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Experimental Work on Previous Concrete for Pavement Applications

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Abstract - *Construction activities mainlydepend on natural resources as a source of raw materials, leading to ecological imbalance. So, the construction industries tend to depend on alternative materials as the source of aggregates in concrete production. Generally, changes in the natural landscape have created a serious problem of rainwater drainage in many cities in India. The Previous concrete has been used in this experimental work. In this study, pervious concrete 15% to 40% voids can be achieved without use of fine aggregate. Generally, single size coarse aggregates are used for the development of mixture design of pervious concrete. However, the quality of previous concrete resulting different from conventional concrete. Thus, this study aims to improve the property of previous concrete through different applications. The void ratio has been compared to previous and conventional concrete. The Cement content of 250 kg/m³ to 400 kg/m³ with an interval of 50 kg/m³ was used in the development of mixture design of pervious concrete. The density of previous concrete is increased while improve of cement content. The development of mixture design of pervious concrete, two different sizes of coarse aggregates of 10 mm – 20 mm and 4.75 mm – 10 mm were used in this experimental work.*

Key Words: Workability, Compressive strength, Void Ratio, Density.

1. INTRODUCTION

Rapidly growing and uncontrolled changes in the natural landscape have created a serious problem of rainwater drainage in many Indian cities. With natural disasters like floodsincreasing every year, there is a need to set up specific water disposal systems in urban and semi-urban areas. Due to lack of modern drainage infrastructure in most of the cities of India,this problem is increasing day by day. During monsoons, most of the rain water collects on the roads. Due to lack of proper design ofdrainage system, rain water is seen on the road. In most cities, the drainage systems are alreadyclogged and in the event of a rain, water is seen on the road. Due to this reason traffic is jammedin the rain and it is also a serious health hazard for the locals. This problem is serious in large cities and industries, where roads are constructed without designing a sewerage system in most open areas. During rains, road water remains stagnant for hours at a time due to poor storm water management. This causes erosion of the road and decreases the age of the road. In the old cities, outlets were provided for rainwater disposal which diverted rainwater into theriver. The design of these outlets was so arbitrary that rainwater would reach the lower pointof its own topography. Foot wells were a common feature of old cities designed to redirect rainwater into groundwater. This type of storm water management design is no longer seen due to unplanned urbanization. Cities are also replacing impermeable land with impermeablesurfaces. The problem is exacerbated by the fact that the drains do not get enough slope to drawWater from the surface water. In our country, industries and cities are facing water crisis due to over-exploitation of groundwater and lack of provision for ground water recharge. Ground water level is constantly falling. Falling water levels are also deepening the well in lifting water.

Pervious concretes have been used in many area, but its applications are limited because of its relatively low strength. Tennis et al. (2004) reported the applications of pervious concrete werein many areas such as low volume pavement, residential roads, sidewalks, parking lots, low water crossings, and tennis courts, sub base of conventional concrete pavement, patios, artificial reefs, slope stabilization, well linings, and tree gates in sidewalks, hydraulic structures, swimming pool decks, pavement edge drains and noise barriers. Indian economy is developing at a rapid pace and hence conservation of natural resources is ofutmost importance. Pavement can be considered as a life line for progress of any nation. Modern day infrastructure calls for use of impervious surfaces of pavement which results intolesser percolation of water into the soil.

- This leads to faster, larger volume and highly polluted water from run-off reaching treatment plant leading to imbalance in ecosystem.
- Therefore, modern cement concrete pavement cannot be a viable option for water recharging.
- India is mainly dependent on rain to meet its water requirement which is plenty during monsoon season.
- In monsoon, every city faces a serious problem of water logging and municipality

have to pay a heavy cost to evacuate logged water.

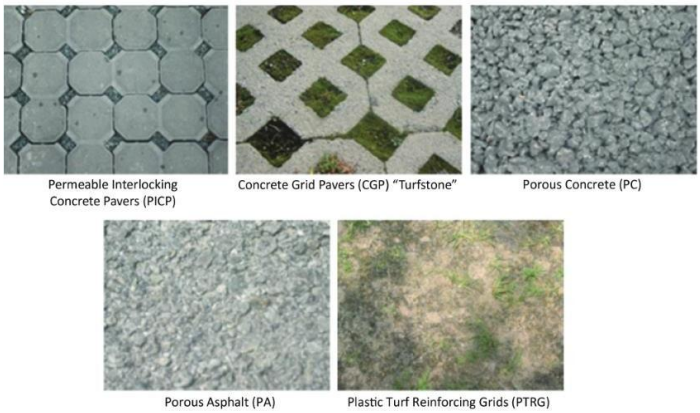

Fig -1: Methods for disposed rain water

1.1 Previous concrete

Pervious concrete is a mixture of cement, coarse aggregates and water. Fine aggregates are not used in the mixture of pervious concrete. In pervious concrete 15% to 40% voids can be achieved without use of fine aggregate. Generally, single size coarse aggregates are used for the development of mixture design of pervious concrete. In pervious concrete, carefully controlled amounts of water and cementitious materials are used to create a paste that forms a thick coating around aggregate particles.

Fig -2: Previous concrete cube

1.2 Applications

- Pervious concretes have been used in many areas.
- Its applications are limited because of its relatively low strength.
- The applications of pervious concrete were in many areas such as low volume pavement, residential roads, sidewalks, parking lots, low water crossings, and tennis courts, sub base of conventional concrete pavement and patios.
- The artificial reefs, slope stabilization, well linings, and tree gates in sidewalks, hydraulic structures, swimming pool decks, pavement edge drains and noise barriers.

Table -1: Comparison of Properties of Conventional Concrete and Pervious Concrete

Properties	Conventional Concrete	Pervious Concrete
Void Ratio	3% -5%	15% - 40%
Compressive Strength	20 MPa- 50 MPa	5 MPa – 25 MPa
Density	2400 kg/m^3 to 2500 kg/m^3	1800 kg/m^3 to 2100 kg/m^3

2. EXPERIMENTAL PROGRAMME

The materials used for preparing the pervious concrete during the present investigation are natural coarse aggregate, VSI coarse aggregate, cement, water and chemical admixture. Ordinary Portland cement, as per IS 12269 (2013) is used for the present investigation. The physical properties of ordinary portland cement are presented in Table-2

Table -2: Properties of physical of OPC

Properties for 53 grade OPC	Result Availed	Specification in IS 12269 (2013)
Fineness in m^2/kg	351	Min 225
Soundness By Le chatelier method in mm	0.4	Max 10
Initial setting time in minutes	35	Min 30
Final setting time in minutes	240	Max 600
3 days compressive strength in MPa	28.75	Min 27
7 days compressive strength in MPa	39.85	Min 37
28 days compressive strength in MPa	54.47	Min 53
Specific Gravity	3.15	3.15

2.1 Mix-Proportion of Pervious Concrete

For development of mixture proportioning of pervious concrete target properties are assumed as shown in Table 3.8. Target properties of pervious concrete are assumed based on NRMCA (2004) guideline. Target properties of pervious concrete are assumed for the construction of pervious concrete pavement for parking area at Gujarat. By this study area same pattern can be applicable in Guntur city, that can help public.

Table -3: Study report of properties of previous concrete

Properties	Target	NRMCA (2004)
Compressive Strength	12 MPa- 15 MPa	3.5 MPa-28 MPa
Void Ratio	20 %	15% - 25%
Density	2000 kg/m³ - 2200 kg/m³	1600 kg/m³ - 2200 kg/m³
Permeability	10 mm/s - 20 mm/s	2 mm/s - 20 mm/s

Present investigation is also carried out on 20 mm -10 mm coarse aggregates for the development of mixture proportioning for the pavement applications. Table-4 showsmixture proportion developed using 20 mm – 10mm (Size B) natural coarse aggregates. For the enhancement of the properties of pervious concrete further investigation is carried out by replacing natural crushed aggregates with VSI aggregates. An attempt has been made to improve the properties of pervious concrete using VSI aggregate on selected mixture proportion.

Casting procedure plays a very important role with respect to all properties of fresh as well as hardened pervious concrete. First of all weighing and batching process of all ingredients of pervious concrete such as cement, coarse aggregate and water is done with high accuracy before starting the mixing process. For the mixing of materials of pervious concrete pan mixeris used. First aggregates are taken in the pan mixture followed by the cement. Dry mixing of material is done. Water is added and mixing is done till the uniform consistence of the perviousconcrete mix is achieved. The mixingof pervious concrete. No chemical admixture is used for the preliminary investigation of development of mixture proportion has been done.

Table -4: Mix-proportion for Pervious Concrete using Coarse Aggregate

Mixture No.	Cement (kg/m³)	Aggregates (kg/m³)	W/C
M 1	250	1000	0.3
M 2			0.35
M 3			0.4
M 4	300	1200	0.3
M 5			0.35
M 6			0.4
M 7	350	400	0.3
M 8			0.35
M 9			0.4
M 10	375	1500	0.3
M 11			0.35
M 12			0.4
M 13	400	1600	0.3
M 14			0.35
M 15			0.4

Fig -3: Rodding of previous concrete

3. RESULTS AND DISCUSSION

Preliminary laboratory investigation is carried out to develop mixture proportioning for pervious concrete pavement. Tables-5 shows the mix proportions that are selected for initial laboratory investigation for the development of mixture proportion of pervious concrete. For the development of mixture design the cement content is used in the range of 250 kg/m³ to 400 kg/m³ as presented in Table-5. Laboratory investigation has been done on two sizes of aggregates for the development of mixture design of pervious concrete. For the mixture design development 10 mm – 4.75 mm and 20 mm- 10 mm of coarse aggregates are used. In the laboratory investigation properties of pervious concrete are found

such as compressive strength, void ratio, permeability and density. Details of investigation results are shown in following section.

Table -5: Properties of Pervious Concrete using Coarse Aggregates (10 mm –4.75 mm)

Mix No.	Cement (kg/m^3)	w/c	Compressive Strength (MPa)	Void content %	Permeability (mm/s)	Density (kg/m^3)
M 1	250	0.3	3.71	25.12	23.28	1950.5
M 2		0.4	4.67	24.5	22.21	1975.1
M 3	300	0.4	5.12	23.7	21.98	2105.3
M 4		0.3	5.5	24.98	20.69	2003.2
M 5		0.4	6.1	23.95	19.76	2115.4
M 6		0.4	6.98	23.1	19.41	2150.8
M 7	350	0.3	7.53	24.1	18.6	2010.3
M 8		0.4	8.65	23.18	18.1	2127.2
M 9		0.4	9.1	22.97	17	2175.3
M 10	375	0.3	9.3	23.5	16.5	2020.21
M 11		0.4	13.49	22.88	15.37	2137.12
M 12		0.4	14	21.5	14.98	2185.5
M 13	400	0.3	15.1	22.75	13.2	2112.5
M 14		0.4	16.98	21.1	12.2	2198.9
M 15		0.4	17.1	18.88	11.5	2217.4

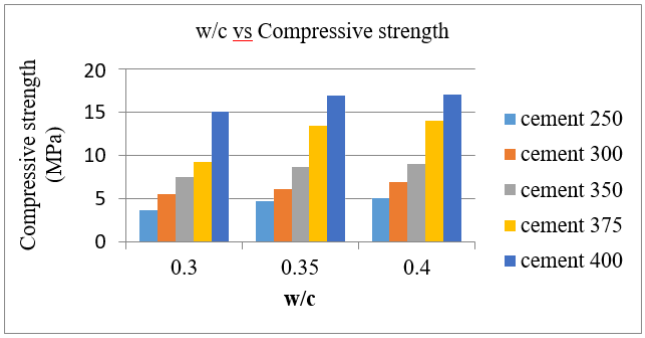

Chart -1: Compressive strength

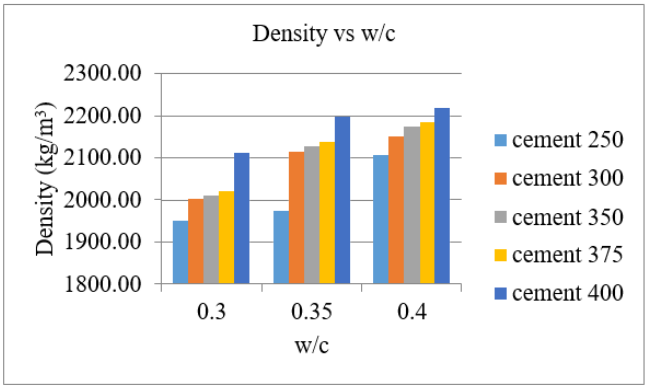

Chart -2: Relationship between w/c and Density

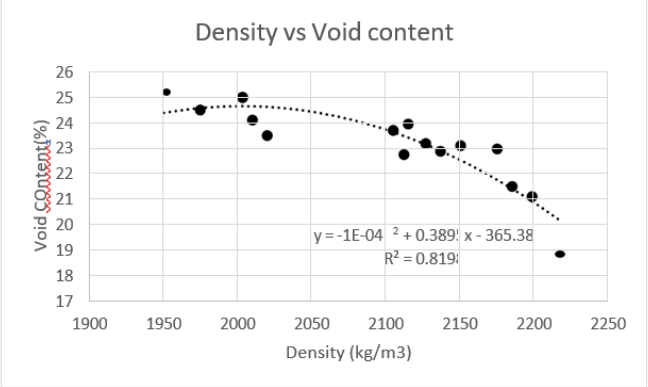

Chart -3: Relationship between Density and void content

4. CONCLUSIONS

- Cement content of 250 kg/m^3 to 400 kg/m^3 with an interval of 50 kg/m^3 was used in the development of mixture design of pervious concrete. It has been observed that higher cement content created more cement paste for pervious concrete. It further reduced the void ratio and permeability of the pervious concrete.

- Density of pervious concrete increased withthe increase of the cement content. On the other hand, lesser cement content reduced the compressive strength of the pervious concrete. This way cement content in the range of 350kg/m^3 to 375 kg/m^3 was found to be good enough to generate cement paste for better workability and meeting with the requirement of other properties for pervious concrete.

- For the development of mixture design of pervious concrete, two different sizes of coarse aggregates of 10 mm – 20 mm and 4.75 mm – 10 mm were used. From the preliminary investigation results, it has been observed that changing the coarse aggregate size had a very limited influence on changes in the void ratio,

permeability and density as compared to the compressive strength for pervious concrete.

- It was observed that 4.75 mm-10 mm size coarse aggregates have larger surface area and hence, more cement paste is utilized in covering the coarse aggregates. Therefore, the compressive strength of the perviousconcrete is improved.

- Different ranges of w/c ratio i.e. 0.3, 0.35 and 0.40 were used for the development of mixture design of pervious concrete. Using 0.3 and 0.35 water cement ratio, the pervious concrete mix obtained was not found to be more workable. Use of 0.4 water cement ratio was found sufficient to prepare cohesive and workable pervious concrete mixture.

- The workability of mixture was measured by preparing a hand ball of the pervious concrete. Adequate paste for the pervious concrete was generated by using 0.4 w/c ratio. The properties such as compressive strength, void ratio and permeability of the pervious concrete made above range of w/c ratio were found in order.

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