REPORT OF DIVISION II
ON
CONSTRUCTION AND MAINTENANCE

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Introduction. Unavoidable conditions imposed by the war made research progress reports by most subcommittees impracticable. During the year, however, outstanding advances were made in roadside and airfield development methods as reported in open committee discussions at the St. Louis meeting.

Highway maintenance costs as affected by the streamlined cross section. Representatives of those State highway departments who have adopted the well-flattened and wide, streamlined, cross section for all new highway construction reported that machine methods of maintenance are now being used to the almost total exclusion of hand labor methods. On older types of cross sections with steep cut and fill slopes, deep V ditches, and narrow shoulders, hand labor is necessary especially for mowing. Hand labor is now reported to be largely unavailable due to the competition of shipyards, minition plants, and other war industries.

Ground covers on access and military roads.--As a result of a decade of roadside development experience, ground covers are now being established on access road construction as a part of original contracts. The present experience of military authorities in charge of the maintenance of cantonments and other areas indicates that maintenance costs are certain to be high if bare soils on slopes, gutters and shoulders are not given this protection. Mulching methods have been widely used in various parts of the Warm Humid and Cool Humid regions both alone and in combination with seeding methods. Wide shoulders are necessary on roads frequently used by military traffic to provide for emergency repair work and for parking overnight of truck convoys between cantonment areas. Experience indicates that wide shoulders can be most economically maintained, in humid regions, if provided with a cover of turf grasses. Turf covered shoulders must, however, be constructed with surface and subbase soils of adequate bearing power and permeability to remain firm even when saturated with moisture. On steep slopes rough turf and bunch grasses have been found to provide adequate cover especially when used in combination with local muloh material.

New machine methods of ground cover establishment developed during the year.--Experience has now indicated that wherever possible highway slopes should be flattened as far as permitted by topography and available right of way. On slopes of 2:1 ratio or flatter seed grasses can usually be readily established. In rough, hilly topography, however, the difficulties of establishing a ground cover on steeper cut slopes must be accepted and compensated for by the use of special fertilizers, seeds, ground preparation methods, and equipment. During the past year some very interesting experiments were reported by the Connecticut State Highway Department and by the Pennsylvania Turnpike Commission, during which the standard mudjack equipment and a special variation of the "Gunite" machine were used to establish seed ground covers on slopes too steep for successful seeding by any ordinary methods.

Connecticut experiments in seeding slopes by use of mudjack equipment. During the meeting motion pictures and Kodachrome slides were shown illustrating methods used and later results accomplished in Connecticut by projecting a mixture of topsoil, fertilizer, grass and legume seeds, and water over steep mulched earth cut slopes.

The work of establishing a vegetative ground cover on steep earth slopes has always been costly mainly because of the difficulty of transporting soil to the top of such slopes and spreading it over the surfaces to be seeded. The mudjack pumps a mixture of earth, seed and fertilizer to the top of even the highest slopes. Here an air line connected to the hose nozzle sprays the mixture to a distance of several feet from the nozzle, forcing the seed and topsoil into a hay mulch previously spread over the ground.

It was explained that the standard mudjack hose and hose nozzle was not specifically designed for this type of work, and was not, therefore, entirely satisfactory. For example, several men were required to shift the heavy hose and nozzle across the slopes. Only a relatively small slope area could be covered from one nozzle position. By comparison the adapted Gunite equipment on the Pennsylvania Turnpike was described as able to spray a large area of slope with seed and soil from one set up at the level of the truck on the road below such slopes.

In spite of these handicaps the following advantage for this machine method of seeding slopes were cited.

(1) The cost of topsoiling and seeding mulched slopes was much less than by any formerly used method.

(2) The grass and other seeds germinated readily. Because of their being forced by the air jet into the mulch seeds were not displaced by either wind or storm water.

It is believed that a nozzle can be designed which will better utilize the air pressure provided behind the mud and seed mixture. With a nozzle specially adapted to the work, the soil, air, water and seed mixture, it is hoped, can be projected from a truck on the road at the foot of the slope. Not only will costs be further reduced if this can be done, but equal or better results in establishing seeded grasses and legumes may be expected.

The Pennsylvania Turnpike experiments.--The Pennsylvania Turnpike between Harrisburg and Pittsburgh is featured by a series of very high steep cut slopes. The soil on these slopes ranges between relatively sterile clays and very poor, rocky, or shaly types of soil. Seeding or any other normal method of ground cover establishment would normally appear hopeless under such conditions. During the 1941 season a series of very successful experiments were carried out on these slopes using a standard Gunite spray unit complete with air compresor and water tank mounted with the unit on a truck trailer. A hammer mill, elevator, and seed hopper and rotary screen were mounted on the truck which towed the Gunite equipment. Soil, lime, fertilizer, peat moss and seed were mixed in this equipment and blown through a hose to the nozzle on the

Figure 1 - Seeding Operations on the Pennsylvania Turnpike

By use of this equipment steep slopes have been sprayed with "Floss", a mixture of fertilizer, lime, organic material such as peat moss, seed and soil, with water added. Costs are much less than by any other method, and good stands of grasses and legumes have been established on slopes on which hand seeding is impossible. (Photo by the Pennsylvania Turnpike Commission).

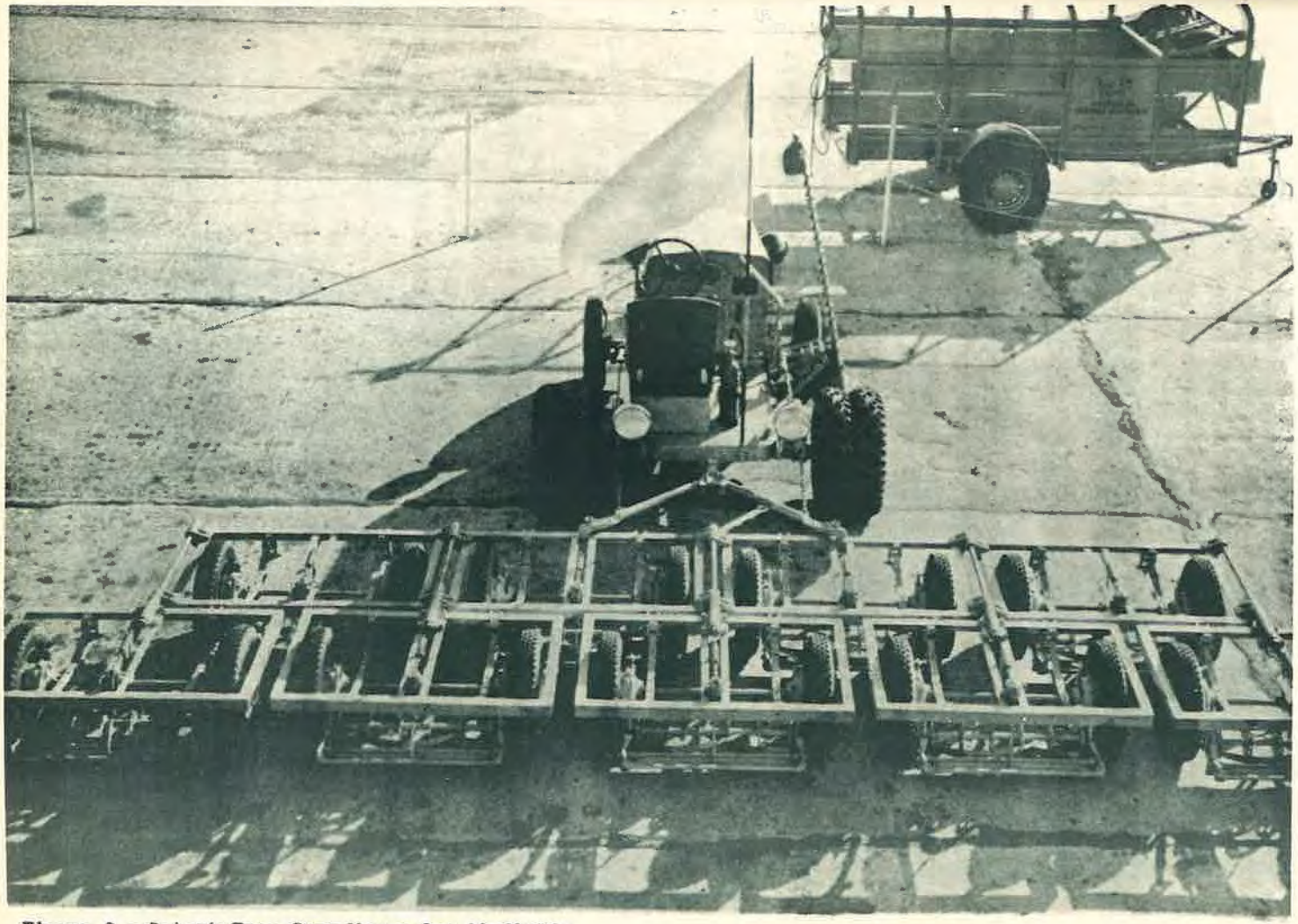

Figure 2 - Latest Type Gang Mower for Airfields

Operating 9 rotary type mower units the equipment mows a swath 21 feet wide at speeds of 20 miles per hour. A capacity of more than 350 acres per 8-hour day on large unobstructed areas. The mowers can be quickly packed into the small trailer at upper right without the use of tools, and can then be drawn by the tractor unit over a highway at speeds of more than 30 miles per hour. This machine may be adapted for highways with a modern cross section operating from 3 to 5 units to fit width of shoulders and gutters.

trailer platform. Just behind the nozzle a stream of water entered the Gunite hose line. The resulting fluid mixture was blown or sprayed as a thin mud over the surface of the slopes. On a few sections of slope mulches were installed before the treatment. The greater part of the slope areas were treated without any mulching or soil preparation. Motion pictures and slides of the operations were shown and the following advantages were claimed for the method as used.

1. The spraying of high slopes with the mixture of fertilizer, lime, organic matter, seed and soil, (called FLOSS) reduced the cost of seeding to a fraction of that of any "hand seeding" possible under such conditions.

2. A successful (though somewhat spotty) seeding job can be accomplished on slopes even steeper than 1:1 - seeding under such steep conditions is not practicable by any other method.

3. Seed sprayed or blown over slopes does not wash off readily because the pressure used forces the soil and seed mixture into crevices among shale and rock particles, and into every finger gully and roughness of earth surfaces.

4. No previous slope "sandpapering" or fine grading is required. In fact the rougher the ground surface the better the "FLOSS" sticks and seed germinates.

5. The Gunite equipment is entirely mobile and by reason of the high pressures possible all parts of the steepest slope can apparently be reached by the "FLOSS" mixture sprayed upward from the roadbed.

Certain disadvantages of the equipment and methods used on the Pennsylvania Turnpike experiments were noted during the discussion. The first experimental machine unit was of improvised design, was high in cost, and too heavy for economical use. It would appear that lighter specialized equipment might readily be designed for this type of work after the war. The area of slope seeded per hour or per day was limited and it is believed that much greater coverage can be obtained by further improvements in this method of seeding. 1/

1/ Details of these experiments on the Pennsylvania Turnpike will be found in Appendix III, p. 99.

New developments in seeding, sprigging and mowing.--During the past year the most important turf developments have been on Army airfields. Turf has been generally recognized by the Army as an important factor in the control of dust which causes serious damage to equipment and personnel. It is also extensively used as a wearing surface and for the control of soil erosion. Much of the planting of turf for military purposes has been on subsoil or other extremely poor soil such as is frequently encountered in road shoulder work. Time and equipment have not been available for extensive use of topsoil.

An interesting new development has been the planting machines for sprigging Bermuda grass. There have been several types of planters built which have given satisfactory results. The one now in most general use plants 6 rows spaced 18 inches apart with the sprigs placed continuously in furrows of adjustable depth. The machine operates readily at a speed of 5 miles an hour and makes it possible to plant extensive areas at a great saving in labor and time.

The large areas planted to turf on airfields have had to be mowed frequently to keep them in satisfactory condition. The usual 5-foot sickle bar type of mower with its restricted speed of less than 5 miles per hour has proved to be too slow for this purpose. Gang mowers of the rotary reel type have given better results. A new type of gang mower has been developed which will mow up to 20 miles an hour cutting a swath over 20 feet wide. This new high-speed mower has some excellent possibilities for use on road shoulders, gutters and slopes provided the turfed areas are moderately flat and not broken with obstacles such as posts, headwalls, and guardrails that will prevent a reasonable operating speed.

The effectiveness of both the planting and mowing equipment has already been demonstrated on airfields where the surfaces are relatively flat and free of obstructions. The use of these new high speed machines on roadsides offers possibilities of reducing costs of both mowing and sprigging to 1/4 or 1/5 of the costs with the equipment now in general use.

Soil tests used in estimating fertilizer requirements.--The use of chemical soil testing methods as a guide to fertilizer requirements on roadsides and airfields to be turfed, made progress in the past year but has not reached the point where definite recommendations can be made. The Virginia Highway Department reports that pH tests and tests for organic matter content have been made with a view toward determining best treatment of soils or soil mixtures for turf production on shoulders, slopes and gutter areas.

The pH values are significant in determining information needed in applying lime to soil. Lime is of value, it is thought, not in reducing pH content alone, but in adding calcium as a plant nutrient, rendering phosphorus fertilizers available, precipitating aluminum, and in other indirect aids to soil fertility.

T. L. Lyon and H. O. Buckman in their book, "The Nature and Properties of Soil", state that "(chemical) soil tests supply only part of information to be considered in making fertility recommendations. The texture and structure of the soil, its organic content, its drainage, its previous lime and fertilizer treatments, the preceding crops * * * * * * * * are a few of the factors most worthy of attention."

In Bulletin No. 22 of the Bureau of Soils, U. S. Department of Agriculture, the following statement is made regarding chemical analysis of the soil.

"The chemical analysis of a soil cannot in itself therefore throw much light on the problem of fertility.* * * * * attention must be directed to the mechanical condition of the soil as effecting the supply of soil moisture, with its dissolved mineral nutrients, to the effects of climate, (crop) rotations. * * * * * The conclusion naturally follows that on the average farm (soil) the great controlling factor in the yield of crops (grass) is not the amount of plant food in the soil, but is a physical factor the exact nature of which is still to be determined."

In view of the above facts the State Highway Department feels that analysis of pH content and that of nitrogen, phosphoric acid and potash will be used as one item of information concerning the selection of fertilizers to be used in growing ground covers on highway areas. Other information as to physical analysis, etc., will also be considered in determining fertilizers to be added and other soil manipulation, treatment with lime, etc., before seeding, sodding or sprigging are performed.

Wartime experience as it will apply to post-war road construction. It is apparent that experience in developing, maintaining, and mowing of turf on airfields is evolving new methods and practices which will be of great value to highway engineers after the war. Economies in machine planting and mowing already made possible by advances in the design of motor operated equipment will go far toward reducing annual highway maintenance costs in the future.

Drainage and Erosion Control

Attention is directed to a paper appearing in the 1942 PROCEEDINGS of the Highway Research Board (Vol. 22 - p. 94) entitled "Runoff from Flight Strips," by Mr. Carl F. Izzard, Highway Engineer, Public Roads Administration, who is Chairman of the Project Committee "Drainage and Drainage Structures" of the Roadside Development Committee. The paper describes experimental work involving the measurement of rates of runoff from paved strips subjected to simulated rainfall. The field work is being done by the Soil Conservation Service in cooperation with the Public Roads Administration.

Analysis of the data had not progressed far enough at the time of the meeting to enable presentation of any results. For those who are interested, the first release of data is being published in the TRANSACTIONS of the American Geophysical Union for 1943, Section of Hydrology, under the title "Analysis of Runoff Resulting from Simulated Rainfall on a Paved Plot."

This experimental project is continuing and will embrace measurements of runoff from turf surfaces of various lengths, slopes, and to the extent feasible, various densities of cover and types of soil.

At the invitation of the Committee, Mr. Rollin J. Smith, Asphalt Engineer, Skelly Oil Company, Kansas City, Missouri, described special investigations and preliminary tests of oil treatments for erosion control.

In humid climates, established vegetation provides the most practical protection against erosion that is now known on noncultivated areas. In certain less humid places, frequently small in total extent, where grass would give the desired protection, establishment of vegetation presents a difficult problem because of active erosion. If some mulch or oil treatment could be applied that would make the soil at least temporarily nonerosive and at the same time permit the establishment of a permanent vegetative cover, it would appear that it might be used as a supplement to our present recognized methods for erosion control.

Because of the interest of the Skelly Oil Company in the possible use of asphalt in erosion control, a product was prepared which was thought to have special properties superior to ordinary asphalt for soil conservation use. Through their cooperation, comparative studies of both ordinary asphalt and the special product were made in a series of tests at the Kansas Agricultural Experiment Station, Manhattan, Kansas. A detailed description of the materials, methods and results appeared as contribution No. 329 by the Department of Agronomy of that institution, in a report covering "Some Experiences with Asphalt in the Establishment of Grasses and Legumes for Erosion Control", by H. E. Myers, Associate Professor of Soils, and R. I. Throckmorton, Head of Department. This information was published in Soil Science, Society of America, Proceedings 1941, Vol. 6 (pp 459-461).