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Use of Pervious Concrete for Environmental Friendly and Sustainable Development

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ABSTRACT- *Pervious concrete or high porosity concrete is referred as specific concrete that lets off water coming from precipitation or other sources to pass them. It helps in reducing the runoffs and increases the ground water levels. The composition of pervious concrete contains cementitious paste with no or a little amount of aggregate. Basically these are used in flatwork applications ,parking areas, light traffic areas, pedestrian walkways, green houses etc. It has a compressive strength of 400 to 4000 psi. The infiltration rate is in the range of 2 to 18 gallons per minute per square foot. Pervious concrete plays a key role in sustainable construction.*
Keywords*: Pervious Concrete, Porosity, Sustainable, Infiltration Rate, Compressive Strength*

I. INTRODUCTION

Pervious concrete was first introduced in the 1800s in Europe as pavement surface and bearing walls. Previously, in the 19th century this concrete was used in a variety of purposes such as load bearing walls, panels and paving. The use of this material is very limited because 3 1234567890"""" ICAEFM IOP Publishing IOP Conf. Series: Materials Science and Engineering 410 (2018) 012005 doi:10.1088/1757-899X/410/1/012005 of its lower strength. Pervious concrete has been extensively used as a structural building material in Europe, Australia and the Middle East for over 70 years. It became popular again in the 1920 for two storey homes in Scotland and England. It became more popular in Europe after the Second World War due to the shortage of cement. It did not become as popular in the US until the 1970s.In India it became popular in 2000. In the United Kingdom in 1852, two houses were constructed using gravel and concrete. It wasn't until 1923 when pervious concrete resurfaced as a usable construction material. In that time it was applied in a limited way to the construction of two story homes in areas such as Scotland, Liverpool, London and Manchester [ACPA, 2006]. After the World War II era the use of no-fine concrete in Europe increased steadily. Since pervious concrete contains less amount of cement content than conventional concrete and cement was scarce at the time, so pervious concrete was gain the popularity for best material in that period. Once again housing construction was its primary use. Later, pervious concrete spread to areas such as Venezuela, West Africa, Australia and Russia. [1]

Now-a-days our modernized cities are covered with air-water procf building material. It obstructs the lack of air permeability and water permeability common concrete pavement so that the rain water is not filtered underground. A large amount of rain water ends up falling on impervious surface such as parking lots, drive ways, sidewalks and streets rather than soaking into soil. This creates a natural imbalance in the ecosystem and leads to various problems like soil erosion, floods, ground water depletion. A simple solution is to be avoiding these problems to stop construction impervious surface and switch to pervious concrete. Working on rain-drain concept, porous concrete allows large amount of water in the body system resulted ground water rechargement and control storm water management. Pervious concrete pavement is the best solution for protecting trees in a impervious surface. Many plants have faced difficulty growing in impervious because air and water can't touch to the roots. Porous concrete helps the adjacent trees to receive more water and air from the soil. Pervious concrete creates opportunity for lands caper and architects who wish to use greenery in parking lots and paved urban areas.

II. MATERIALS AND MIX PROPORTION

The specimens are obtained by the mixture of cement, aggregates, little amount of sand or no sand, water and admixture. During the mixing process, extreme care was taken in order to maintain water content so that the pervious concrete can get better workability. Generally, the mix design were produced with cement to aggregate ratio (C/A) of 1:3, 1:4,1:6 and water cement (w/c) ratio of 0.30,0.35,0.40 respectively. Additionally admixture 7-15 % of silica fume and 5-7% of super plasticizer (weight of cement) were added to the mixture in order to get maximum strength. All the mix designs are prepared to achieve good permeability and porosity.

III. CHARACTERSTICS OF PERVIOUS CONCRETE

The properties of Pervious concrete (PC) such as compressive strength, split tensile strength, permeability, porosity, density, were found vary satisfactory performance and the test results are discussed below in table. [3]

Properties of Pervious Concrete	
Density	1600 to 2000 Kg/m3
Compressive Strength	3.5 to 28 MPa
Flexural Strength	1 to 3.8 MPa
Tensile Strength	1 to 3 MPa
Permeability	8-20 mm/s
Porosity	15 to 35%
Slump	Zero

IV. APPLICATIONS OF PERVIOUS CONCRETE

Natalia I. Vázquez-Rivera et al. (2015) have studied Optimization of pervious concrete containing fly ash and iron oxide nano particles and its application for phosphorus removal. The laboratory prepared pervious concrete can remove phosphorus with the first-order removal constant at 0.031 h-1 and the Freundlich isotherm constant at 2.48 mg1-1/n kg-1 L1/n [4].Darshan S. Shah et al. (2013) have studied the application of Pervious concrete: New Era for Rural Road Pavement. This paper gives the idea about uses of pervious concrete in rural road pavement as well as solves ground water depletion and agriculture related problem. Porous concrete is more favourable because it allows water pass in its body system and control storm water runoff. The research concluded that it is possible to prepare 1m x 1mx 0.15m size pavement with durability properties with a minimum case of Rs 29 per m3 or Rs 193 per m2 or Rs. 18 per feet2 [5]. Shihui Shen et al. (2012) have studied the Pervious concrete with titanium dioxide as a photo catalyst compound for a greener urban road environment In this study titanium dioxide (Ti02) applied into pervious concrete pavement to remove some of these organic pollutant from the air,

so that pervious concrete pavement for sustainable application such as air pollutant removal and storm water management [6].M.Carsana et al. (2013) have studied the use of porous concrete as a building material subjected to its strength durability properties and corrosion control through embedded steel. In the present research mechanical as well as durability properties were studied. Apart from this carbonation induced corrosion properties of the concrete were studied. It is observed that w/c ratio 0.34-0.41 and cement to aggregate ratio 1:4 subjected to fast carbonation and it can't provide long term passivation to embedded steel [7]. Ravindra Rajah et al. (2010) have studied the environmentally friendly pervious concrete for sustainable construction. This paper reports an experimental investigation into the, physical and engineering properties of pervious concrete having varying amount of low calcium fly ash as the cement replacement material. Replacement of 50% cement by fly ash had no significant effect on water permeability but it was noted that there is a marginal strength effect of pervious concrete. Three previous concrete mixtures were prepared by replacing 0, 20 and 50% of fly ash, and its properties were studied. Based on the data, it is obtained that there is a co-relation between strength and porosity and between permeability and porosity. It also found that pervious concrete maintain a porosity range of 15% to 30%. Also it is assuming that replacement of 50% of cement has no significant effect on water permeability. So it is possible to prepare environment friendly pervious concrete with significantly reduced amount of Portland cement with fly ash .[8]

Common applications for pervious concrete are parking lots, sidewalks, pathways, tennis courts, patios, slope stabilization , swimming pool decks, green house floors, zoo areas, shoulders, drains, noise barriers, friction course for highway pavements, permeable based under a normal concrete pavement, and low volume roads. Pictures of some of the applications are shown in Figure 3. Pervious concrete is generally not used solely for concrete pavements for high traffic and heavy wheel loads.

V. PERVIOUS CONCRETE IN INDIA

Pervious concrete can be successfully used in India in applications such as parking lots, driveways, gullies/ sidewalks, road platforms, etc. Over the next 20 years there is expected to be a significant amount of housing construction India. The roads around the apartments/ homes and the surfacing inside the compound can be made with pervious concrete. Massive urban migration in Indian cities is causing the ground water to go much deeper and is causing water shortages. For example, in states like Tamil Nadu residents commonly pay for water delivered and it is not uncommon to receive water only for a few days of a week in many parts of the country. Flooding and extended water logging in urban areas is common since all the barren land which could hold the rain water are being systematically converted into valuable real estate with a result that impervious surfaces such as roads, parking lots, roof tops are covering the natural vegetation. It is indeed ironical that even the world's wettest place

Cherrapunji suffers drought while the monsoons brings flooding. Further, the rain water that falls on the concrete and asphalt surfaces tend to carry a high level of pollution and this pollution ends up in our waterways ultimately. The use of pervious concrete can help alleviate the damage of all of these ills. Another significant advantage in India as compared to Western countries is the significantly lower cost of labor. Much of the pervious concrete construction is manual and can be done without heavy equipment and therefore pervious concrete can be placed at a lower cost even in rural areas. [8]

VI. LIFE CYCLE COST OF PERVIOUS CONCRETE.

No-fine concrete is the ideal solution for light weight roadway such as pedestrian road, parking lots and residential street. As porous concrete is porous is nature, so its various mechanical properties

are weaker than conventional concrete but it can solve many environmental issues such as storm water management and het island effect. The best way to compare this material with other is of its cost parameter and application. In the present there is no long studied has been conducted for its cost analysis. If available it is only suitable for local condition. Only few studied have been done on comparative analysis of cost construction between porous concrete and conventional concrete. The result reveals that the initial cost of porous concrete is high due to controlled design and to maintain proper void. If life cycle cost is determined than its overall benefits can be calculated. It is sometimes very difficult to determine the life cycle cost because of lack of large scale testing, performance analysis and maintenance cost. By determining the actual life cycle cost its cost would be reduced up to 30%.

VII. CONCLUSION

This paper looked at various studies conducted on permeable pavement systems and their current application. The recent innovations like water treatment and recycling pavement system, development of a combined geothermal heating and cooling is promising and it is detailed in cut short, future research works are outlined in brief. These permeable pavement systems are changing the way human development interacts with the natural environment. Its application towards parking lots, highways and even airport runways are all improvements in terms of water quality, water quantity and safety. A caution though is the higher prevalence of airborne dust in India that could lead to clogging of the pervious concrete. Pervious concrete can function with no maintenance and some level of clogging. Nevertheless, frequent preventative maintenance is recommended. In apartment communities, resident associations could perhaps take this over and those applications could be the first ones to be attempted. In future with increased urbanization , diminishing ground water levels and focus on sustainability, technologies such as pervious concrete are likely to become even more popular in India as well as other countries.

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