is a gummy blue clay. To ensure that the slope and the slab will not slide, when the prism excavation is continued to grade, 30-foot piles at 6-foot centres are to be driven along the toe of the slab on the berm. In this connection it is interesting to note that piles were driven in the banks of the present canal to grade to prevent the banks sloughing off when any particular reach is unwatered for repairs, and that they have met with marked success.

The slab construction is at present confined to the two places mentioned, where the work is being carried out by Messrs. Bennett and Kellet, sub-contractors, under Messrs. Baldry, Yerburgh and Hutchinson, general contractors for Section No. 2 of the canal. Mr. J. L. Weller, C.E., is engineer-in-charge for the Department of Railways and Canals, Ottawa.

PRELIMINARY INVESTIGATIONS FOR MASONRY AND FOUNDATION DESIGN.

THE importance of thorough preliminary explorations before designing any foundation or substructure is urged by Henry S. Jacoby, Professor of Bridge Engineering, Cornell University. He made this the subject of a paper presented in February at a good roads congress held at the Cornell College of Civil Engineering and appearing in the April issue of the Cornell Civil Engineer. The following notes on preliminary work, taken from Prof. Jacoby's paper, will be found of considerable value:—

In the first place, test pits may be used for relatively shallow foundations. The advantage of digging a test pit is that the material is found in exactly the condition in which it is naturally placed; its compactness and composition can be learned and therefore a decision made as to the proper stratum upon which to rest the foundation. Also, the bottom of the pit can be tested by proper loading, and a good estimate of its character consequently formed.

A device sometimes used is a sounding rod; this is a bar 1 to 1½ inches in diameter, sometimes driven down with a maul but more properly provided with a cross bar or handle upon which a number of men put their weight to force the rod into the ground. All that can be determined with a sounding rod is that the resistance increases or decreases, that it is slight or considerable; any obstruction, of course, stops the operation and then the problem is, what is that obstruction? Because it is so often misleading, this method is the most unsatisfactory one for making investigations of the soil. For example, at one site eight men on the handle bar could force the rod only 7 feet into the earth, but no trouble was experienced in driving piles to a 70-foot penetration. Another condition often arising is the striking of a thin layer of hard gravel with the sounding rod, while underneath it there may be soft material for a considerable depth. There is no means of knowing the exact conditions unless some other investigation is made.

A much more satisfactory method is by the use of a wood auger, say 2 inches in diameter. It can be attached to a short pipe which is coupled to a number of sections of pipe 6 to 12 feet long. A handle is needed, while a block and fall are also required to operate the device properly if the boring must be carried to a considerable depth. If the hole clogs so that it is impossible to work through the material, it may be necessary to use a one-inch auger for the rest of the boring. Often in working through sand by pouring water into it the sand can be made to retain the form of the hole when it would not otherwise do so. Where the form of the hole cannot be retained a three-inch casing may have to be driven in four or five-foot lengths. This method can be used for depths up to 100 feet, and that covers the great majority of cases. It cannot be used to advantage in fine running sand unless the stratum is very thin. The loose material can be removed by a sand pump, consisting of a long narrow cylinder with a cutting edge at the bottom and above it a flap valve opening upward. It is partly filled by rapidly raising and dropping alternately.

An earth or clay auger has two cutters directed inwards and downwards so as to pull the auger into the material, and to support the excavated material when the auger is withdrawn. This method can be used in frozen earth or in hardpan quite successfully. It is a curious thing that sometimes a larger hole will retain its form where a small one will not. For example, if a 2 or 3-inch hole will not retain its form, many times an 8-inch hole will. Even a post hole digger can be used to a depth of 16 feet with considerable success.

The next standard method is the wash boring. This has been very extensively employed, but not nearly so much as it should be. To-day those who have charge of foundation work certainly ought to have proper equipment of this kind. A standard outfit includes a light tripod casing, hollow drill rods, and a hand force pump. The casing is usually about 2½ inches in diameter inside and the drill rods ⅞ inch outside. The rods are connected by special couplings. The bottom rod has a chopping bit at the end with an X-shaped form, and four holes through which the water jet operates. The force pump should be double acting, with a single handle, and an inch-and-a-half suction. By having a hoisting water swivel at the top the drill rods can be turned without twisting the hose. The material at the bottom is eroded and the jet operated by turning the drill rods. The water passes down through the hollow drill rods and out through the openings at the bottom, erodes the material and brings it up between the two pipes. Samples can be taken from the settlings and the composition of the material determined. The casing, of course, is rotated in the meantime, or, in some cases, driven. By using a double block and a jarring weight the casing can be driven without taking out the drill rods; without that arrangement more time is required. The samples taken from the boring are properly tabled and bottled so that they can be placed in order and examined afterwards. Occasionally boulders or other obstructions are struck. By withdrawing the casing a short distance dynamite may be used to shatter the boulder, thus allowing the process to continue. In this way, borings can be made through sand and gravel, clay of varying hardness, indurated clay, and hardpan. All depends on the care with which the work is done. For small work in light, sandy material a less expensive outfit may be used.

We, of course, do not learn the exact form and condition in which the material rests in its natural location, because it is separated by the water, or the finer material may be brought up and in some cases the coarser pushed aside, so that there is a difference in estimating its character as compared with a test pit. This difficulty can be surmounted by taking out the drill rods at intervals, unscrewing the lower end and putting on a short piece of brass pipe, pushing that down into the material and bringing it up, thus obtaining a piece of the material in