Classification of Highway Subgrade Materials

(Prepared by a Subcommittee Representing the Highway Engineers)

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FOREWORD

The first draft of this report was prepared during a meeting of the Subcommittee at Denver, from May 29 to June 3, 1944. This meeting was preceded by study of the Hogentogler-Barber paper distributed by the Highway Research Board in 1943 and the comments received thereon from highway engineers. Members of the subcommittee also interviewed engineers of several highway departments relative to the matter of subgrade classification and prepared material for consideration at the subcommittee meeting. The report as prepared at that meeting was distributed in July 1944 to the full membership of the committee for comment. In March 1945, the Director of the Highway Research Board distributed the report to engineers of highway departments and to other competent authorities for comment. The report has been revised as a result of consideration of all comments received from these distributions, and the following draft is offered as the final report of the committee.

OBJECTIVE

The objective of this report is to establish a useful classification of subgrade materials that may be made from results of the least possible number of the simple, routine tests performed by practically all highway departments.

TESTS REQUIRED FOR CLASSIFICATION

Test selected as most suitable for meeting the above-stated objective are the three most commonly made on subgrade materials, viz.: sieve analysis, liquid limit, and plastic limit. The methods of test are defined in the Standards of the American Association of State Highway Officials.

That the simple tests here designated are useful and may supply in many instances all the information needed for the adequate and economical design of highway foundations is demonstrated by their successful use by a number of highway organizations for the test evaluation of subgrades, as well as for specific definition of suitable embankment, subbase, and base course materials.

While the "identification" tests here designated are all that are necessary for this classification and may supply in many instances all the test information needed, the committee recognizes that there are other useful "identification" and "strength" tests as well as textural designations which should be used in some cases to supplement the classification tests for the closest possible evaluation of subgrade materials.

CLASSIFICATION PRESENTED

The subcommittee proposes the following for use in the classification of subgrade materials.

1. Classification of Highway Subgrade Materials. Table 1 shows the classification recommended by the subcommittee and includes test limits and group index values.

2. Classification of Highway Subgrade Materials—With Suggested Subgroups. Table 2 shows a suggested subdivision of groups in the classification shown in Table 1. Test limits and maximum group index values are included for each of the subgroups. The use of subgroups and group index values is recommended in instances where the main groups do not classify the soil in sufficient detail and when it is desirable to differentiate between soils within the same group.

3. Group Index. Table 3 gives the empirical formula for obtaining the group index and shows examples of the computation Figure 1 is a chart suitable for rapid graphical determination of the group index values.

4. Liquid Limit and Plasticity Index Ranges. Figure 2 shows graphically the ranges of liquid limit and plasticity index for Groups A-4, A-5, A-6, and A-7 This figure is helpful in subdividing the A-7 group into subgroups A-7-5 and A-7-6.

5. Description of Groups. Table 4 is a word description of materials of the various groups and subgroups.

TABLE 1
CLASSIFICATION OF HIGHWAY SUBGRADE MATERIALS

General Classification	Granular Materials (35% or less passing No 200)			Silt-Clay Materials (More than 35% passing No 200)			
Group Classification	A-1	A-3[a]	A-2	A-4	A-5	A-6	A-7
Sieve Analysis, Percent passing. No 10							
No 40	50 max.	51 min					
No 200	25 max.	10 max.	35 max.	36 min.	36 min	36 min.	36 min.
Characteristics of Fraction passing No 40							
Liquid limit				40 max.	41 min.	40 max	41 min
Plasticity index	6 max.	N.P.		10 max.	10 max.	11 min	11 min
Group Index			4 max.	8 max	12 max.	16 max.	20 max.
General Rating as Subgrade	Excellent to Good			Fair to Poor			

Classification Procedure. With required test data available, proceed from left to right on above chart and correct group will be found by process of elimination The first group from the left into which the test data will fit is the correct classification. (Note all limiting test values are shown as whole numbers. If fractional numbers appear on test reports, convert to nearest whole number for purposes of classification.)

[a] The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2

TABLE 2
CLASSIFICATION OF HIGHWAY SUBGRADE MATERIALS
(With Suggested Subgroups)

General Classification	Granular Materials (35% or less passing No. 200)							Silt-Clay Materials (More than 35% passing No 200)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve Analysis, Percent passing: No 10	50 max										
No 40	30 max.	50 max.	51 min								
No 200	15 max	25 max.	10 max	35 max.	35 max.	35 max.	35 max.	36 min	36 min.	36 min	36 min.
Characteristics of fraction passing No 40											
Liquid limit				40 max.	41 min.	40 max	41 min	40 max	41 min.	40 max	41 min
Plasticity index	6 max		N P	10 max.	10 max	11 min	11 min	10 max	10 max	11 min.	11 min.[a]
Group Index[b]	0		0	0		4 max.		8 max	12 max	16 max	20 max.
Usual Types of Significant Constituent Materials	Stone Fragments, Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	
General Rating as Subgrade	Excellent to Good					Fair to Poor					

Classification Procedure With required test data available, proceed from left to right on above chart and correct group will be found by process of elimination The first group from the left into which the test data will fit is the correct classification

[a] Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see figure 2)

[b] See group index formula and Figure 1 for method of calculation Group index should be shown in parentheses after group symbol as A-2-6(3), A-4(5), A-6(12), A-7-5(17), etc

DISCUSSION

Classification Group Symbols. The symbols used are the A-1 to A-7 series established some 16 years ago by publications of the Public Roads Administration. Table 2 includes suggested subdivisions and introduces the "group index" in order that the classification designation may indicate a closer evaluation of individual samples than was possible with the original Public Roads symbols alone.

Consideration was given to dropping the "A" from the symbols and also to the adoption of an entirely new set of symbols. It was

determined that adjustments in the original test limitations for the Public Roads groups could be made to accomplish the objective of

TABLE 3

GROUP INDEX FORMULA

Group index = 0 2a + 0.005 ac + 0 01 bd

In which

a = That portion of percentage passing No. 200 sieve greater than 35 and not exceeding 75, expressed as a positive whole number (1 to 40)

b = That portion of percentage passing No 200 sieve greater than 15 per cent and not exceeding 55 percent, expressed as a positive whole number (1 to 40).

c = That portion of the numerical liquid limit greater than 40 and not exceeding 60, expressed as a positive whole number (1 to 20)

d = That portion of the numerical plasticity index greater than 10 and not exceeding 30, expressed as a positive whole number (1 to 20)

The following are examples of calculation of the group index

(1) An A-6 material has 65 percent passing No. 200 sieve, liquid limit of 32 and plasticity index of 13 The calculation is as follows

a = 65 − 35 = 30

b = 55 − 15 = 40 (55 is substituted for 65 as critical range is 15 to 55)

c = zero, since liquid limit is below 40

d = 13 − 10 = 3

Group index = 2 × 30 + 01 × 40 × 3 = 7 2

(Should be recorded to nearest whole number which is 7)

(2) An A-7 material has 54 percent passing No. 200 sieve, liquid limit of 62 and plasticity index of 33 The calculation is as follows

a = 54 − 35 = 19

b = 54 − 15 = 39

c = 60 − 40 = 20 (60 is substituted for 62 as critical range is 40 to 60)

d = 30 − 10 = 20 (30 is substituted for 33 as critical range is 10 to 30)

Group index = 2 × 19 + .005 × 19 × 20 + 01 × 39 × 20 = 13 5 (13)

Charts for graphical determination of group index are shown on figure 1

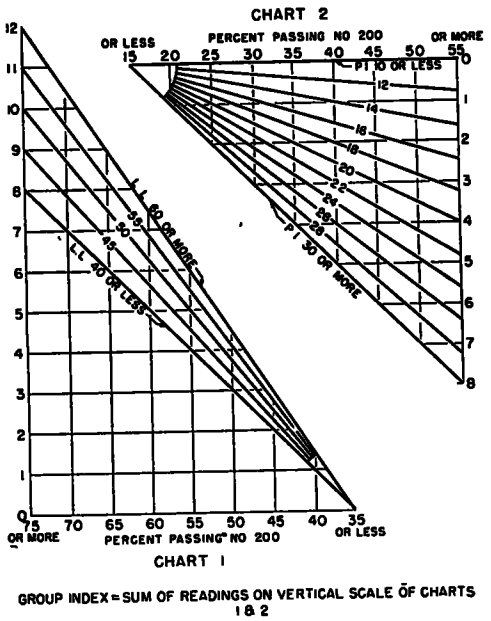

Figure 1. Group Index Charts

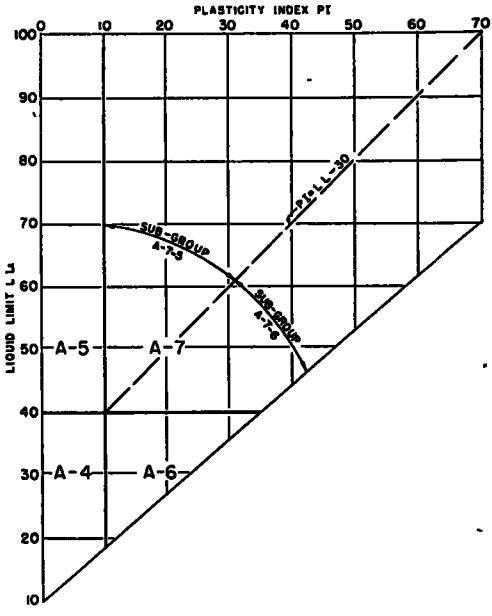

Figure 2. Liquid Limit and Plasticity Index Ranges for the A-4, A-5, A-6 and A-7 Subgrade Groups

this report without actual radical change in the types of materials designated by the symbols. Therefore, as the use of the designations "A-3", "A-7", etc. has been well established by long usage, and as a better method of labeling was not suggested either by the committee or by the various highway engineers consulted, these symbols are retained. While some changes in test limits have been made in

TABLE 4

DESCRIPTION OF CLASSIFICATION GROUPS

GRANULAR MATERIALS—Containing 35 percent or less passing the No 200 Sieve

Group A-1. The typical material of this group is a well-graded mixture of stone fragments or gravel, coarse sand, fine sand and a nonplastic or feebly plastic soil binder. However, this group includes also stone fragments, gravel, coarse sand, volcanic cinders, etc without soil binder

Subgroup A-1-a includes those materials consisting predominantly of stone fragments or gravel, either with or without a well-graded binder of fine material

Subgroup A-1-b includes those materials consisting predominantly of coarse sand either with or without a well-graded soil binder.

Group A-3 The typical material of this group is fine beach sand or fine desert blow sand without silty or clay fines or with a very small amount of nonplastic silt The group includes also stream-deposited mixtures of poorly-graded fine sand and limited amounts of coarse sand and gravel

Group A-2. This group includes a wide variety of "granular" materials which are border-line between the materials falling in Groups A-1 and A-3 and the silt-clay materials of Groups A-4, A-5, A-6, and A-7 It includes all materials containing 35 percent or less passing the No 200 sieve which cannot be classified as A-1 or A-3, due to fines content or plasticity or both, in excess of the limitations for those groups.

Subgroups A-2-4 and A-2-5 include various granular materials containing 35 percent or less passing the No 200 sieve and with a minus No. 40 portion having the characteristics of the A-4 and A-5 groups. These groups include such materials as gravel and coarse sand with silt contents or plasticity indexes in excess of the limitations of Group A-1, and fine sand with nonplastic silt content in excess of the limitations of Group A-3.

Subgroups A-2-6 and A-2-7 include materials similar to those described under Subgroups A-2-4 and A-2-5 except that the fine portion contains plastic clay having the characteristics of the A-6 or A-7 group The approximate combined effects of plasticity indexes in excess of 10 and percentages passing the No. 200 sieve in excess of 15 is reflected by group index values of 0 to 4.

SILT-CLAY MATERIALS—Containing more than 35 percent passing the No 200 sieve

Group A-4. The typical material of this group is a nonplastic or moderately plastic silty soil usually having 75 percent or more passing the No 200 sieve The group includes also mixtures of fine silty soil and up to 64 percent of sand and gravel retained on No 200 sieve The group index values range from 1 to 8, with increasing percentages of coarse material being reflected by decreasing group index values.

Group A-5. The typical material of this group is similar to that described under Group A-4, except that it is usually of diatomaceous or micaceous character and may be highly elastic as indicated by the high liquid limit The group index values range from 1 to 12, with increasing values indicating the combined effect of increasing liquid limits and decreasing percentages of coarse material.

Group A-6 The typical material of this group is a plastic clay soil usually having 75 percent or more passing the No 200 sieve The group includes also mixtures of fine clayey soil and up to 64 percent of sand and gravel retained on the No 200 sieve Materials of this group usually have high volume change between wet and dry states The group index values range from 1 to 16, with increasing values indicating the combined effect of increasing plasticity indexes and decreasing percentages of coarse material.

Group A-7 The typical material of this group is similar to that described under Group A-6, except that it has the high liquid limits characteristic of the A-5 group and may be elastic as well as subject to high volume change The range of group index values is 1 to 20, with increasing values indicating the combined effect of increasing liquid limits and plasticity indexes and decreasing percentages of coarse material.

Subgroup A-7-5 includes those materials with moderate plasticity indexes in relation to liquid limit and which may be highly elastic as well as subject to considerable volume change.

Subgroup A-7-6 includes those materials with high plasticity indexes in relation to liquid limit and which are subject to extremely high volume change.

this revised classification, the word description of the groups as originally promulgated (see *Public Roads*. May 1929 and June 1931) remain generally applicable to the designated groups.

Confusion as to whether a material designated by these group symbols has been classified under the original Public Roads arrangement or under this revised arrange-

ment can be avoided by always showing the group index value (even though zero) in parentheses after the group or subgroup symbol. For examples: A-1-a(0), A-3(0), A-2-7(3), A-4(7), A-6(12), etc.

The Grouping Arrangement and the Group Index A major difference between this and the Public Roads classification is that the Public Roads classification applies only to the soil mortar (Minus No. 10) portion of the material while the proposed classification applies to mixtures of coarse and fine materials, as well as materials consisting only of fine soils. As shown in Tables 1 and 2, the classifying of materials starts by first dividing into "granular materials" and "silt-clay materials" using 35 per cent passing the No. 200 sieve as the arbitrary dividing line between the two general types. This definition of granular material is the same as that given in American Association of State Highway Officials, Standard Specification for Material for use in Embankment Construction, M57.

The granular materials are then divided into groups with the A-1 containing the gravels and coarse sands, either with or without limited amounts of nonplastic or feebly plastic binder, and the A-3 containing the nonplastic, binderless fine sands, leaving the A-2 as the borderline or "catch-all" group of the granular materials. The A-2-4 and A-2-5 subgroups contain gravels or coarse sands inferior to A-1 due either to excessive amounts of binder or excessive plasticity of the binder or both, and fine sands superior to A-3 due to a low-plasticity binder content which facilitates handling and compaction of such fine sands The A-2-6 and A-2-7 subgroups contain gravels and sands with a plastic binder soil having the characteristics of the A-6 and A-7 groups. The quality of these A-2-6 and A-2-7 materials as subgrade ranges from good where percent passing the No. 200 is low (say less than 15 per cent) to increasingly questionable as reflected by extent to which percentages passing the No. 200 exceed 15 and plasticity indexes exceed 10.

Thus, this borderline A-2 group as a whole may contain materials ranging from approximately equivalent to some materials of the A-1 group to materials which are actually inferior to the best materials which can be classified in the A-6 and A-7 groups. Elimination of this condition without a tediously complicated table does not appear practicable. However, the subgroups and the group index system hereinafter discussed take care of the matter of approximate relative evaluation.

The "silt-clay materials" (those containing more than 35 per cent passing the No. 200) are divided into the four main groups A-4, A-5, A-6, and A-7 on the basis of liquid limit and plasticity index only. Inasmuch as each of these groups may contain from zero to 64 per cent material retained on the No. 200 sieve, and in view of the wide liquid limit ranges of the A-5 and A-7 groups and the wide plasticity index ranges of the A-6 and A-7 groups, it is obvious that each group may contain materials of widely different value as subgrade. In other words, the main group symbol performs the important function of indicating the general characteristics of the fine soil portion, but does not evaluate the possible variations in percentages of coarse material, liquid limit, and plasticity index. This desirable within-group evaluation is taken care of by the group index system hereinafter discussed.

The empirical group index formula devised for approximate within-group evaluation of the "clayey granular materials" and the "silt-clay materials" is based on the following assumptions.

a. Materials falling within Groups A-1-a, A-1-b, A-2-4, A-2-5, and A-3 are satisfactory as subgrade when properly drained and compacted under moderate thickness of pavement (base and/or surface course) of a type suitable for the traffic to be carried, or can be made satisfactory by additions of small amounts of natural or artificial binders.

b. Materials falling within the "clayey granular" Groups A-2-6 and A-2-7 and the "silt-clay" Groups A-4, A-5, A-6, and A-7 will range in quality as subgrade from the approximate equivalent of the good A-2-4 and A-2-5 subgrades to fair and poor subgrades requiring a layer of subbase material or an increased thickness of base course over that required under, a, in order to furnish adequate support for traffic loads.

c. The assumed critical ranges of percentages passing the No. 200 are 35 to 75 neglecting plasticity and 15 to 55 as affected by plasticity indexes greater than 10.

d. The assumed critical range of liquid limit is 40 to 60.

e. The assumed critical range of plasticity index is 10 to 30.

The formula will give values ranging from a fraction of 1 to 20, and is so weighted that the maximum influence of each of the three variables is in the ratio of 8 for percent passing the No. 200 sieve, 4 for liquid limit, and 8 for plasticity index. This weighting and the adopted critical ranges represent the best judgment of the committee based on the study of average relative evaluations placed on subgrade materials by several highway organizations which use the tests involved in this classification system.

Under average conditions of good drainage and thorough compaction, the supporting value of a material as subgrade may be assumed as an inverse ratio to its group index, that is, a group index of 0 indicates a "good" subgrade material and group index of 20 indicates a "very poor" subgrade material.

Definitions of Gravel, Sand, and Silt-Clay. The terms "gravel," "coarse sand," "fine sand," and "silt-clay," as determinable from the minimum test data required in this classification arrangement and as used in the word descriptions of this report, are defined as follows:

Gravel—Material passing sieve with 3-in square openings and retained on the No. 10 sieve.

Coarse Sand—Material passing the No 10 sieve and retained on the No. 40 sieve

Fine Sand—Material passing the No 40 sieve and retained on the No. 200 sieve

Combined Silt and Clay—Material passing the No. 200 sieve.

Boulders (retained on 3-in sieve) should be excluded from the portion of the sample to which the classification is applied, but the percentage of such material, if any, in the sample should be recorded.

The term "silty" is applied to fine material having plasticity index of 10 or less and the term "clayey" is applied to fine material having plasticity index of 11 or greater

By keeping the above terms and the group test limits in mind, it is possible with some practice to make fairly close approximations of the correct classifications by visual examination and handling of the materials in a damp condition

While visual classification of subgrade materials does not take the place of laboratory tests, such visual classification by highway engineers should be encouraged. For this reason the above terms are defined to assist the highway engineer in tying in his visual classifications with those based on the laboratory tests.

Comparison with Public Roads Classifications. Description of subgrade materials in Group A-1 to A-7 with some test limitations was contained in *Public Roads* for May 1929. This was elaborated upon and additional test limits given in *Public Roads* for June and July 1931, and still further revised in *Public Roads* for February 1942. Reference to these publications is made for the benefit of those who may wish to review the evolvement of the Public Roads classification and make comparisons with the classification arrangement presented here.

As mentioned under "Classification Group Symbols," the A-1 to A-7 series of designations has been used in this classification arrangement to indicate the same general types of materials as indicated by those designations under the Public Roads classifications However, changes in test limits have been made which the committee considered desirable in order to maintain a consistent descending value from A-1 to A-7 and in order that any particular sample of material may be placed in one definite group Also, some of the tests used in the Public Roads classifications have been eliminated as classification tests and included under recommended "Supplementary Tests." Because of these changes some materials will fall in different groups under the two classification arrangements In view of this, it is desirable to list briefly the major departures from the Public Roads limits as follows.

Group A-1 Plasticity index range has been changed from 4–9 to N P –6 Lower limits on grading band have been eliminated as a rigid grading band is not desired for subgrade materials The group now includes the nonplastic or feebly plastic gravels and coarse sands classified as Group A-2 or A-3 in the Public Roads classification.

Group A-3. This group includes only materials consisting of predominantly fine sand with the clean gravels and coarse sands going to Group A-1 as noted above

Group A-2 The maximum percentage passing the No 200 has been lowered to

35 per cent but this is based on the total material and for the average material is not substantially different from the 45 per cent maximum silt and clay content of the minus No. 10 portion as shown in the Public Roads classification The maximum plasticity index of 15 has been eliminated in order that the A-2-6 and A-2-7 subgroups may be established to include those boderline clayey granular materials not included in the Public Roads classification.

Group A-4. The only important change in this group is to lower the maximum plasticity index from 15 to 10. This is deemed desirable in order that this group be limited to predominately silt materials with the silty clays going to Group A-6.

Group A-5. In the proposed classification this group is limited to high-liquid limit silts with maximum plasticity index of 10. The high-liquid limit, clayey silts will now go to subgroup A-7-5 which will serve to indicate better the characteristics of these materials.

Group A-6 Greater change has been made in this group than in any other. It is limited by minimum plasticity index of 11 and maximum liquid limit of 40. It will include some of the silty clays classified as A-4 and the low-liquid limit, moderately plastic clays classified as A-6 or A-4-6 by the Public Roads method. The majority of highly plastic materials which would fall in the A-6 group under the Public Roads system will be placed in subgroup A-7-6.

Group A-7. Minimum liquid limit has been raised to 40 and minimum placticity index has been lowered to 10. This results in some of the low-liquid limit, silty clays going to Group A-6 with the A-7 expanded to take in some of the former A-5 elastic clayey silts and most of the former A-6 highly plastic clays. It is deemed desirable that A-7 be expanded to include this widened range of poor subgrade materials, but the A-7-5 and A-7-6 Subgroups are introduced to maintain an approximate tie to Public Roads designations.

Group A-8. The A-8 Group, included in the Public Roads classifications and used to describe peats, mucks, etc. ordinarily found in obviously unstable swampy areas, has been omitted from the classification tables included in this report. It is felt that this designation is descriptive more of the state in which the materials are found in place, viz.: low density, high water content, humus content, etc., than the characteristics determinable by the laboratory tests adopted for this classification grouping

The problem ordinarily involved with materials in this state is one of removal or consolidation in such manner as to afford a stable foundation for embankment, and description of such state and treatment belongs properly under the subject of embankment foundations rather than classification of subgrade materials. However, if desired, the A-8 designation may be used in soil reports or on soil profiles in lieu of the groups determinable from the tests used in this classification method to designate obviously unstable swampy materials which are deemed unfit either as embankment foundation or embankment material due to high humus content, etc

SUGGESTIONS ON APPLICATION TO DESIGN AND SPECIFICATIONS

It is beyond the scope of this report to set forth definite methods of design or definite specifications for materials. However, some suggestions as to use of the classification data are in order.

1. *Data To Be Reported*—It is recommended that results of the designated tests, the group symbol and the group index be reported for all materials investigated for subgrade, embankment, subbase and granular base course. This does not suggest exclusion of other test data which may be desirable.

2. *Subgrade and Subbase*—The classification system is so arranged as to include under Groups A-1, A-2, and A-3, materials usually satisfactory as subgrade for moderate combined thicknesses of base and surface courses. It is recognized that the better materials of the other groups may also be satisfactory as subgrade for moderate thicknesses of pavement under favorable conditions.

While it is usually desirable to include in specifications, for individual projects, definite requirements for selected subbase materials, the group symbols A-1-a, A-1-b, A-2-4, A-2-5, and A-3 will serve to identify on soil profiles and in soil reports those materials most suitable as pit-run or cut-run, blanket courses over inferior silt and clay soils. Where thick subbase layers are re-

quired over the poorest clay soils, materials of only fair quality may be used in the lower portion of such layers as A-4 over A-7, if such use will result in economy and will not introduce danger of frost damage due to drainage and climatic conditions. The group index values will serve as a general guide to the depth below the surface at which it is safe to use a particular material as a subbase layer. In order to obtain maximum benefit from layers of selected subbase materials, placing in the thinnest practical courses with thorough compaction is essential.

In connection with materials of the A-1, A-2, and A-3 Groups, it is to be pointed out that under the classification test limits these materials may be so devoid of fines as to require addition of fine material in order to form a firm subgrade or subbase on which to place a base course or pavement. Also, in connection with the use of A-1 and A-2 materials as subbase over clay soils, attention is called to the need for a substantial sand content in the materials or a blanket of sandy soil directly on the subgrade in order to prevent intrusion of clay into the subbase

3. Granular Base Course Materials—The test limits of the A-1 Group, particularly subdivision "a", have been so fixed as to include the friable coarse granular materials which are suitable for granular base course or which can be made suitable by processing. Natural materials may be encountered in construction which fall in this group and would be satisfactory as base course for thin bituminous surfaces without processing. While the A-1 Group is intended to indicate those materials which may be suitable or can be made suitable as granular base course, comparison with properties of materials known to be adequate for base course should be the basis of selection for that purpose.

4. Embankment Materials—In general, materials evaluated as best for subgrade will also form the best embankments with a minimum of construction and maintenance difficulties. It is not within the scope of this report to describe methods of compaction control necessary in the construction of subgrades and stable embankments, or the special tests and investigations which may be necessary to determine safe designs for high embankments of inferior materials.

5. Frost Susceptibility—While the tests and groupings of this classification system may be valuable in identifying materials likely to be weakened by frost action, the general subject is one involving climatic and drainage conditions as well as materials, and is beyond the scope of this report. The materials here classified in Group A-4 are of the type most often identified with "frost heave."

6. Subbase Thicknesses—The committee recognizes that the design of subbase thicknesses (generally considered a part of the pavement structure) involves, in addition to properties of subgrade materials, the following.

(a) Weight and density of expected traffic.
(b) Climate, particularly depth of frost penetration and total precipitation.
(c) The degree of construction compaction control attained by a particular organization.
(d) Drainage conditions—height of subgrade above free water table, etc.
(e) The factor of safety justified by availability of satisfactory subbase materials.

With these several variables in mind, the recommended method of application of the classification tests and groupings to this problem is to apply them first in a particular area (supplemented, if desired, with other tests and textural classifications) in identifying subgrades of roads whose performance, good and poor, is known. It is then a matter of working out suitable designs for the particular conditions of the locality.

It is recognized that empirical methods of approach, such as tables of thicknesses tied to test values, may be helpful if applied to local conditions under competent engineering direction. It is the judgment of the committee that the group index system, which has been introduced, affords a basis of preparation of empirical thickness tables which will compare favorably with similar empirical tables based on more complicated tests used by some organizations.

METHODS FOR TESTS REQUIRED IN CLASSIFICATION

The liquid limit, plastic limit, and plasticity index are determined by A.A.S.H.O. Test Methods T 89, T 90, and T 91, respectively.

Sieve analysis may be determined by A.A.S.H.O. Method T 88, or by A.A.S.H.O. Method T 27 with slight modification. The

modification of Method T 27 consists in soaking the material in water for 2 hr. (both fine and course fractions) after initial drying and weighing and then stirring vigorously for 3 minutes immediately prior to wash-sieving by A.A.S.H.O. Method T 11.

SUPPLEMENTARY TESTS

In addition to the particle size and plasticity tests used for classification purposes under the methods described in this report, the committee recognizes that important additional information can be obtained from other standardized and recognized test procedures, and that such additional information may be essential to the closest possible evaluation of materials for use under particular conditions.

The following are additional test methods adopted as standard by the American Association of State Highway Officials:

Shrinkage Factors of Soils, Method T 92-42
Field Moisture Equivalent of Soils, Method T 93-42
Centrifuge Moisture Equivalent of Soils, Method T 94-42
Compaction and Density of Soils, Method T 99-38
Volume Change of Soils, Method T 116-42

The following are special laboratory test methods which have not been adopted as national standards, but which have received considerable nationwide attention due to published reports regarding their use by some organizations·

Bearing Ratio—(California Method)
Triaxial Shear—(Stabilometer Method)
Capillary and Permeability Tests (Hogentogler and Barber)

CONCLUSION

It is believed that the two principal advantages to be derived from general adoption of this classification system are: (a) it would serve to identify groups of samples from individual projects to such an extent that the number of more complicated and expensive tests, which may be considered desirable, could be reduced substantially by performing them on only typical samples rather than on all samples, (b) it would furnish a medium for better exchange of information on subgrade materials between highway organizations; that is, the group classification and group index could always be given in addition to any other test, textural designation or performance data referred to

Classification of Materials for Subgrades for Airfields and Granular Type Roads

Prepared by T. A. Middlebrooks, U. S. Army Engineers

1. It is believed that the "Soil Classification for Airfields" as outlined in Table 5 and discussed herein embodies the principal features desirable in a soil classification. These features are:

a. The classification should be simple and concise.

b. Names applied to each group should be descriptive and should employ commonly used terms, readily understood by its users from drillers to design engineers, such as, well-graded gravel, silty sand, organic silts, fat clays, etc

c. Symbols should not replace descriptive names, however, where symbols are used as engineering "shorthand," they should have a specific meaning so that they can be readily translated into the commonly used descriptive names.

d. The application of soil classification should be confined to general soil identification.

e. Design considerations should be separate from the classification, and the soil characteristics for design should be obtained from actual tests, such as shear, permeability, bearing ratio, field bearing, etc.

2 The "Soil Classification for Airfields" illustrated in Table 5 has been divided into two principal types—*fine* and *coarse-grained* soils, and these have been subdivided as follows·

a. The coarse-grained soils are subdivided as follows·
   (1) Gravel and gravelly soils—for which the symbol "G" is used
   (2) Sands and sandy soils—for which the symbol "S" is used