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ANALYSIS OF STRUCTURAL PERFORMANCE OF CONCRETE IN BASIC CONSTRUCTION

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Abstract: A field and laboratory study was conducted to evaluate cement kiln dust (CKD) as a soil stabilizer. The performance of CKD from three different cement manufacturers was compared with that of quicklime. Field-work involved construction of test sections along a rural highway in Oklahoma. Observations were made to compare construction requirements for CKD and lime. Treated soil samples were collected from the field to prepare specimens for unconfined compression testing in the laboratory. In situ testing included dynamic cone penetration testing in the stabilized subbase and falling weight deflectometer testing after completion of the pavement. Chemical testing was conducted to determine the chemical makeup of each dust, and soil-CKD mixtures were tested for pH response. Chemical tests on the CKD and CKD-soil mixtures revealed aspects of the CKD composition that can be correlated with the degree of stabilization. Regarding strength improvements, results showed that CKD from one cement plant performed significantly better than lime and CKD from other plants. The laboratory and field test data showed that, overall, CKD was more effective than quicklime for stabilizing soil. Additional laboratory tests showed that the influence of CKD and lime on the plasticity index of soils was similar and that both additives imparted some resistance to freeze-thaw and wet-dry cycles. Observations indicate that treatment with CKD can be cost-effective and that it requires less construction time than treatment with quicklime.

I. INTRODUCTION

Pervious concrete which is also known as the no-fines, porous, gap-graded, and permeable concrete and enhance porosity concrete has been found to be a reliable storm water management tool (Mary, 2010). By definition, pervious concrete is a mixture of gravel or granite stone, cement, water, little to no sand (fine aggregate) with or without admixtures. When pervious concrete is used for paving (Figure 1), the open cell structures allow storm water to filter through the pavement and into the underlying soils. In other words, pervious concrete helps in protecting the surface of the pavement and its environment As stated above, pervious concrete has the same basic constituents as conventional concrete that is, 15% -30% of its volume consists of interconnected void network, which allows water to pass through the concrete. Pervious concrete can allow the passage of 3-5 gallons (0.014 -0.023m3) of water per minute through its open cells for each square foot (0.0929m2)of surface area which is far greater than most rain occurrences. Apart from being used to eliminate or reduce the need for expensive retention ponds, developers and other private companies are also using it to free up valuable real estate for development, while still providing a paved park.

Fig.1 Polish surface of a pervious concrete pavement

Pervious concrete is also a unique and effective means to address important environmental issues and sustainable growth. When it rains, pervious concrete automatically acts as a drainage system, thereby putting water back where it belongs. Pervious concrete is rough textured, and has a honeycombed surface, with moderate amount of surface ravelling which occurs on heavily travelled roadways (Concrete network, 2009). Carefully controlled amount of water and cementitious materials are used to create a paste. The paste then forms a thick coating around aggregate particles, to prevent the flowing
off of the paste during mixing and placing. Using enough paste to coat the particles maintain a system of
interconnected voids which allow water and air to pass through. The lack of sand in pervious concrete results in a very harsh mix that negatively affects mixing, delivery and placement. Also, due to the high void content, pervious concrete is light in weight (about 1600 to 1900kg/m3). Pervious concrete voi
d structure provides pollutant captures which also add significant structural strength as well. It also results in a very high permeable concrete that drains quickly.Pervious concrete can be used in a wide range of
applications, although its primary use is in pavements which are in: residential roads, alleys and driveways, low volume pavements, low water crossings, sidewalks and pathways, parking areas, tennis courts, slope stabilisation, sub-base for conventional concrete pavements etc.

II. AIM OF THE STUDY

The aim of this study is to evaluate the structural performance of pervious concrete in civil engineering construction. To achieve this, the effects of varying the aggregate size on the porosity, compressive strength and specificgravity of pervious concrete were studied. The study covers the simple use of pervious concrete as pavement material in the construction of pedestrian walkways and parking lots

III. SIEVE ANALYSIS OF COARSE AGGREGATE

Using a stack of sieves (BS410), the samples of the coarse aggregates used were graded into two main particle sizes, mainly sample A of 18.75mm and sample B of 9.375mm. The result of the test is as shown in Figure 2 and Figure 3 respectively for samples A and B

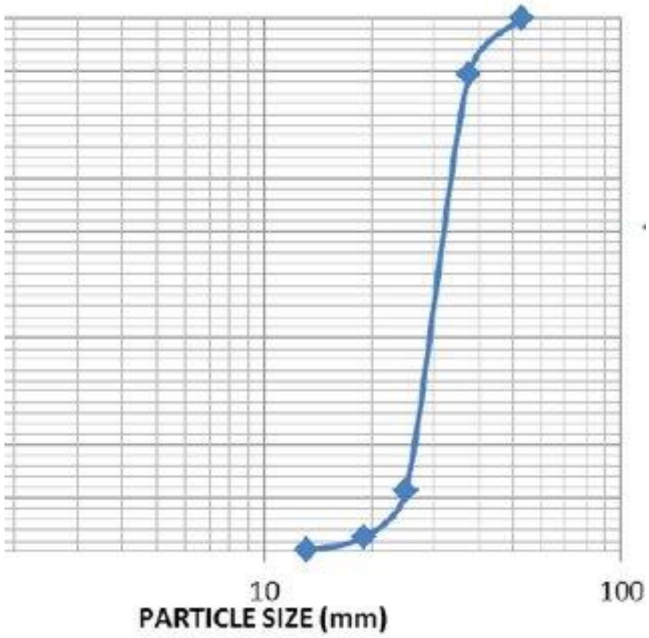

Fig. 2Gradation Curve for 9.375 mm Aggregate Sizes

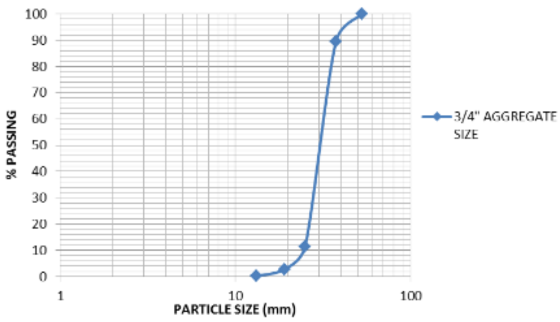

Figure 3: Gradation Curve for 18.75 mm Aggregate Sizes

IV. PREPARATION OF TEST SPECIMEN

Three batches of test specimen were produced from each of the aggregate size representing aggregate cement ratios of 6:1, 8:1 and 10:1 with no fines in the mixes. The materials were batched by weight as in Table 3.As earlier stated, two different sizes of coarse aggregate (crushed stone or granite) were used in this study. The sizes are 3/8-inch (9.375mm) and 3/4-inch (18.75mm) granite. The specific gravity test carried out on the two aggregate sizes gave average value of 2.7. For the two aggregate sizes, the mix proportions were done by weight. From each of the batches, 8 of 150mm concrete cubes were taken. The mix proportioning are as shown in Table 3.

Ratio	Weight of aggregate (kg)	Weight of cement (kg)	Volume produced (m3)
6:1	37.5	6.25	0.025
8:1	50	6.25	0.029
10:1	62.5	6.25	0.033

V. COMPRESSIVE STRENGTH TEST

The aim of the test is to determine the compressive strength of pervious concrete. The test was carried out in accordance with BS1881-108: 1983 and ACI 522R-10. The cubes were tested for compressive strength (Figure 4) at specify ages of 7, 14, 21 and 28 days of curing. The compressive strength of pervious concrete is calculated thus

Compressive strength=crushing load(KN)/Area of cube(m^2)

Figure 4: Compression Testing Machine

Age/Days	Water/Cement ratio	Aggregate cement ratio	Average Compressive Strength
7	0.04	6:1	3.333
14			7.444
21			1.212
28			3.125
7	0.04	8:1	4.219
14			5.221
21			6.115
28			4.998

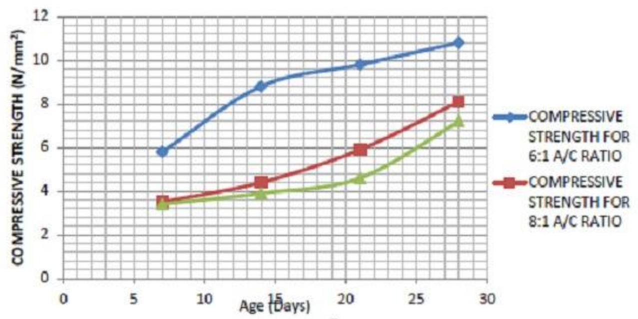

Figure 5: Compressive Strength of Pervious concrete of 3/8" Aggregate size at different Aggregate-Cement Ratio

VI. DISCUSSION OF RESULTS

•The Specific gravity of the coarse aggregate used for 18.75mm and 9.375mm of 2.7 is in agreement with the range of values stipulated by ACI 552-R10

•Pervious concrete made from coarse aggregate size 9.375mm had compressive strength value of 39% compared to that of 18.75mm which is 29% of the maximum value of strength stipulated by ACI 552

VII. CONCLUSIONS

•The smaller the size of coarse aggregate should be able to produce a higher compressive strength and at the same time produce a higher permeability rate.

•The mixtures with higher aggregate/cement ratio 8:1 and 10:1 are considered to be useful for a pavement that requires low compressive strength and high permeability rate.

•Finally, further study should be conducted on the pervious concrete pavement produced with these material proportions to meet the condition of increased abrasion and compressive stresses due to high vehicular loading and traffic volumes

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