positions showed signs of disintegration after a few weeks.

9. All cements resisted disintegration in sea water better in mortar mixtures than in the form of neat briquettes. In most cases the mortar briquettes had normal strength up to 2 years' exposure.

10. The physical qualities of the cement, which depend essentially upon the method of manufacture, would seem to determine its resistance to decomposition when brought into intimate contact with the sulphate and chloride solutions.

11. Contrary to the opinion of many, there is no apparent relation between the chemical composition of a cement and the rapidity with which it reacts with sea water when brought into intimate contact.

12. Tricalcium-sulpho-aluminate could not be formed, and therefore disintegration could not result from this cause.

13. In the presence of sea water or similar sulphate —chloride solutions:

(*a*) The most soluble element of the cement is the lime. If the lime of the cement is carbonated it is practically insoluble.

(*b*) The quantity of alumina, iron, or silica present in the cement does not affect its solubility.

(*c*) The magnesia present in the cement is practically inert.

(*d*) The quantity of SO_3 present in the cement up to 1.75 per cent. does not affect its solubility, but a variation in the quantity present may affect its stability by affecting its rate of hardening.

14. The change which takes place in sea water when brought into intimate contact with the cement is as follows:

(*a*) The magnesia is precipitated from the sea water in direct proportion to the solubility of the lime of the cement.

(*b*) The sulphates are the most active constituents of the sea water and are taken up by the cement. Their action is accelerated in the presence of chlorides. No definite sulphate compound was established.

(*c*) The quantity of chlorine and sodium taken up by the cement is so small that no statement can be made as to the existence of any definite chloride of sodium compound formed with the cement.

15. The SO_3 added to a cement in the plaster to regulate the time of set is chemically fixed so that it will not go into solution when the cement is brought into intimate contact with distilled water.

16. Metal reinforcement is not subject to corrosion if embedded to a depth of 2 inches or more from the surface of well-made concrete.

An economical mine telephone system, already at work in a Prussian mine, has been brought to notice by O. Dobbelstein, a German electrical engineer. Any of the continuous lines of metal extending into the mine—such as rails, air or water pipes, or cables—may be used as a conductor, and the other side is earthed in the usual way, although the metal is already connected to earth. The usual telephone receiver is used. Current is supplied by a battery of 12 volts, and in the secondary circuit an induction coil is used. As the current is not sufficient to ring a bell, a form of relay is necessary. The telephone current energizes a weak magnet, and this vibrates a metal disc, which acts upon the special circuit to ring a bell. Temporary telephones may be quickly put in place, or the installation may be of permanent kind.

PAVEMENT SUB-GRADE.

By S. J. Van Ornum,
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Engineers who have charge of road building have, as a rule, given slight attention or thought to the proper preparation of the earth sub-grade upon which pavements are constructed. It is obvious that the earth under a pavement sustains the weight of the traffic, and if the earth sub-grade is not prepared properly and compacted sufficiently to sustain such loads, irregularities and depressions will gradually appear in the pavement. The official organ of the League of California Municipalities contains an article in its July 13th issue by Mr. Van Ornum which brings up strongly the necessity of carefully constructed sub-grade and carefully prepared specifications covering the same.

The pavement base provides a stable material upon which to construct the wearing surface, and also equalizes and distributes on the earth sub-grade, the loads subjected to the pavement by the traffic.

The weight of loads hauled by wagons and trucks has increased rapidly in the past few years, and especially is this true since the automobile truck has become so successful. Loads as great as ten and twelve tons are now hauled by automobile trucks over pavements which were not constructed to properly withstand such weights. Great care should, therefore, be taken to provide a sub-grade so prepared and compacted that it will sustain the heaviest loads imposed upon the pavement without injury to the base or wearing surface. Recent reports from New York and London state that the excessive loads transported over some of the streets of these cities have caused serious injury to the concrete base. One street pavement in London, which for many years has carried a very heavy street traffic without apparent damage, shows signs of failure since automobile 'bus lines have been running over it, and an examination discloses the fact that the concrete base has badly subsided.

Although engineers realize the necessity of a properly compacted paving sub-grade, yet, in preparing specifications they give slight consideration to this phase of paving construction, with the result that the section relating to the rolling of the sub-grade is generally inadequate and often not sufficiently explicit to obtain a hard and firm sub-grade. When the engineer has implied authority, the phrase "rolled to the satisfaction of the engineer" is quite general. One paving specification recently examined simply states that the sub-grade "is to be compacted by rolling or tamping," but failed to place any conditions or restrictions upon such rolling or the weight of the roller to be used. Another specification for the construction of a standard pavement required the sub-grade "to be compacted by rolling and tamping," and the rolling "to be done by a steam roller of a weight not less than five tons." A five tandem roller has an effective compressive weight of approximately 175 pounds per lineal width of tire, while the wagons hauling the materials over the sub-grade for the paving of the street exert a pressure of over twice this amount and loads as great as one thousand pounds per lineal inch width of wheel tire are at the present time hauled over pavements.

A light roller will not sufficiently compact the earth, nor will it disclose any local weakness in the sub-grade, such as carelessly refilled pipe trenches or an improper character or condition of material immediately underneath