Implementation of Falling Weight Deflectometer Load-Zoning Procedure in Texas

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The Texas Transportation Institute, on behalf of the Texas Department of Transportation (TxDOT), has developed a computer program, LOADRATE (Project 473) to be used as a load-zoning analysis tool for two-layer pavements. A comparison study was undertaken of the solutions generated by LOADRATE and those obtained using the Texas triaxial classification methodology for determining allowable wheel load capacity. The Texas triaxial method historically has been used to determine whether load zoning is warranted on a given roadway and is also used as a "check" for pavement designs generated by the flexible pavement design system computer program when used for low-traffic-volume roadways. For this comparison, deflection data were collected on all load-zoned roads (228.68 mi) in Ellis County of the Dallas district using the falling weight deflectometer. The LOADRATE program was used to compute both unadjusted and adjusted base moduli using the temperature/moisture correction features of the LOADRATE program. An allowable axle load for single, tandem, and tridem axles was then computed by the program using an allowable rut depth of 0.5 in. as the failure criteria. The results generated by the LOADRATE program do not give reasonable allowable loads as a function of pavement thickness. Additional field calibration of the LOADRATE program is warranted.

Of the more than 78,000 centerline-mi of roadway on the state-maintained highway network in Texas, approximately 17,250 mi, or slightly more than 22 percent, is load zoned. This load-zoned mileage is primarily made up of light-duty pavements within the farm-to-market (FM) road system and typically are constructed of unbound base materials with a thin wearing surface of asphalt and aggregate. In areas exhibiting especially weak subgrade soils, some load-zoned roadways are constructed of stabilized materials, including hot-mix asphalt concrete surface courses and asphalt, lime, or cement-treated bases and subgrades.

Load zoning is almost exclusively accomplished by limiting gross vehicle weight to 58,420 lb, the maximum legal load in Texas when many of these roads were constructed. The Texas triaxial load capacity method currently is used to determine whether load zoning is warranted on a roadway segment and provides a means for computing the required thickness of the pavement structure to prevent rutting of the subgrade caused by excessive wheel loads (*1*). On the basis of a need for an improved method of analyzing load-zoned roadways using mechanistic analysis of nondestructive test data, the Texas Department of Transportation (TxDOT) sponsored a research project with the Texas Transportation Institute at Texas A&M University to develop a computer program for determining the allowable axle load and remaining life of light-duty pavements. This program, LOADRATE, uses either falling weight deflectometer (FWD) or dynaflect deflection data to backcalculate moduli values for base and subgrade layers and then uses pavement layer and traffic information to determine the allowable axle load to ensure a minimum 10-year design life that is based on failure caused by rutting (*2*).

OBJECTIVE AND SCOPE

The LOADRATE computer program is currently being evaluated by TxDOT, and the results are being compared with those from the Texas triaxial load capacity method. The objective of this paper is to present findings of one such comparison, involving an analysis of FWD and soil triaxial classification data that were collected for all load-zoned roads in Ellis County (Dallas district). The results of this analysis will be given and the strengths and limitations of each method will be discussed. Conclusions will be drawn on the basis of these results, subject to inferences that can be made using the field data that were collected.

TEXAS TRIAXIAL METHOD

Developed in the late 1940s, the Texas triaxial classification method is used to determine the required thickness of a pavement structure to ensure against subgrade compression failure caused by a design wheel load for either a 10- or 20-year design life. This method is currently used to check pavement designs generated by the flexible pavement design system (FPS) and is used in determining the allowable wheel load for load-zoning purposes (*1*).

The Texas triaxial method classifies paving materials on a scale from 1 to 6 (1 being considered a good flexible base material and 6 being considered a very weak subgrade). These classifications are based on a triaxial test that determines the shearing resistance of soils, soil aggregate mixtures, and base materials. The test consists of applying an axial load to cylindrical specimens of specified dimensions, supported by various, known lateral pressures until failure occurs. The test is run on saturated specimens that yield conservative results, especially for materials in West Texas, where saturated conditions rarely occur (*3,4*).

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A chart that is based on empirical data has been developed that relates the triaxial class and pavement thickness to design wheel load. The pavement thickness necessary to prevent subgrade compression failure (rutting) is determined by reading the design wheel load on the horizontal axis of the chart, intersecting this value with the material classification and then reading the required material thickness in inches off the vertical axis (see Figure 1). For load-zoning purposes, the thickness of the pavement structure and the subgrade soil triaxial classification are known and the allowable wheel load for a 10-year design life is determined on the basis of these values. Allowable wheel loads less than 10,000 lb warrant road load zoning.

For pavement design purposes, a thickness reduction is allowed for pavement layers that are stabilized. The method for determining the allowable thickness reduction is based on the type of stabilizing agent used (cement, asphalt, lime, etc.) and the thickness of the stabilized layer. In determining the allowable wheel load, stabilized layers are accounted for by increasing the effective thickness of the pavement structure. The theory is that stabilized materials, being stiffer than nonstabilized materials, spread the load more and therefore reduce vertical compressive stresses to the subgrade, resulting in a higher allowable wheel load. The allowable thickness reduction is dependent on the cohesiometer value for the material. Table 1 gives recommended cohesiometer values for various stabilized layer types and thicknesses. To determine the equivalent pavement thickness, the cohesiometer value for the stabilized layer is determined from available data or selected on the basis of estimates in Table 1. Referring to Figure 2, the allowable thickness reduction is determined by entering the chart on the vertical axis with the pavement thickness, intersecting the appropriate cohesiometer value line and reading the thickness reduction on the horizontal scale. The equivalent pavement thickness equals the actual pavement thickness plus the allowable thickness reduction (*3*). If a stabilized subgrade exists, only the equivalent thickness reduction resulting from the stabilized layer is included in the equivalent pavement thickness—the actual thickness of the stabilized subgrade is not included.

As an example, the equivalent thickness of the following pavement structure will be determined:

Surface course	*Base course*	*Subbase*
Asphalt surface treatment (1 in.)	10-in. limestone flexible base	6-in. lime stabilized subgrade

Entering Figure 2 with a depth of pavement structure of 17 in. and a cohesiometer value of 250, the allowable thickness reduction is computed as 2.5 in. The equivalent pavement thickness would then be computed as

Surface course	*Base course*	*Equivalent thickness reduction*
Asphalt surface treatment (1 in.)	10-in. limestone flexible base	2.5 in.

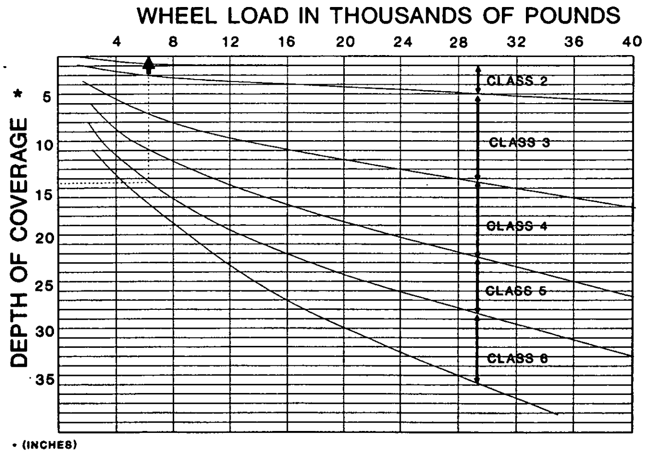

FIGURE 1 Triaxial classification lead capacity chart.

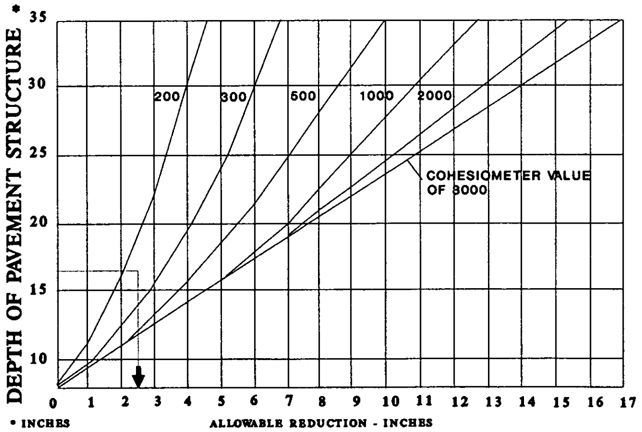

FIGURE 2 Thickness reduction chart for stabilized layers.

TABLE 1 Cohesiometer Values for Stabilized Materials

STABILIZED MATERIAL TYPE	COHESIOMETER VALUE
Lime Treated Base > than 3" Thick	300
Lime Treated Subgrade > than 3" Thick	250
Cement Treated Base > than 3" Thick	1000
Cold Mixed Bituminous Materials > 3" Thick	300
Hot Mixed Bituminous Materials > 6" Thick	800
Hot Mixed Bituminous Materials 4" to 6" Thick	550
Hot Mixed Bituminous Materials 2" to 4" Thick	300

The equivalent pavement thickness would then be 13.5 in. If we assume a soil triaxial classification of 6.0 and refer to Figure 1, we determine that this pavement structure provides sufficient depth of coverage for a wheel load capacity of approximately 6,000 lb (for an estimated design life of 10 years). We would then conclude that this pavement warrants load zoning because the allowable wheel load is less than 10,000 lb.

LOADRATE

The LOADRATE computer program was developed by the Texas Transportation Institute at Texas A&M University. LOADRATE provides a mechanistic modeling approach for analyzing light-duty pavements using backcalculated moduli for the base and subgrade, base course thickness, subgrade material type, and traffic data (*4*). The program is able to correct base moduli for temperature and moisture variation and can predict rutting for three subgrade types; heavy clays (CH), clayey silt/silty clay (CL-ML), and clayey/silty sand (SC-SM). However, the program is flexible and gives the user the option to specify parameters that are based on laboratory data for soil types specific to the roadway being evaluated (*4*).

LOADRATE determines remaining life and allowable axle loads on the basis of a specified limiting rut depth. The program was designed to analyze two-layer problems (base and subgrade) and cannot determine remaining life on the basis of failure from fatigue cracking of an asphalt surface course.

Remaining life calculations require the user to provide either (a) the current annual traffic in 18-kip equivalent single axle loads (ESALs), traffic growth rate, and length of analysis period in years or (b) the 1st and 20th year average daily traffic (ADT) and the total number of 18-kip ESALs in 20 years. The rut depth prediction model relates accumulated permanent strain to number of load applications and subgrade type. The model is of the form

$$\log \varepsilon_p = \log a + b \log N \tag{1}$$

where

ε_p = accumulated permanent strain,
a,b = material constants based on soil type, and
N = number of 18-kip load applications.

The determination of the remaining life then becomes a straightforward calculation that is based on a predetermined allowable rut depth, traffic, and subgrade soil type. TxDOT has established criteria that require a remaining life of at least 10 years for FM roads. If the LOADRATE program determines that 100 percent of the test sections analyzed can accommodate the projected number of 18-kip ESALs without exceeding the predetermined rut depth, then the program reports that legal axle load limits are allowed and load zoning is not required. If the remaining life is computed to be less than 10 years, the program then determines the allowable axle load limits for single, tandem, and tridem axles that would ensure a minimum life of 10 years and reports these reduced axle load limits in the output.

ROADWAYS USED FOR COMPARISON

All load-zoned roadway sections in Ellis County of the Dallas district were tested with the FWD. A total of 31 FM roadways totaling 228.680 mi were measured in this county. Of the 31 FMs measured, only 20 FMs totaling 135.260 mi were either fully or partly compatible for use with LOADRATE. Some were compatible over their entire length and some contained sections within the length of the roadway that were compatible for analysis using the LOADRATE program. Compatibility in this case is defined as a roadway containing only a two-layer pavement structure (a subgrade and a base with a thin surfacing material) or a pavement that could, for practical purposes, be considered as a two-layer pavement structure, as can be seen in Table 2. This limitation is an inherent one and is totally acceptable as the program was designed within this limitation.

The 20 FMs were segmented into roadway sections that were based on changes in the typical sections of the pavements (changes in the structural composition of the layers of the pavements) or changes in traffic volume for a total of 49 roadway sections. Finally, of the 49 sections, 40 sections totaling 114.566 mi were compatible for analysis using the LOADRATE program. This amounted to approximately 50 percent of the measured mileage being compatible for analysis using the LOADRATE program, which is not much different from that stated by the LOADRATE developers in their report (*2*). Although this percentage does not appear to be significant, if it were assumed to represent the percentage of all mileage of load-zoned FMs in the state that could be analyzed using LOADRATE this would amount to an approximate total of 8,625 mi of the approximate 17,250 mi of current load-zoned roadways in the state (a sizeable contribution to load-zone analysis of low-volume roadways).

LIMITS ON INFERENCE SPACE

The subgrade soil of all load-zoned roadways in Ellis County were in the relatively poor category (triaxial class 5.4 to 5.2), as can be seen in Table 2. Obviously, this very limited range inhibits the accuracy of extrapolation of results to the fair and good ranges (triaxial class 4.0 to 1.0). In addition, the deflection collected was taken primarily in the summer months, which may generate moduli of elasticity that are stronger than those that have been generated from deflection data taken during the spring thaw period. Therefore, the results obtained in this comparison and the subsequent observations and conclusions drawn are for a small range of the subgrade triaxial class scale and for moduli values that have been revised or adjusted by the LOADRATE temperature/moisture correction routine from a summer condition to a spring-thaw condition.

WHEEL LOAD CAPACITIES BASED ON TEXAS TRIAXIAL METHOD

The Division of Materials and Tests (D-9) of TxDOT provided the subgrade triaxial class data and the Texas triaxial wheel

TABLE 2 Original Input Data for Texas Triaxial and LOADRATE Methods

	SURFACE		BASE		SUBGRADE SOIL		TRAFFIC		
S#	TYPE	THICK (IN.)	TYPE	THICK (IN.)	DESCRIPTION	TRIAXIAL CLASS	1990 ADT	2010 ADT	20 YEAR ESALS
1	1-C.S.T.	0.50	FLEXBASE	12	SILTY CLAY	5.4	1,150	2,500	436,000
2	2-C.S.T.	1.00	FLEXBASE	14	SILTY CLAY	5.4	1,150	2,500	436,000
3	1-C.S.T. ON 1-C.S.T.	1.00	FLEXBASE	10	SILTY CLAY	5.2	1,200	1,700	461,000
4	2-C.S.T.	1.00	FLEXBASE	12	SILTY CLAY	5.4	1,450	2,900	485,000
5	1-C.S.T.	0.50	FLEXBASE	10	SILTY CLAY	5.4	610	1,050	255,000
6	2-C.S.T.	1.00	LIME TRTD FOUND CRSE	7	SILTY CLAY	5.2	370	710	85,000
7	2-C.S.T.	1.00	FLEXBASE	6	CHALK W/ SILTY CLAY	5.2	5,400	11,100	1,472,000
8	2-C.S.T.	1.00	FLEXBASE	6	CHALK W/ SILTY CLAY	5.2	910	1,800	356,000
9	2-C.S.T.	1.00	FLEXBASE	12	SILTY CLAY	5.3	1,000	2,200	183,000
10	2-C.S.T.	1.00	FOUND CRSE	15	SILTY CLAY	5.3	1,000	2,200	183,000
11	2-C.S.T.	1.00	FOUND CRSE	15	SILTY CLAY	5.3	1,000	2,200	183,000
12	1-C.S.T. ON 1-C.S.T.	1.00	FLEXBASE	10	SILTY CLAY	5.2	590	1,200	120,000
13	1-C.S.T.	0.50	FLEXBASE	6	SILTY CLAY	5.2	590	1,200	120,000
14	1-C.S.T.	0.50	FLEXBASE	6	CHALK W/ SILTY CLAY	5.2	440	910	100,000
15	1-C.S.T.	0.50	FLEXBASE	6	CHALK W/ SILTY CLAY	5.2	1,100	2,200	185,000
16	2-C.S.T.	1.00	FLEXBASE	12	SILTY CLAY	5.3	740	1,400	303,000
17	1-C.S.T. ON 1-C.S.T.	1.00	FLEXBASE	12	SILTY CLAY	5.3	1,100	2,400	427,000
18	1-C.S.T.	0.50	FLEXBASE	6	SILTY CLAY	5.3	450	940	133,000
19	2-C.S.T.	1.00	FLEXBASE	8	SILTY CLAY	5.4	1,050	2,300	143,000
20	A.S.B.	1.25	FLEXBASE	6	SILTY CLAY	5.4	3,600	7,400	299,000
21	2-C.S.T.	1.00	A.S.B.	6	SILTY CLAY	5.4	3,300	6,700	539,000
22	ACP	1.00	FLEXBASE	8	SILTY CLAY	5.4	1,000	1,700	258,000
23	2-C.S.T.	1.00	A.S.B.	6	SILTY CLAY	5.4	1,000	1,700	258,000
24	ACP	1.00	SOIL ASPH BASE	6	SILTY CLAY	5.4	90	180	20,000
25	2-C.S.T.	1.00	LIME STAB BASE	12	SILTY CLAY	5.4	540	1,000	253,000
26	2-C.S.T.	1.00	FLEXBASE	12	SILTY CLAY	5.4	90	180	50,000
27	2-C.S.T.	1.00	FLEXBASE	10	SILTY CLAY	5.4	190	370	46,000
28	1-C.S.T.	0.50	SOIL ASPH BASE	6	SILTY CLAY	5.4	1,550	2,900	491,000
29	1-C.S.T.	0.50	SOIL ASPH BASE	6	SILTY CLAY	5.4	830	1,700	342,000
30	2-C.S.T.	1.00	FLEXBASE	12	SILTY CLAY	5.4	830	1,700	342,000
31	2-C.S.T.	1.00	FLEXBASE	6	SILTY CLAY	5.1	830	1,700	342,000
32	1-C.S.T.	0.50	FLEXBASE	6	CHALK W/ SILTY CLAY	5.2	5,100	12,200	1,608,000
33	1-C.S.T.	0.50	FLEXBASE	6	CHALK W/ SILTY CLAY	5.2	2,500	4,900	911,000
34	1-C.S.T.	0.50	FLEXBASE	6	CHALK W/ SILTY CLAY	5.2	1,050	2,200	583,000
35	2-C.S.T.	1.00	FLEXBASE	6	CHALK W/ SILTY CLAY	5.2	570	1,150	138,000
36	2-C.S.T.	1.00	FLEXBASE	9	CHALK W/ SILTY CLAY	5.2	1,000	2,000	200,000
37	2-C.S.T.	1.00	FLEXBASE	8	SILTY CLAY	5.3	630	1,100	266,000
38	2-C.S.T.	1.00	FLEXBASE	6	SILTY CLAY	5.2	490	950	104,000
39	1-C.S.T. ON 1-C.S.T.	1.00	FLEXBASE	10	SILTY CLAY	5.3	3,500	6,700	360,000
40	1-C.S.T. ON 1-C.S.T.	1.00	FLEXBASE	10	SILTY CLAY	5.3	1,050	2,000	171,000

load capacity for each of the given roadway sections on the basis of the engineering data given to them concerning each section. The wheel loads provided by D-9 were for a 20-year pavement life and, according to the Texas triaxial method, the allowable wheel loads were adjusted by a factor of two to obtain a 10-year pavement life for comparison with LOADRATE output. In addition, the pavement thickness used for the Texas triaxial method is actually an effective thickness, as previously discussed, and not the actual thickness as used by LOADRATE (see Table 3). These allowable wheel load capacities ranged from 3,000 lb to over 13,000 lb/wheel. Because of the basis of the Texas triaxial method, the allowable wheel loads increased with an increase in the effective pavement thickness, as expected. The variability in strength or load-carrying capacity of the base course was not a consideration in this method except, as previously outlined, in the cases in which there existed a stabilized layer. This method assumes a worst-case (saturated) condition and, although it provides a conservative design, does not always represent the conditions in the field. The degree of conservativism is dependent on the conditions at a given site and therefore is not a constant. However, until an acceptable and reliable replacement is decided on, this method is the standard accepted method of load-zone analysis for TxDOT because conservativism is preferred when there is a lack of a better process or methodology.

TABLE 3 Results of Texas Triaxial and LOADRATE Methods

	TEXAS TRIAXIAL METHOD				LOADRATE METHOD			
S#	SOIL CLASS USED	THICK. USED (IN.)	20 YEAR ALLOW. WHEEL LOAD CAPACITY (LBS.)	10 YEAR ALLOW. WHEEL LOAD CAPACITY (LBS.)	SOIL GROUP	THICK. USED (IN.)	ALLOW. AXLE LOAD CAPACITY (LBS.)	ALLOW. WHEEL LOAD CAPACITY (LBS.)
1	5.4	13.5	4,600	9,200	2) SILTY CLAY	12.5	22,000	11,000
2	5.4	15.5	5,400	10,800	2) SILTY CLAY	15.0	20,000	10,000
3	5.2	11.5	3,800	7,600	2) SILTY CLAY	11.0	20,000	10,000
4	5.4	13.5	4,600	9,200	2) SILTY CLAY	13.0	20,000	10,000
5	5.4	11.5	3,200	6,400	2) SILTY CLAY	10.5	22,000	11,000
6	5.2	10.5	3,200	6,400	2) SILTY CLAY	7.0	26,000	13,000
7	5.2	7.5	1,600	3,200	2) SILTY CLAY	7.0	17,000	8,500
8	5.2	7.5	1,600	3,200	2) SILTY CLAY	7.0	22,000	11,000
9	5.3	13.5	4,800	9,600	2) SILTY CLAY	13.0	23,000	11,500
10	5.3	16.5	7,100	14,200	2) SILTY CLAY	16.0	23,000	11,500
11	5.3	16.5	7,100	14,200	2) SILTY CLAY	16.0	24,000	12,000
12	5.2	11.5	3,800	7,600	2) SILTY CLAY	11.0	25,000	12,500
13	5.2	7.5	1,600	3,200	2) SILTY CLAY	6.5	26,000	13,000
14	5.2	7.5	1,600	3,200	2) SILTY CLAY	6.5	26,000	13,000
15	5.2	7.5	1,600	3,200	2) SILTY CLAY	6.5	24,000	12,000
16	5.3	13.5	4,800	9,600	2) SILTY CLAY	13.0	22,000	11,000
17	5.3	13.5	4,800	9,600	2) SILTY CLAY	13.0	20,000	10,000
18	5.3	7.5	1,550	3,100	2) SILTY CLAY	6.5	25,000	12,500
19	5.4	9.5	2,300	4,600	2) SILTY CLAY	9.0	24,000	12,000
20	5.4	9.0	2,100	4,200	2) SILTY CLAY	7.3	22,000	11,000
21	5.4	7.5	1,500	3,000	2) SILTY CLAY	7.0	20,000	10,000
22	5.4	10.5	2,800	5,600	2) SILTY CLAY	9.0	22,000	11,000
23	5.4	7.5	1,500	3,000	2) SILTY CLAY	7.0	23,000	11,500
24	5.4	12.0	3,600	7,200	2) SILTY CLAY	7.0	30,000	15,000
25	5.4	16.5	6,600	13,200	2) SILTY CLAY	13.0	22,000	11,000
26	5.4	13.5	4,600	9,200	2) SILTY CLAY	13.0	28,000	14,000
27	5.4	11.0	3,000	6,000	2) SILTY CLAY	11.0	28,000	14,000
28	5.4	10.5	2,800	5,600	2) SILTY CLAY	6.5	20,000	10,000
29	5.4	10.5	2,800	5,600	2) SILTY CLAY	6.5	22,000	11,000
30	5.4	13.5	4,600	9,200	2) SILTY CLAY	13.0	21,000	10,500
31	5.1	7.5	1,700	3,400	2) SILTY CLAY	7.0	22,000	11,000
32	5.2	7.5	1,600	3,200	2) SILTY CLAY	6.5	23,000	11,500
33	5.2	7.5	1,600	3,200	2) SILTY CLAY	6.5	23,000	11,500
34	5.2	7.5	1,600	3,200	2) SILTY CLAY	6.5	20,000	10,000
35	5.2	7.5	1,600	3,200	2) SILTY CLAY	7.0	25,000	12,500
36	5.2	10.5	3,200	6,400	2) SILTY CLAY	10.0	26,000	13,000
37	5.3	9.5	2,400	4,800	2) SILTY CLAY	9.0	22,000	11,000
38	5.2	7.5	1,600	3,200	2) SILTY CLAY	7.0	26,000	13,000
39	5.3	11.5	3,500	7,000	2) SILTY CLAY	11.0	21,000	10,500
40	5.3	11.5	3,500	7,000	2) SILTY CLAY	11.0	24,000	12,000

WHEEL LOAD CAPACITIES BASED ON LOADRATE METHOD

The Dallas district (District 18) in conjunction with the Division of Transportation Planning (D-10) of TxDOT provided the traffic data for the given roadway sections. District 18 also provided the subgrade soil type and collected the FWD data on the given roadway sections (see Table 2). The soil types given were best represented by choosing the No. 2, silty clay option within the program for this method. The solution generated by the LOADRATE program was an allowable axle load. To compare on an equal basis, this allowable axle load was decreased by a factor of two to an allowable wheel load for this comparison. The legal wheel load in Texas is 10,000 lb/wheel. The allowable wheel loads generated by LOADRATE seem to indicate that load-zoning could be removed for almost all roadway sections without failures occurring within 10 years (see Table 3). The allowable wheel loads tended to vary to some degree yet appear to oscillate around an almost horizontal line at approximately 10,500 to 11,500 lb/wheel (see Figures 3 and 4). The LOADRATE program also prints out the backcalculated moduli it generated that was the basis for its allowable wheel load capacity along with traffic, pavement thickness, and subgrade soil type.

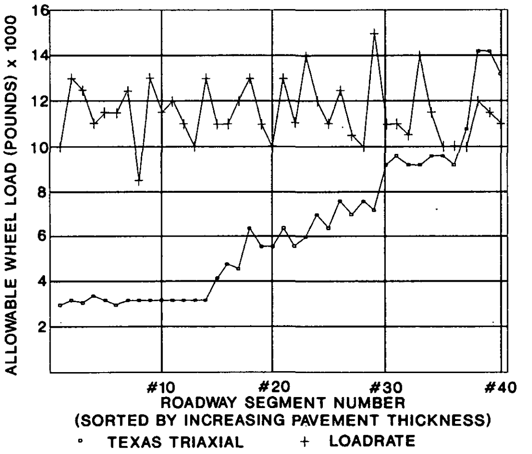

FIGURE 3 LOADRATE method versus Texas triaxial method.

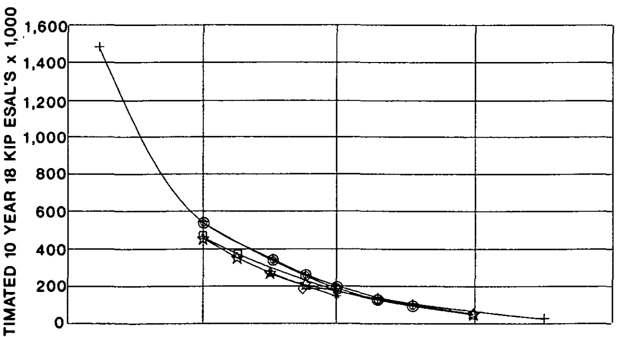

FIGURE 4 LOADRATE allowable wheel load versus accumulated traffic.

LOADRATE RESULTS COMPARED WITH TEXAS TRIAXIAL RESULTS

Currently, the backcalculated moduli generated by the LOADRATE program do not correlate with any degree of confidence with the Texas triaxial method. This is primarily because the Texas triaxial method is measured in the laboratory by testing under worst-case conditions (saturated), whereas the backcalculated moduli of elasticity are measured in the field and are a time-dependent (seasonal) characteristic of the soil. The LOADRATE program does allow for adjustment of the backcalculated moduli values that are based on moisture and temperature. The existing moisture conditions on these roadways, however, were not measured for various reasons; therefore, maximum adjustment allowed by LOADRATE was used to ensure that the most conservative results would be obtained from LOADRATE for comparison with the Texas triaxial method. The moisture and temperature corrections did not change the original allowable axle load in almost all instances. When the corrections did change the allowable axle load (there were only three cases) two sections received increases of 1,000 lb each in allowable axle load and one section received a decrease of 1,000 lb allowable axle load. Even after making this adjustment, the LOADRATE results suggest removal of load zoning on all but two roadway sections. Because of the inconsistency of results from the correction routines, the results reported herein are for the original input and output to the LOADRATE program.

RESULTS AND OBSERVATIONS

The two methods place different significance on input factors such as traffic, moduli values, and soil type (subgrade triaxial class). Traffic is not a standard consideration in the Texas triaxial method but it is a primary input in the LOADRATE method. The moduli values are of no use in the Texas triaxial method but are a necessity in the LOADRATE method. The subgrade triaxial class is a required input in the Texas triaxial method but it is not a user input to the LOADRATE method.

The Texas triaxial method appears to give conservative allowable wheel loads when the effective thickness is less than 15 in. The LOADRATE method appears to give conservative allowable wheel loads when the effective pavement thickness is greater than 15 in. This observation in itself would not lend either method unacceptable. However, the LOADRATE method's liberal allowable wheel loads coupled with the fact that the LOADRATE method tends to suggest removal of load zoning on almost all sections that are currently load zoned lead the authors to believe that more work needs to be done to establish the reasons for this discrepancy and possibly to calibrate or modify, or both, the LOADRATE program for final acceptance and subsequent use by TxDOT.

SUMMARY AND CONCLUSIONS

As mentioned, the Texas triaxial method does have limitations and is a conservative method for a large percentage of load-zoned roadways. However, until an acceptable alternative procedure is developed, tested, and confirmed as a standard method of pavement load-zone analysis, the Texas triaxial method will still remain the standard method used by TxDOT, especially because it is a conservative method for the most part and also because it has been in use for many years in Texas with acceptable results (partially because of its conservative approach).

The results indicate that, although the LOADRATE method allows for a more precise manner of measuring a pavement's load capacity in the field and at any given point in time, the latter could be a disadvantage without readily available information relating to the existing moisture condition and the effect of moisture change along a particular roadway section on the variation of moduli values because they are heavily dependent on moisture conditions. In addition, the backcalculated subgrade moduli values in general appear to be slightly lower than was expected with other backcalculation procedures. Although the LOADRATE method does take traffic into account, the percent error inherent in traffic predictions combined with the fact that the pavement engineering community currently has established no standard, nationwide backcalculation procedure as the most acceptable or realistic, further highlights the need for more work on the LOADRATE program before implementation can be considered.

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