SHRINKAGE AND TIME EFFECTS IN REINFORCED CONCRETE.

In the extensive investigations of the properties and behavior of reinforced concrete that have been made in recent years very little has been done in establishing the effects of loads sustained for long periods of time. This seems the more remarkable in view of the fact that a progressive sagging or cracking has been often noticed.

In a recent issue of Studies in Engineering, of the University of Minnesota, Mr. F. R. McMillan describes a series of tests in which it has been found that certain changes do take place that are chargeable neither to poor construction nor inadequate design, but rather to the nature of the material itself—its tendency to shrink and yield under load. While no attempt is made even to suggest a solution to the problems presented by these shrinkage and time effects, the facts which the author has presented are of sufficient importance to warrant careful attention. With materials and mixtures used in these tests it was deemed safe to predict a shrinkage of from three-fourths to one inch or more in 100 feet when exposed to the ordinary dry air of a heated building. The yielding of the concrete under compressive stress with time, a phenomenon similar to the yielding of ductile metals when stressed beyond the yield point, is greater as the unit stress is greater and seems to go on indefinitely. In these tests the deformation due to yielding was found to be from three to five times that produced immediately upon the application of the load.

A few of the possible results that may be looked for where these twin changes are in progress are suggested. The production of cracks in floors, ceilings, and partitions, even though in no sense indicating a structural weakness, is an undesirable feature. And in certain places with some types of structures or details cracks might leave the reinforcement accessible to moisture and thus prove a source of danger. Sagging of the structural framework may cause the bending of doors in positions, a feature that is both expensive and annoying. The tilting of columns by the unequal shrinkage in the different floors might be a source of high bending moments and column stress. But of far more importance than these may be mentioned the two following possible effects, both of which might in certain instances be of serious consequence:

(1) The continued yielding of the upper fibres of a beam, coupled with the gradual breaking down of the concrete in tension, may result in a progressive destruction of the bond from the centre toward the supports, similar to that occurring with the progressive loading of a beam, as shown by Mr. D. A. Abrams in Bulletin 71, University of Illinois. Also the drying out incident to the large shrinkage movement may assist in this destruction of the bond.

(2) The possibility of high stresses in the longitudinal steel of compression members seems to be the most important conclusion to be drawn from these tests. The time yielding of the concrete under stress, combined with the excessive shortening due to shrinkage, may result in deformations from five to fifteen times those expected from the ordinary calculations. In columns of the ordinary ratio of vertical steel in which no allowance has been made for spirals the resulting steel stress is probably well within the elastic limit, but in those columns designed on the assumption of large loads being carried by the hooping the steel stresses may approach dangerously near the yield point.

VANADIUM.*

Since vanadium has been introduced as a purifying agent in the manufacture of steel, great interest has been evidenced in prospecting for, and in the location of, deposits of vanadiferous ores of commercial value. The main uses of vanadium are for the making of alloys of ferro, cupro, and aluminium vanadium, etc., as well as for the preparation of dyes and a number of chemical products. Vanadium oxides are used to a limited extent for coloring pottery and glass, while the pentoxide provides a useful substitute for gold bronze as an ornamental surface-covering. Numerous applications of the metal depend upon the ease with which its less-oxidized compounds take up oxygen and the higher oxides, and their salts are reduced.

There are few substances which are so widely distributed as vanadium ores, though they are not often found in such quantity as to be of economic importance, and capable of being profitably worked. Important deposits occur in which the metal is present as a sulphide. It is occasionally found as silicates, but the ores most commonly met with are the vanadates. The more important ores are carnotite, patronite, roscoclite, vanadinite, magnetite, and certain iron ores. The best-known mineral is vanadinite, containing theoretically about 19 per cent. of vanadium pentoxide, equivalent to 10.9 per cent. of metallic vanadium. The most important producing districts are Spain, Peru, Colorado, and New Mexico. Of these, Spain produces vanadinite—that is, a vanadate of lead, with an inferior portion of lead chloride. In France and Italy it occurs in bauxite and clay, and may therefore be looked for where igneous rocks kaolize, or break up. In Great Britain deposits occur in the Warlock Head Mine, in Dumfries, and at Harmer Hill, in Shropshire; also in Cheshire at Alderley Edge, 14 miles south-east of Manchester, among the large copper mines there, now closed down. The mineral found there has been given the local name of mottramite. Other vanadium-producing countries are Portugal, Baden, Bavaria, and Sweden.

In America the main output comes from Peru; the ore found there is patronite, a sulphide; also vanadiferous asphalite. In 1912 it was asserted that nearly 90 per cent. of the world's supply came from Peru; the ore carries 15 per cent. of vanadium. The Peruvian mines are at Minasragra, 23 miles northwest of Cerro de Pasco, also at Casapalca. The Colorado ore is a carnotite, a uranyl-potassium vanadate. The New Mexico product is mainly vanadinite.

During 1914 there was a very large output of vanadium ores in the United States, the total quantity of vanadium from carnotite and other ores being approximately 430 tons. Vanadium-bearing ores have been found in Utah, Western Colorado and Michigan. South Australia produces a sulpho-vanadate of copper. In New South Wales vanadium occurs in bauxite and clay. Ores also occur in Rhodesia and South-West Africa.

The developments which have taken place during the last two decades in connection with the making of ferro-vanadium alloys in a direct way, by the treatment of ferrous-vanadium ores, are the outcome of the knowledge acquired through experiments on the Taberg iron ores and products therefrom.

It has been known that the iron produced from the treatment of the Taberg ores at the Eckersholm works

*Engineering (London).