Highway Research Board
Department of Design
Committee on Roadside Development
Sub-Committee on Shoulders

A STUDY OF TURF SHOULDERS

During 1945 and 1946, the Committee on Roadside Development made preliminary studies of highway shoulders, with particular attention to turf shoulders, and as an outgrowth of that study, a Sub-Committee on Shoulders continued work on the subject during 1947.

The Committee has a decided interest in the over-all subject of shoulders, because of the prevailing use of turf as a shoulder surface in the humid regions of the country, and because of questions being raised as to the suitability of turf on shoulders from the standpoints of safety and maintenance.

Advantages of turf shoulders are that they give a good delineation of the pavement edge, are economical to establish and maintain, discourage the use of shoulders as an additional area for constant traffic use, provide a good background for highway signs, and are pleasing in appearance.

Two prevailing complaints against turf shoulders are (1) instability, and (2) "build-up" that interferes with drainage and makes maintenance more difficult. The Committee feels that much could be done to determine ways and means of correcting to a large degree the causes of these two complaints, and three studies are outlined later in this report.

Acknowledging the shortcomings of a too great percentage of turf shoulders, the Committee also feels that some of these shortcomings are not the fault of the turf itself, but are due to a lack of "engineering" of shoulder construction, and to the tendency to make shoulders a dumping ground for left-over soil on construction in the haste to get this last item out of the way for final inspection and completion of the project.

There is justifiable pride in getting vegetation on any kind of soil at the lowest cost to check erosion; or in carefully selecting the very best of high organic matter topsoil to get an even better stand of turf. However, the Committee does not want to camouflage with turf a shoulder that is not stable enough to safely support the traffic using the shoulder in emergencies.

Turf is not proposed as a "cure-all" shoulder surface. In dry regions turf cannot be established or maintained. At other locations and under certain conditions of continued traffic use turf cannot be maintained even in humid regions. At such locations the problem of what type of shoulder construction and surfacing, as well as any discussion of shoulder widths, is outside of the scope of the Committee's current studies.

Instability of Turf Shoulders

Principal causes of instability of turf shoulders are:

1. Insufficient drainage, holding excess water in shoulders.
   a. Inadequate ditch design.
   b. Failure to keep ditches open.
   c. Impervious subgrade.

2. Insufficient compaction.

3. Saturation of a high turf shoulder due to insufficiently free run-off.

4. Construction of shoulders with soil that is inherently unstable.
   a. Soils of high organic matter content chosen to encourage easy establishment of vegetation.
   b. Lack of selection of soil for shoulders. The use of "any old soil" most easily available, whether it be pure sand or poor clay from the lowest levels of a borrow pit.

The first two causes above could be easily corrected in design, construction, and maintenance, and the third cause would be eliminated by control of shoulder build-up. The fourth cause of turf shoulder instability -- types of shoulder soils -- is one requiring further study, as described later.

Turf "Build-Up"

Causes of "build-up" of turf shoulders include:

1. Swelling of fine textured types of soils.
2. Frost heaving.
3. Use of sand, cinders, etc. on icy pavements.
4. Fine stone whipped from flexible type pavements by traffic.
5. Shoulders originally constructed with insufficient rate of slope.
6. Coarse cuttings left on shoulders.
7. Natural growth of vegetation on shoulders (It is possible that any vegetation by its growth reduces density, thereby causing "build-up")
8. Retarded run-off of surface water (even on turf shoulders with good rate of slope), resulting in the depositing on shoulders of the dust and dirt accumulated on the pavement.

The first six causes listed above might be corrected to a large degree by rolling of shoulders, sweeping of stone, sand and cinders from shoulders, increasing the rate of shoulder slope in original construction, and more frequent mowing and raking and removal of the heaviest cuttings. The rolling, sweeping, mowing and raking are continuing operations, of course, and cannot be considered as providing a means of permanent correction. The last two causes listed above are not easily eliminated and studies proposed to overcome or greatly reduce these problems are described later.

Studies For 1948

On the following pages are outlines of three problems proposed for study during 1948. The questions, analyses, and experiments outlined are by no means the job of landscape personnel alone. They constitute a problem of "engineering" safe, attractive and economical shoulders that is a challenge to the combined efforts of the construction, maintenance, soils, and traffic engineers as well as the landscape engineer.

PROBLEM 1. Establishment and maintenance of satisfactory turf on shoulders having sufficient stability to safely support occasional traffic:

Definitions:

"Satisfactory turf" is one consisting of low-growing, turf-forming and wear-resisting grasses or other plants, dense enough and evenly enough distributed to check erosion and present a uniform appearance.

"Sufficient stability" is that capable of safely supporting any type of vehicle (normally using the particular section of highway or area in question) at varying speeds and during at least 95 percent of the entire year, without creating ruts or depressions that are not self-healing or easily repaired with a minimum of maintenance effort.

"Occasional traffic" is that deviating from regular traffic channels only in emergency or for convenience, without such action being at any prescribed point along the highway, or at regular time intervals.

Questions:

1. What degree of stability is needed to permit safe occasional use of shoulders?

    a. What measure of stability is to be accepted by all?
    b. Is actual use at the worst (in relation to stability) season of the year the most acceptable test? (Possibly measuring by definite load, definite bearing area of tire, definite speed, definite measurement of ruts?)

2. Should the entire width of shoulder have a high degree of stability? If not, what stable width adjacent to the pavement is necessary?

    (Answers to this question should be based on pavements of adequate width, where there is not a tendency for traffic to frequently run off the pavement.)

3. What grasses are best suited to establishment and maintenance of turf on stable shoulder soil? What methods best for establishing and maintaining grass under these conditions? (Good results obtained with Fescues and Bermuda particularly. Are there others especially good?)

4. Of what value is the turf itself as a factor in stability?

5. What is the maximum density and minimum pore space on which turf can be maintained?

6. What are the best methods of establishing and maintaining turf under shoulder conditions?

Analyses:

Some existing shoulders have satisfactory turf and a satisfactory degree of stability. Other existing shoulders have satisfactory turf but are decidedly unstable. Much valuable information can be gained by careful analyses of both classes of existing shoulders - those that are stable and those that are unstable. To get a uniformity of results the following procedure is recommended.

1. Time of sampling. Samples from approximately the same location should be taken at several seasons, preferably

   a. Period when frost leaves ground in spring (or comparable spring wet season in southern states.)
   b. Mid-summer, in a dry period when stability would probably be greatest and conditions for growth of turf poorest.
   c. In autumn, before heavy freezing of soil.
   d. In southern states, during mid-winter rainy period.

2. Depth of sampling. Samples should be taken after removal of the top-growth of the vegetation and taken in three-inch layers, to a depth of 9 inches, or with the lowest layer deeper if necessary, to get as low as, or below the elevation of the bottom of the pavement base course.

3. Laboratory information desired. The following list of items is long, but all the information can be obtained by established routine laboratory tests or calculations.

   a. Density (Dry density)
   b. Moisture content
   c. Porosity
   d. Liquid limit
   e. Plastic limit
   f. Plasticity index
   g. Sieve analysis (AASHO specifications)
   h. Specific gravity
   i. pH value
   j. Plant food content (N, P_2O_5, K; also Calcium and Magnesium)
   k. Density of grass roots (wash all soil away from roots, weigh, and calculate on a dry matter basis)

4. Other information desired.

   a. Kind of plants. (Grasses, legumes, or other plants)
   b. Condition of vegetation (percent cover, percent growth, percent weeds, condition of desired plants)
   c. Accurate cross-section of shoulder, taken to hundredths, at intervals of one foot across the shoulder (or less than one foot if extremely rough)
   d. Turf history, (if available) such as date and method of establishment of turf (or other vegetation) and resume of maintenance operations.

Experiments:

The Committee does not offer at this time any specifications or suggested methods of constructing experimental sections of stabilized turf shoulders. For various methods already tried, reference is made to the several reports included in this booklet.

PROBLEM 2. Design of a shoulder cross-section that will be practical from a construction standpoint, and that will lessen or delay shoulder build-up without sacrificing safety or unduly complicating shoulder maintenance operations.

Questions:

1. Does most of the "build-up" that is due to vegetative growth (not deposit of foreign matter in the turf) occur during initial establishment of the turf?

2. What is the maximum rate of shoulder slope that is safe for traffic hitting it at relatively high speeds?

3. The idea of a compound shoulder slope has been advanced, in which the outer half of the shoulder is on a steeper slope than the inner half. (For example, the inner 5 ft. of a 10 ft. shoulder might be on a 3/4" or 1" per ft. slope, and the outer 5 ft. on a 1½" or 2" per ft. slope.) Would such a shoulder cross-section be considered safe?

   See Figure 11, Page 114 and Figure 12, Page 115, 1945 Proceedings, Highway Research Board)

4. To allow for unavoidable natural build-up of turf it has been suggested that shoulders be constructed originally 1" or 0.1' (or perhaps even 1½" or 2") lower than the edge of the pavement. Would such a practice be considered a traffic hazard?

   In this connection, it has also been suggested that a bituminous wedge approximately one foot in width could be used, descending from the pavement edge to the shoulder, to reduce any slight driving shock that might occur, and at the same time serve to seal the pavement edge against surface water draining under the pavement.

PROBLEM 3. Development of maintenance practices that will be of value in retarding and correcting shoulder build-up, and in improving stability of existing turf shoulders without extensive shoulder reconstruction.

1. Rolling
   a. Weight of roller
   b. Season of year
   c. Frequency of rolling

2. Mowing
   a. Frequency
   b. Height
   c. Removal of cuttings

3. Sweeping to remove stone, cinders, loose soil

4. Cutting down shoulders, but still retaining turf cover.
   a. Season of year
   b. Equipment used
   c. Sequence of operations

5. Gradual addition of granular material on shoulder surface.

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