

obtained by subtracting from the total measured deformations at the compression surface the amount of this shrinkage. That is, the ordinates of the net deformation curve are equal to those for the total deformation, less those for the shrinkage curve.

From these curves it can be seen readily how the two elements affect the total deformation, thus the variable shrinkage produces the fluctuations observed in the total while the time yield continues at approximately a constant rate. The curve of net deformation shows a flattening out for the last three months. Whether or not this means that the time yield has ceased cannot be said until further time has elapsed.

The significance of the ratio of the total deformation to that obtained when the load was first applied about seven to one, and of the fact that the deformation has steadily increased for a period of two and one-half years, should not be lost sight of. As these beams were 33 days old, before measurements for shrinkage had begun, and cured open to air except for a single wetting when first

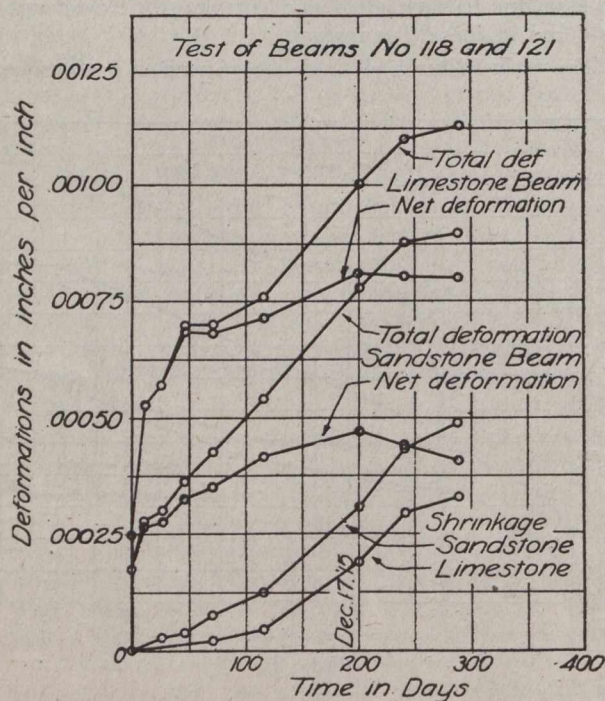


Plate 3.

cast, it is likely that not more than 50 or 60 per cent. of the total shrinkage is shown. That this is true will appear from some of the tests to follow.

The fluctuations in the shrinkage curve and their relation to the seasonal change can be seen very plainly here. It will be noted that a rapid increase in the total measured shrinkage begins each fall at about the time the steam heat is turned on in the building and this is followed by a swelling which begins with that period in the spring when the heat is turned off and when the building is more open to the moist outside air. In this same way may be explained the fluctuations seen in the other laboratory specimens given here and also in the deflections of the wooden horses supporting the $5\frac{1}{2}$ -in. x 30-in. x 12-ft. beam shown on Plate 12. It will, therefore, not be necessary to refer to them again.

The curve of deflection of this beam is shown on Plate 4 along with two beams from the test which follows. The interesting features of this curve are the fluctuations with the seasonal changes in the moisture content of the air, and the relation of the total deflection at the end of

two and one-half years to that measured when the load was first applied.

In description of these beams it is sufficient to say that they were 4 in. x 5 in. in cross-section reinforced with two $\frac{5}{16}$ in. round rods with centres $4\frac{1}{4}$ in. from the compression face. They were cast from a 1:2:4 mixture of a standard grade of Portland cement, an average grade of sand and a crushed limestone of pea size. The load was applied at the age of 33 days. On the usual assumptions the load applied gives calculated stresses of 650 and 15,000 pounds per square inch in the concrete and steel respectively.

Additional Tests of Small Beams.—On Plate 2 are shown the results of measurements on beams of two different aggregates. These are given as they show the results of shrinkage measurements from the time the beams were but three days old until the load was applied, together with the results of load deformation, time yield and additional shrinkage for the remaining period of the test. Some explanation of the difference in behavior of the two aggregates may be necessary; this will be given after considering the general question under discussion.

In this set three beams were made up from each aggregate in a 1:2:4 mixture and cured open to the air after three days under wet burlap. These were 4 in. x 5 in. in cross-section with one $\frac{3}{8}$ in. round rod $4\frac{1}{2}$ in. from

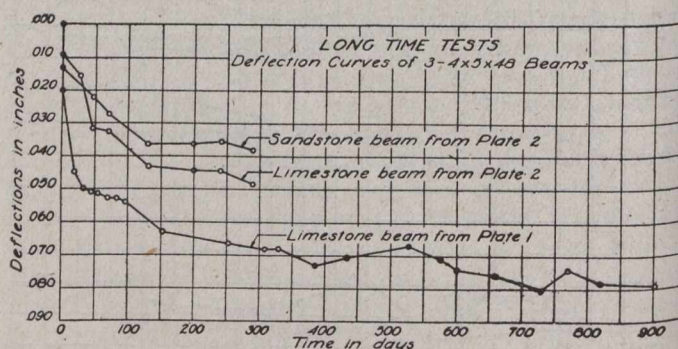


Plate 4.

the top surface. One from each set was loaded when 103 days old with 860 pounds at the centre of a 42-inch span, and measurements taken of the maximum deformation at the compression surface. The results are shown in Plate 2. Results of deflection measurements are shown on Plate 4.

In the curves of Plate 2 the portions from zero to the 103rd day, when two of the beams were loaded, were obtained by measurements of shrinkage on the beams to be loaded. From this point on the shrinkage was determined from measurements on the two beams of each set not under load.

The measurements of the maximum compression in the concrete beginning with the time of application of the load are added to the total shrinkage up to that time to obtain the total deformation shown in the upper curves. To reduce these to the same basis as the beams described under the previous test Plate 3 has been prepared. This shows the total deformation at the compression surface beginning with the day that the load was applied and includes that due to the application of the load and all subsequent deformation from both time yield and shrinkage. Likewise the shrinkage curves shown represent that beginning from the date of loading. These curves are simply the curves from Plate 2 with the shrinkage for the 103 days preceding the loading omitted for convenience of