SOUTHERN RAILWAY COMPANY

OFFICE OF

Chief Engineer M. W. & S.

GENERAL SPECIFICATIONS

FOR

STEEL STRUCTURES

1911

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GENERAL SPECIFICATIONS FOR STEEL STRUCTURES.

PROPOSALS.

Proposals must be made in a lump sum or per pound price, as directed.

Unless specifically stipulated otherwise, the proposals are invited for the superstructure, erected complete, and painted, ready for service; including all labor, staging, tools, etc., excepting wooden floors for railroad bridges, which will be furnished by the Railway Company and framed and placed by the contractor.

When proposals are invited for the superstructure delivered only, it is understood that all members must be furnished complete (painted one coat of paint) and including all field rivets and bolts, pilot-nuts, floor bolts and washers, anchor bolts and lead for bed plates.

All proposals must be based on these specifications and on data furnished by the Railway Company. In case of any discrepancy in the data, or any uncertainty as to the meaning of the specifications, the same must be settled with the Engineer before the contractor submits his proposal.

When required, the contractor shall furnish a stress sheet with his bid. Each pound price proposal shall state the estimated weight of the steelwork. No free transportation for men, tools or materials will be allowed, unless so stated in the invitation to bidders.

The word "Engineer" as used in these specifications, means the "Chief Engineer Maintenance of Way and Structures" of the Railway Company.

RAILWAY BRIDGES.

PART FIRST—DESIGN.

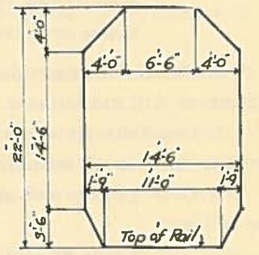
I. GENERAL.

Materials.

1. The material in the superstructure shall be structural steel, except rivets, and as may be otherwise specified.

Clearances.

2. When alignment is on tangent, clearances shall not be less than shown on the diagram; the height of rail shall, in all cases, be assumed at 6 in. The width shall be increased so as to provide the same minimum clearances on curves for a car 80 ft. long, 14 ft. high, and 60 ft. center to center of trucks, allowance being made for curvature and superelevation of rails.



Clearance Diagram.

Drawings.

3. Except in cases where the drawings are prepared by the Railway Company, the contractor shall prepare stress sheet and complete detail drawings of all parts of the structure.

The stress sheet must show assumed dead load, maximum live and dead load stresses, impact, and the proposed sections and areas of all numbers; also sketches of such details as are necessary for a clear understanding of the structure proposed.

Detail drawings must show every part of the structure and give complete dimensions and sizes of all material.

All drawings are to be 23 inches by 35 inches between border lines with ½ inch margin.

Blue prints in duplicate of all drawings must be submitted to the Chief Engineer Maintenance of Way and Structures for approval, and no work shall be done or material ordered until the drawings have been approved by the Engineer, except at the contractor's risk.

The contractor shall furnish to the Railway Company as many blue prints of the approved drawings as may be necessary for the proper inspection and supervision of the work; and when the work is completed, the original tracings shall be furnished free of cost to the Railway Company.

Classes of Structures.

4. The following classes of structures are preferred for the different lengths of spans:

FOR SINGLE TRACK.

Spans up to 110 feet—Plate girders.
Spans from 110 feet to 200 feet—Riveted trusses.
Spans over 200 feet—Pin connected trusses.

FOR DOUBLE TRACK.

Spans up to 110 feet—Plate girders.
Spans from 110 feet to 180 feet—Riveted trusses
Spans over 180 feet—Pin connected trusses.

5. Double intersection trusses will not be permitted. Adjustable members will not be used except by special permission.

6. Generally stringers and floor beams, including end floor beams, will be used on all structures except deck girders.

Spacing Girders

7. Deck girders and stringers on tangent alignment will be spaced as follows:

Spans up to 65 feet—6 feet 6 inches.
Spans from 65 feet to 80 feet—8 feet.
Spans over 80 feet—9 feet.

Deck girders and stringers on curves will be spaced as directed.

Spacing Trusses.

8. The width center to center of girders and trusses shall in no case be less than one-twentieth of the effective span, nor less than is necessary to prevent overturning under the assumed lateral loading.

Skew Bridges

9. Ends of deck plate girders and track stringers of skew bridges at abutments shall be square to the track, unless a ballasted floor is used.

Floors.

10. The cross ties shall be 8 inches wide and spaced not more than 6 inches apart in the clear.

For girders spaced 6 feet and 6 inches center to center, they shall be 11 feet long and have a minimum depth of 10 inches.

For girders spaced 8 feet center to center, they shall be 12 feet long and have a minimum depth of 12 inches.

For girders spaced 9 feet center to center, they shall be 12 feet long and have a minimum depth of 13 inches.

Ties shall be dapped at least ½-inch and not more than 1½ inches over the supporting girders or stringers. The depth of ties shall be increased toward the ends of the girders when necessary, to secure proper dapping.

Ties shall be secured to each girder by a ¾ in. hook bolt every fourth tie. Hook bolts shall be flattened in the body to prevent turning.

There shall be an eight inch by eight inch guard timber on each side of the track, placed with its inner face 2 feet from the gage line of the rail.

These timbers shall be dapped 2 inches over the ties and attached thereto with a ¾-inch bolt every fourth tie, or with a ¾-inch lag screw, in case the bolt interferes with the girder flange.

All floor bolts will have square heads and nuts and be provided with suitable washers under heads and nuts.

Whenever necessary to superelevate the outer rail, beveled ties will be used as far as practicable, and when greater superelevation is needed, separate elevation blocks of the same width as the ties will be bolted to the underside, using two ¾-inch bolts to secure each block to the tie.

For beveled ties the minimum depth given above shall obtain over the girder on the inside of the curve.

All ties shall be carefully dapped so as to have a full and even bearing on the stringers.

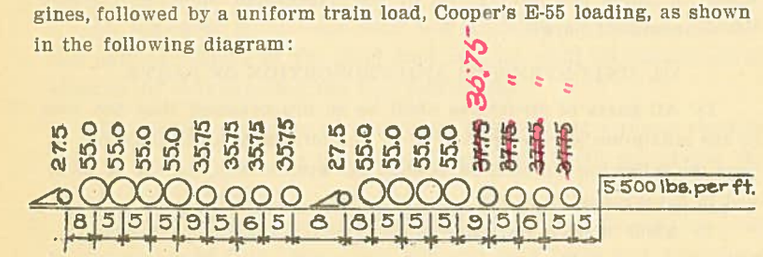
II. LOADS.

Dead Load.

11. The dead load shall consist of the estimated weight of the entire suspended structure. Timber shall be assumed to weigh 4½ pounds per foot B. M.; ballast 100 pounds per cubic foot, reinforced concrete 150 pounds per cubic foot, and rails and fastenings, 150 pounds per linear foot of track.

Live Load.

12. The live load for each track shall consist of two typical engines, followed by a uniform train load, Cooper's E-55 loading, as shown in the following diagram:



Impact.

13. The dynamic increment of the live load shall be added to the maximum computed live load stresses and shall be determined by the formula $I = S \frac{300}{L + 300}$,

where I=impact or dynamic increment to be added to live-load stresses.

S=computed maximum live-load stress.

L=loaded length of track in feet producing the maximum stress in the member. For bridges carrying more than one track, the aggregate length of all tracks producing the stress shall be used.

Impact shall not be added to stresses produced by longitudinal, centrifugal and lateral or wind forces.

Lateral Forces.

14. All spans shall be designed for a lateral force on the loaded chord of 200 pounds per linear foot plus 10 per cent. of the specified train load on one track, and 200 pounds per linear foot on the unloaded chord; these forces being considered as moving.

Wind Force.

15. Viaduct towers shall be designed for a force of 50 pounds per square foot on one and one-half times the vertical projection of the structure unloaded; or 30 pounds per square foot on the same surface plus 400 pounds per linear foot of structure applied 7 feet above the rail for assumed wind force on train when the structure is either fully loaded or loaded on either track with empty cars assumed to weigh 1,200 pounds per linear foot, whichever gives the larger stress.

Longitudinal Force.

16. Viaduct towers and similar structures shall be designed for a longitudinal force of 20 per cent. of the live load applied at the top of the rail.

17. Structures located on curves shall be designed for the centrifugal force of the live load applied at the top of the high rail. The centrifugal force shall be considered as live load and be derived from the speed in miles per hour given by the expression $60—2\frac{1}{2}D$, where "D"=degree of curge.

III. UNIT STRESSES AND PROPORTION OF PARTS.

Unit Stresses.

18. All parts of structures shall be so proportioned that the sum of the maximum stresses produced by the foregoing loads shall not exceed the following amounts in pounds per square inch, except as modified in paragraphs 26 to 29:

Tension.

19. Axial tension on net section.....16,000

Compression.

20. Axial compression on gross section of columns....$16{,}000—70\frac{l}{r}$

with a maximum of.....14,000

where "l" is the length of the member in inches, and "r" is the least radius of gyration in inches.

Direct compression on steel castings.....16,000

Bending.

21. Bending: on extreme fibers of rolled shapes, built sections, girders and steel castings; net section.....16,000

on extreme fibers of pins.....24,000

Shearing.

22. Shearing: shop driven rivets and pins.....12,000

field driven rivets and turned bolts.....10,000

plate girder webs; gross section.....10,000

Bearing.

23. Bearing: shop driven rivets and pins.....24,000

field driven rivets and turned bolts.....20,000

expansion rollers; per linear inch..... $600d$

where "d" is the diameter of the roller in inches.

on masonry 600

Limiting Length of Members.

24. The lengths of main compression members shall not exceed 100 times their least radius of gyration, and those for wind and sway bracing 120 times their least radius of gyration.

25. The lengths of riveted tension members in horizontal or inclined positions shall not exceed 200 times their radius of gyration about the horizontal axis. The horizontal projection of the unsupported portion of the member is to be considered as the effective length.

Alternate Stresses.

26. Members subject to alternate stresses of tension and compression shall be proportioned for the stresses giving the largest section. If the alternate stresses occur in succession during the passage of one train, as in stiff counters, each stress shall be increased by 50 per cent. of the smaller. The connections shall in all cases be proportioned for the sum of the stresses.

Combined Stresses.

27. Wherever the live and dead load stresses are of opposite character, only two-thirds of the dead load stresses shall be considered as effective in counteracting the live load stress.

28. Members subject to both axial and bending stresses shall be proportioned so that the combined fibre stresses will not exceed the allowed axial stress.

29. For stresses produced by longitudinal and lateral or wind forces combined with those from live and dead loads and centrifugal force, the unit stress may be increased 25 per cent. over those given above; but the section shall not be less than required for live and dead loads and centrifugal force.

Net Section at Rivets.

30. In proportioning tension members the diameter of the rivet holes shall be taken $\frac{1}{8}$-in. larger than the nominal diameter of the rivet.

Rivets

31. In proportioning rivets the nominal diameter of the rivet shall be used.

Net Section at Pins.

32. Pin-connected riveted tension members shall have a net section through the pin-hole at least 25 per cent. in excess of the net section of the body of the member, and the net section back of the pin-hole, parallel with the axis of the member, shall be not less than the net section of the body of the member.

Plate Girders.

33. Plate girders shall be proportioned either by the moment of inertia of their net section; or by assuming that the flanges are concentrated at their centers of gravity; in which case one-eighth of the gross section of the web, if properly spliced, may be used as flange section. The thickness of web plates shall be not less than 1/160 of the unsupported distance between flange angles (see 42).

Compression Flange.

34. The gross section of the compression flanges of plate girders shall not be less than the gross section of the tension flanges; nor shall the stress per sq. in. in the compression flange of any beam or girder exceed $16{,}000 - 200\frac{l}{b}$ when flange consists of angles only or if cover consists of flat plates, or $16{,}000 - 150\frac{l}{b}$, if cover consists of a channel section, where l=unsupported distance and b=width of flange.

Flange Rivets.

35. The flanges of plate girders shall be connected to the web with a sufficient number of rivets to transfer the total shear at any point in a distance equal to the effective depth of the girder at that point combined with any load that is applied directly on the flange. The wheel loads, where the ties rest on the flanges, shall be assumed to be distributed over three ties.

Depth Ratios.

36. Trusses shall preferably have a depth of not less than one-tenth of the span. Plate girders and rolled beams, used as girders, shall preferably have a depth of not less than one-twelfth of the span. If shallower trusses, girders or beams are used, the section shall be increased so that the maximum deflection will not be greater than if the above limiting ratios had not been exceeded.

IV. DETAILS OF DESIGN.

GENERAL REQUIREMENTS.

Open Sections.

37. Structures shall be so designed that all parts will be accessible for inspection, cleaning and painting.

Pockets.

38. Pockets or depressions which would hold water shall have drain holes, or be filled with waterproof material.

Symmetrical Sections.

39. Main members shall be so designed that the neutral axis will be as nearly as practicable in the center of section, and the neutral axes of intersecting main members of trusses shall meet at a common point.

Counters.

40. Rigid counters are preferred; and where subject to reversal of stress shall preferably have riveted connections to the chords. Adjustable counters shall have open turnbuckles.

Strength of Connections.

41. The strength of connections shall be sufficient to develop the full strength of the member, even though the computed stress is less, the kind of stress to which the member is subjected being considered.

Minimum Thickness.

42. The minimum thickness of metal shall be ⅜-in., except for fillers.

Size of Rivets.

43. In general, ⅞-in, rivets will be used. The diameter of the rivets in any angle carrying calculated stress shall not exceed one-quarter the width of the leg in which they are driven. In minor parts, ⅞-in. rivets may be used in 3-in. angles, and ¾-in. rivets in 2½-in. angles.

Pitch of Rivets.

44. The minimum distance between centers of rivet holes shall be three diameters of the rivet; but the distance shall preferably be not less than 3 in. for ⅞-in. rivets and 2½ in. for ¾-in. rivets. The maximum pitch in the line of stress for members composed of plates and shapes shall be 6 in. for ⅞-in. rivets and 5 in. for ¾-in. rivets. For angles with two gage lines and rivets staggered the maximum shall be twice the above in each line. Where two or more plates are used in contact, rivets not more than 9 in. apart in either direction shall be used to hold the plates well together. In tension members, composed of two angles in contact, a pitch of 9 in. will be allowed for riveting the angles together.

Edge Distance.

45. The minimum distance from the center of any rivet hole to a sheared edge shall be 1¾ in. for ⅞-in. rivets and 1½ in. for ¾-in. rivets, and to a rolled edge 1¼ in. and 1⅛ in. respectively. The maximum distance from any edge shall be eight times the thickness of the plate, but shall not exceed 6 in.

Long Rivets.

46. Rivets carrying calculated stress and whose grip exceeds four diameters shall be increased in number at least one per cent. for each additional 1/16-in. of grip.

Pitch at Ends.

47. The pitch of rivets at the ends of built compression members shall not exceed four diameters of the rivets, for a length equal to one and one-half times the maximum width of member.

Countersunk Rivets.

48. No value will be given to ⅞-in. rivets countersunk in plates less than ⅝ in. thick, nor to ¾-in. rivets countersunk in plates less than ½ in. thick.

Compression Members.

49. In compression members the metal shall be concentrated as much as possible in webs and flanges. The thickness of each web shall be not less than one-thirtieth of the distance between its connections to the flanges. Cover plates shall have a thickness not less than one-fortieth of the distance between rivet lines.

Minimum Angles.

50. Flanges of girders and built members without cover plates shall have a minimum thickness of one-twelfth of the width of the outstanding leg.

Tie-Plates.

51. The open sides of compression members shall be provided with lattice and shall have tie-plates as near each end as practicable. Tie-plates shall be provided at intermediate points where the lattice is interrupted. In main members the end tie-plates shall have a length not less than the distance between the lines of rivets connecting them to the flanges, and intermediate ones not less than one-half this distance. Their thickness shall not be less than one-fiftieth of the same distance.

Lattice.

52. The lattice of compression members shall be proportioned to resist the shearing stresses corresponding to the allowance for flexure for uniform load provided in the column formula in paragraph 20 by the term $70\frac{l}{r}$. The minimum width of lattice bars shall be 2½ in. for ⅞-in. rivets, 2¼ in. for ¾-in. rivets, and 2 in. if ⅝-in. rivets are used. The thickness shall not be less than one-fortieth of the distance between end rivets for single lattice, and one sixtieth for double lattice. Shapes of equivalent strength may be used.

53. Three-fourths-inch rivets shall be used for latticing flanges from 2½ to 3½ in. wide; ⅞-in. rivets shall be used in flanges 3½ in. and over, and lattice bars with at least two rivets shall be used for flanges over 5 in. wide.

54. The inclination of lattice bars with the axis of the member shall be not less than 45 degrees, and when the distance between rivet lines in the flanges is more than 15 in., if single rivet bar is used, the lattice shall be double and riveted at the intersection.

55. Latice bars shall be so spaced that the portion of the flange included between their connections shall be as strong as the member as a whole.

Faced Joints.

56. Abutting joints in compression members when faced for bearing shall be spliced on four sides sufficiently to hold the connecting members accurately in place. All other joints in riveted work, whether in tension or compression, shall be fully spliced.

Pin-Plates.

57. Pin-holes shall be reinforced by plates where necessary, and at least one plate shall be as wide as the flanges will allow and be on the same side as the angles. They shall contain sufficient rivets to distribute their portion of the pin pressure to the full cross-section of the member.

Forked Ends.

58. Forked ends on compression members will be permitted only where unavoidable; where used, a sufficient number of pin plates shall be provided to make the jaws of twice the sectional area of the member. At least one of these plates shall extend to the far edge of the farthest tie-plate, and the balance to the far edge of the nearest tie-plate, but not less than 6 in. beyond the near edge of the farthest plate.

Pins.

59. Pins shall be long enough to insure a full bearing of all the parts connected upon the turned body of the pin. They shall be secured by chambered nuts or be provided with washers if solid nuts are used. The screw ends shall be long enough to admit of burring the threads.

60. Members packed on pins shall be held against lateral movement.

Bolts.

61. Where members are connected by bolts, the turned body of these bolts shall be long enough to extend through the metal. A washer at least ¼-in. thick shall be used under the nut. Bolts shall not be used in place of rivets except by special permission. Heads and nuts shall be hexagonal.

Indirect Splices.

62. Where splice plates are not in direct contact with the parts which they connect, rivets shall be used on each side of the joint in excess of the number theoretically required to the extent of one-third of the number for each intervening plate.

Fillers.

63. Rivets carrying stress and passing through fillers shall be increased 50 per cent. in number; and the excess rivets, when possible, shall be outside of the connected member.

Expansion.

64. Provision for expansion to the extent of ⅛-in. for each 10 ft. shall be made for all bridge structure. Efficient means shall be provided to prevent excessive motion at any one point.

Expansion Bearings.

65. Spans of 80 ft. and over resting on masonry shall have turned rollers or rockers at one end; and those of less length shall be arranged to slide on smooth surfaces. These expansion bearings shall be designed to permit motion in one direction only.

Fixed Bearings.

66. Fixed bearings shall be firmly anchored to the masonry.

Rollers.

67. Expansion rollers shall be not less than 6 in. in diameter. They shall be coupled together with substantial side bars, which shall be so arranged that the rollers can be readily cleaned. Segmental rollers shall be geared to the upper and lower plates.

Bolsters.

68. Bolsters or shoes shall be so constructed that the load will be distributed over the entire bearing. Spans of 80 ft. or over shall have hinged bolsters at each end.

Wall Plates.

69. Wall plates may be of cast steel or built up of rolled shapes or bars and shall be so designed as to distribute the load uniformly over the entire bearing. They shall be secured against displacement. Their thickness shall not be less than one-eighth their greatest dimension, with a minimum of three inches. Cast wall plates shall be cored with metal not less than ¾-in. thick, and shall have all corners rounded. Sheet lead ⅛-in. thick shall be used under all wall plates.

Anchorage.

70. Anchor bolts for viaduct towers and similar structures shall be long enough to engage a mass of masonry the weight of which is at least one and one-half times the uplift.

Inclined Bearings.

71. Bridges on an inclined grade without pin shoes shall have the sole plates beveled so that the masonry and expansion surfaces may be level.

Name Plate.

72. All bridges must have a cast name plate on each end indicating the name of the builder and the date of manufacture.

FLOOR SYSTEMS.

Floor Beams.

73. Floor beams shall preferably be square to and riveted directly to the girders or trusses.

Stringers.

74. Stringers shall preferably be riveted to the webs of all intermediate floor beams, using connection angles not less than ½-in. in thickness. Shelf angles or other supports provided to support the stringer during erection shall not be considered as carrying any of the reaction.

Stringer Frames.

75. Where end floor beams cannot be used, stringers resting on masonry shall have cross frames near their ends. These frames shall be riveted to girders or truss shoes where practicable.

76. When the rail is on wooden cross-ties the base of the rail must clear the steel work by at least 1½ inches.

BRACING.

Rigid Bracing.

77. Lateral, longitudinal and transverse bracing in all structures shall be composed of rigid members.

Portals.

78. Through truss spans shall have riveted portal braces rigidly connected to the end posts and top chords. They shall be as deep as the clearance will allow.

Double Systems of Bracing.

79. When a double system of bracing is used, generally each system shall be proportioned to resist in tension the total shear in the panel. However, in cases of structures on curves the centrifugal forces may be considered as divided between the two systems in order to secure symmetrical bracing.

Top Bracing.

80. Top lateral bracing in through trusses shall be composed of at least two angles, laced, and of depth equal to the depth of the top chord, with knee braces at each intermediate vertical member.

81. Laterals must be riveted to stringers at points of intersection with at least four rivets.

Transverse Bracing.

82. Intermediate transverse frames shall be used at each panel of through spans having vertical truss members where the clearance will permit.

83. Deck spans shall have transverse bracing at each vertical and end inclined post, the bracing between the end inclined posts designed to carry the lateral load to the supports.

Bottom Laterals.

84. Deck girders 80 ft. long and over, and all viaduct girders, shall have bottom lateral bracing.

Minimum Angles.

85. The minimum sized angle to be used in lateral bracing shall be 3½x3½x⅜ inches. Not less than four rivets shall be used for the connection.

86. Lateral bracing shall be far enough below the flange to clear the ties.

Tower Bracing.

87. Viaduct towers shall preferably have the longitudinal and transverse bracing consisting of horizontal compression struts and double diagonal tension members. The tower girders may serve as top longi-

tudinal struts if properly riveted to the columns. Double-track towers shall have horizontal diagonal bracing at the top.

PLATE GIRDERS.

Camber.

88. Plate girder spans 50 feet long and over shall be built with a camber at the rate of 1/16-in. per 10 feet of length.

Top Flange Cover.

89. Where flange plates are used, one cover plate of top flange shall extend the whole length of the girder.

Web Stiffeners.

90. There shall be web stiffeners generally in pairs over bearings, at points of concentrated loading, and at other points when the thickness of the web is less than 1/60 of the unsupported distance between the flange angles.

The distance between stiffeners shall not exceed that given by the following formula, with a maximum limit of six feet (and not greater than the clear depth of the web):

$$d = \frac{t}{40}(1200 - s)$$

When d=clear distance between stiffeners of flange angles;

t=thickness of web;

s=shear per square inch.

The stiffeners at ends and at points of concentrated loads shall be proportioned by the formula of paragraph 20, the effective length being assumed as one-half the depth of the girders. End stiffeners and those under concentrated loads shall have their outstanding legs as wide as the flange angles will allow, and shall fit tightly against them. Intermediate stiffeners shall have their outstanding legs not less than 1/30 of the depth of the girder plus 2 inches. All stiffeners shall be on fillers.

Cross Frames.

91. Cross frames with at least four angles shall be placed at the ends of deck-plate and at intermediate points about 12 feet apart, and shall generally be connected to both flanges with horizontal plates. However, these connection plates may be omitted at the bottom of cross frames near the center of girder spans which have no bottom cover plates to avoid rivet holes in the horizontal legs of the bottom flange angles.

Stays for Top Flanges.

92. Through plate girders shall have their top flanges stayed at each end of every floor beam, or in case of solid floors, at distances not exceeding 12 feet, by knee braces or gusset plates.

Rivets in Flanges.

93. At least two rows of staggered rivets shall be used in each leg of flange angles that are 6 inches wide or over, to connect to web or cover plates.

94. Where four rows of rivets are used in cover plates of girder flanges, alternating rivet pitch at no point exceeding 4½ inches shall be used on each side of the flange.

Make-up of Girder Flanges.

95. The rivet spacing at the ends of cover plates shall not exceed four diameters of the rivets for a length equal to at least twice the width of the plates.

Ends of Girders.

96. In girders with flange plates it is preferred that no more than one-half the flange section be in the horizontal cover plates.

Generally vertical side plates will be used between the flange angles and the web, if necessary, to keep the center of gravity of the flanges inside the backs of the flange angles.

Web Splices.

97. The ends of through girders shall be provided with cover plates. The shore ends shall be curved at the top to approved radius.

98. Web splice plates shall have at least two rows of rivets each side the splice.

TRUSSES.

Camber.

99. Truss spans shall be given a camber by so proportioning the length of the members that the stringers will be straight when the bridge is fully loaded.

Rigid Members.

100. Hip verticals and similar members, and the two end panels of the bottom chords of single track pin-connected trusses, shall be rigid.

Eye-Bars.

101. The eye-bars composing a member shall be so arranged that adjacent bars shall not have their surfaces in contact; they shall be as nearly parallel to the axis of the truss as possible, the maximum inclination of any bar limited to one inch in 16 feet.

Pony Trusses.

102. Pony trusses shall be riveted structures, with double webbed chords, and shall have all web members latticed or otherwise effectively stiffened.

End Pins.

103. Bottom chord end pins must project beyond the nuts or some suitable device provided by which the structures may be lifted by jacks.

104. All posts having the floor beams riveted between them must have their flanges turned in and have a diaphragm between the segments of the posts at the floor beam connections.

PART SECOND—MATERIALS AND WORKMANSHIP.

V. MATERIAL.

Steel.

105. Steel shall be made by the open-hearth process.

Properties.

106. The chemical and physical properties shall conform to the following limits:

Elements Considered	Structural Steel	Rivet Steel	Steel Castings
Phosphorus, max. . . { Basic . .	0.04 per cent.	0.04 per cent.	0.05 per cent.
{ Acid . .	0.06 "	0.04 "	0.08 "
Sulphur, maximum	0.05 "	0.04 "	0.05 "
Ultimate tensile strength Pounds per square inch	Desired 60,000 1,500,000*	Desired 50,000 1,500,000	Not less than 65,000
Elong., min. in 8", Fig. 1 . .	Ult. tensile str'gth 22	Ult. tensile str'gth	15 per cent.
" " " 2", " 2 . . .			
Character of Fracture	Silky	Silky	Silky or fine granular
Cold Bends without Fracture . .	180° flat†	180° flat‡	90° $d=3t$

*See paragraph 116. †See paragraphs 117, 118 and 119. ‡See paragraph 120.

The yield point, as indicated by the drop of beam, shall be recorded in the test reports.

107. In order that the ultimate strength of full-sized annealed eyebars may meet the requirements of paragraph 183, the ultimate strength in test specimens may be determined by the manufacturers; all other tests than those for ultimate strength shall conform to the above requirements.

Allowable Variations.

108. If the ultimate strength varies more than 4,000 lbs. and less than 5,000 lbs. from that desired, a retest shall be made on the same gage, which, to be acceptable, shall be within 5,000 lbs. of the desired ultimate.

Chemical Analysis.

109. Chemical determinations of the percentages of carbon, phosphorus, sulphur and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer

or his inspector. Check analyses shall be made from finished material, if called for by the purchaser, in which case an excess of 25 per cent. above the required limits will be permitted.

Specimens

110. Plate, shape and bar specimens for tensile and bending tests shall be made by cutting coupons from the finished product, which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of ¾-in. for a length of at least 9 in., with enlarged ends.

111. Rivet rods shall be tested as rolled.

112. Pin and roller specimens shall be cut from the finished rolled or forged bar, in such manner that the center of the specimen shall be one inch from the surface of the bar. The specimen for tensile test shall be turned to the form shown by Fig. 2. The specimen for bending test shall be one inch by ½-in. in section.

113. For steel castings the number of tests will depend on the character and importance of the castings. Specimens shall be cut cold from coupons molded and cast on some portion of one or more castings from each melt or from the sink heads, if the heads are of sufficient size. The coupon or sink head, so used, shall be annealed with the casting before it is cut off. Test specimens to be of the form prescribed for pins and rollers.

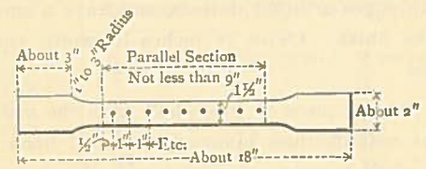


FIG. 1.

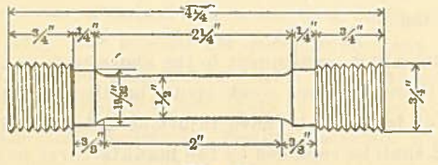


FIG. 2.

Specimens of Rolled Steel.

114. Rolled steel shall be tested in the condition in which it comes from the rolls.

Number of Tests.

115. At least one tensile and one bending test shall be made from each melt of steel as rolled. In case steel differing ⅜-in. and more in thickness is rolled from one melt, a test shall be made from the thickest and thinnest material rolled.

Modification in Elongation.

116. A deduction of 1 per cent. will be allowed from the specified percentage for elongation for each ⅛-in. in thickness above ¾-in.

Bending Tests.

117. Bending tests may be made by pressure or by blows. Plates, shapes and bars less than one inch thick shall bend as called for in paragraph 106.

Thick Material.

118. Full-sized material for eye-bars and other steel one inch thick and over, tested as rolled, shall bend cold 180 degrees around a pin, the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

Bending Angles.

119. Angles ¾-in. and less in thickness shall open flat, and angles ½-in. and less in thickness shall bend shut, cold, under blows of a hammer, without sign of fracture. This test shall be made only when required by the inspector.

Nicked Bends.

120. Rivet steel, when nicked and bent around a bar of the same diameter as the rivet rod, shall give a gradual break and a fine silky, uniform fracture.

Finish.

121. Finished material shall be free from injurious seams, flaws, cracks, defective edges or other defects, and have a smooth, uniform and workmanlike finish. Plates 36 inches in width and under shall have rolled edges.

Melt Numbers.

122. Every finished piece of steel shall have the melt number and the name of the manufacturer stamped or rolled upon it. Steel for pins and rollers shall be stamped on the end. Rivet and lattice steel and other small parts may be bundled with the above marks on an attached metal tag.

Defective Material.

123. Material which, subsequent to the above tests at the mills, and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected at the shop and shall be replaced by the manufacturer at his own cost.

Variation in Weight.

124. A variation in cross-section or weight of each piece of steel of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in case of sheared plates, which will be covered by

the following permissible variations, which are to apply to single plates, when ordered to weight:

125. Plates 12½ lbs. per sq. ft. or heavier:

(a) Up to 100 in. wide, 2½ per cent. above or below the prescribed weight.

(b) One hundred inches wide and over, 5 per cent. above or below.

126. Plates under 12½ lbs. per sq. ft.:

(a) Up to 75 in. wide, 2½ per cent, above or below.

(b) Seventy-five inches and up to 100 in. wide, 5 per cent. above or 3 per cent. below.

(c) One hundred inches wide and over, 10 per cent. above or 3 per cent. below.

127. Plates when ordered to gage will be accepted if they measure not more than 0.01 in. below the ordered thickness.

128. An excess over the nominal weight, corresponding to the dimensions on the order, will be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered	Nominal Weights	Width of Plate			
		Up to 75″	75″ and up to 100″	100″ and up to 115″	Over 115″
¼-inch	10.20 lbs.	10 per cent.	14 per cent.	18 per cent.	. . . .
5/16 "	12.75 "	8 "	12 "	16 "	. . . .
⅜ "	15.80 "	7 "	10 "	13 "	17 per cent.
7/16 "	17.85 "	6 "	8 "	10 "	13 "
½ "	20.40 "	5 "	7 "	9 "	12 "
9/16 "	22.95 "	4½ "	6½ "	8½ "	11 "
⅝ "	25.50 "	4 "	6 "	8 "	10 "
Over ⅝ "	. . . . .	3½ "	5 "	6½ "	9 "

Cast-Iron.

129. Except where chilled iron is specified, castings shall be made of tough gray iron, with sulphur not over 0.10 per cent. They shall be true to pattern, out of wind and free from flaws and excessive shrinkage. If tests are demanded they shall be made on the "Arbitration Bar" of the American Society for Testing Materials, which is a round bar 1¼ in. in diameter and 15 in. long. The transverse test shall be made on a supported length of 12 in. with load at middle. The minimum breaking load so applied shall be 2,900 lbs., with a deflection of at least 1/10-in. before rupture.

Wrought-Iron.

130. Wrought-iron shall be double-rolled, tough, fibrous and uniform in character. It shall be thoroughly welded in rolling and be free from surface defects. When tested in specimens of the form of Fig. 1, or in full-sized pieces of the same length, it shall show an ultimate strength of at least 50,000 lbs. per sq. in., an elongation of at least 18 per cent. in 8 in., with fracture wholly fibrous. Specimens shall bend cold, with the fiber, through 135 degrees, without sign of fracture, around a pin the diameter of which is not over twice the thickness of the piece tested. When nicked and bent the fracture shall show at least 90 per cent. fibrous.

VI. INSPECTION AND TESTING AT THE MILLS.

Mill Orders

131. The test and inspection of all material will be conducted by the Railway Company's Superintendent of Tests, or his representative.

132. The Railway Company shall be furnished in duplicate, complete copies of all bills of material and mill orders, and no material shall be rolled or work done before the Superintendent of Tests has been notified where the orders have been placed, so that he may arrange for the inspection.

Facilities for Inspection.

133. The manufacturer shall furnish all facilities for inspection and testing the weight and quality of all material at the mill where it is manufactured. He shall furnish a suitable testing machine for testing the specimens, as well as prepare the pieces for the machine, free of cost.

134. The Railway Company's Inspector shall have full access at all times to all parts of the mills where material to be inspected by him is being manufactured.

VII. WORKMANSHIP.

General.

135. All parts forming a structure shall be built in accordance with approved drawings. The workmanship and finish shall be equal to the best practice in modern bridge works. Material arriving from the mills shall be protected from the weather and shall have clean surfaces before being worked in the shops..

Straightening.

136. Material shall be thoroughly straightened in the shop, by methods that will not injure it, before being laid off or worked in any way.

Finish.

137. Shearing and chipping shall be neatly done, and all parts of the work exposed to view neatly finished. No sharp or unfilleted re-entrant corners will be allowed.

Size of Rivets.

138. The size of rivets, called for on the plans, shall be understood to mean the actual size of the cold rivet before heating.

Rivet Holes

139. The diameter of the punch shall not be more than 1/16-inch greater than the diameter of the rivet; nor the diameter of the die more than ⅛-inch greater than the diameter of the punch. Material more than ⅝-inch thick shall be sub-punched and reamed or drilled from the solid.

Punching.

140. Punching shall be accurately done. Drifting to enlarge unfair holes will not be allowed. If the holes must be enlarged to admit the rivet they shall be reamed. Poor matching of holes will be cause for rejection.

Reaming.

141. Where sub-punching and reaming are required, the punch used shall have a diameter not less than 3/16-inch smaller than the nominal diameter of the rivet. Holes shall then be reamed to a diameter not more than 1/16-inch larger than the nominal diameter of the rivet. (See 156.) Reaming shall be done with twist drills and without using any lubricant.

142. The outside burrs on reamed holes shall be removed to the extent of making a 1/16-inch fillet.

Planed Edges.

143. Sheared edges of all plates more than ⅝-inch thick must be planed at least ⅛-inch.

Assembling.

144. Riveted members shall have all parts well pinned up and firmly drawn together with bolts before riveting is commenced. Contact surfaces to be painted. (See 173.)

Lattice Bars.

145. Lattice bars shall have neatly rounded ends, unless otherwise called for.

Web Stiffeners.

146. Stiffeners shall fit neatly between flanges of girders. Where tight fits are called for the ends of the stiffeners shall be faced and shall be brought to a true contact bearing with the flange angles.

Splice Plates and Fillers.

147. Web splice plates and fillers under stiffeners shall be cut to fit neatly against flanges.

Web Plates.

148. Web plates of girders which have no cover plates shall be flush with the backs of angles or project above the same not more than ⅛-inch unless otherwise called for. When web plates are spliced, not more than ¼-inch clearance between ends of plates will be allowed.

Floor Beams and Stringers.

149. The main sections of floor beams and stringers shall be milled to exact length after riveting, and the connection angles accurately set flush and true to the milled ends. In case the milling of connection angles is necessary after riveting, the removal of more than 1/16-inch of their thickness will be cause for rejection.

Rivets.

150. Rivets shall have heads of approved shape, full and concentric with shank. Rivets made in worn dies or exhibiting any lips, fins or fillets on head or shank, will be rejected.

Riveting.

151. Rivets shall be uniformly heated to a light cherry red heat in a gas or oil furnace so constructed that it can be adjusted to the proper temperature. They shall be driven by pressure tools wherever possible. Pneumatic hammers shall be used in preference to hand driving.

152. Rivets shall be neat and finished, with heads of approved shape, full and of equal size. They shall be central on shank and grip the assembled pieces firmly. Recupping and calking will not be allowed. Loose, burned or otherwise defective rivets shall be cut out and replaced. In cutting out rivets, great care shall be taken not to injure the adjacent metal. If necessary, they shall be drilled out.

Turned Bolts.

153. Wherever bolts are used in place of rivets which transmit shear, the holes shall be reamed parallel and the bolts shall make a driving fit, with the threads entirely outside of the holes. A washer not less than ¼-inch thick shall be used under nut.

Members to be Straight.

154. The several pieces forming one built member shall be straight and fit closely together, and finished members shall be free from twists, bends or open joints.

Finish of Joints.

155. Abutting joints shall be cut or dressed true and straight and fitted close together, especially when open to view. In compression joints, depending on contact bearing, the surfaces shall be truly faced, so as to have even bearings after they are riveted up complete and when perfectly aligned.

Field Connections.

156. Holes for floor beams and stringer connections shall be sub-punched and reamed to a steel templet, not less than one-inch thick. All other field connections, except those for laterals and sway bracing, shall be assembled in the shop and the unfair holes reamed; and when so reamed the pieces shall be match-marked before being taken apart.

Eye-Bars.

157. Eye-bars shall be straight and true to size and shall be free from twists, folds in the neck or head, or any other defect. Heads shall be made by upsetting, rolling or forging. Welding will not be allowed. The form of heads will be determined by the dies in use at the works where the eye-bars are made, if satisfactory to the Engineer, but the manufacturer shall guarantee the bars to break in the body when tested to rupture. The thickness of head and neck shall not vary more than 1/16-in. from that specified. (See 183.)

Boring Eye-Bars.

158. Before boring each eye-bar shall be properly annealed and carefully straightened. Pin-holes shall be in the center line of bars and in the center of heads. Bars of the same length shall be bored so accurately that, when placed together, pins 1/32-in. smaller in diameter than the pin-holes can be passed through the holes at both ends of the bars at the same time without forcing.

Pin-Holes.

159. Pin-holes shall be bored true to gages, smooth and straight; at right angles to the axis of the member and parallel to each other, unless otherwise called for. The boring shall be done after the member is riveted up.

160. The distance center to center of pin-holes shall be correct within 1/32-in., and the diameter of the holes not more than 1/50-in. larger than that of the pin, for pins up to 5-in. diameter, and 1/32-in. for larger pins.

Pins and Rollers.

161. Pins and rollers shall be accurately turned to gages and shall be straight and smooth and entirely free from flaws.

Screw Threads.

162. Screw threads shall make tight fits in the nuts and shall be U. S. standard, except above the diameter of 1⅞ in., when they shall be made with six threads per inch.

Annealing.

163. Steel, except in minor details, which has been partially heated, shall be properly annealed.

Steel Castings

164. Steel castings shall be free from large or injurious blowholes and shall be annealed.

Welds.

165. Welds in steel will not be allowed.

Bed Plates.

166. Expansion bed plates shall be planed true and smooth. Cast-wall plates shall be planed top and bottom. The finishing cut of the planing tool shall be fine and correspond with the direction of expansion.

Pilot Nuts.

167. Pilot and driving nuts shall be furnished for each size of pin, in such numbers as may be ordered.

Field Rivets

168. Field rivets shall be furnished to the amount of 15 per cent. plus ten rivets in excess of the nominal number required for each

size. If any additional field rivets are necessary they shall be furnished by the contractor for erection at his own cost.

Shipping Details.

169. Pins, nuts, bolts, rivets and other small details shall be boxed or crated.

Weight.

170. The scale weight of every piece and box shall be marked on it in plain figures.

Finished Weight

171. Scale weights of the finished metal work shall be the basis of payment for pound price contracts, provided these weights do not exceed the weights as computed from the plans by more than 2 per cent.; in which case the computed weights, plus 2 per cent., shall be the basis of payment.

No blocking, boxing, paint, cement or other material which may be shipped along with the metal work shall be included in the shipping weight.

No allowance will be made for paint applied after a member is weighed.

The contractor shall furnish to the Railway Company certificate of accuracy of the scales from some reputable scale manufacturer or inspection bureau.

VIII. SHOP PAINTING.

172. Steel work, before leaving the shop, shall be thoroughly cleaned and given one good coating of such paint as may be called for, well worked into all joints and open spaces. No steel work shall be painted before being accepted by the inspector.

Contact Surfaces.

173. In riveted work the surfaces coming in contact shall each be painted before being riveted together.

Inaccessible Surfaces.

174. Pieces and parts which are not accessible for painting after erection, including tops of stringers, eye-bar heads, ends of posts and chords, etc., shall have an additional coat of paint before leaving the shop.

Condition of Surfaces.

175. Painting shall be done only when the surface of the metal is perfectly dry. It shall not be done in wet or freezing weather, unless protected under cover.

Machine-Finished Surfaces.

176. Machine finished surfaces shall be coated with white lead and tallow before shipment or before being put into the open air.

IX. INSPECTION AND TESTING AT THE SHOPS.

177. The inspection of material and workmanship and verifying of weights at the shop will be conducted by the Railway Company's Superintendent of Tests or his representative. The manufacturers shall furnish all facilities for this work at the shop, where the material is being manufactured. He shall furnish a suitable testing machine for testing full-sized members, if required.

178. The Railway Company shall be notified well in advance of the starting of any work in the shop, in order that its inspector may be on hand.

179. The inspector shall have full access at all times to all parts of the shop where material under his inspection is being manufactured.

Accepting Material.

180. The inspector shall stamp each piece accepted with a private mark. Any piece not so marked may be rejected at any time and at any stage of the work. If the inspector, through an oversight or otherwise, has accepted material or work which is defective or contrary to the specifications, this material, no matter in what stage of completion, may be rejected by the Railway Company.

181. Two complete copies of all shipping invoices shall be furnished to the Railway Company with each shipment. They shall show the scale weights of the individual pieces.

X. FULL-SIZED TESTS.

Eye-Bar Tests.

182. Full-sized tests on eye-bars and similar members, to prove the workmanship, shall be made at the manufacturer's expense, and shall be paid for by the purchaser at contract price, if the tests are satisfactory. If the tests are not satisfactory, the members represented by them will be rejected.

183. In eye-bar tests, the minimum ultimate strength shall be 55,000 lbs. per square inch. The elongation in 10 feet, including fracture, shall be not less than 15 per cent. Bars shall break in the body, and the fracture shall be silky, or fine granular, and the elastic limit as indicated by the drop of the mercury shall be recorded.

XI. ERECTION.

General.

184. Unless otherwise specified, the contractor will furnish all tools, appliances, labor, falsework, and other materials; remove, as may be directed, the existing structure, if any, including any old falsework;

erect complete and paint the new structure; furnish and set all anchor bolts; frame and place the wooden floor; remove all falsework, debris or other obstructions, and upon completion leave the new structure in perfect condition ready for service.

Train Service.

185. The Railway Company will generally furnish train service from the nearest station to the site of the work for delivering contractor's material and for receiving contractor's erection outfit when the work is completed.

186. Contractor must give Railway Company at least twenty-four hours' notice when train service is required.

Demurrage.

187. Contractor must receive the material, unload same and release the cars promptly upon their delivery, or he will be required to pay regular demurrage charges.

Handling and Storage.

188. Contractor must carefully unload and store all material to avoid injury to same. Bridge members must be placed on skids above ground so as to be kept clear, and set on edge if necessary, so as not to hold water. Any material damaged in handling may be rejected.

Flagmen and Watchmen.

189. Contractor will be required to furnish whatever watchmen and flagmen are necessary to protect traffic and materials.

Manner of Erection.

190. The method of erection will generally be at the discretion of the contractor, who must submit the erection plans to the Engineer for approval; such approval, however, shall not relieve the contractor of any responsibility.

Maintaining Traffic.

191. When railway traffic is to be maintained during erection, the contractor must conduct his work in a safe manner and cause the very least possible delay to traffic. He will be responsible for any interference with street traffic or navigation caused by his operations.

Derrick Cars.

192. Contractor must obtain permission from the Railway Company before using derrick cars on main track; and, if required, they shall be in charge of a regular train crew at the expense of the contractor.

Falsework.

193. Any falsework which carries railway traffic shall be maintained to the satisfaction of the Railway Company's representative, and any changes in structures carrying traffic required for the purpose of facilitating erection shall be made by the contractor to the satisfaction of the Railway Company's representative.

Masonry Changes.

194. When changes in masonry are necessary to accommodate the new structure, the changes will be made by the Railway Company dur-

ing erection, and between the time of the removal of the old and placing of the new structures. The contractor will arrange his falsework and allow its use by the Railway Company to facilitate the necessary masonry changes, without additional cost to the Railway Company. When required by the Railway Company, contractor will allow the use of his traveler for the purpose of assisting in making the above changes, the use of the traveler to be paid for by the Railway Company at actual cost of labor to handle the traveler for such use, plus ten per cent.

Removing Old Structures.

195. Released structures shall be removed with the least possible damage, and loaded on cars, or neatly piled on skids at the site convenient for future handling, as may be directed. Proper driving nuts will be used to protect the threads of the pins. All damaged or lost parts of the old structure shall be replaced or paid for by the contractor, if he has been previously notified that the old structure is to be re-erected. If the old structure consists of more than one span, each span shall be loaded or piled separately.

Fitting Up New Work.

196. The new structure shall be properly located on the masonry and all members shall be adjusted to correct position before the riveting is started.

Bolting Field Splices.

197. Before riveting, all parts must be drawn tightly together with a sufficient number of bolts to avoid open joints after riveting. At least three-fourths of the holes in floor beam and stringer connections shall have bolts when the connections are required to carry traffic at slow speed.

Compression Splices.

198. Rivets in splices of compression members with faced ends shall not be driven until the members have been subjected to full dead load stress.

Tension Splices.

199. Bottom chord splices in trusses shall be fully riveted before the trusses are allowed to carry traffic.

Pins and Bolts.

200. Proper pilot and driving nuts shall be used for driving all pins. All nuts shall be effectively locked by burring threads or by some other approved method.

Field Riveting.

201. Rivets shall be uniformly heated to a cherry red color and driven by pneumatic hammers in preferance to hand driving. Rivet heads shall be neat and finished. They shall be central on shank, of approved shape, full and of equal size. Rivets shall completely fill the holes, be tight, and grip the assembled pieces firmly. Recupping and calking will not be allowed. No loose, burned, or otherwise defective

rivets will be allowed. In case rivets are to be removed, great care shall be taken not to injure the adjacent metal. If necessary, they shall be drilled out.

Anchor Bolts.

202. Contractor shall drill anchor bolt holes with great care to avoid damage to masonry, and in case of such damage, repairs will be made at his expense. Anchor bolts will be set in cement grout or lead, as may be desired.

Wooden Floor.

203. The Railway Company will furnish at the bridge site the necessary ties and guard timbers for the floor. The contractor will frame the floor timbers, bolt the same in place, properly connect the new flooring to old floor when any exists, and line and spike the track. All ties shall be dapped to give a full and even bearing on the girders or stringers and under the rails. Guard rails shall be framed to a tight fit over ties and secured as shown on plans.

Painting.

204. The completed structure shall be painted two field coats of such paint as may be called for, well worked into all joints and open spaces. The metal work shall be thoroughly cleaned of all rust, loose scale, blistered or damaged paint, before applying the field paint. The first coat must be allowed to thoroughly dry before applying second coat. First field coat must have different color from shop coat, and second field coat from first coat. Each coat must entirely cover previous coats. Tops of stringers and deck girders must receive field paint before wooden floor is placed. No painting shall be done in wet or freezing weather, and only when the surface of the metal is thoroughly dry.

Responsibility.

205. Contractor will assume all risks and be responsible for any loss or damage of whatsoever nature, to himself or the Railway Company, occasioned by flood, accident, fire or any other cause, until the structure is completed and accepted by the Railway Company. He will also be responsible for any or all damage to other property adjacent to the railway incident to the work.

Laws and Permits.

206. Contractor shall obtain all necessary permits and shall comply with all laws and ordinances controlling the work.

Track Changes.

207. Any spur tracks necessary for the contractor's use will be built by the Railway Company at the contractor's expense.

Inspection and Acceptance.

208. The work shall be carried on in a manner satisfactory to the Engineer, and will be subject to his inspection and approval at all times.

HIGHWAY BRIDGES AND BUILDINGS.

XII. HIGHWAY BRIDGES.

209. The above specifications for Railway Bridges shall apply to Highway Bridges with respect to unit stresses, details of design, material, workmanship, inspection, erection and painting as far as practicable, and except as noted hereafter.

Clearance.

210. Unless otherwise called for, all through bridges shall have a clear height of 15 feet.

The supports of all bridges over the railway tracks shall preferably clear main line tracks on tangent at least 10 feet, measured at the top of rail from center line of track. These distances shall be increased for curvature in accordance with Article 2.

211. Steel columns adjacent to railway tracks shall preferably be protected against injury from derailment by encasing them in concrete at least two feet thick, and extending at least five feet high above rail.

Dead Load.

212. For determining the dead load, the weight of plain timber shall be assumed as 4½ pounds per foot B. M.; creosoted lumber 6 pounds per foot B. M.; reinforced concrete and paving brick 150 pounds per cubic foot; wood block paving 75 pounds per cubic foot; granite stone 160 pounds per cubic foot; sand 100 pounds per cubic foot; street car rails and fastenings 100 pounds per linear foot of track.

Live Load.

213. The live load shall be as specified, or one of the following classes be used as directed.

Class A—City and suburban traffic:

For the floor and its supports a uniform load of 100 pounds per square foot of surface of the roadway and sidewalks; or concentrated load of 15-ton road roller, eleven feet between centers of axis, with 12,000 pounds on forward wheel four feet wide, and 9,000 pounds on each of two rear wheels five feet between centers and twenty inches wide.

For the trusses or girders 100 pounds per square foot of floor surface for spans 100 feet or less, and 80 pounds per square foot for spans 200 feet or over, and proportionally for intermediate spans.

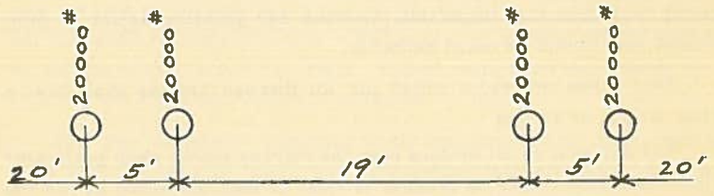
Class B—County Bridges:

Loads 80 per cent. of the above.

Electric Cars

214. Electric Cars. Unless otherwise specified, a train of 40-ton electric cars will be used on each track.

Wheel spacing and axle loads as follows:



Electric car load assumed to occupy a width of twelve feet and combined with above uniform load.

Live load stresses produced by electric cars shall be increased 50 per cent. of the amount given in Article 13, to take care of the effect of impact and vibration.

Lateral Load.

215. A lateral load of 150 pounds per lineal foot of bridge shall be provided for at the unloaded chord, and of 200 pounds considered as moving at the loaded chord.

Distribution of Loads.

216. One-half the weight of the trusses and bracing shall be considered as applied at the unloaded chord, all other dead loads to be considered as applied to the loaded chord.

For floor beams the uniform load shall be assumed to cover both roadway and sidewalk simultaneously. The concentrated load shall be assumed to act with the sidewalk unloaded.

For trusses or girders generally one-half the roadway load and its adjacent sidewalk load shall be assumed as supported by the truss or girder.

When three trusses or girders are used the middle truss or girder shall be assumed to carry one-half the total roadway load.

The uniform load will be considered as moving in computing shears, neglecting the counter action from the partial panel load ahead.

Unit Stresses.

217. Steel hangers for floor beams shall be designed for a tensile unit stress of 12,000 pounds per square inch.

For timber stringers of yellow pine, the maximum fibre stress for bending shall be 1,200 pounds per square inch; compression on side of grain 350 pounds per square inch; shear along grain 80 pounds per square inch; compression in columns $1{,}000 - 10\frac{\text{length.}}{\text{least width.}}$

218. In designing steel floor beams, the timber floor joists shall not be considered as supporting the top flange.

Timber Floor

219. Floor plank for roadway shall be not less than 3 inches thick when one layer is used; when two layers are used, each layer shall be at least 2 inches thick and the bottom layer shall be dressed to even thickness.

Sidewalk floor plank shall be at least 2 inches thick, dressed to even thickness.

Planks shall be securely nailed to floor joist at each intersection.

All timber joists shall be at least 3 inches thick and shall be spaced not over 2½ feet centers for roadway, or 3 feet for sidewalk.

The intermediate joist shall, where possible, lap by each other at their ends, each having a full bearing on the floor beams. The outside lines shall abut over floor beams.

All joist shall be notched ½-inch over floor beams. The outside lines, and at least two intermediate lines, shall be securely attached to floor beam.

In designing roadway floor joists 2/3 the concentrated wheel load shall be considered as supported by each joist.

Lumber shall generally be long leaf yellow pine. White oak plank may be used for the wearing surface of roadway when two layers are used.

Rivets.

220. Size of rivets may be ⅞-in., ¾-in. or ⅝-in.

Minimum Sections.

221. No metal less than 5/16-in. thick shall be used, except for fillers and minor parts. No channels less than 5 inches nor angles less than 2½x2½ inches will be permitted. The minimum size for lateral rods shall be 1 inch square.

Allowance for Corrosion.

222. When the metal is exposed to the action of the injurious gases, the calculated section shall be increased 1/16-in. in thickness, and the minimum thickness of metal will be ⅜-in.

XIII. ROOFS AND BUILDINGS.

223. The above specifications for Railway Bridges shall apply to Roofs and Buildings with respect to unit stresses, details of design, material, workmanship, inspection, erection and painting as far as applicable, and except as noted below.

Loads.

224. Roofs shall generally be designed for a live load of 25 pounds per square foot to cover snow or other loads occurring on roof during construction.

Horizontal wind pressure shall be assumed at 30 pounds per square foot of exposed vertical surface. The wind load in pounds per square foot on roofs shall be taken from the following table, which is computed in accordance with Hutton's formula:

PITCH	VERTICAL	HORIZONTAL	NORMAL
½	19	19	27
1-3	17	12	22
¼	15	8	18
1-5	13	6	15
1-6	11	4	13

Roofs shall be designed to carry such concentrated loads from shafting, cranes, etc., as may be specified.

In addition to the above live loads the structure shall be designed for a dead load consisting of the weight of the metal work, rafters, sheathing, etc., the weight of timber being assumed at 4½ pounds per foot B. M.

Minimum Sizes.

225. Articles 220 and 222 relative to rivets and minimum sizes of metal subject to gases, shall also apply to roofs and buildings. The minimum size angle shall be 2½x2 inches and minimum thickness of metal ¼-in.

Timber.

226. The unit stresses for timber specified in Article 217 for Highway Bridges shall also be used for roofs and buildings.

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