in which P = safe load in lbs., W = weight of hammer in lbs., H = fall of hammer in ft., S = penetration or sinking in inches under the last blow.

Test pits should be sunk for determining the level of the ground water and for making a study of the soil for a reasonable depth more accurately than can be done with borings. Both the maximum and minimum levels of the ground water should be determined, the maximum for obtaining the hydrostatic head on waterproof basements and the minimum for finding the safe level for cutting off wood piles or to determine if it will be better or cheaper to use concrete piles.

When the structures are of any considerable magnitude and piling is unnecessary, tests should be made to determine the bearing capacity of the soil to insure the maximum economy in design. Having ascertained the condition of the soil and decided that piles are not necessary, and having also decided upon the maximum pressure to which the soil is to be subjected, the widths of foundations can be determined from the estimated loads.

Solid ledge forms the most secure support for foundations, providing it goes all round the building. Part earth and part ledge are apt to cause unequal settlements. The ledge, if uneven, should be levelled off and, if on a slope, cut to form steps to give an approximately horizontal surface. In going from rock to earth, the footing courses of the foundation should be spread out to a greater width on the soil next to the ledge, gradually narrowing into the regular width for earth foundations. If there should be any unequal settlement, it will be spread over a greater length of the superstructure and probably save cracks in the walls which might otherwise occur at the junction of earth and rock.

Hard gravel or hard pan is quite as desirable as ledge. Gravel and sand are also good when kept dry. A stratum of 6 to 8 ft. of hard-compacted and well-cemented material, even if underlaid by softer material, is usually safe. With dry sand, this stratum should be double the thickness.

Clayey soils are somewhat treacherous. Upon exposure to the air they dry and crack, and exposed to rain they become semi-fluid or expand. With this soil it is best to open only a small portion of the trench at a time and quickly fill in behind.

With buildings used for industrial purposes, there is usually more or less vibration caused by machinery in motion, and the loads carried by the foundations should be less per square foot of bearing material, or less per pile, than in buildings which are not subject to such vibration. On soft clay or running sand confined, the pressure should not exceed ½ to 1 ton per sq. ft.; medium blue clay, whether or not mixed with fine sand, 1 to 2 tons; hard clay, 2 tons; compact sand and gravel, 2 to 3 tons; hard pan, 5 to 6 tons per sq. ft. Under favorable conditions of soil and use of building, these loads may be exceeded.

In any building with a uniform firmness of earth under it, the area of foundations for walls, towers, piers, and other portions of the building should be in proportion to the pressure. The loads on the outside walls may be a little lighter than those on the piers. In case the soil should vary considerably in one portion from another, the areas supporting equal weights should be changed to correspond with the soil. In this way unequal settlements are avoided and the most economical structures of approximate uniform strength obtained.

Where there is unreliable soil, piling must be resorted to. If firm earth cannot be reached by the bottom of the piles, the supporting force is friction alone. If there should be an underlying firm stratum, even at such a depth that excavation would be too expensive and sometimes impossible, but still within the reach of piles, then piling can be used with good success.

Where wood piles are properly driven, that is, not broomed or broken, the bearing capacity of the piles, when driven into sand, usually shows under the test loads a slight increase over that indicated by the above formula; but those which have brought up hard and have been crippled will show a much less capacity under the test load than was indicated by the formula.

From tests recently made on wood piles embedded in in medium and stiff clay on the site of the new buildings for the Massachusetts Institute of Technology, it was found that for about each 5 ft. of embedment of the pile in clay, 1 ton value could be added to that given by the above formula for drop hammers.

Spruce or similar soft wood piles without iron points, driven with drop hammer, should be used cautiously where there is a hard crust of gravel or sand overlying clay. Oak piles without iron points will usually penetrate the hard ground and come practically to a standstill without material injury. Any wood pile which is to depend largely upon point bearing for its value should be of oak or southern pine.

When piles are driven through a hard fill and an intervening layer of peat, silt or mud, to the hard sub-soil it will be necessary to reduce the value given by the formula as it contains the values of the hard fill above the intervening peat. This value can be approximately corrected by subtracting the value shown when driving in the fill or a conservative value assumed after comparing with other piles passing through no complication of strata.

Unless batter piles are used, it is necessary to drive far enough into the solid material to give stiffness to the structure against vibration, especially where the fill above is soft.

Concrete piles should be used where the distance to good bearing material is great, where wood is scarce or the ground water low. Considerable expense may be saved in the foundations under the latter condition.

The three kinds of material commonly used in foundations are dry rubble masonry, rubble masonry laid in mortar and concrete. Dry work is unsuitable for industrial buildings. Stone laid in cement mortar with bedded joints is very satisfactory and should be used where there is an ample supply of stone at a low price. Concrete is most commonly used and is usually the most convenient material to handle, and under ordinary conditions it can be used at the lowest cost.

A foundation for a chimney and other isolated structure having a small base and heavy pressure should be carried to the lowest depth to which it would be necessary to go with any other work reasonably near it, since if it is on sand there is a liability of undermining it.

Among Canada's imports to Great Britain during the last two fiscal years, the following items are of particular note to the engineer:—

	Value in £ 1913-14.	Value in £ 1914-15.	Increase or decrease.
Asbestos	73,961	92,147	+ £18,186
Mica	8,957	7,611	— 1,346
Machinery	114,977	109,396	— 5,581
Copper	57,110	116,648	+ 59,538
Iron and steel	24,425	110,668	+ 86,243
Crude zinc	18,514	25,526	+ 7,012