Flexible Pavement Design as Currently Practiced in Georgia

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Flexible pavement designs as currently practiced in Georgia are primarily based on the study of the foundations occurring along the projects by means of surveys, analysis of samples representing the various horizons of the foundations, and treatment of the foundations according to their strength and the condition under which they serve, all combined with a uniform depth base and surfacing, utilizing the available materials either existing in the vicinity of or economically accessible to a project.

This paper describes the basic factors considered and the manner in which they are incorporated into flexible pavement design.

●BECAUSE THERE ARE so many variables and factors which have not been evaluated but which influence the design and construction of a satisfactory flexible pavement, no rational formula is used for design of such facilities in Georgia. Instead, the several factors and variables are studied individually and then combined to give what are considered to be adequate pavements. The factors studied include the results of surveys of the foundation materials, in both cuts and fills; surveys of existing deposits of materials, both in the vicinity of and commercial materials economically available to the project; the location of the project; and the present and future anticipated traffic.

Although several types of flexible pavements are built, they all have the same basic design in that provisions are made to strengthen the weaker sections of the foundations by placing over these sections stronger and more stable materials in varying depths so as to result in a reasonably uniform strength subgrade throughout the length of a project. Over this subgrade is placed a base of uniform thickness commensurate with the basic factors previously given and the thickness of the surface course chosen.

FOUNDATION MATERIAL CLASSIFICATION

For general construction purposes, foundation materials are divided into six classes, which from description and field observation can usually be recognized and treated accordingly. The general descriptions and uses of the classes are given in Table 1.

The six classes nicely cover the whole range of natural materials encountered in roadbed construction and are found to be invaluable in obtaining a satisfactory foundation. As previously stated, they can normally be differentiated by field observation and examination; but for judging their value for flexible pavement design, more definite methods of examination are necessary for the first three classifications (see Table 2).

TABLE 1

GENERAL CLASSIFICATION OF FOUNDATION MATERIALS

Group Class	General Description	Usual Types of Significant Constituent Materials	Characteristics and Uses
I	Friable soils	Sands, low clay content sand-clays, sand-gravels, talus materials, cherty materials, and marls	Under proper compaction, generally can be used to full height of embankment, generally do not need subgrade treatment.
II	Plastic soils with low volume change	High clay content sand-clays, sand-clay gravels, cherts, and silty materials	Require careful compaction and moisture control, generally need a topping layer or special treatment to obtain satisfactory subgrade
III	Highly plastic and highly expansive soils	Clays, fine-grained dis-integrated granitic rock, and clay marls	High volume changes or detrimental expansive properties, normally wasted or placed either in the outer areas or bottom of embankments where the unstable features will have little or no effect on the service value of the embankment. If occurring in excavation, they are undercut and drained so that as nearly constant moisture content as possible is maintained Require careful compaction and moisture control, when used as foundation material, need topping layers or special treatment to obtain a satisfactory subgrade
IV	Peat, muck, and organic soils	Highly-organic soils, peat, muck, and other unsatisfactory materials usually found in marshy or swamp areas	Not satisfactory for embankment purposes, usually removed and wasted If used, require special consolidation and topping layers to obtain a satisfactory foundation and subgrade.
V	Laminated materials	Shale, slate partially disintegrated schists	Detrimental weathering properties and tend to disintegrate Use in embankment requires careful compaction and moisture control, large particles must be broken down until at least 40% passes No. 4 sieve. Generally need some form of treatment for a satisfactory subgrade
VI	Rock	Ledge rock, boulders	Cannot be readily incorporated into an embankment by layer construction, requires careful distribution of the particles to avoid pockets and voids. In excavation, undercutting and a topping layer is needed to obtain a satisfactory subgrade, with the rock surface so finished as to furnish proper drainage for the subgrade

TABLE 2

LIMITATIONS OF THE VARIOUS CLASSIFICATIONS OF FOUNDATION SOILS

Foundation Material Group Classification	Foundation Soil Classification	Dry Density, lb/cu ft*	Total Volume Change, %
I	I	100 to 165	0 to 15
II	II-A_1	100 to 165	15 to 25
	II-A_2	90 to 100	0 to 25
III	III-A	90 to 165	25 to 50
	III-B	80 to 90	0+
	III-C	80-	0+

* At 2.65 specific gravity.

Soil surveys are made on each project, with representative samples of the various horizons of the materials encountered being submitted to the laboratory for analyses.

The soil survey consists of drillings made along the centerline of the project, with occasional supplemental soundings to the right and left of the centerline. On the four-lane and wider projects, a three-line survey is made; two of the lines being at some equal distance each side of the centerline with random additional borings being made to secure definite limits of the soil horizons in the cross-section. As the borings are made, the materials in each horizon are given a field identification or description, together with its thickness and extent along the project. All this information is placed on the identification card accompanying the sample. This field description, together with the tests made in the laboratory, enables the engineer to make the correct identification for classification. The tests conducted in the laboratory include gradation, Proctor density, and total volume change from dryness to saturation.

From the results of these tests and the field description, the classification of the material is made for the purpose of designing the subgrade for flexible pavements. Development of this classification, resulting from the study of foundations and subgrades under many hundreds of miles of flexible pavements, has been previously discussed (1).

In general, Class I corresponds to A-1, A-2, and A-3 of the Bureau of Public Roads Soil Classification System; Class II to A-4 and A-5; and Class III to A-6 and A-7.

Each of these classes of materials carries its own depth of subgrade treatment. Class I material conforming to the required subgrade specification requires no treatment; otherwise, a 6-in. treatment. Class II-A_1 carries 6 in.; II-A_2 9 in.; III-A 12 in.; III-B 18 in.; and III-C 24 in. of treatment.

During grading operation the foundation is undercut to the depth required in accordance with these schedules, and backfilled with selected subgrade treatment materials. This furnishes a reasonably uniform subgrade of at least 6 in. in depth throughout the projects. Figure 1 shows the depth of undercut generally made. These subgrades all conform to uniform

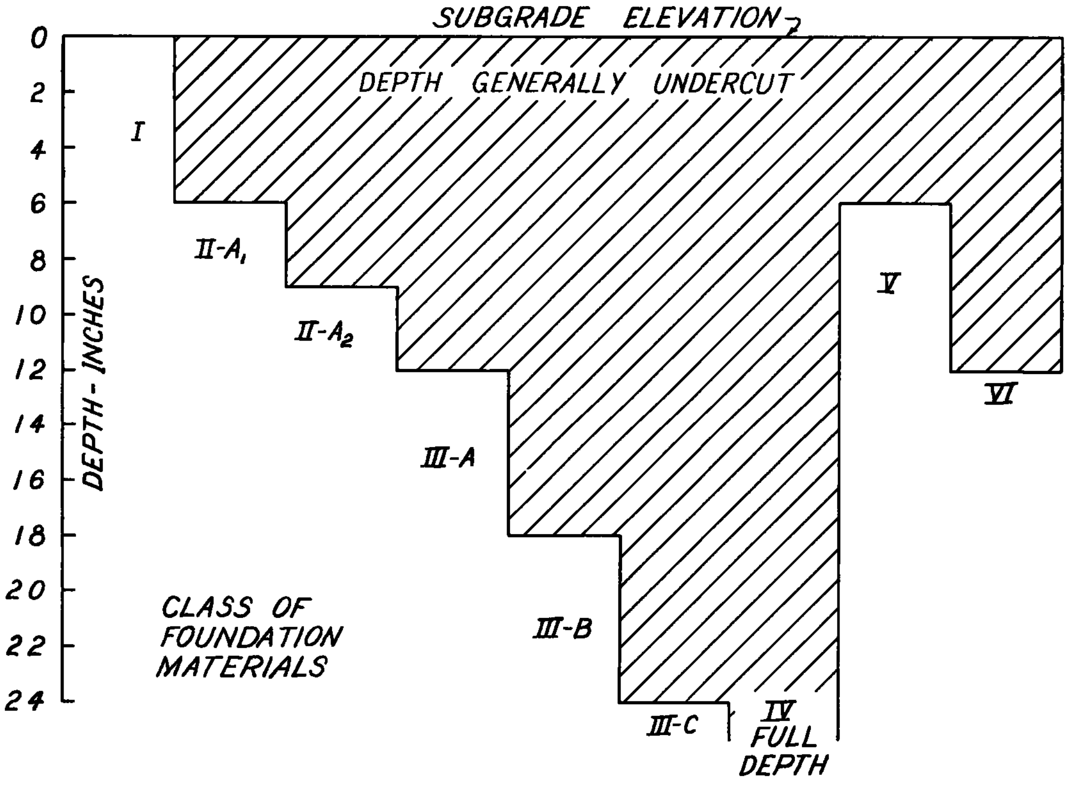

Figure 1. Depth of undercut.

specifications and are required on all projects, regardless of the type and volume of traffic to be carried.

SUBGRADE MATERIALS

The subgrade materials usually consist of the best selected soil materials existing in the vicinity of a project. These soils have varying gradation characteristics, depending on the section of the state in which the projects are located. In the Coastal Region they are usually sands or sand-clays; in the Piedmont Region or the central part of the state they are usually sand-clays, topsoils, or sand-clay gravels; and in the northern region or mountainous part they consist of cherts, talus, or river terrace deposits of sand-clays and sand-clay gravels.

In all cases, wherever possible from an economical point of view, where the undercutting required is 12 to 24 in. selected borrow of at least a Class II material is taken from the cut excavation and placed on the foundation material so that not more than 6 to 9 in. of the more stable subgrade treatment material is required.

In all instances the top 6 in. of the subgrade or subgrade treatment is chosen so as to have a volume change not in excess of 12 percent, but satisfying the other requirements of density and gradation, so that a highly stable material is obtained in the top 6 in. of the subgrade. For comparison purposes this usually conforms to about an A-I material in the Bureau of Public Roads classification.

In many instances materials conforming to the subgrade specifications are not economically available in the vicinity of the project, particularly in the southern sandy regions. In such cases, fines (such as fine silts or friable clay silts) are artifically mixed into the top 6 in. of the sandy material. In other cases the Class II materials, which are the clays, are stabilized with coarse granular materials (sands, stone screenings, etc.), using whichever type may be most economically available.

BASES

From the finished subgrade the bases and surfaces are designed according to the classification of the road, anticipated traffic, type of materials available for use, and other local features, such as water tables, anticipated rainfalls, drainage conditions, and type of traffic expected to use the road. Bases are normally 8 in. in depth, with occasional bases 6 in. or 10 in. deep.

Studies are made in the vicinity of the projects to determine the type of local material suitable for use in base construction.

In the sandy Coastal Region, bases on farm-to-market roads are usually 6 in. sand-bituminous or sand-limerock. The sands are chosen to have a 50-lb stability by the Florida bearing test and the roadway is required to have a minimum of 12 in. of compacted sand conforming to these specifications. This gives the top 6 in. of subgrade high stability, and the 6-in. base is then stabilized with either the bituminous material or crusher-run limerock.

Through the central part of the state the bases are constructed with local sand clays and topsoils, which normally have a weight per cubic foot of not less than 120 lb and a volume change of not more than 6 percent. If the project is anticipated to take heavier traffic than the farm-to-market volume, the top 4 in. of the base is stabilized by scarifying in 1 cu ft of crushed aggregate ranging in size from about 1 in. to $\frac{1}{4}$ in.

In the northern or mountainous section of the state the bases are built of either crushed chert or crushed talus containing a minimum of 60 percent of coarse aggregate retained on the 10-mesh screen and 100 percent passing the $1\frac{1}{2}$-in. screen.

On all primary projects the bases are usually constructed of soil-bound macadam, which is a stone base having the voids filled with a local binder either occurring naturally or artifically produced so as to have a required gradation and a volume change of not more than 6 percent.

All bases, regardless of the type of road, are primed with approximately 0.2 gal per sq yd of a bituminous material after they have been consolidated to 100 percent Proctor density. They are then maintained under rolling for a period of several days to allow curing to take place. After the primes have cured sufficiently, various surfaces are placed thereon.

SURFACES

The bituminous surface consists of either the so-called double surface treatment or hot plant mixtures. A double surface treatment is constructed of an application of bituminous material on the prime, covered by a spreading of crushed aggregate of nominal 1-in. to $\frac{1}{2}$-in. size. This is "choked" with a small amount of crushed aggregate (size $\frac{1}{2}$ in. to No. 4) prior to a second application of bituminous material and a surface covering of material ranging from $\frac{1}{2}$ in. to No. 8. This type of surfacing is used on all farm-to-market, secondary, and medium-traffic roads.

The heavier-traffic roads carry about $1\frac{1}{2}$ in. of hot plant mix binder and a 1-in. asphaltic concrete surface course. To accommodate increased anticipated traffic volume and loads, these surfaces are thickened to as much as 3 in. of asphaltic concrete base course, $2\frac{1}{2}$ in. of binder, and $1\frac{1}{2}$ in. of asphaltic concrete surface.

Most hot plant mix surface course mixture designs are based on minimums of about 2,000-lb stability (Hubbard-Field), but sometimes the stability minimums are increased for more heavily traveled roads.

SHOULDERS

So far, the shoulders usually have been turfed. With a few excepceptions, the shoulder material is a selected local pervious topsoil or other material with sufficient stability to withstand traffic without excessive rutting, but also suitable for growing grass. The exception to the use of the pervious material is that because of the high rainfall (60 to 100 in. per year) impervious material is usually placed on the high side of the steeper curves to keep as much water as possible from seeping into the base and subgrade and consequently softening them.

REFERENCE

1. Abercrombie, W. F., "A System of Soil Classification." HRB Proc., 33:509 (1954).