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Use Of Pervious Concrete In Construction Of Pavement For Improving Their Performance

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ABSTRACT : *Our cities are being covered with building and the air-proof concrete road more and more. In addition, the environment of city is far from natural. Because of the lack of water permeability and air permeability of the common concrete pavement, the rainwater is not filtered underground. Without constant supply of water to the soil, plants are difficult to grow normally. In addition, it is difficult for soil to exchange heat and moisture with air; therefore, the temperature and humidity of the Earth's surface in large cities cannot be adjusted. This brings the phenomenon of hot island in city. At the same time, the plash on the road during a rainy day reduces the safety of traffic of vehicle and foot passenger.*

The research on pervious pavement materials has begun in developed countries such as the US and Japan since 1980s. Pervious concrete pavement has been used for over 30 years in England and the United States. Pervious concrete is also widely used in Europe and Japan for roadway applications as a surface course to improve skid resistance and reduce traffic noise. However, the strength of the material is relatively low because of its porosity. The compressive strength of the material can only reach about 20 - 30MPa. Such materials cannot be used as pavement due to low strength. The pervious concrete can only be applied to squares, footpaths, parking lots, and paths in parks. Using selected aggregates, fine mineral, admixtures, organic intensifiers and by adjusting the concrete mix proportion, strength and abrasion resistance can improve the pervious concrete greatly.

Keywords *air proof concrete, hot island, pervious, pavement, porosity, skid resistance.*

I. INTRODUCTION

Pervious concrete is a mixture of gravel or stone, cement, water and little or no sand which creates an open cell structure that allows water and air to pass through it. According to EPA (Environmental Protection Agency's) storm water runoff can send as much as 90% of pollutant such as oil and other hydrocarbon. The ability of pervious concrete to allow water to flow through itself recharges ground water and minimizes the extent of pollution and storm water runoff. Pervious concrete is used to allow storm water to infiltrate through the pavement and reduce or eliminate the need for additional control structures, such as retention ponds.

The pervious concrete pavement possesses many advantages that improve city environment as follows:

1. The rainwater can quickly filter into ground, so the groundwater resources can renew in time. As the pavement is air permeable and water permeable, the soil underneath can be kept wet.
2. The pervious concrete pavement can absorb the noise of vehicles, which creates quiet and comfortable environment.
3. In rainy days, the pervious concrete pavement has no plash on the surface and does not glisten at night. This improves the comfort and safety of drivers.
4. The pervious concrete pavement materials have holes that can cumulate heat. Such pavement can adjust the temperature and humidity of the Earth's surface and eliminates the phenomenon of hot island in cities.

An experienced installer is vital to success of pervious concrete pavements as with any concrete pavement, proper subgrade preparation is important. The subgrade should be properly compacted to provide a uniform and stable surface. When pervious pavement is placed directly on sandy soil it is recommended to compact the subgrade to 92 to 96% of the maximum density. With silty or clayey soils, the level of compaction will depends on specifics of pavement design and a layer open graded stone may have to be placed over soil.

The voids can range from 18 to 35% with compressive strengths of 10 to 30MPa. The infiltration rate of pervious concrete will fall into the range 80 to 720 liters/minute/square meter. The mixture is composed of cementious materials, course aggregates, water with little or no fine aggregate and admixtures. Addition of small amounts of fine aggregates will gradually reduces the void content and increase the strength, which may be desirable in certain situations. This material is sensitive to changes in water content, so field adjustment of fresh mixture is usually necessary. The correct quantity of water in the concrete is critical. Too much water will

cause segregation, and too little water will lead to balling in the mixer and very slow mixer unloading. The Water/Cement and Cement/Aggregate ratios are normally ranges from 0.25 to 0.45 and 1:3.5 to 1:6.

II. MATERIALS AND MIX PROPORTION FOR PERVIOUS CONCRETE

The basic ingredients of pervious cement concrete mix are not very different from the conventional cement concrete mix, except in the proportion of ingredients. The main ingredients are cementitious material, water, aggregate and if required, admixtures

III. HISTORY OF POROUS CONCRETE

The initial use of porous concrete was in the United Kingdom in 1852 with the construction of two residential houses and a sea groyne. Cost efficiency seems to have been the primary reason for its earliest usage due to the limited amount of cement used. It was not until 1923 when porous concrete re surfaced as a viable construction material. This time it was limited to the construction of 2-story homes in areas such as Scotland, Liverpool, London and Manchester. Use of porous concrete in Europe increased steadily, especially in the World War II era. Since porous concrete use less cement than conventional concrete and cement was scare at that time. It seemed that porous concrete was the best material for that period. Porous concrete continued to gain popularity and its use spread to areas such as Venezuela, West Africa, Australia, Russia and the Middle East (Wanielista et al. 2007).

After World War II, porous concrete became wide spread for applications such as cast-in-place load-bearing walls of single and multistory houses and, in some instances in high-rise buildings, prefabricated panels, and stem-cured blocks (Ghafoori et al. 1995). Also applications include walls for two-story houses, load-bearing walls for high-rise buildings (up to 10 stories) and infill panels for high-rise buildings (Tennis et al. 2004).

IV. OBJECTIVES

The main objective of this investigation is to develop a strong and durable pervious cement concrete (PCC) mix using different types of fine aggregates with varying the quantity of fine aggregates. In addition, it is also aimed to compare the properties of these PCC mixes.

In the present investigation, two types of fine aggregates are used viz., Crushed Stone (CS) and River Sand (RS) are used. The percentage of fine aggregates used in PCC mix is 15 per cent.

The properties of PCC mixes investigated are compressive strength, flexural strength, abrasion resistance, permeability, and clogging potential.

V. SCOPE FOR THE STUDY

1. The present investigation addressed the strength and drainage aspects of pervious concrete mixes and also the influence of CS as a FA. However, other aspects like resistance of pervious concrete mixes against chemical attack, clogging behavior with the use of geo-textiles etc., be addressed.
2. A detailed study is required to know the effects of aggregate gradation with other types of aggregate to obtain higher strength and adequate engineering properties of pervious concrete.
3. The effect of compaction energy is one of the key factors to produce high quality durable concrete. This aspect has to be studied in detail to determine the relationship between compaction energy, porosity and strength parameter.
4. Attempts can also be made to improve the 28-day flexural strength of the pervious concrete mixes using different additives like silica fume, keeping the permeability factor in mind.

VI. RESEARCH METHODOLOGY

After identification of problem and setting the objectives of the research, the research methodology has carefully design to achieve these objectives.

- Collection and study of literature pertaining to the dissertation work.
- Determine the engineering properties of pervious concrete and compare them with conventional concrete.
- Cast various trial mixes with varying percentages of pervious concrete and compare for the compressive strength.
- Prepare test samples with the percentage value and test these samples for the various pavements properties.
- To comment on the suitability and limitations of pervious concrete with conventional concrete in construction of pavements.

VII. CONCLUSION

We could develop strong and durable pervious concrete mixes for low-volume roads. The effects of two types of fine aggregates, i.e. Crushed Stone and River Sand, on various properties of pervious concrete were studied. The fine aggregate to coarse aggregate ratio were as 1:5.720, compared to conventional pervious cement concrete mixes. Cement content was varied from 300 kg/m3 to 340 kg/m3 with an increment of 10 kg/m3. In total 10 different pervious concrete mixes were prepared considering each level of cement content and each type of fine aggregate. In addition steel fiber was used to increase the strength parameter. The effects of such variation on the properties of pervious concrete mixes were studied.

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