REINFORCED CONCRETE SLAB BRIDGE DESIGN BASED ON TESTS OF FULL SIZE SLABS*

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In all of the slab tests at the Bureau of Public Roads, the method of procedure was to apply known concentrated loads on the slag specimens, which rested on two suports. The deformation of the steel reinforcing and concrete, and also the deflection were measured. These deformations or changes in length in the slab were always taken at the "dangerous section," where they were greatest. In a few cases, deformations were also measured over the entire area of the slab. A strain gag capable of measuring changes of 0.0002 of an inch was used in all of the tests, and in addition, the vertical deflections of the slab were obtained, generally by means of a micrometer head reading to 0.001 of an inch.

Theory of Application of Results of Tests.—Consider first a wide slab supporting a single load concentrated at its centre. The maximum deformation occurs under the load, and as the sides of the slab are approached, the deformation becomes smaller.

This curve of deformation is the same in shape for both the steel and concrete. The resisting moment of any slab is directly proportional to the area of the curve of unit deformation. Two similar slabs stressed to have the same area of unit deformation, even though their unit deformation curves are dissimilar in shape, exert equal resisting moments. The effective width of the slab is the width which may be considered as carrying the entire concentrated load. When the value for this width as determined by test is substituted in the common formulas for narrow rectangular beams, these formulas may be directly applied to the design of wide slabs.

A number of slabs have been tested as outlined above, and their effective widths have been obtained from the deformation curves, first, by getting the areas included between these curves and their base lines, then dividing these areas by their maximum ordinates. When the load is placed in the centres of the slab and the width of the slab is more than about twice the span length, the effective width may be considered as equal to seven-tenths of the span length of the slab.

A number of slabs have been tested with a central load and having width equal to twice their span lengths. Table I gives data on the slabs tested at the Bureau of Public Roads during the past 5 years.

Slabs Having Widths Less than Twice Their Span.—The foregoing discussion treats of slabs having widths equal to twice the span length, in which case the sides of the slabs are not stressed appreciably. When the width is less than this, however, stress does reach the sides, and the narrower the slab, the more are the sides put under stress. It will be recognized that the width of the slab plays an important part in influencing the effective width. The amount of this influence has been quite fully investigated by a number of slab tests, in which the width of the specimen has been decreased after each load application, the sides of the slab having been spilt off by means of plugs and feathers. It has been possible to obtain from these investigations the values for effective width given in Table III. These values also are plotted in Fig. 1.

*From "Public Roads."

Table II—Effective Widths Under Central Loads

Center Load.	Slab 835: 10½ in. Effective Depth.	Slab 930: 8½ in. Effective Depth	Slab 934: 6 in. Effective Depth
15,000	.....	11'.4=71.6 per cent span.	12'.7=79.5 per cent span.
20,000	11'.6=72.3 per cent span.	13'.0=81.2 per cent span.	17'.5=109.3 per cent span.
25,000	11'.5=71.9 per cent span.	12'.9=81.1 per cent span.	.....
32,500	12'.1=75.7 per cent span.	.....	.....
35,000	.....	14'.5=90.7 per cent span.	.....
Failure	119,000 lb.	80,000 lb.	40,000 lb.

Two Loads on the Slab.—When the span is such that a single axle load will control the maximum bending moment, the slab is subjected to two wheel concentrations, and the most dangerous condition exists when these wheels are midway between the supports. In order to investigate this condition, tests were made on slabs with two loads spaced 5 ft. apart on the centre line of the slab.

Table III—Values for Effective Widths

Total Width ÷ Span	Effective Width ÷ Span	Total Width ÷ Span	Effective Width ÷ Span
0.1	0.1	1.1	0.67
0.2	0.2	1.2	0.68
0.3	0.28	1.3	0.70
0.4	0.37	1.4	0.71
0.5	0.44	1.5	0.72
0.6	0.50	1.6	0.72
0.7	0.55	1.7	0.72
0.8	0.58	1.8	0.72
0.9	0.62	1.9	0.72
1.0	0.65	2.0	0.72

The above values may be used for spans up to 16 ft. at least, and probably for longer spans.

Note the fact that directly under the load the deformations are greatest, and are even slightly greater than the deformation at the centre of the slab. This stress distribution does not hold, however, for every thickness of slab, for a few of the tests show the deformation to be greatest at the centre. The effective width of slabs loaded in this way may, in general, be assumed as equal to the effective width due to a single load plus 4 ft.

Eccentrically Loaded Slab.—When a heavy load traverses a slab bridge it may not remain at the centre line, but may travel over the bridge near one side. Again there are often occasions where a heavy traction engine will stop at the side of a bridge spanning a stream, in order to replenish its sup-

Table I—Data on Slab Tests of Bureau of Public Roads

Slab No.	Dimensions Span Feet.	Dimensions Breadth Feet.	Depth Total In.	Depth Effective In.	Steel Percentage Longitudinal.	Steel Percentage Transverse.	Central Load Effective width ÷Span.	Failure Span.	Failure Central Load.
679	11.5	6	7	6	0.77	....	...	11.5	21,500
705	6	7	5	4	.91	....	0.9	..	.....
706	3	7	5	4	.91	0.41	...	3	42,800
730	5	7	6	5	.91	....	1.1	6	24,700
	6	..	..	..	...	....	.96	..	.....
736	6	7	4	3	.60	....	...	6	7,560
737	5	7	7	6	.75	.33	1.2	6	34,200
	6	..	..	..	...	....	1.2	..	.....
835	16	32	12	10½	.75	....	*	16	119,000
930	16	32	10	8½	.75	....	*	16	80,000
934	16	32	7	6	.75	....	*	16	40,000

*See next table.