Webology (ISSN: 1735-188X)
Volume 19, Number 4, 2022

Characterization Of The Fine Subgrade Soils Of The City Of Sincelejo In Northern Colombia, Based On The Soaked CBR Test On Undisturbed Samples

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Abstract: The design of a pavement structure depends, among other factors, on the quality of the subgrade, this being a very important variable, because it corresponds to the layer on which the pavement structure rests and, therefore, it must have the ability to withstand the stresses generated by traffic loads, as well as environmental effects. Hence the importance that specialist pavement engineers should pay attention to the geotechnical characterization and the determination of the resistance parameters of the subgrade soils. In countries like Colombia, a test widely used to determine the resistance of the subgrade corresponds to the relative bearing capacity (CBR). In this sense, the different design manuals give recommendations on how the test should be carried out and it is widely accepted by the different state entities; but it must be taken into account that for road sections of highways with similar characteristics, the design CBR of the section must be determined, for which there are various methodologies in the literature. The objective of this research is to analyze the different methodologies to calculate the design CBR for a study area, for which 106 undisturbed samples of fine subgrade soils were taken, taken in different road sectors, which were tested after having been subjected to immersion for a period of four days. The results showed important differences in the design CBR values based on the methodologies applied for its determination.

Keywords: California Bearing Ratio, Design CBR, Bearing capacity.

1. INTRODUCTION

For a pavement project, the variables that are involved in the design must be known, among them is the bearing capacity of the soils, which can present great variability along a road section. To determine this design parameter, the California Bearing Ratio method [1] is usually used, which was developed in 1929 by Porter of the California Department of Highways [2] and would later be modified by the Corps of Engineers of the U.S, Army, to adapt it for use in airport construction during World War II [3]. Currently, it is included in the testing standards and specifications of many countries, as is the case of the ASTM D-1883 and AASHTO T-193 standards, or in the case of Colombia, the INV E-148-13 testing standard. The method allows to determine the CBR of a material with a water content close to the optimum or a range of water content from a specific compaction test and a specific dry unit weight [4].

The importance of CBR lies in the fact that it manages to measure the shear strength of a soil, which allows evaluating the quality of construction materials such as bases, subbases and other granular materials, as well as subgrade soils, which is the case treated in the present study. The test is carried out under controlled humidity and density conditions, thus indicating the quality of the soil [5] [6]. In the case of Colombia, the regulations that regulate this test are divided into two sections, in the first case, there is the CBR test for Granular soils, and in the second case, the test for fine soils or clayey. The INV E-148-13 standard for the case of undisturbed soil samples is the one applied in the present work, to obtain the CBR values of subgrade soils of a fine nature. This test consists of the penetration of a circular piston on the ground, at a constant speed. The CBR is expressed as the percentage ratio between the effort required for the piston to penetrate 2.54 or 5.08 mm (0.1" or 0.2") into the sample tested and the effort required to penetrate the same depths in a standard sample consisting of gravel crushed well graded [7]

Engineers, when faced with the design of a pavement structure, must know the characteristics of the subgrade soils and look for a combination of the different layers of the pavement that is economical and at the same time guarantees adequate stress dissipation of traffic loads and of the environmental effects to which the structure will be subjected, seeking that excessive stresses or deformations do not occur during the design period of the structure [8]. It is important to know the characteristics and resistance properties of the soil, to prevent the level of efforts and deformations generated in the foundation soils, are exceeded and damage to the ground occurs, which reduces the useful life of the structure. To achieve this goal, a single representative CBR value should be selected for each design unit, based on the different CBR values found within each unit. Taking into account that within each design unit, there are CBR values, which are generally different from each other, then the question that needs to be answered is to determine what CBR value should be taken for design. The answer to this question is provided by different methodologies, such as the one stated in the AASHTO – 93 or by the Asphalt Institute [9]. The methods mentioned above may generate design CBR values that are different from each other, which may in turn generate differences in the final thickness of the pavement layers, even when the other input data is the same; everything will depend on the reliability levels of the pavement design methods used and their principles and failure criteria [10].

The purpose of this research is to analyze the results of obtaining the subgrade design CBR through the AASTHO - 93 methodology and the methodology recommended by the Asphalt Institute. For this purpose, clayey soils obtained from a series of pits made within the urban area of the city of Sincelejo in northern Colombia will be studied. In total, there are 106 soil samples, whose physical properties and support capacity were determined through the CBR test. From these results, different methods and criteria were applied to determine the design CBR for homogeneous sections and a comparison of the results obtained was made, highlighting the importance of this procedure in pavement design.

2. EXPERIMENTAL DESIGN, MATERIALS AND METHODS

2.1. Study area description.

The research was carried out in the city of Sincelejo, the capital of the Department of Sucre, which belongs to the Caribbean Region. It is located in the north of Colombia. Due to its geographical location, Sincelejo is a privileged axis due to the intersections between the roads that interconnect the main cities of the north of the region with the interior of the country and, additionally, it is the point of passage and union between the savannah populations of the south of the department of Sucre and the Gulf of Morrosquillo; This location has given the road and communications system the sense of radial growth that distinguishes its urban structure. The roads that connect Sincelejo with the region are: The Tolú Bypass, Vía Sincelejo-Coveñas-Corozal, Sincelejo – San Antonio de Palmito, Sincelejo – Sampués [11].

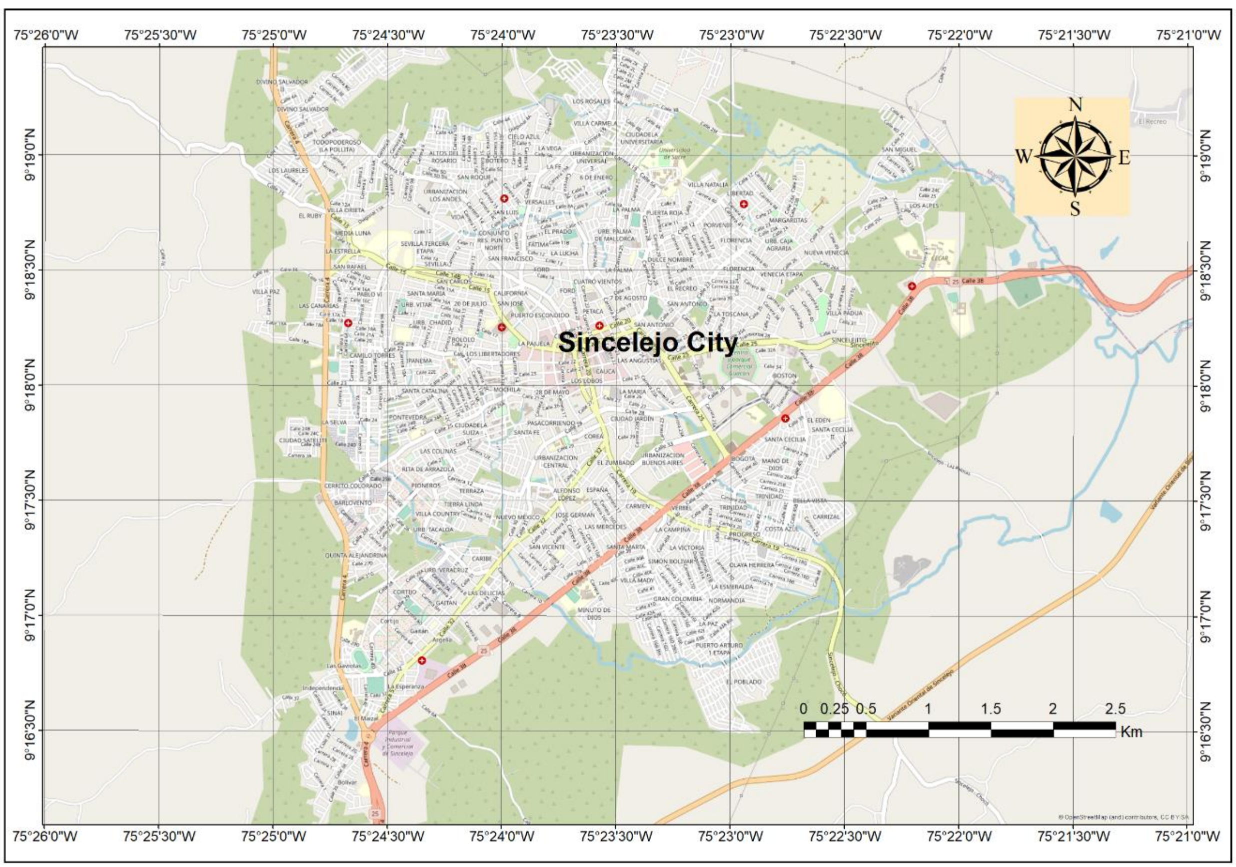

Figure 1. Location of the Study area - Source: self made

2.2. Material and Methods.

The methodology to develop this research has included two phases. In the first phase, samples have been taken in the field and, subsequently, laboratory tests of the different samples, to obtain the physical and mechanical properties of the soils in the area under study. The second phase corresponds to the application of the methods to select the design CBR value and with it, have the resistance properties of the subgrade dreams for the pavement design.

The two phases mentioned are expanded on below.

2.2.1. Sampling and Laboratory tests.

The first stage of the investigation corresponds to taking field samples at the different sites along the road corridors in the study area and carrying out tests on the soil samples. Sampling was done manually at 106 sites. These samples were taken in an altered form to carry out Granulometry, Atterberg Limits and Moisture Content tests, and unaltered samples were taken for the CBR tests, as they were materials with a high percentage of fines or clays.

The samples taken in the field were taken to the laboratory duly packed to preserve their moisture properties and the different tests were carried out. Table 1 shows the type of test performed, as well as the standard or specification that regulates the test in Colombia; additionally, the international reference document of said test is shown based on the standards of the American Society for Testing and Materials.

Table 1. Tests performed on field samples

TESTS			
Type of Test	**Test**	**Standard**	**Reference Document**
Composition	Granulometric analysis of coarse and fine aggregates	INV E – 213 – 13	ASTM C-136 – 06
Cleanliness	Determination of the liquid limit of soils	INV E – 125 – 13	ASTM D 4318 – 10
	Plastic limit and plasticity index of soils	INV E – 126 – 13	ASTM D 4318 – 10
Resistance of material	CBR material of compact soils in the laboratory and on unaltered sample	INV E – 148 – 13	ASTM D 1883 – 07

Source: self made

2.2.2. Determination of the design CBR

For the calculation of the bearing capacity of the subgrade soils, three methodologies were applied, from which it was possible to determine a single representative design CBR value for each case [9], based on the CBR samples taken in the study area.

The first method used corresponds to that of the Asphalt Institute, in which it is proposed that the design CBR of a homogeneous section should be determined as 60, 75 and 87.5% of the individual CBR values of the section that is greater than or equal to to that percentile, which will depend on the traffic that is expected to pass through the design road. The Asphalt Institute provides traffic ranges for which the aforementioned percentiles are recommended. Table 2 shows these ranges.

Table 2. Percentiles to determine the design CBR according to the criteria of the Asphalt Institute

Number of 8.2 ton axles in the design rail	Percentile to determine the design CBR
$\leq 10^4$	60.0
$10^4 – 10^6$	75.0
$\geq 10^6$	87.5

Source: Instituto del Asfalto. Thickness design – Asphalt pavements for highways and streets Manual Series No 1. Novena Ed. (Revisión). Lexington, 2006. P. 26

To apply the methodology, the CBR values of the study area must be organized, from lowest to highest, obtaining the percentage of values greater than or equal to each one of them. From this information, the CBR values are plotted against the percentages obtained and from said graph, the CBR value corresponding to the chosen percentile is selected, according to the design traffic level.

The second method used to determine the value of the design CBR, corresponds to that of the AASHTO, and consists of using the arithmetic mean or average, which results from adding all the CBR values of the section and dividing it by the number of CBR values, thus obtaining the design CBR.

$$\text{Design CBR} = \frac{\sum_{i=1}^{n} \text{CBR}_i}{n}; \quad \text{Eq. 1}$$

Where:

$\sum CBR$ = Sum of the CBR values of the study area
n = number of CBR values considered in the design CBR calculation

The third methodology used to determine the design CBR corresponds to the Mean criterion, which consists of calculating the average of the CBR values. Then Z times the standard deviation is reduced to the selected value, which is a function of the confidence level of the design that is intended to be carried out. Table 3 shows the Z values, according to the confidence level used.

Table 3. Standard Normal Deviation for confidence level values

Confidence interval (CI %)	Standard Normal Distribution (Z)
50	0.00
85	1.00
90	1.282
95	1.645
98	2.054

Source: Carlos Higuera Sandoval, Nociones sobre métodos de diseño de estructuras de pavimentos para carreteras. Volumen I. p. 197

Once the mean value of the CBR of the study area has been calculated and the confidence level has been chosen, as well as the Z parameter, Eq. 2 to calculate the design CBR value.

$$\text{Design CBR} = \overline{\text{CBR}} - (Z * \sigma);\quad \text{Eq. 2}$$

Where:

$\overline{\text{CBR}}$ = Mean value of the CBR values (%)
Z = Standard Normal Deviation (Obtained from Table 3)
σ = Standard deviation of the CBR values

3. RESULTS AND DISCUSSION

For the determination of the CBR values in fine soils, for the urban roads of the city of Sincelejo, 106 soil samples were taken along different road sections and their physical and mechanical properties, as well as their resistance, were characterized. This section presents the most outstanding results and the design CBR values calculated with the different methods discussed above.

The first relevant result is that the fine soils that predominate in the city are classified by the Unified Soil Classification System as CL and CH, that is, clayey soils of low and high compressibility, respectively, and within the AASHTO system as A6. , A-7-5 and A-7-6. The samples with results classified as CL represent 66% of the samples and the remaining 34% correspond to CH soils.

Table 4 shows the results of the tests carried out on the 106 soil samples.

Table 4. Results of the laboratory tests

Road Sectio	Sampl e	Liqui d	Plasti c	Plasticit y	AASHTO	USCS	Natura l	Penetrati on	CB R

n	Depth (cm)	Limit (%)	Limit (%)	Index (%)	Soil Classification	Soil Classification	moisture content (%)	moisture content (%)	(%)
1	40-60	62.8	24.2	38.6	A-7-6	CH	34.5	40.0	0.9
2	35-55	40.0	16.5	23.5	A-6	CL	33.8	40.5	0.4
3	60-80	35.7	18.6	17.1	A-7	CL	23.9	24.5	2.5
4	60-80	32.3	18.5	13.8	A-6	CL	26.2	29.2	1.6
5	50-70	73.0	30.9	42.1	A-7-5	CH	19.0	27.2	2.5
6	25-45	75.0	28.7	46.3	A-7-6	CH	31.5	33.8	3.4
7	45-65	60.4	28.6	31.8	A-7-6	CH	26.3	30.7	3.2
8	45-65	49.6	21.8	27.8	A-7-6	CL	18.7	25.1	2.5
9	35-55	33.4	17.0	16.4	A-6	CL	13.4	39.0	1.6
10	25-45	64.7	31.0	33.7	A-7-5	CH	20.3	41.7	1.6
11	35-55	48.9	23.4	25.5	A-7-6	CL	23.8	26.8	1.6
12	25-45	53.7	19.5	34.2	A-7-6	CH	36.9	45.5	1.5
13	25-45	49.5	20.4	29.1	A-7-6	CL	18.3	29.8	1.9
14	25-45	56.0	26.3	29.7	A-7-6	CH	29.1	30.9	2.5
15	15-35	77.0	31.8	45.2	A-7-5	CH	33.6	46.3	1.6
16	30-50	62.8	28.6	34.2	A-7-6	CH	16.4	32.4	1.5
17	20-40	35.3	17.7	17.6	A-6	CL	22.7	32.7	2.2
18	30-50	34.1	16.6	17.5	A-6	CL	26.1	39.9	1.7
19	30-50	72.3	28.8	43.5	A-7-6	CH	26.8	43.8	1.6
20	40-60	53.8	25.7	28.1	A-7-6	CH	26.3	39.0	2.5
21	20-40	45.6	17.4	28.2	A-7-6	CL	24.8	30.6	1.8
22	20-40	43.0	20.6	22.4	A-7-6	CL	23.7	26.3	2.1
23	25-45	42.8	18.6	24.2	A-7-6	CL	25.0	32.6	2.5
24	25-45	74.9	29.3	45.6	A-7-6	CH	30.4	40.9	1.3
25	25-45	65.9	23.2	42.7	A-7-7	CH	38.1	39.3	1.6
26	20-40	53.0	21.6	31.4	A-7-6	CH	21.1	28.7	2.8
27	20-40	50.2	22.7	27.5	A-7-6	CH	16.2	36.5	1.6
28	20-40	48.5	22.2	26.3	A-7-6	CL	35.3	41.0	1.9
29	25-45	52.9	25.6	27.3	A-7-6	CH	33.5	39.3	1.8
30	25-45	52.2	20.1	32.1	A-7-6	CH	23.8	59.7	2.4
31	70-90	27.4	14.1	13.3	A-6	CL	19.6	83.1	3.2
32	50-70	34.0	17.3	16.7	A-6	CL	7.6	17.7	2.0
33	40-60	45.1	19.7	25.4	A-7-6	CL	40.4	47.4	3.3
34	30-50	26.7	14.4	12.3	A-6	CL	30.3	78.3	4.0

Road Section	Sample Depth (cm)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	AASHTO Soil Classification	USCS Soil Classification	Natural moisture content (%)	Penetration moisture content (%)	CBR (%)
35	25-45	44.3	22.5	21.8	A-7-6	CL	23.8	33.3	1.5
36	20-40	44.9	24.7	20.2	A-7-6	CL	11.8	22.9	3.7
37	15-35	40.6	22.4	18.2	A-7-6	CL	14.3	19.0	2.5
38	15-35	41.0	19.0	22.0	A-7-6	CL	17.8	25.5	4.1
39	15-35	38.1	14.5	23.6	A-6	CL	25.1	25.7	4.9
40	15-35	38.5	13.7	24.8	A-6	CL	17.6	26.4	3.5
41	40-60	54.4	27.5	26.9	A-7-6	CH	20.1	37.2	1.2
42	20-40	43.6	15.6	28.0	A-7-6	CL	26.8	36.9	1.4
43	15-35	33.9	20.1	13.8	A-6	CL	13.4	23.8	1.5
44	15-35	33.3	19.5	13.8	A-6	CL	13.3	29.2	0.9
45	20-40	35.2	16.9	18.3	A-6	CL	15.3	25.9	3.5
46	15-35	48.6	25.0	23.6	A-7-6	CL	14.4	35.2	3.4
47	45-65	55.1	25.0	30.1	A-7-6	CH	18.6	36.3	3.7
48	20-40	38.9	16.3	22.6	A-6	CL	14.0	28.9	3.7
49	15-35	48.0	20.3	27.7	A-7-6	CL	15.2	26.9	2.3
50	15-35	35.7	19.5	16.2	A-6	CL	24.4	36.6	2.5
51	20-40	47.7	20.2	27.5	A-7-6	CL	21.3	32.0	4.0
52	40-60	49.9	24.5	25.4	A-7-6	CL	27.9	36.8	1.3
53	30-50	47.1	21.3	25.8	A-7-6	CL	16.4	22.1	2.3
54	25-45	39.5	20.3	19.2	A-6	CL	19.2	27.7	1.7
55	20-40	53.4	22.4	31.0	A-7-6	CH	15.2	22.5	4.9
56	30-50	52.3	24.6	27.7	A-7-6	CH	13.2	21.5	2.8
57	35-55	32.4	16.7	15.7	A-6	CL	15.3	23.3	3.7
58	25-45	59.5	26.0	33.5	A-7-6	CH	24.0	25.5	2.2
59	25-45	36.2	19.4	16.8	A-6	CL	13.1	34.1	4.6
60	25-45	33.9	19.5	14.4	A-6	CL	22.9	24.5	3.7
61	25-45	36.2	19.4	16.8	A-6	CL	19.1	23.4	3.8
62	25-45	35.4	19.2	16.2	A-6	CL	21.8	27.9	4.0
63	20-40	72.6	33.3	39.3	A-7-5	CH	38.7	40.0	1.4
64	15-35	84.1	32.8	51.3	A-7-5	CH	25.3	27.6	0.5
65	30-50	89.0	35.0	54.0	A-7-5	CH	27.4	29.8	0.6
66	60-80	66.6	21.9	44.7	A-7-6	CH	19.2	30.6	1.1

Road Section	Sample Depth (cm)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	AASHTO Soil Classification	USCS Soil Classification	Natural moisture content (%)	Penetration moisture content (%)	CBR (%)
67	30-50	55.8	21.5	34.3	A-7-6	CH	30.6	31.8	1.1
68	20-40	55.2	18.7	36.5	A-7-6	CH	20.1	37.0	1.8
69	30-50	37.0	17.3	19.7	A-6	CL	20.3	24.1	5.0
70	40-60	53.2	25.7	27.5	A-7-6	CH	20.9	26.2	1.6
71	30-50	34.4	19.6	14.8	A-6	CL	38.0	43.9	2.1
72	30-50	35.0	18.0	17.0	A-6	CL	27.5	40.1	2.4
73	85-105	40.0	20.3	19.7	A-6	CL	12.4	24.2	2.4
74	90-110	41.8	17.6	24.2	A-7-6	CL	19.3	21.1	2.0
75	80-100	40.8	19.1	21.7	A-7-6	CL	26.2	29.5	1.6
76	80-100	37.0	16.4	20.6	A-6	CL	20.1	22.5	3.4
77	100-120	60.1	21.3	38.8	A-7-6	CH	30.6	32.1	1.3
78	80-100	48.9	22.8	26.1	A-7-6	CL	13.2	24.9	1.9
79	85-105	44.6	20.6	24.0	A-7-6	CL	25.4	29.8	2.2
80	90-110	39.4	16.3	23.1	A-6	CL	27.0	30.5	1.5
81	80-100	36.3	19.6	16.7	A-6	CL	22.4	29.4	0.8
82	80-100	46.8	19.9	26.9	A-7-6	CL	18.1	33.9	0.9
83	100-120	30.1	12.8	17.3	A-6	CL	33.6	38.5	0.5
84	80-100	46.9	21.8	25.1	A-7-6	CL	29.9	30.4	2.7
85	40-60	40.8	18.0	22.8	A-7-6	CL	29.4	33.8	2.4
86	35-55	39.1	21.4	17.7	A-6	CL	18.6	30.2	1.6
87	40-60	38.9	23.4	15.5	A-6	CL	18.8	37.1	2.2
88	40-60	47.5	21.9	25.6	A-7-6	CL	9.5	29.3	1.3
89	15-35	47.9	21.5	26.4	A-7-6	CL	29.1	29.3	0.9
90	35-55	49.5	22.3	27.2	A-7-6	CL	24.0	33.5	0.9
91	30-50	48.2	22.5	25.7	A-7-6	CL	30.5	33.4	1.4
92	40-60	36.8	18.0	18.8	A-6	CL	18.4	28.4	2.2
93	70-90	51.8	20.5	31.3	A-7-6	CH	24.9	34.5	1.8
94	65-85	41.3	19.8	21.5	A-7-6	CL	22.8	31.6	1.5
95	35-55	29.5	15.3	14.2	A-6	CL	19.0	24.6	1.3
96	40-60	45.1	20.7	24.4	A-7-6	CL	22.4	23.0	3.4

Road Section	Sample Depth (cm)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	AASHTO Soil Classification	USCS Soil Classification	Natural moisture content (%)	Penetration moisture content (%)	CBR (%)
97	40-60	41.4	19.5	21.9	A-7-6	CL	29.5	31.3	1.4
98	15-35	43.7	25.5	18.2	A-7-6	CL	20.4	33.8	2.1
99	35-55	51.2	22.5	28.7	A-7-6	CH	26.0	30.9	1.3
100	60-80	41.1	21.1	20.0	A-7-6	CL	21.3	24.9	1.6
101	40-60	40.5	20.9	19.6	A-7-6	CL	28.4	32.2	0.8
102	45-65	60.4	28.2	32.2	A-7-6	CH	13.6	34.0	1.0
103	30-50	58.4	27.5	30.9	A-7-6	CH	36.3	38.3	2.1
104	20-40	49.6	22.7	26.9	A-7-6	CL	29.6	33.0	1.5
105	20-40	58.5	27.1	31.4	A-7-6	CH	20.3	26.6	1.8
106	25-45	53.4	24.4	29.0	A-7-6	CH	29.2	34.7	0.9

Source: self made

Table 5 shows a summary of the main properties of the soils, discriminated by soil type within the USCS.

Table 5. General results of laboratory tests

Parámetros	Tipo de Suelo (USCS)	
	CL	CH
No. of samples	70	36
Liquid Limit min. (%)	26	50
Liquid Limit max. (%)	49	89
Plasticity Index min. (%)	12	27
Plasticity Index max. (%)	29	54
CBR min. (%)	0.4	0.5
CBR max. (%)	5.0	4.9

Source: self made

Figure 2 shows the distribution of CBR values for different CBR intervals. This figure is important, because it allows determining how the CBR values are distributed, since the difference obtained between the different methods for determining the CBR will depend on this. Additionally, the graph presents important information, where it can be seen that more than 50% of the CBR values for this type of soil in the study area have values lower than 2.0% and that the greatest number of CBR values are located in the range from 1.0 to 2.0. Similarly, as the ranges of CBR values increase, the number of samples with those values decreases, and it can also be noted that the CBR values of the CH samples are concentrated in the lower ranges, which is very consistent. with the nature of clay soils such as those found in the study area.

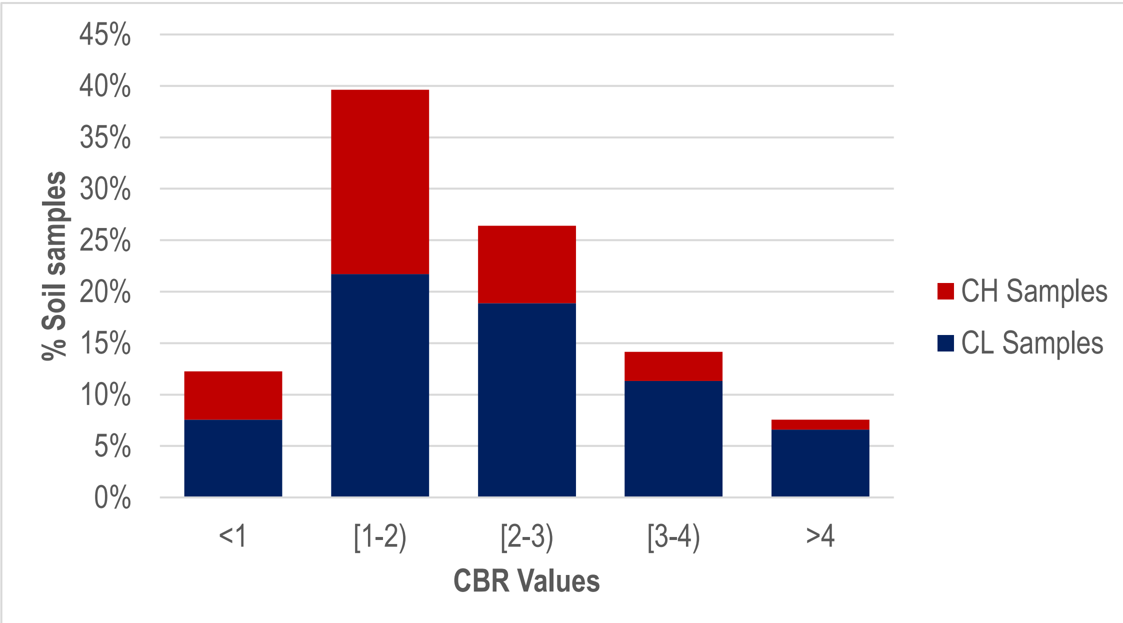

Figure 2. Histogram of the CBR values by intervals - Source: self made

Figure 3 shows the percentiles to be applied, in the case of the criteria of the North American Asphalt Institute. For this purpose, the three values will be taken, 60, 75 and 87.5%, corresponding to the three traffic levels considered, from low volumes, applicable in the case of streets in purely residential areas, to first category roads, as in the case of main urban arteries or national roads that cross the city.

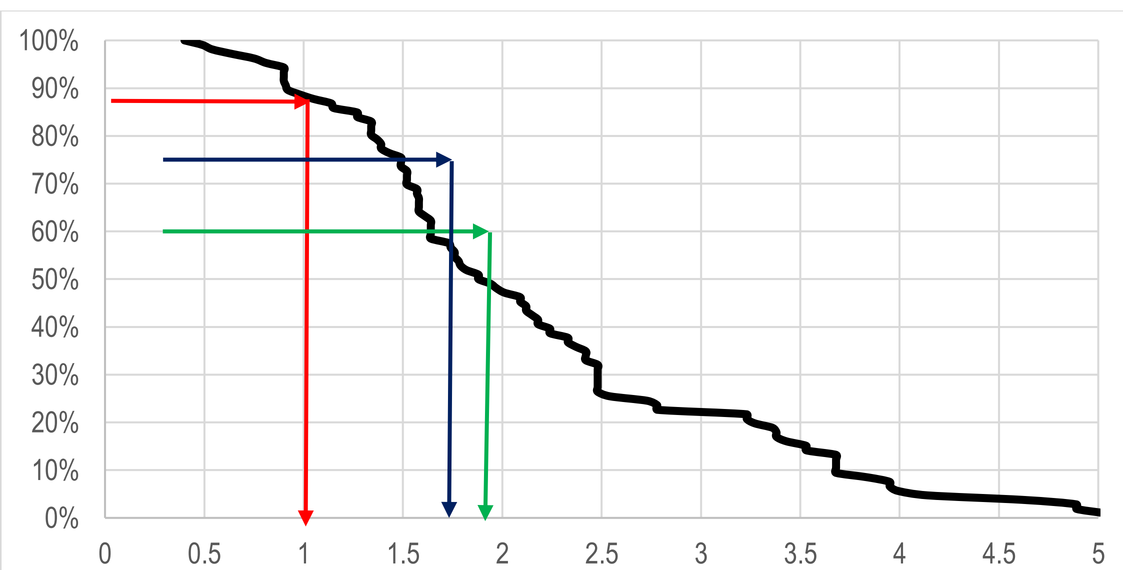

Figure 3. Percentiles of the CBR - Source: self made

For the calculation of the respective design CBR values by the arithmetic average and mean criteria methods, the 106 results of CBR values obtained from the soil samples of the area were used, obtaining CBR min. = 0.4, CBR max. = 5.1, arithmetic mean = 2.15%, standard deviation = 1.05%. It should be noted that in the case of the Mean Criterion, confidence levels of 90 and 95% were taken into account, which are consistent with the importance of the roads in the study area.

Table 6 shows a summary of the different CBR values obtained from the three selected methodologies. In the first instance, it can be seen that the values differ significantly between the different methods, obtaining, for example, a value of 2.16% for the average CBR, while the Mean criterion for a confidence level of 95 %, a value of 0.43% is obtained. On the other hand, it can be seen that the method of the Asphalt Institute for the three percentiles gives very close and relatively conservative values if we observe Figure 3.

Table 6. Design CBR results

Criteria	Sub criteria	CBR (%)
Asphalt Institute	Percentile 60%	1.64
	Percentile 75%	1.49
	Percentile 87.5%	1.05
Arithmetic average	-	2.16
Mean	Confidence interval 90%	0.81
	Confidence interval 95%	0.43

Source: self made

4. CONCLUSIONS

In this work, three different methodologies were shown that are frequently used to determine the subgrade design CBR in road infrastructure projects, and it can be noted that for the specific case of the area studied, the values of the different methods with their particular considerations vary greatly from one to another. For this reason, it is the responsibility of both the road geotechnical engineer and the pavement designer to determine the homogeneous sections in a road project, based on the geotechnical conditions found and to determine, based on field and laboratory tests, the resistance of the foundation soils.

As has been observed, in the case of taking the CBR value as a reference value for the support capacity of the subgrade, it is very important that the criteria adopted by the responsible professionals be in accordance with the characteristics of the project that is to be carried out, this with the purpose of obtaining an optimal pavement solution, optimal being understood as a structure that can last in service with the least possible maintenance during the projected useful life, in such a way that choosing very conservative CBR values can lead to higher project costs and CBR values that are not so conservative may mean greater maintenance of the structures or their premature deterioration, leading to higher costs or a shorter service life of the works, for which the criteria and experiences of the professionals in charge are of vital importance.

ACKNOWLEDGMENTS

The authors thank the engineer Edilberto Elias Contreras Sierra for the contributions made in the development of the research work.

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