Both O. C. Merrill, chief engineer of the Forest Service, and George O. Smith, director of the United States Geological Survey, attacked the statements of Mr. Lincoln and other engineers who testified along the same line. Mr. Merrill declared that Mr. Lincoln's statement that steam and hydro-electric production cost on the average about the same was startling, but wholly incorrect, and proceeded to quote figures from plants in operation. According to these figures the actual switchboard cost of power sold by the New York Edison Co. (Waterside No. 2 station) is approximately five mills per kilowatt-hour. This cost includes labor, fuel, supplies and repairs. On the basis of power generated, where 24.9 per cent. is lost in distribution, the Edison station cost is approximately four mills per kilowatt-hour. Fuel and labor costs of generation at steam plants in California were quoted as 0.336c. for Long Beach and 0.372 for Redondo, while the generation cost at the Pacific Gas and Electric Co.'s Borel hydro-electric plant was only 0.033c., or, with transmission cost added, 0.128 cent.

"On this basis," declared Mr. Merrill, "it would be as profitable to invest $380 per kilowatt capacity for installation at the Borel plant, considering the load factors in each instance, as to invest $50 per kilowatt capacity at the Long Beach steam plant; while the fact that this steam plant was being operated on a 20 per cent. load factor and the hydro-electric plant at 69 per cent. load factor, justified even a larger discrepancy in installation cost."

"In general," said Mr. Merrill, "hydro-electric installation costing eight times as much as steam, instead of three times as much, might be considered economical and profitable."

Dr. Smith attacked the water-power engineers for having made much of the increased efficiency of steam production without having mentioned the equal increase in efficiency of hydro-electric production. Quoting from a report of Samuel Insull, president of the Commonwealth Edison Co., of Chicago, he showed that within the last ten years this company, with its steam plant, had quadrupled its investment and increased its output fifteen-fold. In 1903 a one-dollar investment in the Chicago plant yielded 3 kw.-hr., while in 1913 the one-dollar investment yielded 10 kw.-hr. Chicago, all steam, now shows a per capita consumption of a little over 300 kw.-hr. and an average income of a little more than 2c. per kw.-hr., while San Francisco, part steam and part hydro-electric, shows about the same average consumption, and an average income of a little less than 2c. per kw.-hr.

As compared with the showing of the Chicago steam plant of 10 kw.-hr. per dollar of investment, the San Francisco plant had shown 6 kw.-hr. to each dollar of investment in 1911, while the ratio for the Montana Power Co. (all hydro-electric), where the average consumption was as large as 1,000 kw.-hr per capita, was .15 kw.-hr. per dollar of investment.

The hydration of Portland cement is now under investigation at the Pittsburgh laboratory of the Bureau of Standards. According to the annual report of the director of the Bureau of Standards the first series of tests, already completed, shows what the products of hydration of the constituents of Portland cement are under normal conditions, and also which of the constituents produce the early and which the later hardening. These tests were made with materials produced in an electrical furnace, and with some commercial cements, but in no case were the actual products of hydration compared with the strengths produced.

CLAY AS FOUNDATION SUPPORT.

At a January meeting of the Institution of Civil Engineers of Great Britain, Mr. Arthur L. Bell, presented a paper dealing with the lateral pressure and resistance of clay and the supporting power of clay foundations. The author first makes reference to the difficulty to be anticipated in attempting to estimate the lateral pressures and resistances of clay, its constitution and properties being obscure. He cites Coulomb's and Rankine's theories of earth pressure as being those ordinarily used in English practice and shows that both presuppose a knowledge of the angle of repose, as well as applying, not to undisturbed clay, but to loose-granular mass. He points out that the angles of repose for clay vary, according to the testbooks from 1° to 45°, and observation of the material itself is of little value when selecting the angle to be used for calculations. Widely different results will be obtained according to the angles chosen. The results of calculations by these methods are also found to be at variance with observed facts. The lack of agreement is due not so much to error in the existing theories as to a misapprehension as to the extent of their applicability. The paper goes on to present an extension or modification of Rankine's theory which, when applied to clay would yield results more closely in accordance with fact and observation.

A short description is given of the monolith foundation work at the Rosyth dockyard, as it was in connection with this work that the investigation which forms the subject of the paper was made. As the work of founding the monoliths proceeded, Rankine's formulas were duly applied to the different cases which arose, but in view of the doubt as to the applicability of the formulas to clay, and as to the correctness of the assumed angles of repose, the results were regarded rather as aids to practical judgment than as actual and reliable solutions of the problem of stability. A search through all available records did not yield much information of value or furnish a theory of clay pressure. Practical experience with tunnels and embankments appeared to indicate that the pressures exerted by clay resembled those due to a heavy fluid. This view is supported by a quotation which is made from a previous contribution by the late Sir George H. Darwin. The search revealed a high percentage of failures in work constructed in clay.

The broad conclusions to which the investigation led were that there was no available theory of earth pressure which, when applied to clay, would command the general confidence of engineers. There were no fixed rules of practice, and there were grave differences of opinion as to what intensities of pressure could safely be placed upon clay foundations. Experiments were undertaken with a view to throwing further light upon the question. The first experiments described were made in a small testing cylinder 8 in. in diameter, fitted with gauges at the ends and sides. The results are given of a few tests with this apparatus, but the author does not regard them as having much value.

Up to this point, following established custom, it had been thought that, however difficult it might be to find the true angle of repose for clay, it might be possible by experiment, or as the result of experience, to hit upon an angle which, when introduced into the generally recognized formulas, would give correct results. Suspicions were now felt that the root of the difficulty lay deeper, and that the true reason why Rankine's and Coulomb's theories were not applicable to clay was because clay did not conform to the law of resistance to shear which forms