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RESUCING RUBBER DIPOSITION PROBLEM BY USING EPOXY

Professor A.V. Hankare, Shreeraj Chougale[2], Vaishnav Khorate[3], Sumit Chavan[4], Sanket Hatte[5], & Peamod Shelar[6].

[1] Assistant Professor, Department of Civil Engineering, Tatyasaheb Kore Institute of Engineering and Technology, Warananagar, India email: avhankare@tkietwarana.ac.in

[2] Department of Civil Engineering, Tatyasaheb Kore Institute of Engineering and Technology,Warananagar, India email:shreerajchougale@gmail.com

[3] Department of Civil Engineering, Tatyasaheb Kore Institute of Engineering and Technology,Warananagar, India email: khoratevaishnav@gmail.com

[4] Department of Civil Engineering, Tatyasaheb Kore Institute of Engineering and Technology,Warananagar, India email: sanket.hatte@gmail.com

[5] Department of Civil Engineering, Tatyasaheb Kore Institute of Engineering and Technology,Warananagar, India email: pramodshelar653@gmail.com

[6] Department of Civil Engineering, Tatyasaheb Kore Institute of Engineering and Technology Warananagar, India email: sumitchavan@gmail.com

ABSTRACT:

Airport pavement plays a crucial role in airway transportation. This review helps to examine the various problems on runway pavement surfaces such as rubber deposition. The primary goal is to escalate the maintenance cycle of the runway pavement. A major concern on runway pavement is rubber deposition, for which the current solution is water-blasting which erodes the runway pavement for that purpose provision of epoxy emulsion with stone mastic. Epoxy reduces the friction on pavement, reducing the problem of rubber deposition. The loss of water due to water blasting techniques is an environmental concern in the future. So, it will help in such a way that both the problem of rubber deposition, reduce maintenance of pavement, increase the life span of pavement as well as loss of water will be settled effectively.

Keyword- pavement, Rubber deposition, Epoxy coating Maintenance cycle, Skid resistance, Runway surface texture, Bitumen properties, Aggregate properties, Wear properties, Surface temperature, Real-world conditions simulation, Runway safety, Life cycle assessment, Cost-effectiveness, Environmental impact, Runway friction, Runway surface durability

Introduction:

A runway is a designated rectangular area on land used for aircraft landing and takeoff . Runways can be classified into two types: rigid and flexible. Rigid runways are composed of Portland cement concrete slabs resting on a fixed sub-base. Flexible runways are constructed of several layers of asphalt or bituminous concrete placed on a prepared subgrade .The two major problems that affect runway pavement are rubber accumulation. One of the key aspects of runway maintenance is to ensure the safe landing and takeoff of aircraft, which depends on the adequate runway pavement texture. Runway pavement friction is a critical factor for the safety of landing aircraft. The amount of skid resistance available for an aircraft depends on various factors related to the aircraft, aircraft tire and braking system, runway surface and the environment . Moreover, the surface texture of the runway is influenced by the amount of rubber deposits on the runway during the landing and takeoff. Therefore, removing built-up rubber deposits is a significant factor in determining pavement skid resistance. One of the key aspects of runway maintenance is to ensure the safe landing and takeoff of aircraft, which depends on adequate runway pavement texture aircraft tire is the key component of aircraft, and its wear performance is crucial to the safety of the aircraft. Under the high-speed landing condition, the temperature of the tire tread rises rapidly due to highspeed friction, Wear performance of aircraft tires is directly correlated to temperature. Therefore, it is essential to study the influence of temperature onwear properties.

Material Testing:

Test On Bitumen:

1. Flash and Fire Point of Bitumen
2. Softening Point Bitumen
3. Stripping Value Test on Bitumen

Test On Aggregate:

1. Impact Test on Aggregate

2. Abrasion Value Test on Aggregate

Flash And Fire Point Test

Table 1. Flash and fire point test results.

Sr. No.	Test	Trial 1 °C	Trial 2 °C	Trial 3 °C	Average °C
1.	Flash point	218	223	225	222
2.	Fire point	240	247	250	245

Conclusion:The avg. Flash and Fire point of bitumen is 222 ^{o}C & 245 ^{o}C . As per Airport Authority of India manual, hence we can use tested bitumen in Kolhapur region for runway Softening Point Test:

Table 2. Softening Point test Resul

Sr. No.	Description	Trial 1 °C	Trial 2 °C	Trial 3 °C	Mean °C
1	Temp. at which Sample touches bottom base plate	55	56	68	59.67

Conclusion: The avg. softening point of bitumen is 59.67^{o}C . As per AAI manual, hence we can use tested bitumen in Kolhapur region for runway construction.

Stripping Value Test:

Table 3. Stripping Value Test Results.

SR. No.	Description	Sample 1	Sample 2
1	Time of Mixing	11:30 am	11:35 am
2	Temp. of Aggregates of time of mixing	153 °C	152 °C
3	Temp. of bitumen of the time of mixing	161 °C	160 °C
4	Time of placing in water bath	1:45 pm	1:50 pm
5	Temp. of Water bath	40 °C	40 °C
6	Time of visual inspection	2:00 pm	2:10 pm
7	Coating value	96%	95%
8	Average coating value (%)	95.50%	

Conclusion: The avg. stripping value of aggregate and bitumen is 4.5%. As per Airport Authority of India Manual the stripping value of aggregate and bitumen should not be more than 5%, Hence the tested material safe for using in runway construction.

Impact Value Test:

Table 4. Impact Value Test results

SR.NO.	DESCRIPTION	TRIAL 1	TRIAL 2	TRIAL 3
1	wt. of empty mould	1.62 kg	1.62 kg	1.62 kg
2	wt. of mould with compacted sample	2.32 kg	2.25 kg	2.3 kg
3	wt. of sample	0.069	0.056	0.065
4	wt. of fraction passing 2.36mm IS sieve	0.5	0.55	0.4
5	impact value (/3*100)	7.25	9.82	6.15
6	Avg. Impact Value in %	7.74		

Conclusion: The avg. impact value of aggregate is 7.74%. As per AAI manual the impact value should be less than 30% hence aggregate are safe for using in runway construction.

Los Angeles Abrasion Test:

Table 3. Los Angeles abrasion Test results

SR.NO.	DESCRIPTION	Sample 1	Sample 2
1	Original Wt. of Aggregate W1 gms	5000	5000
2	Wt. of material retained on 1.70 mm is sieve after test W2 gms	4200	3850
3	Wt. of Passing (W1- W2) gms	800	1150
4	Abrasion Value in = W1-W2*W1	16%	23%
5	Avg. Abrasion Value in%	19.50%	

Conclusion: The avg. abrasion value of aggregate 19.50% . As per Airport Authority of India manual the abrasion value Should be less than 30%, Hence the tested aggregate is safe for runway wearing coat.

Prototype Casting and Testing

Mix Design of Concrete Prototype

Casting Size: 610 X 305 X 77 mm

Casting Type: 1) Rigid Salb

2) Rigid Slab with Epoxy coating

Mix Proportion: M40 Grade for Rigid Pavement

Mix proportion design-

1. Target Strength:

fck' = fck +1.65*S (IS 10262:2019)

Target Mean Compressive Strength at 28 Days

S- Standard Deviation

S- 5.0 N/mm^2 IS – 10262-2019 Table 2 Pg no.- 3

2. Water Cement Ratio:

Exposure Condition:- Extremely Severe IS 456:2000 Table – 3&4

Water Cement Ratio – 0.40

3. Water Content:

IS 10262:2019 Table 4 :- pg no.5.

20mm aggregates – 186kg 100mm Slump

For Every 25mm -add 3% - (IS10262) 186+6% of 186 = 19

Water Content = 197 kg

4. Cement Content:

Water Cement Ratio = water content/cement content

Cement Content = water content/water content ratio

Water content = 197 kg

Water Cement Ratio = 0.40

Cement Content = 197/0.4 = 492.5 Kg/m^3 >360kg/m^3

5. Aggregates Proportion between CA & FA IS – 10262 Table -5 pg no. 6.

Zone -II – 0.62

Every 0.05 decrease, increase 0.01. (W/C – 0.4) , (0.5-0.4)/0.05=2 0.62+0.01+0.01 =0.64

Volume of Aggregates = 0.64

The volume of Fine aggregates = 0.42

6. Mix calculation per unit volume of conc.

- Volume of Cement
  Mass of cement/Mass density = 492.5/3.16*1000
- Cement= 0.155 m^3The
- Volume of Water:-
  Mass of water/Mass density = 197/1000 = 0.197 m^3
- Volume of Aggregate
  The volume of all in aggregate = 1-(Volume Cement + Volume of water)

= 1-(0.155+0.197)

= 0.648

Mass of coarse aggregate = Volume of all in aggregate * Volume of Coarse aggregate*specific gravity

coarse aggregate*1000

= 0.648*0.64*2.73*1000

= 1132.18 Kg

Mass of fine aggregate= 0.648*0.424*2.46*1000

= 675.88 Kg

Cement = 492.5 Kg/m^3

Water= 197 Kg/m^3

Fine aggregate = 675.88 Kg/m^3

Coarse aggregate = 1132.18 Kg/m^3

Rigid Slab:

Volume of Casting: 0.6*0.3*0.0254m = 0.0137 m^3

Fine aggregates: 675.88 * 0.0137= 9.259 kg

Coarse aggregates – 1132.18*0.0137= 15.51 kg

Cement– 492.5 * 0.0137=6.74 kg

Water- 197*0.0137= 2.698 kg

Test Performed on Prototype – Skid Resistance Test by Using British Pendulum Tester

Table.4.Skid Resistance Test Result

Test No.	Rigid pavementSurface		Stone Mastic AsphaltSurface		Cement EpoxySurface		Stone Mastic Asphalt Surfacewith Epoxy	
	Dry	**Wet**	**Dry**	**wet**	**Dry**	**Wet**	**Dry**	**Wet**
1	76	62	82	76	70	63	78	71
2	76	63	85	78	71	62	77	70
3	78	66	81	74	73	61	79	70
4	80	72	83	72	72	62	77	71
5	77	68	80	73	72	61	77	72
6	76	63	78	72	73	64	76	72
Avg.	77.16	65.66	81.5	74.16	71.83	62.16	77.33	71

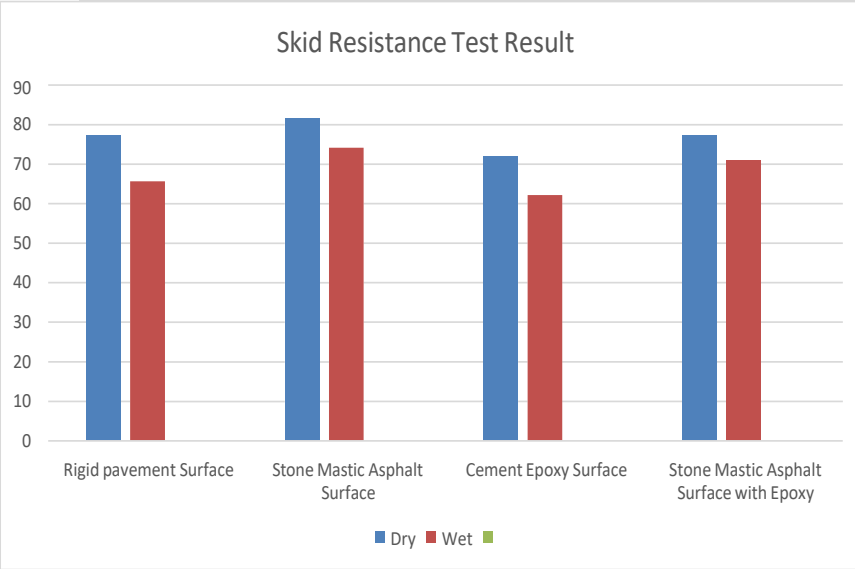

Fig.1 .- Graphical Representation Skid Resistance Test Result

Rubber Deposition Calculation

By using Archards Wear Theory –
The volume of tire material eroded -

V= Volume of wear amount

$$V = K\frac{F_R}{H}L$$

K= Wear Coefficient FR=Normal load

H= Hardness of softer material in the contact

L= Slip Distance FR= 1400 KN , L= 1.47 m, H= 7.74, K= 0.73

V = 188.78$mm3$

Type of Condition	Rigid pavement Surface	Stone Mastic AsphaltSurface	Cement Epoxy Surface	Stone Mastic Asphalt Surfacewith Epoxy

Dry	204.73 mm^3	215.37 mm^3	188.78 mm^3	204.73mm^3
Wet	172.82 mm^3	196.76 mm^3	164.85mm^3	188.78mm^3

Table.5. Calculation Of Rubber Deposited

Surface Temperature

Pavement surface temperature is depending on the following factors.

1) Solar radiation
2) Air Temperature
3) Wind Speed
4) Relative Humidity
5) Cloud Cover
6) Precipitation
7) Road Material
8) Road Geometry
9) Traffic Ground

Conclusion:

The project aimed to evaluate the rubber deposition on runway and reducing it. For these the properties of material are found out as per airport authority standard. The tests evaluated are abrasion, toughness, flash and fire point, softening point, stripping values of aggregate and bitumen. The study also compared the effects of water blasting on pavement surfaces and the cost-effectiveness of applying different coatings to reduce rubber deposition and increase durability. The tests included the toughness and abrasion test, which confirmed the strength of aggregate which used in runway construction against abrasion and toughness. The surface friction test showed that the epoxy resin coated runway surface provided enough friction to prevent skidding and sliding accidents during landing and take-off. But during wet conditions we observe that prototype surface became slippery hence there is chance of sliding during rainy condition. However, the test did not mimic real-world conditions, so more tests are needed to assess the skid resistance of the runway surface under realistic situations.

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