SPECIFICATIONS

FOR _____ BRIDGE OVER _____

AT _____

GENERAL SPECIFICATIONS

FOR

Highway Bridge Superstructures

THE OSBORN ENGINEERING CO.
OSBORN BUILDING,
CLEVELAND, - OHIO.

1901.

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SPECIFICATIONS

FOR.....BRIDGE OVER.....

at.....

The engineer's general drawings consist of:—

Sheet 1. .....

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The superstructure will consist of..... spans..... ....long.

Roadway.....wide, Flooring of single / double *.... thick (See ¶ .....)*

Nailing strips of..... (See ¶ 13)

Pavement of..... .... on..... base (See ¶ .....)

Stringers of .... (See ¶¶ 138, 139 and 140)

.....Sidewalks..... wide. Flooring.....(See ¶¶ 57 and 58)

Nailing strips of.....(See ¶ 59)

Pavement of.....on.....base (See ¶¶ 60 to 66 inclusive)

Stringers of.... ....(See ¶¶ 138, 139 and 140)

Wheel guards of..... (See ¶ 69)

Curbs of.... ....(See ¶ 70)

Contractor to..... ..... Car tracks ..... gauge

.....centers, located.....(See ¶ 71)

Trolley poles to be..... .... by

Contractor,..... ....(See ¶ 72)

Contractor to .... for lighting the structure by.. .....as indicated on drawings and especially specified.

Dead load to be as per ¶ 80. In computing dead load, weights shall be taken as for a .....(See note to ¶ 80)

Uniform live load to be as per.....

Concentrated live loads to be as per... .....

Riveted work to be.....class. (See.... .....)

Paint, "first coat" to be..... ....

"finish coats" to be.... ....

The entire work to be completed on or before... ....19.....

1. DRAWINGS.

Engineer's General Drawings.

1. Accompanying these specifications, and forming a part hereof, are general drawings, as enumerated on the first page of these specifications, embodying the information and data furnished the contractor for his guidance.

ERRATA.

Page 1, Par 2, third line, read "the lengths of spans from center to center of end bearings; the depth from center to center of chords; the"

Page 25, heading of column 5 of table, read "1 ≂ 12d"

Page 29, Par. 145, second line, second word, for "oor" read "floor."

The plus (+) sign shall be used to indicate compression stresses and the minus (—) sign to indicate tension stresses.

Stresses shall be given in pounds, and weights of shape metal in pounds per foot of one piece.

The plans shall also include such detail drawings as are necessary to express the general intent of the whole work.

Shop Drawings.

3. The contractor shall not, except at his own risk, order any material until after the shop drawings have been approved by the engineer. After approval, the contractor shall furnish the engineer, without charge, as many sets of the shop drawings as he may require.

Shop and Order Bills.

4. The contractor shall also furnish the engineer with duplicate copies of all shop and order bills of material and shipping lists of all finished parts, with exact itemized weights of same.

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Engineer's General Drawings.

1. Accompanying these specifications, and forming a part hereof, are general drawings, as enumerated on the first page of these specifications, embodying the information and data furnished the contractor for his guidance.

Contractor's General Drawings.

2. If general drawings are submitted by the contractor with his proposal, they shall include all stress sheets giving the lengths of spans from center to center of chords; the width of the bridge in the clear and from center to center of trusses; the dead , live and other loads on which calculations are based; the dead, live and other load stresses as well as the minimum stresses and sections for all members; the sections and areas of lateral and portal struts, lateral and sway rods or angles; stringers, floor-beams and their connections; sizes of rivets; size, arrangement and character of floor system; and the class or classes of material proposed for use in the various parts of the structure.

The dead loads assumed for calculating the stresses shall not be less than the actual weight of the structure.

The plus (+) sign shall be used to indicate compression stresses and the minus (—) sign to indicate tension stresses.

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Size of Drawings.

5. All drawings shall be of uniform size twenty-four by thirty-six inches (24″ x 36″). They shall be numbered, arranged in systematic order and indexed.

Dimensions.

6. On all drawings dimensions shown in figures shall govern in cases of discrepancy between scale and figures.

Contractor Responsible for Accuracy.

7. The contractor shall check all leading dimensions and clearances as a whole and in detail, the fitting of all details, and become responsible for the exact position and elevation of all parts of the work; and the approval of the working drawings by the engineer shall not relieve the contractor of this responsibility.

Variations.

8. In constructing the work, no variations at any time from the approved drawings, nor from these specifications, shall be made by the contractor, without a written order from the engineer in each case, describing and directing such change.

Notes.

9. Notes or specifications appearing on the engineer's general drawings are to be construed as superseding and voiding any clauses, or parts of clauses, in these specifications, with which they may conflict.

For conventional signs for rivets on drawings, see Appendix.

II. FLOORS AND PAVEMENTS.

For specifications governing the steel floor system see paragraphs 136 to 143, inclusive.

10. Floors and pavements for roadways and sidewalks shall consist of such material as may be shown on the engineer's general drawings and specified on the first page hereof, and shall conform strictly to the following specifications covering the class of flooring or pavements selected, or to such notes and specifications as may appear on the engineer's general drawings.

A. SINGLE THICK PLANK FLOORS FOR ROADWAYS.

Plank.

11. Roadway flooring shall consist of plank of the kind specified on the first page hereof, from eight (8) inches to twelve (12) inches in width, surfaced both sides to two

and three-fourths (2¾) inches thick, the edges straight and parallel from end to end. A variation of more than one-half (½) inch in width will not be allowed.

How Laid.

12. It shall be laid at right angles to the axis of the bridge with one-quarter (¼) inch open joints and fastened to nailing strips or wooden stringers with five (5) inch steel wire nails, at least two for each intersection.

Nailing Strips.

13. Nailing strips for steel stringers shall be of the kind and dimensions and shall be attached as shown on the general drawings. They shall be fastened, at intervals not exceeding three (3) feet, to the steel stringers by five-eighths (⅝) inch bolts. If nailing strips are placed on the top flanges of stringers they shall be surfaced top and bottom to uniform thickness, and bolts shall be countersunk.

Length.

14. All flooring shall be of such length as to lay full width of the roadway, unless otherwise especially shown on the general drawings. When the general drawings show the plank laid in two lengths across the roadway, the joint shall come over a center stringer and be covered with a center strip of such size and quality, and fastened and finished as shown on the drawings. The ends of plank shall be sawed off in a workmanlike manner to a straight line.

Car Tracks.

15. When car tracks are provided, the ends of plank against the treads of rails shall be adzed off, when necessary, flush with the treads. Plank between rails shall be fitted snugly against the inside flanges of the rails, and adzed or chamfered off to leave the flooring with a neat and workmanlike finish.

B. DOUBLE THICK PLANK FLOORS FOR ROADWAYS.

Plank.

16. Roadway flooring shall consist of plank of the kind specified on the first page hereof, from eight (8) inches to twelve (12) inches in width, and shall be laid in two courses, each surfaced both sides to two and three-fourths (2¾) inches thick, the joints straight and parallel from end to end. A variation of more than one-half (½) inch in width will not be allowed.

Lower Course.

17. The lower course shall be laid with one-half (½) inch open joints at an angle of 45 degrees with the axis of the bridge, in opposite directions either side of the center line, and shall be fastened to the stringers by five (5) inch steel wire nails, at least two for each intersection, and clinched under the flanges of steel stringers. After laying, and before the upper course is laid, the lower course shall be covered with two (2) coats of tar, applied hot with swabs.

Upper Course.

18. The upper course shall be laid with closed joints, perpendicular to the axis of the bridge and fastened to the lower course with forty-penny cut nails of approved quality. It shall be of such length as to lay full width of the roadway unless otherwise especially shown on the general drawings. When the general drawings show the plank laid in two lengths across the roadway, the joint shall come over a center stringer and be covered with a center strip of such size and quality, and fastened and finished as shown on the drawings.

Car Tracks.

19. When car tracks are provided, the flooring shall be treated as above specified for single thick plank floors. (See paragraph 15.)

C. BRICK PAVEMENTS FOR ROADWAYS.

Concrete Base.

20. If the drawings indicate buckled, corrugated or other form of metal floor plates as support for the paving, a concrete base shall be laid directly upon such plates to a minimum thickness of not less than two (2) inches over their highest parts, and shall be composed, unless otherwise indicated on the engineer's general drawings, of Portland cement, sand, gravel and cinder, of the qualities hereinafter specified, and in the following proportions, viz.:

1 part of Portland Cement.
2 parts of Sand.
2 parts of Gravel.
4 parts of Cinder.

21. The concrete shall, if so directed by the engineer, be mixed by machinery, the machine to be of an acceptable

design, and capable of proper adjustment to secure thorough mixing and uniform temper of the materials. If mixed by hand, great care shall be taken to secure thorough and uniform incorporation of the entire mass. It shall be laid immediately and compacted by ramming until moisture appears on the surface. The surface shall be made exactly parallel with the finished surface of the pavement. The concrete shall be allowed to set such number of days as directed by the engineer before any walking or teaming over or laying of paving is allowed.

Concrete Floor Plates.

22. If the drawings indicate concrete plates, with or without imbedded metal, as support for the paving, such concrete shall itself form the base, and shall be composed, unless otherwise indicated on the engineer's general drawings, of the same materials in the same proportions, and be mixed, laid, rammed and finished to grades and crowns in the same manner as above specified for concrete base.

23. Concrete plates as support for the pavement shall be laid between and over the steel floor system upon temporary wooden forms, in such manner and to such depths as may be shown on the engineer's general drawings, but in no case shall the minimum depth be less than four (4) inches.

Imbedded Metal.

24. If so indicated on the engineer's general drawings, such form of metal as may be so indicated—such as expanded sheet metal, wire mesh or rods—shall be imbedded in concrete plates and attached to the steel floor system in such manner as may be indicated on the general drawings or directed by the engineer.

Cushion.

25. Upon the above base shall be placed a one (1) inch layer of clean, sharp, coarse sand, as a cushion on which to place the pavement.

Laying Brick.

26. The pavement shall be constructed of a single layer of bricks laid on edge, end to end, at right angles to the axis of the bridge. The bricks shall be set in straight courses, and breaking joints at least three (3) inches with the bricks of the adjoining courses; they shall be set per-

pendicular to the established grade, and to such height as the engineer may direct above the true grade and crown of the roadway when finished, to provide for settlement in pounding and rolling. After the bricks are laid, the end joints shall be made close and compact by the use of an iron bar applied at the ends next to the curb. Every fourth course, or as the engineer may direct, the bricks shall be closed up and the courses straightened by use of a sledge hammer and wood bar placed against the bricks. Nothing but whole bricks shall be used, except in starting a course or in making a closure at curbs, catchbasins, car tracks or other street structures, where not less than one-third bricks may be used in breaking joints. Care shall be taken in breaking and trimming bricks for this purpose, so as not to check or fracture the part to be used.

Ramming.

27. The paving, when laid as specified, shall be thoroughly rammed in courses three times, as may be directed, besides the final or surface ramming, using a large square rammer weighing not less than eighty (80) pounds and having no iron of any kind on its lower face to come in contact with the paving. In the fourth, or final ramming, the pavement shall be surfaced up by using a long straight-edge, and by a thorough rolling of the pavement with a heavy roller weighing not less than five (5) tons. When the ramming and rolling are completed, the pavement shall conform to the true grade and crown of the roadway, as shown on the general drawings and specified on the first page hereof.

Filling Joints.

28. The joints or spaces between the bricks to the full depth of the same shall be filled with grout composed of Portland cement and clean, sharp lake or river sand, both of a quality acceptable to the engineer, in the proportion of one to one. The cement and sand to be thoroughly mixed together dry in a box of proper form and capacity, and afterwards only a sufficient amount of water added to make the grout of the proper fluidity when thoroughly stirred. It shall be prepared only in small quantities at a time and shall be stirred rapidly and constantly in the box while being applied to the pavement, and no settlings or residue will be

allowed to be used. The grout fillings shall be transferred to the pavement in hand scoops, or in such other way as the engineer may direct, and shall then be rapidly swept into the joints with proper brooms.

Unless otherwise directed, the filling is to be done with two applications of the grout; the first two-thirds in depth from the bottom of the spaces to be filled with the grout somewhat thinner than required for the remaining one-third; the remainder of the spaces to be then filled with the thicker grout, and if necessary refilled until the joints will remain full to the top; the brick to be well wetted, as directed, before the grout is applied.

Top Dressing.

29. The surface of the paving, when completed as above, shall, when directed, be covered with a light top dressing of clean coarse sand or gravel of approved quality, which, with all accumulations, shall afterwards be removed from the pavement at such time before the final acceptance of the work as the engineer shall direct.

Car Tracks.

30. The pavement next to the rails at car tracks where they exist, and along curbs and in gutters, shall receive such special treatment as may be indicated on the engineer's general drawings, or directed by the engineer.

Expansion Points.

31. Paving at expansion points in the steel work shall receive such special treatment as may be indicated on the engineer's general drawings or directed by the engineer. Provisions for expansion in the pavement itself shall also be made if required, in such manner and at such points as the engineer may direct.

Prohibit Traffic.

32. All teams and wagon traffic, and all wheeling in barrows, except on planks, shall be rigidly prohibited on the pavement for at least one week after the grout is applied, or until, in the opinion of the engineer, it has become thoroughly set and hardened, so that the bond will not be broken by traffic.

Cement

33. Cement for all paving purposes shall be of the best quality of American Portland cement, and subject at all times to the inspection and tests of the engineer. The brand must be one well known, and one that has been used in im-

portant works in which it has remained at least two years and has shown no signs of deterioration. All cement shall be of uniform quality, color and weight. It shall be of such fineness that not less than ninety (90) per cent by weight shall pass through a sieve of 10,000 meshes per square inch. It shall be without free lime and pats made of neat cement shall show no cracking when immersed in water immediately after setting and left for seven days, nor when subjected to the hot test for twenty-four hours. The initial set of Portland cement shall not take place in less than thirty minutes, nor the final set in less than three hours or more than eight hours. Neat briquettes shall develop the following tensile strengths per square inch:

	AGE.	STRENGTH.
Neat.	24 hrs. (in water after hard set)	175 lbs. or over.
"	1 day air, 6 days water, -	450 " " "
"	1 day air, 27 days water, -	550 " " "
Sand.	(1 to 3) 1 day air, 6 days water,	125 " " "
"	" 1 day air, 27 days water,	200 " " "

Sand used for tests to be standard crushed quartz. Proportions to be taken by weight.

Sand and Gravel

34 All sand shall be clean, coarse and sharp, free from all earthy or organic matter. Gravel shall be clean and free from clay or shale. Sand and gravel shall be subject to the approval of the engineer, and none shall be used until it has been accepted by him.

Cinder.

35. Only such cinder will be accepted upon the work as is obtained from good steam coal, or what is known as "dead end" cinder. It shall be clean and free from unburned coal, ash and refuse. It shall consist of particles not greater than one inch in their greatest dimensions. No cinder shall be used until it has been accepted by the engineer.

Paving Brick.

36. Paving bricks shall consist of the best quality of sound, hard burned, machine pressed paving brick, made and burned especially for street paving purposes, square and straight, free from cracks and other defects, of uniform texture and uniformly of the size shown on plans or ap-

proved by the engineer. Specimen bricks shall be submitted to the engineer, labeled with the name of the manufacturer and the place of manufacture, and all bricks used shall be equal in every respect to the specimens. Specimen bricks broken across, thoroughly dried and weighed, then immersed in water for seventy-two (72) hours and again weighed, shall show a difference in weight dry and wet not exceeding two (2) per cent of the weight dry. Specimen bricks submitted to a one hour test in a standard rattler shall show a loss by abrasion not to exceed eight (8) per cent of the original weight of the bricks tested.

D. MEDINA BLOCK PAVEMENTS FOR ROADWAYS.

Concrete Base.

37. Either a concrete base on metal floor plates, or concrete plates with or without imbedded metal, as may be indicated on the engineer's general drawings, shall be used as support for the paving, and the concrete base or concrete plates shall conform in every respect to the above specifications for brick pavements. (See paragraphs 20, 21, 22, 23 and 24.)

Cushion.

38. The sand cushion shall be of the same thickness and material and laid as above specified for brick paving. (See paragraph 25.)

Laying Blocks.

39. The paving blocks shall be laid and compacted as above specified for brick pavement (see paragraph 26), breaking joints at least two (2) inches, and stones of the same thickness shall be placed in the same row and rows of similar thickness shall be placed together. No gravel or sand shall be placed on top or between the stones as they are laid.

Ramming.

40. The pavement, when laid as specified, shall be thoroughly rammed and rolled as above specified for brick pavement (see paragraph 27), and after ramming and rolling, or during the process, as may be directed, shall be thoroughly sprinkled or washed with water, to insure the thorough bedding of the blocks, leaving the joints or spaces between the blocks their full depth. When this is completed, the pavement shall conform to the true grade and crown of the roadway.

Filling Joints.

41. The joints or spaces between the blocks shall be filled with grout and the surface of the pavement, when completed, shall be top dressed and all wagons or other traffic shall be prohibited, all as above specified for brick pavements. (See paragraphs 28, 29 and 32.)

Car Tracks.

42. The pavement next to the rails at car tracks where they exist, and along curbs and in gutters, shall receive such special treatment as may be indicated on the engineer's general drawings, or directed by the engineer.

Expansion Points.

43. Paving at expansion points in the steel work shall receive such special treatment as may be indicated on the engineer's general drawings or directed by the engineer. Provision for expansion in the pavement itself shall also be made if required, in such manner and at such points as the engineer may direct.

Medina Blocks.

44. Medina paving blocks shall consist of the best quality of Medina sandstone, free from quarry checks or cracks, and from quarry seams or lines of clay, quarried from fine-grained and live rock and showing a straight and even fracture. They shall have parallel sides and ends, with right angle joints, all roughness and points of stone to be broken off, so that when set in place they shall have tight joints for a distance of at least three and one-half (3½) inches from the top downward; the area of the bottom of any stone to be not less than three-quarters (¾) of the area of the top, and the top to have a smooth, even surface. All paving blocks, before being brought to the vicinity of the work, shall be properly inspected and assorted, and classified by thickness into at least three classes, which shall thereafter be kept separated. Blocks shall be within such limiting sizes as are shown on the drawings or approved by the engineer, and all blocks exceeding such limits shall be rejected.

E. SHEET ASPHALT PAVEMENTS FOR ROADWAYS.

On Metal Floor Plates.

45. If the drawings indicate buckle, corrugated, or other form of metal floor plates as support, the sheet asphalt paving shall be laid directly upon such plates to a minimum thickness of four (4) inches, composed of a course of

asphalt binder filling the plates and to a minimum depth of two (2) inches over their highest parts, and an asphalt wearing surface two (2) inches in thickness.

On Concrete Floor Plates.

46. If the drawings indicate a concrete plate with or without imbedded metal as support, the sheet asphalt paving shall be laid directly thereon, composed of an asphalt wearing surface two (2) inches in thickness.

Concrete plates as support for the paving shall be laid between and over the steel floor system upon temporary wooden forms, in such manner and to such depth as may be shown on the engineer's general drawings, but in no case shall the minimum depth be less than four (4) inches.

Imbedded Metal.

47. If so indicated on the engineer's general drawings, such form of metal as may be so indicated—such as expanded sheet metal, wire mesh or rods—shall be imbedded in concrete plates and attached to the steel floor system in such manner as may be indicated on the general drawings or directed by the engineer.

Binder.

48. The binder course on metal floor plates shall consist of a concrete made of clean broken stone not exceeding one and one-fourth (1¼) inches in their largest dimensions, thoroughly screened and mixed with asphaltic cement of the quality hereinafter specified. The stone shall be heated by passing through revolving heaters, and thoroughly mixed with the asphaltic cement by machinery in the proportion of one (1) gallon of asphaltic cement per cubic foot of stone. The binder will be hauled to the work while still hot, carefully spread on the buckle plates with hot iron rakes to the thickness required, and immediately rammed and rolled with a five (5) ton roller until the least thickness above the highest point of the buckle plate is two (2) inches. The upper surface shall be made exactly parallel with the finished surface of the pavement.

Wearing Surface.

49. The pavement mixture forming the wearing surface of the pavement shall be composed of from twelve (12) to sixteen (16) parts of asphaltic cement as hereinafter specified, mixed with from sixty-seven (67) to seventy-three (73) parts of clean, sharp sand of approved quality, and

from fifteen (15) to seventeen (17) parts of pulverized carbonate of lime. These proportions may be varied somewhat if it shall appear to the engineer that better results will be obtained.

The sand and asphaltic cement shall be heated separately to about 300 degrees Fahr. The pulverized carbonate of lime, while cold, shall be mixed with the hot sand in the required proportion, and shall then be mixed with the asphaltic cement at the required temperature, and in the proper proportion, in an apparatus suited to effect a perfect mixture.

Laying.

50. The pavement mixture, when thus prepared, shall be laid on the foundation in two coats. The first, or cushion coat, shall contain two to four per cent more asphaltic cement than is given above, and shall be laid to such depth as will give a thickness of one-half (½) inch after being consolidated by a roller. The second, or surface coat, prepared as above specified, shall be laid on the cushion coat. It shall be brought to the ground in carts at a temperature of about 250 degrees Fahr., and shall then be carefully spread, by means of rakes, in such manner as to give a uniform and regular grade, and to such depth that, after having received its ultimate compression, it will have a thickness of one and one-half (1½) inches, and conform to the true grade and crown of the roadway as shown on the general drawings and specified on the first page hereof. The surface shall be compressed by a hand roller, after which a small amount of hydraulic cement shall be swept over it, and it shall then be thoroughly compressed by a heavy steam roller, the rolling being continued as long as it makes an impression on the surface.

Gutters.

51. The joints of the wearing surface with the curbs shall be poured with asphaltic cement, and the adjoining eighteen (18) inches of the wearing surface in each gutter shall be painted with said cement.

Car Tracks.

52. Where car tracks are provided on the structure, the pavement along the outer edge of each rail and between rails shall be laid as indicated on the engineer's general

drawings, or as may be directed by the engineer. If paving blocks are used they shall conform in every respect to the specifications above for block pavement. (See paragraph 44.) Special care shall be taken with the pavement at tracks and curbs to secure durability and a neat finish.

Expansion Points.

53. Paving at expansion points in the steel work shall receive such special treatment as may be indicated on the engineer's general drawings or directed by the engineer. Provisions for expansion in the pavement itself shall also be made if required, in such manner and at such points as the engineer may direct.

Asphalt.

54. Asphalt shall be equal, in the opinion of the engineer, to the best refined Trinidad Lake Asphalt, obtained direct from the Island of Trinidad. The asphalt shall be used without the admixture of coal tar or any other products or with bitumens of other kind or quality.

All asphalts shall be subject to the approval of the engineer and to such tests as he may require, and the contractor shall afford him free access to the works where the asphalt is treated or mixed, for the purpose of analyzing, and shall also supply him with such samples as he may require.

Petroleum Oil.

55. Heavy petroleum oil—the residuum obtained by distillation of petroleum—shall be free from water, light oils and other objectionable impurities, and of specific gravity of from 18 degrees to 23 degrees Beaumé, and shall bear a fire test of 250 degrees Fahr.

Asphaltic Cement.

56. Asphaltic cement shall be composed of 100 parts of asphalt, carefully refined and brought to a uniform standard of purity and gravity, mixed with from twelve (12) to fifteen (15) parts of heavy petroleum oil.

F. PLANK FLOORING FOR SIDEWALKS.

Plank.

57. Sidewalk flooring shall consist of plank of the kind specified on the first page hereof, surfaced on two sides to two and one-half (2½) inches thick. It shall be of a uniform width of four (4) inches, the edges straight and parallel from end to end. A variation of more than one-fourth (¼) inch in width will not be allowed.

How Laid.

58. Plank shall be laid perpendicular to the axis of the bridge with one-fourth (¼) inch open joints, and shall be spiked to nailing strips or wooden stringers with five (5) inch steel wire nails, at least two for each intersection.

The means of finishing sidewalk flooring at each end, at curbs and under railings, and the fitting around truss members, posts, etc., shall be as indicated on the engineer's general drawings, or as directed by the engineer, to secure at all points a durable, neat and workmanlike job.

Nailing Strips.

59. Nailing strips for steel stringers shall conform in all respects to the above specifications governing nailing strips for single thick roadway flooring. (See paragraph 13.) After the nailing strips are laid, and before the sidewalk planks are placed thereon, the tops of the strips shall be covered with two coats of coal tar, applied hot with swabs.

G. CEMENT PAVEMENTS FOR SIDEWALKS.

60. Cement pavements for sidewalks shall consist of a course of cinder concrete between and over the steel floor system, covered with a cement or granitoid wearing surface.

Concrete Base.

61. The cinder concrete forming the lower course shall be of the same materials as above specified for brick pavements. (See paragraphs 20, 21, 33, 34 and 35.) It shall be laid between and over the steel floor system upon temporary wooden forms, to such shape and depth as are shown on the engineer's general drawings, but in no case shall the minimum depth be less than three (3) inches. It shall be rammed solidly in place until moisture appears on the surface, and smoothed off on top exactly parallel to the finished surface of the sidewalk.

Imbedded Metal.

62. If so indicated on the engineer's general drawings, such form of metal as may be so indicated—such as expanded sheet metal, wire mesh or rods—shall be imbedded in the concrete, and attached to the steel floor system in such manner as may be indicated on the general drawings or directed by the engineer.

Wearing Surface.

63. After the concrete above described has thoroughly set the sidewalk surface shall be laid, with joints at such intervals as may be shown on the general drawings or directed by the engineer. This surface shall consist of two parts; first, a layer of one and one-half (1½) inches thickness; and second, a finishing layer of one-half (½) inch thickness.

First Layer.

64. The first layer shall be composed of three parts of crushed granite or stone to one part of Portland cement of the quality above specified for brick pavements. (See paragraph 33.) The crushed granite or stone shall be entirely free from dust or dirt, and shall consist of irregular, sharp edged pieces, so broken that each piece will not be greater than three-fourths (¾) inch in its greatest dimension.

The crushed granite or stone and the cement in the above mentioned proportions shall be first mixed dry, then sufficient clean water shall be slowly added by sprinkling and the material constantly and carefully stirred and worked until the whole is thoroughly mixed. This mass shall be spread on the foundation and rammed until the interstices are thoroughly filled with cement, and the layer conforms truly to the proper lines. Particular care shall be taken that this layer is well rammed and consolidated along the edges.

Second Layer.

65. After the first layer is complete, the finishing layer shall be added. This shall consist of a stiff mortar composed of equal parts of the cement above specified, and the sharp screenings of the crushed granite or stone, free from earthy or loamy substances, and laid to a depth of one-half (½) inch and carefully smoothed to an even surface, conforming to the true grades and slopes of the sidewalks as shown on the general drawings and specified on the first page hereof. This surface shall receive as a final operation before initial setting takes place, such division into blocks and such surface marking as may be directed by the engineer, and after the first or initial setting takes place, it must

not be disturbed by additional wetting. When the pavement is complete, it shall be covered for at least three days and be kept moist by sprinkling.

66. The pavement shall be fitted around truss members, posts, and against curbs and outside stringers in a neat and workmanlike manner, and to the satisfaction of the engineer.

H. CATCHBASINS.

67. Catchbasins or drains shall be placed as shown on the general drawings, and shall be of the kind, quality and design indicated thereon, and set as directed by the engineer. Paving in gutters near catchbasins or drains shall receive such special shapes or grades as the engineer may direct.

I. MAINTAINANCE GUARANTEE.

68. Whenever brick, Medina stone or asphalt pavements or cement sidewalks are laid, the contractor shall furnish a guaranty bond of one-third (1-3) the estimated cost of the paving. Said bond shall be duly executed before the final payment is made for the work specified in these specifications, and its conditions shall be that the contractor will, at his own cost and expense, keep and maintain and turn over to the owner the pavement in good condition for and in five (5) years after the completion of same; and that the contractor binds himself to repair the pavement during said five years, wherever and whenever and in the manner directed by the engineer or owner within five (5) days after receipt of written notice to that effect; and that, on the expiration of the guarantee period, all imperfections, covering, in all classes of pavement, all depressions, unevenness of surface or base, disintegration, cracks, rolls, chipped or cracked brick or stone and imperfect joints, shall be remedied as the engineer or owner shall direct.

The contractor shall leave the paving in good condition, and, until the owner or engineer shall finally accept the same in writing, the guaranty bond shall remain in full force.

III. WHEEL GUARDS AND CURBS.

Wheel Guards.

69. Unless otherwise shown on the general drawings wheel guards shall be six inches by eight inches (6″ x 8″) of the kind of wood specified on the first page hereof, and supported on blocks of the same kind of wood two and one-half (2½) inches high and eight (8) inches square, spaced four (4) feet on centers and provided with wrought iron washers under head and nut. The guard rail shall have corners chamfered as shown on the general drawings.

Curbs.

70. Curbs shall be composed of such material and so designed as to conform strictly with the general drawings. If stone curbing is used, it shall consist of the best quality of limestone not less than three and one-half (3½) feet long, five (5) inches wide, and of the depth shown on the drawings. It shall be neatly hammer dressed to a depth of at least ten (10) inches on the face next the gutter and three (3) inches on the back, the top to be dressed to a straight line and to a three-eighths (⅜) inch bevel in its width, and to a uniform thickness of five (5) inches. Each end shall be neatly dressed to a one-eighth (⅛) inch joint. It shall be laid carefully to a true line and bedded and backed in cement mortar.

IV. CAR TRACKS AND TROLLEY POLES.

Tracks.

71. When car tracks are required, provision shall be made for properly supporting and fastening rails of the dimensions and pattern shown on the general drawings. If the rails are to be furnished and laid by the contractor, they shall be subject to inspection by the engineer and shall be connected, fastened to the structure and adjusted for straightness to his satisfaction.

In all cases such provision as may be satisfactory to the engineer shall be made for the proper and free expansion and contraction of the rails.

Trolley Poles.

72. If trolley poles are to be furnished and placed in position on the structure by the contractor, or if provision is to be made by him for supporting and attaching same to the structure, the same will be shown and described on the engineer's general drawings and the pattern of poles and their location, or the nature and details of the supports, shall be in strict conformity with the plans furnished.

V. RAILINGS.

Handrail.

73. A substantial handrail not less than three and one-half (3½) feet high and of appropriate design shall be placed on the outside of footwalks, or, when footwalks are omitted, at the outside of the roadway, and drawings shall completely show the design and all sizes, together with the location and style of all posts and connections.

Posts.

74. Railings shall be fully supported and stayed at intervals not exceeding fifteen (15) feet by posts placed at panel points and at equal subdivisions of panels. Railings attached to trusses of through spans having a panel length greater than fifteen feet shall be provided with intermediate posts.

Adjustment.

75. All posts shall be so attached to the structure as to permit of adjustment both vertically and horizontally. When posts are attached to stringers, provision shall be made for the torsional strains produced in the latter by loads applied to the railing.

76. When railings continue from the bridge to posts on abutments or piers, such posts shall be rigidly secured and braced, and an expansion joint shall be provided in the railing at the end of the span.

VI. LIGHTING.

77. If so specified on the first page hereof, provisions shall be made by the contractor for lighting the structure, and the location and design of all posts and fixtures and the method provided for lighting shall be in strict conformity with the general drawings and the hereto appended special clauses covering the same.

VII. NAME PLATES.

78. Two name plates of suitable size and design, and which may be required to be of aluminum or of electro-bronze finish, shall be provided and securely fastened at points to be designated by the engineer. The plates shall be inscribed as directed by the engineer.

VIII. LOADS.

79. All parts of the structure shall be proportioned for the maximum stresses produced by the dead, temperature, wind, and traction loads; and by any combination of such of the following live loads as are specified on the first page of these specifications, for the structure herein referred to.

80. The dead load shall comprise the actual weight of the completed structure. **Dead Loads.**

In determining the dead load, the following unit weights shall be used:

Iron: 3.33 lbs. per lineal foot of bar of one square inch area.

Steel: 3.40 lbs. per lineal foot of bar of one square inch area.

Timber:	Creosoted . . .	5	lbs.	per	foot	Board Measure.
	Oak	4½	"	"	"	" "
	Yellow Pine . .	4	"	"	"	" "
	White Pine or Cedar	3	"	"	"	" "

Rails The actual weight specified.
Concrete: Stone, 125 lbs. per Cubic foot.
Cinder. 100 " " " "
Stone, 150 lbs. per cubic foot.
Brick, 125 " " " "
Sand, 100 " " " "
Asphalt, 90 " " " "

If provision is to be made for the future use of a permanent floor or paving on roadways, or sidewalks, or both, the dead loads assumed in all computations shall, unless otherwise directed, be based on the weights of such permanent floor or paving, and not on the material specified for present use.

Uniform Live Load.

(a) 81. For spans up to 150 feet long, 100 lbs. per square foot of roadway and 80 lbs. per square foot of sidewalks. For spans over 150 feet long, 80 lbs. per square foot of both roadway and sidewalks.

(b) 82. For spans up to 150 feet long, 80 lbs. per square foot of both roadway and sidewalks. For spans over 150 feet long, 60 lbs. per square foot of both roadway and sidewalks.

Concentrated Live Loads.

(a) 83. A steam road roller weighing 35,000 lbs., arranged as follows: 15,000 lbs. on forward roll and 10,000 lbs. on each rear roll; axles eleven feet apart, forward roll four feet face, rear rolls each twenty inches face, rear rolls five feet center to center.

(b) 84. A steam road roller weighing 21,000 lbs., arranged as follows: 9,000 lbs. on forward roll and 6,000 lbs. on each rear roll; axles eleven feet apart, forward roll four feet face, rear rolls each twenty inches face, rear rolls five feet center to center.

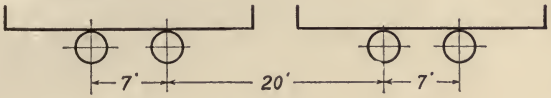
(c) 85. A single horse roller weighing 12,000 lbs., the roll five feet face.

Unit stresses may be increased twenty-five per cent. (25%) for the road rollers, but concentrated loads shall not be considered as distributed over two or more stringers, except when such distribution unquestionably occurs.

If a paved floor of sufficient width be used, the rollers shall be considered when turned at right angles to the axis of the bridge.

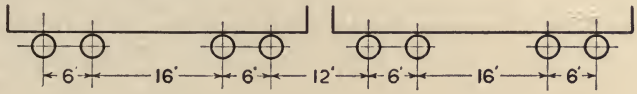
(d) 86. A wagon load of 10,000 lbs. on two axles eight feet apart, wheels five feet gauge.

(e) 87. Two four-wheeled electric motor cars on each track, weighing 30,000 lbs. each, arranged as shown by the following diagram:



Axle load 15,000 lbs.

(f) 88. A train of eight-wheeled electric motor cars on each track, weighing 50,000 lbs. each, arranged as shown by the following diagram.

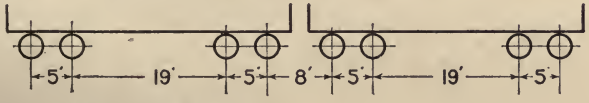


Axle load 12,500 lbs.

(g) 89. A train of eight-wheeled electric motor cars on each track, weighing 80,000 lbs. each, arranged as shown by the above diagram.

Axle load 20,000 lbs.

(h) 90. A train of coal cars of 60,000 lbs. capacity, arranged as shown by the following diagram:



Axle load 23,000 lbs.

Impact Stress.

91. To provide for the effects of impact and vibration, there shall be added to the sum of the dead and live load stresses in each member, and in all joints and connections thereof, an impact stress to be computed by the following formula:

$$I = L \frac{L}{L + D}$$

Where I = Amount of impact stress.
" L = Stress due to live load considered as a static load.
" D = " " " dead load.

Temperatnre Stresses.

92. Where the effect of a variation of 150 degrees F., is to produce stresses in the structure, the maximum of such stresses in each member shall be provided for.

Wind Pressure.

(a) 93. A pressure of 30 lbs. per square foot on the surface of all trusses, railings, posts and bracing of towers, and on the vertical projection of the floor system; and in addition a moving load of 180 lbs. per lineal foot of bridge.

(b) 94. A pressure of 50 lbs. per square foot of exposed surface of all trusses, railings, posts and bracing of towers; and on the vertical projection of the floor system, the structure being considered as delivered.

95. The wind pressures assumed in the calculation shall be considered as acting upon the largest exposed surface, and the greatest results shall be taken in proportioning the parts.

96. The stresses in the chords and end posts of trusses, and the posts of towers, due to wind pressure, need not be considered except:

1st. When the stress per square inch in any member due to wind pressure exceeds one-fourth of the combined stresses from other causes except wind, in which case, the excess of wind stress over one-fourth the combined stress from other causes shall be provided for.

2nd. When the stresses due to wind pressure can cause reversal of stress in a member, in which case such reversal shall be provided for.

Traction Load.

97. In the case of bridges designed to carry electric motors, a traction force equal to 20 per cent of the live load shall be provided for.

IX. UNIT STRESSES.

All parts of the structure shall be proportioned by the following unit stresses:

98. Wrought iron . . . . . 18,000 lbs. per sq. in. **Tension.**
Soft steel . . . . . 20,000 " " " "
Medium steel . . . . . 22,000 " " " "

99. Members with square bearings at both ends, $\dfrac{C}{1+\dfrac{l^2}{36{,}000\,r^2}}$ " " " **Compression.**

Members with square bearings at one end and pin bearings at the other, $\dfrac{C}{1+\dfrac{l^2}{24{,}000\,r^2}}$ " " "

Members with pin bearings at both ends, $\dfrac{C}{1+\dfrac{l^2}{18{,}000\,r^2}}$ " " "

In which C = 18,000 for wrought iron.
" C = 20,000 " soft steel.
" C = 22,000 " medium steel.
" l = length between supports in inches.
" r = least radius of gyration in inches.
" l/r shall not exceed { 125 for main members and / 150 " subordinate members.

Values of $\dfrac{l^2}{r^2}$ may be taken from Osborn's Tables.

100. Pins, closely packed, Medium steel, 25,000 lbs. per sq. in. **Bending.**

101. Pins . . . . . 22,000 lbs. per sq. in. **Bearing.**
Rivets . . . . . 20,000 " " " "

102. Pins and rivets . . . . . 10,000 " " " " **Shearing.**

Girder Flanges.

103. The compression flanges of plate girders and floor beams will be given the same gross area as the tension flanges.

104. Bending in pins will be calculated from distances between centers of bearing.

Pins and Rivets.

105. In deducting rivet holes to obtain the net section of riveted tension members, the rivet hole shall be taken with a diameter one-eighth (⅛) inch larger than the undriven rivet for rivets with full heads, and one-fourth (¼) inch larger for countersunk rivets.

106. The bearing surface of pins and rivets shall be taken on the diameter and not on the semi-circumference.

107. The effective diameter of the driven rivet shall be considered the same as the diameter before driving.

108. In calculating the resistance of rivets to shear and bearing, rivets countersunk in plates less than three-eighths (⅜) inches thick shall not be considered as taking any of the stress from or into that plate.

109. In plates three-eighths (⅜) inch to five-eighths (⅝) inch thick, inclusive, they shall be counted at half value, and for plates over five-eighths (⅝) inch thick, at full value.

110. Field connections shall have at least twenty-five (25) per cent excess of rivets, unless driven by power.

Alternate Stresses.

111. Members subjected to alternate tensile and compressive stresses shall be designed to resist either, and shall have twenty-five (25) per cent excess of strength in their joints and connections.

Combined Stresses.

112. Members subjected to combined bending and direct stresses must be proportioned for the combined stresses.

Timber.

113. The timber parts of the structure shall be proportioned by the following unit stresses, given in pounds per square inch:

CLASS.	SPECIES.	TRANSVERSE LOADING.	END BEARING.	SHORT COLUMN $l<12d$	BEARING ACROSS FIBRE.	SHEAR ALONG FIBRE.
1	White Oak	1400	1300	1000	550	300
2	Long Leaf Pine.	1600	1300	1000	350	200
3	White Pine	1100	900	700	200	150
4	Hemlock	950	850	650	200	100

Timber Columns.

114. Columns whose length exceeds 12 times their least side, shall be proportioned by the following formula:

$$\frac{C}{1 + \frac{l^2}{1{,}000\, d^2}}$$

Where C = Unit stress as given above for short columns.
" l = Length of column between supports, in inches.
" d = Least side of column, in inches.

X. DETAILS OF CONSTRUCTION.

A. CLEARANCES.

Through Bridges.

115. For all through bridges, there shall be a clear head-room above the floor not less than the amount specified on the first page of these specifications and shown on plans; but in no case shall the clear head-room be less than fourteen (14) feet. Knee braces may extend below this limiting height.

Roadway and Walks.

116. Whenever the width of roadway or sidewalks is mentioned, the clear width shall be understood.

Over Tracks, Channels, etc.

117. All clearances shown on the general drawings, for head-room over tracks, clear spans or heights over channels, roadways or other properties shall be strictly adhered to and no part of the structure shall encroach on same.

B. TENSION MEMBERS.

118. Long vertical tension members will preferably be stiffened.

Eye Bars.

119. Heads of eye bars shall be so proportioned as to develop the full strength of the bar. The heads shall be formed by upsetting and forging, and in no case will welding be allowed.

120. Eye bars must be perfectly straight before boring, and bars working together shall be piled and clamped together and bored in one operation.

121. Eye bars shall not be less than five-eighths (⅝) inch thick, and preferably not less than one-fifth (1-5) the width of the bar.

Riveted Tension Members.

122. Riveted tension members shall have an excess of section of twenty-five (25) per cent through pin holes and net section at all other points. Pin plates shall also be proportioned for bearing on pins. The material back of pin shall be proportioned for double shear, using for working length the distance from back of pin to end of plate. But the length of plate back of pin shall not be less than two and one-half (2½) inches.

Rods.

123. All rods with screw ends shall be upset at the ends, so that the area at the root of the thread shall exceed by seventeen (17) per cent the area of the rod.

124. All rods with welded heads must be of wrought iron.

Loop Eyes.

125. When loop eyes are used, the loop must be so designed as to develop the full strength of the bar.

C. COMPRESSION MEMBERS.

Compression Members.

126. Compression members shall not exceed in length 125 times the least radius of gyration for main members, and

150 times the least radius of gyration for subordinate members.

"Main Members" shall include all elements of trusses, posts of towers or bents, and all other members directly acted upon by the live load.

"Subordinate Members" shall include lateral systems, sway bracing, and all other members not directly acted upon by the live load.

127. The several segments or parts of a compression member shall be proportionately as strong as the members taken as a whole.

128. The unsupported width of plate subjected to compression shall not exceed forty-five (45) times its thickness, nor shall the distance between supports in the line of the stress exceed sixteen (16) times its thickness.

Abutting Ends.

129. Abutting ends shall be planed true and square, and no reliance shall be placed upon splice plates. They shall, however, be spliced on all sides, when practicable, by suitable splice plates taking not less than two rows of rivets.

Pin Plates

130. Compression members which are reduced in section by pin holes, must be reinforced by pin plates when the stress per square inch of cross section through the pin hole exceeds that allowed by the unreduced compression unit stress. The length of pin plates back of pins shall not be less than two and one-half (2½) inches.

Lacing.

131. The open sides of compression members shall be stayed by stay plates at the ends, and by diagonal lace bars at intermediate points.

Stay Plates.

132. Stay plates shall have a thickness of not less than one-fortv-fifth (1-45) the unsupported width. They shall generally be not less than nine (9) inches wide, nor less than the least width of the member, nor less then two-thirds (2-3) their own length.

By width of stay plate is meant the dimension parallel to the axis of the member.

Lace Bars.

133. Lace bars shall have a thickness not less than one-forty-fifth (1-45) the unsupported length. They shall be inclined at an angle of not less than 60 degrees with the axis of the member for single lacing, or 45 degrees for double lacing. In this lattter case, they shall be riveted at their intersections and their thickness shall not be less than one-thirty-fifth (1-35) of the distance between end and center rivets.

134. The width of lace bars attaching to two-inch flanges or under, shall be two (2) inches. For flanges varying between two and four inches, it shall be two and one-half (2½) inches. For wider flanges it shall be increased proportionately.

135. When lace bars of a greater thickness than seven-sixteenths (7-16) inch are required, angles shall be substituted.

D. FLOOR SYSTEM.

Floor System

136. The floor system shall be composed of floor-beams and stringers in conformity with the engineer's general drawings, and the methods of fastening the floor or of supporting the pavement, on both roadway and sidewalks, shall conform in all respects to the details shown thereon.

Floor-beams.

137. Floor-beams shall be of rolled or built sections. They shall, in all important truss spans, be riveted to posts. In all cases where hangers are used, they shall be of plates or shapes, and the beams shall be properly secured against rotation.

Stringers.

138. Stringers shall be of rolled or built sections or of such kind of wood as may be shown on the engineer's general drawings and specified on the first page hereof. Iron or steel stringers shall in all cases be provided directly under rails on bridges designed to carry car tracks.

139. Iron and steel stringers shall preferably be riveted to floor-beam webs. If they rest on the floor beams they shall be securely fastened to the flanges thereof.

140. Wooden stringers shall not be less than three (3) inches in thickness. They shall be dapped over supports to bring the tops to a true level. Where stringers rest on top flanges of floor beams, those of each line shall be lapped by each other over each floor-beam to secure a bearing on the full width of the flange for each stringer. Lapping stringers shall be separated by a space of at least one-half (½) inch. When the depth of wooden stringers exceeds four (4) times their thickness, they shall be bridged at intervals not to exceed eight (8) feet with 2″x4″ bridging pieces, each fastened with two ten penny nails at each end.

141. If the drawings indicate buckled, corrugated or other form of metal floor plates as support for the paving, such plates shall be of such material and design as are so indicated and specified on the drawings.

142. Provisions satisfactory to the engineer shall in all cases be made for draining metal floor plates at all points.

143. The upper surfaces of all metal floor plates shall be given a thorough coating of asphalt of a quality satisfactory to the engineer, applied hot with swabs or brushes, before any concrete or binder is laid; this asphalt to take the place of the last field coat of paint as specified for the rest of the structure.

E. LATERAL SYSTEM.

144. The attachment of the lateral system to the chords shall be thoroughly efficient. Preference will be given to a system of bracing capable of resisting compression as well as tension. Connections.

145. When practicable, the lateral system in the plane of the oor shall consist of angles attached to trusses by means of gusset plates.

146. Connections for members made of angles shall be sufficient to develop the full strength of the angles, in accordance with the unit stresses given above.

Eccentric Connections.

147. Laterals shall be as nearly in the planes of the centers of chords as practicable, and when eccentricity is unavoidable, all secondary or bending stresses shall be duly provided for.

Portals.

148. Portals shall be as deep as the allowable head room will permit. They shall consist of a top and bottom flange or strut and stiff intermediate bracing.

149. Portals must be carefully designed and all connections thoroughly efficient.

150. Knees or corner braces shall be used at the bottoms of all portals. Preference shall be given to curved braces.

Intermediate Struts.

151. Top intermediate struts in through bridges shall have a depth not less than that of the top chord, and a ratio of length to least radius of gyration of not more than 150.

Sub Struts.

152. When the distance between top of floor and under side of top strut exceeds twenty-five (25) feet, sub-struts shall be used between the vertical posts, at an elevation sufficient for the allowable head room, and diagonal bracing, preferably consisting of angles, shall be used between the upper and lower struts.

Knee Braces.

153. Knee braces shall be used at all vertical posts when the distance between top of floor and under side of top strut does not exceed twenty-five (25) feet.

Sway Braces.

154. Deck bridges shall have diagonal sway bracing at each post, of the full depth of the truss, and preferably consisting of angles and capable of resisting either tension or compression. Ample provision shall be made at the ends of spans for conveying all wind forces to the piers.

End Struts.

155. Bottom end struts shall be provided for all spans, either deck or through.

F. RIVETING.

Spacing.

156. Rivets shall generally be three-fourths (¾) inch and seven-eighths, (⅞) inch diameter. The pitch shall

never be less than three diameters, and, when practicable, not less than four diameters. It shall not exceed six (6) inches nor sixteen (16) times the thinnest outside plate.

157. The distance from center of hole to the nearest edge of any piece shall, when practicable, be not less than one and one-fourth (1¼) inches for three-fourths (¾) inch rivets, and not less than one and one-half (1½) inches for seven-eighths (⅞) inch rivets. It shall not exceed eight (8) times the thickness of the thinnest outside plate.

158. At ends of compression members the pitch of rivets shall not exceed four diameters for a length equal to twice the depth of the member.

159. Tension on rivets shall be avoided whenever possible.

160. Rivet holes shall be accurately spaced, so that when members are brought into position the holes shall be truly opposite before rivets are driven. Drifting will under no circumstances be allowed.

For conventional signs for rivets on drawings, see Appendix.

G. RIVETED WORK.

161. Riveted work shall be either first or second class as may be shown in the engineer's general drawings, and specified on the first page hereof; and for either class specified, the work shall be done strictly according to the following specifications covering the respective class of work selected.

(a) FIRST CLASS RIVETED WORK.

162. All holes in **both tension and compression members** of all thicknesses less than three-fourths (¾) inch shall be punched full size. Iron.

163. All holes in **both tension and compression members** of all thicknesses three-fourths (¾) inch or greater shall be drilled from the solid.

Soft Steel.

164. All holes in **tension members** of all thicknesses less than three-fourths (¾) inch shall be either punched one-eighth (⅛) inch smaller than the rivet required and reamed to one-sixteenth (1-16) inch larger, or they may be drilled from the solid.

165. All holes in **tension members** of all thicknesses three-fourths (¾) inch or greater shall be drilled from the solid.

166. All holes in **compression members** of all thicknesses less than three-fourths (¾) inch shall be punched full size.

167. All holes in **compression members** of all thicknesses three-fourths (¾) inch or greater shall be drilled from the solid.

Medium Steel.

168. All holes in **both tension and compression members** of all thicknesses less than three-fourths (¾) inch shall be either punched one-eighth (⅛) inch smaller than the rivet required and reamed to one-sixteenth (1-16) inch larger, or they may be drilled from the solid.

169. All holes in **both tension and compression members** of all thicknesses three-fourths (¾) inch or greater shall be drilled from the solid.

(b) SECOND CLASS RIVETED WORK.

Iron

170. All holes in **both tension and compression members** of all thicknesses less than three-fourths (¾) inch shall be punched full size.

171. All holes in **both tension and compression members** of all thicknesses three-fourths (¾) inch or greater shall be drilled from the solid.

Soft Steel.

172. All holes in **both tension and compression members** of all thickness less than three-fourths (¾) inch shall be punched full size.

173. All holes in **both tension and compression members** of all thicknesses three-fourths (¾) inch or greater shall be drilled from the solid.

174. All holes in **both tension and compression members** shall be treated the same as for Medium Steel in First Class Riveted Work. (See paragraphs 168 and 169.) Medium Steel.

(c) GENERAL CLAUSES.

175. Reamed work is not required for lace bars, transverse, diagonal or lateral bracing, except to make holes true and square to members.

176. When plates are drilled as assembled, they must be separated after being drilled and cleaned of chippings forced between them by the drill. The square shoulders of all rivet holes under rivet heads must have a fillet of at least one-thirty-second (1-32) inch neatly removed.

177. Every built member or girder must be true and out of wind, neatly finished to length, and field driven rivets of all main girder connections shall be laid out with templates and accurately drilled so as to pass the rivets cold.

178. Power riveting shall be used wherever possible. All rivets must have neatly capped full heads. Tightening loose rivets by recupping or "setting up" will not be allowed; they must be cut out and redriven, whether in shop or field. Rivets must be properly heated and driven to completely fill the holes. No loose rivets allowed.

179. All bolts must be of neat length and have a washer under head and nut when they are in contact with wood. Washers and nuts shall have a uniform bearing. All nuts shall be easily accessible with a wrench for the purpose of adjustment, and shall be effectively checked after the final adjustment. Rivets shall be used in preference to bolts to resist shearing stresses. When bolts are unavoidable they must be turned to a driving fit and have a washer under each and every nut. Bearing on threads will not be allowed. Bolts.

H. TRUSSES.

Trusses.

180. Trusses shall be of such form that the stresses in each member can be accurately computed. For spans under one hundred (100) feet, trusses will be generally of riveted construction throughout. For spans over one hundred (100) feet, they will be generally pin connected.

Length of Span.

181. In calculating stresses, the length of span shall be understood to be the distance between centers of end pins.

Depth.

182. The depth center to center of chords shall generally be not less than one-eighth (⅛) of the span.

Camber.

183. Trusses shall have just sufficient camber to bring the joints of the compression chord to a true square bearing when the truss is fully loaded. Each member of the truss shall be lengthened or shortened in proportion to the stress to which it is subject under a full dead and a full live load, so that under the full loading each member will be strained to its normal length.

I. PLATE GIRDERS.

Length of Span.

184. In calculating stresses, the length of span shall be understood to be the distance between centers of end bearing plates.

Depth.

185. The depth, which shall preferably be not less than one-twelfth (1-12) of the span, shall be understood to be the distance between the centers of gravity of the top and bottom flanges, unless this distance is greater than the distance back to back of flange angles, in which case the latter will be taken as the effective depth.

In calculating flange rivets at ends of girders, the effective depth shall be taken from center to center of rivet lines.

Flanges.

186. Flanges of plate girders must be proportioned to resist the entire bending moment, except when the web is made in one length or fully spliced to resist bending stresses, in which case one-sixth (1-6) of the area of cross section of the web plate may be considered as effective flange area.

187. Flange plates and angles must be nearly uniform in thickness and shall decrease in thickness from the angles outward. The thickness of flange angles in compression shall not be less than one-thirtieth (1-30) of the total width of flange.

188. Flange plates shall extend at least a foot beyond their theoretical lengths at each end.

189. If practicable, flanges shall not be spliced, but if splicing is unavoidable, they must be fully and properly spliced.

190. The top flange shall be stayed transversely at intervals not exceeding twenty-five (25) times the width.

191. The webs of plate girders shall be proportioned to resist the entire shear. **Web.**

192. Where web splices are necessary, the web shall be spliced by a plate on each side. These splice plates shall each be at least three-fourths (¾) as thick as the web and shall be wide enough to take two rows of rivets on each side of splice.

193. When the shear per foot of vertical depth of girder exceeds the safe shear given by the formula:

$$\frac{20{,}000 \times 12\,t}{1+\frac{d^2}{3{,}000\,t^2}}$$

in which t = thickness of web in inches.
" " d = clear distance between flanges in inches,
the web shall be stiffened by pairs of angles sufficiently close to conform to the formula.

194. The thickness of webs and web splices of floor-beams and main girders shall not be less than five-sixteenths (5-16) inch.

Rivet Spacing.

195. Rivets in flanges shall be spaced sufficiently close to take the increment of flange stress at the successive points. At the ends of the span the rivets must transmit the entire end shear into each flange within a distance equal to the depth between rivet lines of the flanges; but the minimum and maximum spacing of rivets shall be observed, and the web shall be made sufficiently thick to withstand the bearing of the rivets.

J. ROLLED BEAMS.

Beams.

196. Rolled I-beams and channels shall preferably have a depth of not less than one-fifteenth (1-15) the length between centers of support.

K. TOWERS AND BENTS.

Towers.

197. At points shown on plans or approved by the engineer, bents shall be united to form towers. Each tower thus formed shall be thoroughly braced in all directions.

198. Each tower shall have sufficient base, longitudinally, to be stable, when standing alone, without other support than its anchorage, and must be designed to withstand any longitudinal thrust that may be brought upon it, due to the starting or stopping of the specified live loads, co-efficient of friction being taken at twenty (20) per cent.

Columns.

199. Tower columns shall be designed in accordance with clauses covering compression members given above.

200. Columns shall, if possible, be made of segments of one length. When splicing is unavoidable, the segments shall be fully spliced.

201. All columns shall be securely anchored against possible tension by approved bolts.

202. In high towers the columns shall have a uniform batter transversely, sufficient to nearly or quite prevent tension at the base under the greatest wind force specified, either during erection or after completion.

Bracing.

203. Bracing in bents or towers shall preferably be made of angles or other stiff shapes. Preference will be given to that form of bracing which is capable of withstanding either tension or compression.

L. GENERAL.

Minimum Sizes.

204. Unless otherwise noted on the engineer's general drawings, no metal less than five-sixteenths (5-16) inch thick shall be used except for fillers, railings, crestings, and other minor parts of the structure, nor shall any rod have an area less than three-fourths (¾) of one square inch.

Center of Gravity.

205. The resultant stress in each member must coincide with its center of gravity, or the members must be proportioned for the additional stress induced by reason of the eccentricity.

Pins.

206. Pins must be straight and turned accurately to size, the ends to be turned to a smaller diameter for the thread, and must be driven to place by the use of pilot nuts.

207. Recessed hexagon nuts, or plain hexagon nuts with wrought washers one-half (½) inch thick, may be used at the option of the bidder; nuts and washers to have a full, uniform bearing, and wrought washers, if used, to fit the pin with not more than one-sixteenth (1-16) inch play.

208. The diameter of pin shall not be less than three-fourths (¾) the width of the widest eye bar attaching to it.

209. The several members attaching to a pin shall in general be packed so as to produce the least bending moment upon the pin, and all vacant spaces must be filled with filling rings.

Pin Holes.

210. All pin holes must be bored exactly perpendicular to the center lines of stress, out of wind, and not more than one-thirty-second (1-32) inch larger than the diameter of the pin.

Shoes.

211. Shoes shall be securely stayed against upward or side motion by anchor bolts of approved diameter and length.

See Paragraph 265 concerning furnishing and setting anchor bolts

Bed Plates.

212. Bed plates shall be of such size that the pressure per square inch upon the masonry shall not exceed four hundred (400) pounds per square inch. The thickness shall be such that the pressure will be distributed uniformly throughout the plate.

213. Bed plates and bearing plates shall be truly planed on all sliding surfaces.

Sheet Lead.

214. All bed and bearing plates on masonry shall be set on sheet lead not less than one-eighth (⅛) inch in thickness and the full size of the plate. Sheet lead shall be furnished and set by the contractor for superstructure.

Rollers.

215. For spans over seventy-five (75) feet in length, expansion ends shall be provided with nests of friction rollers upon which the pressure per lineal inch of roller shall not exceed 600d, "d" being the diameter of the roller in inches. The roller shall be protected as much as possible by a suitable casing, from dust and foreign matter.

Rollers smaller than three (3) inches in diameter will not be allowed.

Drainage.

216. Wherever there is a tendency for water to collect, the spaces must be drained or filled with waterproof material.

Expansion Points.

217. At all points indicated on the engineer's general drawings satisfactory provisions shall be made for the full and free expansion and contraction of all parts of the structure. All stringers, curbs, pavements, hand rails, street car rails and in fact, all members and material shall be specially designed to insure unobstructed movement.

218. Full details of all expansion joints shall be submitted to the engineer for his approval.

XI. QUALITY OF MATERIAL.

A. WROUGHT IRON.

Manufacture.

219. Wrought iron shall be made by the puddling process or rolled from fagots or piles made up from No. 1 wrought iron scrap, alone or with muck bar added.

Physical Properties.

220. The minimum physical qualities required shall be as follows:

Tensile strength, pounds per sq. inch	48,000
Yield point, pounds per sq. inch	25,000
Elongation, per cent. in 8 inches	20

221. In sections weighing less than 0.654 pounds per lineal foot the percentage of elongation required shall be 15 per cent.

Cold Bending Tests.

222. Cold bending tests shall be made on specimens cut from the bar as rolled. The specimen shall be bent through an angle of 180 degrees by a succession of light blows.

Nicking Test.

223. When nicked and bent, it shall show a generally fibrous fracture, free from coarse crystalline spots. Not over 10 per cent of the fractured surface shall be granular.

Hot Bending Tests.

224. Hot bending tests shall be made on specimens cut from the bar as rolled. The specimens, heated to a bright red heat, shall be bent through an angle of 180 degrees by a succession of light blows and without hammering directly on the bend.

225. If desired, a bar shall be worked and welded in the ordinary manner without showing signs of red-shortness.

Yield Point.

226. The yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

Finish.

227. All wrought iron must be practically straight, smooth, free from cinder spots or injurious flaws, buckles, blisters or cracks. As the thickness of bars approaches the

maximum that the rolls will produce the same perfection of finish will not be required as in thinner ones.

In flat and square bars one thirty-second (1-32) inch variation either way from the size ordered will be allowed.

In round iron one one-hundreth (1-100) inch variation either way from the size ordered will be allowed.

B. CAST IRON.

228. Castings shall be of tough, gray iron, free from injurious cold shuts or blow holes, and of smooth, workmanlike finish.

One sample bar, one inch square, about five feet long, cast in sand mould, shall be furnished from each cast. This sample bar shall be capable of sustaining on a clear span of four and one-half (4½) feet, a central load of 500 pounds when tested in the rough bar.

C. STEEL.

Kind.

229. All steel used shall be open hearth, made at works of established reputation which have been successfully manufacturing steel for at least one year.

Acid Open Hearth.

230. If made in an acid furnace, the amount of phosphorus and sulphur in the finished product shall not exceed eight one-hundredths (.08) of one per cent and six one-hundredths (.06) of one per cent respectively.

Basic Open Hearth.

231. If made in a basic furnace, the amount of phosphorus and sulphur shall not exceed six one-hundredths (.06) of one per cent, and five one-hundredths (.05) of one per cent respectively.

Test Pieces.

232. The tensile strength, elastic limit, elongation and reduction of area shall be determined from a standard test piece cut from the finished material and planed or turned parallel for at least ten (10) inches of its length, the piece to have as nearly one-half (½) square inch sectional area as practicable, and the elongation to be measured on an original length of eight (8) inches.

Specimens for bending tests shall be cut from the finished section and shall be of the same form as those used for tensile tests.

Number of Tests.

233. Three specimens, two for tensile tests and one for bending test, shall be furnished from each melt, except where a melt is rolled into widely varying sections, when each of such widely varying sections shall be represented by at least one test.

Where only a small portion of a melt is rolled into the order covered by these specifications, it is left to the discretion of the engineer or his authorized representative to reduce the number of tests.

If the manufacturer so desires, the bending tests may be made on the broken tensile test pieces instead of on specimens as specified above.

Full Size Test.

234. Eye-bars shall be of medium steel. Full-sized tests shall show twelve and one-half (12½) per cent elongation in fifteen feet of the body of the eye-bar, and the tensile strength shall not be less than 55,000 pounds per square inch. Eye-bars shall be required to break in the body, but should an eye-bar break in the head, and show twelve and one-half (12½) per cent elongation in fifteen feet and the tensile strength specified, it shall not be cause for rejection, provided that not more than one-third (1-3) of the total number of eye-bars tested break in the head.

Grades.

235. Steel shall be of three grades: medium, soft and rivet.

Medium Steel.

236. Specimens from finished material, cut to size specified above, shall have an ultimate tensile strength of not less than 60,000 nor more than 70,000 pounds per square inch; an elastic limit of not less than 35,000 pounds per square inch; and an elongation of not less than twenty-two (22) per cent.

This grade of steel to bend cold 180 degrees over a mandrel, the diameter of which is equal to the thickness of the piece tested, without a crack or flaw on the outside of the bent portion.

Soft Steel.

237. Specimens from finished material, cut to size specified above, shall have an ultimate tensile strength of not less than 52,000 nor more than 62,000 pounds per square inch; an elastic limit of not less than 32,000 pounds per square inch; and an elongation of not less than twenty-five (25) per cent.

This grade of steel must stand bending cold 180 degrees and close down flat on itself without sign of fracture on convex side of curve.

Rivet Steel.

238. Specimens cut to size specified above shall have an ultimate tensile strength of not less than 50,000 nor more than 60,000 pounds per square inch; an elastic limit of not less than 30,000 pounds per square inch; and an elongation of not less than twenty-six (26) per cent.

Chippings and Alterations.

239. All blooms, billets or slabs shall be examined for surface defects, flaws or blow holes before being rolled into the finished sections, and such chippings and alterations made as will insure solidity in the rolled sections.

Branding.

240. Every finished piece of steel shall be stamped with the melt number, and steel for pins shall have the melt number stamped on the ends. Rivets and lacing steel, and small pieces for pin plates and stiffeners, may be shipped in bundles, securely wired together, with the melt number on a metal tag attached.

Chemical Analysis.

241. The chemical analysis for carbon, phosphorus and sulphur of each melt must be furnished to the engineer or his representative at the mill, before any of the material rolled from said melt is shipped from the mill.

Finish.

242. Finished material must present a smooth, clean surface, free from buckles, flaws, cracks, ragged edges, or any other defects, and must be straight throughout and true to section.

Variation in Weight.

243. A variation of more than two and one-half (2½) per cent from ordered weight will be considered cause for rejection.

For all plates ordered to gauge, there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

THICKNESS OF PLATE. Inch.	WIDTH OF PLATE.		
	Up to 75 inches. Per cent.	75 to 100 inches. Per cent.	Over 100 inches. Per cent.
1/4	10	14	18
5/16	8	12	16
3/8	7	10	13
7/16	6	8	10
1/2	5	7	9
9/16	4½	6½	8½
5/8	4	6	8
Over 5/8	3½	5	6½

244. Shipments of material from the mills will not be permitted until after the tests have been made. Copies of all shipping invoices must be furnished to the engineer or his representative at the mill as shipments are made. **Shipments.**

D. CAST STEEL.

245. Steel castings shall be made of a first class quality of open-hearth steel, sound, smooth, true to pattern, and free from blow-holes, flaws and warps. All steel castings shall be thoroughly annealed at a temperature sufficiently high to make a blue scale, and when tested in three-quarter (¾) inch round turned test pieces, cut from castings, or from extensions cast to the castings, shall show an ultimate strength of from 65,000 to 75,000 pounds per square inch, and an elongation of not less than fifteen (15) per cent in two (2) inches, and including the break.

E. PAINT.

246. All paint for use in the "first coat" shall be of the best quality of Graphite paint or of Carbon Primer, of a manufacture acceptable to the engineer. **Quality of Paint.**

247. All paint for use in the "finish coats" shall be of a quality and color to be determined by the engineer.

Inaccessible Surfaces.

248. All surfaces that are inaccessible after being riveted, or after erection, shall have, before assembling or before erection, two (2) coats of pure red lead and boiled linseed oil, mixed in the proportion of eighteen (18) lbs. of lead to one (1) gallon of oil.

All bolts which are to remain permanently in the structure are to be dipped in "first coat" as described above.

First Coat.

249. As soon as shop work is complete, the material shall be thoroughly cleaned from all scale, rust, grease, or other foreign matter, and given one coat of "first coat," as described above.

Erection Marks.

250. Erection marks shall be made on the painted surface and not on the bare metal and then oiled over.

Retouching for Finish Coats.

251. After erection and before applying the finish coats, the material shall again be retouched and field rivets shall be painted with the "first coat," as described above; the field rivets shall be painted as soon as practicable after driving.

Finishing Coats.

252. All metal work shall, after erection, be thoroughly cleansed from mud, grease, or any other objectionable material that may be found thereon (wire brushes or scrapers shall be used when necessary, or required by the engineer), and painted with two (2) coats of "finish coat," as specified above.

No painting will be allowed in wet or freezing weather, and all surfaces must be dry when paint is applied.

Turned and Planed Surfaces.

253. All turned or planed surfaces shall be coated with a mixture of white lead and tallow before being exposed to the weather.

Copies of Orders.

254. All paint and oil used for the structure shall be especially purchased, and the contractor will furnish the engineer with copies of all orders for same; and until such copies have been received by the engineer, no paint shall be applied.

F. TIMBER.

255. All timber shall be of the best quality of the kind specified, cut from sound, live timber, free from loose or rotten knots, worm-holes, wind shakes or splits, reasonably well seasoned, straight-grained, square-edged, and free from any defect calculated to impair its strength or durability. Sap wood shall not be allowed in more than ten (10) per cent of the pieces of one kind, and no piece will be accepted showing sap covering more than one-fourth (¼) the width of the piece on any face at any point, nor more than half the thickness of any plank at its edge, at any point. **Timber.**

XII. WORKMANSHIP.

256. All workmanship must be strictly first class. **Workmanship.**

257. All members that may be become bent or in any way injured in transportation or erection, or from any cause, must be repaired, straightened, and made good to the satisfaction of the engineer.

258. All plates and shapes shall be carefully straightened before the work is laid out, and all work must be finished in a neat and workmanlike manner. The edges of sheared steel plates in main members shall be carefully faced or planed to effectively remove defects caused by shearing.

259. No forging or other work must be performed on any material at a temperature as low as a blue heat, and all steel forged work must be afterward thoroughly and uniformly annealed by heating throughout to a uniform dark-red heat and being allowed to cool slowly. **Annealing**

260. Due regard must be had for the neat and attractive appearance of the finished structure; and details of workmanship of an unsightly character will not be allowed. **Appearance.**

XIII. INSPECTION AND TESTS.

Mill and Shop Inspection.

261. All material shall be subject to inspection at mills and shops during the various processes of manufacture, and free access must be permitted for the engineer or his inspectors at any works where material is in process of manufacture. A notice of at least one week must be given to the engineer when his inspector may be on hand for the performance of his duties.

262. All materials and workmanship shall be subject to the inspection and rejection of the engineer; and all materials condemned by him shall be immediately removed from the work.

Inspection not to relieve Contractor.

263. The inspection of the work shall not relieve the contractor of his obligation to perform sound and reliable work, as herein provided. And all work of whatever kind which, during its progress and before it is finally accepted, may become damaged from any cause, shall be replaced by good and sound work, satisfactory to the engineer.

XIV. ERECTION.

Erection.

264. The contractor shall erect the bridge with its floor or pavement, railings, and all other details, fastenings and attachments complete, in a thoroughly workmanlike manner and ready for travel, and to the lines and grades furnished by the engineer.

Anchor Bolts.

265. The contractor for superstructure shall furnish and put in place all stone bolts and anchors for attaching the iron or steel work to the masonry. He will drill all the necessary holes in the masonry and set all bolts in neat Portland cement of a brand satisfactory to the engineer. When the requirements of the contract demand that the bolts or anchors be built in the masonry the contractor for the superstructure shall furnish said bolts or anchors and deliver them at the bridge site at such time as may be ordered by the engineer, but he will not be required to place them.

Lines, Grades, etc.

266. All lines and grades are to be given by the engineer.

267. The stakes and marks given by the engineer must be carefully preserved by the contractor, who shall give the engineer all necessary assistance and facilities for the establishment of the lines and grades, and the measuring up of the work.

Unloading.

268. All material shall be unloaded at the bridge site with care, and piled on skids well above the level of the ground.

False Work.

269. The contractor shall furnish and erect all falsework, staging and scaffolding, and all tools and erection plant necessary to do the work thoroughly and expeditiously, and he shall remove the same as fast as the advance of the work will permit.

270. Before placing any falsework, the contractor shall submit to the engineer for his approval, duplicate drawings, showing the location of all bents, and the placing of falsework other than such as is so approved shall not be allowed.

Maintain Traffic.

271. In carrying on the work, all operations of the contractor shall be made with reference to keeping streets and roadways open for street-car, wagon and foot travel, except where the nature of the work, in the opinion of the engineer, demands a suspension of such travel.

272. Traffic shall be maintained on all railways, canals or navigable rivers passing under or near the work, and all telegraph, telephone, or other wires, and all gas, water or sewer pipes shall be maintained in serviceable condition and free from injury unless special written permission is given by the engineer for interfering with the same.

Permits and Licenses.

273. The contractor shall give to the proper authorities all requisite notices relating to the work in his charge, and obtain all official permits and licenses for temporary obstructions, and pay all proper fees for same; and he shall pay for any other legal charges from city, town or county officers.

Fences and Lights.

274. The contractor shall provide suitable fences around the work; and red cautionary lights at night at all places where necessary, and shall also provide watchmen, if deemed necessary by the engineer.

Damages.

275. The contractor shall pay all damages or losses or claims recovered that the owner may be made liable for, and save the owner harmless in all things from any accident which may happen or arise by reason of failure, neglect or refusal on his part or that of anyone in his employ to take all necessary precaution to prevent the same, and also arising from any and all encroachments or trespassing on the neighboring property.

Refuse Material and Rubbish

276. All refuse material and rubbish that may accumulate during the progress of the work shall be removed from time to time, and upon the completion of the work all surplus material, falsework and rubbish shall be removed from the vicinity of the structure as may be directed by the engineer.

XV. GENERAL CONDITIONS.

277. The structure shall be built under the direction of the engineer in charge, in accordance with the engineer's general drawings, and will include all work of any description, whether specifically set forth herein or on the drawings, or not, to make the superstructure complete and ready for use, to the entire satisfaction of the engineer.

Patented Devices.

278. All fees or royalties for any patented invention, article or arrangement that may be used upon or in any manner connected with the construction, erection of the work, or any part thereof, embraced in these specifications, shall be included in the price mentioned in the contract; and the contractor shall protect and hold harmless the owner against any and all demands for such fees, royalties or claims, and before the final payment or settlement is made on account of the contract, the contractor must furnish acceptable proof of a proper and satisfactory release from all such claims.

Subletting.

279. No part of the work shall be sublet, nor shall the contract for the whole or any portion of the work be assigned unless by written consent of the engineer.

Employees.

280. Should any disorderly or incompetent person be employed upon the work, he shall upon notice from the engineer be discharged and not employed again without his permission.

Changes.

281. The work shall be done substantially in accordance with the accepted plans, details and directions by the engineer and in accordance with these specifications, but the right is reserved by the owner, without incurring any liability therefor, to make such changes in the said general or detailed plans and in the specifications as the engineer may deem necessary for the convenience, safety and stability of the work, or as shall be deemed advisable or desirable by him to make the same a satisfactory piece of work.

282. The right is also reserved by the owner, without incurring any liability therefor, beyond the contract price, except as hereinafter provided, to increase or diminish the amount of labor or material, or both, herein provided for, within such limits as shall be deemed necessary by said engineer to make said work, when completed, a satisfactory piece of work.

283. But if any such change in any of the said general or detailed plains, or in the specifications, shall, in the opinion of said engineer, materially increase the actual cost of performing the labor necessary to construct the portions of the work thereby changed, beyond what such labor would have cost, as aforesaid, if performed without such change, then the contractor shall receive the amount of such increased cost, as determined by the engineer, with ten (10) per cent thereof additional, such percentage to be for and in lieu of profits; any decrease in such cost, as determined by the engineer, shall inure to the benefit of the owner.

284. And if by any such change in any of the said general or detail plans, or in these specifications, any material is used in the structure, the cost of which is, in the opinion of

the engineer, in excess of that herein provided for, the contractor shall receive such excess of cost, as determined by the said engineer, and ten (10) per cent thereof additional, such percentage to be for and in lieu of profits; any decrease of such cost, as determined by said engineer, shall inure to the benefit of the owner.

Claims.

285. The contractor shall make no claim against the owner for damages or losses occasioned by the elements, or from any other causes for which the owner is not responsible. No claim for extra work not provided for in the plans and specifications will be allowed unless a written order to perform such work shall have been given by the engineer, and all claims for such work shall be presented in writing for settlement in the monthly estimate next after such work shall have been performed. Claims by the contractor for damages by reason of any detention on the part of the owner will not be allowed, but any such detention shall make a corresponding extention of the time for completion of the contract.

Commencement of Work.

286. The work herein provided for shall be commenced upon any part or portion of the same, as the engineer may direct, within ten (10) days after receipt of written notice from the engineer so to do.

Prosecution of Work.

287. The work shall be prosecuted continuously and in the most energetic, expeditious and workmanlike manner, with the largest force of all classes of workmen that can be worked to advantage, and the contractor shall supply sufficient plant to work at such places and at as many places as the engineer may direct until the whole shall have been completed; or work upon any part or portion of the structure shall at any time be wholly or partially suspended or discontinued by order of the engineer whenever in his opinion the best interests of the owner or the progress of the work upon other parts or portions of the structure may demand it.

Completion of Work.

288. The entire work herein provided for shall be prosecuted in such manner that the whole shall be complete and ready for acceptance by the owner at or before the time specified on the first page hereof, or in the event that the contrac-

tor fail to complete the work within such specified time, he will be liable for any and all damage which the owner may suffer in consequence of the delay; provided, that any mutual agreement, set forth in the contract of which these specifications form a part, relating to damages for delay of competion after the specified time or to awards for completion before the specified time, shall be and remain in full force and effect.

289. If the contractor fails to complete the entire work herein provided for within the time specified on the first page hereof, the engineer will receive from the owner full compensation for cost of all engineering superintendence rendered from and after such time and until the said work is entirely completed. The amount of such compensation shall be paid out of and deducted from any money due or that may become due to the contractor for this work, and final payment to the contractor shall not be made or authorized by the owner until a bill for such superintendence shall have been received from the engineer and paid by the owner.

290. In the event that the contractor shall abandon the work and refuse or fail to commence it again within three (3) days after written notice from the engineer, directing him to resume work, has been mailed to or left for the contractor at his last known residence, then the sureties on his contract shall be notified and directed to complete the work. **Abandonment.**

291. If at any time during the progress of the work it should appear by the report of the engineer that the force employed, the quantity or quality of tools, appliances provided, or that the progress or character of the work or material furnished are not respectively such as, in the opinion of the engineer, will ensure the completion of the work under this contract within the time specified, or not in accordance with the specifications, then and in that case the engineer may serve written notice on the contractor to at once supply such increase of force, appliances or tools, and to cause such improvement to be made in the character of the work or materials, as will be required to make the same conform to these specifications and the requirements of the engineer; and if,

on the expiration of three (3) days after the service of such written notice upon the contractor and sureties personally, or by leaving same or mailing same for them at last known addresses, the contractor shall have failed to furnish to the engineer satisfactory evidence of his efforts, ability and intentions to remedy the specified deficiences, the engineer may thereupon enter and take possession of the said work or any part thereof, with tools, materials, plant, appliances, houses, machinery and other appurtenances thereon, hold the same as security for any or all damages or liabilities that may arise by reason of the non-fulfillment of this contract within the time specified, and, furthermore, may employ the said tools and other appurtenances, materials, and such other means as the said engineer may deem proper to complete the work at the expense of the contractor, and may deduct the cost of the same from any payment then due or thereafter falling due to the contractor for this work; and, in case the contractor shall not complete the work within the time herein specified, and the engineer shall, notwithstanding such failure, permit the contractor to proceed with and complete the said work as if such time had not elapsed, said permission shall not be deemed a waiver in any respect by the owner of any forfeiture or liability for damages or expenses thereby incurred, arising from such non-completion of said work within the specified time, but such liability shall continue in full force against the contractor and his sureties as if such permission had not been given.

Estimates and Payments.

292. Approximate estimates will be made monthly by the engineer if requested by the contractor, upon the amount of acceptable material delivered at the bridge site or erected in place, and also reasonable estimates will be allowed at the discretion of the engineer upon acceptable material in reasonable amounts and proper condition.

Ninety (90) per cent of the amounts of such estimates will be paid in cash within three (3) days after payment thereon is ordered by the owner, provided no legal restraints are placed upon such owner preventing such payment. The remaining ten (10) per cent will be paid within ten days after the final completion and acceptance by the engineer and

owner of all the work herein specified, provided the same is free from all claims for labor and material under these specifications, which might in any manner become a lien upon said structure or upon the owner.

Comply with all Laws.

293. The contractor shall be required to comply with all federal, state, city, town or other laws and statutes in force in the locality, and it is understood and agreed that the contract of which these specifications are a part is made and executed subject to the terms and conditions of any and all such laws. The contractor will be expected to inform himself regarding such laws, and to govern himself accordingly.

Special Clauses.

294. All the written part of these specifications, appearing on the first page hereof, is to be in as full force and receive the same attention as if printed herein.

295. Any special clauses attached hereto, and referring to this structure, are to be considered as a part hereof, and shall be as carefully noted and as strictly followed as if printed herein.

Plans and Specifications

296. The plans and specifications are intended to be explanatory of each other, but should any discrepancy appear, or any misunderstanding arise as to the import of anything contained in either, the explanation of the engineer shall be final and binding on the contractor; and all directions and explanations required, alluded to or necessary to complete any of the provisions of these specifications, and give them due effect, will be given by the engineer.

Owner.

297. The term "owner," as herein used, is understood to mean the individual, company, corporation, state, county, city, town or village, to whom the structure will belong when completed, and for whom the engineer has charge of the work.

Engineer.

298. The term "engineer," as herein used, is understood to mean the chief engineer in charge of the work, and the work at all times shall be under his control, and the decisions of said engineer upon all questions as to estimates or the

determination of the quantity or quality of the work, and on all other questions herein left to his discretion, shall be final and conclusive.

The above constitute the specifications referred to in the contract of the undersigned with

.....

dated .....

Contracting firm .....

By .....

CONVENTIONAL SIGNS FOR BRIDGE RIVETS