EXPERIMENTAL ANALYSIS OF PERVIOUS CONCRETE PREPARED FOR RIGID PAVEMENTS

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ABSTRACT: Pervious concrete is a concrete mixture prepared from cement, aggregates, water, little or no fines and in some cases admixtures. It is considered because of its ability to reduce storm water runoff and to initiate the filtering of pollutants. Because the hydrologic properties of pervious concrete has been the primary reason for its reappearance in construction, the focus of previous research has been on maximizing the drainage properties of the mix with single-sized aggregates.

Pervious concrete pavements are gaining popularity for storm water management. Therefore, there is an impending need for the development of quality control and acceptance specifications. The most important aspect, which draws the attention of environmental agencies and cities and municipalities, is its ability to reduce storm water runoff. The Pervious Pavement System is a sub-class of pervious pavement system where the vast majority of the surface is impermeable

The porous concrete filled with coarse aggregate which is replaced with palm kernel shell wrapped partially and removing fine aggregate. This research, however, investigates the effects of aggregate properties and gradation on the strength, as well as hydrologic properties of pervious concrete mixtures. The tests applied are workability, compressive testing and flexural testing where we have the results of 7 and 28 days strength. About 36 cubes were prepared for compressive testing and 36 beams were prepared for flexural testing.

Keywords: Pervious Concrete, Agro waste, Replacement, Compressive Testing, Flexural Testing, Permeability Test

I. PERVIOUS CONCRETE

Pervious concrete is a porous concrete paving material which permits rain and storm water runoff to percolate through it rather than flood surrounding areas or storm drains. It is usually a mixture of 10-20mm average size of the aggregate, hydraulic cement, other cementitious materials, admixtures and water. When properly placed, pervious slabs will contain voids that would be filled by sand. Like a honeycomb these voids are held together with cement. These irregular voids thus add great strength to the slab. Our designed pervious mixture is the result of over 25 years' experience. When cured it resembles pervious slabs. Pervious concrete pavement is one of the promising pavement technologies, as it can help overcome traditional pavement environmental impacts, assist with storm water management, and provide an effective low impact development solution. Pervious concrete is not difficult to place, but it is different from conventional concrete, and appropriate construction techniques are necessary to ensure its performance. It has a relatively stiff consistency, which dictates its handling and placement requirements. The use of a vibrating screed is important for optimum density and strength. After screening, the material usually is compacted with a steel pipe roller. There are no bull floats, derbies, trowels, etc. used in finishing pervious concrete, as those tools tend to seal the surface. Joints, if used, may be formed soon after consolidation, or installed using conventional sawing equipment. (However, sawing can induce ravelling at the joints.) Some pervious concrete pavements are placed without joints. Curing with plastic sheeting must start immediately after placement and should continue for at least seven days.

INTRODUCTION OF MATERIALS:
Following materials were used in the experimental investigation
1. Cement (OPC 43)
2. Coarse aggregate
3. Palm Kernel Shell
4. Water

PREPARATION OF THE PERVIOUS CONCRETE USING FOLLOWING MATERIALS:
1. Ordinary Portland Cement 2. Normal Coarse Aggregate

3. Palm Kernel Shell 4. Water

Fig Material Required

Fig VICAT APPRATUS

Table. Chemical Composition of Cement

Oxide Composition	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_2	K_2O	N_2O
Percentage (%)	63	20	6	3	1.5	2	1	1

Table. Physical Properties of OPC 43

Properties	Results
Fineness	7%
Specific Gravity	3.15
Standard Consistency	31.5
Initial Setting Time	35min
Final Setting Time	300min

Fig. Cement

Table. Properties of Coarse Aggregate

PROPERTIES	RESULTS OBTAINED	IS SPECIFICATIONS
Specific gravity	2.70	2.6
Water absorption	0.81 %	-
Impact value	6.16%	LESS THAN 45%
Los Angeles abrasion value	22.04%	LESS THAN 50%

Fig. CRUSHED STONE (Coarse aggregate)

II. PALM KERNEL SHELL

Palm kernel shells (or PKS) are the shell fractions left after the nut has been removed after crushing in the Palm Oil mill. Kernel shells are a fibrous material and can be easily handled in bulk directly from the product line to the end use. Large and small shell fractions are mixed with dust-like fractions and small fibres. The palm kernel is the edible seed of the oil palm fruit. The fruit yields two distinct oils: palm oil derived from the outer parts of the fruit, and palm kernel oil derived from the kernel. The pulp left after oil is rendered from the kernel is formed into palm kernel cake, used either as high-protein feed for dairy cattle or burned in boilers to generate electricity for palm oil mills and surrounding villages. Palm Kernel Shell was ordered from Indiamart @ rate of Rs.2.5/Kg. It was delivered from Chennai. M-30 grade of Pervious concrete (C: S: A) =1:0:2.85. Moisture content in kernel shells is low compared to other biomass residues with different sources suggesting values between 9% and 11%. Compared to other residues from the industry, it is a good quality biomass fuel with uniform size distribution, easy handling, easy crushing, and limited biological activity due to low moisture content.

Table. Properties of PKS

PROPERTY	VALUE OF PKS
Bulk density Mg/m^3	0.74
Dry density Mg/m^3	0.65
Water content (%)	9
Water absorption (%)	14
Specific gravity	1.62

Impact Value (%)	4.5


Fig. Palm Kernel Shell

III. SLUMP TEST (WORKABILITY TEST)


Fig. Process of Slump Cone Test

COMPRESSIVE TESTING


Fig. CUBICAL MOULDS


Fig. Preparation of Specimen


Fig Testing of Specimen

FLEXURAL TESTING

Fig. Prepared Beam

Fig. Testing Machine

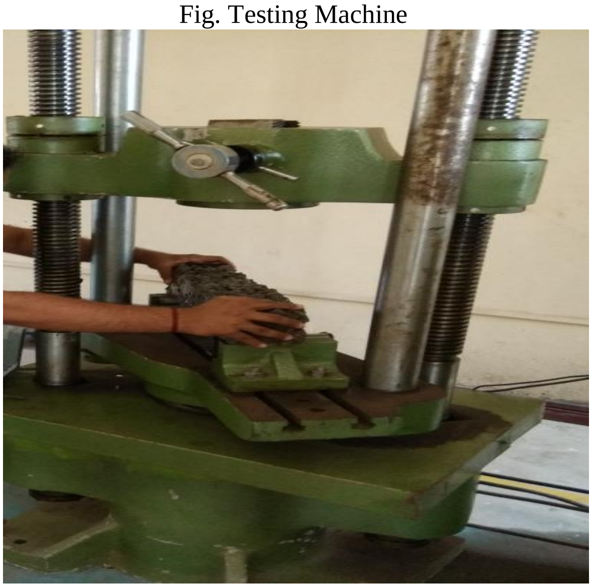


Fig. Placing Specimen for Testing

WATER PERMEABILITY TEST

The water discharged was collected in a known-weight-recipient and the time for collect 750 to 1,000 mL of water was measured. Four trials were carried out for each sample and the hydraulic conductivity was calculated by the average of the obtained values. Once obtained the volume of discharge and the elapsed time for its collection, the hydraulic conductivity was determined by Equation:

$$\mathrm{k} = \frac{V.L}{h.A.t}$$

Where, k is the hydraulic conductivity (cm/s), V is the volume of discharge (cm^3), L is the length of specimen (cm), h is the column height (cm), A is the cross-sectional area of specimen (cm^2) and t is the time for discharge (s).

IV. RESULTS

ANALYSIS OF SLUMP TEST

Following results of slump test were obtained for different mixes of concrete prepared by replacement of cement.

Table. SLUMP VALUES OF MIX DESIGN

S NO.	Mix Proportion	SLUMP VALUE
1	1:2.85	0-10

ANALYSIS OF COMPRESSIVE STRENGTH

Following Nomenclature was adopted for testing of different types of mixes prepared by replacement of coarse aggregate by 0%, 10%, 15%, & 20%, 25% and 30% of Palm Kernel Shell by weight of cement.

Table. Types of Mixes

TYPE OF MIX	% OF PALM KERNEL SHELL
CC	0% (CONVENTIONAL CONCRETE)
MD 1	10 %
MD 2	15%
MD 3	20%
MD4	25%
MD5	30%

Fig. Specimen of Pervious Concrete

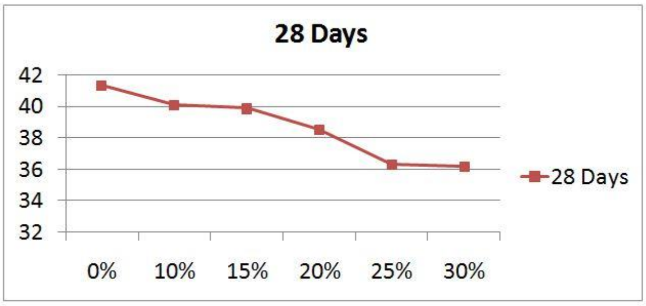
Table. Average Compressive strength 7 Days (N/mm^2)

Mix	Replacement	Average Compressive strength 7 Days (N/mm^2)
CC	0%	20.1
MD1	10%	19.55
MD2	15%	18.32
MD3	20%	18.29
MD4	25%	17.65
MD5	30%	17.11

Graph. Compressive strength 7 Days

Table. Average Compressive strength 28 Days (N/mm^2)

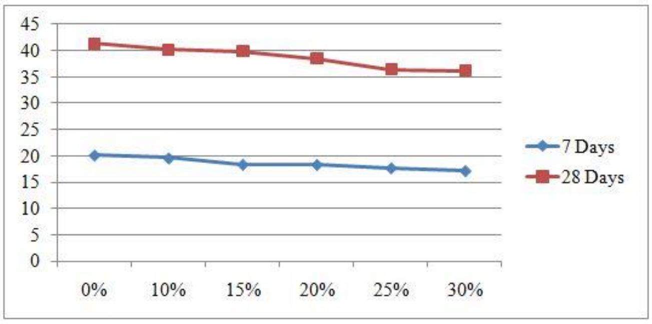
Mix	Replacement	Average Compressive strength 28 Days (N/mm^2)
CC	0%	41.33
MD1	10%	40.12
MD2	15%	39.87
MD3	20%	38.52
MD4	25%	36.33
MD5	30%	36.19



Graph. Compressive strength 28 Days

Table . Compressive strength 7 and 28 Days

Mix	Replacement	Average Compressive strength 7 Days (N/mm^2)	Average Compressive strength 28 Days (N/mm^2)
CC	0%	20.1	41.33
MD1	10%	19.55	40.12
MD2	15%	18.32	39.87
MD3	20%	18.29	38.52
MD4	25%	17.65	36.33
MD5	30%	17.11	36.19



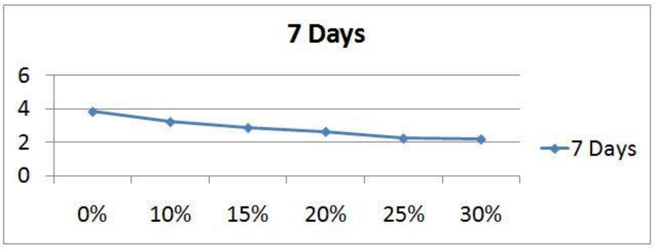
Graph . Comparison between Compressive Strength of Pervious Concrete after 7 and 28 Days Curing

V. FLEXURAL STRENGTH

Following Nomenclature was adopted for testing of different types of mixes prepared by replacement of coarse aggregate by 0%, 10%, 15%, & 20%, 25% and 30% of palm kernel shell by weight of cement

Table. Flexural strength after 7Days Curing

Mix	Replacement	Average Flexural Strength 7 Days (N/mm^2)
CC	0%	3.83
MD1	10%	3.21
MD2	15%	2.86
MD3	20%	2.62
MD4	25%	2.22
MD5	30%	2.17

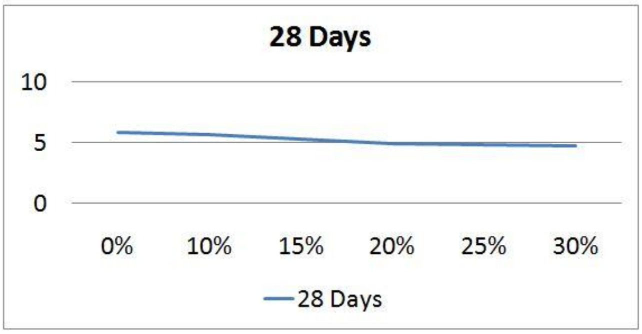


Graph. Flexural strength after 7Days Curing

Table. Flexural strength after28 Days Curing

Mix	Replacement	Average Flexural Strength 28 Days (N/mm^2)
CC	0%	5.8

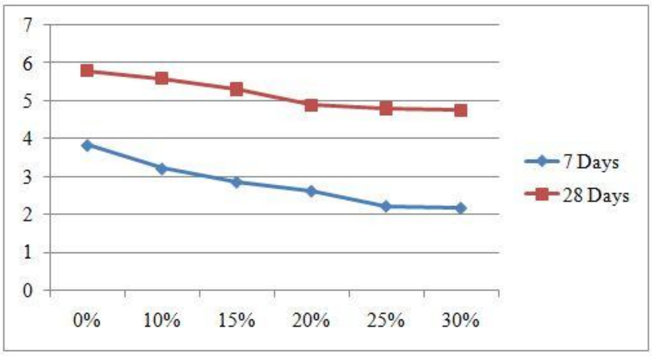
MD1	10%	5.6
MD2	15%	5.32
MD3	20%	4.9
MD4	25%	4.81
MD5	30%	4.76



Graph. Flexural strength after28 Days Curing

Table. Flexural strength after 7 and28 Days Curing

Mix	Replacement	Average Flexural Strength 7 Days (N/mm^2)	Average Flexural Strength28 Days (N/mm^2)
CC	0%	3.83	5.8
MD1	10%	3.21	5.6
MD2	15%	2.86	5.32
MD3	20%	2.62	4.9
MD4	25%	2.22	4.81
MD5	30%	2.17	4.76



Graph. Comparison of Flexural strength after 7 and28 Days Curing

WATER PERMEABILITY TEST

Following Nomenclature was adopted for testing of different types of mixes prepared by replacement of coarse aggregate by 0%, 10%, 15%, & 20%, 25% and 30% of palm kernel shell by weight of cement

Table. Permeability Value for 10% replacement of CA by PKS

Permeability Value for 10% replacement of CA by PKS		
Time (Sec)	Height (cm)	Coefficient of Permeability K (cm/sec)x10^-3
0	100	-
5	89.8	2.36
10	79.8	2.59
15	68.3	3.42
20	58.3	3.48
25	48	4.27
		Average = 3.224

Table. Permeability Value for 15% replacement of CA by PKS

Permeability Value for 15% replacement of CA by PKS		
Time (Sec)	Height (cm)	Coefficient of Permeability(K) (cm/sec)x10^-3
0	100	-
5	84	2.70
10	72.8	3.14
15	61.9	3.56
20	50.9	4.30
25	39.8	5.41
		Average = 3.852

Table. Permeability Value for 20% replacement of CA by PKS

Permeability Value for 20% replacement of CA by PKS		
Time (Sec)	Height (cm)	Coefficient of Permeability (K) (cm/sec)x10^-3
0	100	-
5	88.4	2.71

10	76.6	3.15
15	64.7	3.71
20	52.9	4.43
25	41.3	5.44
		Average K= 3.89

Table. Permeability Value for 25% replacement of CA by PKS

Permeability Value for 25% replacement of CA by PKS		
Time (Sec)	Height (cm)	Coefficient of Permeability K (cm/sec)x10^-3
0	100	-
5	83.7	1.60
10	77.6	1.66
15	71.6	1.77
20	65.4	1.99
25	59.4	2.15
		Average K= 1.83

VI. CONCLUSIONS

Following were the conclusions carried out

- The strength properties of pervious concrete containing aggregate with partial replacement of Palm Kernel Shell (PKS), without any fine aggregate and admixtures were investigated for 7 and 28 Days.
- The experimental investigations were carried out to determine the compressive strength, flexural strength and Water Permeability Test.
- The compressive strength, flexural strength and permeability values change with aggregate content and PKS content.
- The compressive strength and flexural strength values varied.
- Based on experimental results, it can be concluded that, when runoff collection is of primary concern and strength is not a governing issue, the use of pervious concrete can be regarded as a suitable and sustainable choice in various storm water management applications.

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