GROSTLOG 2022
Global Research on Sustainable Transport & Logistics

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/altr

ANALYSIS OF RUNWAY CONDITIONS OF STA 0+000 - 1+200 YOGYAKARTA INTERNATIONAL AIRPORT USING PCI (PAVEMENT CONDITION INDEX) METHOD

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Abstract: Runway is the main facility in an airport that is used by planes as both takeoff and landing path. As the runway ages, it slowly hardens because of the operational traffic flight, leading to any levels of damage. Pavement Condition Index (PCI) method canbe used to measure the hardening condition in an airport runway. In this method, there are 3 (three) main parameters, identify type of pavement damage, determine adisstress serevity, and the number of damage or damage density (distress density). In this case study located at Yogyakarta International Airport, evaluations using Pavement Condition Index (PCI) method have been done to the runway with 3,250 m x 45 m dimensions at STA 0+000 – 1+200. These evaluations are according to ASTM (American Society for Testing and Materials) D5340 document with 10% area sample. From this set of evaluations, the average of Pavement Condition Index(PCI) number in section 1 to section 12 of Runway Yogyakarta Internasional Airportis 93.23 and is considered as GOOD.

Keywords : *Airport, PCI, ASTM D5340-98, Flexible Pavement, Pavement Damage, Runway*

INTRODUCTION

In an airport, the Runway in the form of flexible pavement construction is included in the main facility which is the most important construction component at an airport whose function is as a place for aircraft to take off and landing. A good runway pavement construction is one that is free from moderate damage and heavy damage, which is expected to facilitate aircraft operational activities in this area and still prioritize the security and safety of civil aviation operations.(Kania, Ulfa, and Arubusman 2021)

Literature Review

Types of Flexible Pavement Damage

According to KP 94 (2015), types of flexible pavement damage that generally occur on the Runway, include :

a. Cracking, consists of : longitudinal, trasnversal, slippage, reflective cracking, block cracking, and alligator crack (fatigue crack).
b. Distortion, consists of : surface lowering on wheel track (rutting), swilling, corrugation and shoving, and local depression.

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Advances in Transportation and Logistics Research
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c. Disintegration, consists of : raveling, potholes, stripping, Jetblast induced erosion, and damage of patching corner.
d. *Loss of Skid Resistance*, it means Loss of pavement construction surface tightness due to polished aggregates, contamination of oil and rubber deposits, and the release of asphalt material to the surface (bleeding).

Causes of Pavement Damage

The causes of damage that generally occur on the Runway of an Airport, include lateral shrinkage on the surface layer due to temperature differences, flight traffic loads that exceed construction capacity, poor drainage systems, less dense or less thick surface layers, unstable base soil or layers below the surface, poor material quality and natural factors.

Therefore, the inspection of the feasibility of the Runway pavement must always be carried out at the scheduled time at an airport, so that the feasibility of the Runway can reachs the safety and security aspects for flight operations at the airport. The inspection of the feasibility of the Runway at the Airport is carried out by the personnel of the Airport Technical and Facilities team using an inspection vehicle in the form of a car.

All results of the Runway feasibility inspection must be properly recorded in the inspection form and must be reported to the General Manager/Airport Leader (AM YIA, 2020).

Pavement Damage Handling

In treating pavement damage on a runway, priority might be given to damage with large dimensions or large area damage, moderate or heavy damage, and a location the damage spot is inside the aircraft's movement area (not on the shoulder of the runway).

METHOD

The Pavement Condition Index (PCI) method is an estimation of road pavement conditions with a rating system to describe pavement conditions in the field, particularly on the surfacean, especially on the surface with a calculation reference according to the American Society for Testing and

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Materials D5340-98 (ASTM, 1998). With this method, accurate data and forecasts of conditions can be obtained based on the conditions in the pavement road or Runway at the time of survey or monitoring. Pavement Condition Index (PCI) percentage levels are written in 0 (Failed) – 100 (Excellent).

The Pavement Condition Index (PCI) method was chosen as the pavement damage index because, it may also be used to determine priority maintenance on pavement damage with effective and efficient way.

For the determination of sample units that must be surveyed in a section of pavement at the airport, the equation formula contained in the ASTM document D5340-98 can be used :

$$n = \frac{Ns^2}{\frac{e^2}{4}(N-1) + s^2}$$

Where,

N = the total number of sample units in a section of pavement,
e = Allowed errors in estimation from the PCI section (e = 5)
s = PCI standard deviation between sample units within a section (for AC, s = 10)

Following the selection of the sample unit, the following steps are taken in order to analyse the survey data:

a. Identify the type of pavement damage, the distress severity of the damage, and the number or density of damage .
b. Calculating the *Distress Density*, which means Percentage the size of particular of damage to a sample unit's area.
c. Determine a Deduct value using the curves that have been provided in the ASTM document.
d. Calculating the Allowable Number of Deduct (m), which means the maximum of deduct value in every types of damage that allowed for calculation in the assessment of pavement conditions.
e. Calculating a Total Deduct Value (TDV) and determine the Corrected Deduct Value (CDV).
f. Using the ASTM D5340-98 Equation, determine pavement conditionvalue and calculate the PCI value.

The PCI value obtained from the calculation is then classified into a

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PCI value diagram so that the category of pavement conditions in the sample that has been surveyed and calculated can be determined

Figure 1. PCI Value Chart and Pavement Condition Categories

Source : ASTM D5340-98

DISCUSSION AND RESULT

Identification Types, dimensions, and serevity level of damages

Table 1. Types, dimensions, and serevity level of damages

STA	CODE	TYPES OF DAMAGE	LENGTH (*m*)	WIDTH (*m*)	AREA/ *Ad* (m^2)
0+700 – 0+710	$10L_1$	*Patching*	*0,30*	0,30	0,09
	$10L_2$	*Patching*	*0,30*	0,30	0,09
	$10M_1$	*Patching*	0,30	0,30	0,09
	$10M_2$	*Patching*	0,40	0,40	0,16
	$10M_3$	*Patching*	0,40	0,40	0,16
	$10L_3$	*Patching*	0,80	0,80	0,64
	$12M_1$	*Raveling*	1,1	-	1,1

Remarks :

Source : Survey results

10 L : *patching damage with low serevity level*

10M : *patching damage with medium serevity level*

12M : *Raveling damage with medium serevity level*

Calculating the Distress Density

Based on the identification of the type of damage and serevity level of pavement damage from survey in the field, then a calculation of the

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percentage of damage or distress density can be carried out using the following formula,

$$\frac{Ad}{As} \text{x} 100\%$$

or

$$\frac{Ld}{As} \text{x} 100\%$$

Where :

Ad = The total area of the damage type for each severity level

Ld = The total length of the damage type for each severity level

As = The total area of the Unit's sample

The total area of the Unit's sample (*As*) obtained from length of STA 0+700 – 0+710 multiplied by width of Runway it is 45 meters.

For an example of calculating the precentage of pavement damage, damages on section 8 is used for patching damage types with Low serevity levels,

$$\frac{(10L1 + 10L2 + 10L3)meters}{10\ meters \text{ x } 45\ meters} \text{x} 100\%$$

$$\frac{(0,09 + 0,09 + 0,64)meters}{10\ meters \text{ x } 45\ meters} \text{x} 100\%$$

$$\frac{0,82}{450} \text{x} 100\% = 0,18\%$$

For an example of calculating the precentage of pavement damage, damages on section 8 is used for patching damage types with Medium serevity levels,

$$\frac{(10M1 + 10M2 + 10M3)meters}{10\ meters \text{ x } 45\ meters} \text{x} 100\%$$

$$\frac{(0,09 + 0,16 + 0,16)meters}{10\ meters \text{ x } 45\ meters} \text{x} 100\%$$

$$\frac{0,41}{450} \text{x} 100\% = 0,09\%$$

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For an example of calculating the precentage of pavement damage, damages on section 8 is used for Ravelling damage types with Medium serevity levels,

$$\frac{(12M1)meter}{10\ meter\ x\ 45\ meter} x100\%$$

$$\frac{(1,1)meter}{10\ meter\ x\ 45\ meter} x100\%$$

$$\frac{1,1}{450} x100\% = 0,24\%$$

Determine a Number of Deduct (Deduct Value)

The graph in the figure below can be used to determine the deduct value.

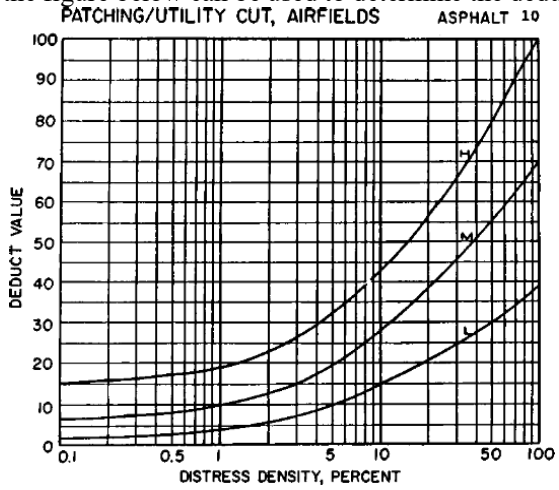

Figure 2. Charts to determine Deduct Value of Patching damage

Source : ASTM D5340-98

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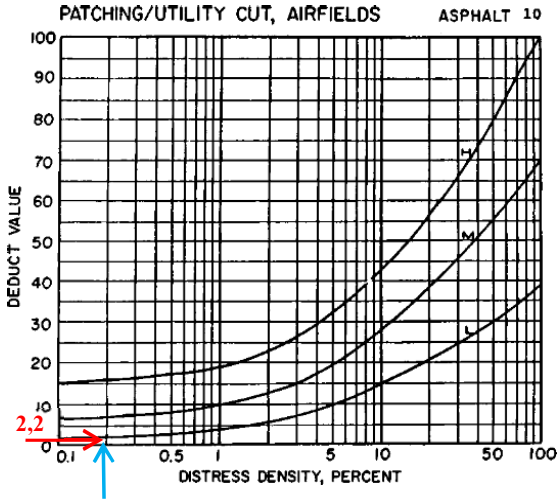

Figure 3. Deduct Value of Patching damage Low Serevity Levels

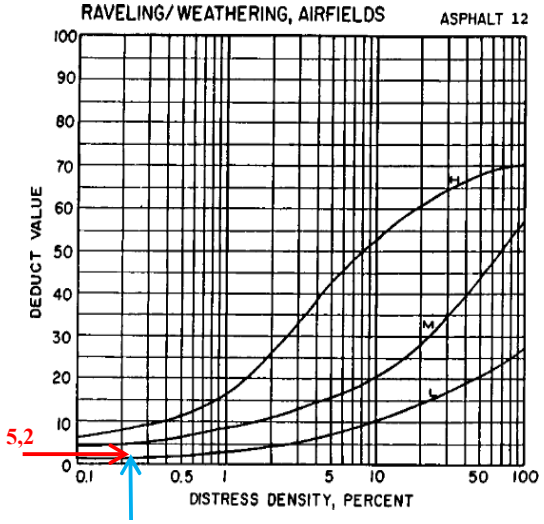

Figure 4. Charts to determine Deduct Value of Ravelling damage

Source : ASTM D5340-98

Calculating the Allowable Number of Deduct (*m*)

By sorting the DV values from smallest to largest and then using the formula to calculate the value of Allowable Number of Deduct (*m*),

STA	CODE	Total of Damages Area (m^2)	*Density* (%)	*Deduct Value*
0+700	10L	0,82	*0,18*	2,2
–	10M	0,41	*0,09*	7
0+710	12M	1,1	0,24	5,2

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$$m = 1 + (\frac{9}{95}) \times (100 - HDV)$$

$$m = 1 + (\frac{9}{95}) \times (100 - 7)$$

$$m = 1 + (\frac{9}{95}) \times (93)$$

$$m = 9{,}8$$

Determine the *q* Values and Calculating the Total Deduct Value (TDV)

The Total Deduct Value (TDV) Is calculated by adding the Deduct Value (DV) on each q (the number of deduct values (DV) greater than 5). For example, on the q values = 2, the Total Deduct Value is (7 + 5,2 + 2,2). While on the q values = 1 (on DV = 5,2 changed to 5). The Total Deduct Value (TDV) and the DV on each q values were calculated, and the findingsare as follows:

Table 2. Total Deduct Value for q = 2

STA	CODE	Total Damages Area (m^2)	*Density* (%)	*Deduct Value*	*m*	*TDV*	*q*
0+700 – 0+710	10L	0,82	*0,18*	2,2	9,8	14,4	2
	10M	0,41	*0,09*	7			
	12M	1,1	0,24	5,2			
TDV (Total deduct value)				14,4			

Table 3. Total Deduct Value for q = 2

STA	CODE	Total Damages Area (m^2)	*Density* (%)	*Deduct Value*	*m*	*TDV*	*q*
0+700 – 0+710	10L	0,82	*0,18*	2,2	9,8	14,2	1
	10M	0,41	*0,09*	7			
	12M	1,1	0,24	5			
TDV (Total deduct value)				14,2			

Determine the Corrected Deduct Value (CDV)

Corrected Deduct Value (CDV) is the corrected subtraction value, which is calculated by adding the Deduct Values (DV) for each Q value. After that, it is decided by choosing the proper curve from the Total Deduct Value (TDV) and Corrected Deduct Value (CDV) connection graphs contained in the American Society for Testing and Materials document D5340-98.

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Advances in Transportation and Logistics Research
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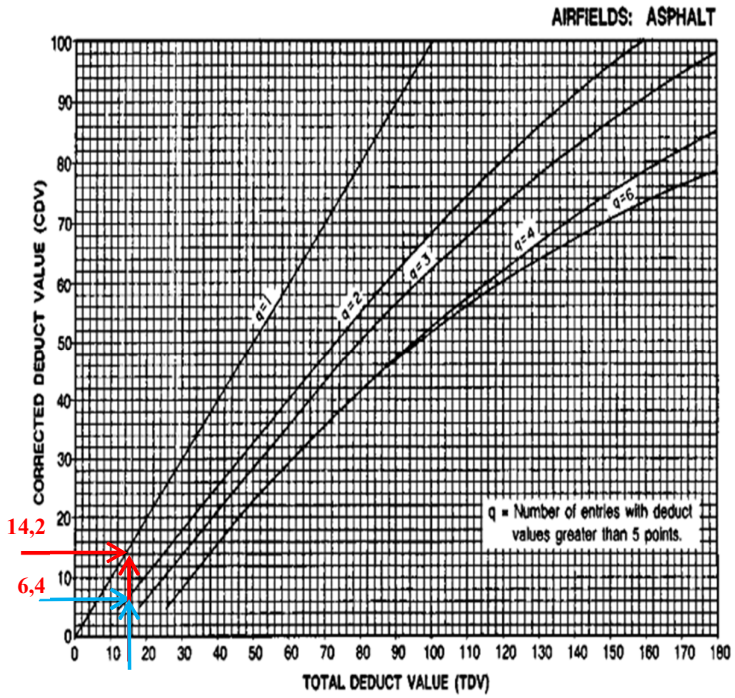
Figure 5. Charts for determining the Corrected Deduct Value



Source : ASTM D5340-98

PCI Values Calculation

to calculate the Pavement Condition Index (PCI) value, the following equation can be used :

$$PCI_s = 100 - CDV$$

According to results of *Corrected Deduct Value (CDV)* calculation in section 8, then the Pavement Condition Index (PCI) value is determined as follows :

$$PCI_s = 100 - 14{,}2$$

$$\boldsymbol{PCI_s = 85{,}8}$$

According to Figure 1, the Pavement Condition Index (PCI) value is 85,8 and is considered as *"GOOD"* .

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Table 4. PCI Value in Every Section

SECTION	STA	*CDV maks*	PCI VALUE	REMARKS
1	0+000 - 0+010	21	79	*SATISFACTORY*
2	0+100 - 0+110	0	100	*GOOD*
3	0+200 - 0+210	0	100	*GOOD*
4	0+300 - 0+310	0	100	*GOOD*
5	0+400 - 0+410	32	68	*FAIR*
6	0+500 - 0+510	0	100	*GOOD*
7	0+600 - 0+610	0	100	*GOOD*
8	0+700 - 0+710	14,2	85,8	*GOOD*
9	0+800 - 0+810	0	100	*GOOD*
10	0+900 - 0+910	0	100	*GOOD*
11	1+000 - 1+010	14	86	*GOOD*
12	1+100 - 1+110	12	88	*GOOD*
AVERAGE PCI VALUE			**92,23**	*GOOD*

Source : survey results

The results of the Yogyakarta Internasional Airports's Runway survey with Pavement Condition Index (PCI) method in section 1 to section 12 obtained an average score of 93.23 and is considered as "GOOD".

CONCLUSION

The average score of Pavement Condition Index (PCI) in all sections from section 1 to section 12 on Yogyakarta Internasional Airports's Runway has an average score of 92.23 and is classified as "Good" condition/category, Therefore In order to prevent the damage in the existing conditions in sections 1 to section 12 on the Runway of Yogyakarta International Airport from getting worse, and to maintain the safety and security standards of civil aviation operations at Yogyakarta International Airport, then the pavement damage must still be handled through maintenance or repair of the damage.

The recommended way to handle this damage is to make repairs with local cutting methods and re-patching on the pavement where damage occurs such as patching damage, raveling, Longitudinal and Transverse Crack, Alligator Crack, and surface lowering on wheel track (Rutting).

In order to make solid/compact re-patching repair results, then it is done with the addition of patch dimensions from the existing damages, provided that the addition of dimensions for re-patching by 0.1 meters for Low damage serevity level, addition by 0,2 meters for Medium damage

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
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serevity level, and addition by 0,3 meters for High damage serevity level. While the depth for re-patching repair for all types and serevity levels of damage is 0.07 metres, (7 *centimeters*).

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