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USE OF HYPO SLUDGE IN PERVIOUS CONCRETE: AN EVOLUTION TOWARDS A BETTER INDIA

Miss. Pradnya G. Wasnik [1] Miss. Shweta Jaiswal[2] Mr. Vikas R. Bankar[3]

[1]Student, [2]Student,[3]Assistant professor, B.E Department of Civil Engineering

Jagadambha college of engineering and technology, Yavatmal

E-mail ID: pradnya.wasnik1@gmail.com

E-mail ID: shwetajaiswal581@gmail.com

ABSTRACT: *In recent years, pervious concrete has become a popular strategy to mitigate a cost of materials and environment related issues such as storm water runoff, and storm water management. It also relates to the low ground water level, agricultural problems. Pervious concrete technology has introduced in rural road as road pavement material. By capturing the rainwater and allowing it to seep into the ground thereby resulting in the ground water level recharge. This technology has created more efficient land use by eliminating the need for retention ponds and other costly storm water management devices.*

KEY WORDS: *pervious concrete, storm water, ground water level recharge, storm water management*

1.INTRODUCTION

The pervious concrete is a special type of concrete consists of a gap-graded system, generally contains cement, coarse aggregate, little or no sand, admixtures, and water. The combination of these components will produce a hardened material that allows water to pass through the concrete easily. Pervious concrete could be more considered as environment friendly concrete for sustainable construction. Pervious concrete is generally used in sidewalks, for low-traffic volume roads and for parking this special class of concrete has several other environmental benefits such as reduce tyre pavement interaction.

It is the need of an hour to use the other material than natural resources as it is consumed very heavily by rapid urbanization. The eco system should be conserved and natural resources should be preserved. To make the concrete permeable the hypo sludge (paper crete) is used. The pavements are constructed with the help of pervious concrete and it is found to be unique and it is good method to capture rain water and it can be properly lead into the ground. The shape of aggregate is also important when used in pervious concrete. The roads of India face lot of problems like water logging, runoff water etc. If the pervious concrete is used in these areas the results can be promising. The cement can be replaced by hypo sludge. The pervious concrete is considered as an environmental protection agency which is used to provide pollution control and storm water management.

MATERIALS

The pervious concrete consists of

- Portland cement
- Water
- Coarse aggregates
- Hyposludge.

1.Hypo sludge- **Hypo sludge** is mainly produced in a large amount as by product of paper industry and is usually used in concrete production as partial replacement of cement. It contains low calcium and minimum amount of silica and it is due to presence of silica and magnesium properties, so that it behaves like cement.

Fig.1 Hypo sludge

2.OBJECTIVES AND SCOPE OF WORK

- To estimate material characterization (compressive strength)
- Conduct permeability test to investigate the porous characteristics.
- To study economic feasibility and benefits of Portland cement pervious concrete.
- To organize workshops/ short term causes on Portland cement pavement design.

3.FUTURE POSSIBILITIES

- Designs of heat retention basins and water recharge stations.
- Prepare draft standard of pervious concrete.
- Develop noise performance predictive model.

- It recharges the ground water level by simply allowing the water to pass through it.
- Manages the storm water runoff and restricts it's un-necessary collection on the road pavements.

Fig 2. Pervious concrete pavement

4.APPLICATIONS

It is mostly applied in roads with low traffic usage and sidewalks.

- It has also been applied in permeable drainages in water and power recourses.
- Noise barriers, decks of swimming pools
- Used in sludge beds in sewage treatment plants,.
- Also used for tennis courts, embankments and wall lining in water wells.
- Aquatic amusement centres.
- It is also used in parking areas.

Fig. 3 pervious concrete used in tennis court

5. ADVANTAGES OF THE PERVIOUS CONCRETE

- Reduce the amount of untreated runoff discharging into storm sewers.
- Directly recharge groundwater to maintain aquifer levels.
- Channel more water to tree roots and landscaping, so there is less need for irrigation.
- Mitigate pollutants that can contaminate watersheds and harm sensitive ecosystems.
- Eliminate hydrocarbon pollution from asphalt pavements and sealers.

6. DISADVANTAGES OF PERVIOUS CONCRETE

- It is more expensive to install as compared to traditional pavements.
- The proper and regular maintenance requirements of permeable pavement are quite

different. It is prone to clogging if the water in the reservoir isn't drained out properly.

- They aren't as strong as traditional pavements which is done of the **asphalt pavements**

7. MAINTENANCE

Over time sand, dirt, vegetation and other debris can collect in pervious concrete voids and reduce its porosity, which negatively affects the functionality of the system. Thus, periodic maintenance may be required to remove surface debris. The two methods are,

- Pressure washing
- Power vaccuming

8.TESTING OF MATERIALS

8.1 Tests on cement

a. Specific gravity of cement

b. Fineness of cement

c. Consistency of cement

8.2 Tests on aggregates

a. Specific gravity of aggregate

8.3 Tests on concrete

a. Slump cone test

b. Compressive strength

c. Permeability test

d. Infiltration test

Tests on cement

Specific gravity- It is normally defined as the ratio between weight of given volume of material and weight of equal volume of water.

Here,

W1= Empty flask

W2= Weight of flask + Cement

W3=Weight of flask + Cement +Kerosene

W4=Weight of flask + Kerosene

$$Sg = \frac{(W2-W1)}{(W2-W1)-(W3-W4)\times 0.79}$$

Fineness of cement- Fineness of cement is property of cement that indicates particle size of cement and specific surface area and indirectly effects heat of hydration.

The fineness is found to be 2.83 %

Consistency of cement-Normal consistency of cement is defined as that consistency which will permit the Vicat's plunger to penetrate the cement paste after mixing with water.

The found result is 37 %

Tests on aggregate

Specific gravity of aggregates- It is normally defined as the ratio between weight of given volume of material and weight of equal volume of water.

Here,

W1= weight of saturated surface dry sample

W2= weight the of pycnometer + Water + aggregate

W3= the weight of the pycnometer + water

W4=weight of oven dried sample

$$Sg = \frac{W4}{W1-(W2-W3)}$$

Tests on concrete-

Workability test by slump cone method- It means the minimum water content at which the concrete is workable. The result found is 50 mm of slump.So, the concrete is workable.

Compressive strength on concrete- Compressive strength is the capacity of material withstand loads.

Type of cube	Age of cube	C/S area mm²	Load KN	Compressive strength in N/mm²	Avg
Conven con.	7 days	150x 150	300 250 325	13.33 11.11 14.44	12.9
	21 days	150x 150	450 325 375	20 14.44 16.66	17.0
	28 days	150x 150	650 375 545	28.88 16.66 24.22	23.2

FOR PERVIOUS CONCRETE

Type of cubes	Age of cube	C/S area mm²	Load KN	Compressive strength N/mm²	Avg
10 % Pervious concrete with hypo sludge	7 days	150x 150	205 175 155	9.11 7.77 6.88	7.9
	21 days	150x 150	225 200 200	10 8.88 8.88	9.2
	28 days	150x 150	300 375 300	13.33 16.67 13.33	14.4

Void content test for pervious concrete- Voids are the small openings of the concrete that allow the water to pass through it.

Void content of pervious concrete is about 15-35%. More porosity leads to the more permeability
1.Weigh the dry concrete sample.

2. Weight the empty container.

3. Fill the container with water at initial level and weigh it.

4. Place the dry sample inside the water container (approximately for 5 min).

5. Empty the water upto initial level and weigh it.

Wsdry = Dry Concrete weight

Wc = weight of empty container
Wc+w = Weight of container with water at initial level

Ww1 = Wc+w -Wc= mass of water.

Wc+w+s = weight of container with sample with water at initial level Ww2 = Wc+w+s- Wc – Wsdry= weight of water in the container

Ww3 = Ww1 - Ww2 = Mass of water displaced

Vw = Ww2/γw

% of voids = Vs – VwVs ∗100

Void content found is about 25 % which is the reason that lets water to pass through it.

Permeability test of the pervious concrete

For the measurement of the permeability of pervious concrete 300 mm and 450 mm water heads were adopted for measuring permeability. For measuring permeability cylinder of size 150 x 150 mm are casted. The cubes are casted in the moulds. And water permeability is then calculated using Darcy's First Law.

$$K = \frac{aH}{At} \times \left(\log \frac{H1}{H2} \right)$$

Where, k = Coefficient of water permeability

a= cross-sectional area of graduated cylinder

A= cross-sectional area of specimen
H = height of the specimen

t = time

H1 = the initial water head

H2 = the final water head

The value obtained for the permeability test ranged between 15 mm/sec to 24 mm/sec which is 20 mm/sec.

Infiltration test- The test was carried out on the sample of 0.3x0.3 with 0.07 m thickness. The time was set for 1 min to calculate the percolation of water through it. The result was found to be 900 ml of water per min. The following figure

shows the infiltration test that is carried out on the concrete sample.

Fig. No 4 Sample for the infiltration test

9.COST REQUIRED

After calculations the cost required for one cube of conventional concrete measuring in dimensions as 15cm×15cm×15cm is Rs. 64 whereas the cost for pervious concrete cube having same dimensions is Rs. 47 only.

The cost for the prototype of pervious concrete having dimension 0.3m×0.3m×0.07m is found to be Rs. 67. For the prototype of conventional concrete the consideration is as Rs. 92.

10.ACTUAL IMPLEMENTATION OF PROJECT

The actual implementation of the pervious concrete along with 10 % of hypo sludge is done in the parking of a residence measuring 10 m in length and 2.5 m in width. The actual pictures of the area before and after the completion of work are shown.

Fig. No. 5 Area selected for the parking (Before completion of work)

Fig. No. 6 The parking area after completion of work followed by the compaction

11.CONCLUSIONS

- Currently, pervious concrete pavement is becoming a popular choice over the world as an effective storm water runoff management device.

- The main problem of using Pervious concrete is it's strength, But it has the highest porosity with void content of 25 %.
- The more porosity results in higher permeability. Hence, Pervious concrete is one of the best solutions for heavy storm water management.
- It has the ability to percolate water through it Which directly results in increases ground water level because **'when it rains, it drains.'**

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