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Analysis of Flexible Pavement Distresses

A Case Study of Kandahar- Spin Boldak Highway in Afghanistan

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ABSTRACT:*Pavement maintenance is an essential part of the transportation infrastructure system as it ensures pavements' safety, durability, and functionality. The pavement Condition Index (PCI) is a commonly used approach for assessing road surface conditions. It involves assigning a numerical value to the condition of a pavement based on the extent and severity of distress observed on the surface. This method is widely adopted because it is objective, simple, and cost-effective. The PCI is used to guide maintenance strategies and decisions, effectively managing pavement assets over their service lives. The current study uses the PCI method to apply maintenance strategies to evaluate and analyze asphalt pavement failures in the Kandahar-spin Boldak highway. A 10km long section of the highway was selected for study in this research. The data was collected from a field survey, and the ASTM D6433 standard method was used to calculate PCI. The collected data were analyzed using the statistical software S.P.S.S. and Minitab program. The data analysis revealed that the 10km Kandahar-spin Boldak highway was in poor condition. The most prominent distresses were rutting, longitudinal/transverse, and alligator cracks. This distress was more prevalent than any other type of distress. As a result of this finding, it was concluded that the current maintenance strategies were inappropriate to apply. Therefore, new maintenance strategies must be implemented to improve the pavement condition on this section of the highway. These strategies could include rehabilitation, resurfacing, or reconstruction to ensure the safety and longevity of the pavement.*

Keywords: *Pavement maintenance, Pavement Condition Index (PCI), ASTM D6433 standard method, Case study, Kandahar.*

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I. INTRODUCTION

1.1 Overview

Roads are constructed as essential infrastructures to enable mobility and accessibility for socio-economic activities in society. Highways play a crucial role in supporting the growth of the economy, agriculture, and other sectors. However, the repeated traffic loads on roads lead to their deterioration. Hence, it is necessary to apply maintenance strategies to extend their life cycle. Developed countries typically use the Pavement Condition Index (PCI) standard method to analyze road surfaces before maintenance. The PCI method rates the road surface on a scale of Failed, Very Poor, Poor, Fair, Good, Very Good, and Excellent. Maintenance strategies can be applied if the PCI rating is Excellent, Very Good, Good, or Fair. Otherwise, the road may need rehabilitation, resurfacing, or reconstruction. By applying effective maintenance strategies, the service life of roads can be prolonged, making transportation networks more reliable, efficient, and safer.

Roads are crucial for developing societies and countries, as they provide essential connections between various regions to facilitate the transportation of people and goods. However, the lack of regular maintenance programs, delayed repairs, and weakness in road construction can lead to structural and functional damage. Preserving roads on the same standard as when they were first built becomes challenging, leading to problems such as pavement cracks, holes, and undulations. As a result, roads become less efficient, unsafe, and unreliable, causing inconvenience for road users and posing high economic costs to society. Therefore, it is necessary to implement regular maintenance programs to minimize damage and increase the longevity of roads, reducing the need for expensive repairs and replacements. Effective maintenance programs can help to ensure that roads remain in good condition, facilitating the safe and efficient transportation of people and goods and supporting the continued development of countries and societies [1].

Initially, damage to a road may seem insignificant, but over time it worsens and can manifest as visible structural distress and a decrease in ride quality. Swiftly addressing any distress can be remedied through reasonable measures to restore the road to its original state. However, if these early warning signs are ignored, it will lead to accumulated damage, requiring more expensive repair measures. Understanding the acceleration and accumulation of damage is crucial to comprehending the importance of proactive, affordable maintenance methods [1].

1.2 Objective of the study

- To identify different types of cracks & defects in the Kandahar -spin Boldak old highway.
- To investigate and analyze asphalt pavement defects using the Pavement Condition Index (PCI) method.

1.3 Site Location

The focus of this study is evaluating the condition of the Kandahar-Spin Boldak old highway, which serves as a critical transportation route connecting Kandahar city with Spin Boldak district. As one of the longest and most important arterial roads in Kandahar province, this road spans a length of 100 kilometers with a width of 7 meters. However, the assessment will be conducted on a 10-kilometer segment for this study. The findings of this study will provide insight into the current state of the road and offer recommendations for potential improvements to ensure safe and efficient travel for all road users.

Source: SIGAR analysis

Figure 1: Afghanistan main highway [2]

II. LITERATURE REVIEW

Road pavements are typically classified into three main categories based on their characteristics and materials: flexible, rigid, and unpaved [3]. Flexible pavements are constructed with a flexible asphalt layer that can adapt to changes in temperature and load [4, 5]. They typically have smooth surfaces and are commonly used for low to medium-traffic roads. In contrast, rigid pavements consist of a concrete layer designed to withstand heavier loads and provide greater durability. Rigid pavements are often used for high-traffic volume highways and airports. Lastly, unpaved road surfaces, such as gravel or dirt, are typically used in rural areas and are less expensive to construct but require more frequent maintenance. Understanding the differences between these pavement types is important in determining the most suitable material for a given road application.

2.1 Pavement Deterioration

Pavement deterioration is the gradual process through which pavement experiences damage due to environmental conditions and traffic loading. Unfortunately, water penetration can lead to the destruction of pavement structures in a single season. As roads age and experience use, they deteriorate, so regular maintenance is essential to ensure their safety, efficiency, and durability. Newly paved roads tend to deteriorate in the first ten to fifteen years, the deterioration process is gradual, but this process accelerates without timely maintenance. Recently constructed roads have been observed to experience rapid deterioration, which can be attributed to factors that can contribute to pavement deterioration, including excessive loads and changes in climate, poor drainage, and the use of low-quality pavement materials. Cracks, potholes, rutting, raveling, depressions, and damaged edges are typical road distresses. These problems can impact the safety and quality of the road surface for travel, possibly resulting in early failure and hazardous traffic conditions [6, 7].

2.2 Pavement Distresses

- Asphalt pavement, a widely used road surfacing material, is susceptible to surface distresses that can compromise its performance and longevity. This surface can be broadly classified into four major categories: Surface defects, disintegration, surface deformation, and cracking [1, 8].
- Cracking, the first category, refers to forming fissures or breaks in the asphalt pavement surface; various factors can cause these issues, such as fatigue, thermal stress, and shrinkage. These cracks can be classified into several types, including longitudinal, transverse, block, and alligator cracking [9].
- The second category, surface deformation, encompasses a range of distresses that result in the pavement surface becoming uneven or distorted. Various factors can cause these issues, such as traffic loading, settlement, and frost heave. Common types of surface deformation include rutting, shoving, and corrugation [10].
- The third category, disintegration, refers to separating the asphalt pavement surface into smaller pieces or particles. Various factors can cause these issues, such as weathering, oxidation, and water infiltration. Common types of disintegration include raveling and stripping [11].
- The final category, surface defects, encompasses a range of distresses that result in the appearance of irregularities or blemishes on the pavement surface. Various factors can cause these issues, such as poor construction practices, material deficiencies, and environmental factors. Common types of surface defects include potholes, bleeding, and cracking due to construction practices [12].
- In conclusion, the categorization of asphalt pavement surface distresses into four major categories, namely cracking, surface deformation, disintegration, and surface defects, provides a useful framework for identifying and addressing the underlying causes of these distresses and for implementing effective strategies for maintenance and rehabilitation to prolong the service life of the pavement.

2.3 Classification of Cracks

2.3.1 Alligator of Fatigue Cracks

Repeated traffic loading on the asphalt concrete surface can cause common pavement distress known as alligator or fatigue cracking. This type of cracking is characterized by interconnected cracks resembling the scales on an alligator's skin, hence the name. The cracks are typically shallow and extend perpendicular to the pavement surface.

According to the Federal Highway Administration (F.H.W.A.), fatigue cracking results from cumulative damage caused by repeated traffic loading, which leads to the progressive formation and growth of cracks in the asphalt layer. This cracking is particularly common in high-traffic areas, such as intersections and heavily traveled highways.

The F.H.W.A. recommends several strategies for preventing and mitigating alligator or fatigue cracking, including proper pavement design, material selection, and construction practices. Regular maintenance, including crack sealing and patching, is also critical for extending the service life of asphalt pavements and minimizing the need for costly repairs or reconstruction [13].

2.3.2 Longitudinal and Transverse Cracks

The cracking in the pavement can occur in two types - longitudinal cracks that run parallel to the centerline or traffic direction and transverse cracks that are perpendicular to the centerline. These types of cracking are usually the result of multiple factors, including traffic loading, temperature fluctuations, and moisture infiltration.

Improper joint construction is one of the many factors that can cause longitudinal pavement cracks, excessive traffic loading, and asphalt mixture segregation. Transverse cracks, on the other hand, are often caused by the contraction and expansion of the pavement due to temperature changes.

Proper pavement design, material selection, and construction practices are critical to prevent and mitigate longitudinal and transverse cracking. Regular maintenance, such as crack sealing and patching, can also help extend the service life of asphalt pavements and minimize the need for costly repairs or reconstruction [14].

2.3.3 Block Cracking

Block cracking is a pavement distress characterized by the asphalt concrete surface undergoing shrinkage due to temperature fluctuations and aging. It can develop interconnected cracks that divide the pavement into rectangular blocks. These cracks are typically larger than one foot in both dimensions and are called block cracking.

Block cracking typically occurs in areas of low traffic volume, such as parking lots and residential streets, where the pavement is subjected to fewer load repetitions. However, it can also occur on high-volume highways if the pavement is aged and in poor condition.

Proper pavement design, material selection, and construction practices are essential to prevent and mitigate block cracking. Regular maintenance, including crack sealing and patching, is also crucial for extending the service life of asphalt pavements and minimizing the need for costly repairs or reconstruction [14].

2.3.4 Edge Cracking

Edge cracking is a type of pavement distress edge cracking is a type of cracking that typically occurs parallel to the pavement's edge, which extends longitudinally and transversely. These cracks usually start from the pavement edge and extend between 0.3-0.5 meters away from the edge, branching out towards the shoulders.

Edge cracking is often caused by traffic loading, aging, and lack of support at the pavement edge. It can also be exacerbated by environmental factors such as moisture infiltration and freeze-thaw cycles.

Proper pavement design, material selection, and construction practices are critical to prevent and mitigate edge cracking. Providing adequate support at the pavement edge through shoulder stabilization techniques can also help reduce the risk of edge cracking. Regular maintenance, such as crack sealing and patching, is also crucial for extending the service life of asphalt pavements and minimizing costly repairs or reconstruction [14].

Table 1: Cracks measurement and severity levels

Cracks	Measurement	Severity Levels		
		High (H)	Moderate (M)	Low (L)
Alligator cracks	square meter (m2)	the cracks spalled	The cracks lightly spalled	The cracks were not spalled.
Lon/Tran cracks	linear meter (m)	width more than 75mm	width from 10mm to 75mm	width less than 10mm
Block cracks	square meter (m2)	width more than 6mm	width from 3mm to 6mm	width less than 3mm
Edge cracks	linear meter (m)	Considerable breakup	Moderate cracks with some breakup	shallow surface cracks, no breakup

Source: ((ASTM D6433.2007, 2008) pp (10 – 23))

2.4 Surface deformation:

2.4.1 Rutting

A rut is a type of pavement distress characterized by surface depressions in the wheel paths. Excessive traffic loading is one of the factors that can cause depressions in the pavement, preliminary pavement design or construction, and poor drainage.

Pavement uplift may occur along the sides of a rut when it forms. However, in many cases, ruts are only visible after rainfall when water accumulates in the wheel paths. This is because water pools in the depressed wheel paths, making the ruts more visible.

Ruts can lead to other types of pavement distress, such as cracking and pavement deterioration, if not addressed promptly. Proper pavement design, material selection, and construction practices are critical to prevent and mitigate ruts. Regular maintenance, such as resurfacing and patching, can also help extend the service life of asphalt pavements and minimize the need for costly repairs or reconstruction [10, 14].

2.4.2 Corrugation

Corrugation is a type of pavement distress that appears as a series of closely spaced ridges and valleys, also known as ripples, at regular intervals along the pavement. These ridges are perpendicular to the traffic direction and can reach several millimeters in height.

Corrugation typically results from a combination of factors, including excessive traffic loading, preliminary pavement design or construction, and poor surface drainage. It can lead to uncomfortable ride quality, increased vehicle wear and tear, and reduced skid resistance, compromising safety.

Proper pavement design, material selection, and construction practices are essential to prevent and mitigate corrugation. Maintaining proper surface drainage through longitudinal and transverse slope correction techniques can also help reduce the risk of corrugation. Regular maintenance, such as resurfacing and patching, is also crucial for extending the service life of asphalt pavements and minimizing costly repairs or reconstruction [10].

2.4.3 Crawl or Shoving

Crawl or shoving is a type of pavement distress characterized by the longitudinal movement or offset of the pavement surface in the direction of traffic. This localized movement is typically caused by the shear stresses generated by repeated motor traffic loads. As vehicles drive over the pavement, they produce short, high waves on the surface layer of the pavement., leading to the development of crawling or shoving.

Crawl or shoving can lead to uncomfortable ride quality, increased vehicle wear and tear, and reduced skid resistance, which can compromise safety. It is often caused by a combination of factors, including inadequate pavement design or construction, poor drainage, and excessive traffic loading.

Proper pavement design, material selection, and construction practices are critical to prevent and mitigate crawling or shoving. Providing adequate pavement thickness and support can help reduce the risk of shear stresses and offset. Proper surface drainage through longitudinal and transverse slope correction techniques can also help reduce the risk of the crawl or shoving. Regular maintenance, such as resurfacing and patching, is crucial for extending the service life of asphalt pavements and minimizing costly repairs or reconstruction [10].

2.4.3 Depressions

Depressions in the pavement are a common form of distress characterized by localized surface areas with elevations slightly lower than those of the surrounding pavement. They are often caused by settlement or consolidation of the pavement layers or inadequate pavement thickness or support. Depressions can also be caused by repeated heavy wheel loads or poor drainage, leading to subgrade softening and pavement deformation. Depressions can lead to poor ride quality, increased vehicle wear and tear, and reduced skid resistance, which can compromise safety. Proper pavement design, material selection, and construction practices are essential to prevent and mitigate depressions. Providing adequate pavement thickness and support can help prevent settlement and consolidation while maintaining proper surface drainage can help reduce the risk of subgrade softening and deformation. Regular maintenance, such as patching and resurfacing, is crucial for extending the service life of asphalt pavements and minimizing costly repairs or reconstruction [10].

Table 2: Cracks measurement and severity levels

Cracks	Measurement	Severity Levels		
		High (H)	Moderate (M)	Low (L)
Rutting	square meter (m2)	the average Depth of rutting is more than 25 mm.	The average Depth of rutting is 14-25 mm.	The average Depth for rutting is 6 - 13 mm.
Corrugations	linear meter (m)	severely affect ride quality	significantly affect ride quality.	Not significantly affect ride quality
Shoving	square meter (m2)	Shove causes high-severity ride quality	Shove causes medium-severity ride quality	Shove causes low-severity ride quality
Depressions	linear meter (m)	greater Depth of the decline is more than 50 mm.	The Depth of this level of intensity is between 25 - 50 mm.	Depth of depression between 13 - 25 mm

Source: ((ASTM D6433.2007, 2008) pp (10 – 23))

2.5 Disintegration

Potholes are a common type of pavement distress characterized by localized surface areas with circular or bowl-shaped depressions that vary in Depth and width. The pavement surface is typically the result of multiple contributing factors, including traffic loading, freeze-thaw cycles, and moisture infiltration. Potholes typically have a diameter of about 750 mm and vertical aspects close to the top of the pit.

If potholes are not repaired or filled in a timely manner, they can significantly damage vehicles and compromise safety. The damaged pavement material is usually removed to repair potholes, and the area is cleaned and prepared for patching. Patching material is then applied to the area and compacted to restore the pavement surface to its original level.

It is important to note that potholes can be preceded by other types of pavement distress, such as cracking and alligator cracking, which may indicate a need for more extensive pavement repairs. Therefore, regular pavement inspections and maintenance are critical for identifying and addressing pavement distresses before they develop into more significant problems [15].

Table 3: Pothole's measurement and severity levels

Maximum Depth (mm)	Median Diameter (mm)		
	100 -200	201 - 450	451 - 750
13 -25	Low	Low	Medium
26 – 50	Low	Medium	Higher
More than 50	Medium	Medium	Higher

Source: ((ASTM D6433.2007, 2008) pp (10 – 23))

2.6 Pavement Condition Index (PCI)

The overall condition of a pavement network is evaluated using the Pavement Condition Index (PCI), which involves a comprehensive field inspection of the pavement surface and substructure to identify and quantify pavement defects like cracks, patches, and utility trench cuts. The PCI is calculated using a standardized formula that assigns a numerical value to each pavement distress based on its severity, extent, and location. The values are then weighted based on the importance of each distress in contributing to overall pavement deterioration. The result is a single numeric score that reflects the overall condition of the pavement network, ranging from zero (very poor) to 100 (excellent).

The Pavement Condition Index (PCI) is a commonly used metric by transportation agencies and pavement management systems (P.M.S.) to allocate resources effectively and prioritize maintenance and rehabilitation efforts based on the overall condition of the pavement network. The PCI is determined through a thorough field inspection of the pavement surface and substructure, which involves identifying and quantifying different types of pavement defects like cracks, patches, and utility trench cuts. By regularly monitoring the PCI, agencies can identify trends in pavement conditions and make data-driven decisions to optimize pavement management strategies and budgets [16].

To determine the overall condition of a pavement network, a comprehensive field inspection is conducted to evaluate various pavement defects such as cracks, patches, and utility trench cuts. These defects are classified and measured to calculate a Pavement Condition Index (PCI) for each road segment using a pavement management system (P.M.S.) program. The PCI scale ranges from 0 to 100, where 100 indicates excellent condition, and 0 indicates the poor condition. Transportation agencies commonly use the PCI to prioritize and allocate pavement maintenance and rehabilitation resources. [17].

2.6.1 Pavement Condition Rating

The pavement condition rating is determined by the Pavement Condition Index (PCI) value, which ranges from excellent to fail, as illustrated in Table 4.

Table 4: Pavement condition index ranges (ASTM D6433.2007, 2008)

Pavement Condition Rating	Pavement Condition Index
Excellent	85 – 100
Very Good	70 – 85
Good	55 – 70
Fair	40 – 55
Poor	25 – 40
Very poor	10 – 25
Failed	0 – 10

III. RESEARCH METHODOLOGY

3.1research methodology steps

The methodology was conducted in five distinct steps to achieve the research objectives.

- **Data survey on the site investigation:** To achieve the research objective, before conducting the study, it was imperative to choose a pavement section that represents different potential conditions, including excellent, satisfactory, inadequate, and new. The following steps will be taken to achieve the results of that survey.
- **Step 1:** Identify the branch of the pavement which is 10 km in length. Start from A.N.S.T.O. to Tor-KOTAL on the Kandahar Spin-Boldak old highway.
- **Step 2:** divide that branch into three sections (A, B, C). The length of each section is 3.3 km.
- **Step 3:**we decide on the pavement sections dividing them into smaller sample units. The standard size for asphalt pavement samples from the (ASTM-D6433) sample unit is (255 ± 95). The Kandahar Spin-Boldak old highway width is 7m. So, we took the length sample of 35m. So, the total area of the sample is equal to 245m2; then, the number of samples present in the section will be determined from the following equation.

$$\text{N} = \frac{Lenght\ of\ the\ section}{Length\ of\ the\ sample} = \frac{3300m}{35m} = 95\ samples \quad (1)$$

- **Step 4:** The selection of sample units to be inspected may vary depending on the desired confidence level. It could be all sample units in the section, several sample units that provide a 95% confidence level, or a smaller number.

a. The number of sample units selected for inspection can vary depending on the level of confidence desired. The selection may include all sample units in the section, a few that provide a 95% confidence level, or a smaller number.

b. The formula to calculate the minimum number of sample units (n) needed to survey within a given section to obtain a statistically fair estimate (95% confidence) of the PCI of the section is:[18, 19].

$$\text{n} = NS^2 / \left(\left(\frac{e^2}{4}\right)(N-1) + S^2\right) \qquad (2)$$

Were

e = The acceptable level of error in estimating the section PCI is typically expressed as e = $\pm$ 5 PCI Points;

s = The standard deviation between sample units' PCI within the section is denoted as 's.' During the initial inspection, the standard deviation is considered ten for A.C. pavements and 15 for P.C.C. pavements, and this assumption must be checked after determining PCI values. For further inspections, the standard deviation from the previous inspection is used to determine the minimum number of sample units 'n.' The section's total number of sample units is represented as 'N.'

N= The total number of sample units in the section refers to the number of distinct locations where the pavement condition will be evaluated.

Step 5: After determining the number of sample units to be inspected, the spacing interval for the units is calculated using systematic random sampling. The samples are equally spaced throughout the section, with the first sample chosen randomly. The sampled units' spacing interval (i) is calculated using the following formula and rounded down to the nearest whole number.

i = N / n (3)

Were

N = The total number of units sampled in the section

n = the number of unit samples to be inspected.

3.2 Data Collection and analysis method

The Pavement Condition Indicator (PCI) is a number that represents the overall condition of a pavement surface. It considers structural integrity, surface operational condition, and localized roughness and safety. However, the PCI cannot measure structural capacity or provide a measurement of roughness. (ASTM D6433.207, 2008)

The Federal Aviation Administration (F.A.A.) suggests that road pavement assessments follow ASTM 6433, the Standard Test Method for Road Pavement Condition Index Surveys. The Pavement Condition Index (PCI) is a numeric evaluation of a pavement's surface condition. It provides a useful way to describe distress and equally compare pavements. (ASTM D6433.2007, 2008) shown in Figure 2.

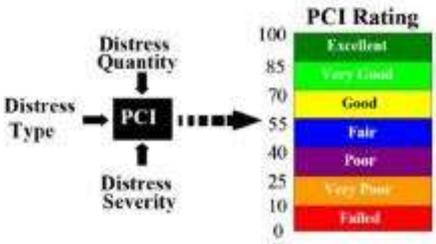

Figure 2: PCI MODEL (ZALTUOM, 2011)

I. CALCULATION OF PCI

1. To determine the deduct value (DV) for each distress type and severity level combination, refer to the distress deducts value curves provided in ASTM standard D 6433. These curves are illustrated in figures included in the standard, as shown in the following figures.

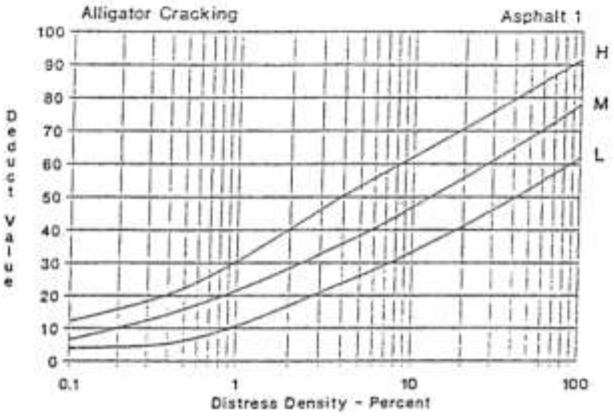

Figure 3: Alligator Cracking (ASTM D6433.2007, 2008)

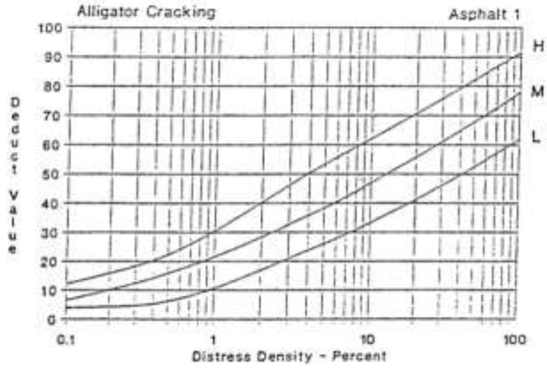

Figure 4: Block Cracking (ASTM D6433.2007, 2008)

ASPHALT- SURFACED ROADS AND PARKING LOTS			SKETCH
CONDITION SURVEY DATASHEET			35 M
FOR SMPLE UNIT			
BRANCH (1)	SECTION(A)	SAMPLE UNIT (1)	7 M 245 SQUM
SERVED BY(HIJRATULLAH & HAYATULLAH)	DATE(2022 / 02 / 10)	SAMPLE AREA(245 SQU M)	

1 -Alligator Cracking	6- Depression	11 - Patching & Util Cut Patchin	16 - Shoving
2-Bleeding	7- Edge Cracking	12 - Polished Aggregate	17 - Slipage Cracking
3-Block Cracking	8- Jt Reflecting Cracking	13 - Potholes	18 - Swell
4-Bumps and Sags	9- Lane / Shoulder Drop / Off	14 - Railroad Crossing	19 - Weathering / Raveling
5- Crugation	10 - Long & Trans Cracking	15 - Rutting	

DISTRESS SEVERITY	QUANTITY											TOTAL	DENSITY %	DEDECT VALUE
10M	1.56											1.56	0.64	0.1
10L	1.2											1.2	0.49	0
13L	1											1	0.41	10
1H	24.57											24.57	10.03	63
15H	98											98	40.00	83
10H	1.15	7	4.5									12.65	5.16	23
13M	2											2	0.82	28
16M	1.54											1.54	0.63	7
												0	0.00	
												0	0.00	
												0	0.00	
												0	0.00	
												0	0.00	
												0	0.00	
												0	0.00	

Table 5 Datasheet for section A, sample one

2. Involves determining the Corrected Deduct Value (CDV) from the total deduct value and q by referring to the relevant correction curve for AC pavements in the ASTM standard.

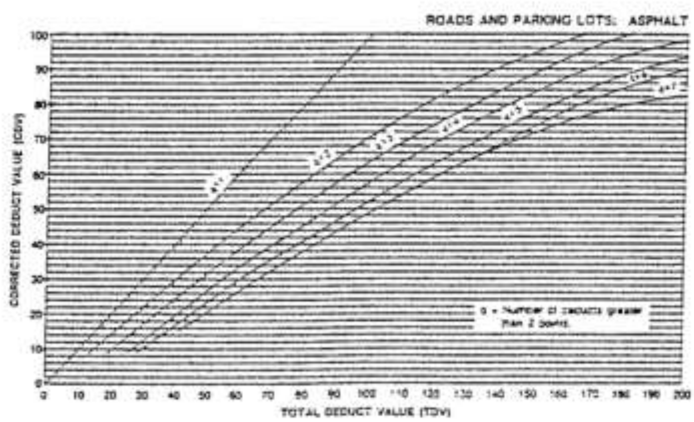

Figure 5 Total Deduct Value (ASTM D6433.2007, 2008)

Table 6: Calculated CDV for section A, sample 1

m=1+(9/98)(100-maxDV)≤10

m=1+(9/98)(100-maxDV)=2.6

0.6 * 28 ≈ 16.8

#	Deductvalue										Total	q	CDV
1	83	63	16.5								162.5	3	94
2	83	63	2								148	2	92
3	83	2	2								87	1	86
4											0	0	
5											0	0	
6											0	0	
7											0	0	
8											0	0	
9											0	0	

PCI=100-Max CDV	= 6
MaxCDV	= 94
Ratting	=Failed

4.2 Total Distresses of Sections A, B, C

The real distress and their severity level in sections A, B&C are listed in the following tables.

Table 7: The total amount of the distresses of the checked samples in section A

Section A Distresses								
Severity	Rutting	Long/Tran	Alligator	Potholes	EdgeCracks	BlockCracks	Shoving	Slip/Cracking
High	1194.2	171.66	130.72	3	0.6	0	0	0
Medium	371	64.54	82.02	3	0	0	1.54	0
Low	60.8	34.7	19.4	15	0	0	0	0

Table 8: The total amount of the distresses of the checked samples in section B

Section B Distresses								
Severity	Rutting	Long/Tran	Alligator	Potholes	EdgeCracks	BlockCracks	Shoving	SlippageCracking
High	280	19	112	0	0	2.85	0	0
Medium	523.4	315.85	521.81	2	0	0	91	0
Low	638.5	39.7	250.21	19	0	0	0	4.25

Table 9: The total amount of the distresses of the checked samples in section C

Section C Distresses

Severity	Rutting	Long/Tran	Alligator	Potholes	EdgeCracks	BlockCracks	Shoving	SlippageCracking
High	103.8	2.7	0	0	0	0	0	0
Medium	1150.7	141.9	94.5	2	0	0	0	0
Low	251.7	280.3	214.3	17	0	0	0	0

4.3 Determination of Section PCI:

After performing a random selection on all of the sample units that are subjected to the survey, the PCI of the section is computed by using equation 4 to determine the area-weighted PCI of the sample units that were chosen at random

$$(\text{PCIr}).PCIs = PCIr = \frac{\sum_{i=1}^{n}(PCIri * Ari)}{\sum_{i=1}^{n} Ari} \qquad (4)$$

1. Average PCI of section A

PCI=(6+8+4+3+12+10+8+13+11+29+22+7+12)/13=11.154 PCI = **11.2**

Rating= very poor

2. Average PCI of section B

PCI=(27+38+42+42+22+32+8+36+0+16+4+12+6)/13=21.92 PCI = **21.92**

Rating= very poor

3. Average PCI of section C

PCI=(26+24+30+14+32+11+12+30+40+28+32+5+34)/13=26.5 PCI = **26.5**

Rating= poor

II. RESULT & DISCUSSION

The result was found that in all three sections, the rutting percentage was more than all other distress; the result for the Kandahar-spin Boldak old highway states that the highway's surface is in failed condition. The maintenance activities should not be applied because of the wastage of resources.

Based on the results obtained from the survey, the average PCI of section A was 11.2, indicating a very poor rating. This means that the pavement section in this area is in critical condition, with numerous defects such as cracks, potholes, and depressions. The low PCI value of section A can be attributed to the heavy traffic load and lack of proper maintenance, leading to the degradation of the pavement surface.

Similarly, the average PCI of section B was 21.92, also indicating a very poor rating. This section of the pavement had a higher number of defects, including alligator cracking, longitudinal cracking, and edge cracking. The low PCI value of section B suggests that the pavement structure has failed, and major rehabilitation work is required to restore its condition.

On the other hand, the average PCI of section C was 26.5, indicating a poor rating. Although this section had a higher PCI value than sections A and B, it still requires significant maintenance and repair work to improve the pavement condition. The primary defects in section C included alligator cracking, potholes, and depressions, indicating a need for proper maintenance and rehabilitation work.

In addition to the average PCI values, it is worth noting that sections A and B have very poor ratings, while section C has a poor rating. This indicates that the pavement condition in all three sections requires immediate attention and maintenance. The poor condition of the pavement in these sections may be attributed to several factors, such as heavy traffic volume, poor drainage, inadequate pavement design, or poor construction practices. Identifying the underlying causes of pavement distress is important to develop an effective and sustainable pavement maintenance plan. Furthermore, the results of this study highlight the importance of regular pavement inspections and monitoring. By identifying and addressing pavement distress in its early stages, costly and extensive repairs can be avoided, and the overall service life of the pavement can be prolonged. Based on these findings, it is recommended that the relevant authorities take immediate action to address the pavement distress in sections A, B, and C. This may involve implementing regular maintenance activities such as crack sealing, patching, and resurfacing, and addressing any underlying drainage or design issues.

In conclusion, the survey results highlight the importance of regular pavement maintenance and rehabilitation to improve pavement conditions and ensure safe and smooth transportation. The PCI values obtained from the survey can be used to prioritize and allocate resources for maintenance and rehabilitation based on the pavement defects' severity.

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