COMPACTION OF SOILS

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Compaction of soils has progressed rapidly in the last 10 years until at the present time it is generally recognized, where stability or settlement is a problem, that all embankments and foundations for dams, levees, highways, airports, and other structures should be compacted. Compaction, however, is not a new development. The first compaction probably dates back to the use of droves of sheep marched across earth dams as the embankment was placed to provide necessary compaction. It is quite probably that it was from this early method of compaction that the sheepsfoot roller itself was developed. Although compaction at the present time is generally accepted as an essential feature of earth construction, it is only recently that the various factors involved have been fully understood. If maximum compaction is to be consistently obtained, it is imperative that all these factors be fully understood by both the design and construction engineer. The construction engineer's thorough understanding of the necessity for, and the way and means of, obtaining maximum compaction is of major importance, since he has to actually obtain compaction under varying field conditions.

FUNDAMENTAL FACTORS INFLUENCING COMPACTION

The actual densities which can be obtained vary widely with the gradation of the soil, the moisture content of the soil, thickness of layers, the number of passes, and the weight and type of the compaction equipment. Due to the marked effect of the specific gravity, the gradation and shape of the particles, it has been found impossible to set a definite density for any given soil. The result has been to develop compaction tests such as the Proctor Test as a means of determining the density obtainable. In this paper 'maximum density' is used as the density obtained by the modified A.A.S.H.O. procedure at optimum moisture used by the Department. The reason that compaction increases stability of granular soil is due to grain interlocking. In granular soils which are loosely placed, the shearing strength depends primarily upon the consolidation characteristics of the soil, since the resistance in shear is brought about by particles being forced away from the shear plane. In the case of dense granular soils, additional compaction is impossible and it is necessary to roll one particle over the other or actually lift the soil mass before it can be sheared. In addition to the molded moisture content having an effect on density, it also has a marked effect on the overall stability of the mass. Recent experiences have definitely shown that non-optimum than when molded a few percentages on the wet side of optimum. However, in expansive soils, the reverse is true and higher stability is obtained when the soil is molded on the wet side of optimum.

COMPACTION METHODS

There are various methods of obtaining the desired compaction. The use of each method depends upon the conditions and type of soils involved. Specifications usually require in addition to the unit pressure, a certain minimum spacing of the feet, area, length of project, and weight per foot of drum. The sheepsfoot roller is adapted to cohesive soils where the resulting kneading effect is essential. The sheepsfoot roller is not necessarily satisfactory on granular soils. It will provide compaction in such soils; however, the upper 6 inches are usually disturbed by the feet. It is important that the maximum compaction obtained, in the upper surface, other methods below are necessary.

Pneumatic roller.—Rubber-tired rollers have been used quite extensively on highway and airport construction. They are particularly advantageous in compaction and finishing of the surface of subgrade or base courses. In some soils, such as cohesive silts, higher densities can be obtained with this type of equipment than is obtained with sheepsfoot rollers. It is necessary, however, to use material in approximately 3-inch gross layers in the construction of a dam in the northwest (uniform silt) the maximum densities obtained by placing loess in approximately 3-inch gross layers are in the neighborhood of 105 pounds per cubic foot, and represented about 90% of maximum compaction. In the construction of an airport in that immediate area, the rubber-tired rollers were experimented with at the beginning of the project and it was found in that case by placing loess in approximately 3-inch gross layers of densities of 120 to 125 pounds per cubic foot of loess obtained, or 100% Modified A.A.S.H.O. The pneumatic-tired roller is also useful in finishing the surface after sheepsfoot and tractor compaction.

Smooth rollers.—Although smooth rollers have been used extensively in highway construction, they are not considered satisfactory where a high degree of compaction of subgrades and bases, they are considered satisfactory.