METHOD OF DESIGN

of

DECK PLATE GIRDER BRIDGE

by

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DECK PLATE GIRDER BRIDGE

Span 40 ft.

Thesis of Sim. B. Christy Jr.

June, 1919

GENERAL DESCRIPTION

Ties on tangents will be 8 inches by 10 inches laidon 8 inch face and spaced 14 in. between centers; guard rails will be 7 inches by 7 inches and spaced 7 ft.-8 1/2 in. between centers. Ties will be notched 3/4" over stringers and guard rails, and 3/8" over ties. Guard rails will be bolted to each end of every other tie; and ties and guard rails will be secured to stringers by hook bolts at each end of every fourth tie.

Beams or deck girders on masonry will be spaced 7 ft.-0" center to center (ties 10 ft. long) .

Live Load will be COOPERS CLASS E-50 as per diagram.

Variation in length for change of tempreture to the amount of 1" in 100 ft. shall be provided for by sliding plates.

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METHOD of DESIGN

The stresses and shear in the various sections of the girder will be obtained from diagram.

THE TRACK

Assume weight of rails to be 80 lbs. per yard and that the maximum weight on each cross tie is approximately one half the load on one driver or 10000lbs. The rails are 4 ft.- 11" apart center to center and equidistant from center ,its span is 7 feet. The effective depth will be taken at 9-1/2 inches due to notches in ties, the unit stress in the outter fiber will be 1095 lbs. per square inch due to wheel load alone, to this add 20 lbs, for rails . Southern Pine timber has a safe unit stress of 1200 lbs. therefore it may be used.

DEPTH of GIRDER

To obtain the ecconomical depth of girder use formula $h^2 = 2M/st$ where h equal depth of girder, s the unit stress of the material used, t the thickness of the web, and M the absolute maximum moment . With this formula h will be found to equal 58.34 inches therefore for safety and convenience we will use a girder 5 feet deep.

SECTIONAL AREA of FLANGES

From the diagram the flange stresses may be found ;

Dead Load------------------------	18000	lbs.
Live Load------------------------	164000	lbs.
Maximum Stress------------------	182000	lbs.
Minimum Stress------------------	18000	lbs.

Therefore from formula $9000(1+\text{min./max.})$ the unit stress for medium steel ,allowing 25% increase, gives 9882 lbs. The area of the flange section is hence $182000 \div 9882 = 18.32$ square inches.

The effect of the wind was here considered and found that due to the shortness of the girder it was not necessary to take it into account.

Now considering the area to be used the following pieces are selected.

2 Equal Angles	6"x 6"x 1/2" = 2(5.75-1.5) =	8.5 sq. in.
1 Plate	14"x 1/2" = 7.0-2.1 =	4.9 " "
2 Plates	14"x 3/8" = 2(5.25-2.1) =	6.7 " "
		20.1 sq. in.

WEB SECTION

The web is to be proportioned to take the entire vertical shear, the unit stress being 6000 lbs. per sq. in. At the support this will require $104000 \div 6000 = 17.33$ sq. in.

But since no plate is to be less than 3/8" from practical specifications and web plates are rarely made to exceed 1/2" in thickness and since the rivet holes in the web are punched 15/16" in diameter we may assume a web plate 3/8" thick which will have a gross sectional area of 60 x 3/8" = 22.5 sq. in. and will allow 14 rivets which will just be enough to fullfill our condition, therefore we will use plates 5 ft. x 10ft. x 3/8" with stiffners every 5 ft. and riveted on with 14 rivets in a row.

WEB SPLICES

The webs are to be spliced at every other 5 ft. division the thickness of the splice plate is to be the same as the web that is 3/8" thick and 14 " wide.

At least 4 rows of rivets will be required, the outter spaced 1 3/4" from edge and the distance between the inner and outter will be 2 3/4" since the inner rows are to be 5" apart in order to give room for the 3 1/2" stiffeners.

The number of rivets required is found by determining the strength of a 7/8" rivet. The unit shearing stress of soft steal rivets is 6600 lbs. per sq. in. and the area of a 7/8" rivet is 0.6013 sq. in. Therefore in double shear 0.6013 x 6600 x 2 = 7640 lbs. but the bearing strength in a 3/8" plate is 7/8" x 3/8" x 13200 = 4330 lbs. Hence at 10 ft. splice we have 63500 lbs. ÷ 4330 = 14.7 rivets. In the following manner the 20 ft. splice could be found to require only 7 rivets but due to the center of the span falling at the 20 ft. splice and for uniformity we will use 15 rivets in a row and staggered for 4 rows through out the entire bridge.

WEB STIFFENERS

It is impossible to determine theoretically what size angles are needed as stiffeners but assumptions are made according to the depth of the girder.

Let 5" x 3 1/2" angles be used as stiffeners and where there are no splice plates let and additional 3/8" filler be used in order not to have to bend the stiffener over the flange angle.

The spacing of the rivets in the flange will be the same as in the stiffeners.

LENGTH OF COVER PLATES

To determine the length of the cover plates calculate the net sectional area and knowing the live load bending monents find what distance from the center the bending moments correspond to the bending moment for the calculated sectional area.

These distances will be found to be for the longer plate 14.3 ft. from the center and for the shorter 9.2 ft. from center.

BED PLATES

The expansion due to tempreture is to be taken care of by sliding plates . One plate is to be riveted on the lower side of the girder the other is to be bolted into the masonry and angles are to be bolted to it forming a channel for other plate to slide in . This arrangement is to be only on one end the other end being fixed by bolting to the masonry .

UPPER LATERAL SYSTEM

Since these members have to take both compression and tension we use two formulas for the unit stress . For compression only 12600 - 60 l/r.

For the greatest stress.   8400(1-max. lesser/2 max.greater)
Now after obtaining the unit stress in all the members find the stress in the member due to wind and divide the stress by the unit stress finding the area required and select an angle suitable to this sectional area . The following angles will be found to fit the given conditions.

2 members of 2 angles each	3"x 3" x 1/2" = 4.62 sq. in.	
1 member of one angle	4"x 3" x 1/2" = 3.25 " "	
1 member of one angle	4"x 3" x 7/16"= 2.9 " "	

LOWER LATERAL SYSTEM

The wind panel load on the lower system is found to be 795 lbs. and the greatest stress in the second lateral brace is 2968 lbs. in tension and 3465 lbs. in compression and the unit stress is 2430 therefore the gross area is 3465 ÷ 2430 = 1.42 sq. in. hence use 3"x 3" x 7/16" angle .

The first brace will require a smaller section due to its shortness but in view of the stress due to its own weight and secondary stresses due to eccentric connections we will use a 3"x 3"x 7/16" angle . The stresses in the third and fourth members differ very little from the stress in the second member and we are on the safe side by assuming braces as 3"x 3"x 7/16" angles.

TRANSVERSE BRACING

The intermediate transverse bracing is inserted as an aid in securing general stiffness for the structure . The stress due to wind is transmitted through the lateral system and the girders .

The transverse bracing is located at the middle and composed of 3"x 3"x 3/8" angles united by small plates 3/8" thick.