Design of a concrete-steel highway bridge for Dry Fork Crossing, Salem Road, Phelps County, Mo.

Edward V. Damotte

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DESIGN OF A CONCRETE-STEEL HIGHWAY BRIDGE

for

Dry Fork Crossing-Salem Road

Phelps Co. Mo.

By

Edward V. Damotte

A

THESIS

Submitted to the faculty of the

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

DEGREE OF

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

Rolla Mo.

1916.

Approved by:  

19559
Design Of A Concrete Steel Highway Bridge For Dry Fork Crossing - Salem Road

Data:

Clear Roadway - 16 feet.
5 Spans, clear 100 feet.
Live load, 16 Ton Road Engine, 2/3 weight on one axel or 12 3 lbs. per sqft. of surface.
Dead load, Concrete as hereafter determined plus 8 inches of gravel.

\[ f_g = 16000 \text{ lbs per sqin}. \]
\[ f_c = 500 \text{ lbs per sqin}. \]
\[ n = 15 \]
\[ \phi = 0.005 \]

The above symbols are in general use.

Procedure

The load conveyed to the floor slab from each large wheel equals 10700 lbs. and from each small wheel 5350 lbs.
The weight of the slab per sqft. assuming 8 inches thickness which is safe equals 100 lbs. per sqft. The weight of gravel 8 inches in thickness equals 67 lbs.
Total weight per sqft. equals 166 lbs. say 170 lbs.

Considering a strip 1 foot wide as a beam between two supports, floor slab between longitudinal T girders, see Plate 6 Type 4 for dimensions,

\[
M = \frac{4 \times 12 \times 5330}{4} + \frac{170 \times 8 \times 8 \times 12}{8}
\]

\[
= 30520 \text{ in. lbs.}
\]

Solving for steel area using the approximate formulae derived in Turneaure and Waurer, Art. 54, formulae 3'.

\[
A_s = \frac{M}{f \cdot j \cdot d}
\]

\[
A_s = \frac{80520}{16000 \times 7/3 \times 8}
\]

\[
A_s = .72 \text{ sqin. steel.}
\]

Cantilevers projections of floor slabs.

The cantilevers are 42 inches in length as shown in Plate 6 Type 4. But the load can only act out a distance of 20 inches.

The moment then becomes.

\[
\frac{W_{L \cdot L}}{L} + \frac{W_{D \cdot L}}{L} = \frac{5000 \times 20}{1} + \frac{400 \times 20}{1}
\]

\[
= 108000 \text{ in. lbs.}
\]
For the lateral slab reinforcement 3-5/8" round rods will be used.

**Longitudinal T Beams.**

The Total dead load equals 3000 lbs. per foot.

The moment then equals;

\[ M_{D.L.} = \frac{WL^2}{8} \]

\[ M_{D.L.} = \frac{3000 \times 20 \times 20 \times 12}{8} \]

\[ M_{D.L.} = 1800000 \text{ in. lbs.} \]

Live load equals 125 lbs. per sqft. Total load then equals

40000 lbs. or 20000 lbs. over one beam.

\[ M_{L.L.} = \frac{20000 \times 20 \times 12}{8} \]

\[ M_{L.L.} = 600000 \text{ in. lbs.} \]

\[ M_{D.L.} + M_{L.L.} = 2400000 \text{ in. lbs.} \]
Using a 32 in. beam with d equals 28 inches and solving for the area of steel.

\[
A_s = \frac{M}{fs \cdot jd}
\]

\[
A_s = \frac{2400000}{1600 \times 28}
\]

\[
A_s = 5.35 \text{ sqin. steel.}
\]

For T beam reinforcement 8-7/8" square rods will be used.

**Estimate Cost**

Concrete ------ 17.8 cuyds. @ $5.00 = $89.00

Steel ------ 2228 lbs. @ $0.45 = $100.00

Super Structure 5 Spans = $946.00

**Piers And Abutments**

4 Piers 17' x 15' x 2' are to be used.

2 Abutments 17' x 15' x 2' are to be used.

Concrete ------ 111.2 cuyds. @ $5.00 = $556.00
Wing Walls

The wing walls are considered as a vertical slab fixed at both ends. Designing each foot as a beam fixed at both ends.

The formulae:

\[ M = \frac{1}{18} \text{wh}^3 \]

as derived by TurneaudeMaurier page 372, was used.

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The detail of the placing of the rods is shown in the detail Drawings, Plate 8.
The slab is 9 inches thick and has a footing of 18 inches. 1-1/2" round rod is placed vertically each foot in the wall to prevent unsightly horizontal cracks. The horizontal reinforcement extends into the abutment 18 inches as shown.

Estimate

Concrete ---- cuyds -- 15.2 @ $5.00 = $76.00
Steel ---- lbs. -- 600 @ $.45 = $270.00

TOTAL 4 walls = $416.00

Total Cost

Superstructure --- $946.00
Piers and Abutments $556.00
Concrete and Steel in place = $1918.00

Note:--

The above estimate does not include excavating and filling.

A study was made of 3 different types of reinforced concrete. The investigation was conducted in the same manner as the above:
(7)

Using the same data and investigating with a 25 feet span. The following results were obtained.

Type 1. Plate 3.

Cubds. Concrete  \(32 \times 5.00\) = \$160.00
Steel in lbs. 2422.4 \(\times 0.045\) = \$109.00
\[\text{Total 4 spans} = \$1076.00\]

Type 2. Plate 4.

Cubds. Concrete 24.2 \(\times 5.00\) = \$121.00
Steel in lbs. 4664 \(\times 0.045\) = \$211.00
\[\text{Total 4 spans} = \$1428.00\]

Type 3. Plate 5.

Cubds. Concrete 20 \(\times 5.00\) = \$100.00
Steel in lbs. 5678 \(\times 0.045\) = \$255.50
\[\text{Total 4 spans} = \$1422.00\]

It will be noted that Type 1 Plate 3 is the more economical. A further investigation using a 20 feet gives the following results.
Type 1. Plate 6.

Guyds. concrete -- 17.3 @ 5.00 = $89.00
Steel in lbs. 2228 @ .045 = $190.00

Total 5 spans = $946.00

The additional cost of the extra pier equals

18.5 guyds. concrete @ 5.00 = $92.50.

Adding this to the total cost of the super structure gives $1038.75 which is lower than Type 1. Plate 3.

The following designs and drawings are based upon the above figures.