Soil Compaction

Excerpted and adapted from Jonathan Stephens "The Effects of Large Dirt Piles on Soil Compaction", report for GEOL 399, Undergraduate Geological Research, Spring 2010. Conducted under the supervision of Dr. Joan Fryxell, Geology Department, California State University San Bernardino.

INTRODUCTION:

The compaction of soil can have positive as well as negative effects on the surrounding environment. A positive effect is that compacted soil supplies a good foundation for buildings; construction agencies use this when constructing buildings. A negative aspect of soil compaction is that it disturbs native vegetation. It can decrease water flow through the soil and the volume of water the soil can store. This makes it harder for the native plants to get water. It also inhibits soil aeration and root penetration. Compaction occurs when force is applied to the soil.

Several methods of measuring soil compaction use soil penetrometers. The ease with which something can be pushed through the soil is affected by the degree of soil compaction and soil water content. Compacted soils and dry soils are more difficult to penetrate than uncompacted or wet soils. We used a dynamic penetrometer, as described by Herrick and Jones (2002), in which the number of blows, delivered with standardized force, that are required to drive a rod a specified distance into the soil is taken as a relative measure of compaction. Penetrometer measurements were taken in six plots in a disturbed site and at six locations in undisturbed vegetation.

METHODS:

Penetrometer design and operation:

The penetrometer we used consisted of a 12" long rod of rebar, a 4" tall collar of pipe, and a sliding hammer with a 28" long sleeve that fit over the pipe collar (Figures 1 & 2).

Figure 1. Penetrometer rebar and collar.

Figure 2. Sliding hammer in 2" diameter pipe.

The sliding hammer consisted of a weight encased in a hollow steel tube. The tube was 28 inches long and 2 inches in diameter. The weight was a 9 ½ inch long, 2 inch diameter solid steel rod with a handle that, together, weighed 10 pounds. Raising the weight to the top of the tube and releasing it caused it to strike with a standardized, repeatable force.

To take a penetrometer measurement, the rebar rod was placed in the collar on the ground (Fig. 3). The tube of the sliding hammer was placed over the rebar and collar, the hammer was lifted to the top of the tube and then released (Figs. 4 and 5). This process was repeated until the rebar rod had been driven eight inches into the soil, and the top of the rebar was flush with the top of the collar (Fig. 6). The number of strikes required to accomplish this was recorded.

Figure 3. Rebar and collar set up before penetration.

Figure 4. Sliding hammer placed over the rebar and raised, before first hit.

Figure 5. Hammer released (after first hit).

Figure 6. Rebar penetrated to standard depth.

Penetrometer measurements were taken in six 6 x 6-m plots in an area that was the former site of a spoil pile and heavy equipment activity. In each plot, ten penetrometer readings were taken on a transect running diagonally through the plot. In addition, ten penetrometer readings were taken along six transects in adjacent undisturbed vegetation.

RESULTS

Soil penetrometer measurements are shown in Table 1. There were some points where a large rock was apparently hit during the penetrometer measurements. These would not allow the device to penetrate the soil, despite many impacts. These are indicated by an asterisk in Table 1 and are omitted from any calculations.

Table 1. Soil penetrometer measurements in six disturbed and six undisturbed plots. Ten readings, their averages and standard deviations are given for each plot and/or site. The readings are the number of strikes required to drive the rebar rod eight inches into the soil.

	Plots in disturbed area						Plots in undisturbed area					
Plot ID	1A	2A	3A	4B	5B	6B	U1	U2	U3	U4	U5	U6
Reading 1	13	15	26	30	31	15	4	8	7	2	5	3
2	20	22	28	30	20	23	5	6	4	6	2	3
3	15	32	27	36	25	19	4	8	7	15	4	3
4	22	25	26	31	32	22	5	8	5	12	5	3
5	25	27	26	20	32	10	7	10	4	6	5	3
6	29	25	45	26	27	19	4	7	5	6	2	5
7	20	22	43	19	25	24	4	4	9	13	4	3
8	28	29	60*	31	33	22	5	9	4	9	3	6
9	50*	19	37	26	28	15	4	8	6	7	4	4
10	29	21	49	21	33	22	6	10	9	6	4	3
Average.	22.3	23.7	34.1	27.0	28.6	19.1	4.8	7.8	6.0	8.2	3.8	3.6
S.D.	5.9	5.0	9.4	5.6	4.4	4.5	1.0	1.8	1.9	4.0	1.1	1.1

* Values indicated by an asterisk are points at which the penetrometer hit a rock. These values were omitted from calculations of averages and standard deviations.

REFERENCES CITED

Herrick, Jeffrey E. and Tim L. Jones. 2002. Division S-6—Notes. A dynamic cone penetrometer for measuring soil penetration resistance. *Soil Science Society of America Journal* 66:1320-1324.