

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

NOVEL THEORY APPLIED TO DIFFICULT FOUNDATION

PAPER PREPARED FOR THE CANADIAN SOCIETY OF CIVIL ENGINEERS, DESCRIBING THE METHOD EMPLOYED IN DESIGNING FOUNDATIONS FOR THE FEDERAL LEGISLATIVE PALACE IN MEXICO CITY.

By **SIFROY JOSEPH FORTIN**, Mem. Am. Soc. C. E.,

Chief Engineer's Branch, Department of Public Works of Canada, Ottawa, Ont.

IN designing the foundations of the Federal Legislative Palace now being built by the Mexican Government in the city of Mexico, the novel assumption was made that the bearing capacity of the subsoil gradually decreases from the perimeter towards the centre of gravity of the structure.

The building is 420 feet long, 370 feet wide, and in a general way it is composed of three stories and a basement; the highest part of the steelwork in the dome is 221 feet above the foundation.

Work was begun in 1905, after many preliminary experiments rendered necessary owing to the unreliable bearing capacity of a heterogeneous subsoil. The consolidation of the ground, to which we will refer later, was finished in 1910 and the erection of the steel structure was started in April of the same year. Due to the political troubles since 1910, work on the structure has been entirely stopped since the summer of 1913. If the work is carried out according to the original design it will cost over \$12,000,000.

The design of the superstructure, which is of the well-known type of steel skeleton, though very complicated, did not present any unusual problem, but the foundations were designed according to a new theory. The usual way of designing foundations is to assume that the subsoil has a uniform resistance and, therefore, it is loaded at a uniform pressure per unit of surface; the contrary idea prevailed in designing the foundations of the Palace, for the capacity of the subsoil to resist pressure was assumed to gradually decrease from the perimeter towards the centre of gravity of the building.

The greater part of the city of Mexico is built on the site of an old lake called Texcoco, whose elevation is 7,400 feet above sea level. Mountains surround the Valley of Mexico, one of which, the Ajusco, rises 13,000 feet above sea level. The site of Mexico City is the lowest part of the valley and for ages volcanic ejections, alluvial matter, etc., have been washed down into the valley from the mountain sides. At the Palace site the soil is composed of a layer of filling matter, debris, dust, etc., about seven feet thick; underneath comes a very peculiar and unique

substance. It has the appearance of clay and lies in alternate beds of various thicknesses of brownish and reddish color. That substance is as soft as butter and some of it emits a peculiar smell as of decomposed vegetable matter. It is mixed in various proportions with volcanic ejection or sand.

From time to time one comes across a thin layer of sand and occasionally we meet a pocket which no doubt was originally filled with water. This substance weighs sometimes as little as 70 pounds per cubic foot; that is to say, some 10 to 15 per cent. more than pure water. When this substance is taken out of the ground, the water cannot be squeezed out by pressure, but if left exposed to the atmosphere and to the sun, it loses from 41 to sometimes 82 per cent. of its volume, becoming a gritty lump. This subsoil has an unknown depth, artesian wells 800 feet deep having been bored without finding bed-rock, though occasionally the drill meets boulders of various sizes.

This clayey material cannot support even a light load without deformation. When the steel for the structure arrived at the site it had to be spread evenly on the ground, otherwise uneven settlement was immediately observed. In all constructions of any importance the walls have to be carried up level in order to avoid uneven sinking. It can be judged from this that foundations in Mexico City are a very delicate problem. Almost all the buildings in the city are out of level and out of plumb.

The most peculiar thing, however, in connection with foundations in Mexico is that the centre of the buildings almost invariably sinks more rapidly than the perimeter; not only that, but the elevations, if of any length, say, 75 feet long or longer, invariably sink more in the centre than on the ends, taking a concave form.

The engineer in charge of the foundations for the Federal Legislative Palace was Senor Gilberto Montiel, who was also at that time Deputy Minister of the Department of Public Works. Senor Montiel was fully aware of the bad quality of the subsoil of Mexico and particularly of the fact stated above, that all foundations sink more in the centre than on the edges. He looked about for an

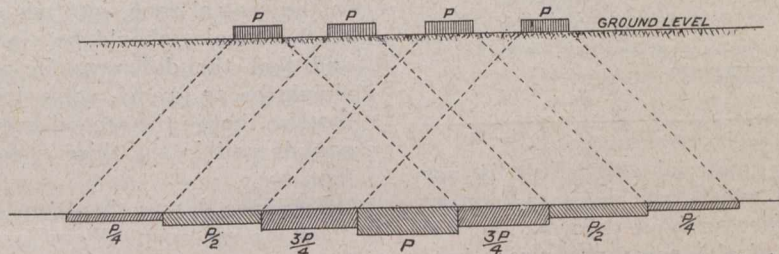


Fig. 1.—Illustrating the Variation of Resistance of a Plastic Body from the Edges to the Centre of a Foundation.