water is employed, the mixing process does not usually occupy enough time to thaw out frozen lumps, even of small size. The sand and other aggregate should always be heated.

The writer always advocates heating the water also. A small expenditure will cover the cost of the apparatus necessary for this purpose, and the fuel bill is relatively small. If steam is employed for this purpose it will be found exceedingly valuable to lead a pipe or hose to the point of deposit and heat and clean the forms, and the reinforcement, if used. The writer has often taken the temperature of the concrete at the moment of depositing, and periodically for hours afterwards, and has observed temperatures of 70 to 80 degrees F. in the concrete being deposited and temperatures of over 40 degrees F. six hours afterward, when the workmen commenced to travel over the fresh concrete, simply laying planks for runways.

It is usually impracticable to place concrete at temperatures below 20 degrees F., because of the effect of the cold upon the workmen. The writer has, however, successfully placed many yards at temperatures down even to zero, where the men were protected and where the mixing and placing operations were so arranged as to be of exceedingly short duration for each batch.

The erection of a canvas or other more substantial enclosure completely around the work involved, is always effective but somewhat costly. Heat may be obtained from salamanders, temporary steam coils, etc., and the writer has thus often succeeded in thawing out frozen floor slabs covered on top only with hay and canvas. Canvas alone in such locations is not sufficient protection, the dead air imprisoned in hay or shavings being necessary as an insulator.

For mass concrete work the use of chemicals added to the water may be advisable where the temperatures do not fall much below the freezing point. The writer has used no chemical except common salt, which has shown good results in several experiments, and no detrimental results in actual work.

The safest and most economical method of handling concrete for each separate operation must be determined for itself. In freezing weather it may be advisable to manufacture the different parts of the structure in a temporary factory and afterward erect them "in the dry," as is steel. On the other hand the "wet" method may be necessary, and then some scheme should be devised for handling the concrete direct from the mixer to the place of deposit without intermediate dumping. Derricks, cars, etc., will readily accomplish this.

The Surface of the Earth

In commencing this article I do so with a desire to draw the attention of those interested in the practical business of building construction in the matter of its statical value, especially as to foundations, as these constitute the fundamental basis of all successful structures.

As a corollary it might be stated that the constituent materials of the crust of the earth, or its geology, are only known in a mediocre or general way by architects and builders, and, strange to say, this very important matter is rarely or never introduced into the curriculum of architectural or engineering schools, most of the courses being devoted to things terrestrial and not subterranean, notwithstanding the fact that as every structure must stand on mother earth it behooves the constructor to have a knowledge of the materials on which the intended bridge or building is to rest and remain stable and permanent.

In order, therefore, that one may determine the materials composing the site, it is imperative that the engineer, architect or builder should ascertain what is in the upper crust of the earth, to the depth of the excavation, as planned, to obtain the footings and full depth of cellar or foundation walls; and should these be, or be intended to be carried down to a great depth, as in the case of a very high or heavy building or bridge, then this can only be found by borings or drillings made vertically through the several strata, until the desired material is definitely located. For example, we will assume that it is specified that the footings must rest on good, permanent, solid rock, free from fissures, clefts, water courses or other damaging or deleterious features, and that the level of these footings is so deep as to necessitate caisson work; then the borings, if made close together at spaced intervals of, say, from two feet to four feet in squares, will convey to the engineer the natures of the compositions forming the stratas at the desired level, and experience must dictate the proper course of treatment required to properly support the superstructure. In rock it is now usual to employ concrete to level up the inequalities of the surface in the area of the footings after it has been proven and positively assured that the rock in its mass is solid and dependable, no matter at what depth this is obtained, and with the assistance of reinforcement by the insertion of grillage, rods or any other means of strengthening to make the concrete more cohesive and reliable. But it does not always happen that rock is obtainable, and on account of the vagaries of nature that the site may so vary in its sectional profile as to make the bed of the rock dip or drop at so sharp an angle as to leave along its side a stratum composed of hard or soft clay, mud, sand, quicksand, or even soft or rotted rock itself, and it is the presence of these unsafe factors which places a mental strain on him who is in charge, and taxes his ingenuity in order to provide sufficient bearing, and it is here we will take up the consideration of the ingredients as they may occur.

Quicksand is a sand composed of particles so round and so fine as to possess no coherency whatsoever, and is so utterly incapable of solidity as to be classed as a liquid, so that it flows through the fingers and, like water, yields under pressure, being so elastic and so full of voids, and therefore absolutely unfit for the resisting places of footings or the sustaining of weights. It is then imperative that it be removed either by suction pumps or excavating, or be penetrated through to a depth where a more