Application of airport pavement management system engineering essay

Environment, Air

Zamhuri Hj. DrahmanAbstractAs the volume of air traffic continues to grow, aircraft movements on airport pavement will inevitably increase. To cope with such growth it is necessary to make optimal use of all available pavements resources. By carrying out the right maintenance at the right time, an airport operator will be able to reduce the overall need for maintenance, which in turn will produce economic benefits. This paper proposes an alternative method in predicting the pavement condition based on maintenance history and recorded data. A Pavement Management System (PMS) is a cost-effective tool to provide a systematic, objective and consistent procedure to evaluate existing and future pavement condition. A PMS also provides a means to help manage pavement maintenance expenditure more economically and efficiently. They provide an objective approach to pavement management and allow for multiple budget options and scenarios to be run quickly and assist in project formulation for maintenance and rehabilitation works. Keywords—Pavement Management, Airport Pavement Management System

---

* Correspondence Author: Ir. Zamhuri Hj. Drahman (Master Student) Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS), Kota Samarahan, Sarawak, Malaysia (phone: +60198587007; e-mail: aduka007@gmail. com)INTRODUCTIONMalaysia Airports Holdings Berhad (MAHB) currently is managing a total of 38 airports, comprising of 6 internationals, 17 domestic, and 15 Short Take-Off and Landings (STOL) airport throughout Malaysia (www. malaysiaairports. com. my). As a norm for all airport authorities, pavements are their biggest single

asset and should be well managed to ensure high safety standards for passengers and aircrafts. Owing the fact that airports are scattered all over the country, there is a vital task for MAHB to embark on developing a structured and systematic airport pavement management system in order to capitalize on limited resources and funding. This paper attempts to formulate a systematic and efficient approach in conducting pavement evaluation and recommend a cost effective maintenance practice. The main objectives of this paper are to promote predictive maintenance culture and to encourage proactive towards maintenance rather than reactive maintenance culture. This paper covers the proposed method in the following sequence. The objective and rationale behind the proposed method is presented in Introduction Section. In the next section will discuss the literature review of the Airport Pavement Management System. Followed by the explanation on methodology used in achieving the research objectives as well as an overview the current practice of managing airport pavement by MAHB prior to the implementation and operation of the Airport Pavement Management System (APMS) in the following section. Result Analysis will present the results of data analysis. Finally, the last section is Conclusion as the closure of this paper. LITERATURE REVIEW

Pavement Management System

As defined by the FAA (2006), APMS provides a consistent, objective and systematic procedure in establishing facility policies, setting maintenance priorities and schedules, allocating resources for pavement maintenance and rehabilitation. According to Frank (2007), APMS is a process to sustain pavements in an acceptable condition and maximize its performance thus, minimize the investment in it.

Costs

According to Hudson et al. (1994), the costs involved with an APMS include the costs of developing and implementing an APMS, plus the ongoing cost to acquire and process the APMS. These are not one-time costs since the database must be updated to remain current. Other than that are the actual expenditures on procuring the pavement evaluation system. There are also costs associated with computer hardware and software as well as labor costs associated with those operating and maintaining the APMS. Training, both initial and refresher is another cost associated with the use of an APMS. METHODOLOGYData CollectionThe method on the airport pavement management system that is proposed in this paper uses data from Kuching International Airport, Sarawak, Malaysia. This airport is denoted as KCH following International Air Transport Association (IATA) code with 2454 m in runway length and 46m width. The runway has direction 07/25 represents the runway designation of magnetic azimuth, which is measured clockwise from the magnetic declination. Pavement strength (PCN) for KCH is 82/F/C/X/T. This means that the load bearing capacity of the pavement is 82, F denote flexible pavement, C shows the strength of subgrade based on CBR values between 4 to 8 (Low Strength); X illustrates that the allowable tire pressure for particular pavement is limited to 1. 5 Mpa; and T indicates that the pavement strength value (PCN) is evaluated by Technical method. Data related to aircraft movements as well as types of aircraft also uses data from

KCH while traffic data used is data from year 2006. MethodologyThe methodology used in evaluation of airport pavement incorporate the evaluation of functional and structural condition of pavements. The functional condition relates to comfort (Woods, 2008) and safety (FAA, 1997). The structural condition of pavement could be evaluated through Non-Destructive test (FAA, 2011). Figure 1 presents the methodology used in research analysis. methodology. jpgFigure 1: Flow chart of the methodology of analysisAccording to Figure 1, the analysis methodology begins with the overview of current maintenance practices as carried out by MAHB through their existing M&R Standard Operating Procedures (SOP). The records indicates that prior to the implementation of an airport pavement management system (APMS) on year 2006, the evaluations are made using engineering experience and judgments alone. Test frequency is selectable and adjustable to meet specific operations. There is no specific area mapping being carried out and mechanical testing was carried out only in those areas with significant structural distress. Maintenance and Development Budget usually determined by assessing the current rate of deterioration. The process will continued with visual distress survey followed by physical data collection activity where a structural and functional data will be collected through site non-destructive test. Analyzing a collected data will be done using selected software before establishing a documented rehabilitation option, financial optimisation and M&R plan.

RESULT ANALYSIS

Visual Data

During the implementation of visual distress survey at KIA were carried out, the Pavement Condition Index (PCI) survey method and the MicroPAVER software were used. The MicroPAVER software is used to store, manipulate, and report on the data. The software accepts and stores pavement inspection data, calculates PCI values for each pavement section surveyed, and analyzes and reports on the data. Table 1. 0 shows a breakdown of pavement distress for all pavement sections at Kuching International Airport. Pavement distress is divided into load related, climate/durability and other distress.

Table 1. 0 – Distress Cause Breakdown

AirportLoad relateddistressClimate DurabilityAge distressOtherdistressKCH29%34%20%Rutting, alligator cracking and corrugation are part of load related distresses for asphalt pavement; for rigid pavements corner breaks, shattered slabs and faulting.

Climate/durability/age distresses include, but are not limited to, longitudinal and transverse cracking for both asphalt and PCC pavements, block cracking and reflection cracking for asphalt pavements, joint seal damage and spalling for PCC pavements. Other distresses include, but are not limited to oil spills shoving and jet blast erosion. Table 2. 0 below, indicates that the weighted average PCI for each of the three types of pavement usage are above the minimum 60 PCI levels.

Table 2. 0 – Pavement Usage PCI values at Kuching International Airport

Use CategorySectionsArea (M2)AveragePCIPCI Std. Weighted PCIAPRON1788, 638. 7082. 6524. 9788. 54RUNWAY13111, 144. 4288. 2316. 8688. 73TAXIWAY780, 453. 4576. 8612. 6171. 67ALL

37

280, 236. 57

83. 51

20. 81

83. 77

One section had a rating of Failed, representing 362. 5 sq meters. One section had a rating of Very Poor, representing 1, 650. 00 sq meters . One section representing 9, 900. 00 sq meters had a rating of Poor, Sixteen sections had a rating of Fair, representing 45, 475. 00 sq meters. Seven sections had a rating of Satisfactory representing 72, 189. 27 square meters. Twenty three sections had a rating of Good representing 150, 659. 80 square meters.

Maintenance and Rehabilitation Plans

Budgets

Budget from MicroPAVER software was derived based on the current visual distress survey at Kuching International Airport. Fund for the next 5 years M&R then be allocated for accordingly. The budget expenditures, for

Rehabilitation and Maintenance, planned for Kuching International airport are summarized in Table 3. 0.

Table 3. 0 - Funded Maintenance and Rehabilitation for Kuching International Airport

Funded M & R for Kuching International Airport (KCH)

YEAR

BUDGET

FUNDED

Stop GapPreventiveMajor Under CriticalMajor Above CriticalUnfunded

Annual Budget 100, 000. 00

20065, 685. 4028, 588. 2012, 993. 3839, 804. 362, 174, 488. 1720076, 721. 1519, 480. 5368, 980. 70

-

1, 986, 236. 2920087, 307. 3521, 498. 56

-

-

2, 065, 493. 8220098, 124. 3223, 448. 38

-

-

2, 148, 198. 2820109, 225. 2427, 416. 82

-

-

2, 253, 920. 86

37, 063. 46

120, 432. 49

81, 974. 08

39, 804. 36

10, 632, 337. 42

Annual Budget 500, 000. 00

20065, 685. 40266, 206. 7468, 139. 51258, 511. 211, 667, 016. 6520076, 774. 4319, 683. 99167, 298. 64106, 562. 611, 493, 888. 5420087, 307. 3521, 498. 56296, 883. 17

-

1, 255, 304. 5320098, 124. 3223, 663. 14

-

-

1, 303, 586. 9620109, 225. 2427, 539. 54

-

-

1, 373, 705. 16

37, 116. 74

358, 591. 97

532, 321. 32

365, 073. 82

7, 093, 501. 84

Annual Budget 1, 500, 000. 00

20065, 685. 40266, 206. 74490, 779. 66924, 612. 38578, 275. 3320076, 774. 4319, 683. 99615, 470. 33

-

-

20087, 307. 3521, 498. 56

-

-

-

20098, 124. 3223, 663. 14

-

-

-

20109, 225. 2427, 539. 54

-

-

-

37, 116. 74

358, 591. 97

532, 321. 32

365, 073. 82

578, 275. 33

Note: Currency in Ringgit Malaysia (RM)

Functional Data

Friction Data and Results

The summary of test results is shown in Table 4. 0. For the purposes of this paper the friction data will be presented as the characteristic of functional data for KCH airport. In general, the significant rubber deposits are found in the 3 and 5 meter offset from the runway centreline. This coincides with the majority of the aircraft gear position landing at the airports runway. Beyond this offset distance the friction values on runways were generally acceptable. In general, as illustrated in FAA (1997), any Mu value, at 65 kph, lower than 0. 36 is considered symptomatic of high hydroplaning potential and requires immediate action. Areas between 0. 64 and 0. 36 require planning to improve the friction value. Areas with Mu greater than 0. 64 are considered satisfactory and require no action. All distances are from the end lights of the runway. The rubber deposits are from 300 meters to 600 meters. The low Mu value in this area is an average of 0. 14. This is significant to aircraft during rain and the area should be derubberised immediately. The rest of the runway, outside the rubber deposit area has a reasonable 🕴u range.

Table 4. 0 – Friction Data Summary

Runway Thirds

RWY 07

1

2

3

Average

Test Length (m)

3 meters right of CL0. 4510. 6870. 7470. 628

2000

5 meters right of CL0. 4290. 6420. 6790. 5849 meters right of CL0. 780. 7370. 7560. 75815 meters right of CL0. 780. 7620. 7540. 7563 meters right of CL0. 7910. 7190. 4540. 655

2000

5 meters right of CL0. 7600. 7130. 4050. 6269 meters right of CL0. 7820. 7790. 7430. 76815 meters right of CL0. 7800. 7620. 7540. 756As a conclusion the following conclusions can be made: 1. Rubber deposits removal should be carried out at Kuching International Airports. 2. The timing of friction testing must be accordance with FAA AC5320-12C. 3.

Consideration shall be given to the mix design of a wearing course with more macro texture.

Structural Data

The structural data for the pavements are collected by taking deflection measurements using a Heavy Weight Deflectometer (HWD). The HWD is capable of applying a dynamic force, depending on the stiffness of the pavement structure, equivalent to a load up to approximately 260 kN (26 tons) at the pavement surface using a 450mm diameter plate. This HWD load configuration simulates the effect of actual heavy wide-body aircraft induced loads. Based on the HWD test results, the layer stiffness of asphalt pavement, granular base and/or subgrade are derived and used for the calculation of the Pavement Classification Number (PCN) value using the PCN-module of the ELMOD software. The ELMOD software PCN-module calculates the Technical PCN and the residual life for the pavement. The PCN expresses the bearing strength of the pavement for unrestricted operations. If the particular aircraft has a lower Aircraft Classification Number (ACN) value than the PCN value of the pavement, the use of the pavement is permitted unrestrictedly. If the PCN-value of the pavement is lower than the ACN-value of the (design) aircraft, the use of the pavement is restricted.

Table 5. 0: Technical PCN/ACN results for pavements at Kuching International Airport

Branch

PCN

ACN

Code

Aircraft Type

Runway12062F/A/W/TA330-200Taxilane12062F/A/W/TA330-200TWY A11562F/A/W/TA330-200TWY C11462F/A/W/TA330-200TWY E6036F/A/W/TB737-400TWY F836F/A/W/TB737-400TWY G1964F/A/W/TA330-200AP 017672R/C/W/TA330-200AP 026273R/C/W/TA330-200AP 038672R/C/W/TA330-200AP 046372R/C/W/TA330-200AP 067672R/C/W/TA330-200AP 076673R/C/W/TA330-200AP 0812073R/C/W/TA330-200AP 095473R/C/W/TA330-200AP X7073R/C/W/TA330-200AP Y6373R/C/W/TA330-200GSA01810R/C/W/TFokker 50 HTPGSA021111R/C/W/TFokker 50 HTPHORNBILL 01189R/B/W/TFokker 50 HTPThe PCN calculations have been based on the estimated coverages for 20 years traffic. The PCN analysis shows in general clear difference between rigid and flexible pavements. This is due to the nature of the ACN/PCN method. The subgrade deformation (vertical stress) for flexible pavements is the critical characteristic, whereas for rigid pavements this is the flexural strength of the concrete. It is important to note that the magnitude of PCN-value has a substantial influence by the number of coverages.

Residual Life Results

The residual life of the pavement structures was calculated using the ELMOD Software. The estimation of the residual life is based on the selected fatigue equations and the predicted future aircraft traffic. The mechanistic-empirical methods are used in the estimation of the residual life and the overlay works. Tables 6. 0 show the results for the estimated overlay thickness and the calculated residual life for KCH airport pavements.

Table 6. 0 Residual Life and Overlay Thickness for Kuching International Airport

BranchTrackSectionRemaining Life (Year)Overlay Thickness (mm)Runway15m R12002200320042003m R12002200320042006m L1200220032004200TWY A10m R12003m R12006m L1200TWY C10m R12003m R12006m L11957TWY E10m R120022003m R120022006m L12002200TWY G15m R12003m R195976m L11878AP 01AP 011200AP 02AP 021200AP 03AP 031200AP 04AP 041200AP 05AP 051200AP 06AP 061200AP 07AP 071200AP 08AP 081200AP 09AP 091200AP XAP X1200AP YAP Y1200GA 01GA 0111549GA 02GA 0211839HRNBL 01HRNBL 011200Taxilane20m L1200220032003m R1450122003350555m L1200220032006m L11783220031192

DISCUSSION AND RECOMMENDATION

Discussion

The setting-up, implementation and operations of APMS by MAHB as part of its pavement management initiative, has put MAHB into a level higher than the norm. As one of the airport operators operating more than 35 airports at a time, the management has to be super efficient in optimizing allocation of funds to maintain its airport pavement at a structurally safe and functionally sound. The proactive approach in managing airport pavement will allow the authority to be able to forecast future deterioration, isolating critical sections, identifying types of deterioration, optimizing M&R program, comparing pavement current performance between airports, hence able to prioritize rehabilitation and budget optimisation between airports.

Recommendations

Based on the APMS project outline, technical data on airport pavement which is comprised of visual distress data, functional data (IRI & friction value) and structural data were collected in May 2006. These technical parameters shall be the initial database and represent the datum databases in the APMS. They need to be updated periodically throughout the years. This will enable the Agency to refine the modeling of the airport to monitor future pavement performance with respect to functional and structural parameters.

ACKNOWLEDGEMENT

This research was carried out with support data from Kuching International Airport (KCH). Appreciation is also extended to Prof. Dr. Wan Hashim B. Wan Ibrahim, Dean, Faculty of Engineering, Universiti Malaysia Sarawak for the feedback to improve this paper.