STORMWATER MANAGEMENT FOR WATER CONSERVATION BY PERVIOUS CONCRETE

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Abstract : Concrete is a widely used structural material consisting essentially of a binder and a mineral filler. Concrete has been the leading material since it was used and is bound to maintain its significant role in the upcoming future due to its durability, adaptability to any shape and size and many other applications. It is a composite material produced by mixing cement, inert matrix of sand and gravel or crushed stone. Pervious concrete is a type of concrete that has a low water-cement ratio and contains none or very little amount of sand. This concrete has a light colour and open-cell structure because of which they do not absorb heat from the sun; they also do not radiate the heat back into the atmosphere, which reduces heating in the environment. Pervious concrete has low installation costs. In addition, it filters the storm water thus reducing the number of pollutants entering the rivers and ponds. Pervious concrete also improves the growth of trees. In the present study the behavior of pervious concrete has been studied experimentally. Various mix proportions were prepared by using different water cement ratio, coarse aggregate and cement. The water-cement ratio of 0.4 is found to be optimum. Different properties of pervious concrete e.g. workability, compressive strength test at 3, 7 & 28 have been studied experimentally. Experimental results showed that mix design of 1:4 (cement: coarse aggregate) gives good strength of pervious concrete. The mix proportions with fine aggregates size (2mm to 4.75 mm) gives lower strength when compared to mixes with no fine aggregate.

***IndexTerms* - Concrete, Compressive strength, Water cement ratio.**

I. INTRODUCTION

Stormwater is water from precipitation such as rain, sleet, or melting snow. Stormwater can soak into the soil (infiltrate), be held on the surface and evaporate, or runoff and end up in nearby streams, rivers, or other water bodies (surface water).In natural landscapes such as forests, the soil absorbs much of the stormwater and plants help hold stormwater close to where it falls. In developed environments, unmanaged stormwater can create two major issues: one related to the volume and timing of runoff water (flooding) and the other related to potential contaminants that the water is carrying (water pollution).

Stormwater is also an important resource as the world's human population demand exceeds the availability of readily available water. Techniques of stormwater harvesting with point source water management and purification can potentially make urban environments self-sustaining in terms of water. Impervious surfaces such as driveways, sidewalks, and streets block rainfall and other precipitation from infiltrating naturally into the ground, leading to even more stormwater and potential pollutant runoff. Stormwater management involves the control of “run off” from precipitation. Stormwater management is the effort to reduce runoff of rainwater or melted snow into streets, lawns and other sites and the improvement of water quality, according to the Environmental Protection Agency (EPA).

1.1 Importance and Necessity of Stormwater management

Stormwater management is important to prevent physical damage to persons and property from flooding and to maintain the ecological integrity, quality and quantity of our water resources. Stormwater can also be considered a resource that provides benefits such as groundwater recharge and flood protection. Stormwater management also assists with the reduction and prevention of many different sources of pollution, which enter local waterways. Stormwater management can provide economic benefits to local communities as well. Proper management can result in reduced costs and/or fees for remediation of adverse impacts to stream channels, water quality, property damage and loss of life created by increased stormwater runoff.

II. PERMEABLE PAVEMENT

A pavement system designed to achieve water quality and quantity benefits allowing movement of storm water through the pavement surface and into a base/sub-base reservoir.

Examples include: - Pervious concrete, porous asphalt and permeable pavers / blocks.

Numerous types of permeable pavement are available. Some of them are:

1. Permeable concrete

2. Permeable asphalt
3. Permeable interlocking concrete paver
4. Concrete grid paver
5. Plastic reinforcing grids filled with gravel
6. Plastic reinforcing grids with grass

2.1. Permeable Concrete

Permeable concrete is a mixture of Portland cement, fly ash, washed gravel, and water. The water to cementitious material ratio is typically 0.35 – 0.45 to 1.

2.2. Layers of Permeable Pavement

1. Surface layer.
2. Gravel base.
3. Sub-base.
4. Under drains.

2.3. Materials required

1 Cement
2 Coarse aggregate
3 Water

III. METHODOLOGY

Pervious concrete cubes using different mix design were cast.

1. Pervious concrete of design mix ratio 1:0.08:4 (cement: sand: coarse aggregates) and water cement ratio equals to 0.35. Angular aggregates of size 10 to 15 mm were used in this pervious concrete sample.
2. Pervious concrete cube of design mix ratio 1:4 (cement: coarse aggregates) and water cement ratio equals to 0.4. Rounded aggregates of size 10 to 20 mm were used in this pervious concrete sample.
3. Perviousconcreteofdesignmixratio1:3(cement: coarse aggregates) and water cement ratio equals to 0.35. Rounded aggregates of size 10 to 15 mm were used in this pervious concrete sample.

IV. RESULTS AND DISCUSSION

Table 4.1Compressive strength

MIX DESIGN	COMPRESSIVE STRENGTH (N/mm^2)		
	7 days	**14 days**	**28 days**
1:3	4.59	14	26.75
1:0.08:4	3.98	13.96	24.27
1:4	4.9	14.98	27.75

Table 4.1 shows that compressive strength of pervious concrete made using different mix design and checked at 7, 14 and 28days. Table 4.1 also summarized the following points-

1. Pervious concrete of design mix 1:0.08:4 have good permeability but the bonding between aggregates, cement and sand is not strong enough for the construction of permeable pavement. Hence, compressive strength of this sample is less than 4MPa.
2. The bonding between cement and aggregates is very strong of the pervious concrete cube sample of design mix 1:3 due to presence of comparatively high volume of cement but the permeability of this sample is very low as compared to other samples.
3. The permeability of pervious concrete cube sample of design mix 1:4 is very high and the compressive strength of this concrete cube sample is nearly 5 MPa. So this design mix can be used for the construction of permeability pavement because of good balance in permeability and the compressive strength of the concrete.
4. Permeable pavement can store up to 4 litres of water in its base reservoir under the surface area of 1 square feet of pavement.

Figure 4.1 shows that graphical variation of different mix design with respect to compressive strength for 7, 14 and 28 days.

Figure 4.1 Graph of compressive strength

V. CONCLUSION

This study summarized the diffuse literature on permeable and porous pavement systems. Permeable pavement systems (PPS) have become an important integral part of sustainable urban drainage systems despite the lack of corresponding high-quality research in comparison to other research areas. In contrast, porous pavements are usually associated with clogging problems and are therefore not as much applied in practice as PPS. Design, maintenance and water quality control aspects relevant to the practitioner were outlined for permeable and porous pavement systems. The detailed design and specific maintenance requirements for PPS do not allow for the specification of general guidelines. Research is therefore likely to be empirical and of applied nature in the future.

1. Pervious concrete of design mix 1:0.08:4 have good permeability but the bonding between aggregates, cement and sand is not strong enough for the construction of permeable pavement. Hence, compressive strength of this sample is less.
2. The bonding between cement and aggregates is very strong of the pervious concrete cube sample of design mix 1:3 due to presence of comparatively high volume of cement but the permeability of this sample is very low as compared to other samples.
3. The permeability of pervious concrete cube sample of design mix 1:4 is very high and the compressive strength of this concrete cube sample is also high compared to other samples.
4. So this design mix can be used for the construction of permeability pavement because of good balance in permeability and the compressive strength of the concrete.
5. Water cement ratio of 0.4 is found to be optimum.

REFERENCES

[1] Satish kumar, Dr. Devinder Sharma, Er. Neeraj Kumar (2018) "Permeable Concrete as A Road Pavement", (IRJET), Volume 5, Issue 01, Page No.254-257.

[2] Ning Xie , Michelle Akin , Xianming Shi (2018) "Permeable Concrete Pavements: A Review Of Environmental Benefits And Durability", (JCP), Page No.1606-1621.

[3] Akshay Tejankar, Aditya Lakhe, Manish Harwani, Prem Gupta (2016) "The Use Of Permeable Concrete For Ground Water Recharge", (IJERA), Volume6, Issue 9 (part3), Page No.60-63.

[4] Sneha Page, Prachi Bhikule, Shital Wadile, Parag Deshmukh, Prof. Y. D. Deore, Prof. R. R. Lomte (2018) Mitigation of Flooding & Improvement of Ground Water Table Using Permeable Concrete", (IJSRSET), Volume4, Issue 1, PageNo.1357-1360.

[5] S.O. Ajamu, A.A. Jimoh, J.R. Oluremi (2012) "Evaluation of Structural Performance of Pervious Concrete in Construction", (IJET), Volume2, Issue 5, Page No.829-836.

[6] A.Ayyappan, D.Dinesh kumar, G.Sangeetha, S.Roshini, M.Sivasangari (2018) "Experimental Study of Pervious Concrete", (IJSDR), Volume 3, Issue 3, Page No.138-147.

[7] Suma Paralada (2018) "Pervious Concrete with Varying Percentage of Fine Aggregate" IJRSET, Volume 6, Issue 1, Page No.2094-2098