

1908

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T 198

T H E S I S

for

DEGREE OF BACHELOR OF SCIENCE

in

CIVIL ENGINEERING

-SUBJECT-

DESIGN OF A RE-INFORCED ARCH OVER FRISCO
RAILROAD ON TENTH STREET, ROLLA, MISSOURI.

DON M. NEER.

1908.

8298

SPECIFICATIONS FOR CONSTRUCTING A RE-INFORCED CONCRETE
ARCH BRIDGE ON TENTH STREET OVER FRISCO RAILROAD, ROLLA, MISSOURI.
LOCATION.

This bridge shall be located so that its center line will coincide with the center line of Tenth Street, so that the two (2) inside faces of the abutments will be perpendicular to the center line of Tenth Street and will be fifty-one (51) feet from the center line of the main track of the Frisco Railroad.

GENERAL DESCRIPTION.

This bridge will be built of concrete with steel rod reinforcement, as shown on the plan. It will be one hundred two (102) feet between the faces of the abutments.

The abutments shall be carried down into the rock ledge underlying the soil, to such a depth as shown on the plans or such depth as the engineer, in charge of the work, shall deem necessary as the work progresses.

The data furnished to bidders by the City Council, regarding depths of foundations, are to be considered as merely approximate, and bidders must assume the risk of having to go to a greater or less depth without altering in any way their schedule price, unless, in the opinion of the City Council, the contractor be really entitled to extra commission on account of material variation from the data furnished, in which event, the amount of such extra compensation shall be determined solely by the City Council.

APPROXIMATE QUANTITIES.

The approximate quantities in the bridge are as follows:
Concrete in the abutments to the springing line 288 Cu. yards;

Concrete in the arch ring between springing lines, ^{including coping and spandrel walls} 295 Cu
yards; steel bars for re-inforcement, 91.43 tons.

These quantities will be used in comparing tenders for awarding the contract but they are not to be considered as in any way binding upon the City Council.

SCOPE OF CONTRACT.

This contract, of which these specifications form a part, will include the furnishing of all materials for, and the building complete of the bridge with its abutments, all in accordance with the specifications and aforesaid plans. No allowance will be made for excavation, nor any materials used in staging, cribs, forms, or centers, as the unit prices named for the items mentioned above in the list of approximate quantities must include all such work and material.

All the work herein outlined is to be done in strict accordance with the following specifications, the following plans, and such instructions as may be given from time to time by the City Council or its duly authorized representative.

INSPECTION.

All materials used on the work for the permanent structure shall be inspected after delivery at site, unless the contractor shall elect to have any materials inspected elsewhere, in which case the said materials shall be inspected by the engineer at the place designated by the contractor, but all expenses connected with such inspection shall be borne by the contractor.

Samples of steel bars, cement, and other materials, as may be used in the construction of this bridge, will be taken from the work at various times during its progress, and tests will be made upon the same, as a check upon the qualities of the materials furnished.

As the contractor is paid for doing this work in accordance with the spirit of the plans and specifications, it is not to be construed that any inspection, or the presence of an inspector or inspectors on the work at any time relieves the contractor of his responsibility in any degree whatever.

FINAL INSPECTION AND LOAD TEST.

Before the completed work is accepted and paid for, the contractor shall notify the City Council in writing, that the structure is ready for final inspection. Upon the receipt of this notification, the City Council will arrange to give the entire work a thorough inspection and test, either in person or through a competent representative who has not been regularly employed on this work.

Any defects or omissions noted during this inspection must be made good by the contractor without extra charge, before the said work will be accepted or paid for in full.

The bridge shall be subjected to the full live load test, not later than forty-five (45) days after the removal of the forms.

EXCAVATION.

All earth excavations are to be carefully shored, so as to keep the earth outside the excavation in an undisturbed condition. Rock excavation must be carried into the solid ledge,

as much as the engineer in charge deems necessary to insure sufficient grip of abutments to make same rigid and immovable. Floor of said excavation may be left rough, but seams or cracks must be cleaned out and filled with concrete.

FORMS.

Suitable forms must be provided to give the concrete constructions the exact dimensions and finish shown on the drawings. Care must be taken to make the form strong enough to resist the spading or ramming or lateral thrust of concrete without any distortion or change of position.

The form planks for all exposed portions of the work are to be two (2) inches by six (6) inches dressed and matched flooring laid closely.

The forms for all the unexposed portion of the work may be made ^{of} rough plank.

CONCRETE.

Concrete for the abutments shall be composed of one part of some high-class Portland Cement, approved by the engineer; three parts coarse clean sand; six parts of broken stone, whose greatest dimensions shall not exceed two and one-half (2 1/2) inches, and whose least dimension shall not be less than one half (1/2) inch, and of such sizes between said greatest and least dimensions that when mixed in the above named proportions all voids shall be filled.

Concrete for the arch ring, coping, and spandrel walk, shall be composed of one part of some high-grade Portland Cement, approved by the engineer; Two parts coarse, clean sand; Four parts broken stone whose greatest dimensions shall not

exceed two and one-half ($2\frac{1}{2}$) inches, and whose least dimensions shall not be less than one-half ($\frac{1}{2}$) inch, and of such sizes between the greatest and least dimensions that when mixed in the above named proportions all voids shall be filled. These ingredients are to be measured by volume and in such manner as shall be satisfactory to the engineer in charge so that there can be no doubt that the required proportion of each kind is being provided.

A quarter-barrel sack of cement, as packed by the manufacturer, and weighing not less than ninety-five (95) pounds, shall be taken as a cubic foot, or the packed barrel, weighing not less than three hundred eighty (380) pounds, as four cubic feet.

All concrete is to be mixed wet, and to be deposited with sufficient tamping to open up any air pockets. Concrete may be mixed in an acceptable form of mixing machine. In case of hand mixing, the sand and the cement are to be thoroughly mixed, dry; the sufficient clean water must be added, and then the mortar must be thoroughly mixed, after which the broken stone is to be added. The stone must be thoroughly drenched with clean water before being mixed with the mortar. All concrete is to be turned at least three times after wetting. The amount of water to be used in mixing the mortar will be determined by the engineer in charge.

In general, all concrete is to be mixed and deposited to the satisfaction of the engineer in charge of the work.

On all exposed surfaces of the coping and arch ring, the forms shall be thoroughly plastered with a mortar composed of three (3) parts of red granite screenings, not to exceed one fourth ($\frac{1}{4}$) inch in the greatest dimension and one part Portland

Cement, and of sufficient to insure that no limestone will be exposed. After the limestone concrete has been deposited back of the mortar facing, the mortar on the surface shall be thoroughly spaded or troweled and flushed against the forms so that there will be no cavities or visible voids. The forms shall be removed when the concrete has sufficiently set to maintain itself, but while it is still green and friable and the fresh surface washed with a suitable brush and free flow of water to cut and rinse clean until a cement film is removed and a clean exposure of the red granite left in low relief. In case the forms are removed too late to accomplish the finish described above, the contractor will be required to obtain a similar effect by bush hammering and washing the tooled surface with a half and half dilution of hydrochloric acid and thoroughly rinsed with water.

The concrete on all exposed surfaces other than those of coping and arching, shall be thoroughly spaded adjacent to the form and sufficient mortar flushed to the surface to fill all cavities and voids so that when the forms are removed the finish described above may be applied. The forms shall be removed as soon as the concrete has set sufficiently to maintain itself and the fresh surface washed with brush and water in the manner described above, sufficiently to remove all forms and board marks and to give a surface finish approximately the same as described for the coping and arch ring.

A good, clean, workmanlike finish on all surfaces throughout the work, but especially on all angles, will be required.

DRY SURFACES IN CONCRETE.

Should, during the construction, any surface of the concrete be allowed to harden or dry before the entire concrete for such portion of the structure be placed then immediately the placing of fresh concrete, the said dry surface shall be swept perfectly clean with brooms, then wetted thoroughly with clean water, and flushed with grout made of one (1) part cement and three (3) parts sand. It is necessary that every precaution shall be taken to render the concrete truly monolithic, and the forming of dry surfaces shall be prevented as far as practicable.

CEMENT.

All cement used on the work must be Portland Cement of a brand approved by the City Council, and shall be dry and free from lumps, put up in strong, sound barrels well lined with paper, so as to be reasonably protected from moisture, or in stout cloth or canvas sacks.

Each package shall be plainly labeled with the name of the name of the brand and the manufacturer.

Any package broken or containing damaged cement, may be rejected or accepted as a fractional package at the option of the engineer in charge of the work. All cement must be accessible, either in cars or in warehouses, to the City Council or its engineer in charge of the work, for the purpose of taking samples for tests at least ten (10) days previous to the time said cement is to be used in the work.

TESTS OF CEMENT.

All cement must conform to the standard specifications for cement adopted by the American Society for Testing Materials in June, 1904. The minimum tensile strength of briquettes made from samples of the cement, and one (1) square inch in section, shall be as follows:

NEAT CEMENT.

Twenty-four (24) hours in moist air - - 150 to 200 pounds;

One day in moist air, six (6) days in water -- 450 to 550 pounds.

One day in moist air, twenty-seven (27) days in water

- - - - - 550 to 650 pounds; this cement must show no retrogression of strength within the periods specified.

One day in moist air, six (6) days in water - - - - -

150 to 200 pounds.

One day in moist air, twenty-seven (27) days in water

- - - - - 200 to 300 pounds.

SAND.

All sand used on this work to be clean, course, sharp sand as will pass a number twenty (20) sieve, and remain on a number thirty (30) sieve.

BROKEN STONE.

The stone for concrete must be clean and free from all dirt and dust, and be a sound, hard rock, to be approved by the City Council. Where concrete must be placed through between re-inforcing bars or other restricted place, not stone will be used that will not freely pass through such space in any direction of the stone.

STEEL RE-INFORCEMENT.

The concrete shall be re-inforced by approved steel square bars, having a mechanical bend, and an elastic limit not less than 45000 per square inch; and shall be of such dimensions and placed in such manner as indicated on the plans. No allowance will be made for cutting, bending, or placing any of these rods, as the unit price must include all such work in addition to the material itself. Only the actual metal placed in the permanent structure will be allowed for. The amount of metal in the structure is to be determined by an actual count of the prices with measurement of their lengths and sections, taken with the proper weight per lineal foot for the different sections. The weight per foot of said sections may be determined by actually weighing several pieces of different sections, or such other method as seems expedient to the City Council and acceptable to the contractor.

Especial care is to be taken in placing the bars according to the plans, so as to secure as near as possible the same condition assumed in the design of the bridge. Preference will be given to such methods where the bars are accurately spaced and wired in place before concrete is placed in the forms. All shavings, blocks, and chips, or other foreign matter is to be carefully removed from the forms before concrete is placed.

PLACING CONCRETE DURING FREEZING WEATHER.

No concrete shall be placed during freezing weather.

BACK FILLING.

As soon as the concrete work is completed or at such time as the City Council may direct, the space around each abutment shall be filled with earth, preferably clay, thoroughly dampened and

well rammed in layers not exceeding six (6) inches in thickness. The back filling is to be carried to the original surface as it existed at the time of starting the excavation, unless the City Council direct otherwise. There will be no direct payment for this back filling as the cost of same is to be covered by unit price of concrete in place. The contractor shall remove at his own expense all falsework, centers, forms, rubbish, earth, or other useless materials caused by his operations.

ALTERATIONS OF PLANS.

The City Council shall have the power to vary, extend, increase, or diminish the quantity of the work, or to dispense with a portion thereof, during its progress, without impairing the contract, and no allowance will be made the contract except for work actually done.

MEASUREMENTS.

All the work and materials embraced in this contract of which these specifications form a part, shall be measured and paid for in two (2) items only, viz:

Item 1. Cubic yards of concrete in place;

Item 2. Pounds of steel bars in place.

The cost of any materials or work incidentals and accessory thereto, must be avered by the unit prices for the above two (2) items, as no direct payment will be made for the materials and work embraced in these specifications and plans other than for the two items above.

Should occasion arise for the doing of other work and the

furnishing of other material than such materials avered by these specifications and plans, but deemed necessary by the City Council in order to complete said structure, then same shall be considered and treated as an "extra" according to paragraph four (4) of the General Stipulations attached thereto.

PAYMENTS.

Payment for work shall be made in cash upon final completion and acceptance of the work and the City Council may make such partial estimates and payments thereon as it may deem best, provided, however, at least twenty-five (25) percent of the entire price be retained until the bridge is subjected to and has satisfactorily withstood the full live load test as hereinbefore provided.

GENERAL STIPULATIONS.

IT IS FURTHER EXPRESSLY AGREED between the parties hereto that this contract is made subject to the conditions and stipulations which follow:

1. The first party shall not assign or transfer this contract or sublet any of the work embraced in it.

2. The first party shall commence work at such points as the City Council may direct, and shall conform to its directions as to the order of time in which the different parts of the work shall be done, as well as to all its other instructions as to the mode of doing the same.

3. Whenever the contractor is not present on the work, orders will be given to the superintendants or overseers in immediate charge thereof, and shall by them be received and obeyed; and if any person employed on the work shall refuse or neglect to obey the directions of the City Council, or its duly authorized agents, in anything relating to the work or shall appear to the City Council to be incompetent, disorderly, or unfaithful, he shall, upon the requisition of the City Council, be at once discharged and not again employed on any part of the work.

4. Any work not herein specified, which may be fairly implied as included in this contract, of which the City Council shall be the judge, shall be done by the first party without extra charge.

The first party shall also do such extra work in connection with this contract, as the City Council shall especially direct and if it shall be of a kind for which no price is stated in this contract, such price will be fixed by the City Council, but no claims for extra work shall be allowed unless the same was done

in pursuance to special orders, as aforesaid, and the claims presented as soon as practicable after the work is done and before the final estimate.

5. The first party shall, upon being so directed by the City Council, remove, rebuild, or make good at his own cost, any work which the latter shall decide to be defective, and omission to condemn any work at the time of its construction shall not be construed as an acceptance of any defective work, but the first party shall correct any imperfect work whenever discovered before the final acceptance of the work.

6. If, in the opinion of the City Council, the first party at any time during the process of the work is not prosecuting the work with sufficient force to insure its completion within the time specified in this contract, it may notify the first party to employ such additional force as they deem sufficient, and on the failure of the said first party to comply with such notice within three (3) days after its delivery, the City Council may put on additional force at the cost of the said first party, or it may, at its option, declare this contract annulled and the power is reserved to the City Council to suspend or annul this contract or to suspend the doing of any work thereunder at any time for any failure on the part of the first party to fulfill the same, or for other good cause; and any action of the City Council in suspending or annulling this contract, or suspending the doing of the work thereunder, and its decision as to the existence of cause or reason for such annulment or suspension, shall be conclusive as to the existence of such cause or reason in any controversy or litigation between the parties hereto, or others claiming unto them. And if this contract be so suspended

or annulled the said first party shall not be entitled to any thing on account of damages thereby, nor shall such annulment or suspension in any wise affect the said right of said Rolla to damages and penalties claimed by it on account of the failure of the said first party.

7. The first party will be required to observe all city ordinances in relation to obstructing the streets, maintaining signals, keeping open the passageway and protecting same where exposed, and generally, to obey all laws and ordinances controlling or limiting those engaged on the work; and the said first and second parties hereby expressly bind themselves to indemnify and save harmless Rolla from all suits or actions of every name and description brought against the said city for or on account of any injuries or damages received or sustained by any party or parties by or from the acts of said contractor, or his servants or agents, in doing the work herein contracted for or by or in consequence of any negligence in guarding the same, or any improper material used in its construction, or by or on account of any act or omission of the said first party or his servants or agents.

8. The first party further agrees that he will pay for the work and labor of all laborers, teamsters, teams, and wagons employed on the work, and for all materials used therein.

9. The work embraced in this contract shall be begun within - - - - - days after this contract binds and takes effect, and shall be prosecuted regularly and uninterruptedly thereafter (unless the said City Council directs otherwise in writing) with such forces as to secure on or before the - - - - -

day of - - - - - 19- - -, the full completion of all the work embraced in this contract, and if the contractor shall fail to complete the work embraced in this contract within the time above specified, an amount equal to the sum of fifteen dollars (\$15) per day for each and every day thereafter until such completion, shall be deducted as liquidated damages for such breach of this contract from the amount of the final estimate of such work; or, if he shall have completed the bridge previous to the time herein stated, he shall receive a bonus of fifteen dollars (\$15) per day for each and every day the bridge is completed previous to the time herein specified for completion.

And no extension of the time hereinbefore provided for the completion of said work, granted by said third party at the request or upon the petition of the Contractor, shall be held or taken as a waiver of the right to deduct the sum of fifteen dollars (\$15) aforesaid for each and every day said contract shall remain uncompleted after the time herein provided for the completion of said work, unless such waiver be expressly made by resolution of the City Council at the time such extension is made.

10. To prevent all disputes and litigation it is further agreed by the parties hereto that the City Council shall in all cases determine the amount and quantity of the several kinds of work which are to be paid for under this contract, and it shall decide all questions which may arise relative to the execution of this contract, on the part of the contractor, and its estimates and decisions shall be final and conclusive.

11. This contract entered into is subject to the City Charter and Ordinances in general.

12. It is further expressly agreed and stipulated by the said party of the first part that he will not require laborers employed by him on such work to labor more than eight (8) hours per day, and the said party of the first part further agrees that he will faithfully and in all respects comply with all the provisions of this Missouri State Law in the doing of said work.

13. In consideration of the completion by the said first party of all work embraced in this contract in conformity with the specifications and stipulations herein contained, Rolla, party of the third part, hereby agrees to pay to the said party at the following rate, viz:

For each cubic yard of concrete the sum of - - - - -
- - - - -

For each ton of steel bars, for re-inforcement, the sum
of - - - - -

For - - - - -
- - - - -

At the completion and acceptance of the entire work by the City Council the balance held in reserve and due the contractor will be paid him in cash, according to the above schedule of prices, out of the funds under disposal of the City Council, according to the Charter and Ordinances of said City, and that his receipt for same shall be in full of all claims against Rolla on account of said work.

Said parties of the second part hereby guarantee that the said party of the first part will well and truly perform the covenants hereinbefore contained, to pay for the work and labor

of all laborers and teamsters, teams, and wagons, employed on the work, and for all materials used therein, and if the cost of such labor and materials is not paid in full by the said party of the first part, then the said parties of the second part hereby agree to pay for said work, labor and materials, or any part thereof which shall not be paid by said first party within ten (10) days after the money for such work, labor, and materials become due and payable, and this provision shall entitle any and all laborers and teamsters and owners of teams and wagons who may do work, and the parties who may furnish materials on or for the improvements to be due under this contract, to sue and recover from said second parties, or either of them the amount due or impared to them, or either of them, by said first party; but said second parties shall not be liable on this guarantee on account of the materials used and the labor done upon said work beyond the sum of - - - - - Dollars; the estimated cost of materials used and labor done upon said work.

And said parties of the second part hereby agree with Rolla that said party of the first part will well and faithfully perform each and all of the terms and stipulations in the foregoing contract to be done, kept and performed, on the part of the said first party, but said parties of the second part shall not be liable herein beyond the sum of - - - - - Dollars.

IN WITNESS WHEREOF, the said parties of the first and second part have hereunto set their hands and seals respectively and Rolla executes this contract by the mayor of the City of Rolla.

----- (Seal)

----- (Seal)

----- (Seal)

----- (Seal)

----- (Seal)

----- (Seal)

ROLLA, MISSOURI.

By -----
Mayor.

Attest: -----
City Clerk.