foundation. But this hard pan may have but little thickness and be underlaid by loose materials, even by quicksand. Its thickness, therefore, should be ascertained, and no building, bridge, or embankment placed upon it which will be liable, by its weight, to break through the stratum.

Clay, especially such as occurs in alluvial formations, is one of the foundations most to be suspected. For although very solid when dry, powerful rains will convert it into mortar; or it may be underlaid by that most slippery of all foundations, quicksand, which, if a stream of water should find access to it beneath the clay, will be swept away with astonishing rapidity, undermining, of course, the superincumbent structure. A case of this kind occurred in East Hampton, Massachusetts, in the summer of 1860; when a factory, just erected by Hon. Samuel Williston, was injured in one night to the amount of some $50,000.

But the engineer and architect should be acquainted with the solid strata beneath alluvium; not only with their nature, but their position, whether horizontal or inclined. For if inclined, the loose materials above will be very liable to slide down, and therefore without due precaution no structures of great weight and importance, whether embankments, quays, or houses, should be placed upon them.

The dip and strike of the strata, as well as their nature, should also be known to the engineer, in laying out railroads and canals, on other accounts. To locate them on the line of strike is the most unfavorable of all directions, while the most favorable is to cross them at right angles. Still more important are the dip and strike in tunneling. To carry a tunnel through a hill on the line of strike, or with the rock dipping from the workman, is most unfavorable, because the work must be done on the edges of the strata. The most favorable is where the drilling can be made on the broad face of the strata. The nature of the rock, too, is very important. Some formations have so little coherence, that if a tunnel be made through them, the roof will fall in. Others are so hard, that it is almost as easy to drill and blast iron. This is especially true of the compact trap rocks and some varieties of porphyry. Cuttings through them are so costly, that, if possible, they should be avoided; though the tufaceous traps are not difficult to blast. These trappean rocks are apt to occur when least expected, and the engineer, before he decides upon an extensive cutting or tunnel, ought to be confident that he shall not unexpectedly encounter these hard materials. He ought to find out, if possible, also, where faults exist, what strata are pervious or impervious to water, and where springs may be expected.

The question as to the probable success of boring Artesian wells has become, at this day, one of great interest and importance, and also one of great difficulty, concerning which the most practiced geologist may be mistaken. Certain principles, however, are true in respect to such explorations. One is, that we can not expect success if the underlying rock in the region is all unstratified, nor unless some stratum can be reached whose outcrop rises higher than the surface of the well; that is, although water may be found, it will not rise to the surface. So if all the strata are equally pervious to water, no hydrostatic pressure will force it upward.

2. *Materials.*

For most common purposes of construction men are obliged to use such materials as are easily accessible, though perhaps not the best. The most valuable are often remote and costly. Some kinds of rocks, however, the world over, are always highly prized. Such are the marbles, granites, porphyries, serpentines, alabasters, soapstones, etc. The most valuable monu-