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Experimental Investigation on Repair and Maintenance of Flexible Pavement using Geosynthetics

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Abstract: ***The activity of vehicles on the surface of street yield distortions in the asphalt structure, these disfigurements corrupt the asphalts and abnormalities, trenches, splits and potholes. Potholes headed for be found in any urban and provincial territory of the nation. In India where the improvement of potholes on the streets and extremely common.as request to keep up these streets, it is important to distinguish the reason for potholes and successful cures. In the greater part of Indian urban communities potholes are repaired with outdated methods, nowdays geosynthetics are ordinarily utilized as a part of adaptable street base strengthened by embeddings them commonly at the interface between the base course and the subgrade.***
Keywords: Potholes, cause of potholes, repair techniques, geosynthetics, flexible pavement, cyclic plate load.

I. INTRODUCTION

Streets in India are fundamentally bitumen-based macadamized streets. The principle streets in India are under immense weight and in extraordinary need of modernization so as to deal with the expanded necessities of the Indian economy. Notwithstanding support, the extension of the system and broadening of existing streets is winding up progressively imperative. This would then empower the streets to deal with expanded activity, and furthermore take into consideration a comparing increment in the normal development speed on India's streets. Advancement of potholes on Indian streets and avenues after the beginning of rainstorm is a typical wonder. Consistently there is an open objection and daily papers are brimming with pictures demonstrating potholed street asphalts. Hot blend black-top plants are generally closed down amid storms and no hot bituminous blend is accessible for filling potholes. Thusly, numerous potholes are either not repaired or repaired with out of date procedures. Geosynthetics have been effectively used to satisfy various capacities that contribute altogether to the great execution of roadways. They incorporate the elements of partition, stiffening, reinforcement, drainage, separation, and protection. One or on the other hand a greater amount of these different capacities has been utilized as a part of no less than six imperative roadway applications. The applications incorporate the movement of intelligent splitting in black-top overlays, detachment, adjustment of street bases, adjustment of street delicate subgrades, what's more, parallel seepage. This paper outlines the systems and additionally enter propels in every last one of these numerous applications.

II. MATERIALS

A. Geotextile

The geotextile texture should be a woven, non-woven or weaved texture comprising of long-chain polymeric fibers or yarns, for example, polypropylene, polyethylene or polyester or any blend thereof, framed into a steady system to such an extent that the fibers or yarns hold their relative position to each other. There are a few application territories for geotextiles requiring particular capacities specifically separation, filtration, drainage, reinforcement.

HTSF W-3020A is woven geo-textile made of 100% polypropylene Multifilament yarn, which are made from very high tenacity yarn and very good stability.

Figure 1 Geotextile (HTSF-W3020A)

The table below provides the Physical properties of used geotextile.

Table 1 Physical Properties of Geotextile

Sr. No.	Design-parameter	HTSF-W3020A
1	Material Geo-bag textile	100% P.P
2	E.O.S. (mm) Pore size (mm)	>0.15 <0.70
3	Specific gravity	0.91
4	Thickness in mm (min) at 1KPa Pressure	0.8
5	Breaking Strength from (5cm x 20 m strip) (IS: 1969 – Latest edition) Warp	> 100 K.N.
6	% in Elongation at break (IS: - Latest edition) Warp	<28
7	Grab strength test (3" x1" strip) (ASTM-D- 1682) Warp way (Kgs)	>0.220
8	% in Elongation (Grab test) (ASTM-D- 1682) Warp way	<28
9	Tear Strength (Single rip) (ASTM-D-1682) Wrap way (Kgs)	>0.60
10	Water permeability (Lim/m2/Sec. At 10 cm water head)	>20
11	G.S.M.	430 GSM
12	Width of Fabric .cms Length of roll mtrs.	>150 >100

III.OBJECTIVE

A. To evaluate the comparative performance of pavements with and without geosynthetic stabilization by experimental investigations on subgrade sample.

B. To provide solution for flexible pavement failure (for potholes) with geosynthetics (geotextile).

IV.EXPERIMENTAL WORK

A. Aggregate testing

The aggregate performance tests were performed on the various specified properties, and the resulting test results were compared with the allowable values in the MORTH specification, as shown in the table.

Table 2 Test Result of 6mm Grit

TEST RESULT						
Specification: Morth 5th Revision						
Sr. No	SIEVE SIZE	% PASSING	REQ.	FLAKINESS INDEX, %	ELONGATION INDEX, %	METHOD OF TEST
01	9.5 mm	100	100	-	-	IS:2386 (Part-1):1963 Reaffirmed 2016
02	6.3 mm	93.46	90-100			
03	3.35 mm	51.95	45-65	Combined Shall be < 35% (As per Morth)		
04	1.18 mm	12.42	10-30			
05	0.075 mm	3.99	2-8			

OTHER TEST RESULTS				
Sr. No	TYPE OF TEST	RESULT	REQUIREMENT	METHOD OF TEST
1	Water Absorption, %	0.93	Max 2 %	IS:2386 (Part-3):1963 Reaffirmed 2016
2	Specific Gravity	2.829	-	

Table 3 Test Result of 10mm Aggregate

TEST RESULT						
Specification: Morth 5th Revision						
Sr. No	SIEVE SIZE	% PASSING	REQ.	FLAKINESS INDEX, %	ELONGATION INDEX, %	METHOD OF TEST
01	12.5 mm	100	100	17.05	22.21	IS:2386 (Part-1):1963 Reaffirmed 2016
02	10.0 mm	88.50	85-100			
03	4.75 mm	5.95	0-20	Combined Shall be < 40% (As per Morth)		
04	2.36 mm	0.94	0-5			

OTHER TEST RESULTS				
Sr. No	TYPE OF TEST	RESULT	REQUIREMENT	METHOD OF TEST
1	Water Absorption, %	0.89	Max 2 %	IS:2386 (Part-3):1963 Reaffirmed 2016
2	Specific Gravity	2.868	-	
4	Impact Value, %	13.95	<45% for Concrete & <30 % for Wearing surfaces	IS:2386 (Part-4):1963 Reaffirmed 2016
6	Abrasion Value, %	17.84	<45% for concrete & <30% for wearing surfaces	

Table 4 Test Result of 20 mm Aggregate

TEST RESULT						
Specification: Morth 5th Revision						
Sr. No	SIEVE SIZE	% PASSING	REQ.	FLAKINESS INDEX, %	ELONGATION INDEX, %	METHOD OF TEST
01	40.0 mm	100	100	15.26	20.14	IS:2386 (Part-1):1963 Reaffirmed 2016
02	20.0 mm	91.52	85-100			
03	10.0 mm	2.15	0-20	Combined Shall be < 40% (As per Morth)		
04	4.75 mm	0.08	0-5			

OTHER TEST RESULTS				
Sr. No	TYPE OF TEST	RESULT	REQUIREMENT	METHOD OF TEST
1	Water Absorption, %	0.87	Max 2 %	IS:2386 (Part-3):1963 Reaffirmed 2016
2	Specific Gravity	2.870	-	
4	Impact Value, %	13.26	<45% for Concrete & <30 % for Wearing surfaces	IS:2386 (Part-4):1963 Reaffirmed 2016
6	Abrasion Value, %	16.24	<45% for concrete & <30% for wearing surfaces	

Table 5 Test Result of 40mm Aggregate

TEST RESULT						
Specification: Morth 5th Revision						
Sr. No	SIEVE SIZE	% PASSING	REQ.	FLAKINESS INDEX, %	ELONGATION INDEX, %	METHOD OF TEST
01	63.0 mm	100	100	11.25	13.27	IS:2386 (Part-1):1963 Reaffirmed 2016
02	40.0 mm	89.63	85-100			
03	20.0 mm	5.21	0-20	Combined Shall be < 40% (As per Morth)		
04	10.0 mm	0.52	0-5			

OTHER TEST RESULTS				
Sr. No	TYPE OF TEST	RESULT	REQUIREMENT	METHOD OF TEST
1	Water Absorption, %	0.81	Max 2 %	IS:2386 (Part-3):1963 Reaffirmed 2016
2	Specific Gravity	2.873	-	
4	Impact Value, %	11.24	<45% for Concrete & <30 % for Wearing surfaces	IS:2386 (Part-4):1963 Reaffirmed 2016
6	Abrasion Value, %	14.36	<45% for concrete & <30% for wearing surfaces	

Table 6 Test Result of 45-63mm Aggregate

TEST RESULT						
Specification: Morth 5th Revision						
Sr. No	SIEVE SIZE	% PASSING	REQ.	FLAKINESS INDEX, %	ELONGATION INDEX, %	METHOD OF TEST
01	90.0 mm	100	100	9.63	11.52	IS:2386 (Part-1):1963 Reaffirmed 2016
02	63.0 mm	96.36	90-100			
03	53.0 mm	42.15	25-75	Combined Shall be < 35% (As per Morth)		
04	45.0 mm	2.85	0-15			
05	22.4 mm	0.74	0-5			

OTHER TEST RESULTS				
Sr. No	TYPE OF TEST	RESULT	REQUIREMENT	METHOD OF TEST
1	Water Absorption, %	0.79	Max 2 %	IS:2386 (Part-3):1963 Reaffirmed 2016
2	Specific Gravity	2.882	-	
4	Impact Value, %	9.85	<45% for Concrete & <30 % for Wearing surfaces	IS:2386 (Part-4):1963 Reaffirmed 2016
6	Abrasion Value, %	13.26	<45% for concrete & <30% for wearing surfaces	

B. bitumen testing

Bitumen grade was used in this study is VG-30. Sample of bitumen were tested for penetration test, ductility test, viscosity test and softening point test. The test results of different bitumen tests results are shown in table:

Table 7 Bitumen Test Result

TEST RESULT			
			Method of Test: IS:1201-1220:1978 Reaffirmed 2009
Sr. No.	TESTS	RESULTS	REQUIREMENT AS PER IS:73-2013
1	Penetration at 25° C,0.1mm, 100gm, 5s	52	Min 45
2	Softening Point, ° C	49.5	Min 47° C
3	Absolute Viscosity at 60° C, Poise	2932	2400-3600
4	Kinematic Viscosity at 135° C, cSt	429	Min 350
5	Ductility @ 25° C	95	Min 40 cm

C. Design and Method

The experimental work is performed on mild steel plate box having following properties:

1) Size of Box: 0.8 x 0.8 x 0.8 m.

2) Thickness of the plate: 1.20 mm.

Figure 2 Mild Steel Box

3) The Cyclic plate load test is to be performed with geotextile as reinforcement, same as with geogrid. (IS: 5249-1992, clause 6)

4) The below figure shows the different pavement layers with their dimensions.

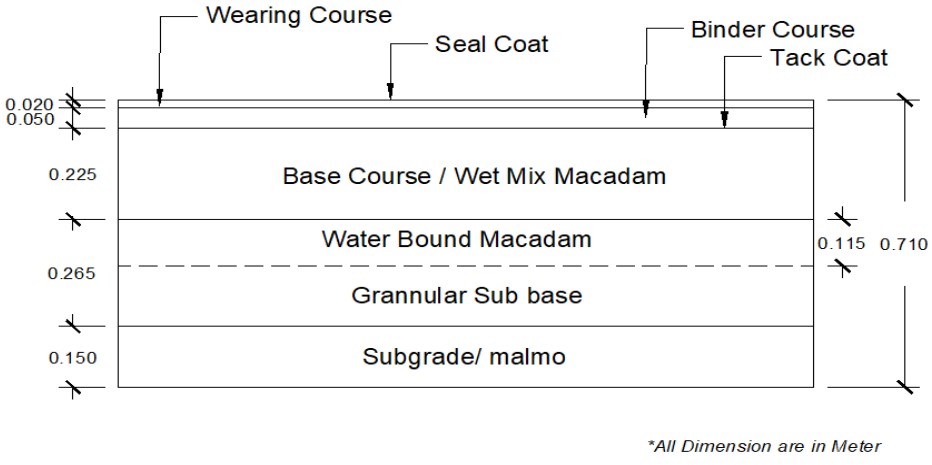

Figure 3 Pavement Layers in Prepared Sample

Pavement Layer Criteria: for the 2 msa traffic with CBR 4%, (Source: IRC:37 (2001) Page No. 23, Pavement Design Catalogue)

a) Granular Sub base = 265 mm
b) Base Course = 225 mm
c) Binder Course = 50 mm
d) Wearing Course = 20 mm

By the formula of density, we can find the total mass at desirable compaction density.

Density = Mass/volume

Table 8 Layer Composition

Layer	Density (gm/cm^3) (As per Morth 5th Revision)	Volume (m^3)	Total Weight (kg)
Subgrade	1.785	0.096	171
Granular Subbase	1.803	0.096	173
Water Bound Macadam	1.803	0.0736	132
Base Course /Wet Mix Macadam	2.214	0.144	318
Binder Course	2.214	0.032	70
Wearing Course	2.214	0.0128	28

D. Preparation of Pavement Layers

Figure 4 Laying and Compaction of Subgrade

Figure 5 Laying and Compaction of Subbase

Figure 6 Laying and Compaction of WBM

Figure 7 Laying and Compaction of WBM final layer

Figure 8 Laying and Compaction of Base course/WMM

Figure 9 Laying and Compaction of Binder Course

Figure 10 After Completion of Laying and Compaction of Wearing Course

E. Cyclic Plate Load Test for Normal Sample

1) Load Test calculations:

a) Assume SBC = 40 t/m2

b) Test load = 40 x 2.50 = 100 t/m2

Pressure Gauge Least Count = 10 kg/cm2

Ram Dia = 9.62 cm2

= 9.62 x 10

= 96.2 kg

Plate Area = 0.075 x 0.075 = 0.005625 m2

Total Apply Load = 100 x 0.005625 = 0.5625 ton = 562.5 kg

Increment nos. = 562.5/5 = 112.5 kg but Actual apply load = 96.2, therefore increment = 6 with maximum load of 96.2 kg.

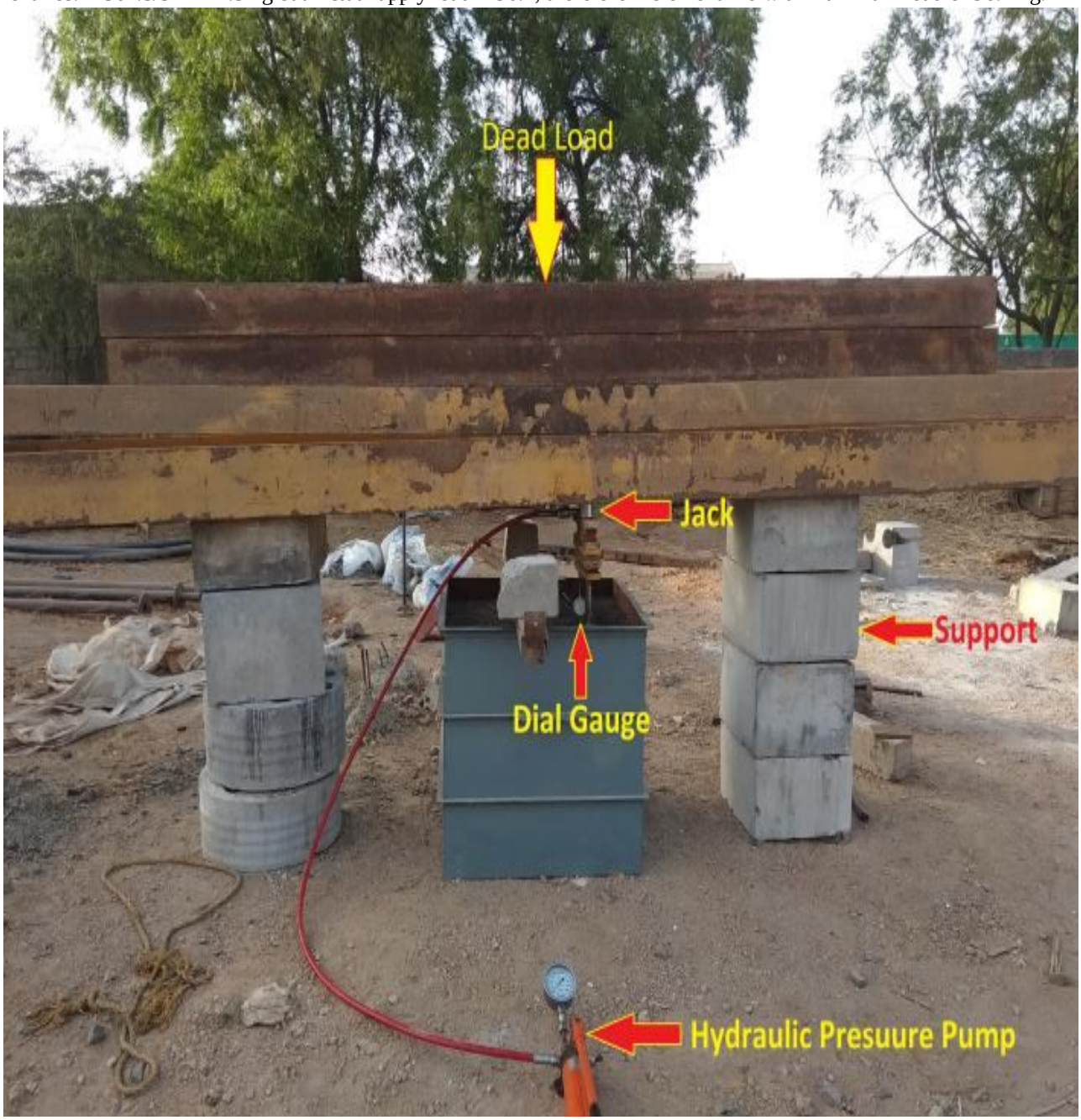

Figure 11 Test Setup

Table 9 Test Result of Cyclic Plate Load for Normal Sample

Sr. No.	Load (Kg)	Dial Gauge Readings, mm	Settlement in mm
Point - 1			
0	0.0	30.00	0.00
1	96.2	28.10	1.90
Release Reading	0.00	29.05	
2	192.4	27.90	2.10
Release Reading	0.0	28.40	
3	288.6	26.60	3.40
Release Reading		27.22	
4	384.8	26.12	3.88
Release Reading	0.0	26.70	
5	481	25.90	4.10
Release Reading	0.0	2625	
6	562.5	25.38	4.62
Release Reading	0.0	25.90	
Point - 2			
0	0.0	30.00	0.00
1	96.2	26.78	3.22
Release Reading	0.00	27.21	
2	192.4	23.20	6.80
Release Reading	0.0	24.10	
3	288.6	21.40	8.60
Release Reading	0.0	23.62	
4	384.8	20.22	9.78
Release Reading	0.0	21.58	
5	481	19.73	10.27
Release Reading	0.0	20.95	
6	562.5	19.45	10.55
Release Reading	0.0	20.61	

Sr. No.	Load (Kg)	Dial Gauge Readings, mm	Settlement in mm
Point - 3			
0	0.0	30.00	0.00
1	96.2	27.35	2.65
Release Reading	0.00	27.88	
2	192.4	26.70	3.30
Release Reading	0.0	27.48	
3	288.6	25.18	4.82
Release Reading		26.50	
4	384.8	24.65	5.35
Release Reading	0.0	25.60	
5	481	24.08	5.92
Release Reading	0.0	25.32	
6	562.5	23.90	6.10
Release Reading	0.0	24.82	
Point - 4			
0	0.0	30.00	0.00
1	96.2	27.90	2.10
Release Reading	0.00	28.12	
2	192.4	26.23	3.77
Release Reading	0.0	27.05	
3	288.6	25.55	4.45
Release Reading	0.0	26.60	
4	384.8	24.02	5.98
Release Reading	0.0	25.80	
5	481	23.82	6.18
Release Reading	0.0	25.05	
6	562.5	23.08	6.92
Release Reading	0.0	24.75	

Sr. No.	Load (Kg)	Dial Gauge Readings, mm	Settlement in mm
Point - 5			
0	0.0	30.00	0.00
1	96.2	26.88	3.12
Release Reading	0.00	27.60	
2	192.4	25.40	4.60
Release Reading	0.0	26.75	
3	288.6	24.62	5.38
Release Reading	0.0	25.05	
4	384.8	23.72	6.28
Release Reading	0.0	24.62	
5	481	23.39	6.61
Release Reading	0.0	24.15	
6	562.5	22.85	7.15
Release Reading	0.0	23.98	

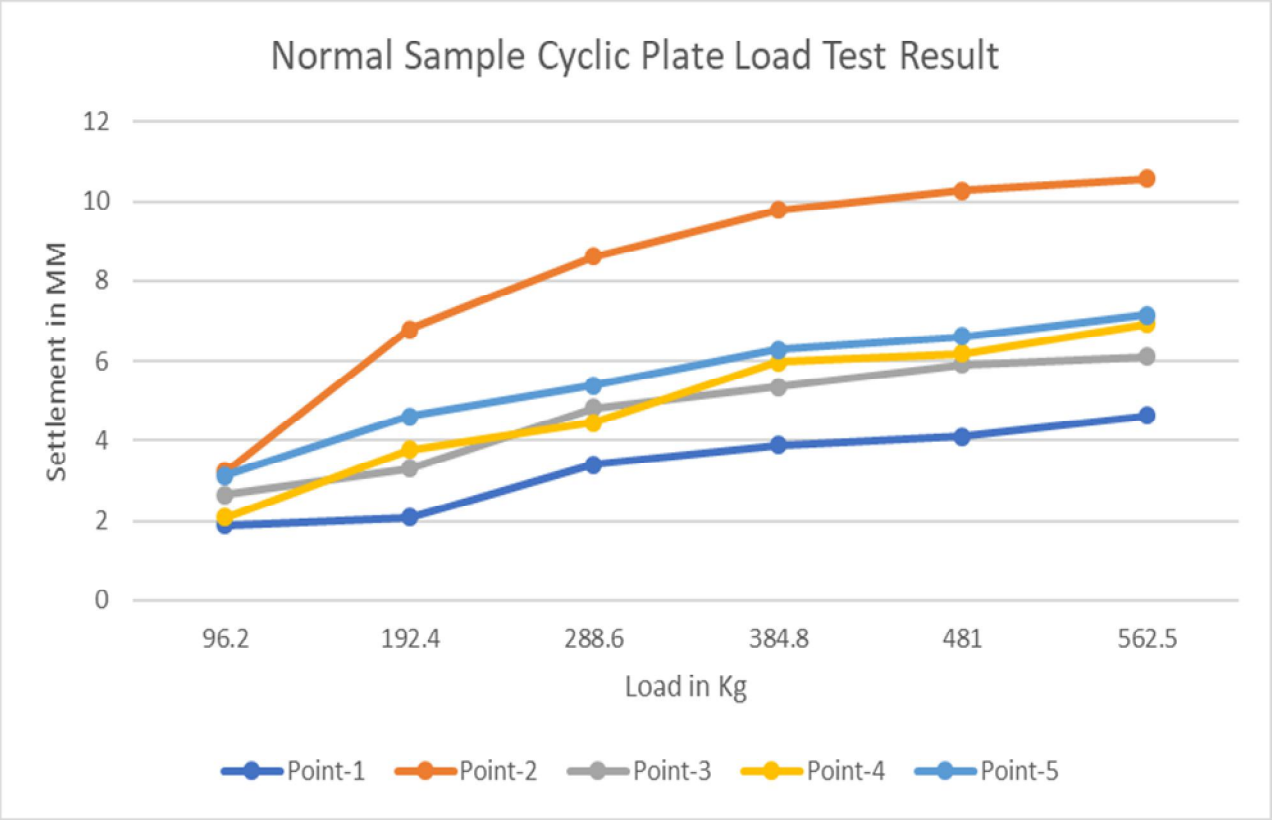

Figure 12 Graphical Representation of Normal Sample Result

F. Cyclic Plate Load Test for Geotextile Based Sample

Figure 13 Position of Pothole

The Fig. 13 Showing the position of the pothole, which is shown in irregular shape. The while square boundary is the marking for the cutting and dig out up to the Base course.

Figure 14 Geotextile Laying

The Fig. 14 Shows the dig out portion and placing of geotextile in the position. The geotextile is nailed at four corners for kept it appropriate position.

Figure 15 Laying of Bitumen Concrete

Fig. 15 showing the laying of bitumen concrete on the geotextile. After fill out the portion, proper compaction is done. On the surface of bitumen concrete the aggregate dust is sprinkled.

Figure 16 Testing on Geotextile Based Sample

Table 10 Test Result of Cyclic Plate Load for Geotextile Based Sample

Sr. No.	Load (Kg)	Dial Gauge Readings, mm	Settlement in mm
Point - 1			
0	0.0	30.00	0.00
1	96.2	29.80	0.20
Release Reading	0.00	29.84	
2	192.4	29.44	0.56
Release Reading	0.0	29.68	
3	288.6	28.92	1.08
Release Reading	0.0	29.10	
4	384.8	28.55	1.45
Release Reading	0.0	28.95	
5	481	27.60	2.40
Release Reading	0.0	28.10	
6	562.5	27.05	2.25
Release Reading	0.0	27.75	
Point - 2			
0	0.0	30.00	0.00
1	96.2	28.87	1.13
Release Reading	0.00	29.22	
2	192.4	28.33	1.67
Release Reading	0.0	28.90	
3	288.6	27.69	2.31
Release Reading	0.0	28.32	
4	384.8	27.24	2.60
Release Reading	0.0	27.72	
5	481	26.70	3.30
Release Reading	0.0	27.08	
6	562.5	26.22	3.78
Release Reading	0.0	26.88	

Sr. No.	Load (Kg)	Dial Gauge Readings, mm	Settlement in mm
Point - 3			
0	0.0	30.00	0.00
1	96.2	27.78	2.22
Release Reading	0.00	28.44	
2	192.4	27.35	2.65
Release Reading	0.0	27.95	
3	288.6	27.02	2.98
Release Reading		27.60	
4	384.8	26.66	3.34
Release Reading	0.0	27.00	
5	481	26.20	3.80
Release Reading	0.0	26.45	
6	562.5	25.92	4.08
Release Reading	0.0	26.22	
Point - 4			
0	0.0	30.00	0.00
1	96.2	28.10	1.9
Release Reading	0.00	28.44	
2	192.4	27.54	2.46
Release Reading	0.0	27.98	
3	288.6	27.33	2.67
Release Reading	0.0	27.92	
4	384.8	26.89	3.11
Release Reading	0.0	27.56	
5	481	26.66	3.34
Release Reading	0.0	27.25	
6	562.5	26.04	3.96
Release Reading	0.0	26.97	

Sr. No.	Load (Kg)	Dial Gauge Readings, mm	Settlement in mm
Point - 5			
0	0.0	30.00	0.00
1	96.2	27.65	2.35
Release Reading	0.00	28.00	
2	192.4	27.17	2.83
Release Reading	0.0	27.68	
3	288.6	26.59	3.41
Release Reading	0.0	27.43	
4	384.8	26.13	3.87
Release Reading	0.0	27.09	
5	481	25.74	4.26
Release Reading	0.0	26.86	
6	562.5	25.22	4.78
Release Reading	0.0	26.30	

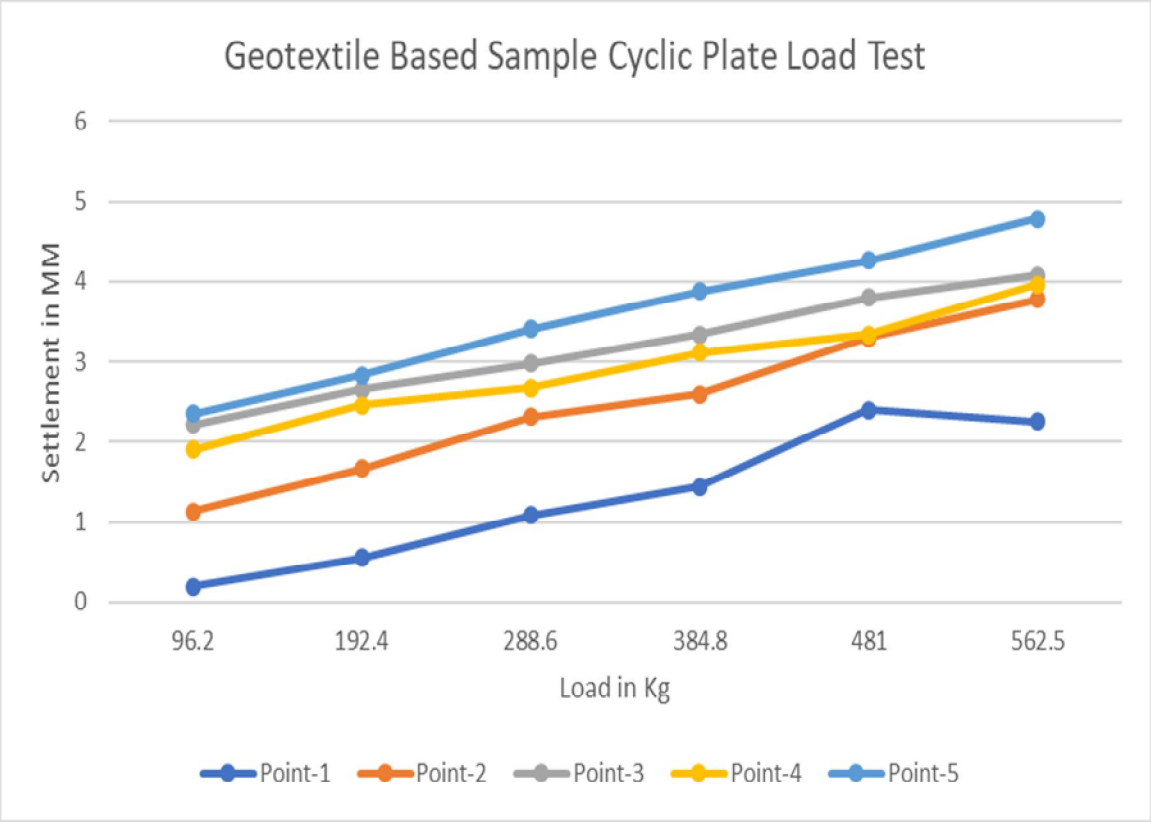

Figure 17 Graphical Representation of Geotextile Based Sample

Table 11 Comparison of Results

Point	Loading	Normal Sample Result, (Settlement in mm)	Geotextile Based Sample Result, (Settlement in mm)	Decrement in Settlement (%)
1	96.2	1.90	0.20	89.47
	192.4	2.10	0.56	73.33
	288.6	3.40	1.08	68.23
	384.8	3.88	1.45	62.62
	481	4.10	2.40	41.46
	562.5	4.62	2.25	51.29
2	96.2	3.22	1.13	64.90
	192.4	6.80	1.67	75.44
	288.6	8.60	2.31	73.13
	384.8	9.78	2.60	73.41
	481	10.27	3.30	67.86
	562.5	10.55	3.78	64.17
3	96.2	2.65	2.22	16.22
	192.4	3.30	2.65	19.69
	288.6	4.82	2.98	38.17
	384.8	5.35	3.34	37.57
	481	5.92	3.80	35.81
	562.5	6.10	4.08	33.11
4	96.2	2.10	1.9	9.52
	192.4	3.77	2.46	34.74
	288.6	4.45	2.67	40.00
	384.8	5.98	3.11	48.00
	481	6.18	3.34	45.95
	562.5	6.92	3.96	42.77
5	96.2	3.12	2.35	24.67
	192.4	4.60	2.83	38.47
	288.6	5.38	3.41	36.61
	384.8	6.28	3.87	38.37
	481	6.61	4.26	35.55
	562.5	7.15	4.78	33.14
				Avg - 47.12

V. CONCLUSION

Based on the laboratory experiments and analysis, the following conclusions are drawn,

A. It is observed that, for geotextile-based sample results are decreased than normal sample (Table 11) which indicates that the use of geotextile in repair of potholes can increase the load carrying capacity and gives better strength in repair.

B. The average decrement in geotextile based sample is 47.12% compared to normal sample.

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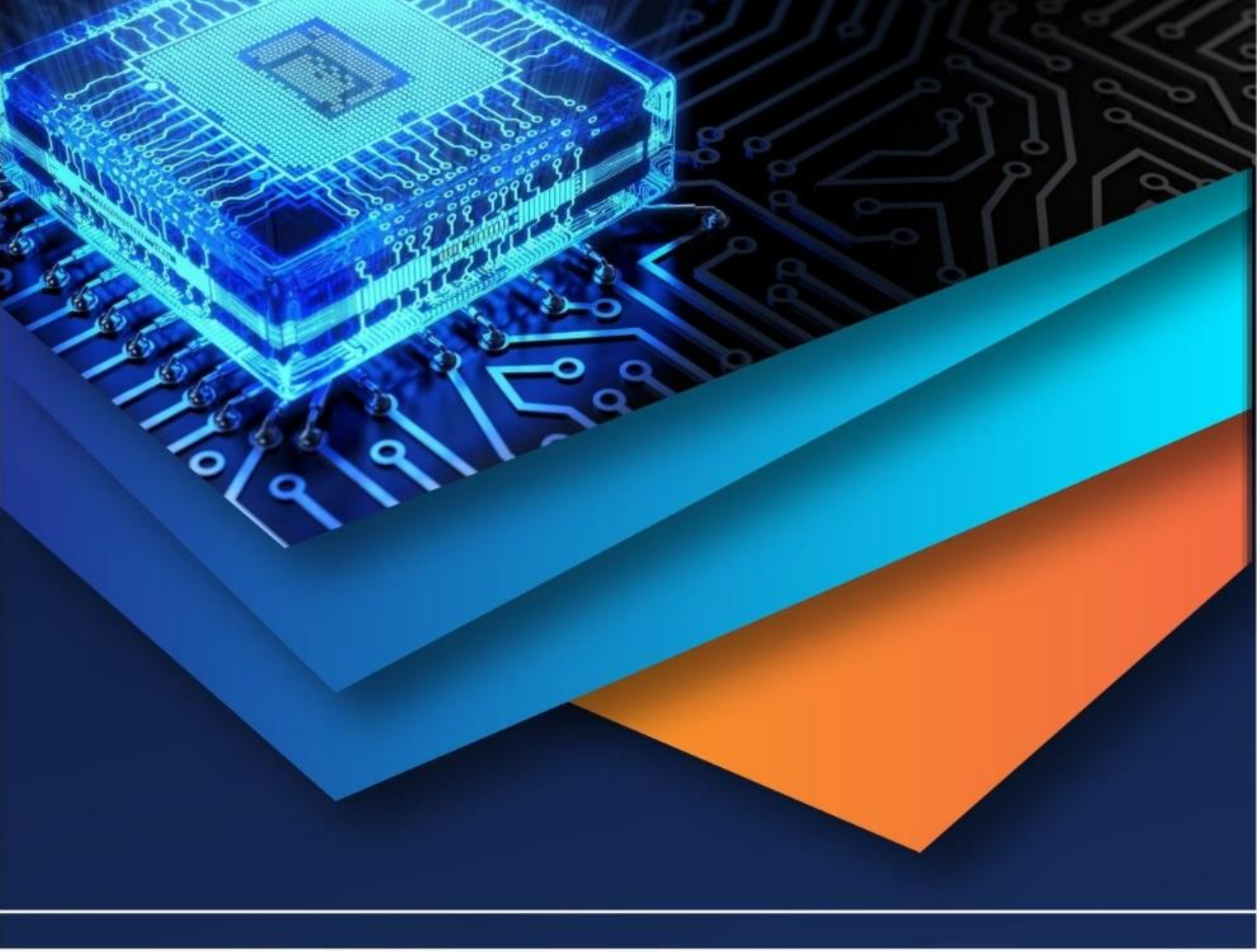

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