Modified Triaxial Design Method

Contents:

Section 1

Introduction

The Texas Triaxial Classification of soils was developed in the late 1940s and early 1950s by the department as an indexed soil/base classification system related to material shear strength. Evaluating a material for its Texas Triaxial Classification is covered in “Tex-117-E, Triaxial Compression for Disturbed Soils and Base Materials.”

The Modified Triaxial Design Method requires the use of the subgrade and/or base Texas Triaxial Class as derived from laboratory test results. The results of the analysis are used to determine the minimum amount of material, better than the subgrade, required to prevent shear failure of the subgrade, or to ensure base materials are not over-stressed. Combinations of pavement layers and materials are used; therefore, there are procedures to correct this total thickness to account for stiffer materials in the pavement structure that will reduce subgrade stress levels.

When the method was first developed, the cohesiometer was used to determine the relative stiffness of bound or improved materials. The test is obsolete, though there are cohesiometer values that are used to determine the modified structural thickness.

Section 2

Procedure

After materials have been classified according to Tex-117-E 'Part I, Standard Triaxial Compression Test' or 'Part II, Accelerated Method for Triaxial Compression of Soils,' and cohesiometer values for stabilized layers and surfacing have been determined, follow these steps for checking thickness design and ensuring sufficient material to prevent compressive failures.

1. Obtain the current and projected traffic from the Transportation Planning and Programming Division of TxDOT.
2. Select a design wheel load from the traffic data and known local conditions. Use the 'Flexible Base Design Chart' to calculate total depth of pavement to protect the sub-grade.
3. Reduce total depth of pavement by using the 'Thickness Reduction Chart for Stabilized Layers' whenever stabilized and stiffer layers are used in the pavement structure.
   - ♦ Enter above depth (from 2 above) on ordinate of 'Thickness Reduction Chart for Stabilized Layers,' and follow horizontally and intersect the curve for the cohesiometer value selected, then project downward to the abscissa and read the reduction in depth due to stiffer layers.
   - ♦ Standardized cohesiometer values have been determined for various materials and have been incorporated into various guidance including the design checks built into FPS19W. **Table 1.** reflects these values:

Table 1 Standardized Cohesiometer Values for Design

Material Type	Cohesiometer Value (C_m)
Lime Treated Base greater than 3" thick	300
Lime Treated Subgrade greater than 3" thick	250
Cement Treated Base greater than 3" thick	1000
Cold Mixed Bituminous Materials greater than 3" thick	300
Hot Mixed Bituminous Materials greater than 6" Thick	800
Hot Mixed Bituminous Materials 4" to 6" Thick	550
Hot Mixed Bituminous Materials 2" to 4" Thick	300
Untreated Materials	100

- ♦ Cohesiometer values (corrected to represent values from 76 mm [3 in.] height specimens) are used on the 'Thickness Reduction Chart for Stabilized Layers' regardless of thickness of stabilized layer except in the following cases:
  - Consideration should be given to increasing the design wheel load by 30% if traffic is anticipated to have over 50% tandem axles where asphaltic mixtures are used.
  - The modification of cohesiometer values for 76.2 mm (3 in.) high specimens for application to other thickness' of asphaltic mixtures is obtained by **Equation 1**:

    Equation 1

    $$C_M = Ct^2 / 9$$

    Where:

    - C_M = Modified cohesiometer value
    - C = Standard cohesiometer value for a 76.2 mm (3 in.) height specimen
    - t = Proposed thickness of bituminous mixtures, mm (in.).

4. The load frequency design factor can be obtained from **Table 2**. This table was originally used to correct for repeated wheel loads prior to the development of the TxDOT Flexible Pavement design System (FPS). It is recommended that FPS be used in lieu of this table.

   The depth obtained from the 'Thickness Reduction Chart for Stabilized Layers' is multiplied by the LFD factor and used with the 'Flexible Base Design Chart' to design each course of the pavement structure.

Table 2 Criteria for Obtaining the Load - Frequency Design Factor Table

Criteria for Obtaining the Load - Frequency Design Factor		
Total Equivalent 8.172 mgm (18 Kip) Single Axle Load Applications	**Design Wheel Load in Pounds (ATHWLD)**	***Load Frequency Design Factor**
14,000	6,000	0.65
25,000	6,200	0.70
38,000	6,300	0.75
61,000	6,500	0.80
100,000	6,800	0.85
150,000	7,200	0.90
250,000	7,900	0.95
400,000	8,700	1.00
600,000	9,500	1.05
1,000,000	10,900	1.10
1,500,000	12,000	1.15
2,500,000	13,500	1.20
4,000,000	14,900	1.25
10,000,000	17,300	1.35

*A load-frequency design factor less than 1.0 is not recommended for the design of the main lanes of a controlled access highway.

5. **Table 3**, 'Suggested Minimum Thickness of Surface Course', presents data which was interpreted from good engineering practice supplemented by AASHO Road Test data and is a method for determining the minimum thickness of surface courses.

Table 3 Suggested Minimum Thickness of Surface Course Table

Suggested Minimum Thickness of Surface Course			
Total Equivalent 8.172 mgm (18 Kip) Single Axle Load Applications	**When Tests Show Materials to be Specifications Grades* of Base Materials (Item 247)**		
	Grade 1	**Grade 2**	**Grade 3**
14,000	ST	ST	ST
25,000	ST	ST	ST
38,000	ST	ST	ST
61,000	ST	ST	38 mm (1-1/2 in.)
100,000	ST	38 mm (1-1/2 in.)	50 mm (2 in.)
150,000	ST	44 mm (3/4 in.)	64 mm (2-1/2 in.)
250,000	32 mm (1-1/14 in.)	50 mm (2 in.)	76 mm (3 in.)
400,000	38 mm (1-1/2 in.)	57 mm (2-1/4 in.)	89 mm (3-1/2 in.)
600,000	44 mm (1-3/4 in.)	64 mm (2-1/2 in.)	102 mm (4 in.)
1,000,000	50 mm (2 in.)	76 mm (3 in.)	114 mm (4-1/2 in.)
1,500,000	64 mm (2-1/2 in.)	89 mm (3-1/2 in.)	127 mm (5 in.)
2,500,000	76 mm (3 in.)	102 mm (4 in.)	140 mm (5-1/2 in.)
4,000,000	89 mm (3-1/2 in.)	114 mm (4-1/2 in.)	152 mm (6 in.)
10,000,000	114 mm (4-1/2 in.)	140 mm (5-1/2 in.)	178 mm (7 in.)

*It is assumed that the material in question is no better than the grade shown.
**Exclusive of Cohesionless Materials
Notes: ST denotes surface treatments.

6. Combinations of materials may be evaluated using this procedure. If a subbase is provided, it may be evaluated to ensure sufficient material is provided with a better classification as a cover to prevent compressive failures of that course. Likewise, a base may be evaluated using its classification to determine sufficient cover of materials to protect it. This process may be iterative to optimize and possibly minimize the amount of more expensive base materials in deeper base placements. To assist with performing this analysis independent of the design process, the Beaumont District created the Flexible Base Design for Better Material spreadsheet to perform the calculations automatically.

Section 3

Limitations

Considerable caution and good engineering judgment should be used in selecting cohesiometer values for use in reduction of base depths. This is especially true in cases where hot mix-cold laid asphaltic concrete is bid as an alternate to hot mix asphaltic concrete laid hot.

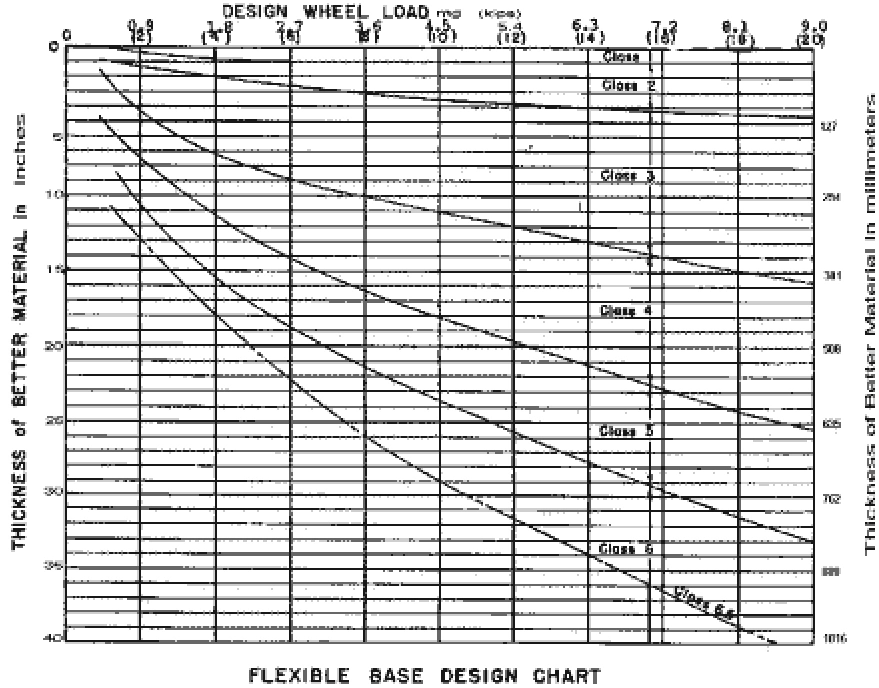
New materials and recycled materials are often non-uniform. The strengths of stabilized materials vary tremendously depending on the amount and type of stabilizer present. As a result, it may become difficult to assign a cohesiometer value with confidence. Since the highest value used is 1000 and was based on heavy amounts of stabilizer, it is recommended that the cohesiometer value be adjusted downward to reflect the reduced strength.

When determining a modified cohesiometer value for 6-inch or greater layer thickness, use a value of six (6) inches in the formula for thickness, **t**.

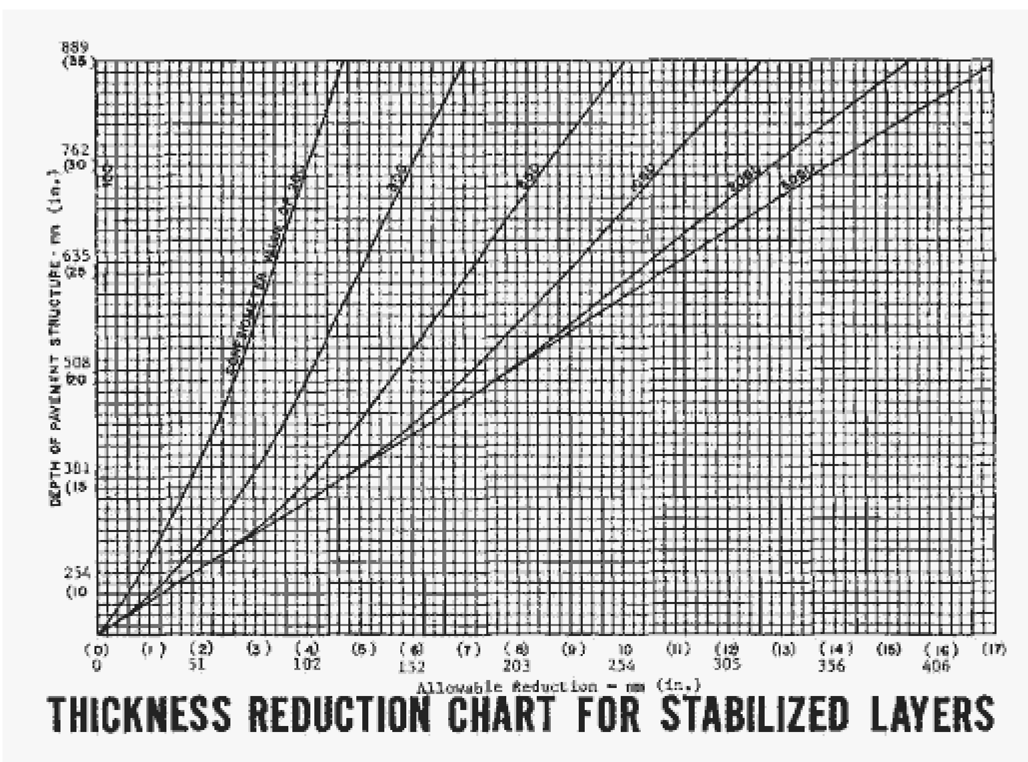
When adjacent layers of stabilization and asphaltic concrete are used, the cohesiometer value to be used with the 'Thickness Reduction Chart for Stabilized Layers' should be equal to the sum of the standard cohesiometer value for the stabilized layer and the modified cohesiometer value of the asphaltic concrete.

When two adjacent layers of stabilization are used, or if a layer of untreated flexible base material exists between asphaltic concrete and a stabilized layer, only the greater of the two cohesiometer values in the ‘Thickness Reduction Chart for Stabilized Layers’ should be used.

In the case of stabilized bases, sub-bases and sub-grades, average values rather than highest values should be selected for use in 'Thickness Reduction Chart for Stabilized Layers.'



Flexible Base Design Chart.



Thickness Reduction Chart for Stabilized Layers.