1916

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

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DESIGN OF A CONCRETE-STEEL HIGHWAY BRIDGE

for

Dry Fork Crossing-Salem Road

Phelps Co. Mo.

By

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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

BATCHLOR OF SCIENCE IN CIVIL ENGINEERING

Rolla Mo.

1916.

Approved by: Elmo G. Harris

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 125 lbs. per sqft.of surface.

Dead load, Concrete as hereafter determined plus 8 inches of gravel.

f_s = 16000 lbs per sqin.

f_c = 500 lbs per sqin.

n = 15

p = .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,

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

$$= 80320 \text{ in. lbs.}$$

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

$$A_s = \frac{M}{f_s jd}$$

$$A_s = \frac{80320}{16000 \times 7/8 \times 8}$$

$$A_s = .72 \text{ sqin. steel.}$$

Cantilevere projections of floor slabs.

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

The moment then becomes.

$$M_{L.L.} + M_{D.L.}$$

$$= \frac{5000 \times 20}{1} + \frac{400 \times 20}{1}$$

$$= 108000 \text{ in. lbs.}$$

$$A_s = \frac{M}{f_s\, jd}.$$

$$A_s = \frac{108000}{16000 \times 7/8 \times 8}.$$

A_s = .96 sqin. steel.

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 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 in. lbs.

$M_{D.L} + M_{L.L.}$ = 2400000 in. lbs.

Useing a 32 in. beam with d equals 28 inches and solving for the area of steel.

$$A_s = \frac{M}{f_s jd}.$$

$$A_s = \frac{2400000}{16000 \times 28}$$

$$A_s = 5.35 \text{ sqin. steel.}$$

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. @ $.045 =$ 100.00

$ 189.00

Super Structure 5 Spans ------------------ = $ 946.00

Piers And Abutments

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

2 Abutments 17' × 15' × 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. Desiging each foot as a beam fixed at both ends.

The formulae:-

$M = 1/18\ wh^3$ as derived

by Turneau and Maurier page 372, was used.

h	p	H	M	A_s
1	33	17	67	
2	67	67	533	
3	100	150	1800	.134 -- 2 -- 3/16" round rods.
4	133	267	4267	
5	167	417	8333	.12 -- 2 -- 5/16" " " .
6	200	600	14400	
7	233	817	22867	
8	267	1067	34133	.27 -- 2 -- 7/16" " " " .
9	300	1350	48600	
10	333	1667	66667	.53 -- 2 -- 5/8" " " " .
11	367	2017	88733	
12	400	2400	115200	.92 -- 3 -- 5/8" " " .

The detail pf 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	@ $.045	=	$28.00
				+	$104.00
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.

Useing the same data and investigating with a 25 foot span. The following results were obtained.

Type 1. Plate 3.

Cuyds.	Concrete	-- 32	@ 5.00	= $ 160.00
Steel in lbs.		2422.4	@ .045	= $ 109.00
				$ 269.00
Total		4	spans	= $ 1076.00

Type 2. Plate 4.

Cuyds.	Concrete	24.2	@ 5.00	= $ 121.00
Steel	in lbs.	4664	@ .045	= $ 211.00
				$ 332.00
Total		4	spans	= $ 1428.00

Type 3. Plate 5.

Cuyds.	Concrete	20	@ 5.00	= $ 100.00
Steel	in lbs.	5678	@ .045	= $ 255.50.
Tptal		4	spans	= $ 1422.00

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

Type 1. Plate 6.

Cuyds. concrete — 17.8 @ 5.00	=	$ 89.00
Steel in lbs. 2228 @ .045	=	$100.00
		$189.00
Total 5 spans	=	$ 946.00

The additional cost of the extra pier equals

18.5 cuyds. 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.