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Additional Considerations on Compaction of Soils in Developing Countries

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ABSTRACT

Due to lack of heavy compaction equipment in most developing countries, earth-works are frequently executed using labour-intensive methods. As a result, compaction standards established in developed countries are often not achieved in developing countries, particularly in the rural areas. In view of this, the effect of compacting soils at various efforts in the laboratory as well as in the field has been investigated in Tanzania in an attempt to evaluate the compaction methods and equipments commonly used.

Laboratory compaction tests at efforts lower than Standard Proctor have been carried out by varying the mass of the dropping rammer, the dropping height and the thickness of soil layers. The results obtained have been correlated to field compaction test results. The effectiveness of compacting tropical soils by labour-intensive methods (e.g. compaction by human-feet, hand-rammers and human-towed concrete rollers) has been compared to that of heavy plants.

The effect of compacting soils at a minimum of 50 % Standard Proctor effort has been investigated. A comparison between compaction at 50 % and 100 % Standard Proctor compaction efforts has been carried out on the basis of the following engineering properties: California Bearing Ratio, C.B.R. swell, swelling pressure, compressibility, permeability, shear strength and shrinkage characteristics.

Compaction in many parts of the tropics is also greatly affected by unavailability of sufficient water within economical distances. Attempts have therefore been made to compact soils from the wet side, as most tropical soils attain natural moisture contents well above the optimum during the rainy season.

Dry compaction of tropical soils has also been investigated in this work.

The conclusions and recommendations resulting from the laboratory and field tests conducted may be summarised as follows:

1. The scatter of dry density values obtained at low compaction efforts (e.g. 25 % and 50 % Standard Proctor efforts) is high compared to that at Standard Proctor and Mod. AASHO compaction efforts.

2. Compaction at 50 % Standard Proctor effort results in 92-95 % of Standard Proctor maximum dry density.

3. For a given degree of compaction there exists a threshold impact, below which the required compaction cannot be achieved.

4. At every compaction effort there exists an optimum working condition of the laboratory compaction apparatus at which the values of maximum dry density obtained are highest. For compaction at 50 % Standard Proctor effort this has been shown to occur at half the impact of Standard Proctor effort.

5. Compaction by human-feet and hand-rammers results in low degree of compaction and the variation in dry densities obtained is high. About 80-92 % of Standard Proctor maximum dry density can be achieved. There are also problems of supervision and implementation during compaction. Thus compaction by the two methods could be appropriate in limited areas but should be avoided in big projects.

6. Compaction by human-towed concrete rollers (mass = 1.0-1.5 tonnes) is quite promising. About 95 % of Standard Proctor maximum dry density can be achieved using 6-12 passes of the rollers on lifts of about 10-15 cm thick. Hence compaction by concrete rollers should be encouraged in the rural areas of developing countries.

7. Compaction at efforts lower than Standard Proctor could be considered for earth structures in which permeability and settlement are governing factors and vertical stresses of up to 100 kN/m^2 exist. In cases where shear strength is governing, compaction at efforts lower than Standard Proctor could also be attempted for lateritic soils and tropical black clays. Half Standard Proctor effort should be regarded as the lower limit.

8. Moisture changes during and after compaction of tropical soils should be kept to a minimum in order to avoid subsequent shrinkage and possible crack formation. This requirement is particularly important for tropical black clays.

9. Different compaction curves can be obtained for tropical soils depending on whether they are compacted from the dry or wet side. Compaction of black cotton soil from the wet side results in an increase in dry density whereas for volcanic ash lower dry densities are obtained.

10. Black cotton soils and volcanic ash cannot be compacted dry due to high swelling pressure and significant loss in strength at the dry end on inundation. Dry compaction of lateritic sands is possible subject to obtaining satisfactory field test results.