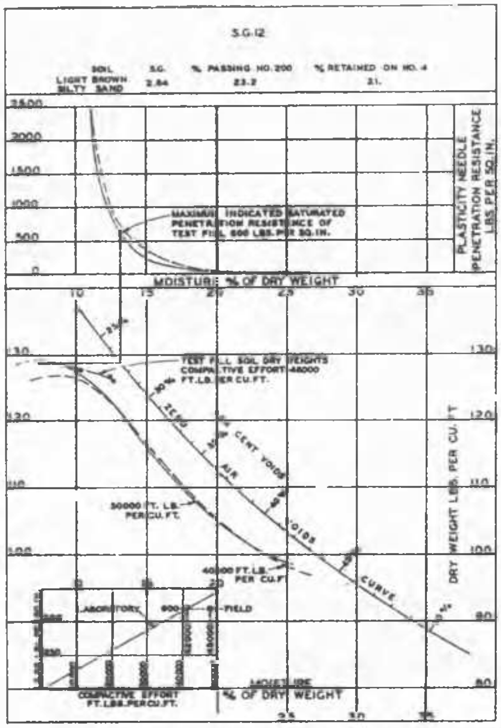

FIG. 1

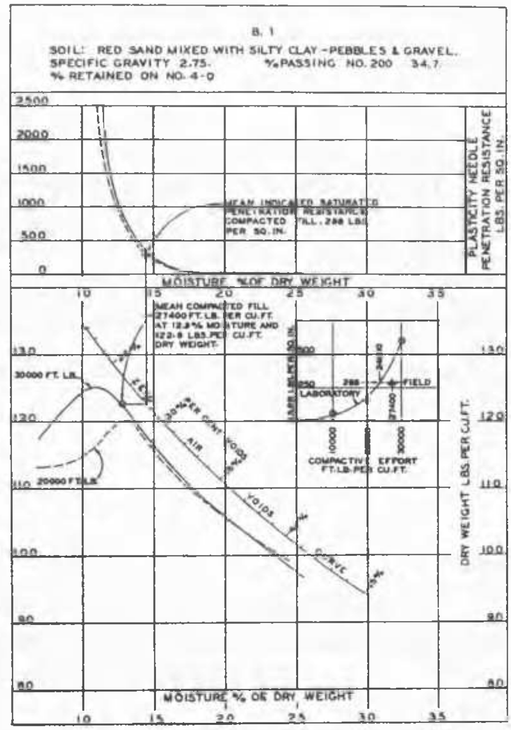

FIG. 3

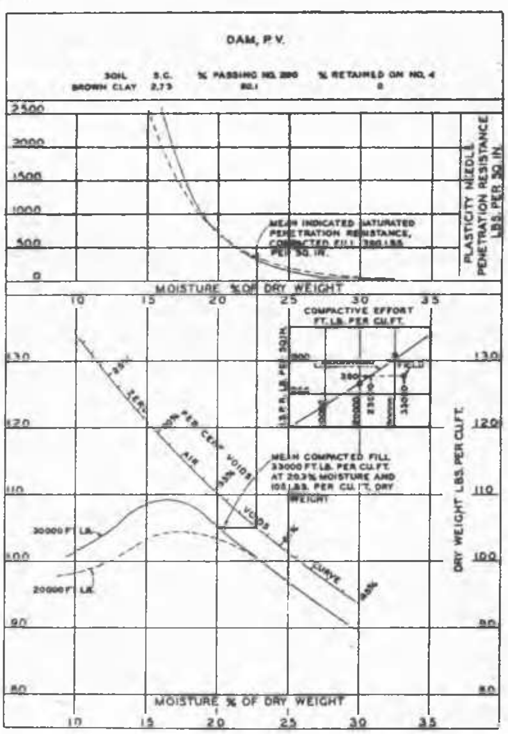

FIG. 2

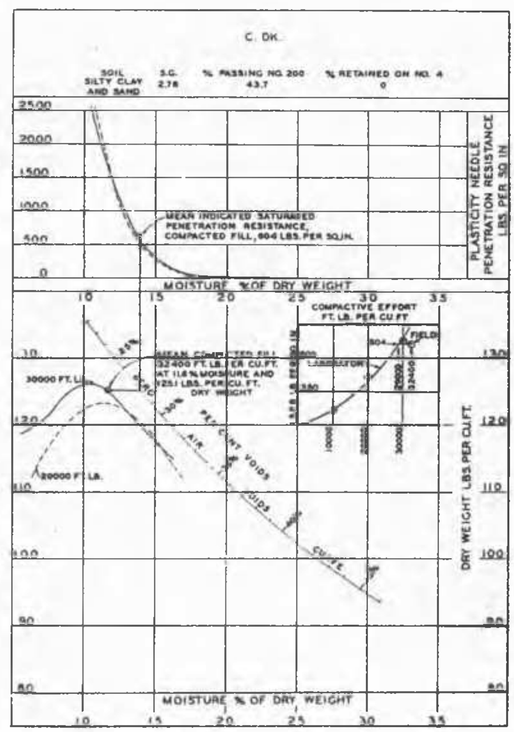

FIG. 4

Description of test results shown in Fig. 2.- The soil used in this case (Dam PV) was a brown, sandy clay, 60% of which was finer than the 200 mesh sieve. It is difficult to determine the relationship here as the field point is on the compaction (dry weight) curve, next to the zero air voids curve, but 26,000 ft lb per cu ft in the laboratory is estimated equivalent to the 33,000 ft lb per cu ft calculated from the drawbar pulls; the 26,000 ft lb value was found by interpolating along a direction parallel to the zero air voids curve between the points where each curve starts to curve away to the left from a direction parallel to the zero air voids curve. The required field compaction is then 127% of the laboratory compactive effort expended to secure the same soil dry weight.

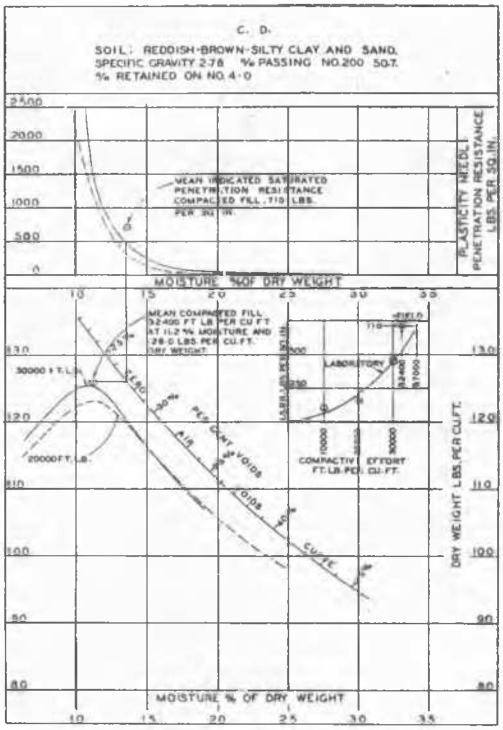

FIG. 5

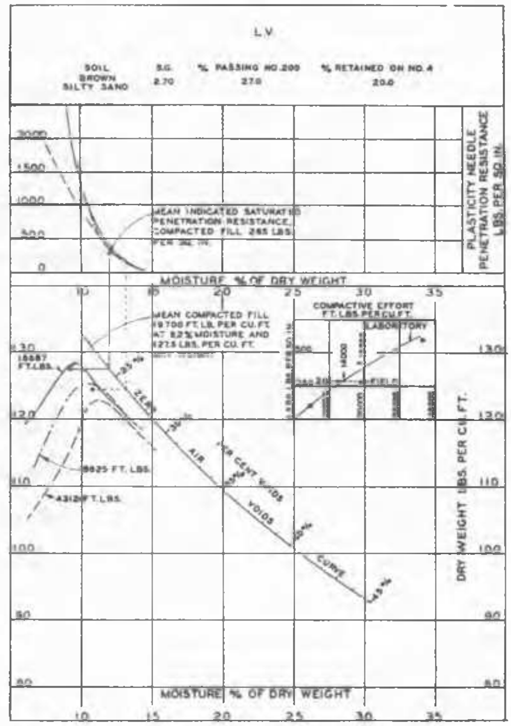

FIG. 6

Description of test results shown in Fig. 3.- The soil used in this case (Dam B1) was just about ideal for compacted fill construction with 34% finer than the 200 mesh sieve and only a negligible quantity retained on the 4 mesh per inch screen. Here, again, the field point is close to the zero air voids curve, but it is estimated that 25,000 ft lb per cu ft laboratory compaction is equivalent to the 27,400 ft lb per cu ft field compaction, making the field requirement about 110% of the laboratory compactive efforts.

Description of test results shown in Figs. 4 and 5.- The two soils used for these structures (Dams CDK and CD) were quite similar in appearance and test results to the one shown in Fig. 3, but slightly finer, 44 and 50% passing the No. 200 sieve. In the case of Fig. 4, it is estimated that 29,000 ft lb per cu ft in the laboratory is equivalent to the 32,400 ft lb per cu ft used in the field, making the field requirement 112% of the laboratory. For the case of Fig. 5, it is estimated that 32,000 ft lb per cu ft in the laboratory is equivalent to the 32,400 ft lb per cu ft in the field, a ratio of 101% .

Description of test results shown in Fig. 6.- The soil represented by Fig. 6 (Dam LV) differs somewhat from the others, about 23% being finer than the 200 mesh sieve and about 20% being retained on the No. 4 sieve. It will be noted that two "mean fill densities" are shown; the lower one was secured with too small roller teeth; the higher dry weight was secured by increasing the area of the roller teeth from 6 to 8-1/2 sq in. After increasing the area of the sheepsfoot roller teeth area the ratio of field to laboratory compaction efforts required was 19,700 + 17,200 = 114% . The smaller area teeth gave considerable trouble with full penetration permitting the drums to bear directly on the soil and thus to transfer an unknown portion of the roller weight to the soil, decreasing the pressure on the sheepsfoot teeth and lowering the drawbar pull and consequent compactive effort.

Comparison of field and laboratory compactive efforts by use of the indicated saturated penetration resistance.- There is shown on Figs. 1 to 6 inclusive, a smaller figure wherein the indicated saturated penetration resistance (I.S.P.R.) secured by various laboratory compactive efforts are shown. The mean indicated saturated penetration resistance for the dams, as determined by tests,are shown at the field (equipment) compactive efforts. Then, the laboratory compactive efforts required to duplicate the field indicated saturated penetration resistances (measured in the constructed dam) were read from the laboratory curves and placed on the figures, making possible a comparison between field and laboratory compactive efforts on the basis of similar indicated saturated penetration resistances rather than by a soil dry weight comparison. This method of comparison should be superior to the more direct appearing soil dry weight method because of the difficulty of getting a soil sample to compact for test that will be representative of the job, as far as compacted dry weight at a given compactive effort is concerned. The indicated saturated penetration resistance method eliminates this difficulty as there is not much variation in compactive efforts versus indicated saturated penetration resistance between widely variable soils (See Fig. 7).

Table 1 shows a comparison of the two methods of compactive effort comparisons; the values derived by the methods described in the foregoing paragraph are given in the table and those secured from the dry weight comparisons given in the description of Figs. 1 to 6 are shown in parentheses in the right hand column.

CONCLUSION

The foregoing analysis of field and laboratory compaction results demonstrates that

TABLE 1

Comparison of Laboratory and Field Compactive Efforts
By Use of The Indicated Saturated Penetration Resistance

Dam	Mean Indicated Saturated Penetration Resistances of Compacted Fills, Lb Per Sq In	Required Laboratory Compactive Efforts to Secure Indicated Saturated Penetration Resistances of Compacted Fills, Ft Lb Per Cu Ft	Field Compactive Efforts Expended by Sheepsfoot Rollers xa) Ft Lb/Cu Ft	Ratio, Field Compactive Efforts to Laboratory Compactive Efforts, Per cent
S.G.	600	42,000	48,000	115 (100) x)
P.V.	390	23,000	33,000	142 (127)
B.I.	288	24,000	27,400	114 (110)
C.Dk.	604	29,000	32.400	112 (112)
C.D.	710	37,000	32,400	88 (101)
L.V.	285	14,000	19,700	140 (114)

x) Values in (100) are those given in the text, as determined by estimation from the position of the compacted fill dry weights on the compactive effort vs. soil dry weight curves of Figs. 1 to 6 inclusive.

xa) Drawbar pull (lbs) × number of roller trips over each vertical foot of compacted fill + roller width (ft).

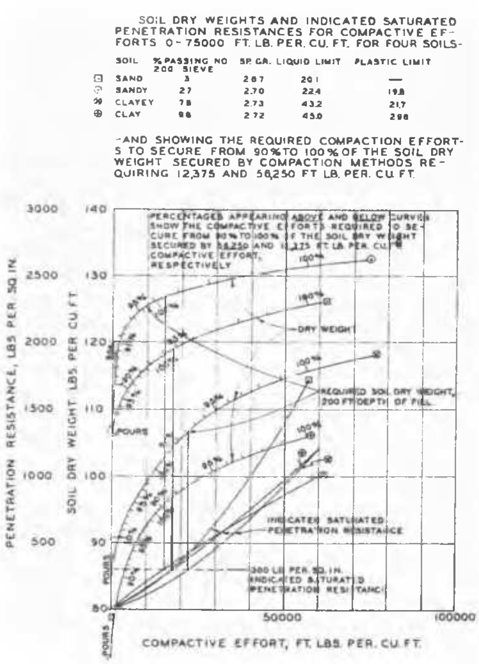

FIG. 7

the laboratory data can be applied to the design of sheepsfoot rollers of such size as may be required (within the limitation of the power of tractors now available) for any individual soil compaction project wherein a shear strength of soil has been selected that will result in the most economical structure; that is, soil compaction costs can be estimated for various embankment slopes that will have equal factors of safety or for pavement or structure subgrades that will yield a prescribed amount under equivalent loadings. It is appreciated that the data presented herein are limited in scope and that more should be accumulated wherever possible; however, the purpose of this discussion is to call attention to the methods to use for this purpose.

Attention is called to the circumstance that the use of "90% density" of a 56,250 ft lb per cu ft compaction "standard" does not mean that 90% of 56,250 = 50,625 ft lb per cu ft compaction is being secured but, instead, only 1500 ft lb per cu ft or 17,500 ft lb per cu ft may be required, dependent on whether the soils are sandy or clayey 4) (See Fig. 7) and, also, the shear strengths may be reduced to 47% or 42% of the "standard" value in the case of sandy or clayey soils 5) while, at the same time, the consolidation under loading, after compaction is finished, may be increased 275 or 225% in the case of sandy or clayey soils.

REFERENCES

1) Engineering News-Record, Aug. 31, Sept. 7, 21, 28, 1933.
2) American Society of Civil Engineers, Proceedings, Vol. 110- (1945), Page 683.
3) Laboratory Soil Compaction Methods, Penetration Resistance Measurements, and the Indicated Saturated Penetration Resistance. Paper to this Conference.
4) See Paper No. IXb 12, This Conference.
5) See Paper No. IXb 11, This Conference.

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