EVALUATION OF FLEXIBLE PAVEMENT DAMAGE USING THE PCI (PAVEMENT CONDITION INDEX) METHOD BASED ON CORE DRILL DATA, CASE STUDY: ON THE MANDARIN ROAD TO THE PRESIDENT NICOLAO LOBATO ROUNDABOUT AND THE BEBONUK ROAD IN DILI CITY, TIMOR-LESTE"

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ABSTRACT

Localization and characterization of road damage are used in an effort to accelerate road repairs. The evaluation results were compared with field data and laboratory data. The results of the analysis show that the average PCI on the right side of the road reaches a value of 68 with a good rating good, on the left side it is worth 62 with a good rating good, and for the Bebonuk road section it is worth 39 with a bad rating poor. The average value of core drill is 86.85% and 99.92%, while the average PCI value is 35.36%. Asphalt content extracted with specifications 0.3, JMF 5.4% and penetration of 5.1%.

Keyword: *Data Core Drill, Flexural Pavement, PCI method, Road Damage*.

1. INTRODUCTION

Pavement is evaluated based on visual observations, recording of road conditions, types of damage identified on the road surface, and condition of road structures[1]. Road turbulence can be divided into two categories, namely functional failure and structural failure[2].

Pavement condition index (PCI) is a method of measuring pavement performance which is used as an indicator of pavement condition which includes the quantity and severity of each type of damage[3]. [4], the PCI method is a comprehensive measure of road conditions that are visually observed in the field according to the road sample being analyzed. The PCI range is 0 to 100, where 0 indicates poor/failed pavement and 100 means very good[5]. Data *Core drill* is the result of testing asphalt concrete samples taken from a flexible pavement structure[6]. Data The core drill in this study include bulk specific gravity of compacted Hot Mix Asphalt (HMA) using saturated surface dry specimens, moisture content and density whose tests were carried out at the[7]. The purpose of this study was to determine the cause of road damage and determine the PCI rating on the Mandarin road to the Nicolao Lobato roundabout and the Bebonuk road section in the capital city of Dili, Timor-Leste.

2. METODOLOGI

Pavement structural damage is a function of the class of damage, its severity, and the amount or density of the damage. The formulation of the index that considers these three factors is problematic because of the many possible conditions. To overcome this difficulty, "inferred values" are introduced, as a basic pattern of weighting factors, to indicate the degree of influence that each combination of damage class, severity and density has on the pavement condition[8].

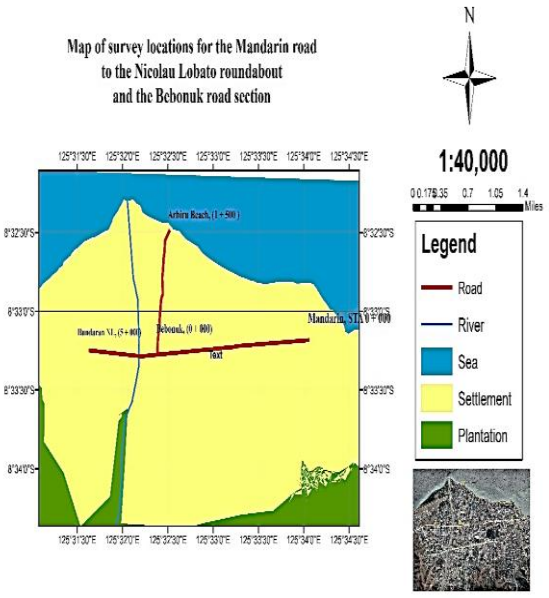
PCI is a numeric index that varies from zero (0), for pavements that are damaged or in poor

condition, to one hundred (100) for pavements that are in perfect condition.
Table 1, shows PCI ranges with appropriate qualitative descriptions of pavement conditions [9].

Table 1. PCI (Pavement Condition Index) Rating Range.

Nu.	PCI Rating Range Table	
	Rating	Classification
1	100 - 85	Excellent
2	85 - 70	Very Good
3	70 - 55	Good
4	55 - 40	Moderate
5	40 - 25	Poor
6	25 - 10	Very Poor
7	10 - 0	Failed

2.1 Description of the Study Area



Note: = Research Location for Mandarin Road – Nicolau Lobato Roundabout and Bebonuk Road.

Figure 1a. Research Site Map

The Mandarin road to the Nicolao Lobato Roundabout and the Bebonuk road section are located in the western part of the capital city of Dili/Timor-Leste. This road section was used as a survey location to evaluate existing roads in the Dili area. The research location and its information can be shown in Figure 1a.

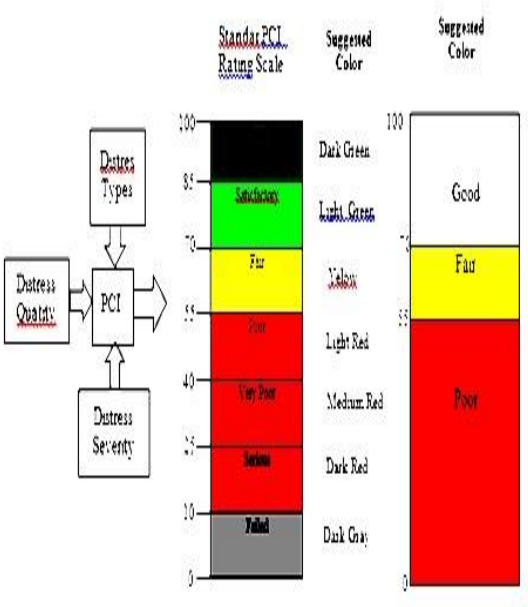


Figure 1b. PCI rating Scale [10].

2.2. Pavement Condition Survey and Assess ment Procedure

According to[10], PCI is a numerical index starting from 0 for damaged pavement and 100 for perfect pavement, with a standard of excellent, very good, good, moderate, poor, very poor, and failed. The PCI calculation is based on the results of a visual assessment that identifies the type, extent of damage and quantity of damage. PCI was developed to provide an indicator of pavement structural integrity and surface use conditions. The hazard information obtained as part of the PCI condition survey provides information on the causes of road damage from vehicle loads and climate. PCI rating scale can be seen in Figure 1b.

2.3. Pavement Condition Evaluation System

According to[11], the pavement condition evaluation system is to anticipate asphalt conditions, one method of surveying asphalt conditions is as shown by Asphalt Condition List (PCI). This type of damage to the adaptable asphalt is mostly shifting. In particular for reasons of ascertaining the pavement condition list, the degree of seriousness of the hazard is introduced.
Types of adaptable asphalt damage (black-top) can generally be named by:

1. Deformation

Deformation is the arrangement of the road surface from a unique profile (after constructio n)[9]. Damage affects road comfort (damage, p uddles that reduce surface discomfort) and can reflect damage to the asphalt structure, significa ntly reducing asphalt condition.

According to [12] here are several types of asphalt damage that can be adapted, more specifically and the level of damage can be seen in Table 2 below.

Table 2. Specifics and Degree of Damage [12]

Nu.	Table of specification and degree of damage Damage Type	Damage Rate	unit
1	Alligator cracking	L,M,H	m^2
2	Bleeding	L,M,H	m^2
3	Block cracking	L,M,H	m^2
4	Corrugation	L,M,H	m^2
5	Depression	L,M,H	m^2
6	JT. Reflection	L,M,H	m^2
7	longs & trans cracking	L,M,H	m^2
8	Pothole	L,M,H	number
9	Lane/Shoulder drop-off	L,M,H	m
10	Polished Aggregate	L,M,H	m^2
11	Patching	L,M,H	m^2
12	Raveling/Weathering	L,M,H	m^2
13	Rutting	L,M,H	m^2
14	Shoving From PCC	L,M,H	m^2
15	Swell	L,M,H	m^2
16	Bump and sags	L,M,H	m^2
17	slippage cracks	L,M,H	m^2
18	edge Cracking	L,M,H	m
19	delamination	L,M,H	m

Note; L = low severity, M = medium severity, H = high severity.

2.4 Terms in the PCI (Pavement Condition Index)

Calculation in the PCI calculation, according to [10], there are terms, namely:

a. Density (Level of Damage)

Density of damage (density) is the percentage of the total area or length of a type of damage to the total area or length of the road section that is measured to be used as a sample, which is expressed by equations 1 and 2.

b. Conduct road condition survey

The corrected reduction value (CDV) is obtained from the curve of the relationship between the total abatement value (TDV*)* and the abatement value (DV*)* by selecting the appropriate curve. The following is a graph of the curve correction relationship between TDV and CDV. The correlation of the curve correction between the total deduct value (Total Deduct Value, TDV) and the corrected deduct value (Corrected Deduct Value, CDV), can be seen in Figure 2.

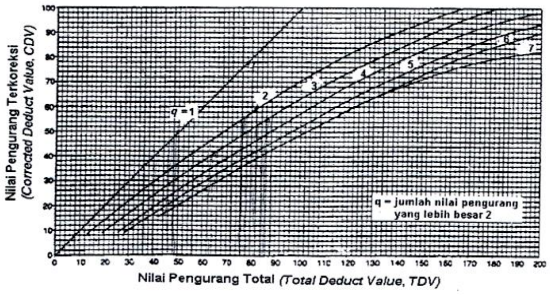


Figure 2. Curve correction relationship between the total deduct value (*Total Deduct Value, TDV*) and corrected deduct value (*Corrected Deduct Value*, CDV) [8]**.**

2.5 Determination of the PCI method

Visual survey conditions are a method for detecting future road conditions, and inspection of surface pressure on the road pavement so that it can provide accurate information to the maintenance department then decision making can decide on the status of the existing road so as to investigate with efficiency and various materials and techniques according to treatment and cost quantity [13].

[10] Calculation of Pavement Condition Index (PCI) of the pavement as a whole on certain roads can be seen in the following equations.

$$Density\ (\%) = \frac{A_d}{A_d} \times 100 \qquad 2.1a$$

Or

$$Density\ (\%) = \frac{L_d}{A_s} \times 100 \qquad 2.1b$$

Where:

Ad = Total area of one type of damage for each level of damage severity (sq .ft or m^2)

As = Total area of sample unit (sq.ft or m^2)

Ld = Total length of one type of damage for each level of damage severity (m).

$$m = 1 + (9/98)(100 - HDVi) \quad 2.2$$

$$PCI = 100 - CVD \quad 2.3$$

Where:
m = number of deductions from the permit, including fraction, for the sample unit under review.
HDVi = the highest individual deduct value for sample i.

$$PCI_f = \sum \frac{PCI_s}{N} \quad 2.4$$

With:
PCIf = Average PCI value of the entire study area
PCIs = PCI value for each sample unit
N = Number of samples.

2.6 Core drill

Base on [14], core drill is a method of sampling asphalt concrete in a flexible pavement structure. Samples were taken in the form of cylinders and then taken to the laboratory to test the thickness of the pavement, the level of density and the characteristics of the flexible pavement mixture. The core drill test is taking the asphalt concrete model by using a drill with a drill bit in the form of diamonds, by testing the asphalt structure, so that the model is in the form of a cylinder. Structure according to road construction, type of pavement, percentage of arrangement, and changes in road structure according to the inspection carried out. Core drill data in this research is from the National Directorate of Research and development, Ministry of Public Work Dili/Timor-Leste.

3. RESULTS AND DISCUSSION

Research on flexible pavement using the PCI method based on core drill data, can spatially visualize these conditions in the study area, as shown in Table 3.

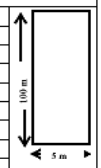
Table 3. form for road pavement conditions at STA 0+300 to 0+400

FIELD OBSERVATION DATA FOR EACH UNIT SAMPLE

Flexible Pavement

Road : Mandarin - Bundarang Nicolao Lobato and Bebonuk	Date : 20/05/2021
	Station : 0+300 s/d 0+400
Surveyed by : Brigida A. F. De Almeida	Unit Sample : 4
JENIS KERUSAKAN	Wide Area : 500.00 m²

1. Alligator cracking	11. Patching
2. Bleeding	12. Polished
3. Block cracking	13. Ravelling/Weathering
4. Corrugation	14. Rutting
5. Depression	15. Shoving From PCC
6. JT. reflection	16. Swell
7. Longs & Trans Cracking	17. Bump and Sag
8. Pothole	18. Slippage Cracks
9. Lane/Shoulder drop-off	19. Edge Cracking
10. Polished Aggregate	20. Delamination



TYPE OF DAMAGE AVAILABLE

		7			19			4			3									
		8	x	0.8	100	x	0.3	20	x	2	9	x	1							
	L										9.0	m²								
Total Severity	M	6.4	m²		30	m²														
	H							40	m²											

PCI CALCULATION

DISTRESS TYPE	SEVERITY	DENSITY %	DEDUCT VALUE	
7	M	1.28	4	PCI = 100 - CDV
19	M	6.0	11	= 100 – 65
4	H	8.0	59	= 35
3	L	1.8	2	Rating = Poor
TOTAL DEDUCT VALUE (TDV)			76	
CORRECTED DEDUCT VALUE (CDV)			65	

Visually, having 40 sample units on the Mandarin – Nicolao Lobato roundabout has samples of 40 and 15 sample units on the Bebonuk road with different types of damage. Value PCI maximum on the pavement conditions of the Mandarin – Nicolao Lobato roundabout and the Bebonuk road section, a maximum of 98 was obtained on the sample unit 2 with a rating perfect value and a minimum of 28 obtained for the sample unit 19, the bad category occurred on the right side of the road, on the left side. The maximum of 96 is found in sample units 1 and 2 with an excellent and a minimum value of 19 with the very poor found in sample unit 12 and the Bebonuk road segment obtained a PCI maximum of 88 with a perfect rating PCI value minimum of 2 with a failed rating in sample unit 8.

From output, the average *PCI* 68 with rating good on the right and 62 with rating good and the Bebonuk road section has an average PCI of 40 with a poor rating. The percentage of pavement condition values in each segment in the *PCI* the right side of the road obtained rating bad of 5 segments with a percentage of area (% area) of 9.19%, Very good at 43.02% with 10 segments, moderate 13.01% with 5 segments, *Good* by 34.77% total 10 segments, and Perfect by 50.47% totaling 10 segments. The average PCI value for flexible pavement for the entire sample unit is calculated using equation 4. Similar to the PCI average see in figure 3 below.

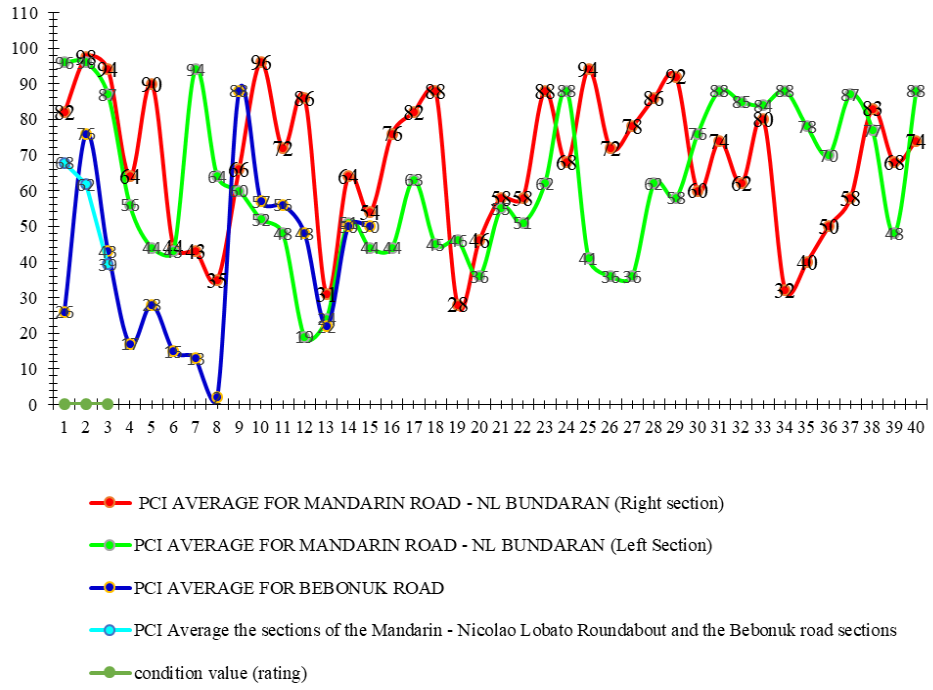


Figure 3. Average PCI and PCI of the Mandarin – Nicolao Lobato roundabout and the Bebonuk road segment

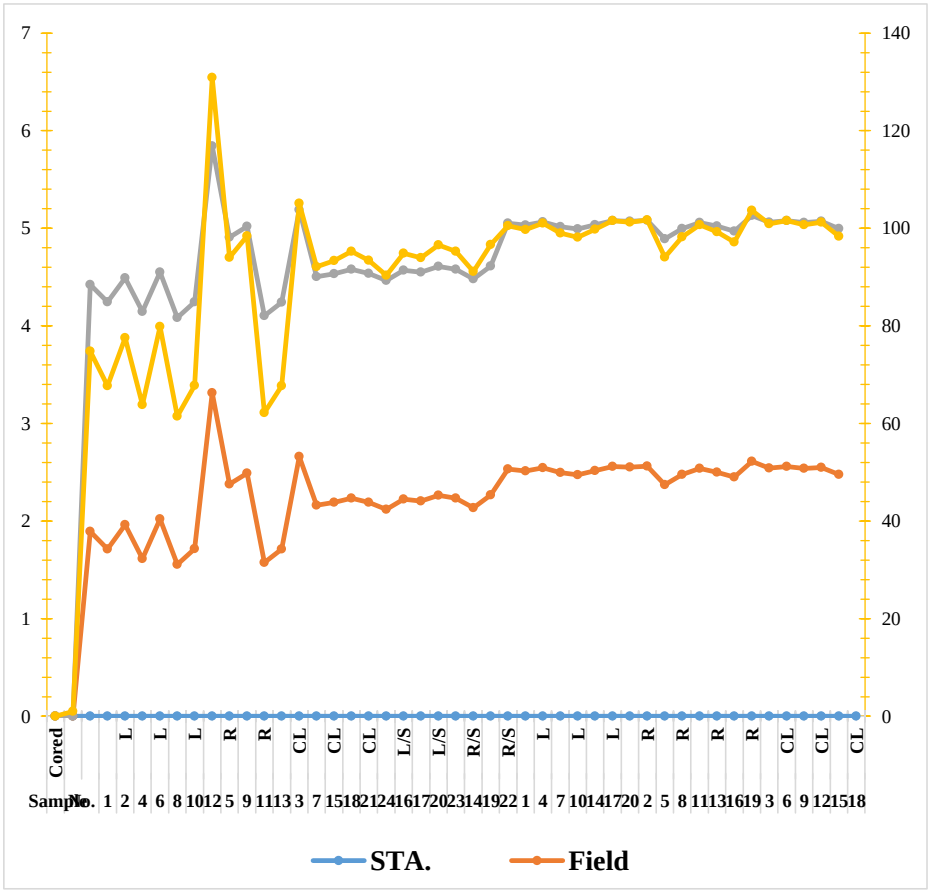


Figure 4. Output Asphalt Core Drill Thickness & Density

3.2. Asphalt Content

Asphalt content was observed 5.1% obtained from testing the extracted asphalt concrete and contained therein a mixture of pavement materials. Output shows that the JMF specification is above the asphalt content value with the JMF specification value of 5.4%. Output Average percentage of aggregate weight as seen in Figure 5 below.

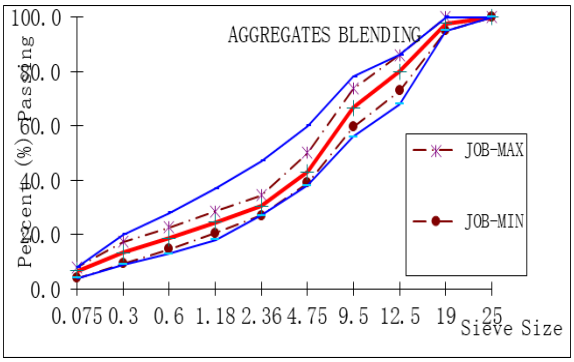


Figure 5. Output graph of pavement layer gradation against *JMF*.

Output Specification JMF is above Average weight percentage of aggregate passing 1", C1/2", 3/4", 3/8", #4, #8, #16, #30, #50, #200 obtained from output the test sieve analysis of asphalt concrete samples.

3.2.1 Density of Asphalt Concrete

Output Pavement layer density of asphalt concrete for the Mandarin – Nicolao Lobato roundabout which obtained the average Bulk from the field was 2.046 gr/cm^3 and the Bebonuk road segment the average Bulk was 2.518 gr/cm^3 based on laboratory testing the average value is below Bulk JMF is 2.849 gr/cm^3. Based on output the laboratory test density of asphalt concrete on the Mandarin – Nicolao Lobato roundabout is 86.85% and the Bebonuk road is 99.92%.

3.2.2 Pavement condition of Mandarin - Nicolao Lobato Roundabout and Bebonuk Road Section.

Inspection this damage visually identifies the type of damage to the existing. The inspections are expressed in PCI. The Mandarin – Nicolao Lobato Roundabout 4 km section was inspected which was divided into 40 sample units, and the 1.5 km Bebonuk road section was inspected which was divided into 15 sample units.

The reference in this study, there are 20 types of road damage, but obtained 11 types of road damage on the right and on the left side of the road there are 13 kinds of road damage and Bebonuk road section there are 10 types of road damage that occur in each damage has a percentage, among others, can be seen in Figure 6 below.

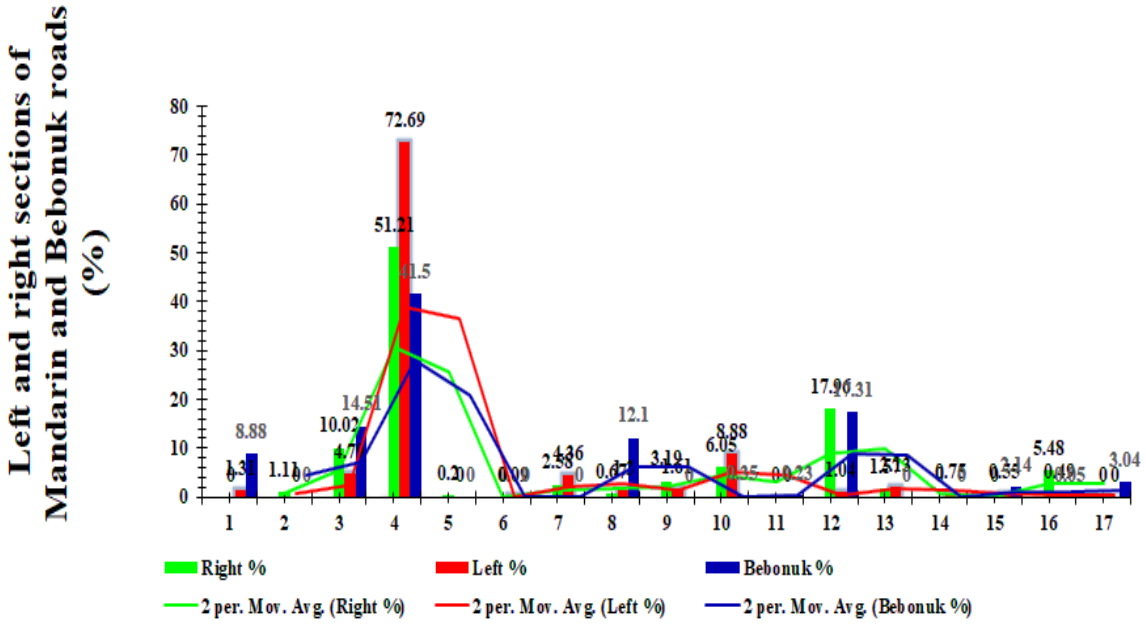


Figure 6. Percentage of types of damage on the Mandarin – Nicolao Lobato roundabout section and the Bebonuk road section.

Output obtained an average PCI of 68 with rating Good on the right on the left of 62 with rating Good and the Bebonuk road section with an average PCI of 40 with a Rating (*Poor*). . The percentage of pavement condition values in each segment in the *PCI* the right side of the road obtained rating Poor for 5 segments with a percentage of area (% area) of 9.19%, very good of 43.02% with a total of 10 segments, fair of 13.01% total 5 segments, Good at 34.77% totaling 10 segments, and excellent at 50.47% totaling 10 segments.

The PCI on the pavement conditions of the Mandarin – Nicolau Lobato roundabout and the Bebonuk road section obtained a maximum value of 98 on the sample unit 2 with a perfect rating condition value and a minimum condition value of 28 obtained on the sample unit 19 poor categories occur on the right side of the road, at the left side of the road is obtained a maximum value of 96 is found in sample units 1 and 2 with a perfect rating and the minimum value is 19 with a very bad category found in sample unit 12 and the Bebonuk road section obtained a maximum PCI value of 88 with a perfect rating found in the sample unit is 9 and the minimum PCI value is 2 with a failed rating in the sample unit 8.

The factors that cause damage to the Mandarin – Nicolau Lobato roundabout and Bebonuk roads are caused by the use of high asphalt content in the asphalt mixture, the air content in the asphalt mixture is too high. low and the use of too much asphalt in prime coat work or tack coats. The stability of the asphalt mixture is low, the lack of stability of the mixture can be caused by too high asphalt content, and too much fine aggregate, so that the aggregate is round and slippery or the asphalt cement is too soft. Lack of compaction of base fill material or asphalt material, and poor way of installing material from below. Weakening of the binder or rock, the compaction is not good, because it is carried out in the rainy season and the material mixed in the asphalt surface layer is not good. Easily absorbed penetration asphalt, high fine aggregate content of low penetrating asphalt in the volume of the asphalt mixture that undergoes changes.

4. CONCLUSION

From the results of the analysis and discussion of this study, the researchers can conclude as follows:

1. The results of the Pavement Condition Index (PCI) survey of the Mandarin – Nicolao Lobato roundabout and Bebonuk roads, Dili district, Dom Aleixo sub-district, after the analysis was carried out, rating good, with an average PCI value of 68, on the Mandarin–Nicolao Lobato roundabout on the right and left sections with an average PCI of 62 with a good rating while on the Bebonuk road the PCI value is average The average is 39 with a rating Poor. The maximum PCI value on the Mandarin – Nicolao Lobato roundabout, on the right side of the road is 98 with rating Excellent in the sample unit 2 or station 0 + 000 to 0 + 200, the minimum PCI value is 28 with rating poor on the sample unit 19 and on the left side the minimum value is 19 with a very poor rating very poor on the sample unit 12 and the Bebonuk road section a minimum value of 2 with rating failed on the sample unit 8, or Station 0+700 S/D 0+800.
2. Based on visual observations made on the Mandarin – Nicolao Lobato roundabout road section and the Bebonuk road section, Dili district, Dom Aleixo sub-district, there were 17 types of damage, including Crocodile Skin Cracks, Overweight, Cracked Blocks, Curly/Wavy, Subsidence, JT Connection Reflection, Long and Trans Cracking, Holes, Edge Cracks, Utility Patches, Grain Release, Grooves, Crescent Cracks, Bumps and drops, expands. The biggest type of damage is curly/wavy covering an area of 2217.01 m^2 or 125.41 %, on the left and right sections of the Mandarin – Nicolao Lobato roundabout. And the Bebonuk road section has the largest type of damage, namely Curly with an area of 645.65 with a percentage of 41.40%.
3. Asphalt content is below JMF requirements, so it will affect the Mandarin – Nicolao Lobato roundabout and Bebonuk roads. This causes the asphalt to harden quickly, and the pavement to crack quickly is caused by the asphalt layer on the aggregate being thin.

4. The results of the study conducted showed that the damage to the Mandarin - Nicolao Lobato roundabout road with an average PCI value of 68, a maximum PCI value of 98 resulted in *rating* Perfect, while the minimum PCI value of 28 resulted in rating failed, so the next recommendation is the need for a study of damage below the pavement surface.

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