PRELIMINARY REPORT
EXPERIMENTAL STABILIZED TURF SHOULDERS FOR NEW JERSEY PARKWAYS

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During the turf conference held at Syracuse University in April of this year, at which many of you were present, Mr. Allen Ely, Soils Engineer for the New Jersey State Highway Department, and I came to the conclusion that much remained to be learned about stabilized turf shoulders for highway and parkway use. We were especially interested in the design and construction of a stabilized turf shoulder for parkway purposes.

The Problem: Our problem was to design a stabilized turf shoulder suitable for parkway use and construct a sample section before fall of 1947. Time was limited because the paving plans would be in the process of preparation during the fall and winter months and it was believed that it would be desirable to use a stabilized turf shoulder on parkways if we could design one that would meet our requirements of:

1. Adequate width for break downs and emergency stops.
2. Turf that would stand the wear of occasional use by passenger vehicle traffic.
3. Possess sufficient load bearing capacity during all types of weather and at all seasons of the year.
4. Present an attractive appearance throughout the year.

Typical Cross Section Design: After considering many different plans, it was decided to use a ten foot shoulder consisting of a three foot bituminous concrete shoulder next to the concrete pavement with the remaining seven feet built of a stabilized turf shoulder that would carry the load of passenger vehicles and at the same time support the growth of a good turf. The three feet of bituminous concrete pavement in the shoulder next to the pavement was believed necessary for the wear that this area generally receives from passenger cars that run off the edge of the concrete pavement. The bituminous concrete pavement would prevent the area adjacent to the edge of the concrete slab from forming a dangerous rut and would eliminate the unattractive appearance of worn out turf at this location.

In designing the stabilized turf shoulder it was decided to use a 5 percent cross slope for the 10 ft. shoulder as originally planned when the Department was considering surfacing the entire 10 ft. shoulder with a bituminous concrete material. The 5 percent cross slope provided sufficient slope to allow the water from the concrete roadway to run-off rapidly and also kept the water away from the edge of the concrete pavement. The same cross slope was maintained in the sub-base of the shoulder which helped drain the water away from under the concrete slabs. This would reduce the danger of pumping at the joints.

Two types of typical cross sections were designed and used in the construction of the experimental stabilized turf shoulders.

Typical Cross Section No. 1. This section consisted of a eight inch sub-base of bankrun sand which remained constant with a six inch top course designed in two layers of three inches each. The bottom 3 in. layer of $1\frac{1}{2}$ in. stone, sand, and soil remained constant whenever Section No. 1 was used. The materials used were mixed according to volumetric proportions.

2 parts of $1\frac{1}{2}$ in. stone (Trap Rock Used)
1 part of bankrun sand
$\frac{1}{2}$ part of soil (Topsoil)

All materials used were of a clean nature and the soil had only an average of 2.17 percent organic content. Our usual topsoil specification is 4 percent organic content by weight for soil brought in on the job by the contractor. As this soil was the only type available at the time, it was used and proved satisfactory.

The top three inch layer was variable. Section 1 No. 2 Variable had volumetric proportions as follows:

3/4 part - $1\frac{1}{2}$ in. stone (Trap Rock Used)
1 part - Bankrun sand
$1\frac{1}{4}$ parts - Soil (Topsoil)

During the construction of the experimental stabilized turf shoulders, it was decided to design a third section with an 8 in. sand sub-base that remained constant with one 6 in. top course all mixed in one operation in order to reduce cost of construction. Section 1 No. 1-A Variable had the following volumetric proportions.

3 parts - $2\frac{1}{2}$ in. stone (Trap Rock Used)
1.5 parts - Bankrun sand
2 parts - Soil (Topsoil)

Typical Cross Section No. 2 consisted of a four inch sub-base of $1\frac{1}{2}$ in. stone and sand that remained constant. The top 10 in. course was designed in two layers. The top layer was six inches in depth consisting of $1\frac{1}{2}$ in. stone, sand and soil variable in each test plot. The bottom four inch layer was made up of bankrun sand which remained constant.

Materials: Some of the materials used have already been mentioned. In addition to the $2\frac{1}{2}$ in. stone, $1\frac{1}{2}$ in. stone, a dirty screening and dirty road stone were used. All of these various kinds of materials were tried in order to find a cheap type of inert material that would prove satisfactory for our needs.

The comparative cost of these materials are as follows:

	Average Price delivered cu. yd.
$2\frac{1}{2}$ in. stone (Trap Rock)	$3.18
$1\frac{1}{2}$ in. stone (Trap Rock)	3.25
Dirty screenings	2.99
Dirty road stone	2.99
Bankrun sand	1.00

The three ft. bituminous concrete shoulder was constructed of a cold mix type A material placed on a six inch stone base of compacted 1½ in. stone and screenings. The base measured three feet six inches in width.

<u>Material Specifications</u>: The suggested material specification as prepared by our Soils Engineer at the present time is as follows:

The materials for stabilized turf shoulders shall consist of a mixture of two and one-half (2½ in.) inch broken stone or slag, topsoil, and bankrun sand or washed sand.

<u>Broken Stone</u>: Broken stone shall be either trap rock, dolomite, granite, limestone or gneiss. Only one of these kinds shall be used unless otherwise approved by the Engineer.

Trap Rock shall mean a basic igneous rock consisting principally of augite and plagioclase. It shall be of medium or fine grain texture with even distribution of constituent minerals and uniform quality and color, and the percentage of wear (Deval) shall be not more than 3.

Slag shall be air cooled blast furnace slag, and shall consist of angular fragments reasonably uniform in density and quality, reasonably free from thin, elongated and glassy pieces, dirt and other objectionable matter, shall weigh not less than 70 lb. per cu. ft., and shall have a percentage of wear, Los Angeles Test, of not more than 40.

<u>Stone Grading</u>: Broken stone and slag shall be graded as follows:

		Round Openings inches
2½ in. stone -	100% passing	3½
	85-100% passing	3
	0- 45% passing	2¼
	0- 5% passing	1¼

Both square sieve openings and round screen openings may be used to grade the materials in the laboratory, but in case of discrepancy the grading by round screen openings shall govern.

<u>Topsoil</u>: The material obtained from stripping, which is suitable for topsoil, shall be cleaned by removing lumps, roots, matted leaves, stones more than one inch in diameter, branches and other unsuitable matter. Growing weeds shall be removed from stored topsoil immediately before it is used. When the quantity of topsoil obtained in this manner is insufficient for the Project, the Contractor shall furnish from other sources the additional material required and shall clean it as above described, and the cleaned topsoil shall have an organic content of not less than four percent by weight. All topsoil shall have a Hydrogen Ion value of not less than 5.8 and not more than 6.5, and if necessary, lime shall be added to obtain the required value.

The bankrun or washed sand shall be so graded: 100 percent pass 3/4 in. sieve, 90-100 percent pass No. 4 sieve, and 0.7 percent pass No. 200 sieve.

All percentages are to be based on the total weight of the sample.

The material shall be mixed according to the following volumetric proportions:

2½ in. stone or slag	-	3 parts by volume
Bankrun or washed sand	-	1½ parts by volume
Topsoil	-	2 parts by volume

Method of Construction: In constructing the experimental turf shoulders a sample section of existing highway known as New Jersey Route 30 was selected. The existing ten foot improved stone shoulders were excavated to a depth of 14 inches and then the sub-base course of 8 in. of sand in Section No. 1 or 4 in. of 1½ in. stone and sand were put in place for Section No. 2 and compacted. The top course consisting of two layers were put in place on both sections.

In Section 1 the two layers were pulvi-mixed separately by using a Seaman Pulvi-Mixer. This machine can be set for mixing material up to twelve inches. After mixing each layer they were rolled separately with a six ton smooth roller. At least 2 to 3 passes were made over the separate layers.

In Section 2 the top six in. layer was pulvi-mixed and then rolled with a six ton smooth roller. Two to three passes were made over the top six inch layer. Each separate layer was compacted as it was built.

Hydrated lime was applied at the usual rate in sufficient quantity to correct the Hydrogen Ion value so that it was not less than 5.8 and not more than 6.5. The hydrated lime was spread before pulvi-mixing and then completely mixed by machine in the top layer of each plot.

After the top layer on each typical section had been rolled, a 5-10-5 commercial fertilizer was added at the rate of 2000 lb. per acre. Heavier application of fertilizer was used because of the small amount of topsoil mixed with the sand. No organic material had been added in most test plots. At some locations Driconure was applied at the rate of 50 lb. per plot. The fertilizer was raked into the topsoil with a heavy iron garden rake and then seeded at the rate of 12 lb. per 1400 sq. ft. plus additional allowance for extra repair of an area equaling 600 sq. ft. Total amount of seed used was 12 lb. per 2000 sq. ft.

After sowing the seed, the shoulder area was rolled with an empty water ballast hand roller.

Five different grass seed mixtures were used in seeding the experimental turf shoulder plots.

	percent
A. Kentucky Blue Grass	45
Red Top	15
Chewings Fescue	20
White Clover (Dutch)	10
Timothy	5
Oats	5

	percent
B. Kentucky Blue Grass	50
Red Top	15
Chewings Fescue	15
Meadow Fescue	10
Timothy	5
Oats	5

C. Chewings Fescue (Sandy soil & dry condition)	percent
	35
Red Top	30
Kentucky Blue Grass	20
Oats	5

D. N. J. No. 1 - Soils of average fertility.	percent
Kentucky Blue Grass	45
Red Top	25
Colonial Bent Grass	10
Perennial Rye Grass	15
White Clover	5

E. N. J. No. 4 - Poor, shaley, sandy or clay soils.	percent
Red Top	20
Chewings Fescue	40
Kentucky Blue Grass	10
Colonial Bent	10
Perennial Rye Grass	15
White Clover	5

Mulching: Since the seeding had to be done out of season during the latter part of June and early July, the turf shoulders were mulched with hay at the rate of 100 lb. per 1400 sq. ft. By using the hay mulch we were able to obtain a good stand of grass in spite of a dry period that occurred during the first part of July.

After the turf had grown 1½ in. - 2 in. the hay mulch was removed by the use of a hand hay fork. Any hay that did not remove easily was allowed to remain. The remaining mulch did not cause any damage to the new grass.

Watering: During the very dry period the newly seeded shoulders were watered by use of a water wagon with a special sprinkler pipe extension. The shoulders were watered thoroughly approximately every three days until it rained.

Protection: During July and August no traffic was allowed to use the shoulders. Delineators were placed 50 ft. apart along the edge of the bituminous portion of the shoulder to keep cars and trucks off of the newly constructed shoulder. On September 19, 1947 the delineators were removed and traffic was allowed to use the experimental stabilized turf shoulder.

Observations: To date we have had extreme weather conditions with long periods of wet weather and long intervals of dry weather. The shoulders have been observed to date under both of these conditions.

After a period of one week of heavy rainfall, the stabilized shoulders showed no signs of any soft spots or erosion. A passenger vehicle or truck could travel over the shoulder without leaving any indication of wheel tracks. Farmers' tractors had used the shoulder and very little sign of the tracks could be seen.

During the month of October, New Jersey had a prolonged drought with only .08 of an inch of rainfall, as compared with an average of 3.79 in. Even after this dry period all test plots were green and in good growing condition. It was observed that the plots having the stone sub-base showed some drying as compared with the plots with a bankrun sand sub-base.

The stabilized turf shoulders were observed on November 14, 1947 after a record rainfall of 4.39 in. for the first 11 days of November and it was learned that all of the test plots stood up very well except one known as Sec. 1 No. 6 Double Variable No. 2, Station 222+00 to 224+00, right side, which was constructed of the following material:

1.50 parts - 1½ in. stone (Trap Rock)
2.0 parts - Bankrun sand
2.50 parts - Soil (Topsoil)

This section had a 6 in. top layer with a large volume of topsoil placed on an 8 in. sand sub-base. This test plot showed evidence of rutting near the edge of the 3 ft. bituminous concrete portion of the shoulder where a truck had run off the pavement.

Moisture tests were made after a heavy rainfall and it was found that Sec. 1 No. 7 (6 in. Top Course Depth) of dirty screenings and soil retained more moisture than the other sections because the 8 in. sand sub-base showed a 14 percent moisture content. Where 2½ in. stone was used in Section 1 No. 1-A Variable 20 percent moisture content was found in the 4 in. sand bottom layer above the four inches of 2½ in. stone and sand sub-base. The coarser material allowed the moisture to pass through to the sand layer very quickly while the other screenings held it in Sec. 1 No. 7 (6 in. Top Course Depth).

Conclusions: 1. It was learned that the construction of stabilized turf shoulders could be built during the summer months of June and July successfully. It is also believed the period of construction could be extended through August by using the same practice of mulching the newly seeded areas.

2. It has been proven that a good stand of turf may be established on a stabilized shoulder by following the procedure described.

3. The three feet of bituminous concrete pavement used as part of the ten foot shoulder has to date eliminated any wearing out of the turf next to the paved area.

4. Stabilized turf shoulders as constructed have proven satisfactory in both dry and wet weather for passenger vehicle use during the late summer and early fall.

5. Turf shoulders greatly improve the appearance of parkways and highways.

DISCUSSION OF REPORT BY DEAKIN

(Questions were addressed to the author)

It is important that a progress report on this experimental work be made next year, particularly because it deals with existing fine grained soils instead of granular soils.

Would the cost of construction and maintenance of these stabilized turf shoulders be higher or lower than for bituminous surfaced shoulders?

> Cost would be no more than the crushed stone type of shoulder presently used in New Jersey. The sub-base material is not included in shoulder cost. The sub-base material under the pavement is carried out across the shoulder area anyway, so the additional stabilized material for the shoulder does not add much to cost. Lower maintenance cost is anticipated as the constant scraping with a grader necessary with the crushed stone type shoulder will be avoided with the turf shoulder.

Could ground limestone have been used instead of hydrated lime? Could some ground limestone be used in the future to determine the relative merits of each material?

> Our only objection to ground limestone is the slowness with which it acts. We would be willing to try it out as a comparison with hydrated lime.

Could observations in the next few years be made of maintenance practices in relation to build-up of the shoulder? For example, leaving cuttings after mowing against removing all cuttings?

> We will do this; it seems to be a desirable study.

In the experimental section a 3 ft. width bituminous strip was used adjacent to a 10 ft. pavement lane width. Would this bituminous strip be necessary adjoining 11 ft. or 12 ft. pavement lanes? Why is a 3 ft. width used?

> The bituminous strip would be used, regardless of pavement lane width. It is desirable for a permanent attractive shoulder even on rural sections of highway. We have noted a $1\frac{1}{2}$ ft. width of wear on shoulders, but a 3 ft. bituminous strip is more practical to build and more stable than a narrower width.

Should not the difference in character of surface (bituminous material versus turf), and the need for good drainage be recognized by a test installation in which a shoulder pitch of 1 in. per ft. instead of the reported 5 percent would be used for the turf portion of the shoulder? It seems that better drainage over turf would be obtained and that there would be less trouble from build-up.

> Some test sections could be worked in for that purpose. Our design engineers want shoulders to be a safe place to stop.