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Comparative Analysis of the Design of an Asphalt Pavement by AASHTO 2002 and Instituto Nacional de Vias of Colombia Methodology

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Abstract

Pavement design becomes an essential task when planning road infrastructure works that are consistent with the needs of a country, seen both from the point of view of comfort and road safety, as well as economy and durability. To achieve this objective, it is necessary for designers to use design methodologies that guarantee durable and economically viable pavement structures, for which today there is a variety of design methods, these can be categorized into two large groups: traditional methods, called empirical and the most recent, but less used, called empirical-mechanistic methods. In Colombia, the design guides are prepared based on an empirical approach and most of the pavements built in the country have been designed following this way, as a result of not having their own investigations that allow implementing an approach empirical-mechanistic in the designs, resulting in an arduous task for the designer who wishes to use this methodology, since he need to resort to foreign literature and calibrations obtained in other latitudes, which does not necessarily guarantee reliable input parameters. In 2002, the AASHTO published the document Mechanistic - Empirical Pavement Design Guide, which provides a mechanistic-empirical methodology for the design of pavements, including new factors and predicting the behaviour of pavements over time, giving designers an agile and reliable tool for designing pavements. Unfortunately, in order to apply this methodology in the country, it is necessary to calibrate and adjust the input variables, in order to obtain reliable results, which is why this methodology for pavement design is not very popular in Colombia. The purpose of this work is to make a comparison of the results obtained from an empirical methodology and another mechanical-empirical one. For the first, the Asphalt Pavement Design Manual of the Instituto Nacional de Vias de Colombia (INVIAS) has been taken as a guide and for the second, the Mechanistic design software - Empirical Pavement Design Guide, Level 3, is used, being able to obtain pavement thicknesses for some roads located in the City of San Juan de Pasto (Colombia). The input variables of both methods are very similar and for the present investigation, it worked with different levels of traffic (500.000, 1.000.000 and 1.5000.000 repetitions of equivalent standard axles) and with different resistance of the subgrade soil (CBR values of 3, 4, 5, 6, 7, 8, 10, 12). The climatic variables are related to those of the project area and the properties of the materials were selected from the INVIAS Specifications for Asphalt Concrete, base and subbase granular materials. As a final product, several alternatives of designed structures could be obtained, resulting in significant differences in the thicknesses obtained by the two methodologies. Therefore, taking into account that the input data were the same, it can be concluded that in order to apply the empirical-mechanistic methods in Colombia, a calibration of the input data must be carried out, in such a way that these are adjusted to the particular conditions of the country

Keywords: flexible flooring, flooring design, AASHTO 2002, rational design

I. INTRODUCTION

The purpose of Pavement Engineering is the design, construction, maintenance and management of road infrastructure projects, seeking that the products obtained are as economical as possible, providing safety and comfort for their users. To carry out these objectives, as it is a multidisciplinary activity, different branches of engineering are involved, such as geotechnics, pavements, materials, structures and transport systems [1].

Pavements are solutions for the conception of roads, being thought, designed and built with the aim of improving and maintaining road corridors in optimal and safe conditions, in order to allow the transit of people or goods and services, in such a way that they become structural elements that intervene in the construction of the road network in each country [2]. Pavements are structures commonly formed by several layers, which rest on the foundation soil or better known as subgrade. Said layers are made up of the running layer, which in turn rests on other layers of a granular, simple or treated nature. The pavement is designed in order to transfer and distribute traffic loads safely to the subgrade and to resist adverse environmental conditions, during a determined design period [3].

At present, for pavement design, there are mainly two types of methodologies: empirical methods and mechanistic-empirical methods, also called analytical or rational methods. Empirical methods include those based on subgrade engineering classification, relative shear strength, road experiments such as the WASHO Road Test (1952-1955), and the AASHTO practical test (1958-1962). That is, empirical design methods consider the observed behaviour of pavements in service under traffic, environmental and material conditions similar to those existing in the observed sections. On the other hand, empirical-mechanistic methods are focused on the mechanics of materials, allowing a theoretical analysis of the behaviour of the pavement in the face of load stresses, such as traffic and stresses induced in the structure by climatic variations [4], [5], [6], based on two principles; Permanent deformation, which refers to permanent, plastic or irrecoverable deformation of the pavement structure and Fatigue cracking, which consists of cracking generated by a series of interconnections of cracks caused by fatigue failure of the surface, under repeated transit loads [7]. Some authors affirm that mechanistic or rational methods are a better alternative if compared with empirical pavement design methodologies, but their applicability in many places is limited, since it requires that their variables be calibrated in the locale, so that your application is reliable [8].

In Colombia, it can be noted that most of the main highways have their tread made up of asphalt materials, that is, they would be classified within the category of asphalt pavements. In addition to this, it is known that more than 80% of the cargo in Colombia is mobilized through highways, observing a limited road network with little capacity [9]. In addition, it is well known that currently, for one reason or another, the roads (mainly the most travelled), are deteriorated by many factors, such as the rugged topography of the terrain, the properties of the subgrade soils, the inclemency of the climate and the wear itself produced by vehicular traffic [7]. Due to these reasons, the design of the pavements becomes a very sensitive task, where the designer must estimate with the greatest possible precision the variables involved in the operation of the pavements, in order to obtain structural packages that satisfy the real expected demands.

In Colombia, the design of pavements is based mainly on empirical methods and in a small proportion, on mechanistic methods, but these pavements are not directly related to a design methodology, because in the country no fatigue laws have been developed that characterize the fatigue behaviour of local materials based on their mechanical, physical and rheological properties [10]. Consequently, Colombian designers are forced to resort to fatigue laws calibrated for other countries with conditions of traffic, climate and materials very different from those of the project site [11]. That is why any change in the design variables, such as traffic or weather, can generate a loss of reliability to the method in the pavement sizing phase [12]. In the country, generally the design of pavements is governed by variables such as traffic, the geotechnical characteristics of the foundation soil, the mechanical characterization of the materials used for construction and a design methodology, seeking that the loads imposed by the traffic, they do not generate excessive permanent deformations and that the structure can withstand the environmental conditions, associated with both precipitation and the temperature to which the pavement will be subjected during its service life [13].

For all the above, it is of particular interest, the choice of the design methodology to implement for the dimensioning of the layers that will make up the pavement, because the performance of the structure will depend on the results obtained over the years of service. That is why this work shows a comparison of the new flexible pavement structures designed for the city of Pasto, applying the AASHTO Empirical-Mechanistic Pavement Design Guide ME-PDG 2002 (Mechanistic - Empirical Pavement Design Guide). 2002 - Level 3 and the Manual for the design of asphalt pavements with medium and high volumes of traffic of the Instituto Nacional de Vías.

II. MATERIALS AND METHODS

To carry out the present work, we proceeded to design several asphalt pavement structures made up of three layers (Figure 1): asphalt concrete for the tread layer, supported by a granular base layer and finally a layer granular subbase. In the case of granular materials, these were selected in such a way as to comply with the current specifications of the National Institute of Highways of Colombia. Regarding the analysis of the structures, these were carried out taking into account different resistances of the foundation soils of the pavement, for which they worked with various values of CBR of the subgrade. The two methodologies used are described below, those found in the Asphalt Pavement Design Manual of the Instituto Nacional de Vías (INVIAS) and in the Mechanistic - Empirical Pavement Design Guide - AASHTO 2002 - Level 3.

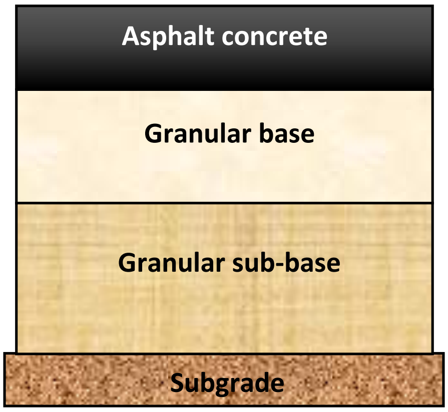


Fig. 1. Pavement structure analysed

II.I Flexible Pavement Design Methodology according to the Asphalt Pavement Design Manual of the Instituto Nacional de Vías - INVIAS

The design methodology developed by INVIAS is applicable to pavements on interurban highways with two or more lanes and takes into account a wide range of probable design transits. It is based on existing design methods, experience in pavement construction and operation, the theory of structural behaviour, and the characteristics of available materials. Its calibration and validation was carried out from study sections of the national road network, from which the main variables that affect the performance of a pavement could be determined, such as: the number of equivalent axles supported by the structure, the value support of the subgrade, the thicknesses and types of materials used, among other aspects. In preparing the design manual, the AASHTO, version 1993 and rational (mechanistic-empirical) methods were used, based on the fatigue curves developed by Finn, which involve the level of cracking in service. From the analysis carried out, they were able to obtain as a basic equation for pavement sizing purposes, the one recommended by the AASHTO method.

For the design of the different alternatives, the following considerations were taken into account:

- Value of the standard normal error (So), equal to 0.44.
- Value of the normal standard deviation Zr = -1.282, corresponding to a confidence level of 90%.
- Loss of serviceability APSI, equal to 2.2 (initial serviceability of 4.2 and final serviceability of 2.0).
- Structural coefficient (ai), depending on the different potentially usable materials (dense hot mix, dense cold mix, stabilized base with asphalt emulsion, cement stabilized base, granular base and granular sub-base).
- Drainage coefficient (mi) of the granular layers, depending on the precipitation and the quality of the drainage, assuming that the pavement will be at humidity levels close to saturation for periods close to 15% of the exposure time.
- The transits were categorized according to the accumulated number of repetitions in the design lane, in categories ranging from T1 to T9.
- The climatic regions were classified according to temperature and rainfall, thus resulting in 6 regions (R1 to R6).
- The characterization of the subgrade, based on the resilient modulus, considering five different categories (S1 to S5).

Based on the above considerations, pavement design charts were constructed that depend on climatic conditions (R), traffic levels (T), subgrade soil resilience conditions (S) and characteristics of the materials defined for each one of the layers; resulting in six design cards, which are applicable in the ranges shown in Table 1.

The methodology followed to apply the design letters, consisted of defining each of the design variables that the method takes into consideration and based on these, determining the pavement structures that meet the specifications, choosing as a design alternative, the one that best suits the needs of the project.

Table 1. Ranges contemplated in the design charts

Letter	Climate Region (R)	Subgrade Bearing (R)	Transit Range (T)
1	R1	de S1 a S5	de T1 a T9
2	R2	de S1 a S5	de T1 a T9
3	R3	de S1 a S5	de T1 a T9
4	R4	de S1 a S5	de T1 a T9
5	R5	de S1 a S5	de T1 a T9
6	R6	de S1 a S5	de T1 a T9

Source: INVIAS. Manual de diseño de pavimentos asfálticos en vías con medios y altos volúmenes de tránsito, 1998. p.72.

II.II Flexible Pavement Design Methodology according to Mechanistic –Empirical Pavement Design Guide - AASHTO 2002

The design methodology found in the North American guide is of an empirical-mechanistic type, in which the designer need to start from a preliminary design and determine if it meets the established requirements and performance criteria. This process requires testing practical approaches and going through an iterative process until an acceptable solution is found. Software is available for the application of the method.

This design guide uses traffic variables, weather conditions, subgrade parameters, and material properties, with the objective of evaluating the behavior of the pavement throughout the useful life of the structure or design period. . This is done through predictions of the impairments that are considered in the analysis, taking into account the laws of behavior that are presented in said guide.

In Figure 2 the procedure is outlined in a general way, which is followed for the design of asphalt pavements through the AASHTO 2002 methodology.

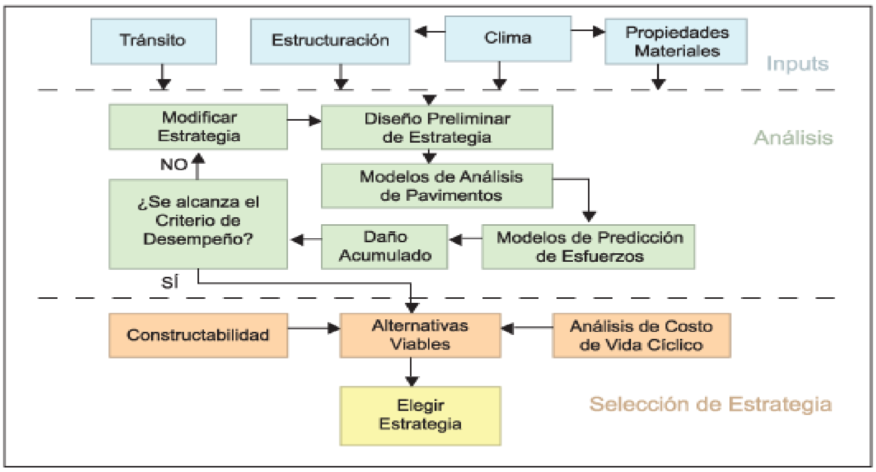


Fig. 2. General Design Procedure for Asphalt Pavements

Source: Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures, National Cooperative Highway Research Program 1-37A, Final Report, March 2004

The AASHTO 2002 design method allows to analyze the fulfillment of the criteria, through output graphs obtained from the software that accompanies this design guide. In Figure 3, the fulfillment of design criteria during the design period is presented in a general way.

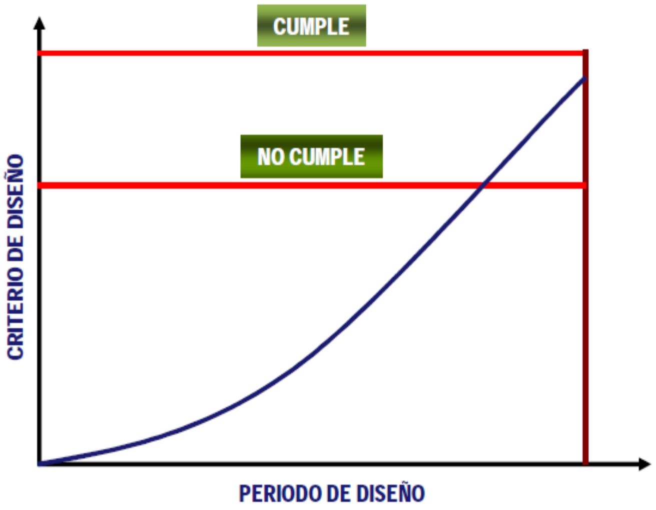


Fig. 3. Compliance with design criteria

Source: Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures, National Cooperative Highway Research Program 1-37A, Final Report, March 2004

The deteriorations that can be predicted through the Mechanistic –Empirical Pavement Design Guide, are fatigue cracking, longitudinal cracking, thermal cracking, IRI and rutting.

The methodology found in the Guide uses a hierarchical approach to determine the design variables, for which effort levels that are in accordance with the level of importance of the road are considered. The method considers 3 entry levels, which are: Level 1 (High reliability), Level 2 (Medium reliability) and Level 3 (Low reliability). The latter is applicable to low-impact designs, where the input parameters are default values, based on local experience.

It should be noted that for the present study, the use of Level 3 has been taken into consideration.

Next, the variables involved in the design of pavements by the AASHTO 2002 methodology are presented:

- The characteristics of the subgrade, whose most used representative parameter in Colombia corresponds to the CBR values of the foundation soils. For this variable, the guide presents a table with typical values of the different types of soil, both of a fine nature and of a frictional nature, obtained from existing experience and historical data.
- The properties of the materials are fundamental in the design of pavements for this methodology and is closely linked to the performance of the pavement, therefore, the determination of their properties allows optimizing the selection of thicknesses of the pavement structure. In the case of asphalt binders, conventional tests are used. In the case of Level 3, the Grade of the binder is used, which can be obtained from the Witczak Equation, or from volumetric relationships.
- Environmental conditions are very important in the performance of flexible pavements. Factors such as precipitation, temperature changes, freeze-thaw cycles, among other environmental phenomena are taken into account, which can affect the layers of the pavement or the subgrade and therefore the performance of the pavement. The guide software includes the Enhanced Integrated Climatic Model (EICM) for the creation of humidity and temperature profiles. It should be taken into account that for the creation of a weather station, the software requires data collection every hour, for a period of time not less than two years, of the following data: temperature, wind speed, cloud cover, precipitation and relative humidity.
- Traffic loads are expressed for this methodology as the number of 8.2-ton equivalent axles on the design lane during the design period. In the case of Level 3, it can be calculated based on the TPD, % of trucks and the loads, taken from local, regional or national averages.

The design software is based on the multilayer elastic solution, where the main routine is performed by the JULEA program and is complemented by the “D FEM Desai” for special load conditions and non-linear material. On the other hand, changes are predicted over time in the strength and stiffness of materials, in temperature, humidity, in addition, it predicts changes over time of seasonal variations and traffic.

To apply the software, the following steps are followed:

- Compilation of input data: traffic variables, environmental data, characterization of materials and definition of the pavement structure (pre-sizing).
- Determination of stresses and deformations.
- Analysis of failure modes: fatigue and rutting.
- Result of the tentative section: satisfactory or unsatisfactory.

Using the NCHRO M-E PDG software, pavement structures can be obtained for the conditions set by the designer. The software generates reports on the variation of the modulus of the asphalt concrete with time, variation of the subgrade modulus with time, the predicted depth of the rut in time, behavior of the IRI in time, longitudinal cracks in time and other criteria of performance (Terminal IRI, Long. Cracking, Alligator Cracking, Transverse Cracking, Fatigue Fracture and Permanent Deformation).

In Figures 4 - 9, the reports of the ME –PDG software are presented, in which the variations of the input parameters are observed.

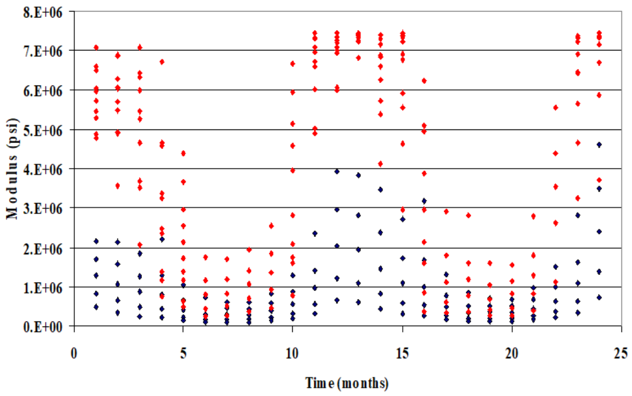


Fig. 4. Variation of the modulus of asphalt concrete with time

Source: Software Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures

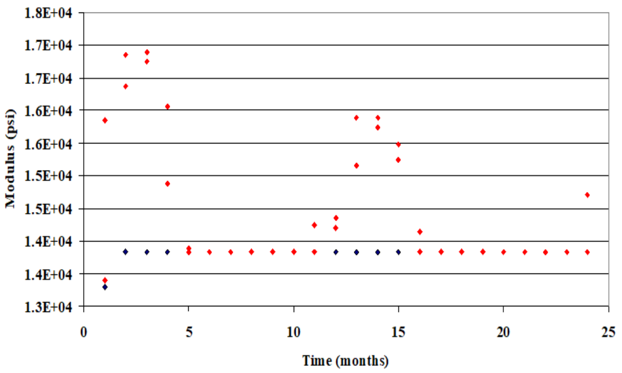


Fig. 5. Variation of the subgrade modulus with time

Source: Software Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures

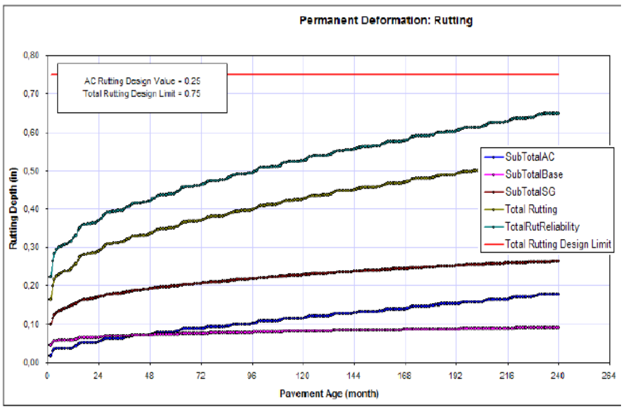


Fig. 6. Predicted rut depth over time

Source: Software Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures

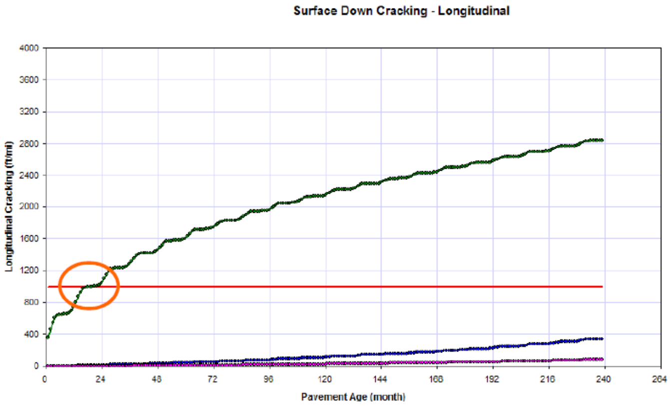


Fig. 7. Longitudinal fissures in time

Source: Software Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures

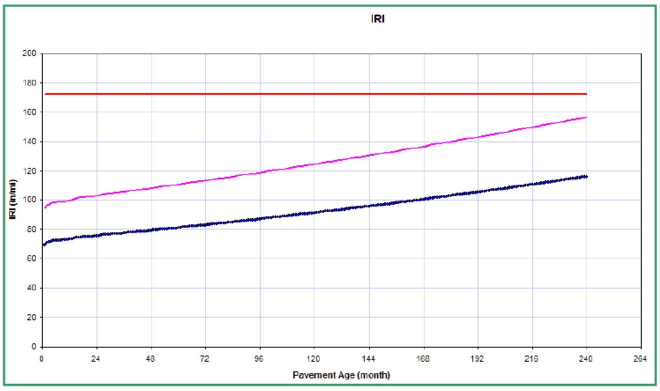
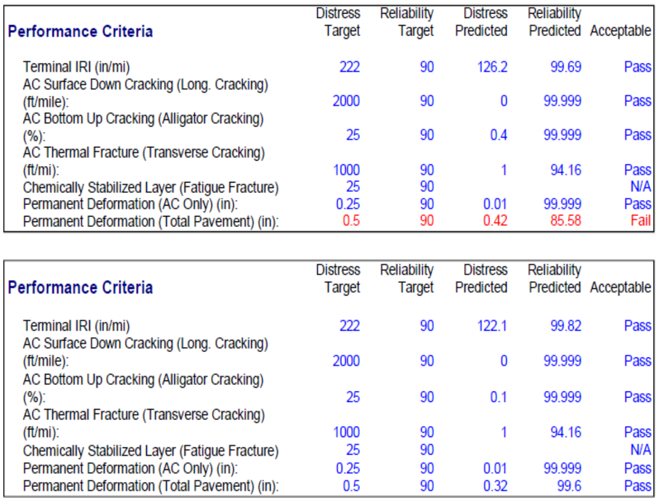


Fig. 8. IRI behavior over time

Source: Software Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures



Performance Criteria	Distress Target	Reliability Target	Distress Predicted	Reliability Predicted	Acceptable
Terminal IRI (in/mi)	222	90	126.2	99.69	Pass
AC Surface Down Cracking (Long. Cracking) (ft/mile):	2000	90	0	99.999	Pass
AC Bottom Up Cracking (Alligator Cracking) (%):	25	90	0.4	99.999	Pass
AC Thermal Fracture (Transverse Cracking) (ft/mi):	1000	90	1	94.16	Pass
Chemically Stabilized Layer (Fatigue Fracture)	25	90			N/A
Permanent Deformation (AC Only) (in):	0.25	90	0.01	99.999	Pass
Permanent Deformation (Total Pavement) (in):	0.5	90	0.42	85.58	Fail

Performance Criteria	Distress Target	Reliability Target	Distress Predicted	Reliability Predicted	Acceptable
Terminal IRI (in/mi)	222	90	122.1	99.82	Pass
AC Surface Down Cracking (Long. Cracking) (ft/mile):	2000	90	0	99.999	Pass
AC Bottom Up Cracking (Alligator Cracking) (%):	25	90	0.1	99.999	Pass
AC Thermal Fracture (Transverse Cracking) (ft/mi):	1000	90	1	94.16	Pass
Chemically Stabilized Layer (Fatigue Fracture)	25	90			N/A
Permanent Deformation (AC Only) (in):	0.25	90	0.01	99.999	Pass
Permanent Deformation (Total Pavement) (in):	0.5	90	0.32	99.6	Pass

Fig. 9. ME –PDG Design Results Screen

Source: Software Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures

III. RESULTS AND ANALYSIS OF RESULTS

To carry out the present work, the design of several pavement structures was carried out, depending on the design traffic and the properties of the subgrade. This section presents the input variables of the designs and the results of the structures that comply with these designs for both study methodologies.

III.I Design of Pavement Structures - Design Variables

Design period: The design period corresponds to 10 years.

Analysis Parameters: All the parameters mentioned below have a Reliability of 90%. The limit values of the parameters involved in the design are: Initial IRI 2.0 m / km, Terminal IRI 4.0 m / km, AC Bottom Up cracking Alligator Cracking 25%, Permanent Deformation - Total Pavement 19 mm, Permanent Deformation - AC Only 6 mm .

Design Traffic: Design Traffic is expressed in 8.2 ton equivalent standard axles on the design lane. For this purpose, the following considerations were taken: Tire load = 9000 lb, Tire Pressure 120 psi, standard deviation Wheel wander 10 in, monthly repetitions of buses and trucks of 3,300, 6,600 and 10,000 and in the case of Annual growth, this is took 5%. Based on the previous data, three levels of traffic were obtained, which are shown in Table 2.

Table 2. Design Transits

Monthly Transit	Design period	Growth rate	Traffic on equivalent axles
3.300	10 years	5 %	500.000
6.600	10 years	5 %	1.000.000
10.000	10 years	5 %	1.500.000

Climate variable: to use the ME - PDG software, you must have a database of a climate station. For the case of the present study, to work with a Level 3, a station with the same conditions was taken as a reference to the city of San Juan de Pasto (Colombia), which is located at latitude 1 ° 12 'N and longitude 77 ° 16 'W, at an altitude of 2527 meters above sea level, with an average annual rainfall of 700 mm and an average annual temperature of 14 ° C. In this way, the US station called "Johnstown, Pa" was chosen, which is located at longitude 78 ° 50 W and at an altitude of 2280 meters above sea level. This station has the necessary information to determine the climatic parameters in pavement design.

Structure materials: the materials for this study correspond to the rolling layer and granular type materials that will serve as the base and sub-base, as well as the subgrade, the layer where the pavement structure will be supported. In the case of the wearing course, asphalt concrete with a dense MDC2 mix has been selected, which meets the requirements of article 450-13 of INVIAS. For the granular base the BG2 type of article 330 - 13 is used and for the granular Subbase, a type SBG-1 of article 320 - 13, of the INVIAS material specifications. The initial modulus of elasticity, under optimum moisture and density conditions, is 40,000 psi for the BG-2 and 20,000 psi for the SBG-1. In the case of the subgrade, a correlation equation is used to determine the resilient modulus, from the CBR values. In Equation 1, you can see the expression used to determine the CBR values found in Table 3.

Table 3. Relationship CBR - Resilient modules

Subgrade CBR value (%)	Resilient Module (psi)	Resilient Module (kg/cm^2)
3	5.161	360
4	6.204	430
5	7.157	500
6	8.042	560
7	8.876	620
8	9.669	680
9	10.425	730
10	11.153	780
11	11.854	830
12	12.533	870
13	13.192	920
13.5	13.500	950

With the data previously described, the design of 8 pavement structures was carried out, using the methodology of the INVIAS Asphalt Pavement Design Manual and the Mechanistic –Empirical Pavement Design Guide of the AASHTO 2002.

III.II Design of Pavement Structures - Design Results

The following tables present the result of the structural packages resulting from the designs, obtained based on the design variables defined above and using the new flexible pavement design methodologies of INVIAS and AASTHO 2002.

The Tables show the different results, based on X CBR values (4, 5, 6, 7, 8, 9, 10 and 11) and on 3 different design traffic levels (500.000, 1.000.000 and 1.500.000 repetitions of 8.2 ton standard axles). As can be seen, the thicknesses are presented for each of the structural layers under consideration (asphalt concrete, granular base and granular subbase).

Table 4. Design results for CBR 3

	INVIAS Method		AASHTO ME- PDG Method			
Subgrade (CBR%) Traffic	3≤CBR <5		CBR =3, (5161 PSI)			
T1 0.5 < $N_{8.2}$ ≤1	10	CA				
	20	BG				
	25	SBG				
Ta = 500.000			falla	falla	O.K	
		CA	10	10	12.5	
		BG	20	25	20	
		SBG	25	25	25	
Tb = 1.000.000			falla	falla	O.K	
		CA	10	12.5	15	
		BG	20	20	20	
		SBG	25	25	25	
T2 1.0 < $N_{8.2}$ ≤ 2	10	CA				
	20	BG				
	35	SBG				
Tc = 1.500.000			falla	falla	falla	O.K
		CA	10	12.5	15	15
		BG	20	20	20	25
		SBG	35	35	35	35

Table 5. Design results for CBR 4

	INVIAS Method		AASHTO ME- PDG Method		
Subgrade (CBR%) Traffic	3≤CBR <5		CBR =4, (6204 PSI)		
T1 0.5 < $N_{8.2}$ ≤1	10	CA			
	20	BG			
	25	SBG			
Ta = 500.000			falla	falla	O.K
		CA	10	10	12.5
		BG	20	25	20
		SBG	25	25	25
Tb = 1.000.000			falla	falla	O.K
		CA	10	12.5	12.5
		BG	20	20	25
		SBG	25	25	25
T2 1.0 < $N_{8.2}$ ≤ 2	10	CA			
	20	BG			
	35	SBG			
Tc = 1.500.000			falla	falla	O.K
		CA	10	12.5	15
		BG	20	20	20
		SBG	35	35	35

Table 6. Design results for CBR 5

	INVIAS Method		AASHTO ME- PDG Method		
Subgrade (CBR%) Traffic	5≤CBR <7		CBR =5, (7157 PSI)		
T1 0.5 < $N_{8.2}$ ≤1	10	CA			
	15	BG			
	20	SBG			
Ta = 500.000			falla	O.K	O.K
		CA	10	12.5	15
		BG	15	15	15
		SBG	20	20	20
Tb = 1.000.000			falla	O.K	O.K
		CA	10	12.5	15
		BG	15	15	15
		SBG	20	20	20
T2 1.0 < $N_{8.2}$ ≤ 2	10	CA			
	20	BG			
	20	SBG			
Tc = 1.500.000			falla	falla	O.K
		CA	10	12.5	15
		BG	20	20	20
		SBG	20	20	20

Table 7. Design results for CBR 6

	INVIAS Method		AASHTO ME- PDG Method		
Subgrade (CBR%) Traffic	5≤CBR <7		CBR =6, (8042 PSI)		
T1 0.5 < $N_{8.2}$ ≤1	10	CA			
	15	BG			
	20	SBG			
Ta = 500.000			falla	O.K	O.K
		CA	10	12.5	15
		BG	15	15	15
		SBG	20	20	20
Tb = 1.000.000			falla	O.K	O.K
		CA	10	12.5	15
		BG	15	15	15
		SBG	20	20	20
T2 1.0 < $N_{8.2}$ ≤ 2	10	CA			
	20	BG			
	20	SBG			
Tc = 1.500.000			falla	falla	O.K
		CA	10	12.5	15
		BG	20	20	20
		SBG	20	20	20

Table 8. Design results for CBR 7

	INVIAS Method		AASHTO ME- PDG Method		
Subgrade (CBR%) Traffic	7≤CBR <10		CBR =7, (8876 PSI)		
T1 0.5 < $N_{8.2}$ ≤1	7.5	CA			
	15	BG			
	20	SBG			
Ta = 500.000			falla	O.K	
		CA	7.5	10	
		BG	15	15	
		SBG	20	20	
Tb = 1.000.000			falla	falla	O.K
		CA	7.5	10	12.5
		BG	15	15	15
		SBG	20	20	20
T2 1.0 < $N_{8.2}$ ≤ 2	7.5	CA			
	20	BG			
	20	SBG			
Tc = 1.500.000			falla	falla	O.K
		CA	7.5	10	15
		BG	20	20	20
		SBG	20	20	20

Table 9. Design results for CBR 8

	INVIAS Method		AASHTO ME- PDG Method		
Subgrade (CBR%) Traffic	7≤CBR <10		CBR =8, (9669 PSI)		
T1 0.5 < $N_{8.2}$ ≤1	7.5	CA			
	15	BG			
	20	SBG			
Ta = 500.000			falla	O.K	
		CA	7.5	10	
		BG	15	15	
		SBG	20	20	
Tb = 1.000.000			falla	falla	O.K
		CA	7.5	10	12.5
		BG	15	15	15
		SBG	20	20	20
T2 1.0 < $N_{8.2}$ ≤ 2	7.5	CA			
	20	BG			
	20	SBG			
Tc = 1.500.000			falla	falla	O.K
		CA	7.5	10	15
		BG	20	20	20
		SBG	20	20	20

Table 10. Design results for CBR 10

	INVIAS Method		AASHTO ME- PDG Method		
Subgrade (CBR%) Traffic	10≤CBR <15		CBR =10, (11153 PSI)		
T1 0.5 < $N_{8.2}$ ≤1	5	CA			
	15	BG			
	20	SBG			
Ta = 500.000			falla	falla	O.K
		CA	5	10	12.5
		BG	15	15	15
		SBG	20	20	20
Tb = 1.000.000			falla	falla	O.K
		CA	5	12.5	15
		BG	15	15	15
		SBG	20	20	20
T2 1.0 < $N_{8.2}$ ≤ 2	7.5	CA			
	15	BG			
	20	SBG			
Tc = 1.500.000			falla	falla	O.K
		CA	7.5	10	15
		BG	15	15	15
		SBG	20	20	20

Table 11. Design results for CBR 12

	INVIAS Method		AASHTO ME- PDG Method		
Subgrade (CBR%) Traffic	10≤CBR <15		CBR =12, (12533 PSI)		
T1 0.5 < $N_{8.2}$ ≤1	5	CA			
	15	BG			
	20	SBG			
Ta = 500.000			falla	falla	O.K
		CA	5	10	12.5
		BG	15	15	15
		SBG	20	20	20
Tb = 1.000.000			falla	falla	O.K
		CA	5	12.5	15
		BG	15	15	15
		SBG	20	20	20
T2 1.0 < $N_{8.2}$ ≤ 2	7.5	CA			
	15	BG			
	20	SBG			
Tc = 1.500.000			falla	falla	O.K
		CA	7.5	10	15
		BG	15	15	15
		SBG	20	20	20

IV. CONCLUSIONS

With the development of this work, it was possible to compare the results obtained when designing the structure of an asphalt pavement, using for this purpose, two different methodologies: the Empirical-Mechanistic Pavement Design Guide ME-PDG 2002 (Mechanistic - Empirical Pavement Design Guide) AASHTO 2002 - Level 3 and the Manual for the design of asphalt pavements with medium and high volumes of traffic of the National Institute of Roads. With the exercise carried out, it was possible to determine that with the same input variables such as climate, traffic, load capacity of the subgrade and characteristics of the materials, the structures obtained by the two methods analyzed differ, both in thickness and performance throughout the design period.

This can be attributed to the following considerations:

In the tread and asphalt base layers, an increase in temperature causes a decrease in stiffness and, therefore, an increase in the deformation of the pavement. This is not evaluated by traditional empirical methods, but by the AASHTO 2002 ME-PDG Design Method.

Traditional empirical methods consider constant temperatures, constant loads and constant resilient modules throughout the year, which does not reflect the behavior of the structure in reality and does not include deterioration models due to weather, materials or due to variations in traffic throughout of the useful life of the structure. On the other hand, the AASHTO ME-PDG 2002 software allows the applicability of deterioration models and obtaining the progression of the performance of the pavement structure over time.

In the design method of the Instituto Nacional de Vías, changes in traffic or weather conditions in the study area generate loss of reliability in the prediction of pavement sizing

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