 of these pilasters to form, three sides to each pilaster, with an average height of 5 feet each, 2 feet from spandrel wall to back as an average, and one root thick, whence we have a girth average for each pilaster of 5 feet. Lay the sheeting horizontal, and we have 6 pieces required @ 5 feet each or 30 feet for each pilaster: likewise the studding will require 6 studs for each pilaster or 30 linear feet or 20 board feet. We have then 30 + 20 or 50 board feet by 32 or 1600 board feet required for the pilasters.

Wing Forms: -

Use same methods as above and assume total length of all wings at 90 linear feet, average height at 19 feet and two sides to form. We have then 20 pieces of sheeting required @ 90 feet and 68 pieces of
studding, @ 19 feet making a total requirement of 1800 feet + 874 feet or 2674 board feet: and form both sides requires a total of 5348 board feet. Allowing for corners we will call this 5500 bd.ft. 

Wing Pilasters:
There are 6 of these wing pilasters: allow 8 studding to each one, making 48 pieces @ 20 feet is 640 feet. Sheet 3 sides, average 2 feet wide and one foot thick, total girth of five feet, makes 6x21 pieces @ 5 feet or 630 board feet: total of these pilasters, 640+630 or 1270 board feet.

Standard Sidewalk Brackets:
There are 30 of these brackets, 3 sides to form, two sides taken at 6 feet long by 2 feet wide, or 60 sides, and 30 sides taken at 6 feet long and one foot wide, we have then 60x6x2 or 720 lineal or board feet and 30x6x1 is 180 lineal or board feet: also 30 feet of 2"x4" for each bracket or 900 lineal or board feet, making a total of 600+180+720 or 1500 board feet.

Sidewalk Forms:
Assume the length to be formed at 320 lineal feet and the width at 5 feet and also assume it will require 6 pieces @ 320 feet or 1920 board feet of sheeting. Allow 3 pieces or 920 lineal feet of
2"x4" for studding, or 640 board feet, but make this item 1000 board feet for safety account of building conditions. For the beam running under the sidewalk, from bracket to bracket, we have 3 sides to form or say a girth of 4 feet by 320 feet or 1280 board feet, making a total for the sidewalk forms of 1920+1000+1280 or 4200 board feet.

Handrail Forms:

For the handrail forms, no new material need be provided since by this time all arch and spandrel wall forms have been removed and sufficient salvage should be available for this work.

Abutment and Pier Excavations:

Since the abutment and pier excavations are carried below low water level of the creek, tight sheeting will have to be driven around the excavation pit walls to retain in place the banks and also to keep out surface water. For this work 2"x6" lumber will be used, with 4"x6" wailing strips. For the pier the length of the excavation will be 35, 35, 10, and 10, or 90 lineal feet. We shall consider driving the sheeting into the ground 1½ feet below the bottom of the excavation pit. The length of this sheeting will be taken at eight feet: whence we require
190 pieces, 2"x6"x8' or 1520 board feet. Also allow 2 sets of 4"x6" walling strips around the pit, or 2x90 is 360 board feet. Also provide for one set of upper braces crosswise of the pit, since the lower walling strip can be braced against the pile heads of the foundation piling, i.e. 4 pieces 4"x6"x10' or 80 board feet. Thus the pier excavation lumber is 1520+360+80, or 1960 board feet.

For the abutment excavations, both are taken as alike, and the distance around the pit to be sheeted is 19, 24, 30, 10, 22, 24, 25 and 10 or 164 lineal feet. For these pits 2"x12" sheeting can be used, each 8 feet long, and we will require 170 pieces, 2"x12"x8' or 2720 board feet: and for two abutments we estimate with salvage from pier and other abutment already built; this quantity should be multiplied by 1½, making a total for the two abutments sheeting only, 3400 board feet. We require also 3 sets of 4"x6" walling strips around this pit, or 3x164 is 492 lineal feet or 984 board feet, and 2 sets of cross braces at 10 foot centers is 2(8,8,15,15,15,12,8, and 8) or 180 lineal feet or 360 board feet. The total material required then for the two abutment excavations is 3400+980+360 or 4744 board feet.
Summary of Form Lumber Required

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount (Board Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abutment excavations</td>
<td>4744</td>
</tr>
<tr>
<td>Pier excavations</td>
<td>1920</td>
</tr>
<tr>
<td>Beam under sidewalk</td>
<td>1280</td>
</tr>
<tr>
<td>Sidewalk forms</td>
<td>2920</td>
</tr>
<tr>
<td>Bracket forms</td>
<td>1500</td>
</tr>
<tr>
<td>Wing Pilasters</td>
<td>1270</td>
</tr>
<tr>
<td>Wing forms</td>
<td>5348</td>
</tr>
<tr>
<td>Pilaster forms</td>
<td>1600</td>
</tr>
<tr>
<td>Spandrel Wall forms</td>
<td>4600</td>
</tr>
<tr>
<td>Wing forms</td>
<td></td>
</tr>
<tr>
<td>Arch forms, light-dimension</td>
<td>3528</td>
</tr>
<tr>
<td>Arch forms</td>
<td>2800</td>
</tr>
<tr>
<td>Arch forms, Heavy</td>
<td>2604</td>
</tr>
<tr>
<td>Arch forms</td>
<td>6620</td>
</tr>
</tbody>
</table>

From the above we estimate about 6600 board feet required for pit excavations, some of which will be pulled after placing of the concrete in the pits. The sheeting in the rear of the arches abutments, WILL NOT be allowed to be pulled. Sheeting around the pier and in front of the abutments and at the sides, will be allowed to be pulled if the contractor sees fit to do so, but often the expense of pulling this material is greater than its value since the concrete runs between the driven sheeting, causing a severe wedging action when the sheeting is pulled.

We have not been allowed for any scaffolding in the above or material for runways for conveying concrete to the forms, expecting we shall have on hands sufficient salvage material usable for this purpose taken from the preceding work. Of the above amount of form lumber required, we estimate there is about 40000 board feet which will have to be worked upon.
by carpenter forces to form the various parts of the structure. It is evident, however, not all of this material will require the same amount of labor spent upon it that some of it will require. Of the above 40,000 feet we estimate that 31,000 will be light form construction which is the most expensive to build, while 9,000 will be of the heavy type. As a method of arriving at the cost of labor to construct these forms, we use $50 per thousand board feet as the cost of the light type of form construction, and $35 for the heavy type.

Using now the quantities which have already been calculated for the amount of work and materials required for the completed structure, we pass to the estimate of the cost of the work; but before doing so we should here present some local conditions which affect the cost of the work and materials used in the structure. Also it should be borne in mind this estimate when opened at the public letting, cannot be exceeded in the award of the contract, that is to say no award of contract would be legal which exceeds the estimate of the engineer under the state law governing such matters. It becomes necessary therefore to use a more liberal figure in making up such an estimate than one would use if actually bidding on the
work in competition with others who may also want the job. The estimate of the engineer must be a sort of balance wheel, it is to protect the public from excessive cost of public work, yet liberal enough to provide for continuance in business, since bridge work of this character is different from other types of public improvement work. The bridge contractor usually has to make rather large investments to get his equipment to the site of the job and he usually has to work under greater difficulties due to his surroundings than obtains on some other classes of work, so we estimate unit costs in bridge work considerably higher than we do on, for instance, a paving job, which may be administered under ideal working conditions. Likewise, the low bridge received at a public bridge letting may be influenced very largely by the status of the bridge contractor at the time the work is offered. If a bridge contractor has an idle organization and equipment, he will probably bid much lower for work than he would if he had on hands about all the work which his organization can handle, also most bridges are required to be started at once and pushed to as early completion as possible. Another consideration in bridge work is the bonding
companies. Bonding Companies are careful not to bond a contractor if his liability is already high compared to his financial condition. Flood water may quickly change a bridge contract from a profit to a loss, and for these reasons, bridge estimates should be made on an entirely different basis than would obtain on a contract wherein the possibility of loss could be better controlled.

Crushed rock will cost $3.50 per cubic yard on the job. Sand $1.50 per cubic yard on the job, and cement $2.75 per barrel net. Structural steel, or reinforcing steel, will cost 4¢ per pound on the job but this price will not include the placing or bending of the same. To produce a cubic yard of concrete and place the same in the forms is a variable quantity as to cost, depending somewhat on the amount placed. Where work is in relatively thin slabs, the cost is much higher than in mass concrete work. In this bridge, we have no very large blocks of concrete anywhere, and in the spandrel walls and sidewalks, brackets, etc., we have small sections, so the cost of filling the forms, that is, mixing, chuting, spading, etc., is taken at $2.50 per cubic yard, which figure is based upon my experience in keeping cost on work of this character. The cost of a cubic yard of concrete based upon the above, and based
upon a labor cost for unskilled labor at 40¢ per hour
together with some allowance for incidentals is as fol-
lows:

1-2-4- mixture, 6 sacks of cement @ $2.75 bu. $4.00
2/3 Cu.Yd. of sand @ $1.50 cu.yd. 1.00
1 Cu.Yd. of rock @ $3.50 cu.yd. 3.50
Mix and place 2.50
hydrated lime, water, loss of
materials, wear and tear, loss
of time, etc. - - - - - - - - - - 1.00
$12.00

By the same reasoning, the 1-3-5 mix will cost
about $10.00 per cubic yard.

We do not estimate the handrailng of the bridge on
a cubic yard basis, but on a lineal foot basis, this too,
is a matter of experience and we have found that $5 per
lineal foot is adequate and reasonable for this type of
construction.

We pass now to the detailed estimate.
ESTIMATE OF COST OF THE BRIDGE

Pier Excavations:
This will be all wet heavy material,
62 cu. yds. @ $4.10 per cu. yd. - - - - $ 254.20

Abutment Excavations: - (Wet)
This material will be not only wet and heavy but will have to be moved back away from the banks to prevent surcharge on the excavations, 476 cu. yds. @ $4.10
per cu. yd. - - - - - - - - - - - - 1951.60

Abutment excavations: - (Dry)
This material is easy of removal, but some of it must be returned for use in filling over the completed arches,
1194 cu. yds. @ $1.00 - - - - - - - - - - 1194.00

Foundation Piling, Pier & Abutments:
210 18-foot piles F.O.B. Topeka @35¢
per foot, delivered on the job - - - - 1323.00

Driving 3780 feet of piling @ 60¢ - - - - 2268.00

Foot Bridge:

Construction and removal of temporary foot bridge, as required on plans - - - - 300.00

Present Old Bridge:
Removal of present old bridge, clean old lumber of nails, etc., pile on parking - 100.00

Steel Reinforcing:
55000 lbs. of reinforcing steel on the job, bent as required on the plans, ready for placing, @ 4¢ - - - - - - 2200.00

Structural Steel:
1218 lbs. rolled steel I-beams @ 5¢ - - 61.00

Concrete:
538 cu. yds. 1-2-4 mix in place @ $12.00, 6456.00
452 " 1-3-5 mix in place @ $10.00 4520.00
**Handrailining:**

313 lineal feet of handrailining in place @ $5.00 per lineal foot = $1565.00

**Curb & Gutter:**

390 lineal feet of 7"x18" Combined C.&G. @ $1.10 = 429.00

**Brick Paving:**

512 sq. yds. of brick paving @ $4.50 = 2304.00

**Asphalt Paving:**

Cut and replace asphalt paving on Chestnut St. from end of old bridge, back to space required from Chestnut St. abutment, being 10'x30' or 34 sq.yds. @ $3.50, = 119.00

**Bridge Lighting System:**

This will be done by the water and light department of the city, and is not charged against this contract.

**Finish on Sidewalk:**

313 x 5' of cement finish to be placed on the bridge sidewalks, not taken care of in above concrete estimate, @ 6¢ per sq.ft. = 93.90

**Backfilling:**

We expect the above prices for dry excavation to take care of all backfilling required.

**Forms:**

For the support of the forms, together with the lumber and erection of same, we have as follows:

- 1560 1560 lineal feet of 8" temporary piling furnished and driven, for arch supports @ 50¢, = 780.00
- 2604 board ft. of 10"x10" caps @ $65 per M = 169.26
- 6620 " 4"x12" floor-beams @ $65 = 430.30
- 2800 " 2"x10" Cut F-beams @ $45 = 126.00
- 8528 " 2"x6" Arch lagging @ $40 = 341.12
- 19707 " " other light form material @ $38 per M = 748.87
- 6600 " 2"x6" and 2"x12" material for abutment and pier excavations @ $65 per M = 429.00
Forms: - Cont.

9000 Board Ft. of heavy form support construction @ $35 per M - - - - - - - $ 315.00
31000 Board Feet of light form construction at $50 per M - - - - - - - - - - - 1550.00
Placing above reinforcing steei in the forms - - - - - - - - - - - - - - 400.00

Add 15% for profit, overhead and incidentals, - - - - - - - - - - - 4534.23

$ 30228.25

City and State bonds are $15 per $1000.00 of the contract: use $35000 @ $15 - - 525.00
Public and private liability insurance is a variable depending upon the nature of the work the men are doing, the various risks averaging $6.50 on the $100 payroll for labor and we gather from the above there will be approximately $13000 in labor on this structure, whence for this insurance, 845.00
Total estimated cost of the bridge, $ 36142.38

We shall carry the estimate for approval before the board of City Commissioners at $36142.00

The above estimate will be read and offered for the approval of the City Commissioners just before bids are opened for the work at the date set for the contract letting, which follows; thus no one knows in advance of the opening of the bids what the estimate of the Engineer will be. By this method it is advisable the estimate be reasonable or there can be no letting of the contract, and a part of the work at least must be done over again.
# CONTRACT LETTING

"Commission C number, Topeka, Kansas, Tuesday, January 30, 1923.

The City Commission met in regular session at 9:30 o'clock A.M., with the following Commissioners present: Commissioners Hancock, McGiffert, Stanfield, and Stevens, - - - 4, Mayor Corwine in the chair.

The date and hour having arrived for the opening of bids for the Seventh Street bridge, as set at the meeting of January 16, 1923, the City Clerk was instructed to read first the estimate as filed by the City Engineer, under oath, of the cost of the work, as follows:

Topeka, Kansas, January 29, 1923.

The Mayor and Commissioners,
City of Topeka, Kansas,
Gentlemen:

Following a motion passed by your honorable body calling for the reception of bids for the construction of the Seventh Street Bridge over Shunganunga Creek, plans for which were approved by you on January 16, 1923, and bids for which are to be publicly opened and ready on January 30, 1923, I present the following detailed estimate of the cost of the same, under oath:

For the bridge complete, as per plans, lump sum, - - - - - $36,142.00

Extra items in case the same are needed after opening up of the work:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 cubic yards of extra excavation</td>
<td>$4,150.00</td>
</tr>
<tr>
<td>below elevation 2.00</td>
<td></td>
</tr>
<tr>
<td>25 cubic yards of extra excavation</td>
<td>$1,250.00</td>
</tr>
<tr>
<td>above elevation 2.00</td>
<td></td>
</tr>
<tr>
<td>15 cubic yards of extra 1-3-5 concrete</td>
<td>$180.00</td>
</tr>
<tr>
<td>@ $12.00</td>
<td></td>
</tr>
<tr>
<td>25 &quot; &quot; &quot; &quot; 1-2-4 concrete</td>
<td>$375.00</td>
</tr>
<tr>
<td>@ $15.00</td>
<td></td>
</tr>
<tr>
<td>10 linear feet of extra wood piling</td>
<td>$6.00</td>
</tr>
<tr>
<td>in place @ 60'</td>
<td></td>
</tr>
</tbody>
</table>
Estimated cost of the bridge and also providing for unit prices on extra items that may require use upon opening up of the work — — — — — $37,43.00

W. E. Baidry, of lawful age, being first duly sworn, says that he is the acting and legally qualified City Engineer of the City of Topeka, Kansas; that the above is a full, true, correct and complete detailed estimate of the cost of public improvement above designated, and that the cost of said improvement is reasonable and just in all respects.

Subscribed in my presence and sworn to before me this January 29th, 1923.

(Signed) Etta Covey, City Clerk.

"On motion of Commissioner Hancock, the estimate of the Engineer was approved as read by the following vote: Ayes, Commissioners Hancock, McGiffert, Stanfield, Stevens, and Mayor Corwine --- 5.

"The Mayor then instructed the Clerk to proceed with the opening of the bids previously filed for the work, which were read and tabulated as follows:

Est. Fred Midland Nathan T. Engr. Luettjohann Bridge Co. Hopkins

For bridge complete as per plans, $36,142.00 $31,200.00 $37,900.00 $32,750.66

100 cu. yds. of extra excavation below elevation 2.0, per cu. yd. 4.15 2.00 11.00 8.00

25 cu. yds. of extra excavation above elevation, 2.0, per cu. yd. 1.00 2.00 1.30 1.25

15 cu. yds. of extra concrete, 1-3:15 mix, per cu. yd. — — — — — — — — 12.00 20.00 17.50 20.00

25 cu. yds. of extra concrete, 1-2-4 mix, per cu. yd. — — — — — — — — 15.00 25.00 26.00 35.00

10 lineal feet of extra wooden piling, in place, per lineal foot, — — .60 1.00 1.15 1.25
The low bidder is determined by adding the bid on the contract as per plans, to the amount of the unit prices given for extra work, multiplied by the unit quantities, thus we have the following sum total as the various bids received:

\[ \$37143.00 \quad \$32385.00 \quad \$40011.50 \quad \$34769.41 \]

"Commissioner Hancock, moved that the contract for the construction of a double reinforced concrete arch bridge across Shunganunga Creek at Seventh Street be awarded to Mr. Fred Luttjohnn, at $31200.00 for the structure as planned, and if extra work be required, the same to be done at his bid for same, he being under the estimate of the Engineer and the lowest bidder, which motion prevailed by the following vote; Ayes, Commissioners Hancock, McGiffert, Stanfield, and Mayor Corwine, --- 5.

"On motion of Commissioner Hancock, the certified checks of the unsuccessful bidders was ordered returned to them at once, and the check of the successful bidder, Mr. Luttjohnn, was ordered retained until suitable bonds as required in the specifications, were filed and approved. The motion prevailed".

The above sets forth the procedure used in opening bids and awarding contracts by the city. If the estimate of the Engineer had been exceeded by the bidders then all bids would have been rejected by the City Commissioners, and a date set for the reception of new bids. This date when new bids could be received is covered by
the statutes. In the event no bidder is received under the engineer's estimate at the second contract letting, a third date may be set, and the process continued until there is no hope of anyone taking the work under the estimate, in which case the city may proceed to do the work itself, either to award the work to someone to do at the estimate, or to actually buy tools and equipment to do the work itself, PROVIDED, the cost of the work does not exceed the estimate. This is here set forth in order to show the necessity of real study of the estimate, to be sure that the same is just and reasonable, both to the bidders and to the public. Personally, I like my estimates to be somewhere in about the middle of the bidding; however, in this I do not always succeed. I had a bridge letting previous to this one which was for a large single arch reinforced concrete bridge, 30 foot roadway, and two five-foot cantilevered sidewalks, over the Shunganunga Creek at Lake Street. This job was designed for a single car track as well as for the usual traffic. At the first letting of this bridge, my estimate was just $200 lower than the lowest bid received, and the bidder in this case was a thoroughly reliable contractor who wanted to build the bridge. All bids were rejected, and new bids received a week later. The low bidder at the
first letting, in the meantime was awarded three other bridges on highway work upon which he had bid, so he did not bid at the second letting, and although the estimate was raised at the second letting, no bids under it were received, and a third letting was called for, with the result that the bridge cost the city over $5000 more than it would have cost had the Commissioners had the power to have awarded it to the low bidder at the first letting. However, the law is made to be obeyed, and should be always, so the city was simply the loser. In this case I made a careful estimate the first time, and on a $35000 job, to be off $200 was not so bad, but it turned out to be expensive for the city. In this bridge letting of the Seventh Street bridge, I was further away from the low bidder than I should have been, possibly, but I did not care to have the experience of the Lake Street Bridge letting repeated.
CONSTRUCTION

While the contract for the construction of the bridge was let on January 30th, actual construction work on the ground did not begin until in April. The reason for this was largely due to weather conditions, since concrete would have to be poured if any pits were opened, and also some delay was experienced in obtaining the piling for the job.

The bridge was staked out for the abutment and pier foundations, by the Engineering Department of the city. Reference lines were laid outside of the work and accessible for future use such as the center line of the arches, and spring line, also the outside lines of the abutments, and the center line of the pier.

An inspector representing the city was kept upon the work continuously from the day the work started until the work was finally received by the city. This inspector was supplied with a form of daily report upon which he showed the kind of work done by the workmen each day, separating the common labor from the skilled labor, and giving the rate of pay per hour for each man. Also this inspector was required to show on his reports the amount of cement used each day and the approximate amount of concrete placed in the structure. When driving piling placed in the leads, and the amount cut off if
any was noted for each pile. This inspector was made responsible for the success of the job from the standpoint of appearance of the finished structure. It was his duty to see to it the concrete was well spaded in the forms, and that no honeycomb places appeared in the finished work. We did not make this inspector responsible for any lines, nor for the checking of the steel work, but that duty being left to the engineering department alone. This inspector, Mr. W. P. Wilcox, of Topeka, has in this structure a very creditable piece of work; he has produced here that appearance in concrete work which is so desirable, for he is very insistent with the laborers in pouring concrete that the mixture be held to the proper consistency, and that the same be well spaded in the forms.

Mr. W. A. Saylor was superintendent of the construction work for Mr. Fred Buttjohann, the contractor. To Mr. Saylor is due much credit in the manner in which he handled the work. His bridge lines are straight, and the finished bridge is strictly in accordance with the plans. To Mr. Saylor also belongs credit for being able to see ahead and to read plans so that the work flows ahead freely and to avoid those distressing features which so frequently occur in work of this kind where some essential detail has been omitted, or where the plans may fail to properly connect one part with another.
During the construction, the writer made only such trips to the work as his time permitted, except that I checked up the steel and forms before pouring of concrete, and directed some deviation from the plans in matters of raising the grade of the approaches, and the handrailng, and the lighting of the bridge.

Herewith are copies of the monthly estimates issued to the contractor during the progress of the work, and also a copy of the final estimate showing the amount of extra work that was done over the contract as originally planned. Here is seen the advisability of having extra items in the bidding forms for use in building a structure of this kind, they come in very handy at the close of the work.

These estimates were presented to the City Commissioners for payment at the time of paying the regular monthly bills against the city. These estimates pass from the City Engineer to the Commissioner of Streets and Public Improvements, then to the City Auditor. The estimate is prepared between the twenty-fourth and the twenty-seventh of each calendar month during the progress of the work and after being properly signed by all concerned is placed in the appropriation ordinance along with other bills against the city. The check covering the work is issued on the sixth of the month following the making of the estimate.
The form of these estimates is recommended to the reader in that they present the entire status of the job at all times, particularly as to the amount of funds left in the appropriation, which is very essential in a city where numerous projects are continuously in course of construction.
CONTRACTOR: Fred Luttjohann

FOR: Construction of a reinforced concrete arch bridge over Shangamung Creek at Seventh Street

Contract No.: Contract Expires: January 30, 1926 December 1st, 1923

<table>
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<tr>
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<th>Amount</th>
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<tr>
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</tr>
<tr>
<td>Less previous estimate paid</td>
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<tr>
<td>Balance in fund</td>
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<tr>
<td>Amount this estimate</td>
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<td>Credit</td>
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</tr>
<tr>
<td>Total</td>
<td>$32385.00</td>
</tr>
</tbody>
</table>

To the Honorable Board of City Commissioners,

Gentlemen:

I submit herewith the first monthly estimate to Mr. Fred Luttjohann under his contract for the construction of a reinforced concrete arch bridge over Shangamung Creek at Seventh St.

To bridge 16% complete on original contract of $31200.00 - - - - - - - $4992.00

Less 10% retained - - - - - - 499.20

$4492.80

Less previous estimates paid - - - 0.00

Due this estimate - $4492.80

(Copy of the original)

I have checked the above estimate and it is O. K. (Office Engineer)

I hereby certify that the above estimate is correct. (City Engineer)

I hereby approve the above estimate. (Commissioner of Public Works)

I hereby recommend that the above estimate be Paid (City Auditor)

State of Kansas, Shawnee County, ss.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God. (Contractor)

Subscribed and sworn to before me, this day of 1922.

7th St. Bridge Est. 21 City Clerk
To the Honorable Board of City Commissioners,

Gentlemen:

I herewith submit the 2nd monthly estimate to Fred Luttjohn under his contract for the construction of a reinforced concrete arch bridge over Shunganunga Creek at 7th Street.

To Bridge 30% complete on ($31200.00) $9360.00
Less 10% 936.00
Less previous Est. 4492.80
Due this Est. $3931.20

(Copy of the original)

I have checked the above estimate and it is O. K.

I hereby certify that the above estimate is correct.

I hereby approve the above estimate.

I hereby recommend that the above estimate be

City Engineer.

Commissioner of Public Works.

City Auditor.

State of Kansas, Shawnee County, ss.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

Subscribed and sworn to before me, this day of 192

City Clerk.

7th Bridge #2
**MONTHLY ESTIMATE**

**ENGINEERING DEPARTMENT**

**CONTRACTOR** Fred Luttjohnann

**TOPERA, KANSAS, June 27, 1923**

**Construction of reinforced concrete arch bridge over Shunganunga Creek at 7th Street.**

<table>
<thead>
<tr>
<th>Contract Let</th>
<th>Contract Expires</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 30, 1923</td>
<td>December 1, 1923</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total amount in fund</td>
<td>$32365.00</td>
</tr>
<tr>
<td>Less precious estimate paid</td>
<td>8424.00</td>
</tr>
<tr>
<td>Balance in fund</td>
<td>23961.00</td>
</tr>
<tr>
<td>Amount this estimate</td>
<td>4212.00</td>
</tr>
<tr>
<td>Credit—$4900</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$19749.00</td>
</tr>
</tbody>
</table>

To the Honorable Board of City Commissioners,

Gentlemen:

I herewith submit the 3d monthly estimate to Fred Luttjohnann under his contract for the construction of a reinforced concrete arch bridge over Shunganunga Creek at 7th St.

To Bridge 45% complete on original contract of $31200.00 -- -- -- $14040.00

Less 10% 1404.00

Less previous estimate 8424.00

Due this estimate $4212.00

(Copy of the original)

I have checked the above estimate and it is O. K.

I hereby certify that the above estimate is correct.

I hereby approve the above estimate.

I hereby recommend that the above estimate be

City Engineer.

Commissioner of Public Works.

City Auditor.

State of Kansas, Shawnee County, ss.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

Subscribed and sworn to before me, this ______________ day of ___________ 1922.

City Clerk.
To the Honorable Board of City Commissioners,

Gentlemen:

I herewith submit the 4th monthly estimate to Fred Luttjonann under his contract for the construction of a reinforced concrete Arch Bridge over Shunganunga Creek at 7th Street.

To Bridge 65% complete on original contract of $31300.00 - - - - - - - - - - - - - - $20280.00

Less 10% $2028.00

Less previous estimate $18252.00

Due this estimate $5516.00

(Copy of the original)

I have checked the above estimate and it is O. K.

I hereby certify that the above estimate is correct.

I hereby approve the above estimate.

I hereby recommend that the above estimate be

__________________________
City Engineer.

__________________________
Commissioner of Public Works.

__________________________
City Auditor.

State of Kansas, Shawnee County, ss.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

Subscribed and sworn to before me, this day of 192.

__________________________
7th St. Bridge #4
City Clerk.
CONTRACTOR

Fred Luttjohann

TOPEKA, KANSAS. August 27, 1923

FOR

Construction of reinforced concrete Arch over Snunganunga Creek at 7th Street.

January 30, 1923

Contract Expires December 1, 1923

Total amount in fund $32385.00
Less previous estimate paid 18252.00
Balance in fund 14133.00
Amount this estimate 7020.00
Credit—Debit 7113.00

To the Honorable Board of City Commissioners.

Gentlemen:

I herewith submit the 5th monthly estimate to Fred Luttjohann under his contract for the construction of a reinforced concrete Arch Bridge over Snunganunga Creek at 7th Street.

To bridge 90% complete on original contract of $31200.00 - - - - - - - - $280'0.00
Less 10% 2808.00
Less previous estimate 18252.00
Due this estimate $7620.00

(Copy of the original)

I have checked the above estimate and it is O. K. __________________________________________________________

I hereby certify that the above estimate is correct. __________________________________________________________

City Engineer.

I hereby approve the above estimate. __________________________________________________________

Commissioner of Public Works.

I hereby recommend that the above estimate be __________________________________________________________

City Auditor.

State of Kansas, Shawnee County, ss.

I DO SOLEMELY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

Subscribed and sworn to before me, this __________________ day of ____________ 192

7th St. Bridge #5

City Clerk.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTRACTOR</td>
<td>Fred Luttjohann</td>
<td></td>
</tr>
<tr>
<td>FOR</td>
<td>Construction of reinforced concrete arch bridge over Shunganunga Creek at Seventh Street.</td>
<td></td>
</tr>
<tr>
<td>Contract Let</td>
<td>January 30, 1923</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contract Expires: December 1, 1923</td>
</tr>
<tr>
<td>Total amount in fund</td>
<td>$32385.00</td>
<td></td>
</tr>
<tr>
<td>Less previous estimate paid</td>
<td>25272.00</td>
<td></td>
</tr>
<tr>
<td>Balance in fund</td>
<td>7113.00</td>
<td></td>
</tr>
<tr>
<td>Amount this estimate</td>
<td>561.60</td>
<td></td>
</tr>
<tr>
<td>Credit</td>
<td>$6551.40</td>
<td></td>
</tr>
</tbody>
</table>

To the Honorable Board of City Commissioners.

Gentlemen:

I herewith submit the 6th monthly estimate to Fred Luttjohann under his contract for the construction of a reinforced concrete Arch Bridge over Shunganunga Creek at Seventh Street.

To bridge 92% complete on original contract of $31200.00

\[-\text{Less 10\%} \quad 2870.40\]
\[-\text{Less previous estimate} \quad 25272.00\]
\[-\text{Due this estimate} \quad 561.60\]

(Copy of the original)

I have checked the above estimate and it is O.K.

I hereby certify that the above estimate is correct.

I hereby approve the above estimate.

I hereby recommend that the above estimate be

|                                 |
| City Engineer.                 |
| Commissioner of Public Works.  |
| City Auditor.                 |

State of Kansas, Shawnee County, 66.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

Subscribed and sworn to before me, this day of 1927.
CONTRACTOR TOPEKA, KANSAS, October 27, 1923

Construction of reinforced concrete Arch Bridge over Shunganunga Creek at 7th Street.

Contract Let January 30, 1923; Contract Expires December 1, 1923

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total amount in fund</td>
<td>$32385.00</td>
</tr>
<tr>
<td>Less previous estimate paid</td>
<td>25833.60</td>
</tr>
<tr>
<td>Balance in fund</td>
<td>6551.40</td>
</tr>
<tr>
<td>Amount this estimate</td>
<td>280.80</td>
</tr>
<tr>
<td>Credit - Do not deduct</td>
<td>$6270.60</td>
</tr>
</tbody>
</table>

To the Honorable Board of City Commissioners.

Gentlemen:

I herewith submit the 7th monthly estimate to Fred Luttjohann under his contract for the construction of a reinforced concrete Arch Bridge over Shunganunga Creek at 7th Street.

To Bridge 93% complete on original contract of $31200.00 - $29016.00

Less 10% 2901.60
Less previous estimate 25833.60
Due this estimate $280.80

(Copy of the original)

I hereby certify that the above estimate is correct.

City Engineer.

I hereby approve the above estimate.

Commissioner of Public Works.

I hereby recommend that the above estimate be

City Auditor.

State of Kansas, Shawnee County, ss.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

Subscribed and sworn to before me, this __________________ day of ___________________ 1923.

City Clerk.
MONTHLY ESTIMATE
ENGINEERING DEPARTMENT

CONTRACTOR: Fred Lutt Johann
TOPEKA, KANSAS, November 27, 1923

FOR: Construction of reinforced concrete Arch Bridge over Shunganunga Creek at 7th Street.

Contract Let: January 30, 1923
Contract Expires: December 1, 1923

<table>
<thead>
<tr>
<th>Total amount in fund:</th>
<th>$3235.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less previous estimate paid:</td>
<td>2614.40</td>
</tr>
<tr>
<td>Balance in fund:</td>
<td>620.60</td>
</tr>
<tr>
<td>Amount this estimate:</td>
<td>1404.00</td>
</tr>
<tr>
<td>Credit:</td>
<td>$4866.60</td>
</tr>
</tbody>
</table>

To the Honorable Board of City Commissioners.

Gentlemen:

I herewith submit the 8th monthly estimate to Fred Lutt Johann under his contract for the construction of a reinforced concrete Arch Bridge over Shunganunga Creek at 7th Street.

To Bridge 98% complete on original contract of $31200.00 - $3057.60

Less 10%: $3057.60

Less previous estimate: $2614.40

Due this estimate: $1404.00

(Copy of the original)

I have checked the above estimate and it is O. K.

I hereby certify that the above estimate is correct.

I hereby approve the above estimate.

I hereby recommend that the above estimate be

State of Kansas, Shawnee County, ss.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

Subscribed and sworn to before me, this ________ day of ____________ 192

7th St. Bridge #8

City Clerk.
I herewith submit the 9th and final estimate to Fred Luttjohann for the construction of a reinforced concrete Arch Bridge over Shunganunga Creek at 7th Street.

To original contract, complete $31200.00

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 extra ft. of Bridge Handrailing</td>
<td>45</td>
<td>$4.00</td>
<td>180.00</td>
</tr>
<tr>
<td>124 extra sq. yds. of brick paving</td>
<td>124</td>
<td>$4.00</td>
<td>496.00</td>
</tr>
<tr>
<td>133 sq. yds. of extra brick paving, re-aid on new concrete base, asphalt fill,</td>
<td>133</td>
<td>$2.75</td>
<td>360.25</td>
</tr>
<tr>
<td>64 sq. yds. old brick sidewalk re-aid, @ 8%</td>
<td>64</td>
<td>$1.84</td>
<td>118.00</td>
</tr>
<tr>
<td>843 sq. ft. of new cement walk alongside of new extra concrete retaining walls, @ 20%</td>
<td>843</td>
<td>$1.25</td>
<td>106.25</td>
</tr>
<tr>
<td>162 sq. ft. of new driveway at alley, @ 25%</td>
<td>162</td>
<td>$1.00</td>
<td>162.00</td>
</tr>
<tr>
<td>143 lineal ft. of new cement curbing, due to raise of grade, 7th St. approach, @ 90%</td>
<td>143</td>
<td>$1.25</td>
<td>178.70</td>
</tr>
<tr>
<td>35 lineal ft. of 15&quot; sewer pipe, fur. &amp; laid @ $1.25</td>
<td>35</td>
<td>$1.25</td>
<td>43.75</td>
</tr>
<tr>
<td>2 3-foot catchbasins, @ $35</td>
<td>2</td>
<td>$35</td>
<td>70.00</td>
</tr>
<tr>
<td>1 3-foot catchbasin-mannoe, @ $55</td>
<td>1</td>
<td>$55</td>
<td>55.00</td>
</tr>
<tr>
<td>1½ lineal ft. of new manhole, @ $7</td>
<td>1½</td>
<td>$7.50</td>
<td>11.25</td>
</tr>
<tr>
<td>2 Manhole covers, @ $15.50</td>
<td>2</td>
<td>$15.50</td>
<td>31.00</td>
</tr>
<tr>
<td>47 cu. yds. extra concrete in wing wall extensions @ $25</td>
<td>47</td>
<td>$25</td>
<td>1175.00</td>
</tr>
<tr>
<td>68 cu. yds. extra excavation for wing wall &quot; @ $2,</td>
<td>68</td>
<td>$2.00</td>
<td>136.00</td>
</tr>
<tr>
<td>6 cu. yds. extra concrete in drain box @ $25</td>
<td>6</td>
<td>$2.50</td>
<td>15.00</td>
</tr>
</tbody>
</table>

For laying, trenching, backfilling, taking up old pipe and re-laying the same, catchbasin drain pipe, as per bill filed $78.20

Extra dirt hauled in for raise of grade on 7th St. intersection, as per bill filed - 7.00

Trimming rail case to work out lamp post plans, as per bill filed. - - - - - 9.60

I have checked the above estimate and it is O. K.
To the Honorable Board of City Commissioners.

Gentlemen:

(Final Estimate Continued.)

Taking up old curb and gutter on 7th for raise of grade as per bill filed, $25.60
580 lbs. steel in sidewalk over fills @ 4¢ 23.20
$144.00

Add 15% to above extra work for profit, use of tools, and overhead 21.60
$165.60 $165.60

Total cost of the improvement, Less 10% retained for 30 days, as required by law 3475.16
$3176.48

Less previous estimates
Due this estimate, 2751.80
3753.08

I have checked the above estimate and it is O. K. (Office Engineer)

I hereby certify that the above estimate is correct. Signed (City Engineer.

I hereby approve the above estimate. Signed (Commissioner of Public Works.

I hereby recommend that the above estimate be Signed (City Auditor.

State of Kansas, Shawnee County, ss.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

(Contractor) 192

Subscribed and sworn to before me, this day of 7th St. Bridge #9--Final

City Clerk.
MONTHLY ESTIMATE
ENGINEERING DEPARTMENT

CONTRACTOR  Fred Luttjonann
TOPEKA, KANSAS, January 27, 1924

FOR
Construction of reinforced concrete Arch Bridge over Shunganunga Creek at Seventh Street.

Contract Let  January 30, 1923  Contract Expires  December 1, 1923

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total amount in fund</td>
<td>$32385.00</td>
</tr>
<tr>
<td>Less previous estimate paid</td>
<td>$3276.48</td>
</tr>
<tr>
<td>Balance in fund</td>
<td>$31108.52</td>
</tr>
<tr>
<td>Amount this estimate</td>
<td>$3475.16</td>
</tr>
<tr>
<td>J.0% - Debit</td>
<td>$2366.64</td>
</tr>
</tbody>
</table>

To the Honorable Board of City Commissioners.

Gentlemen:

I herewith submit the 10% retained for 30 days, as required by law from the final estimate of Mr. Fred Luttjonann for the construction of the Seventh Street Bridge.

To 10% retained from the final estimate  -  -  -  $3475.16

I have checked the above estimate and it is O. K.

__________________________
City Engineer.

__________________________
Commissioner of Public Works.

__________________________
City Auditor.

State of Kansas, Shawnee County, ss.

I DO SOLEMNLY SWEAR, That the foregoing account is just and correct, is due and remains unpaid; that the charges therein are the legal or ordinary charges for such work. So help me God.

__________________________
Subscribed and sworn to before me, this day of    192

7th Street Bridge #10--10%
HAROLD B. WOLFE
COMMERCIAL PHOTOGRAPHER
720 Kans. Ave.
Phone 2-2534
TOPEKA KANSAS
The photograph herewith shows the bridge completed and as seen from the up-stream side of the bridge. A better view might be obtained of the manner in which the structure fits the place for which it was designed, if a picture was taken from some point well above the structure, but such a view was impossible. However, the bridge does meet every condition for which it was designed. The small store seen in the picture at the further end is expected in time to be removed and permit of Seventh Street to come on to the bridge from the east, along the south side of the Shunganunga. Until this is done the full benefit of the bridge will not be obtained by the community which it serves, but steps are now being taken towards accomplishing this end.

The city administration under which this bridge was built is very proud of the structure, and I believe the City of Topeka is proud of it. The bridge will serve the traffic which any future may bring to it, I am sure, and now after being in actual service for more than two years, passing the heat of summer and the cold of winter, it shows no signs of distress anywhere of which I am aware. To Mr. Fred Luttjohann of Topeka, the contractor for the work, has been given much praise for the creditable manner in which he conducted his construction operations, the speed with which he built the bridge, and for his kind and helpful cooperation in the entire project.
The writer is proud of the bridge. I hope the reader will, if he is in the City, take time to look it over. I have also built a number of similar structures over the city which are also, I believe, filling the need for which they were created as well as is the bridge at Seventh Street.

The End.

W. E. Bailey, B.S.
Topeka, Kansas,
May, 1926.