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DISCUSSIONS ON PAPER THE FACTORS INFLUENCING COLLAPSE SETTLEMENT IN COMPACTED SOILS BY A.R. BOOTH

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The paper focuses attention on an important problem and upon perusal I find that the principal conclusions reached are quite in accord with our information from the several hundred million cubic meters of sandy-clayey soils used in earthmoving construction during the past few years in Brasil. However, I want to say that the title of the paper attracted my special attention, because we have never had collapse settlements in compacted soils.

The problem is really one of nomenclature and of compaction decisions and specifications. We only talk of an embankment as being compacted when we are not merely spreading in layers (20 to 30cm thick) at appropriate water contents, but also applying mechanical compactive effort of full coverages by regular passes of equipment: thereupon, we find that one does not fail to achieve about 94 to 95 percent Proctor. An embankment end-dumped usually produces something in the order of 88 to 90 percent Proctor; and an embankment placed in layers will usually give about 90 to 93 percent Proctor.

First and foremost I emphasize that in embankment construction using fine-grained soils we have fortunately stayed away from the Modified AASHO (or Modified Proctor) specifications. We tried it and wisely discarded it. There is a limit to how much useful compactive effort a soil can absorb, and for our clayey soils that limit happens to be close to 100 - 102 percent Proctor (beyond that over-compaction shearing slickensides begin to proliferate); in very granular (and dry) materials it may be of interest to use Modified Proctor (about 106 - 112 percent Proctor) and highway grade and subgrade horizons may employ the Modified reference.

Incidentally the first interesting observation is that the percent compaction index leads one to believe that the parameter varies linearly from 0 to 100 percent. In fact there is an exponential variation (typical exhaustion-type curve) varying from about 90 percent to about 110 percent. In compacted materials we cannot accept anything less than about 94 percent because that is the minimum necessary for reasonable homogeneity.

The second important point is that since either of the references is arbitrary, we should select the one most technically convenient. To deal with compacted soils between 95 and 102 percent Proctor means that I can use the Proctor optimum water content as a reasonable reference. In contrast, such densities would represent roughly 86 to 93 percent Modified, which means that by using the Modified Proctor optimum moisture as a reference I am far too dry!

Permit me to say that I am simply appalled by the thought of discussing compacted materials at 70, 75, 80, 85 and 90 percent compaction (Modified), and at 80 percent compaction moisture contents! If I move so far away from my reference, what is the use of the reference?

In short, Mr. Booth's data fully support our overall laboratory and field conclusion that our compacted clayey materials do not exhibit collapse problems. The locus of Proctor peaks approximately coincides with the curve of 85 percent degree of saturation; we have never observed collapse at percent saturations higher than about 75 percent. Moreover, we never consider anything really compacted at less than about 94 percent Proctor (about 85 percent Modified) and at such densities there is no collapse.

Incidentally, as a final point, I should emphasize that all our inspection techniques and laboratory testing and subsequent conculsions are presently based on the Hilf-Proctor test (without predrying and without reuse of material for compaction points). In clayey materials the errors introduced by the earlier compaction test routines are very serious. I refer the reader to some of the data presented in my Special Lecture (e.g. Fig. 5), on compaction results in the extremely clayey material of the Salto Osorio Dam.