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DESIGN AND RE-CARPETING 0F RUNWAY 09/27 PAVEMENT AT MUMBAI INTERNATIONAL AIRPORT

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Abstract: Airport runways are built to exacting, internationallymandated standards. But frequent landing and take-off of flights lead to wear and tear of runways. Natural weather phenomena like rain and sun also affect the runway surface.Re-carpeting is essential for the safety of flights. All re-carpeting activities on runways are likely to lead to flights being rescheduled though they are not always cancelled or disrupted. Airport runways at all times need to be of a specified strength or Load Classification Number (LCN), which is a system of classification of the supporting capacity of pavements without cracking or becoming permanently deformed. Airport pavements are constructed to provide adequate support for the landing.

In order to satisfactory, the pavement must be with quality and adequate thickness that it will not fail under the loads. In addition, it must possess sufficient inherent stability to withstand, without damage, the abrasive action of traffic, adverse weather conditions, and other deteriorating influences. To produce such pavements requires a coordination of many factors of design construction, and inspection to assure the best possible combination of available materials and a high standard of workmanship. The paper deals with the various methods involves in strengthening of runway pavement by examining the runway for a variety of issues including whether the aircraft is having a smooth ride as it lands, rubber deposits and removal, raveling observed at touchdown zone and rubber removal area, reflection cracks, patching on runway, pop outs and coarse aggregate loss, alligator cracking, surface irregularities on the line markings, shoving and uneven surface. Software results by considering number of flights along with loading damage ratio is calculated which results in thickness for re-carpeting further this ratio is considered for thickness of pavement if number of flights increase.

***Index Terms* - Component, formatting, style, styling, insert.**

1. INTRODUCTION

The growth of economy of any country depends upon the development of transportation. Among all transportations air transport is most expensive and the fastest. Airport Runways are designed to with stand the loads imposed on the pavement by airplanes and to produce a stable, firm, smooth landing and takeoff. And the pavement is to be all weather and all year, surface resistant debris or other particles blown off or picked up by the jet blast or propeller wash. To agreeably full fill these prerequisites, the asphalt should be of such quality and thickness that it won't fizzle under the heap forced. Moreover, it should have adequate natural strength to withstand, without harm, the grating activity of traffic, unfriendly climate conditions, and other breaking down impacts. To deliver such asphalts requires a coordination of numerous components of plan, development, and review to guarantee the most ideal mix of accessible materials and an exclusive expectation of workmanship.

For every periodical years the runway to be tested weather the runway is possessing the engineering properties and is there any rubber deposits and removal, ravelling observed at touchdown zone and rubber removal area, reflection cracks, patching on runway, pop outs and coarse aggregate loss, alligator cracking, surface irregularities on the line markings, shoving and uneven surface etc., and according to the result maintenance of runway is to be done. This paper deals with 3rd stage of maintenance that is runway re-carpeting.

Airport runways are built to exacting, internationally mandated standards. But frequent landing and take-off of flights lead to wear and tear of runways. Common climate marvels like downpour and sun additionally influence the runway surface. Therefore, contingent upon the volume of traffic and the assortment of airplane, the runway should be 're-carpeted' at regular intervals.

Air terminal asphalts ought to fulfill protected and regular airplane activities; accordingly, it is important to screen these surfaces and actualize costly upkeep and rehabilitation works. The Airport Pavement Management System (APMS) is a way to deal with screen the asphalt condition and to decide the needs for intercession, to design, and to distribute resources through procedures. The technique for observing asphalt conditions is currently embraced by the air terminal administration organization since it is important to the air terminal operability.

Pavement Maintenance Management System (PMMS):

Many airports around the world are facing a rapid increase in traffic. Due to this increase in aircraft traffic movements, the pressures on airside pavements and the needs for maintenance rise. This increased need for maintenance combined with increased traffic demands complicate the decision to take an asset out of service for maintenance. From exploratory interviews, it was found that the main challenge in pavement management is to select maintenance projects that need to be carried out. Identifying which pavement sections need to be maintained or repaired is not a problem; the problem is selecting the right pavement sections for maintenance and rehabilitation (M&R) when not all of them can be repaired due to budget or time restrictions. This research has focused on pavement management decision making in airports with high traffic demands. The research will be focused on pavements on the airside of airports, particularly runways, taxiways, and aprons.

A PMMS gives a precise, unbiased and reliable procedure to assess future and existing asphalt condition. A PMMS likewise gives a way to help oversee asphalt upkeep expenditure more monetarily and effectively. They give a target way to deal with asphalt the executives and taken into consideration various spending alternatives and situations to be run rapidly and aid project definition for upkeep and Re-Habilitation works.

A PMMS usually uses as pavement status, called Pavement Condition Index (PCI), as the premise from which current and future asphalt condition can be assessed. From the assessed future asphalt condition, numerous financial plan and maintenance scenario scan be run to determine the most economy effective maintenance answers for the asphalts on the air terminal.

There are 4 types of maintenance in runway pavement i.e.,

A. Rotten maintenance
B. Preventive Maintenance
C. Re-habilitation Maintenance [re-carpeting]
D. Re-construction

2. LITERATURE SURVEY

The FAA required the utilization of balanced out bases for all asphalts that will be needed to help airplane weight of 45,350 kg or more. This review was performed to determine the current state of the art in terms of understanding stabilization mechanisms, design procedures, and considerations. Field information were gathered to give an audit of the presentation of numerous asphalts at high-volume air terminals that help hefty airplane loads. Field data collected included structural

Data Collection

Runway	Length	Longitudinal Slope	Width	Transverse Slope
09/27	3660 metres	0.8%	75 metres	1.5%
14/32	2990 metres	--	45 metres	--

Runway Re-carpeting:

A Pavement Maintenance Management System (PMMS) gives an efficient, unbiased and predictable methodology to assess existing and future asphalt condition. A PMMS additionally gives a way to help oversee asphalt upkeep use data in the form of non-destructive testing (NDT) performed with a falling weight deflectometer, visual condition survey using the pavement condition index (PCI) procedure, and construction and maintenance history data. The NDT was assessed to decide modulus esteems for the different asphalt layers. The PCI data were compared to determine rehabilitation efforts required to maintain the pavement at appropriate levels.

The field data collected which includes non-destructive data (NDT) and pavement condition index (PCI) data obtain with Falling Weight Deflecto-Meters. The PCI data provides a visually assess the performance, strength and life of the pavements. The NDT data provides input to structural evaluations by allowing for the back computation of layer modulus values for were also collected to determine the effort require to maintain the pavement at an acceptable level of performance. Sample were collected at one selected site to allow for an in detail assessment of the performance of the stabilized layer material.

This specification details the requirements for materials, manufacture, supply, placing, compaction and acceptance for:

1 Dense Graded Asphalt Surface Courses(AC) for the taxiway aircraft pavements,
2 Dense Graded Asphalt Surface Courses(AC) for shoulders, and
3 Dense Graded Bituminous Macadam Courses(DBM) for taxiway aircraft pavements and shoulders.

3. EXPERIEMENT

TABLE I. Testing the engineering properties of existing runway and number of aircrafts utilizes the runway.
TABLE II. Analyzing the runway pavement strength and engineering properties according to the results get in field study.
TABLE III. Design of runway re-carpeting and Asphalt Mix Design by using FAARFIELD software
TABLE IV. Material availability and time management in construction of re-carpeting.
TABLE V. Asphalt laboratory tests and on site tests for regaining the engineering properties of the runway

all the more financially and proficiently. They afford an objective approach to the pavement management and permit for multiple scenarios and budget options to be assist in project formulation and sprint quickly for the re-habilitation maintenance works.

Aircraft traffic movement :
The number of departures and arrivals for the Runways has been derived on the basis of 6 months aircraft landing data provided by Mumbai International Airport Private Limited (MIAL).

Pavement Condition Index:

Visual Inspect On Runway 09/27 -*Site Inspection*:
Visual Inspection: Some of the damages of pavement are easily identified by the necked eye. The visual inspecting of the pavement helps to examine the existing drainage condition and drainage structure of the pavement slope and note the evidence of the adverse effects of frost action, reactive aggregates, swelling, surface drainage design, frost, cracks etc.,

Testing and collecting Samples :
The physical tests and materials analysis are to be conducted according to the reports of site inspection, old records study, and reason for evaluation. A material evaluation for the design mix is most important and more samplings are to be tested and evaluation of network analysis is prepared. The thickness, general condition and quality of the materials of existing pavement structure comes under the sampling and testing.

Direct Sampling :

The supplement sampling and tests are comes in basic evaluations consists of visual inspection. The new pavement is constructed according to FAA standards and also some defects don't identify in visible sign of wear (or) stress, these are corrected on the bases of data as shown on the as-bult sections for the most recent projects.

Roughness Assessment and Grade :

Indication of pavement roughness level is a reflection of pavement serviceability. Roughness assessment methods, grade changes and profile of pavement is known as profile measurements. Pavement profiles are evaluated with programs like ProFAA. Measuring the evaluation of in-service pavement roughness was currently researching by the FAA. Upon completing this research, the FAA is going to update guidance on Runway pavement roughness development.

Heavy Weight Deflectometer (HWD)

Heavy Weight Deflectometer (HWD) is gadget used to ascertain the properties of the current asphalt without destructing the asphalt.Dynatest built up the 1st commercially available Heavy Weight Deflectometer (HWD). The HWD can apply a loading in the range of 30-320kN, empowering it to simulate even the most extreme aircraft wheel load,

- To resolve the layer of failure and the optimum re-carpeting solutions.
- For Quality control check of existing and new pavement structure.
- Improve and identify with pavement modelling.
- Used in pavement management system.
- Used to pavement research program.
- Kind of layers and there thickness

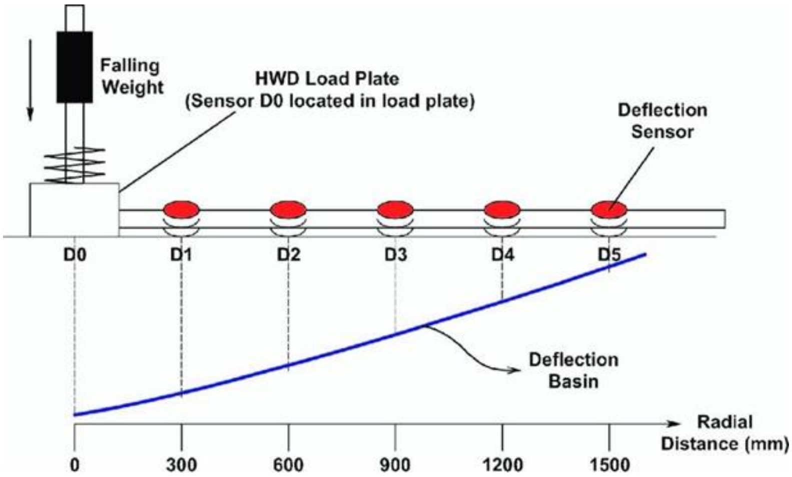

Figure : Schematic Of Heavy Weight Deflectometer HWD Test

Existing Pavement Thickness :From the above investigation of the runway by HWD, the summary of existing pavement layer properties for runway 09/27 is presented in the below Table

Table : Existing Pavement Layers Properties For Runway 09/27

Material type	Average thickness (mm)	Average layer moduli (MPa)
Asphalt course (AC)	600	1000
Cement treated base or old PCC	300	15000
Granular base course	800	500
Sub grade		180

TESTING

Selection Of Lots And Test Sites:

a) Select an area where more traffic lane show similar visuals appearance.
b) Record the location and length of each lot within the appropriate specified limits.
c) Mark 3 test sites at the 1/4 points and midpoint of the lot, in which wheel path has the lowest surface texture.

Test Procedure:

a) Sweep off all loose particles and dust. Ensure that the test site is dry, clean and free from oil and grease.

b) Glass beads are filled in brass cylinder by dipping into the container and striking off any excess.

c) Tap 3 times on the base of the filled cylinder on a hard surface and top up the cylinder striking off any excess.

d) Pour the glass beads in the cylinder onto the road surface into a small pile on the selected area. Make sure that there the glass beads are blow away due to wind effect.

e) By using the sand spreader, gently spread the glass beads circular spiral motion until the diameter of circle stabilize, by keeping the face of the sand spreader flat. So that the glass beads goes down into the surface voids. The sand patch is levelled to the highest point on the pavement surface.

f) By using the scale measure the diameter of the circle at 4 evenly spaced diameters and record the measurements. Average the 4 readings, to determine Dmm (average diameter (D mm)) of the circle.

g) After completion of test sweep off the glass beads away from the pavement surface and discard.
h) Repeat from step: a to step: g for each test on selected site.

PAVEMENT RECARPETING

Testing Of Trial Section*:*

The QC must test the density of each finished asphalt trial section. A minimum of 10×100mm cores and 20 nuclear density tests must be taken.

The QC shall present a calibration between cores and nuclear density testing so that all asphalt in the works can be tested by nuclear means.

The cores shall also be used to derive the compaction factor for the asphalt after it comes out of the paver. The surface smoothness and surface levels of the test section must be tested by the QC.

Milling the existing pavement surface:

The existing pavement surface of the runway is removed by the mechanical milling machine. There are 3 milling machine width

1. 1.0m to 0.9m
2. 1.3m to 1.2m
3. 2.0m to 1.9m

Cleanliness and Overlaying:

Bituminous material will be kept uncontaminated and clean. On the milled surface after applying tack coat solitary traffic is allowed to run on bituminous material. The overlaid surface is occupied with laying and compacting the following course. Should any bituminous material become debased and the QA shall make it good.

Cleaning the Surface:

The milled surface was cleaning the loose and extraneous matter by menace of mechanical broom like Bobcat or standard equipment / method where the bituminous work is laid. By using high pressured air jet with a compressor to remove loose matter or dust available full time on the site.

Spreading:

After the surface is cleaned and check for the thickness of milled area and free form dust, and tack coat is applied. The work of mechanical paver access, bituminous material is spread equally and levelled and tamper by approved self propelled paving machine. The materials are supplied continuously to paver and laid without delay, as soon as possible after arriving to the site. The mechanical paver must be self- propelled and designed, constructed, adjusted and operated so as to continuously spread and compact the hot asphalt without segregation to the specified thickness or levels and to comply with the surface tolerance requirements.

Laying:

On the pavement surface the presence of free-standing water during rainy season, fog and some dust storms, to avoid this situation the milled surface is covered. After the rain the bituminous surface of prime coat is to be blown off with high pressure air jet to remove excess moisture and the surface is left for some time to dry before laying starts. If the air temperature at the surface is less then the 10^0c, the laying of bitumen mixture is to be stopped. Below 10^o C for mixes with conventional bitumen and 15^oc for mixes with polymer modified bitumen.

The mechanical paver must incorporate:

i. A floating screens unit which is heated uniformly throughout its full length prior to the commencement of spreading operations in each work period, and it is maintained in a heated condition throughout the spreading
ii. A pre-compaction device over the full length of the screed unit consisting of either vertically oscillating tamper blades or a mechanism for including vertical vibration of the screed plate, or both
iii. Individually automatically controlled screw conveyors capable of distributing the asphalt laterally and evenly without segregation in front of the full length of the screed and which extend to within 300mm of each of the screed

The mechanical paver must be equipped to enable automatic control of thickness:

i. Using a fixed string line or a mobile level averaging beam on one side of the machine concurrently with:
ii. Fixed string line on the other side ;or
iii. A mobile level average beam on the other side; or

Joint matching device on the other side.

Using an electronic device on one side of the machine:

- An electronic device on the other side ;or
- A joint matching device on the other side.

Compaction:

After spreading the bituminous material by the mechanical paver the surface is compacted in layers as soon as possible, which is enable the designed thickness, surface level, regularity requirements and compaction be achieved. The voids are removed from the laid bituminous material by compacting perfectly.

Joints :

The longitudinal joints are laid by pre mixed bituminous materials, there the compaction is done fully and the joints are made flush by using one in the following method:

i. As a hot joint by using two or more pavers are operating in the site, the sufficient proximity for adjacent widths to be fully compacted by continuous rolling;

ii. Where job planning and weather conditions permit the placement of the adjoining the lane before the temperature in the paved edge of the lane being placed has dropped below 70°C, the joint may be treated, as a warm joint. To achieve this, the full width of the first placed lane must receive breakdown rolling to the full width of the lane being placed.

iii. The edge of the first placed lane must be pressed hard and formed while hot to a straight, tight face at approximately 45° to the vertical using steel lutes or similar equipment.

iv. Pneumatic tyred rolling and vibrating rolling must proceed along the first placed lane to within 50 to 70 mm of the edge, but not to the extent that will collapse or roll over the edge. After placing of the adjacent lane, the initial passes of the vibrating rolling are to be within 50 to 70 mm of the joint to bed the mat and then the joint shall be rolled.

v. The medium pneumatic tyred roller must overlap the previously placed lane by at least 500 mm; as a cold joint by cutting back the exposed joint to a straight clean face between vertical and 45° using a cutting wheel attached to the vibrating roller.

vi. For a vertical face, the cut back will be at a distance equal to specified layer thickness. And discarding the loosened material and tack coat on the vertical face completely. The edge shall be checked transversely with a straight edge to determine if any roll over has occurred, before placing the adjoining lane.

If roll over is evident, the width of cut back shall be increased to remove material. Cutting with a jack hammer or diamond saw is not permitted.

4. RESULT

Test Reports / Results:
Table: Effective Specific Gravity Of Mix

EFFECTIVE SPECIFIC GRAVITY OF MIX			
	Runway 09/27 –ch. 3260.0 to 3350.0 offset – 0.0 to 15.0m North & South side from C/L (1st layer and Top layer)		
Sl.No.	**Trial No.**	**Units**	**I**
1	Mass of Flask W1	gms	2492
2	Mass of Flask + Sample W2	gms	5062
3	Mass of Dry Sample in Air (A)	gms	2570
4	Mass of cover plate and Flask filled with water at 25° c (D)	gms	10017
5	Mass of cover plate, same and Flask filled With water at 25° c (E)	gms	11608
6	Gmm = A/(A+D)-E		2.625
	Average Gmm		2.625

Table : Bitumen Extraction Test

Description		Test
Weight of mix sample (gms)	W1	1160
Before extraction filter paper weight (gms)	W2	5.5
After extraction filter paper weight (gms)	W3	6.0
Weight of dry aggregates after extraction (gms)	W4	1100
Weight of filter paper after extraction	W5=(W3-W2)	0.5
Weight of bitumen (gms)	W6=(W1-(W4+W5)	59.50
%of bitumen	= (W6 x 100) / W1	**5.13**

Table : Grading Of Aggregate For DAC

GRADING OF AGGREGATE FOR DAC						
Weight of sample -1 for gradation = 1100.0 gms.						
I.S Sieve size	**Weight of retained material**	**% of retained**	**Cum. % of retained material**	**% of passing**	**JMF Limit**	
(mm)	(gms)	(%)	(%)	(%)	Lower	Upper
26.5	0	0	0	100	100	100
20.0	16	1.45	1.45	98.55	97	100
13.2	143	13.00	14.45	85.55	84	91
9.5	132	12.00	26.45	73.55	72	78
4.75	223	20.27	46.73	53.27	51	57
2.36	182	16.55	63.27	36.73	35	41
1.180	92	8.36	71.64	28.36	27	31
0.600	98	8.91	80.55	19.45	18	24
0.300	65	5.91	86.45	13.55	12	15
0.150	61	5.55	92.00	8.00	7	10
0.075	29	2.64	94.64	5.36	5	7
Pan	47					

Table: Bitumen Emulsion Test

Bitumen emulsion test					
Material :	PMB 40		**Date of testing :**	06-03-2020	
Location :	Change : 2936.0 to 2986.0m Offset : 15.0 to 30.0m south side from centre line				
Calculation part :					
Sl.No	**Description**	**Test Number**			**Average (Kg/m^2)**
		1	**2**	**3**	
1	Tray size (m)	0.300 x0.300			
2	Area of tray (Sq. m)	0.0900			
3	Weight of tray taken = W kg	0.548	0.581	0.592	0.429
4	Weight of tray + spray emulsion = W1 kg	0.587	0.621	0.629	
5	Weight of spray emulsion = W2=W1-W kg	0.039	0.040	0.37	
6	Rate of Emulsion spray = W2/0.090 (kg/m^2)	0.433	0.444	0.411	

Limit : 0.400 kg/m^2 (as per Schedule of Quantities)

5. CONCLUSION

The ICAO has adopted a pavement classification system for reporting airfield strength. This system reports a unique PavementClassificationNumber (PCN), which indicates the aircraft with an Aircraft Classification Number(ACN) equal to or less than the PavementClassificationNumber (PCN)can operate on the runway pavement subject to any limitation on tyre pressure. Runway Pavement are classified according to their strength, and they are given a Load Classification Number (LCN) or Single Wheel Loading (SWL) of its weakest point (Swatton 2008). Performance operating limitations of an aircraft require a length of runway that is sufficient to ensure that the aircraft can either be brought safely to stop or complete take-off safely after starting a take-off run. The frequency of landing (loading) influences the RunwayPavementPerformance.

The project work follows the runway recarperting, as generally known that runway is very important with a reason that the landing plays a vital role of the flights, similarly takeoff of the flights is also very important in the airport.

1. Time management : Seven hours' of work from 09:30am to 04:30pm the entire batch are working on the Runway Re-carpeting work which was pre planed and time to time batch change and safety precaution is managed properly.
2. Increasing the strength : The pavement engineering properties of Runway 09/27 is increased by the Re-habilitation or Runway Re-carpeting maintenance, which was economical and gives 20 years life span for the Runway.

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PAVEMENT RE-CARPETING SELECTION PROCESS :

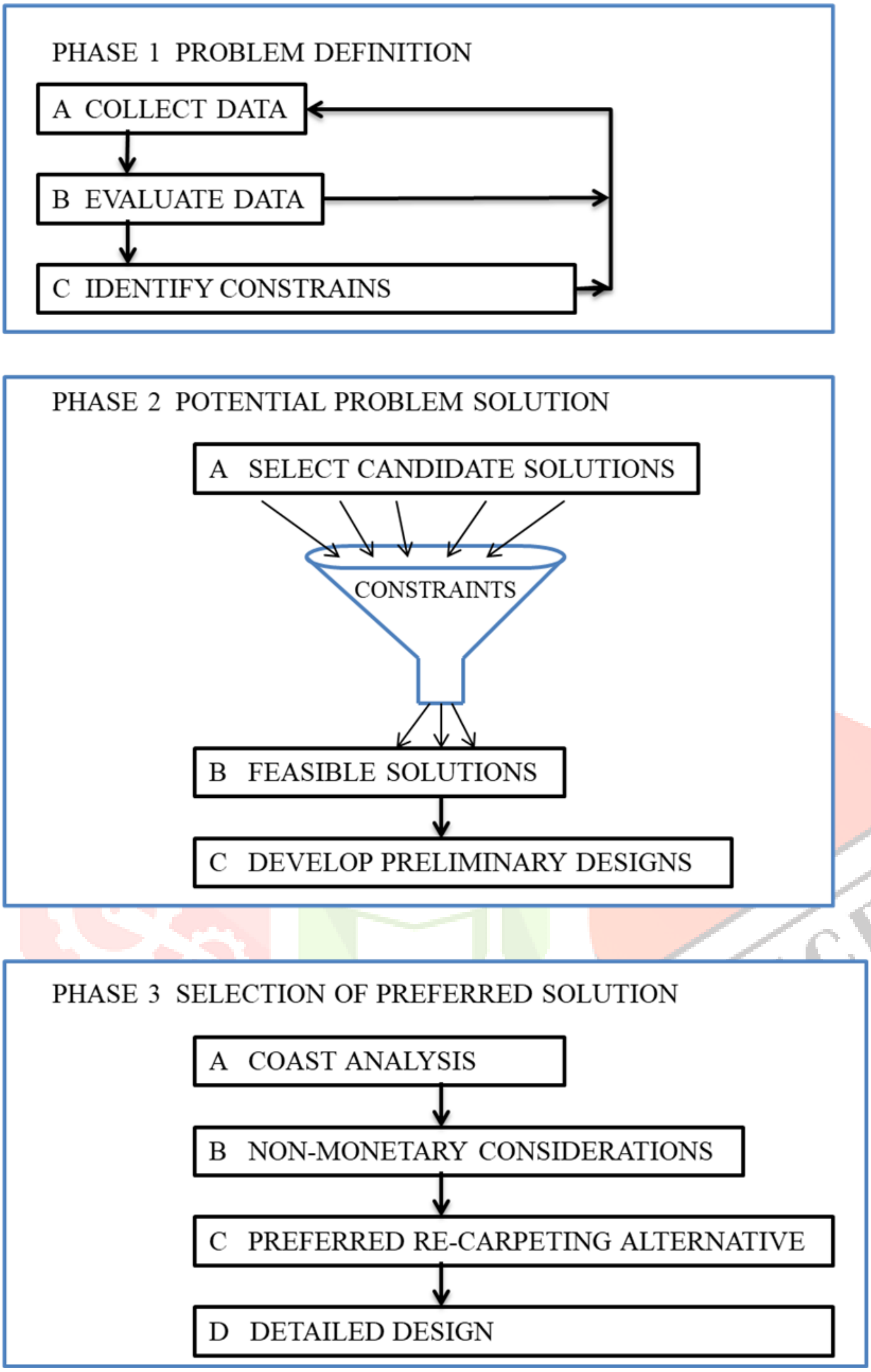

Figure 9 : Batching Plant

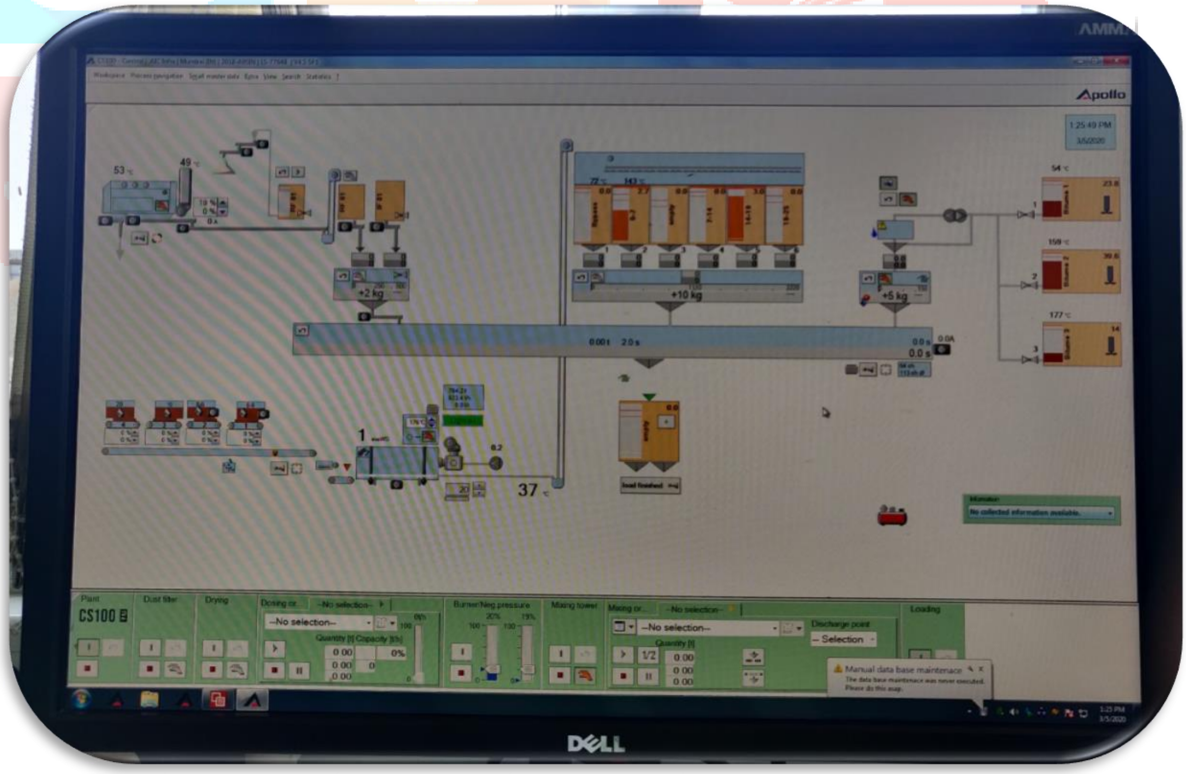

Figure 10 : Computer Operation For Batching Plant

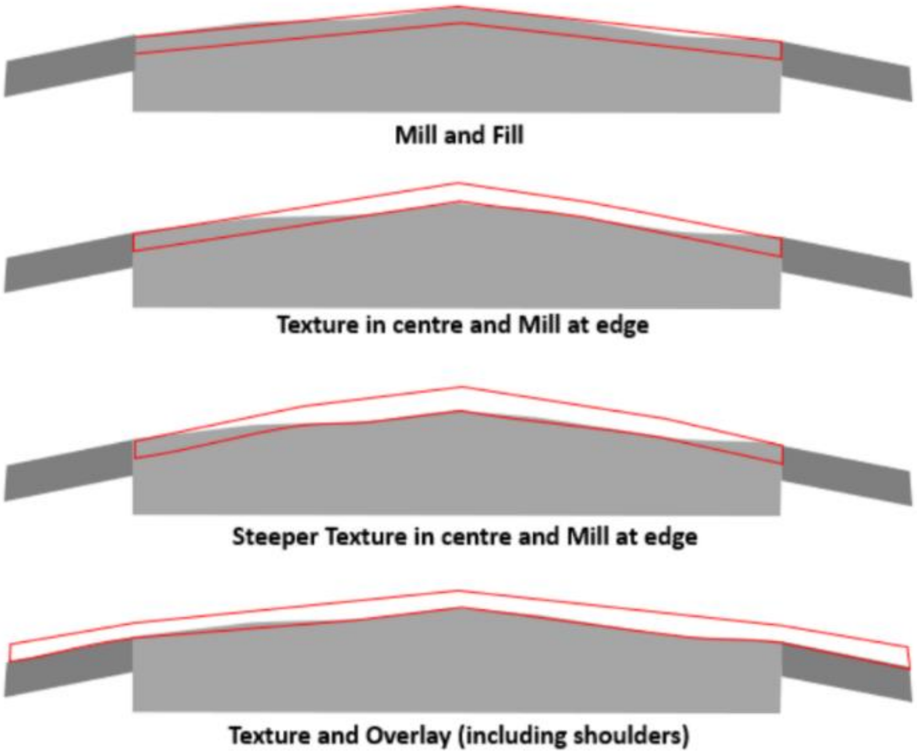

Figure 11 : Four Approaches to Runway Resurfacing Design (Cross section)

Figure 12 : Milling And Transporting Milled Material For Recycle

Figure 13 : Depth Check Of Milled Area

Figure 14 : Appling Tack Coat One Wheel Markings

Figure 15 : Cleaning The Milled Surface With Bobcat

Figure 16 : Cleaning The Milled Surface With Blower

Figure 17 : Cleaning The Milled Surface With Compressor

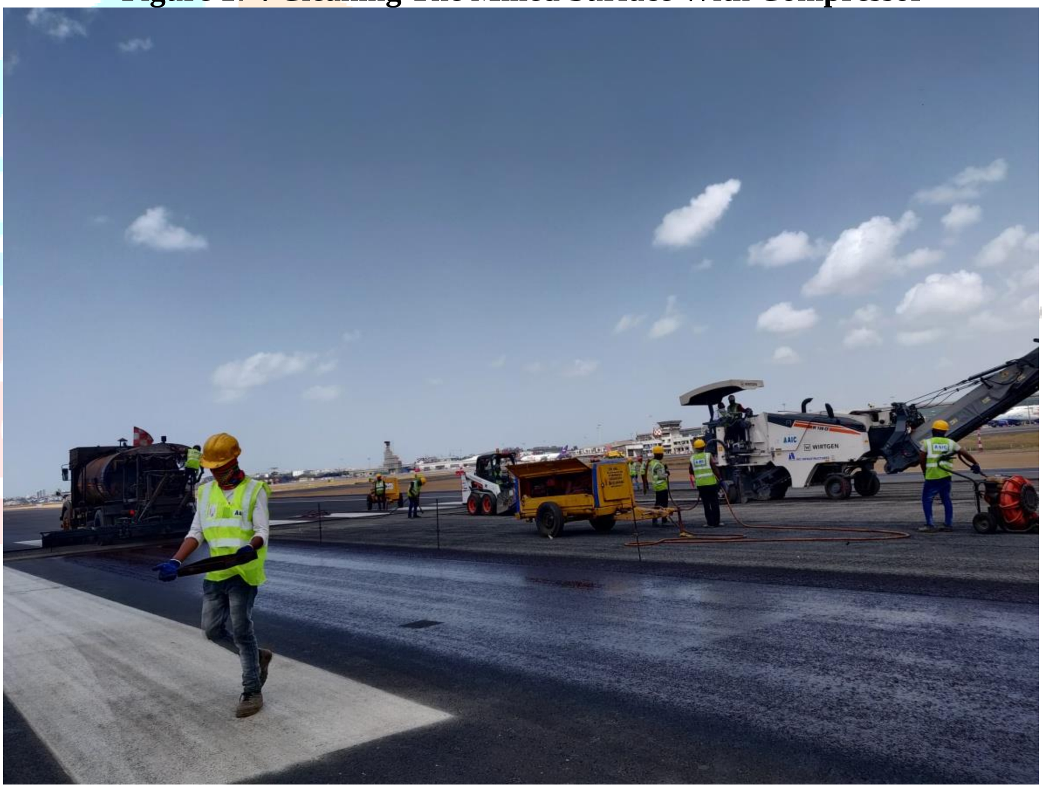

Figure 18 : Appling Tack Coat On The Milled Surface

Figure 19 : Appling Brush Tack Coat On The Pavement Edge

Figure 20 : Setting Up The Paver Dimensions

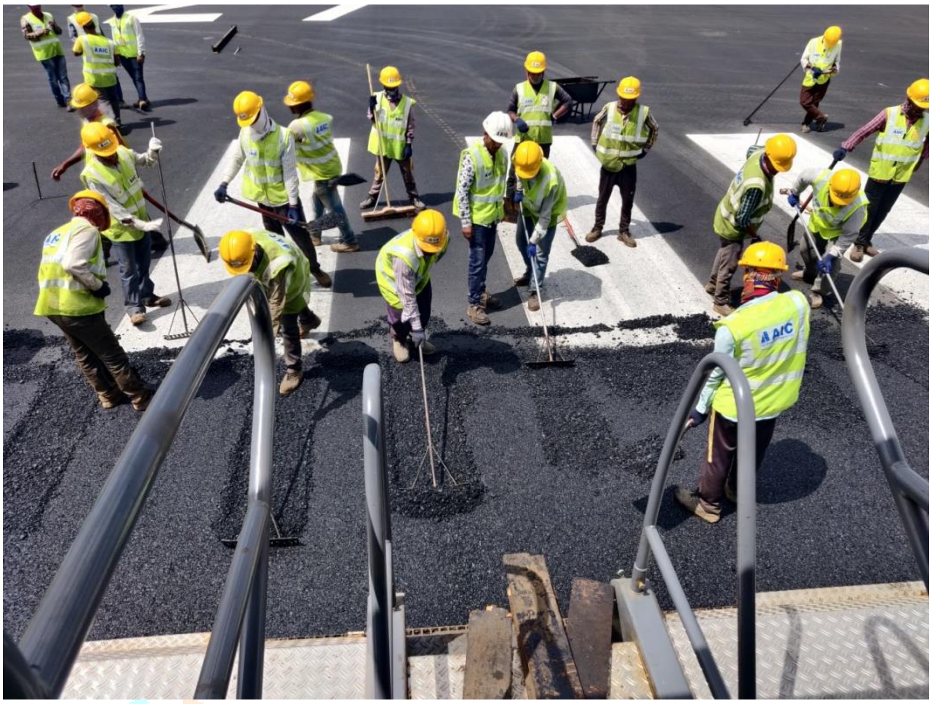

Figure 21 : Paver Starts Laying The Surface

Figure 22 : Compacting The Pavement By Tandem Roller

Figure 23 : Compacting The Pavement By Pnenumatic Roller

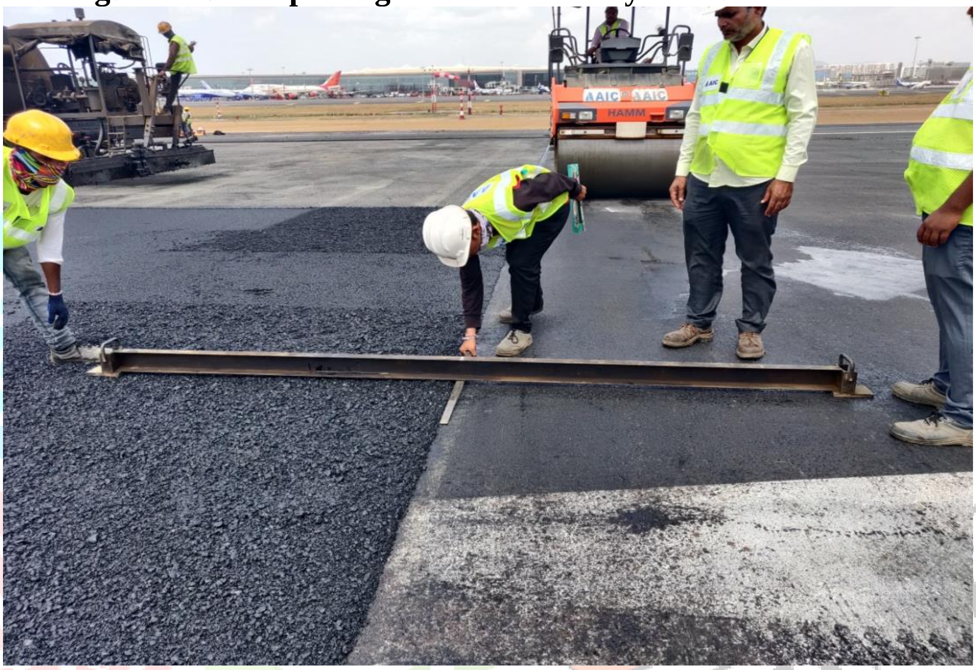

Figure 24 : Undulations are Measuring by Straightedge Test

Figure 25 : Tamping the sample to reduce the voides

Figure 26 : Level check and fixing a point

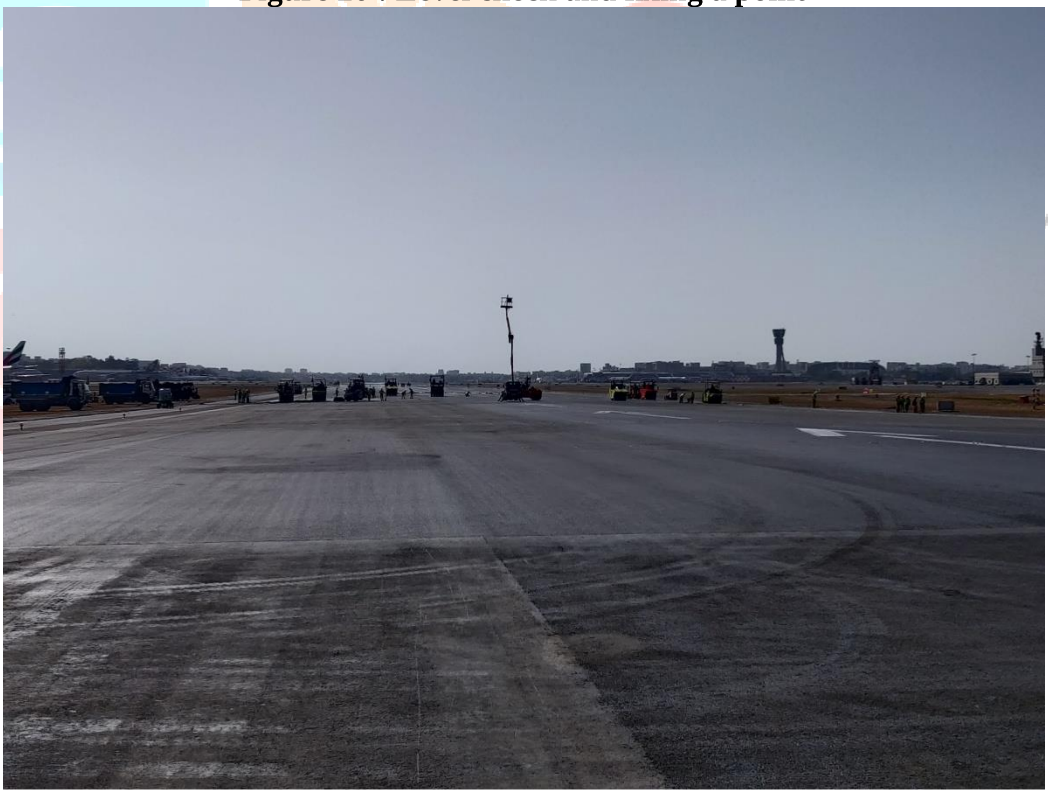

Figure 27 : New re-carpeted Runway pavement

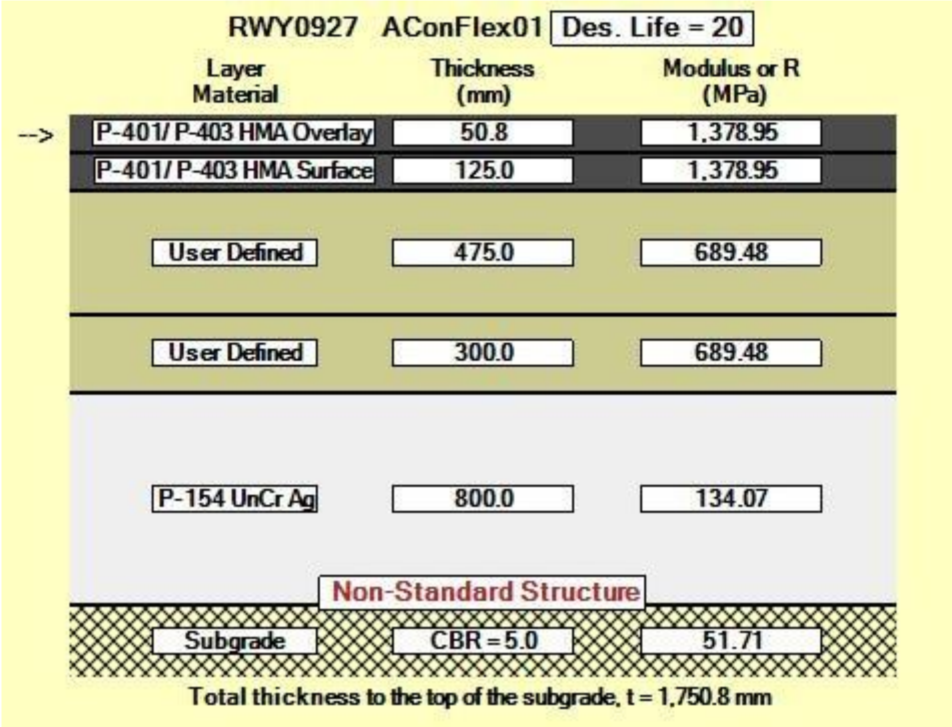

Figure 28 : Different lawyers Thickness of Re-carpeting Pavement of Runway09/27

Thickness according to FAARFIELD software :
Total thickness to the top of the subgrade = 1,750.8mm
The structure is AC Overlay on Flexible.
Asphalt CDF RATIO = 0.9696.
Design Life = 20 years.
Thickness = 1750.8mm

Table 23 : Thickness of individual layers

S.No.	Type	Thickness (mm)	Modulus (MPa)	Poisson's Ratio
1	P-401/P-403 HMA Overlay	50.8	1,378.95	0.35
2	P-401/P-403 HMA Surface	125.0	1,378.95	0.35
3	User Defined	475.0	689.48	0.35
4	User Defined	300.0	689.48	0.35
5	P-154 UnCr Ag	800.0	134.07	0.35
6	Subgrade	0.0	51.71	0.35