TURF ON STABILIZED SOILS

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At the last annual meeting of the Highway Research Board I described to you investigations on the development of turf on stabilized soils conducted by the Corps of Engineers in the warm humid regions of the United States. Today we will discuss similar work under different climatic conditions.

In 1946 the Corps of Engineers Soils Laboratory at Boston, Mass. installed a joint drainage and turf test area just outside Boston, at Nahant, Massachusetts. This area receives about 38 inches of rainfall annually, evenly distributed over the year. This investigation, while primarily for the purpose of studying runoff and drainage characteristics of granular base materials, offered an excellent opportunity to observe turf development under extremely adverse conditions. It is this phase of the work with which we are concerned in this paper.

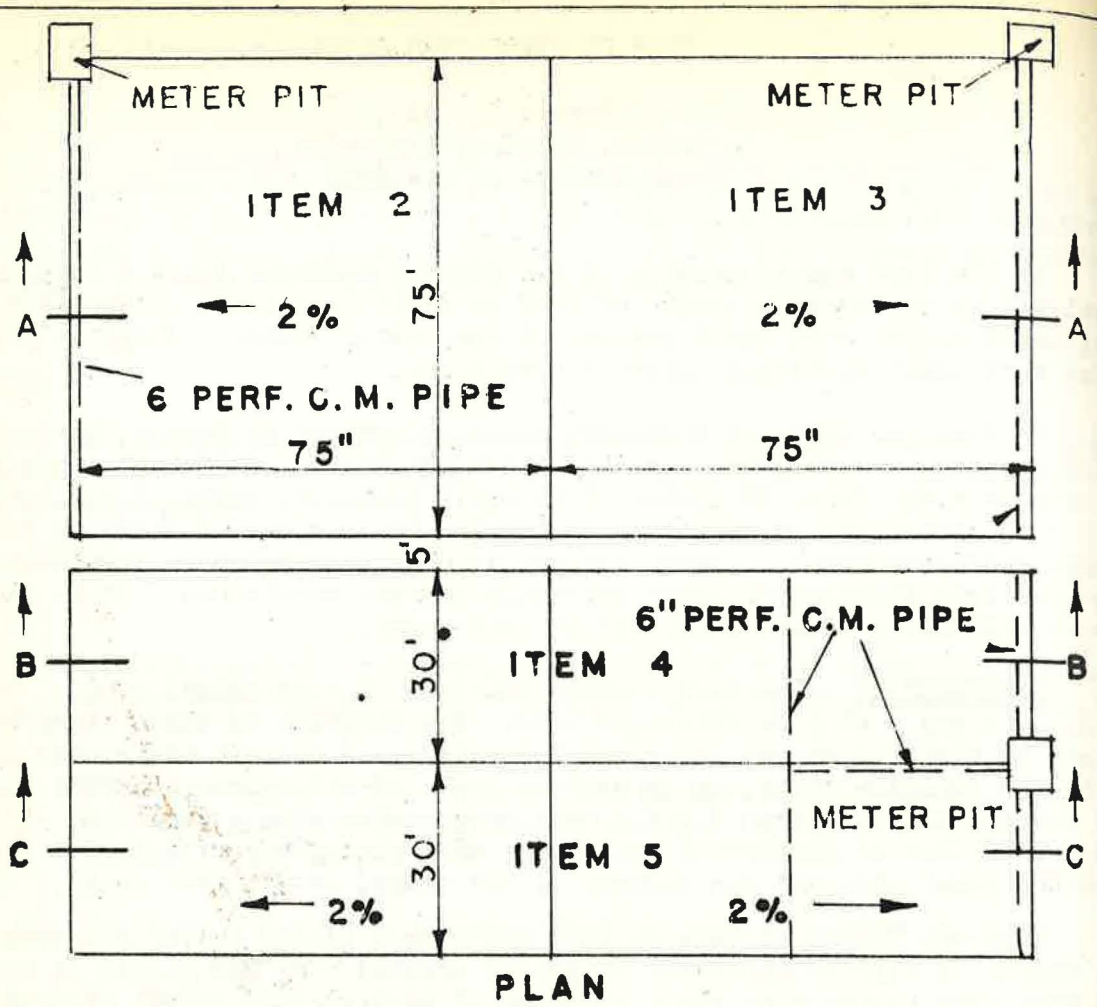
CONSTRUCTION - The test section consists of 6 principal items. Four of these, Nos. 2, 3, 4 and 5 will be discussed here. The subgrade of these items was graded to simulate an airfield runway cross section having a 2 percent transverse slope. As part of the drainage study, an impervious layer of bituminous concrete was placed under items 2 and 3. Items 3 and 4 were constructed with a compacted silty-clay subgrade. Two lines of perforated metal pipe were placed under half of items 4 and 5, one on the lower side and one halfway up the slope, or 37½ feet apart.

Eighteen inches of bankrun sand gravel was placed on the subgrade of items 2, 4, and 5. A similar thickness of ½-inch crushed rock was placed on item 3. All items were than topped with about 6 inches of bankrun sand gravel blended with sufficient selected loam to provide 2 percent organic matter in items 2, 3, and 4 and 3½ percent in item 5. This loam was added after placement of the subgrade materials and blended by two passes of a Rototiller. The surface was then brought to final 2 percent transverse slope and compacted.

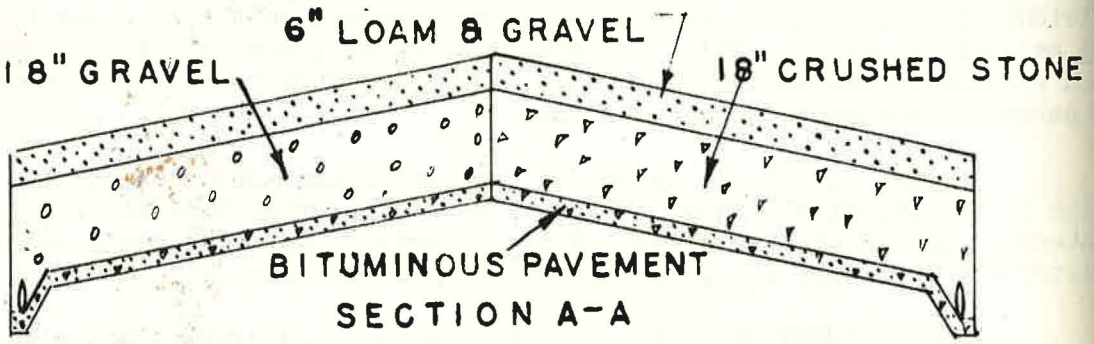
Figure 1 gives the layout of the test items and shows details of construction of the principal items. Figure 2 shows the grain size distribution of the base materials and of the two blends of top material. Note the small change in grain size distribution brought about by the addition of the loam.

ESTABLISHMENT OF TURF - All items were lined, fertilized with Milorganite, and seeded to red fescue at the rates of 35 lbs., 25 lbs., and 8 lbs. per 1,000 sq. ft., respectively. Seeding was completed in July 1946. All items were then covered with a light hay mulch and watered as required for the remainder of that summer and fall. Watering would have been unnecessary if seeding had been accomplished at the proper season.

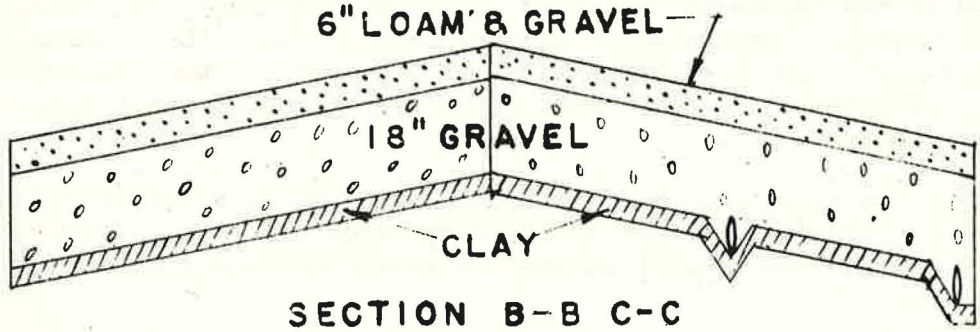
With the exception of a few spots caused by an excess of mulch, the above treatment resulted in a uniform stand of grass on all items. Surplus mulch, which would have damaged the turf if allowed to remain in place, was removed early in the spring.



PLAN



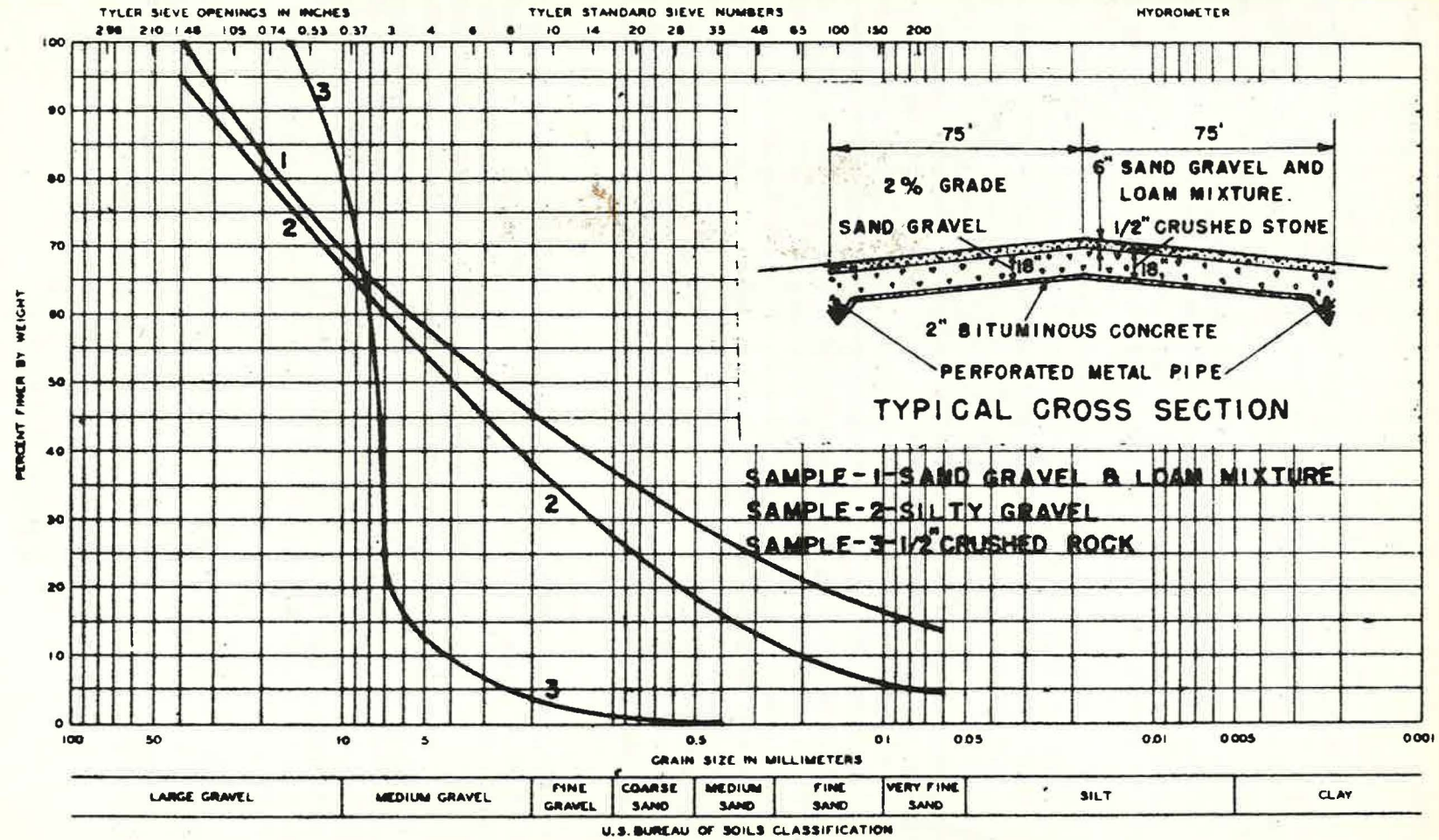
SECTION A-A



SECTION B-B C-C

TURF RUNWAY INVESTIGATION

NAHANT, MASS. FIGURE 1



TURF RUNWAY INVESTIGATION
NAHANT MASS.
FIGURE 2

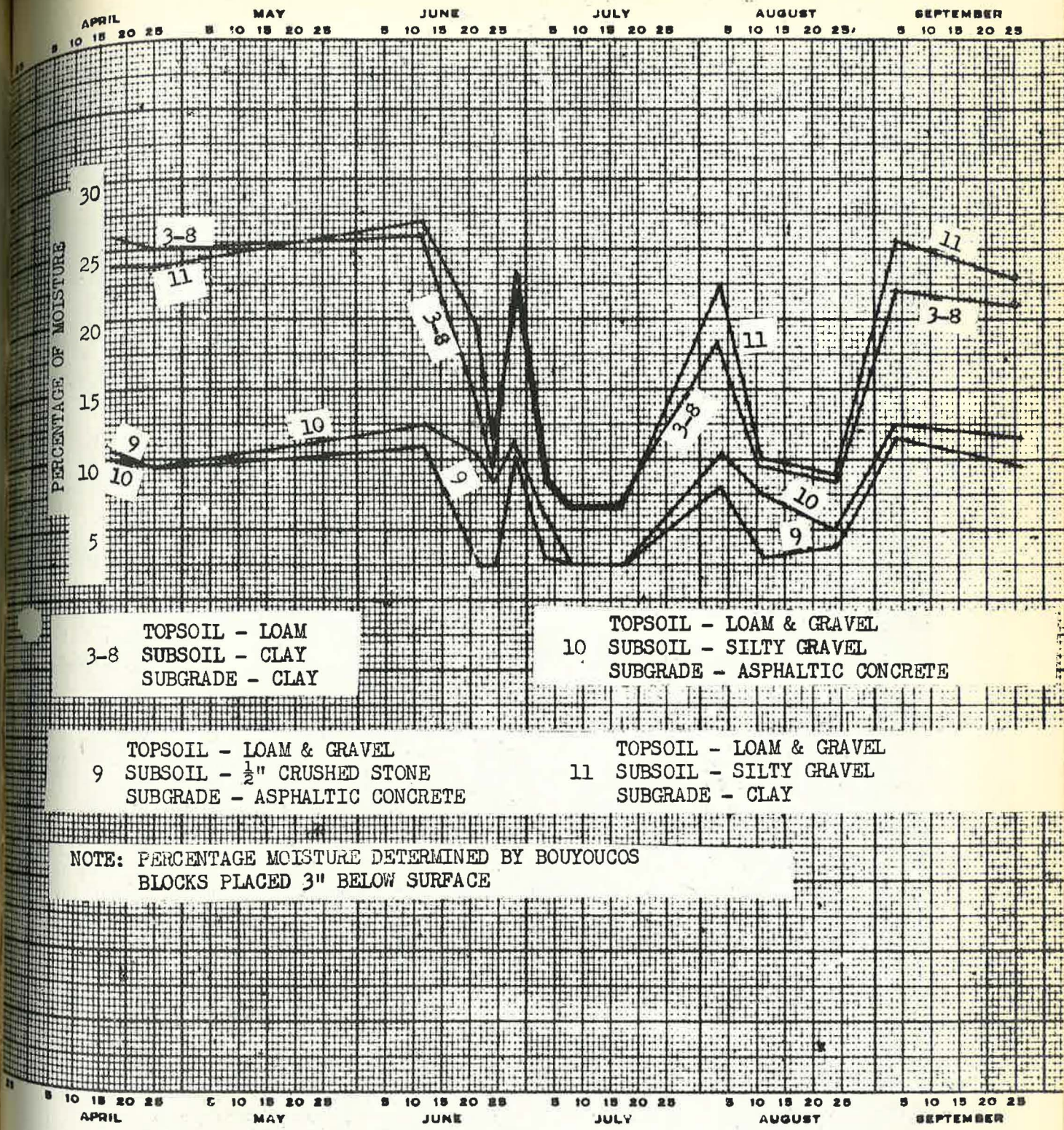
MAINTENANCE - The test items have been maintained through two summers, not including the establishment period in 1946. Maintenance consisted of the minimum amount of mowing and fertilization. No reseeding has been done nor has any watering been done except during the establishment period.

No attempt was made to perform intensive management which would not be characteristic of that given to turf shoulders in actual practice. A sickle bar mower was used often enough to keep weeds and grass under control. Height of cut was about 3 inches. The inside halves of items 4 and 5 received 25 lbs. Milorganite per 1000 sq. ft. in October 1946. In July 1947 the entire area was refertilized with Milorganite at 35 lbs. per 1000 sq. ft. and in September 1947 the inside halves of items 4 and 5 received additional Milorganite at rates of 50 lbs. and 25 lbs., respectively. These fertilizer variables were added to provide a check on nitrogen requirements.

OBSERVATIONS - Observations recorded here include the period from establishment through April 1948. The original application of Milorganite, while sufficient to establish the turf, was not enough to produce the desired density in a reasonable period. Nitrogen deficiency was apparent on all items and was especially noticeable on item 3 which has the crushed stone base. The turf on item 3, with minor exceptions, suffered severely from drought during 1947. For extended periods the moisture level of this item fell as low as 2.5 percent in the top 3 inches. The exceptions were limited areas where an accidental overdose of fertilizer had produced a heavy turf. These areas remained green through most of the dry period and resumed growth earlier in the fall. Increased ability to withstand drought and maintain growth was also evident on those portions of items 4 and 5 which received extra fertilizer. Moisture levels of the various items during the period April through September 1947 are shown in Figure 3. Percentage moisture was determined by means of Bouyoucos blocks placed 3 inches below the surface. The percentage moisture as determined by these blocks checked reasonably well with laboratory determinations, especially at the lower levels. Any slight error in individual percentage moisture does not materially affect the comparative fluctuations in moisture level, and therefore, is of minor importance here.

Root penetration was measured in April 1948. One pit each was dug in items 2 and 3 and 2 pits in item 4. The latter pits were located across the high and low rates of fertilizer, one in the drained and one in the undrained area. Roots had penetrated to a depth of 15 inches in all items except the heavily fertilized and undrained portion of item 4. In this pit roots had penetrated to a depth of 12 inches on the heavily fertilized side and 15 inches on the lightly fertilized side. (Figure 4). This was in contrast to the full 15-inch penetration for both rates of fertilizer on the drained area. There was a marked difference in the amount of ground water present in the two areas. Roots in item 2 are shown in Figure 5. Figure 6 shows root development in the crush stone in item 3. Density of the turf was in proportion to the rate of fertilization.

BEARING VALUE - California Bearing Ratio tests were made on items 2 and 3 at four locations on each one. Test procedure consisted of removing surface vegetation, placing a thin leveling course of sand, and seating the piston with a 10 lb. per sq. in. load. A penetration of 0.05 in. per minute to a total penetration of 0.5 in.



TURF RUNWAY INVESTIGATION
NAHANT MASS.

FIGURE 3

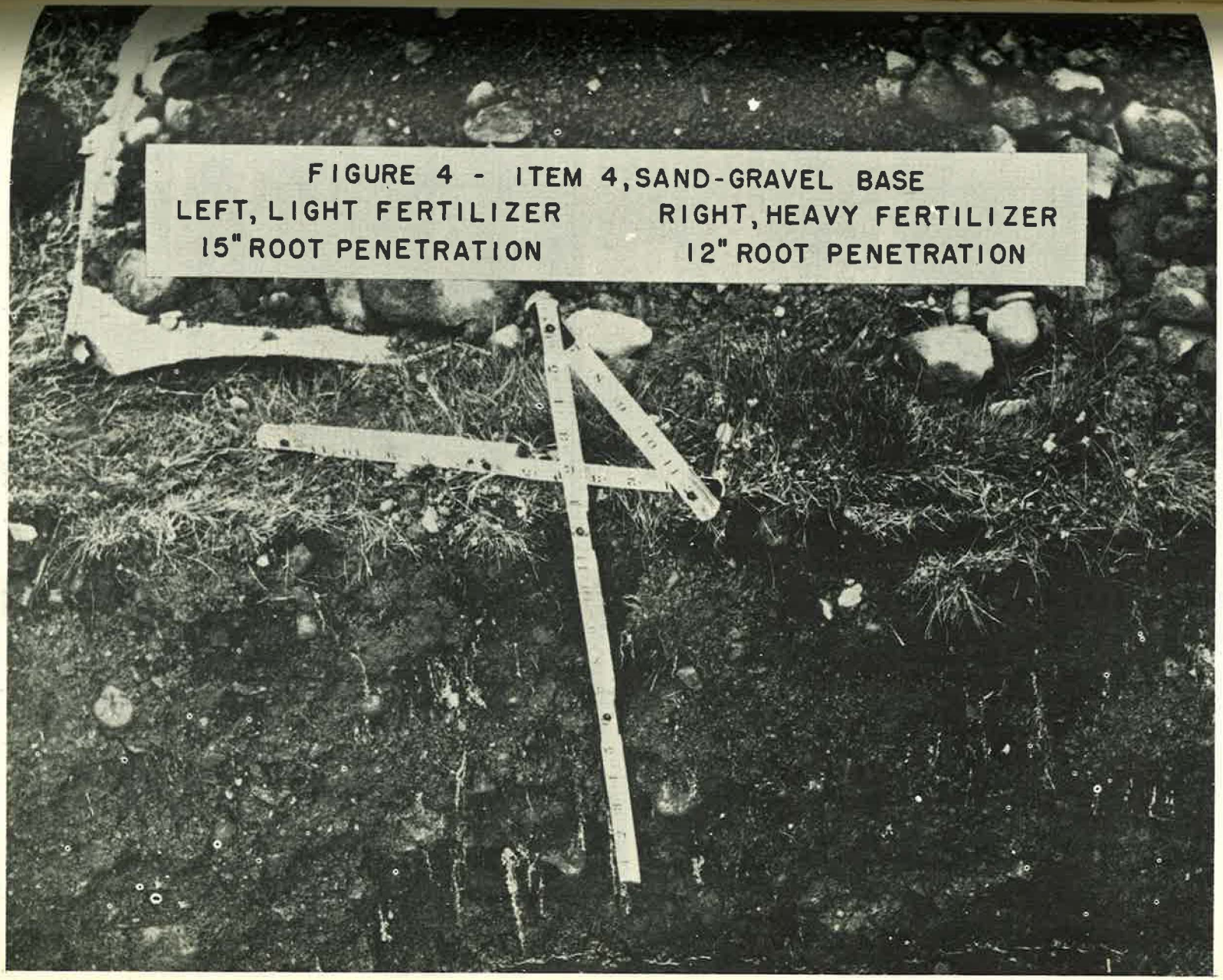


FIGURE 4 - ITEM 4, SAND-GRAVEL BASE
LEFT, LIGHT FERTILIZER — 15" ROOT PENETRATION
RIGHT, HEAVY FERTILIZER — 12" ROOT PENETRATION

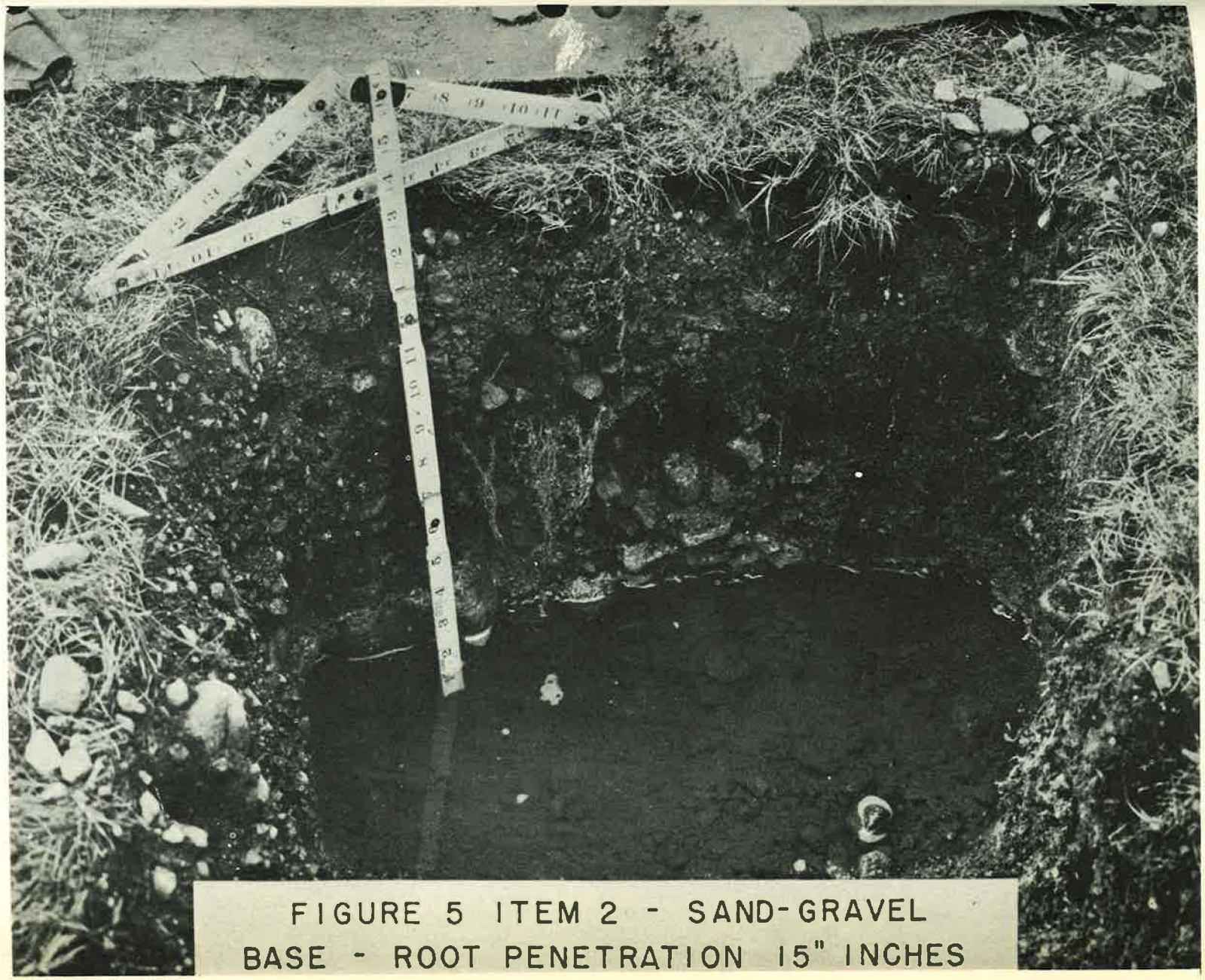


FIGURE 5 ITEM 2 - SAND-GRAVEL
BASE - ROOT PENETRATION 15" INCHES

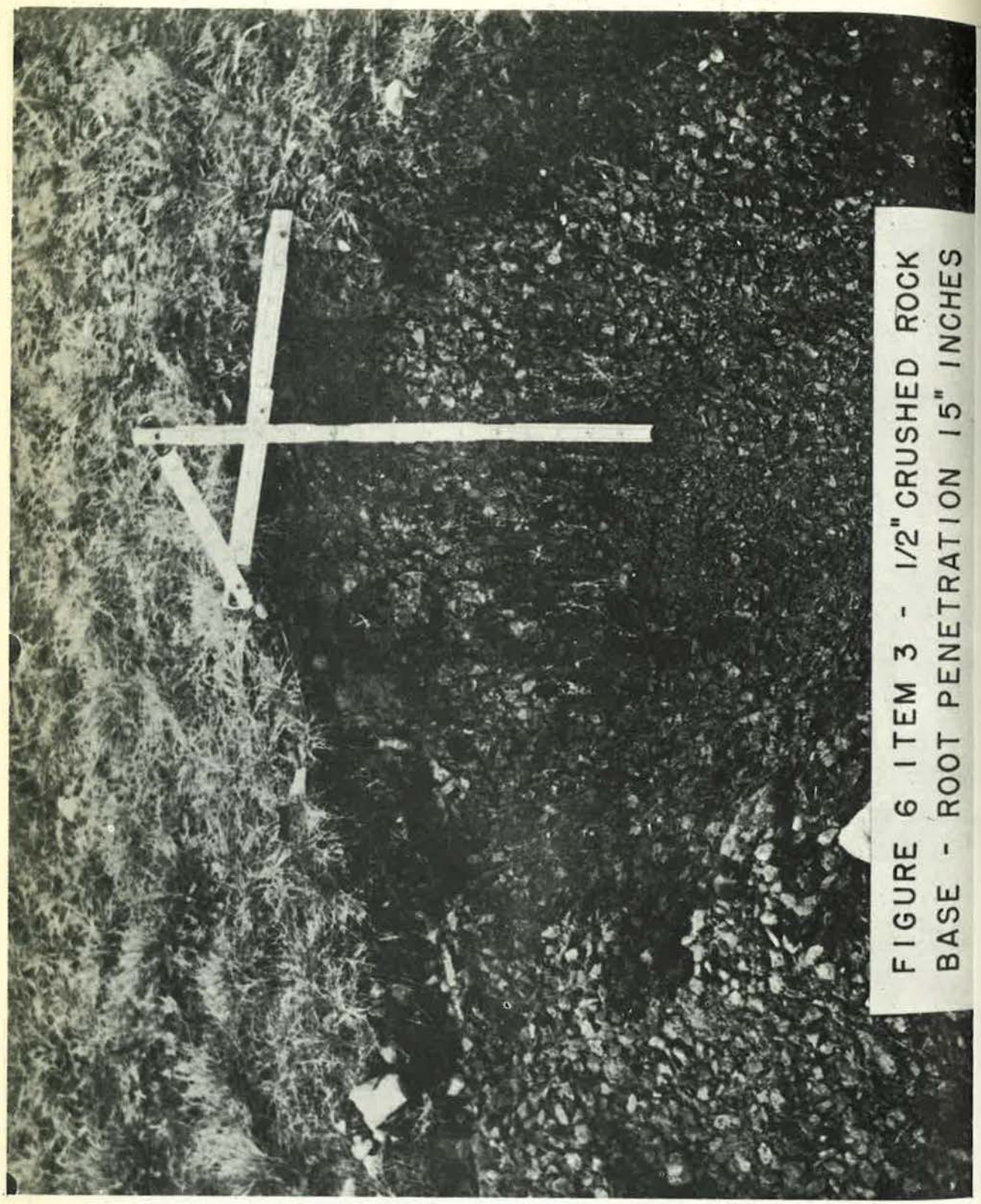


FIGURE 6 ITEM 3 - 1/2" CRUSHED ROCK BASE - ROOT PENETRATION 15" INCHES

was made with load recorded at each 0.05 in. penetration. Three trials were made at each location except where considerable variation in results existed, in which case additional tests were run. Organic content of the soil at time of the tests varied from 3.2 percent to 7.1 percent.

Results of the tests were erratic and serve principally to indicate that a more reliable method of evaluating stability or load bearing value is required. C.B.R. values varied from about 1.5 to about 4.5 for 0.2-inch penetration. These values would indicate a much lower bearing value than experience indicates is normal for the type of construction.

CONCLUSIONS - Observation of the test area over a period of 2½ years serves to substantiate results of previously reported tests made in other climatic areas. Turf was easily established on all items. Development of turf density varied primarily with rate of fertilizer on all sand-gravel bases. Moisture was a limiting factor on the crushed stone base. On the basis of these tests we can conclude: (1) that 15 percent soil passing a No. 200 sieve is ample for turf production; (2) that 2½ percent organic matter is sufficient for the establishment of turf on granular bases; (3) that at least yearly applications of fertilizer are necessary for the maintenance of turf on bases similar to those under test; (4) that the organic content will increase naturally over a period of several years; and (5) that the C.B.R. method of determining load-bearing value of a turfed area is of little value.