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### Design of Geocell Reinforced Pavement Overlays Geopolymer Concrete

Rushikesh Sapkal, Shivam Kasurkar, Rohit Patil, Sanket Kamble, Prof. Vishwjeet Kadlag,

B.E Students, Department of Civil Engineering, Dr. D Y Patil School of Engineering and Technology, Lohegaon,

Pune, Maharashtra, India<sup>1-4</sup>

Assistant Professor, Department of Civil Engineering, Dr. D Y Patil School of Engineering and Technology, Lohegaon,

Pune, Maharashtra, India<sup>5</sup>

**ABSTRACT**: This paper defines the outcomes of a experimental studies carried out for examining the structural behavior of different types of cell-filled pavements. The main objective of the current study is to inspect the behavior of pavements built by filling the cells with (a) cement concrete (b) geopolymer concrete. A formwork of sections of thin recycled plastic sheets was used to construct cell-filled concrete pavements, which function as cast-in situ linked block pavements. A comparison of expenses of different types of cell-filled concrete pavements with those of traditional flexible and rigid pavements planned for low traffic volumes roads specifies that cell-filled pavements are cost-effective compared with conventional pavements, mainly in locations with lack of aggregates.

**KEYWORDS:** geocell pavement, geocell, geopolymer concrete, pavements, fly ash, concrete road.

#### **I. INTRODUCTION**

Most of the low volume village roads being constructed are flexible roads providing with a thin layer of bituminous surface. Fairly these roads get damaged due to overloaded vehicles, inadequate drainage capability also water logging problems, and hence requirement of early periodic maintenance. Also, in the absence of adequate fund and timely maintenance, the serviceability level of the roads deteriorates quickly.

Therefore, to there is a need to come up with new progressive technologies. The cell filled concrete pavements gives long-lasting concrete pavements at low early cost which are more durable and almost maintenance free. The cells are tensioned and spread across the foundation layer and concrete is poured and compacted into the cells. Upon compaction the cell walls get deformed resulting in interlinking of end-to-end individual concrete block.

Fly ash is formed from burning of coals in thermal plants. 66% of countries electricity depends on thermal power plants. The consumption of coal produces tones of fly ash which is a left-over waste product. The fly ash can be used in concrete by replacing certain proportion of cement. Replacement cement by fly ash decrease cost of construction as fly ash is low-priced. Fly ash also helps in improving strength and ease of pumping of concrete and lesser heat of hydration. The purpose of study to use M30 grade of concrete at 7,28,90 days curing by partial replacement of cement by fly ash and conducting various tests for geocell reinforced pvements.

#### **II. OBJECTIVES**

- Design and Evaluation fly ash-based concrete for plastic cell reinforced concrete pavements.
- Wide-range of studies on mechanical behaviour of concrete containing fly ash of various ratios and comparison of the outcomes with normal concrete.
- The core objective of replacement of fine aggregate and cement is to development the strength of concrete by partial replacement of cement by fly ash.
- To compare the performance of conventional concrete pavement, flexible Pavement and cell-filled geo polymer fly ash concrete pavement of different categories.
- Use of industrial waste in full way to decrease the disposal problem in current and upcoming days and significantly decrease co2 release and plastic dumping

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#### **III. PROJECT SCOPE**

- The cell filled concrete pavements gives long-lasting concrete pavements at low early cost which are more durable and almost maintenance free.
- Fly ash can be used with admixtures for increasing strength of concrete with partial replacement of cement
- Cement is costly and scarce so the partial replacement of these material by fly ash respectively, helps to reduce the cost of construction.
- Use of fly ash helps in reducing the environment pollution during the disposal.

#### **IV. METHODOLOGY**

#### 4.1 Identification and Selection of site.

- Study of previous research paper, drawings, design criteria, of existing structure if available.
- Preparation of test specimens.

4.2 Testing

- Grain size distribution of fine and coarse aggregate.
- Tests on aggregates for concrete physical properties.
- Standard consistency of cement.
- Test on cement initial and final setting time.
- Fresh concrete tests workability test slump cone test.
- Hard concrete tests Compressive strength test

4.3 Preparation of geocell pavement based on result.

#### V. RESULTS AND DISCUSSIONS

#### DETAILSOFTESTSPECIMENS

Standardmouldswereusedforcasting150mmcubespecimen,150mmdiameter. Atotalof45 specimens were castand the details are given in Table below.

#### Table no-1 :Detail softest specimens

Serial No	Specimen	Size(mm)	Numbers
1.	Cube	150x150x150	45

#### **5.1 MIX PROPORTION:**

For1m<sup>3</sup>concrete Cement =372 kg/m<sup>3</sup>

Water		=186 liters/m <sup>3</sup>
Fineaggregate		=662.0 kg/m <sup>3</sup>
Coarseaggregate		= 1107 kg/m <sup>3</sup>
w/cratio Design mix proportion :	1 :1.78 :2.97	= 0.5

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#### 5.2 Specimen Identification

#### Table no-2: identification for cubes:

Designation	Cement%	Flyash %	Fine aggregate%	Coarse aggregate%	Noofcubes
Ν	100	0	100	100	6
S1	85	15	100	100	6
S2	80	20	100	100	6
<b>S</b> 3	75	25	100	100	6
S4	70	30	100	100	6

#### Table no-3: MixProportion for1m<sup>3</sup>

Mix designation	Water(lite	Cement(kg/	Fly	Fineaggregate	Coarseaggrega	Specimens
	rs)	m³)	ash(kg/m <sup>3</sup> )	(kg/m³)	te	
					(kg/m³)	cubes
Ν	186	372	0	662	1107	6
S1	186	316.2	55.8	662	1107	6
\$2	186	297.6	74.4	662	1107	6
\$3	186	279	93	662	1107	6
S4	186	260.4	111.6	662	1107	6

#### 5.3 GRAINSIZEDISTRIBUTIONOFAGGREGATES:

ISSievesize	Weightretained	%Weightretained	Cumulative%	Cumulative
	U		weightretained	weightof passing
4.75mm	0.105	5.25	5.25	94.75
2.36mm	0.137	6.85	12.1	87.9
1.18mm	0.366	18.3	30.4	69.6
600µ	0.686	34.3	64.7	35.3
300μ	0.589	29.45	94.15	5.85
150μ	0.107	5.35	99.5	0.5

Finenessmodulus= 
$$\frac{\sum cumulative\% retained}{100}$$

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Table no-5: Sieve analysis of coarseaggregate

ISSievesize	Weight	%Weight	Cumulative%	Cumulative
	retained	retained	weightretained	weightof passing
80mm	0	0	0	100
40mm	0	0	0	100
20mm	0.5	25	25	75
10mm	1.41	70.5	95.5	4.5
4.75mm	0.071	3.55	99.05	0.95
2.36mm	0.010	0.5	99.55	0.45
1.18mm	0	0	99.55	0.45
600μ	0	0	99.55	0.45
300μ	0	0	99.55	0.45
150μ	0	0	99.55	0.45

Finenessmodulus= $\frac{\sum cumulative\%retained}{100}$ 

#### Table no-6:Results of sieveanalysis

Particulars	Coarseaggregate	Fineaggregate
EffectivesizeD10	11	0.37
Uniformitycoefficient	1.54	2.54
Coefficientofcurvature	1.048	0.807
Fineness%	7.173	3.06
Zone	Zone1	Zone1

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#### 5.4 TESTSONAGGREGATES:

#### Table no-7: Results on physical properties of aggregate

Particulars	Fineaggregates	Coarseaggregates
Bulkdensity(kg/m <sup>3</sup> )	1.451	1.594
Voidratio	0.644	0.878
Specific gravity	2.386	2.994
Porosity	39.18	46.75

#### **Discussions:**

The particle size distribution and shape of particle affects the bulk dencity. Less void content is occupied by aggregate when when there is a high bulk dencity. Here, the bulk density is higher compact form than in loose form i.e, the voids are less in compact form. so itcan be assumed that from void ratio and porosity that voids are less in compact condition.

#### 5.5 TEST ON CEMENT-INITIAL AND FINAL SETTING TIME:

#### 1) Results

Initial setting time is about 30 minutes and Final setting time is 600 minutes which is approximately10hrs.

#### 2) Discussion

As per IS 4031 (part 5) :the initial setting time of the Portland cement should not be less than 30minutes and final setting time is about 10 hours. The setting time is influenced by temperature, moisture and quantity of gypsum in cement. For the given sample the initial setting time wasgottenas30minuteandfinalsettingtime gotas600minutes.Henceforthitcanbeusedfortransportation,placing, compaction and delaying the procedure of hydration or hardening of cement. The final setting time simplifies safe elimination of scaffolding or form.

#### 5.6 NORMAL CONSISTENCY OF CEMENT:

**Results:** Normal consistency of cement is found to be 32%.

#### Discussion

As per IS 4031 (part 4) 1988: the standard consistency is proportion of water by weight of cement that permits the plunger of 10mm diameter to enter upto a depth of nearby the bottom of mould. Its relative mobility of a freshly mixed cement paste or mortar or its competence to flow. Generally, the regular consistency of standard cement varies from 26%-33%. In the test, the normal consistency of cement was increased as 32%, which is within the specified limit. Hence this consistency can be used to determine water content for other tests like initial and final setting time, soundness and compressive strength.

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## *5.7 FRESH CONCRETE TESTS-WORKABILITY TESTS:* SLUMP CONE TEST:

Table no-8: Results of slump test

Mix	Slump (mm)
Ν	42
S1	44
S2	47
\$3	50
S4	48



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#### 5.8 HARD CONCRETE TESTS:

#### 3) Compressive strength tests:

MIX

Ν

# Table no-9: Results of compressive strength test 7 Day's (N/mm²) 28 Day's (N/mm²) 90 Day's (N/mm²) 24.4 37.3 38.2

S1	21.5	34.9	35.48
S2	22.7	36.7	39.35
S3	29.4	44.6	46.45
S4	25.1	39.1	40.20

#### Table no 10: Compressive strength of concrete at different stages



The above graph shows following points:

- 1. The blue bar indicates tests performed at 7 days.
- 2. The red bar indicated tests performed at 28 days.
- 3. The green bar indicated tests performed at 90 days.



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- 4. The x axis contains specimens mentioned in table no2.
- 5. The y axis indicated number of days.



#### Discussions:

It can be seen that there is growth in strength with the rise in fly ash percentages. The maximum compressive strength was attained by 25% replacement of fly ash, which was found about 44.6 Mpa compared with 37.3Mpa for the control mix at 28th day. The compressive strength of concrete is improved as fly ash content rises up to 30%, beyond that compressive strength was significant reductions due to rises of free water content in the mixes. This means that there is an rise in the strength of 20% associated to the control mix. Still, mixtures with 30% replacement of fly ash gave the lowest compressive strength 31.6Mpa. It is recommended that up to 30% of fly ash can be use as replacement of cement.

#### VI. CONSTRUCTIONS OF GEOCELL REINFORCED PAVEMENT

6.1 Clearance of location and layout marking for both geocell road and cement concrete road.





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- Placing bolder on side cement concrete pavement and 40mm aggregate on geocell reinforced pavement.
- Placing murum on both the side of 150mm thick layer.
- Tamping and spreading water alternately on the pavement.
- Placing aggregate on cement concrete road and tamping it.
- Applying formwork for cement concrete road.



• Spreading and stretching geocell confinement on the prepared sub-base course.





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- preparing concrete of grade M30 with partial replacement of fly ash with 25 % and filling geocell web evenly with it. Also placing concrete in prepared formwork for cement concrete road.
- Removing formwork after twenty-four hour of cement concrete road.
- Curing for 28 days two times per day.



#### VII. CONCLUSION

- Geocell reinforced pavements relieves hydrostatic pressure and manages surface water.
- Geocell reinforced pavements removes formwork and hence no need of expansion joints.
- Geocells reinforced pavements guarantees precise concrete depth.
- Better durability. The reduction in free lime and the resulting increase in cementitious mixes, combined with the decrease in permeability improve concrete durability. This affords some benefits
- Better workability. The round shaped particles of fly ash act as tiny ball bearings within the concrete mix, thus providing a lubricant effect. This similar effect also progresses concrete pumpability by decreasing frictional losses throughout the pumping process and flat work finish ability.

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