iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** XII **Month of publication:** December 2018

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue XII, Dec 2018- Available at www.ijraset.com

Use of No-Fines Concrete in Minor Structures for Cost Effective Construction

Shivakumar Mahto[1], Anshul Kumar[2]
[1]*Department of Civil Engineering, Mizan Tepi University*
[2]*Department of Civil Engineering, Mizan Tepi University.*

Abstract: The goal of sustainable construction is to reduce the environmental impact of a constructed facility over its lifetime. Concrete is the main material in the gulf cooperation council. Therefore, it makes economic and environmental sense to use porous materials in the making of new type of concrete for different application. The studies showed that there is reasonable research on porous concrete, the practical implementation in the region greatly lacks behind, especially due to the lack of economic viability and awareness of such application at the current time. In the present investigation an attempt is made to access the properties and performance of no-fines concrete by conducting various fundamental test and cube compressive strength. The physical properties of aggregates and concrete was found to be satisfactorily fulfilling all the minimum requirements. Henceforth, the attained compressive strength of no-fine concrete is sufficient enough to withstand the load of lower structures and therefore the cost of the concrete can also be considerably reduced as compared to the conventional concrete.
Keywords: No fine concrete, Mix Design, Cube compression strength, Field implementation.

I. INTRODUCTION

A. General

Concrete is a very strong and versatile moldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can concrete to harden and gain strength over many years. It is estimated that the present consumption of concrete in the world is of the order of 10 billion tons (12 billion tons) every year. Humans consume no material except water in such tremendous quantities.

B. Porous Concrete

Pervious concrete (also called porous concrete, permeable concrete, and no fines concrete) is a special type of concrete with a high porosity use for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing ground water recharge. Pervious concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab. Pervious concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways and greenhouses. It is an important application for sustainable construction and is one of many low impact development techniques used by builders to protect water quality. Pervious concrete has been used in many countries for many years, and is now becoming more than just an oddity in the United States. The impetus behind this surge in application is a growing need to take full advantage of shrinking building sites, and to accommodate storm-water runoff in the process. Inherent to the air-void nature of pervious, or porous concrete, is the potential for a lack of durability and toughness, which often impacts application choices and project volume. Experts in the art of pervious materials and practice have long sought out ways to improve the material’s durability, and to add to the long-term comfort level of owners that choose it and architects that specify it.

C. Application of Porous Concrete

Porous pavement can generally be substituted for traditional pavement provided that soil characteristics, slope, climate, depth to groundwater, and vehicle usage/loading are suitable. There should be a relatively deep water table or distance to bedrock from the bottom of the system. Underlying soils should be well-drained with a minimum infiltration rate of 0.3 inches per hour and slopes no greater than 5%. While 0.3 inches per hour is the minimum recommendation according to the South Carolina BMP Handbook, systems have been successfully designed for subgrades having lower infiltration rates. To compensate for the lower structural support capacity of clay soils, additional sub base depth is often required. The increased depth also provides additional storage volume to compensate for the lower infiltration rate of the clay subgrade. Underdrain usage can also help in low infiltration rate situations.

D. Mixture Proportioning

Pervious concrete uses the same materials as conventional concrete, with the exceptions that the fine aggregate typically is eliminated entirely, and the size distribution (grading) of the coarse aggregate is kept narrow, allowing for relatively little particle packing. This provides the useful hardened properties, but also results in a mix that requires different considerations in mixing, placing, compaction, and curing. The mixture proportions are somewhat less forgiving than conventional concrete mixtures, tight controls on batching of all of the ingredients are necessary to provide the desired results. Often, local concrete producers will be able to best determine the mix proportions for locally available materials based on trial batching and experience.

The key objective is to analyse the performance of no fine concrete by experimental test such as cube compressive test and a practical implementation of this concrete was evident by constructing a minor structure i.e sitting bench and it was kept under observation for a period of 6 months. During this period it was seen that there was no change in the structure despite of various environmental condition.

E. Need for the study

The use of cement concrete has been very vital in the building construction and many other minor constructions. Since in India due to diverse topography the availability of fine aggregates such as sand has been very rare and scarce leading to increase in cost day by day. Therefore there is a need to carryout studies in order to evaluate the performance of the new concrete mixes with new ideas and to obtain information on the long term benefits over conventional concrete.

F. Objectives

1) To assess the physical properties of coarse aggregate, fine aggregate and cement.
2) To design the proportion of the material by adopting concrete mix design as per IS 10262:2009
3) To conduct the cube compression strength on adopted concrete mix.
4) To compare the strength of prepared concrete mix cube by varying 7 and 28 days
5) To compare the cost analysis of the selected concrete mix and to compare with conventional concrete mix block

G. Methodology

1) Selection of the aggregate and cement
2) Selection of coarse aggregate proportion
3) Determination of total mix proportion by concrete mix design.
4) Evaluation of prepared concrete mix by attained mix proportion
5) Analysis and Results
6) Conclusions.
7) Recommendations.

II. MIX DESIGN CALCULATION

The mix design was carried out as per IS10262:2009. The step by step procedure and calculations are is deliberated as below

1) *Step 1*: Target strength for mix proportioning:-

$$f'ck = fck + 1.65s$$

As per IS 10262:2009,

Standard deviation, $s = 4\ N/mm^2$

Therefore target strength

$= 20+1.65 \times 4$

$= 26.60\ N/mm^2$

2) *Step 2:* Selection of w/ c ratio:-

As per IS 456:2000,

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue XII, Dec 2018- Available at www.ijraset.com

Maximum water-cement ratio = 0.5 (Mild exposure) water cement ratio as 0.4
0.4 < 0.5, hence ok

3) *Step 3:* Selection of water content
Maximum water content =186litres for 20 mm aggregates
Estimated water content for 75 mm
Slump = 140 + 3/100 x 140
= 144.2litres

4) *Step 4:* Calculation of cement content
Water cement ratio =0.40,
Cement content = 144.2/0.40
=360.5kg/m^3>320 kg/m^3

5) *Step 5:*.Proportion of volume of coarse aggregate and fine aggregate content
As per IS code 10262:2009, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.50 =0.62 and
Volume of fine aggregate = 1-0.62=0.38
In the present case water-cement ratio is 0.40. Therefore. Volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.10. The proportion of volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01 for every ± 0.05 change in water-cement ratio).
Therefore corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.40 = 0.62.

6) *Step 6:*.Mix calculations
The mix calculations per unit volume of concrete shall be as follows:
a) Volume of concrete = 1 m^3
b) Volume of cement= mass of cement/specific gravity of cement x 1/1000
= [360.5/3.15] x [1/1000]
= 0.1144 m^3
c) Volume of water = [144.2/1] x [1/1000]
= 0.1442 m^3
d) Volume of all in aggregates
= a – (b + c)
= 1 – (0.1142+0.1442)
= 0.694 m^3
e) Mass of coarse aggregate 20mm
=dx Volume of CA x specific gravity of CAx1000
= 0.694x0.62x2.68x1000
=1153.15 kg
f) Mass of coarse aggregates 10mm
= d x Volume of FA x specific gravity of FA
= 0.694x0.38x2.65x 1000
= 698.718 kg

7) *Step 7:* Adopted Mix Proportions for trial number
Cement = 360.5 kg/m^3
Water = 144.2 kg/m^3
Coarse aggregate 10 mm = 698.718 kg/m^3
Coarse aggregates20 mm = 1153.15 kg/m^3
Water cement ratio = 0.4
Therefore, our required mix design proportion for porous concrete mix material =1:0.5:2.784:1.856

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue XII, Dec 2018- Available at www.ijraset.com

III.EXPERIMENTAL INVESTIGATION

In the present study the mixture in stone aggregate adopted for cement concrete is 60% of 20mm downsize and 40% percent of 10 mm downsize was incurred and ratio of cement was added to the attained mix proportion as per the mix design and finally a very negligible amount of 0.5% sand was added to the total mix for better bonding characteristics. Basic engineering tests on aggregates and binder were conducted in the laboratory to assess their properties.

Trial mix specimens were prepared at the attained mix proportions and subjected to cube compressive strength for a curing period of 3 days, 7 days, 14 days and 28 days The results of the cube compressive strength was fulfilling the target strength required for the concrete mix and indicated there is a sufficient strength to withstand the upcoming load coming on to the prepared test specimens.

A. Constituents of a Mix

1). Aggregates: Aggregates offer good compressive and shear strength, along with this they provide good interlocking facility with sufficient permeability. Aggregate mainly consisting of both coarse and fine aggregates. Coarse aggregate of 19 mm to 2.36 mm and fine aggregates of 2.36 mm to 75 µ were used. The test results are presented in table 1.

TABLE 1
Physical Properties Of Aggregates

Description of Aggregate Tests	Test Results	Requirements as per 10262:2009 Specifications
Aggregate Impact value (%)	21.94	Max 24%
Flakiness and Elongation Index (Combined) (%)	27.57	Max 30%
Los Angeles Abrasion value (%)	19.44	Max 30%
Water Absorption (%)	0.5	Max 2%

2). Specific Gravity: The specific gravity values of coarse and fine aggregate and cement are presented in the table 2.

TABLE 2
Specific Gravity Of Materials

Description of materials	Specific Gravity
Coarse aggregate 20mm	2.65
Coarse aggregate 10mm	2.68
Cement	3.12

3). Sieve analysis Test for Aggregates: Sieve analysis helps to determine the particle size distribution of the coarse and fine aggregates. The cumulative passing and fineness modulus are shown as below in the table 3 and table 4 for both the 10 mm and 20 mm downsize aggregate.

TABLE 3
Sieve analysis for coarse aggregate (10 mm).

Is sieve mm	Wt. retained	Cum. wt. retained	Cum. % by wt. retained	% by wt. retained	Grading zone
12.5	0	0	0	100	100
10	54	54	1.8	98.2	85.1
4.75	2775	2829	94.3	5.7	0.2
2.36	156	2985	99.5	0.5	0.5
Pan	15	3000	100	0	
			195.6		
		Fineness modulus	1.96		

TABLE 4.
Sieve analysis for coarse agg. (20 mm)

IS sieve mm	Wt. retained	Cum. wt. retained	Cum. % by wt. retained	% by wt. passing	Grading zone
40	0	0	0	100	100
20	435.75	435.75	14.525	85.48	85.1
10	2489.25	2925	97.5	2.5	0.2
4.75	63	2988	99.6	0.4	0.5
2.36	0	2988	99.6	0.4	
Pan	12	3000	100	0	
			311.225		
		Fineness modulus	3.11		

B. Compressive Strength of Concrete

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical molds of size 15 cm x 15cm x 15 cm are commonly used.

1) Procedure for preparation of test specimens: For each cube .take the quantities of materials as follows-

Mix the cement and sand with trowel on non-porous plate for one minute. Then add water to the mixture of cement, sand and mix it until the mixture of uniform color is obtained. The time of gauging shall in any case not be less than 3 minutes and not more than 5 minutes, gauging time is the time elapsed between the water added to the mix and casting of cubes. Place the entire quantity of mortar in the hopper of the cube molds.

a) Remove the specimen from water after specified curing time and wipe out excess water from the surface.
b) Take the dimension of the specimen to the nearest 0.2m
c) Clean the bearing surface of the testing machine
d) Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
e) Align the specimen centrally on the base plate of the machine.
f) Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
g) Apply the load gradually without shock and continuously at the rate of 140kg/cm^2/minute till the specimen fails
h) Record the maximum load and note any unusual features in the type of failure.

Fig. 1 Prepared cube for compressive strength test

Fig.2: Cube Compressive strength test for prepared cube

The results of cube compressive strength has been tested under the loading machine and has been tabulated in table 5 and table 6 as shown below.

TABLE 5.
AVERAGE COMPRESSIVE STRENGTH IN 7 DAYS

S.N.	P (KN)	Size (mm)	F=P/A (N/mm^2)	Avg comp. strength (N/mm^2)
1	395	150	17.55	17.92
2	405	150	18	
3	410	150	18.22	

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue XII, Dec 2018- Available at www.ijraset.com

TABLE 6.
Average Compressive Strength In 28 Days

S.N.	P (KN)	Size (mm)	F=P/A (N/mm^2)	Avg comp. Strength (N/mm^2)
1.	560	150	24.88	25.92
2.	580	150	25.77	
3.	610	150	27.11	

So the avg. compressive strength of porous cube for 7 days is 17.92N/mm^2, which is nearer the 2/3 of the target mean strength and for 28 days is 25.92N/mm^2, which is around 90% of the target mean strength which implies it is fit for the concrete use as per the codes.

C. Field Implementation

A minor structure i.e. sitting bench has been implemented by making use of the mix proportions attained by the mix design and has been tested for its durability for different seasonal. It is been observed that the structure constructed by making use of no fine concrete was stable enough and withstand the various seasonal variations. The figure below shows the planning and implementation of the bench,

1) Procedure for the Field Implementation

a) Firstly the location and the area was properly chosen within the campus.

b) Then a pit is excavated of two rectangle of 45×60 cm. area at adequate distance.

c) A wooden framework has been made for the required dimensions

d) After placing the framework in the excavated area the prepared concrete in adequate ratio of

Height (H) =75cm.,
Width (B) =60cm. &
Length (L) =45cm.
Area =2(LB+BH+HL)
=21150cm^2,
Volume =L×B×H
=202500 cm^3
=0.2025 m^3

For both rectangular boxes, concrete volume =0.405m^3,

As per the mix design proportion for porous concrete: the ratio of cement, sand and coarse aggregate is 146.0025:73.00125:406.471:270.98. The procedure is as followed

i) After preparing concrete mix oil is applied inside surface of wooden framework and concrete is poured into the shuttering with proper compaction,.

ii) Later on a slab is placed on both the concrete wall exactly at the center so that the load is distributed equally on both the walls

After one day framework is removed and gaining strength in concrete curing was done properly

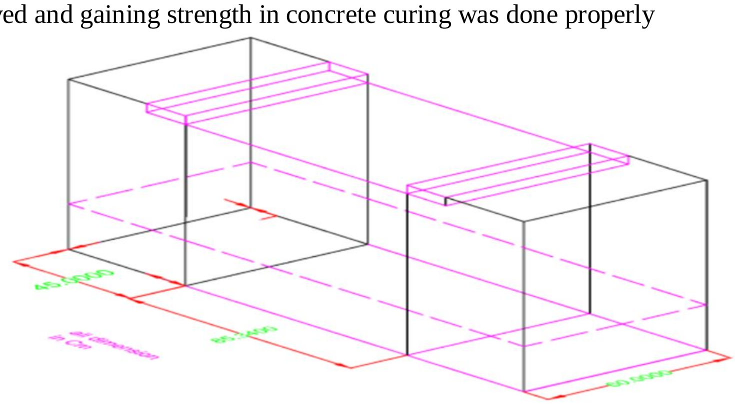


Fig. 3 Design of Planned Bench

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue XII, Dec 2018- Available at www.ijraset.com

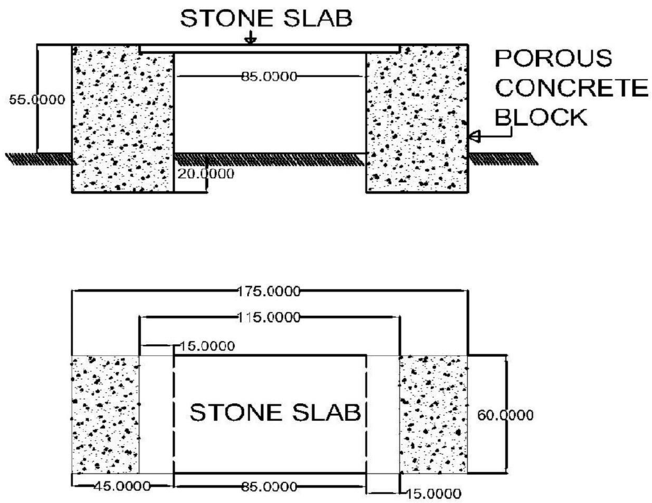


Fig 4 2D Elevation &Plan Diagram

Fig 5 Pouring of concrete and slab in wooden framework.

Fig 6. After completion of the construction

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue XII, Dec 2018- Available at www.ijraset.com

D. Cost analysis

The cost incurred in implementing sitting bench has been tabulated and shown in the table 7 as below;

Cement = 15.2/1+0.5+2.784+1.856
= 2.47bags of cement

Aggregate = 2.47×4.64
=11.46 m^3

TABLE 7.
Cost Analysis

Particulars	Qty	Rates	Amount
		Rs	Rs
(a) Materials			
Cement	2.47	300	741
Aggregate	11.46	1000	11460
		TOTAL	12201 Rs
(b) Labour			
Mason	1	360	360
Mazdoor	2	300	600
Sundries,T&P Etc	Lump sum	200	200
		Total	1160 Rs
		Total(A+B)	13361Rs
		Adding 1.5% Water charges	200.41
		Grand Total	Rs.13561.41

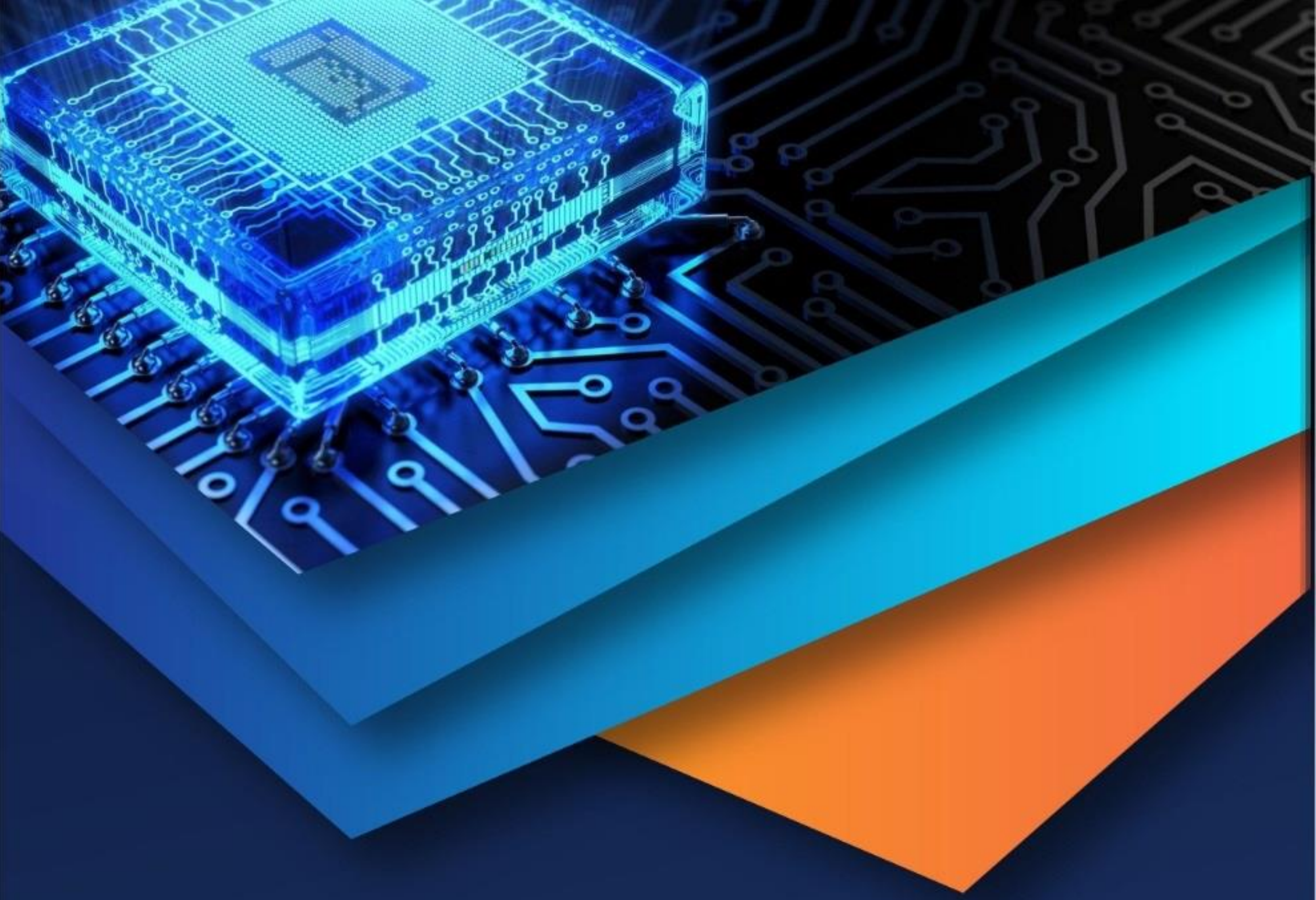
IV.CONCLUSIONS

From the present investigation it can be concluded that the materials being used for the making of no-fines concrete were satisfying the requirements of aggregates and cement concrete for the current mix design. It is observed that the results of compressive strength of no-fine concrete was almost near to the target mean strength and can be used for the purpose of low construction which aids the use of normal cement concrete (low construction such as parking lots, sitting benches, compound walls etc.). An example of sitting bench has also been implemented in the field and the pictures of the same is attached in the report in methodology section. Also, it is seen that the cost of the construction may be considerably decreased as there is an absence of sand in porous concrete which adhere the increase in the cost of normal concrete construction.

Thus, it can be recommended that the use of no fine concrete can be advantageous in the constructions of minor structures

REFERENCES

[1] Tennis, P.D., Leming, M.L., & Akers, D.J. (2004). Pervious concrete pavement. Portland Cement Association National Ready Mixed Concrete Association.
[2] Yang, J., & Jiang, G. (2003). Experimental study on properties of pervious concrete pavement materials. Cement and Concrete Research, 33, 381–386
[3] Sri Ravindrarajah, R., & Aoki, Y. (2008). Environmentally friendly pervious concrete. Paper presented to the Second International Conference on Advances in Concrete and Construction, Hyderabad, India, February
[4] Zhuge, Y. (2006). A review of permeable concrete and its application to pavements. 19th Australasian Conference on the Mechanics of Structures and Materials, 601–607
[5] Neithalath, N., Weiss, J. & Olek, J. (2006). Characterizing enhanced porosity concrete using electrical impedance to predict acoustic and hydraulic performance. *Cement and Concrete Research*, *36*, 2074–2085.
[6] Park, S.-B., & Tia, M. (2004). An experimental study on the water-purification properties of porous concrete. *Cement and Concrete Research*, *34*, 177–184
[7] Schaefer, V.R., Wang, K., Suleiman, M.T., & Kevern, J.T. (2006). Mix design development for pervious concrete in cold weather climates. Report Number 2006-01, National Concrete Pavement Technology Centre.
[8] Aoki, Y., Sri Ravindrarajah, R., & Khabbaz, H. (2008). Environmentally friendly sustainable pervious concrete. 20th Australasian Conference on the Mechanics of Structures and Materials, 2–5 December 2008, Toowoomba, Australia, pp. 567–570
[9] IS-456:2000:-Plain and Reinforced Concrete-Code of Practice.
[10] IS-10262:2009:- Concrete Mix proportioning.
[11] IS-383:1970:- Specification for Coarse and Fine Aggregate.
[12] Ghafoori, N., & Dutta, S. (1995). Laboratory investigation of compacted no-fines concrete for paving materials. Journal of Materials in Civil Engineering, 7, 183–191



doi crossref
10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY