From Table II., which gives the maximum stresses, it will be seen that the maximum compression stress in the concrete is 459 lbs. per sq. in., due to dead + live load, and 610 lbs. per sq. in. when the influences due to temperature variations are added. The allowable compression stress is nearly reached in all sections, while the tension stress in the steel has the maximum value of only 6,700 lbs. per sq. in., and the tension in the concrete 196 lbs. per sq. in.

Table II.—Maximum Stresses in Lbs. per Sq. In.

e = at extrados i = at intrados

Point.	Stresses due to p+g: Compression in concrete	Tension in steel	Stresses due to: Compression in concrete	Tension in steel	Tension in concrete
0	*e* 445	*i* compr.	*e* 570	*i* 980	*i* 69
1	*e* 459	*i* compr.	*e* 552	*i* 700	*i* 46
2	*e* 405	*i* compr.	*e* 435	*i* compr.	*i* compr.
3	*i* 440	*e* compr.	*i* 472	*e* compr.	*e* compr.
4	*i* 452	*e* compr.	*i* 567	*e* 1400	*e* 94
Springing line					
5	*i* 380	*e* 420	*i* 610	*e* 6700	*e* 196

In order to prove the correctness of the results derived by the above described method of calculations, a careful test loading was arranged. Three railway trucks, weighing about 48 tons each when loaded with potash

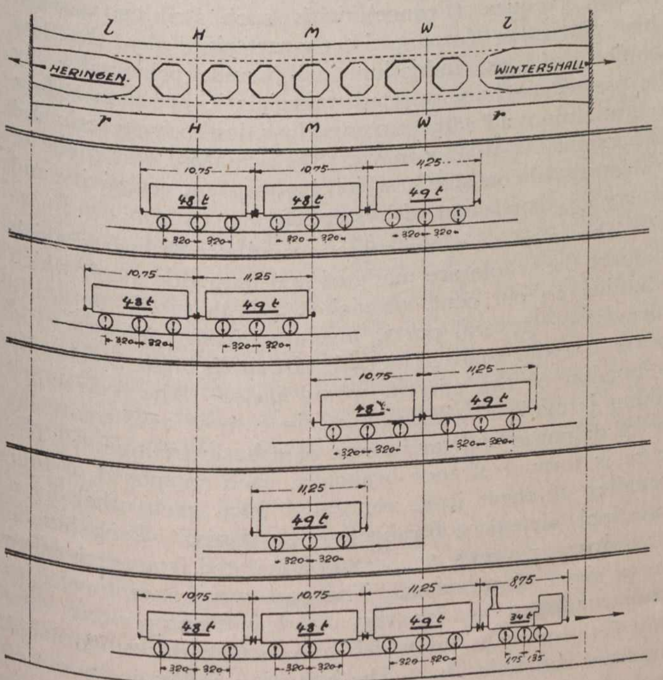

Fig. 9.

salts, and a locomotive weighing 34 tons, were used. Five different cases were examined (diagrammatically shown in Fig. 9):

(1) Three trucks placed symmetrically at the middle of the bridge.

(2) Two trucks, standing at the point at which the roadway is divided.

(3) The same as 2, at the opposite end.

(4) One truck at the middle.

(5) The whole train crossing the bridge at full speed.

The deflections were measured by means of wooden levers magnifying five times. Measurements were taken at both sides (called l and r in Fig. 9 and Table III.) in three vertical planes lettered H, M and W. The instruments were arranged in these three planes, not only under the bridge floor (called b) but also directly under the arches (a), so that the deflections were measured at twelve points in all. In Table III. are given the calculated and measured deflections. The results show a remarkably close agreement between them in all points, proving the possibility of computing correctly structures of this type. The modulus of elasticity derived from the test is 4,200,000 lbs. per sq. in., which is double that usually assumed in calculation. It must be remembered, however, that the concrete was five months old, and of

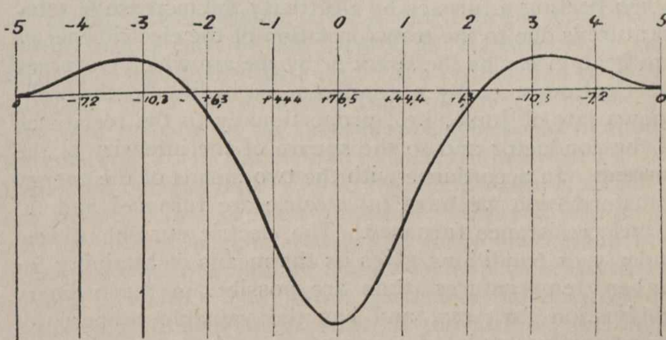

Fig. 10.

exceptionally good quality, being a 1:6 mixture of natural ballast from the Werra River with cement. Cubes of the same mixture gave a crushing strength of 5,100 lbs. per sq. in. after 28 days.

Table III.—Deflections in 1/25 of an Inch.

Loading Case	Side of Bridge	Location of Point	H Calculated	H Measured	M Calculated	M Measured	W Calculated	W Measured
1	*l*	*a*	+1.0	+1.0	+2.1	+2.2	+1.0	+0.7
		b	+1.4	+1.2	+2.9	+3.2	+1.4	+0.9
	r	*a*	+1.0	+1.0	+2.1	+2.2	+1.0	+1.2
		b	+1.4	+1.2	+2.9	+3.0	+1.4	+1.4
2	*l*	*a*	+2.5	+2.3	+1.0	+1.4	—1.5	—1.2
		b	+2.8	+2.0	+1.3	+1.3	—1 5	—1.2
	r	*a*	+2.5	+2.0	+1.0	+1.2	—1.5	—1.2
		b	+2.8	+2.2	+1.3	+1.4	—1.5	—1.2
3	*l*	*a*	—1.5	—1.2			+2.5	+2.4
		b	—1.5	—1.4			+2.8	+2.7
	r	*a*	—1.5	—1.2			+2.5	+2.6
		b	—1.5	—1.2			+2.8	+2.6
4	*l*	*a*			+1.7	+1.7		
		b			+2.5	+2.3		
	r	*a*			+1.7	+1.6		
		b			+2.5	+2.5		
5	*l*	*a*			+2.1	+2.4		
		b			+2.9	+3.2		
	r	*a*			+2.1	+2.4		
		b			+2.9	+3.2		

The deflections were calculated as bending moments produced by the "v" forces. The general expression for the "v" force, acting in the point m of the arch, is

$$V_m = \lambda M_m \frac{\sec \phi_m}{E J_m},$$

where λ is the distance between the points for which the "v" force is calculated (here 1/10 of the span), M_m is the bending moment, E the modulus of elasticity, J_m the moment of inertia at the point m, and ϕ the angle as defined above. In Fig. 10 is shown the influence line for the deflection at the crown; the figures written on the ordinates give the deflections in 1/25,000 of an inch for a force of one ton.