

Analysis of the Deterioration of the urban road network in the central sector of the Municipality of Ricaurte Cundinamarca

Análisis del Deterioro a la red vial urbana del sector centro en el Municipio de Ricaurte Cundinamarca

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ABSTRACT

The municipality of Ricaurte located in the department of Cundinamarca / Colombia, is characterized for being a pioneer in tourism activities in the upper Magdalena region because its position and geographical conditions favor the development of activities in this sector and also the income of the economic system of the resources of the population another boom of the municipality is the exponential growth of the population by the arrival of housing projects of recognized construction companies such as Amarillo, Bolivar, Cusezar among others; The urban sector of the municipality includes all its urban agglomerations, its infrastructure and urban development as well as the neighborhoods categorized in the EOT for this reason the accesses and paved roads described in the road inventory in the center-urban sector are of vital importance for the municipality. urban sector that are of vital importance for the development of the general activities of the population for this reason they must be analyzed and evaluated over time to determine the deterioration of pathological affectations in the pavements that starts from the surface wearing course implementing technical methodologies to calculate the partial qualification of deterioration according to each type and thus take corrective or preventive actions of the most deteriorated sections in order to preserve the road patrimony of the municipality.

Key words: Pavements, Road assets, roads, Deterioration, Surface course, Urban.



RESUMEN

El municipio de Ricaurte, ubicado en el departamento de Cundinamarca (Colombia), se caracteriza por ser pionero en actividades turísticas en la región del Alto Magdalena, ya que su ubicación y condiciones geográficas favorecen el desarrollo de actividades en este sector y también los ingresos del sistema económico de la población. Otro auge del municipio es el crecimiento exponencial de la población por la llegada de proyectos habitacionales de reconocidas empresas constructoras como Amarilo, Bolívar, Cusezar, entre otros. El sector urbano del municipio incluye todas sus aglomeraciones urbanas, su infraestructura y desarrollo urbano, así como los barrios categorizados en el EOT. Por esta razón, los accesos y las vías pavimentadas descritas en el inventario vial del sector centro-urbano son de vital importancia para el municipio. El sector urbano es de vital importancia para el desarrollo de las actividades generales de la población, por lo que debe ser analizado y evaluado a lo largo del tiempo para determinar el deterioro de las afectaciones patológicas en los pavimentos que se inicia desde la capa de rodadura, implementando metodologías técnicas para calcular la calificación parcial del deterioro según cada tipo y así tomar acciones correctivas o preventivas de los tramos más deteriorados con el fin de preservar el patrimonio vial del municipio.

Palabras clave: Pavimentos, Patrimonio vial, Carreteras, Deterioro, Capa superficial, Urbano.

Introduction

The conservation and condition of the road inventory of the municipality must always remain in good condition to maintain the proper functioning of the road system that includes its trafficability, traffic and accessibility to the different sectors of the identified urban agglomerations, taking into account that the urban area includes most of the general activities of the population of the municipality of Ricaurte.

It is vital and important to recognize and analyze the deterioration of road sections built under flexible, articulated and rigid pavements present in the road inventory of the central sector of the municipality in order to establish a partial qualification of the deterioration and its pathologies and what causes are causing these failures that can be random since it depends on factors of vehicle traffic, materials and construction processes in the structural conformation of the road.

According to (Universidad Privada del Valle, 2021) the deterioration of pavements in an advanced and not very passable state negatively affects the normal development of the general activities of the population, since the municipality is characterized by being a tourist destination, having a poor condition in the road infrastructure will negatively impact the concept and vision of the internal inhabitant and visitor of the municipality, as well as affect all the development sectors of the municipality.

The constant maintenance and rehabilitation of pavements that have failed due to pathological affectations in their wearing course, which is the main one to receive the main loads that generate the deterioration, will strengthen and prolong the useful life of the present pavement, as well as improve the mobility and transit of vehicles and inhabitants that visit and spend the night in the municipality.

Supporting the above according to (Martinez, 2015) it is necessary to make recommendations to the entities responsible for the roads which is the municipal administration and its delegates to create action plans in prevention, maintenance and rehabilitation of the pavements of the sections identified with high ratings and deterioration indexes of deficient or failed affectation.

Materials and methods

This is a qualitative and quantitative research with a descriptive approach, since the analysis of road deterioration began with the recognition of the road infrastructure present in the urban area of the municipality of Ricaurte, obtaining true information of the road inventory under the territorial organization document, which in this case according to its population classification is the EOT, under the following image the road scheme of the center sector was recognized.

Figure 1.

Inventory of urban roads in Ricaurte-Cundinamarca.

Inventory of Urban Roads of the Municipality						
Item	Nomenclature	Neighborhood	Length (Meters)	Width (Meters)	Area (m2)	Observation
1	Diagonal 7a	Ricaurte (Center)	843	12	10116	Collector Streets
2	Race 16	Ricaurte (Center)	1098	12	13176	Collector Streets
3	Race 15	Ricaurte (Center)	997	14	13958	Collector Streets
4	4th Street	Ricaurte (Center)	148	8,68	1284,64	Local Streets
5	Race 14	Ricaurte (Center)	620	8,6	5332	Local Streets
6	Transversal 14 B	Ricaurte (Center)	45	8	360	Local Streets
7	6th Street	Ricaurte (Center)	288	12	3456	Local Streets It is not part of the sector.
8	5th Street	Ricaurte	262	7,73	2025,26	Local

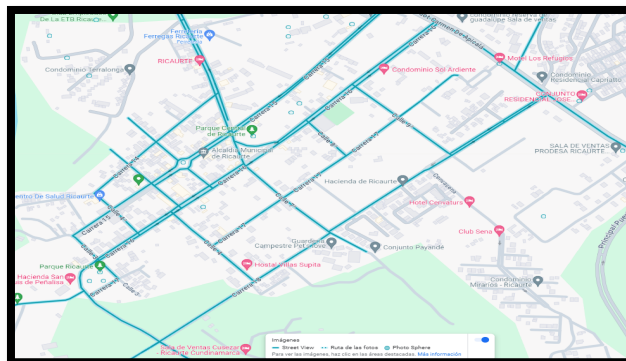
		(Center)				Streets
						Not part of the central zone
9	3rd Street	Ricaurte (Center)	161	7,04	1133,44	Local Streets
10	No nomenclature	Ricaurte (Center)	73	7	511	Local Streets
						Not applicable
11	No nomenclature	Ricaurte (Center)	243	6	1458	Local Streets
						Not applicable.
12	2nd Street	Ricaurte (Center)	1175	6,5	7637,5	Local Streets
13	Race 18	Ricaurte (Center)	485	7,8	3783	Local Streets
14	Race 18	Ricaurte (Center)	630	9	5670	Local Streets
15	9th Street	Ricaurte (Center)	288	7,5	2160	Local Streets
16	8th Street	Ricaurte (Center)	130	8,02	1042,6	Local Streets
17	7th Street	Ricaurte (Center)	386	7	2702	Local Streets
18	4th Street to	Ricaurte (Center)	266	7,54	2005,64	Local Streets
19	Race 17	Ricaurte (Center)	675	8	5400	Streets Local
20	4th St. with 14th St. and 15th St.	Ricaurte (Center)	216	6,96	626,4	Local Streets
Total			8903	171,37	838,374 8	
Total, Linear Meters			8903			
Total, Area Analyze					838,374 8	

Source: (Mayor's Office of Ricaurte, 2000) Modified by author.

Therefore, a road layout was made using Google maps or Google Earth to determine the polygon of the analysis sector, which includes the central sector of the urban area of the municipality of Ricaurte and thus geographically recognize the specific roads to which the analysis of the surface deterioration in the conformation of each type of pavement was generated.

Figure 2.

Geographical recognition of the road sections analyzed.



Source: (google maps)

When specifically recognizing the road sections to be analyzed, the visit and field work were carried out to collect data, under the visual mechanism (qualitative) that according to its form or distinctive affection we can classify the type of deterioration pathologies, as well as (quantitatively) under the survey of measurements in meters² or linear meters we determine their degree of incidence, severity and deterioration according to each type of pathology.

Figure 3.

Deteriorating road section



When collecting data in the field work, according to each type of pavement, its type of pathology or deterioration will be classified in order to implement technical methodologies that allow us to evaluate and determine the qualification of affection and deterioration of the pavements present in the road sections.

For the flexible pavement, the VIZIR methodology was adopted and implemented, its origin is French, created by engineers with a PhD in pavements and its objectives are to qualify and

evaluate the conditions of the flexible pavement in its service design life, the damages and affectations present, which are classified in two severity groups, group (A) determine damage to the structural conformation of the pavement, group (B) is attributed to functional damage in service and serviceability of the pavement and thus calculate its deterioration rating on a scale defined under working tools such as spreadsheets endorsed for use by INVIAS.

Table 1.

Rating Ranges VIZIR Methodology.

Rating Ranges	
Range	Rating
1 Y 2	Good
3 Y 4	Regular
5,6 Y 7	Deficient.

Source: Taken from (INVIAS, n.d.) prepared by author.

For rigid pavement, the PCI methodology was implemented (Varela, 2002) which translates to pavement condition index in concrete and asphalt, this is only used in rigid pavements that according to its conformation and structure by its separation of slabs, slabs are analyzed by concrete slab regardless of the area of it, it can be evaluated under stretches of 50 meters to 100 meters maximum this according to the length of the slab to obtain more reliable results, this methodology allows us to determine the numerical index of deterioration on a scale of 0 - 100.

Table 2.

PCI Methodology Rating Scale.

PCI Rating Range	
Range	Ranking
100-85	Excellent
85-70	Very Good
70-55	Good
55-40	Regular
40-25	Malo
25-10.	Very Bad
10-0	Failed

Source: (Varela, 2002) , prepared by author.

For the articulated pavement, the methodology ICP- articulated pavement condition index was used following the steps of a guide designed by (Carlos Hernando Higera, 2009) thus facilitating the methodology to determine the state of deterioration and its qualification in a numerical range described in the following table.

Table 3.

ICP deterioration rating scale for articulated pavements.

ICP qualification	
Rating	Service Level
5	Very Good
4	Good
3	Regular
2	Malo
1	Very Bad

Source: (Carlos Hernando Higera, 2009) prepared by author.

By tabulating the data collected in the road sections and implementing the technical methodologies by pavement type, the deterioration rating of the surface wearing course of the pavement present was calculated and determined for each identified road section, with the following results.

Results

Table 4.

Total road survey of the analyzed road layout .

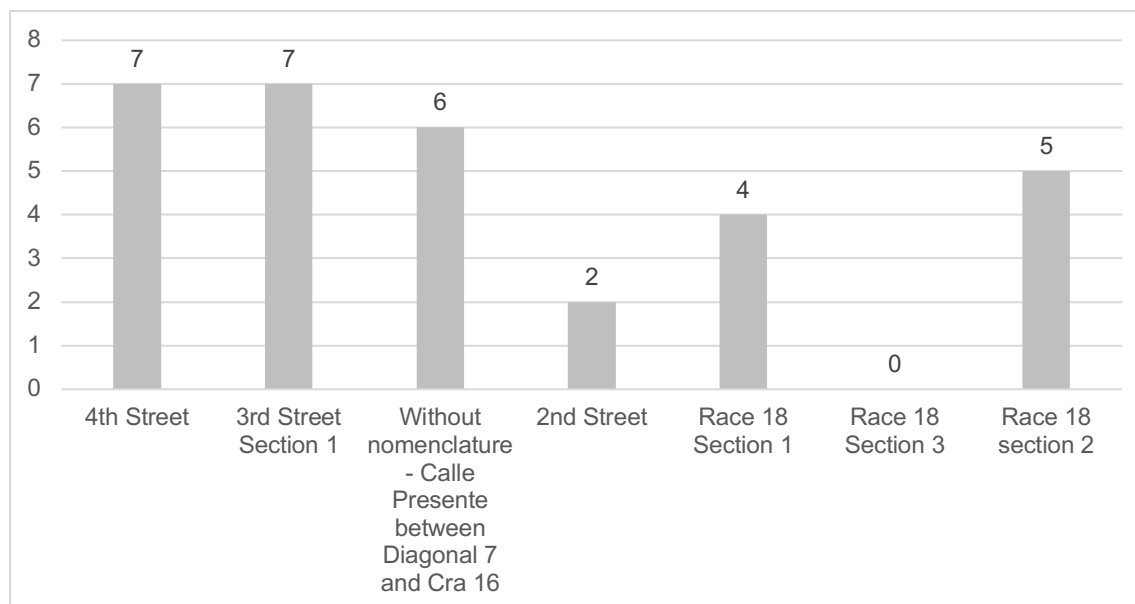
Description	Linear Meters
Flexible Pavement	2216
Articulated Pavement	908
Rigid Pavement	580
Location Error	856
Pavement Excellent condition	2095
Diagonal 8 - Under Construction	843
Unidentified - No pavement	343
Total	7841meters

The following results were obtained for the flexible pavement.

Table 5.

Final qualification of the flexible pavement.

Item	Nomenclature	Neighborhood	length (Meters)	Width	Area (m2)	Rating	Method	State
1	4th Street	Downtown Sector	78	8,68	677.2	7	VIZIR	Deficient
2	3rd Street Section 1	Downtown Sector	80	7,04	563,2	7	VIZIR	Deficient
3	Street without nomenclature	Downtown Sector	73	7	511	6	VIZIR	Deficient
4	2nd Street	Downtown Sector	1175	6,5	7637,5	2	VIZIR	Good
5	Race 18 section 1	Downtown Sector	300	8	2400	4	VIZIR	Regular
6	Race 18 section 2	Downtown Sector	270	9	2430	0	VIZIR	None
7	Race 18 section 3	Downtown Sector	240	8	1920	5	VIZIR	Deficient
Total			2216		16138,7	4		Regular

Figure 5.*Final qualification of the flexible pavement.*

It is evident in the previous bar chart that the most affected roads are 4th Street, 3rd Street in its first section, street without nomenclature and 18th Street, which is in a range of **DEFICIENT**, this qualification indicates that the pavement is in a failed state and needs a total structural reconstruction for new use and operation, On the other hand, for the sections that are in a rating range of 1 - 4, preventive and corrective measures can be taken in order to mitigate the pathological deterioration and prolong the useful life of the pavement until it reaches a state of final failure and is forced to be technically reconstructed.

The following results were obtained for the rigid pavement:

Table 6.*Final grading of rigid pavement.*

Item	Nomenclature	Neighborhood	length (Meters)	Width	Area (m2)	Rating	Method	State
1	4th Street	Downtown Sector	55	8,68	477,4	88,75	PCI	Very Good
2	8th Street	Downtown Sector	130	8,02	1042,6	89,85	PCI	Excellent

3	7th Street Section 1	Downtown Sector	120	7	840	95,16	PCI	Excellent
4	Race 17 Section 2	Downtown Sector	275	8	2200	84	PCI	Good
5	Race 14	Downtown Sector	620	8,6	5332	71,67	PCI	Good
Total			1100		4560	89,44	PCI	Excellent

Figure 6.

Final grading of rigid pavement.

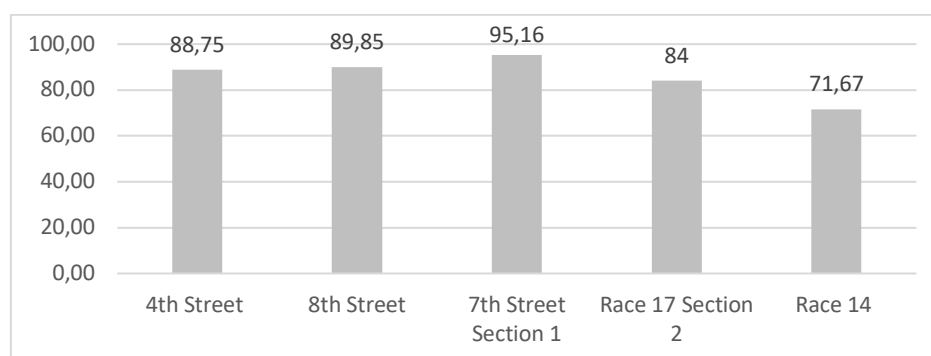


Table 7.

Final grading of the articulated pavement.

Item	Nomenclature	Neighborhood	length (Meters)	Width	Area (m2)	Rating	Method	State
1	3rd Street Section 2	Downtown Sector	80	8	640	5	ICP	Excellent condition.
2	9th Street	Downtown Sector	288	7,5	2160	4	ICP	Good

3	7th Street Section 2	Downtown Sector	140	8	1120	3,5	ICP	Regular
4	17th Street Section 1	Downtown Sector	400	8	3200	3,8	ICP	Good
Total			908		7120	4,1	ICP	Good

Figure 7.

Final grading of the articulated pavement

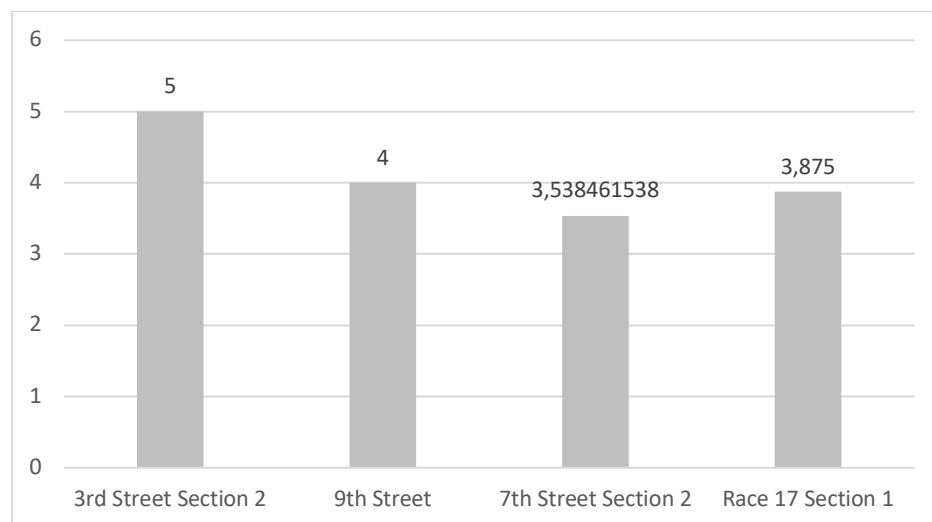


Table 8.

Flexible Pavement Rehabilitation Alternatives

Maintenance or Rehabilitation Alternatives for Flexible Pavements				
VIZIR Rating Range	Rating	Maintenance	Rehabilitation	Prevention Actions
1 y 2	Good	Routine maintenance such as mitigation of cracks and crevices with asphalt emulsions according to the continuous traffic of vehicles on the road section.		Take restrictions mainly on the transit of heavy vehicles, i.e. vehicles with more than two axles on the urban area of the municipality where the state of deterioration of the pavement was analyzed.
3 y 4	Regular	Routine maintenance such as mitigation of cracks and crevices with asphalt emulsions according to the continuous traffic of vehicles on the road section.	In the most affected areas of the section, rehabilitation actions can be chosen by means of technical and specialized construction processes in order not to affect the pavement structure and the regular and normal passage of vehicles on the wearing course.	Take restrictions mainly on the transit of heavy vehicles, i.e. vehicles with more than two axles on the urban area of the municipality where the state of deterioration of the pavement was analyzed.

Table 9.

Maintenance or Rehabilitation Alternatives

Maintenance or rehabilitation alternatives				
Type of Damage	Crack and joint sealing	Slab Replacement	Full plate thickness repair	Milling or planing
Cracks and fissures of all types		X	X	
Corner Cracks	X			
Slabs divided by cracks		X		
Aggregate polishing.				X
Hollowing.		X		

Table 10.

Maintenance or Rehabilitation Alternatives

ICP qualification	Service Level	Action Category
5	Very good	Routine Maintenance
4	Good	Routine and Recurrent Maintenance
3	Regular	Reinforcement and Routine Maintenance
2	Malo	Rehabilitation
1	Very Bad	Reconstruction

Conclusions

With the superficial analysis to determine the deterioration of the pavements present in the urban road network of the central sector of the municipality of Ricaurte and the

implementation of the methodologies we can establish the current state of each road section in the conformation of its superficial structure mainly, but it also initiates a starting point to determine the affectation of the internal structure of the pavement that conforms it in its material layers.

A clear example is 3rd Street on flexible pavement, which is in a poor and failed state, but its traffic is constant since it connects the El Pesebre neighborhood, Carrera 15 and one of the accesses to the settlement or neighborhood with a high rate of housing, which is Villa Carolina.

It can be evidenced that the municipal administration has not implemented any type of preventive or corrective maintenance in the most affected trafficable and commercial sections, analysis, highlights the reconstruction of some sections that are the most important in the urban area of the municipality as they provide accessibility to the downtown sector where most of the economic activities are generated, processable, commercial etc. of the municipality and its population, to this I emphasize the road section of the 7th diagonal, Carrera 15 and Carrera 16 that are in excellent condition.

The municipal administration should carry out a stricter control of the intervention activities by private contracting companies, in order to guarantee and reduce the possible failures and pathologies of pavement deterioration, according to the intervention of Carrera 14 on more than two occasions, which generated its accelerated deterioration.

It is necessary as soon as possible the intervention of the failed sections described in the content of the project, since Ricaurte is characterized for being a tourist attraction of the upper Magdalena region welcoming the seasonal population of the municipalities and surrounding cities such as the capital Bogotá, in order to preserve and improve the road heritage of the inhabitants and the image of the municipality in front of the tourist population, which is one of the main generators of economic activities for the population of the municipality.

Through the professional technical processes implemented and demonstrated in this project according to its approach in the road branch of the professional life of a civil engineer, it is proposed to be a pioneer in the referential use of the same in the conservation of the road heritage of any city, municipality, sector, locality, neighborhood and others throughout our region or throughout our Colombian national territory.

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