Taxiway Pavement Evaluation to Support the Operational of Terminal 2 Juanda Airport

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***Abstract*— The movement of aircraft and passengers at Juanda international airport is increasing every year. In 2012, the air side infrastructure of Juanda airport almost reached the maximum capacity. In other side, PT. Angkasa Pura I as the operator of Juanda airport had planned to revitalize the Juanda airport terminal that located on the south side. This terminal was not operated for 8 years. The pavement of taxiway should be evaluated its strength. The evaluation method compared The Pavement Classification Number (PCN) of taxiway pavement with Aircraft Classification Number (ACN). If PCN value was higher than ACN value, so the taxiway pavement could serve aircraft movements. The pavement of taxiway on Juanda airport evaluated by using software COMFAA. Data input into the software COMFAA was the existing pavement structure and the movement of the aircraft that will to use south side of Juanda Airport Terminal. The scenario 1 result is the exiting pavement should be overlaid 7 inches to support The operational of Terminal 2 Juanda Airport. In other side, scenario 2 result showed that the existing taxiway pavement structure was able to hold the load of aircraft movements over 20 years. The PCN value is 80.2 dan the ACN values are 89.3 in the scenario 1 and 75 in the scenario 2.**

Keywords—pavement, airport, taxiway

I. INTRODUCTION

Juanda airport is one of the international airports in Indonesia. The movement of passengers and aircraft was increased every year. The increase in passenger and aircraft movements have an impact on the need of additional infrastructure at Juanda Airport. So the Juanda airport operator, PT. Angkasa Pura I has planned to revitalize the previous terminal which is located at the south side of the airport runway Juanda. The purpose was to increase the Juanda airport capacity.

The existing airport facilities that located at south side runway are terminal building, apron and taxiway. In order to revitalize south side of the runway, the existing terminal building will be replaced with new terminal building. The existing apron and taxiway will be evaluated because the terminal was not operating for approximately 8 years. This paper will discuss the evaluation the existing air side pavement at south side runway Juanda Airport, in order to support the Operational of Terminal 2 Juanda Airport.

II. LITERATURE STUDY

Pavement Classification Number

Pavement classification number (PCN) is the code that showed strength and properties of aerodrome pavement. Pavement classification number (PCN) usually consists of 5 parts. The first part shows strength of the pavement. The second part shows the type of pavement, flexible or rigid pavement. The third part of PCN shows the strength of subgrade. The strength of subgrade consists of 4 grade, A for high strength subgrade (All CBR above 13%), B for medium strength subgrade (CBR between 8% to 13%), C for low strength subgrade (CBR between 4% to 8%), D for ultralow strength subgrade (CBR below 4%). The fourth part is either a letter, or a number with units expressing the maximum tire pressure that the pavement can support. W is the highest, indicating that the pavement can support tires of any pressure. Other letter classifications are X for maximum tire pressure 1.75 MPa, Y for maximum tire pressure 1.25 MPa, and Z for maximum tire pressure 0.5 MPa. The final part of PCN is just describes how the first value was worked out, a T indicates technical evaluation, or a U indicates usage (a physical testing regime).

Aircraft Classification Number

The aircraft classification number (ACN) is a number expressing the relative effect of an aircraft on the runway pavement for a specified standard subgrade category by ICAO. Subgrade category consists of 4 grade, A for high strength subgrade (All CBR above 13%), B for medium strength subgrade (CBR between 8% to 13%), C for low strength subgrade (CBR between 4% to 8%), D for ultralow strength subgrade (CBR below 4%).

III. METHOD

The evaluation of taxiway pavement at Juanda Airport use Pavement Classification Number (PCN) and Aircraft Classification Number (ACN) Method that is developed by Federal Aviation Association (FAA). All of the data that is used in the study, is secondary data. That is existing pavement layer thickness, soil support, annual aircraft departure, and the destination of international flight at Juanda Airport. Pavement Classification Number (PCN) and Aircraft Classification Number (ACN) analysis is used COMFAA 3.0 Software. There are 2 scenarios in the study. First scenario, aircraft maximum takeoff weight (MTOW) is assumed as aircraft gross weight. The other scenario, aircraft gross weight is depend on fuel load, that is carried by aircraft. Fuel load is depend on aircraft destination. The conclusion of this study is PCN and ACN value comparison at Juanda Airport and existing pavement thickness evaluation. The method of this study is showed on the flowchart below:

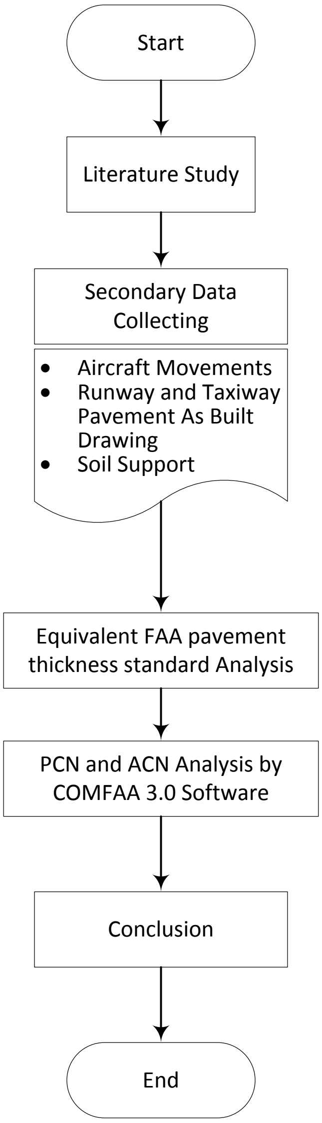

Figure 1. Study Analyzed Flowchart

III. RESULTS AND DISCUSSION

Federal Aviation Association (FAA) Pavement Thickness Standard Equivalent Analysis

The analysis purposes to convert existing pavement thickness to FAA pavement thickness standard. Existing pavement thickness data is collected from as built drawing of runway and taxiway pavement on The Final Report of Evaluation of The South Parallel Taxiway Pavement Strengths at Juanda Airport. Existing pavement material thickness data, typically consists on:

a. Asphalt Concrete Overlay (estimated material coefficient, a1=0.44), 60 millimeter thickness.
b. Asphaltic concrete wearing course (AC-WC, estimated material coefficient, a2=0.28), 540 millimeter thickness.
c. Crushed Aggregate Base Course (estimated material coefficient, a3=0.14), 500 millimeter thickness.
d. Subgrade

Existing pavement thickness above is analyzed by Microsoft excel which support to COMFAA 3.0, that is used to analysis PCN and ACN at Juanda Airport. The calculation of FAA pavement thickness standard equivalent shows on Figure 2.

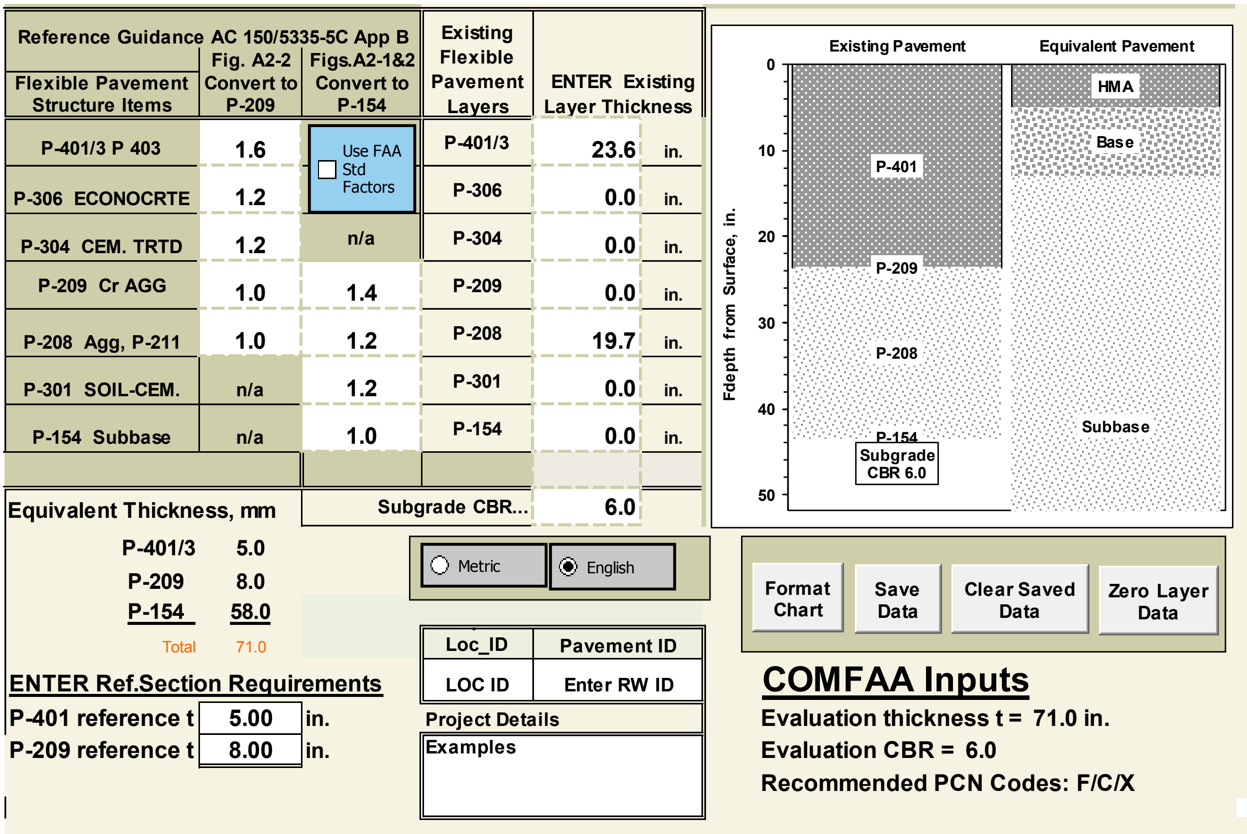

Figure 2. The calculation of FAA pavement thickness standard equivalent

From Figure 3, the result of FAA pavement thickness standard equivalent analysis shows as below:

a. Asphalt Concrete (P-401) = 5 inch = 127 mm
b. Crushed Aggregate Base Course (P-209) = 8 inch = 203.2 mm
c. Subbase Course (P-154) = 58 inch = 1473.2 mm
d. Equivalent FAA pavement thickness standard total = 71 inch = 1803.4 mm

Microsoft excel, that is used to calculate the equivalent of FAA pavement thickness standard, does not consider the age of pavement. Whereas, the age of pavement contribute to index/level of pavement service. Therefore, we use structural number formula to modify the equivalent of FAA pavement thickness standard calculation. Because, the structural number formula considers index/level of pavement service at the first open traffic (IPo) and index/level of pavement service after design life is fulfilled (IPt).

Index/level of pavement service at the first open traffic (IPo) is assumed 4.0. Index/level of pavement service after design life is fulfilled (IPt) is assumed 2.5. Because, pavement still serve the aircraft movement. If we compare between IPt and IPo, percentage of index/level of pavement service after design life is fulfilled, decreased become 62.5%.

Structural number is depending on pavement material coefficient and pavement material thickness. Structural number formula is showed below:

$SN = a1*d1+a2*d2+a3*d3$

Based on pavement material thickness data, the calculation of existing pavement structural number is showed below:

62,5%*(0.44*6+0.28*54+0.14*50) = 15.475

The equivalent of FAA pavement thickness standard calculation (on Figure 2) should be calibrated with the existing structural number. The calculation of new equivalent FAA pavement thickness standard shows below:

a. Surface course thickness is 5 inch (=12.7cm); a1 = 0.44
b. Base course thickness is 8 inch (=20.32cm); a2 = 0.14
c. Subbase course thickness is adjusted by existing pavement structural number, which its material coefficient (a3) is 0,10. Sub base thickness calculation is showed below:

(0.44*5+0.14*8+0.10*d3) = 15.475
d3 = 27.722 inch
= 70.422 cm

d. Total thickness is 40.72 inch = 103.44 cm.

Annual Aircraft Departure Forecasting

South side Juanda Airport Terminal or Terminal 2 Juanda Airport is operated to serve all internationals and several domestics flight. Domestic flight, that is served at Terminal 2 Juanda Airport, is Garuda Indonesia Airways (GIA) only. Total annual aircraft departure forecasting for 20 years that use Terninal 2 Juanda Airport, is showed Table 1.

Tabel 1. Total annual aircraft departure forecasting at Terminal 2 Juanda Airport

Aircraft Type	A-320	A-330	A-332	A-333	B-738	B-747	B-772	B-773	CRJ
Weekly	191	8	1	1	194	7	4	10	9
Annual	9932	416	52	52	10088	364	208	520	468

Noted: B-772 = B777-200
B-773 = B777-300

Aircraft Maximum Take Off Weight (MTOW) Analysis

Pavement Classification Number (PCN) and Aircraft Classification Number (ACN) Analysis

Scenario 1

The Scenario 1 of Pavement Classification Number (PCN) and Aircraft Classification Number (ACN) Analysis is assumed that gross weight aircraft is maximum takeoff weight (MTOW). The pavement strengths of Terminal 2 Juanda Airport is decided by Pavement Classification Number (PCN) and Aircraft Classification Number (ACN) analysis. Pavement Classification Number and Aircraft Classification Number (ACN) is analyzed by COMFAA 3.0 software. The data should be prepared to PCN analysis by COMFAA 3.0, are soil support, equivalent FAA pavement thickness standard, and annual aircraft departure forecasting. All of the data is already discussed above. The result of PCN and ACN analysis scenario 1 is showed on Table 2 and Figure 3 and Figure 4.

Table 2. The COMFAA Software Output on Calculation of PCN and ACN Analysis at Terminal 2 Juanda Airport Scenario 1

No	Plane	GWin	AD out	COV 20yr	ACN in	6Dt	COV to F	CDF t	GW cdf	PCN cdf
1	CRJ 1000	92300	468	2.54E+03	27.5	21.51	1.01E+304	38.17	104036.1	31.7
2	A320 Twin opt	172842	9932	5.35E+04	47.3	34.71	3.15E+06	41.83	165221.2	44.6
3	B777-300 ER	777000	520	7.97E+03	89.3	42.56	3.56E+03	42.98	726571.2	80.2
4	B777-200 ER	657000	208	3.03E+03	68	35.26	9.38E+04	41.74	636943.2	64.8
5	B747-400	877000	364	4.18E+03	72.6	36.57	2.33E+04	42.74	822846.4	65.9
6	B737-800	174700	10088	5.67E+04	50.3	35.79	1.44E+06	41.93	166121.2	47.2
7	B737-900 ER	188200	364	2.06E+03	56	30.09	3.26E+05	42.21	176973.4	51.9
8	A330-300 std	509047	468	5.00E+03	72.6	37.13	2.43E+04	42.64	478310	66.4
9	A330-200 std	509047	52	5.52E+02	71.6	30.77	2.81E+04	42.58	479139.9	65.6

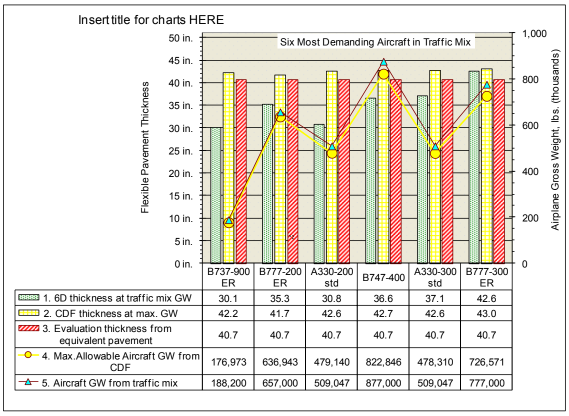

Figure 3. The comparison of Equivalent FAA Pavement Thickness and The needs of pavement thickness based on Aircraft Load Repetition Scenario 1

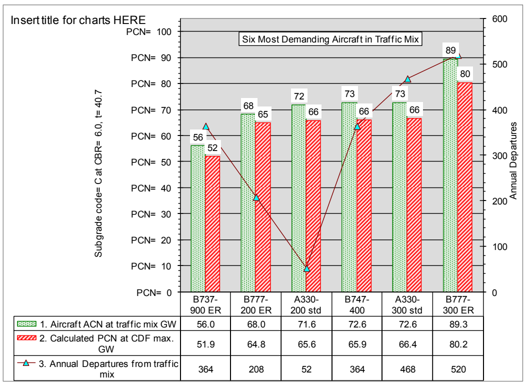

Figure 4. The Comparison of ACN and PCN at Juanda Airport Based on Equivalent FAA Pavement Thickness and Aircraft Load Repetition Scenario 1

Scenario 2

Aircraft Maximum Take Off Weight (MTOW) is one of the data that is used in pavement strength analysis at Terminal 2 Juanda Airport. In scenario 2, Aircraft Maximum Take Off Weight (MTOW) is depend on the number of passengers and the distance of aircraft destination. The number passenger affect on payload and the distance of aircraft destination affect on fuel volume that it is carried. Aircraft is assumed fulfilled. And, fuel load is assumed depend on aircraft destination. Fuel load is depend on aircraft destination, that its included fuel extra for 2 hours emergency plan travelling. The first step of fuel load calculation is to estimate normally travel time. The estimation of travel distance and travel time international flight, that its departure from Juanda Airport, is showed on Table 3.

Table 3. The Estimation of Travel Distance and Travel Time International Flight at Juanda Airport

Destination	Distance		Aircraft Type	Normally Travel Time Estimation
	Kilometer	Mil		
Penang (PEN)	1959	1217	A320	3 hours 55 minutes
Johor Bahru (JHB)	1406	873	A320	3 hours 20 minutes
Kuala Lumpur (KUL)	1649	1025	A320	3 hours 30 minutes
Singapura (SIN)	1359	844	A320	3 hours 15 minutes
Bangkok (DMK)	2701	1679	A320	3 hours 50 minutes
Taipei (TPE)	3705	2302	A333 (non direct)	-
	3705	2302	A332 (direct)	6 hours
Hong Kong (HKG)	3284	2041	B772	5 hours 45 minutes
	3284	2041	A333	5 hours 35 minutes
Jeddah (JED)	8626	5360	B747	8 hours 15 minutes
Bandar Seri Begawan (BWN)	1371	852	A320	3 hours 10 minutes

On Table 4, its shows the correlation between maximum fuel weight and maximum travel distance for each international flight aircraft type, that is departure from Juanda Airport.

Table 4. The Correlation Between Maximum Fuel Weight and Maximum Travel Distance for Each International Flight Aircraft Type at Juanda Airport

No.	Aircraft Type	Maximum Fuel Load (kg)	Maximum Travel Distance on Payload and Maximum Fuel Load (km)	Fuel/Travel Distance (kg/km)
1	A-320	29,659	6,500	2.677
2	A-332	109,185	13,900	7.855
3	A-333	76,561	11,900	6.434
4	B-772	94,240	9,700	9.715
5	B-744	164,064	13,450	12.198

Next step is decided the aircraft gross weight which is consists of operating empty weight, payload, and fuel load. Operating empty weight is on aircraft catalogue. Payload is assumed that aircraft is fulfilled passenger. And fuel load is assumed based on Table 5. The gross weight of international flight route that is departure from Juanda Airport showed on Table 5.

Table 5. The gross weight of International Flight Route at Juanda Airport

No.	Destination	Normal Distance (km)	Normal Distance + 2 Hours Emergency Flight (km)	Aircraft Type	Fuel/ Travel Distance (kg/km)	Total Fuel (kg)	OEW + PL (kg)	Gross Weight (kg)
(a)	(b)	(c)	(d)=(c)+ 1700	(e)	(f)	(g)=(f)*(d)	(h)	(i)=(g)+(h)
1.	PEN	1,959	3,659	A320	2.677	9,794.86	61,000	70,795
2.	JHB	1,406	3,106	A320	2.677	8,314.52	61,000	69,315
3.	KUL	1,649	3,349	A320	2.677	8,965.02	61,000	69,965
4.	SIN	1,359	3,059	A320	2.677	8,188.71	61,000	69,189
5.	DMK	2,701	4,401	A320	2.677	11,781.14	61,000	72,781
6.	TPE	3,705	5,405	A333	6.434	34,774.13	173,000	207,774
		3,705	5,405	A332	7.855	42,456.47	168,000	210,45

No.	Destination	Normal Distance (km)	Normal Distance + 2 Hours Emergency Flight (km)	Aircraft Type	Fuel/ Travel Distance (kg/km)	Total Fuel (kg)	OEW + PL (kg)	Gross Weight (kg)
7.	HKG	3,284	4,984	B772	9.715	48,421.87	190,470	238,892
		3,284	4,984	A333	6.434	32,065.55	173,000	205,066
8.	JED	8,626	10,326	B744	12.198	125,957.24	242,672	368,629
9.	BWN	1,371	3,071	A320	2.677	8,220.83	61,000	69,221

The result of PCN and ACN analysis scenario 2 is showed on Table 6 and Figure 6 and Figure 7.

Table 6. The COMFAA Software Output on Calculation of PCN and ACN Analysis at Terminal 2 Juanda Airport Scenario 2

No	Plane	GWin	AD out	COV 20yr	ACN in	6Dt	COV to F	CDF t	GW cdf	PCN cdf
1	CRJ 1000	92300	468	2.54E+03	27.5	21.51	1.01E+304	38.17	104036.1	31.7
2	A320 Twin opt	172842	9932	5.35E+04	47.3	34.71	3.15E+06	41.83	165221.2	44.6
3	B777-300 ER	777000	520	7.97E+03	89.3	42.56	3.56E+03	42.98	726571.2	80.2
4	B777-200 ER	657000	208	3.03E+03	68	35.26	9.38E+04	41.74	636943.2	64.8
5	B747-400	877000	364	4.18E+03	72.6	36.57	2.33E+04	42.74	822846.4	65.9
6	B737-800	174700	10088	5.67E+04	50.3	35.79	1.44E+06	41.93	166121.2	47.2
7	B737-900 ER	188200	364	2.06E+03	56	30.09	3.26E+05	42.21	176973.4	51.9
8	A330-300 std	509047	468	5.00E+03	72.6	37.13	2.43E+04	42.64	478310	66.4
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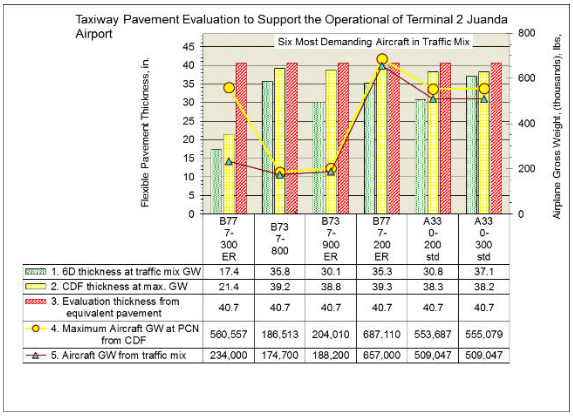

Figure 6. The comparison of Equivalent FAA Pavement Thickness and The needs of pavement thickness based on Aircraft Load Repetition Scenario 2

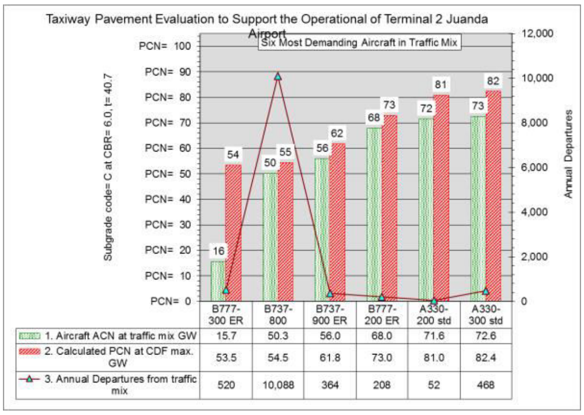

Figure 7. The Comparison of ACN and PCN at Juanda Airport Based on Equivalent FAA Pavement Thickness and Aircraft Load Repetition Scenario 2

IV. CONCLUSION

1. The existing airport pavement layer is consists on:
   (a) Asphalt Concrete Overlay (estimated material coefficient, a1=0.44), 60 millimeter thickness.
   (b) Asphaltic concrete wearing course (AC-WC, estimated material coefficient, a2=0.28), 540 millimeter thickness.
   (c) Crushed Aggregate Base Course (estimated material coefficient, a3=0.14), 500 millimeter thickness.
   (d) Subgrade
2. The calculation of equivalent FAA pavement thickness standard shows below:
   (a) Surface course thickness is 5 inch (=12.7cm); a1 = 0.44
   (b) Base course thickness is 8 inch (=20.32cm); a2 = 0.14
   (c) Subbase course thickness is 27.72 inch (=70.42cm); a2 = 0.10
3. In scenario 1, all of aircraft gross weight is assumed as maximum takeoff weight (MTOW). Existing airport pavement needs asphalt concrete overlay 7 inches thickness. The greatest ACN value is 89.3, higher than the greatest PCN value, it is 80.2.
4. In scenario 2, all of aircraft gross weight is assumed that is depend on travel distance, existing airport pavement still have ability to hold aircraft movement weight. The greatest ACN value is 73, lower than the greatest PCN value, it is 82.

V. REFERENCES

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