nature of the work some form of portable extensometer was necessary and for this, that known as the Berry strain gauge or some modification of it, has generally been used.

Any type of extensometer which has to be attached to a specimen and removed again between readings cannot possess the accuracy of measurement usually obtained from the stationary forms. Then, again, concrete is a material for which the ratio of stress to deformation is much more variable than it is for the metals. Moreover, for any given concrete and for all stresses above moderate working values, Hooke's law of proportionality between stress and strain does not obtain. Further, it is usually quite impossible to know at just what stage of the operation of loading, the concrete in tension will crack and throw upon the reinforcement the bulk if not all of the tension which it had been carrying. In consequence of these limitations it will be conceded that the figures obtained from the use of the portable extensometer, especially on concrete structures, must be interpreted in a broad and liberal manner and that they must not be considered as reflecting the last refinement of physical measurement. It should be noted, too, that the inevitable errors are probably relatively greater for small deforma-
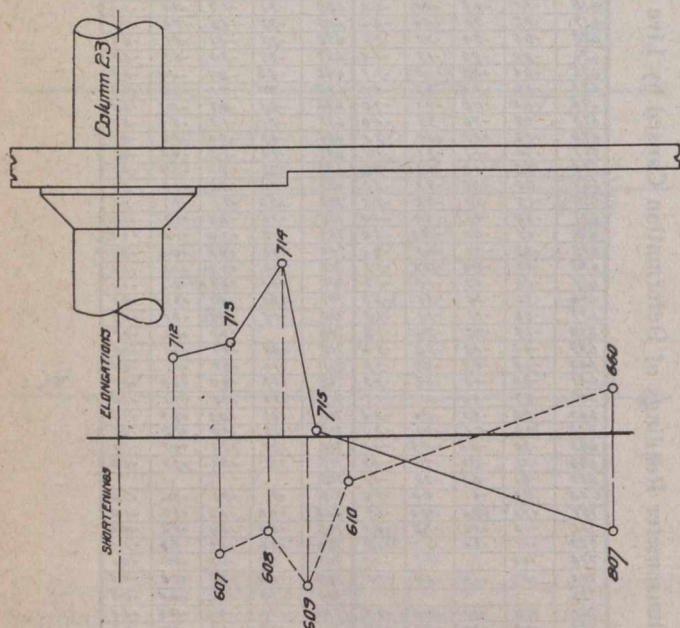


Fig. 10—Deformations in Steel and Concrete Graphically Shown

Top of slab shown thus ——————
Bottom of slab shown thus — — — — — —

tions than for large since the ratio of a probable error to a large deformation is less than to a small one.

With respect to the Simpson Building test, there is one point to which attention might be called because it relates to a phenomenon which has been observed in several previous tests and is one which concerns the values to be assigned for the working stresses in both materials. To illustrate, Fig. 10 has been prepared from the test data. It will be seen that the various values of the observed deformations for the several gauge lines lying diagonally in one direction from column 23 have been plotted with respect to a horizontal axis, elongations upward and shortenings downward. Whether these relate to steel or concrete does not concern us, since it is to only one position on this radial line that attention is invited. Generally speaking, when either line crosses the horizontal axis, it denotes a point of zero deformation and therefore a point of zero flexural stress and of zero bending moment.

If both lines cross the zero axis at the same point, it denotes a true point of contraflexure at which the stresses are mainly shears. In Fig. 10, however, this is not the case and for some distance outward from gauge line 715, the slab appears to be altogether in compression, and at gauge line 610; this, according to the records, is equal to an average stress of 70 pounds per square inch with a resultant acting much nearer the lower face than the upper. Moreover, in this particular region, the situation is not complicated by the presence of three or four superimposed layers of metal such as are found in some other places. This phenomenon is probably due to the partial behavior of the slab as an arch, an hypothesis, indeed, for which there is considerable warrant, since the peculiarity has been observed and reported on several occasions.

The city architect of Toronto, Mr. Pearse, is to be commended on the way in which he has planned these investigations and on the amount of profitable study which he has devoted to this problem of construction. All of the doubtful points have not been cleared up as yet, although much light has been thrown on many of them. As a result of careful and patient work by many investigators, the design of flat slab structures is to-day on a much more intelligent basis than it was five years ago.

## WATERWORKS DEPT., CITY OF EDMONTON

A report just issued by City Commissioner A. G. Harrison, of the city of Edmonton, covering 1917, says that the waterworks department for the city enjoyed a surplus of $38,189.75. The total mileage of mains under pressure in the system at present is 164.8 miles. The total cost of water maintenance for the year amounted to $6,346.95, making an average cost of maintenance per mile, $38.70. During the year, 168 new water services were installed and 132 house sewer services. The total number of house services to date is 9,602 and the total number of water services 10,839. The average cost of maintenance per water service is 73 cents.

The growth of the system has been remarkable during the past ten years. In 1908, the city had 2,520 water services, 200 hydrants and 48.8 miles of water mains. In 1917, the number of water services had increased to 10,829 with 787 fire hydrants.

The number of water meters in use in the city is 7,700 and the average cost of maintenance per meter is 96½ cents.

The service given has been constant througrout the whole period and by regular daily tests the water supply is shown to be free from all contamination. One pound of liquid chlorine per million gallons was all that was found necessary, and proved to be far more economical than the old hypochloride of lime system.

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The report of the Department of Public Works for the Province of British Columbia show an expenditure in 1916-17 of $48,754 in construction of roads and trails in the districts of Fernie, Greenwood, Kamloops, Kaslo, Revelstoke, Richmond, Similkameen, Skeena, Slocan, Yale and Ymir.

The iron work on the six new vessels to be built by the Lyall Shipbuilding Co., Vancouver, B.C., for their own use, will be manufactured in the shipbuilding yards by the company. Manager Cook is having installed under the superintendence of Supt. F. Davey, a large blacksmith shop, equipped with two steam hammers, furnaces and modern machinery for the carrying out of part of the ship construction.