Storm Water Management by Porous Concrete

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ABSTRACT:
Storm water is water that originates during precipitation event and snow/ice melts. Traditionally surface runoff considered as undesired water which needed to be drain off as soon as possible from urban as well as rural areas. Present drainage system involves construction of drains but this system only transfer the flood from one place to another. Porous concrete is relatively a new technique which provides an alternative solution for managing storm water in a more effective manner. Due to rapid flow rate of water through porous concrete rainfall can be captured and percolate into ground and thus discharging ground water. Porous pavement technology creates more efficient land use by eliminating the need for retention ponds, swales and other storm water management devices. Pervious surface treatment retain the water subsurface as it gradually infiltrates into the soil, holding the storm water in multiple air voids also assisting in water quality through degradation of hydrocarbon in carbon dioxide and water.
This project examines the use of different material for making porous concrete, their effect on characteristics of porous concrete and suitability for managing storm water. Cost estimation of various samples determines the most economical solution which can be used for porous pavement. This analysis also helps us to better understand the use of porous concrete for rain water harvesting.

Keyword: - Porous Concrete, Compressive Strength, Seepage, Admixture (Sikapalstiment 100).

INTRODUCTION:

Storm water runoff occurs when rain falls. This runoff causes increased pollution in rivers and streams, flash flood and loss of rainwater that could increase water table. Reason behind these is impervious road surface and improper drainage system, because of the impermeable surface in urban areas, flooding occurs very often as a human made event. Runoff from such surfaces has high velocity, which adds to storm water drainage system. This increases peak flow and overland flow volume and decreases natural ground water flow (as no percolation is possible). At the same time water demand increases day by day but there is scarcity of water hence it is necessary to preserve this natural resource.
Storm water management means to manage surface runoff. It can be applied in rural areas but is essential in urban areas where runoff cannot infiltrate because the surfaces are impermeable. Traditional model of storm water management is based on a misconception. It aims the draining of urban runoff as quick as possible with the help of channels and pipes, which increases peak flow and costs of storm water management. This type of solution only transfers flood problems from one section to another section. Hence we should go for new way for managing this storm water. This can be achieved by using porous concrete[Honey Gaur].

RESULTS AND DISCUSSION:

1. **Test Conducted on Cement**
   a) **Fineness test:**
      Result: - 1 gram (1% by weight)

   b) **Consistency test:**
      Result: - 38 %

2. **Test Conducted on Porous Concrete**
   a) **Compressive strength test:-**
      Cube specimen: The test specimens recommended are 150*150*150 mm cubes.

Table 1 Compressive Strength Observation

S.No.	SPECIMEN	COMPRESSIVE STRENGTH (7 DAYS) N/mm^2	COMPRESSIVE STRENGTH (28 DAYS) N/mm^2
1	1:5 cement and coarse aggregate (10 mm)	2.9	4.81
2	1:5 cement and coarse aggregate (20 mm)	2.13	3.55
3	1:0.5:5 cement, sand and coarse aggregate	5.7	8.5
4	1:0.5:5 cement, glass powder and coarse aggregate	6.2	9.5
5	1:0.5:5 cement, sand and coarse aggregate with 1% admixture	8.7	13.5
6	1:0.5:4 cement, sand and coarse aggregate with 1% admixture	9..8	15.2

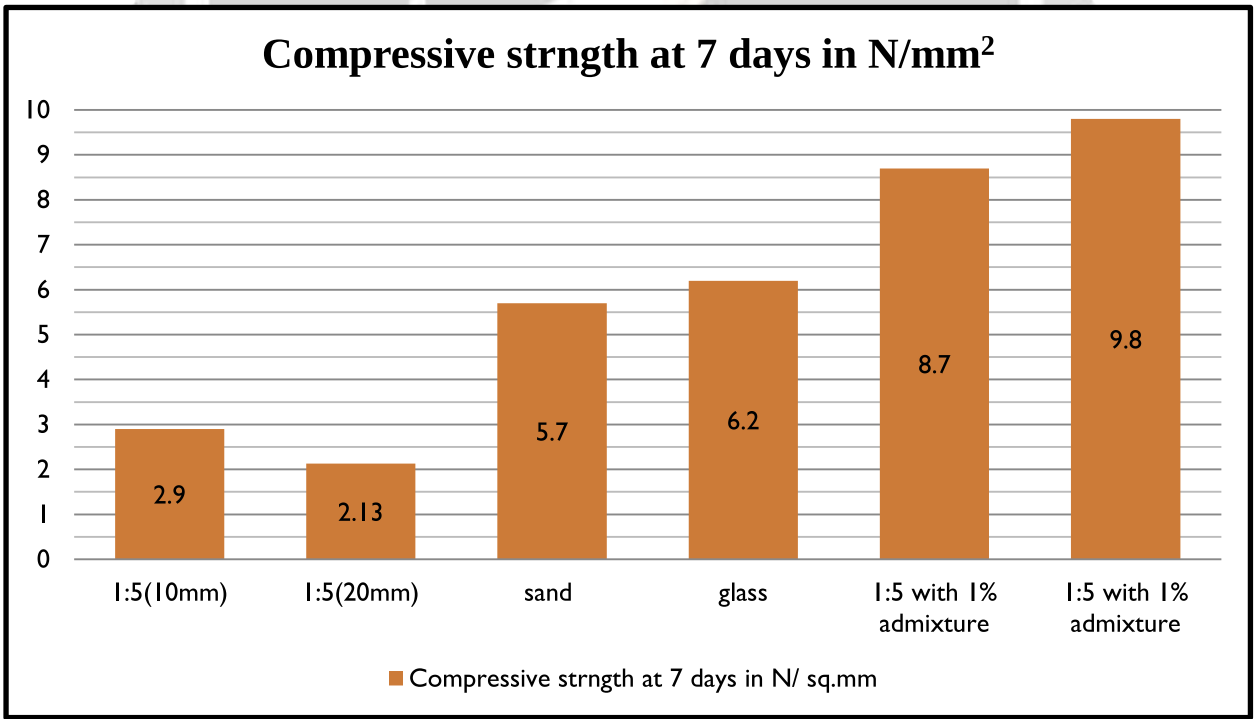

Fig 1 Compressive Strength at 7 days in N/mm^2

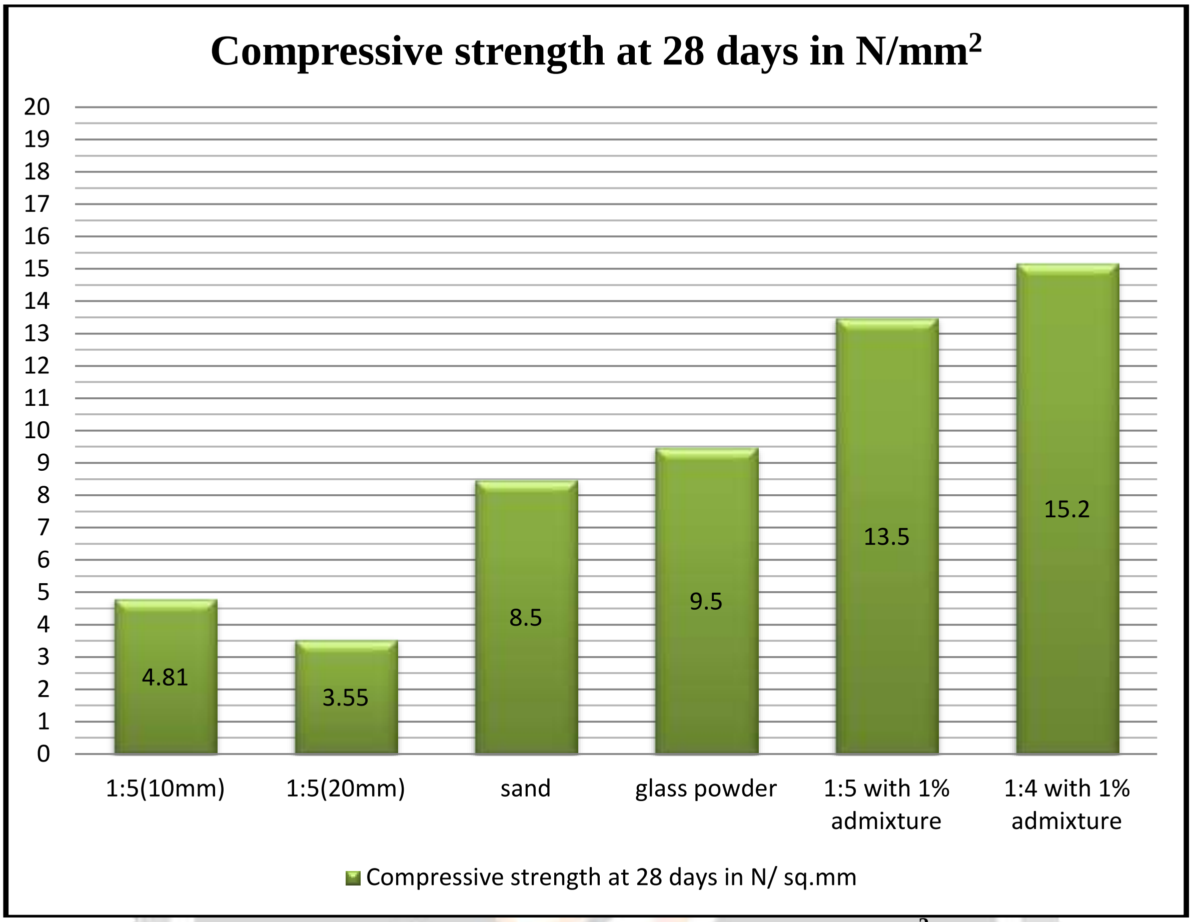

Fig 2 Compressive strength at 28 days in N/ mm^2

b) **Seepage test: -** For checking seepage 1000 ml of water is poured on porous concrete specimen. The volume of water passed per 1000 ml is measured and gives the seepage efficiency is determined.

Table 2 Seepage Observation

S.No.	Specimen	Seepage Efficiency
1	1:5 Cement and coarse aggregate (10mm)	97%
2	1;5 cement and coarse aggregate (20mm)	96%
3	1:0.5:5 cement, sand and coarse aggregate	94%
4	1:0.5:5 cement, glass powder and coarse aggregate	92%
5	(1:0.5:5)Cement, sand and coarse aggregate with 1% admixture	90%
6	(1:0.5:4)Cement, sand and coarse aggregate with 1% admixture	89%

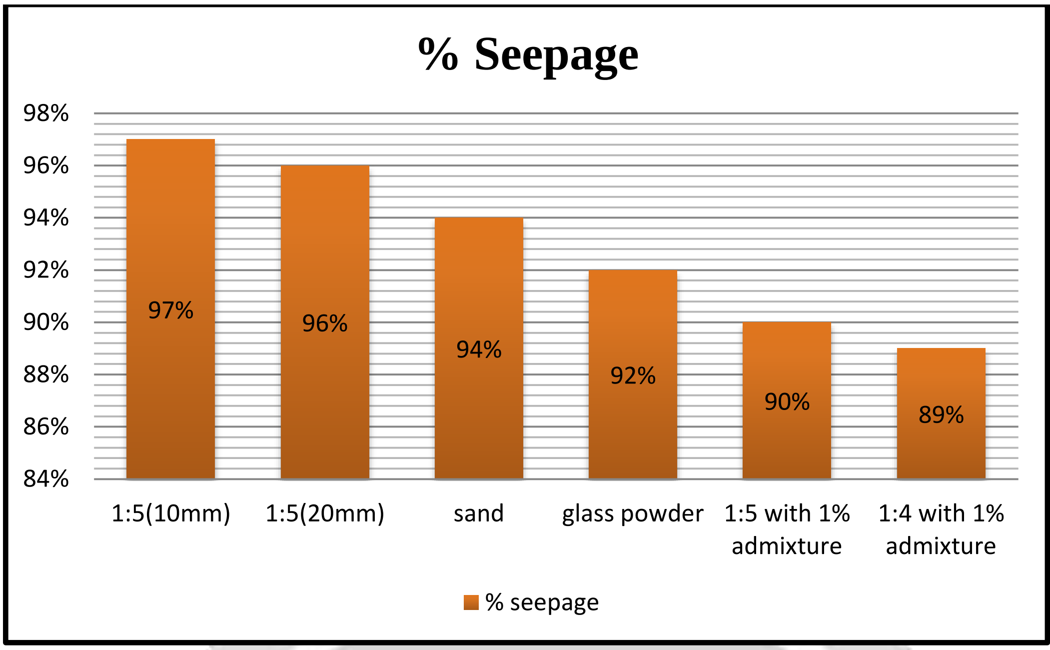

Fig 3

Seepage Percentage

COST ESTIMATION:

Cost Estimation of Materials and Samples: Cost of porous pavement is generally higher (about 10%) than cost for non porous pavement, but they are said to be offset by the elimination of need for detention basin and other storm water infrastructure. Costs vary with material availability, site condition, project size etc.

Unit costs of various materials involved in this project are as follows:-

Table 3 Cost of various materials

S.No.	Material	Unit cost (Approx)
1.	Cement	220 Rs/bag
2.	Sand	555 Rs/m^3
3.	Coarse aggregate 10mm	186 Rs/m^3
4.	Coarse aggregate 20mm	660 Rs/m^3
5.	Admixture	40 Rs/ kg

Note:

- Volume of cement in 10 m^3 of porous concrete can be calculated by – 15.2/total ratio
- 1 m^3 of cement =30 bags of cement

S. no.	Sample	Cost per m^3 (Approx)
1	1:5 cement and coarse aggregate (10 mm)	Rs1905.1
2	1:5 cement and coarse aggregate (20 mm)	Rs 2504.7
3	1:0.5:5 cement, sand and coarse Aggregate	Rs 1821.4
4	1:0.5:5 cement, glass powder And coarse aggregate	Rs 1756.7
5	1:0.5:5 cement and coarse aggregate and 1% of admixture	Rs 1961.4
6	1:4cement and coarse aggregate and 1% of admixture	Rs 2268.3

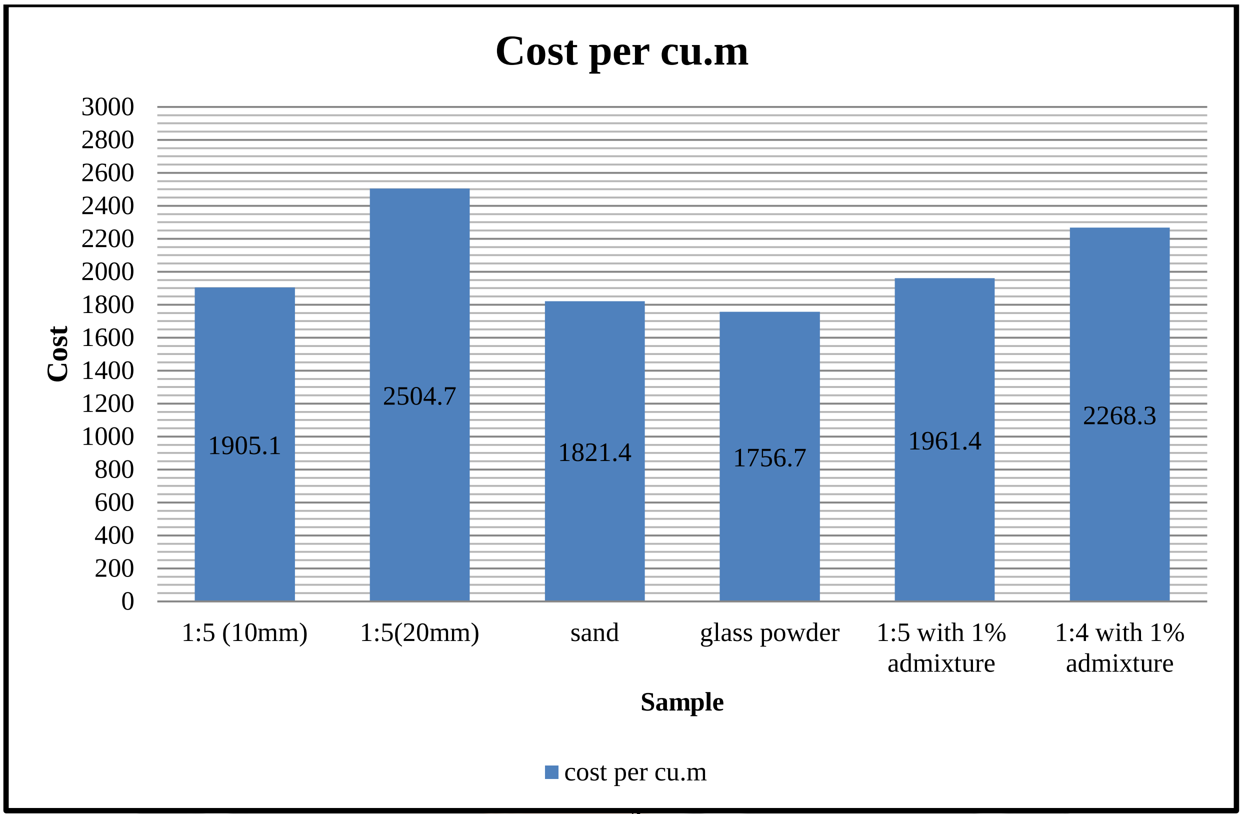

Fig. 4 cost per m^3 of various samples

RESULT:

From the data obtained from compressive strength test and seepage test a graph is plotted with compressive strength (at the end of 28 days) on ordinate and percentage seepage on abscissa. The graph so obtained shows that compressive strength varies inversely with seepage. Compressive strength is less when we used no fine concrete, but addition of little amount of fines in the form of sand and glass powder will increase the compressive strength; this will subsequently reduces the seepage characteristics. Analysis also shows that addition of admixture (water reducer) increases compressive strength without much loss of seepage efficiency.

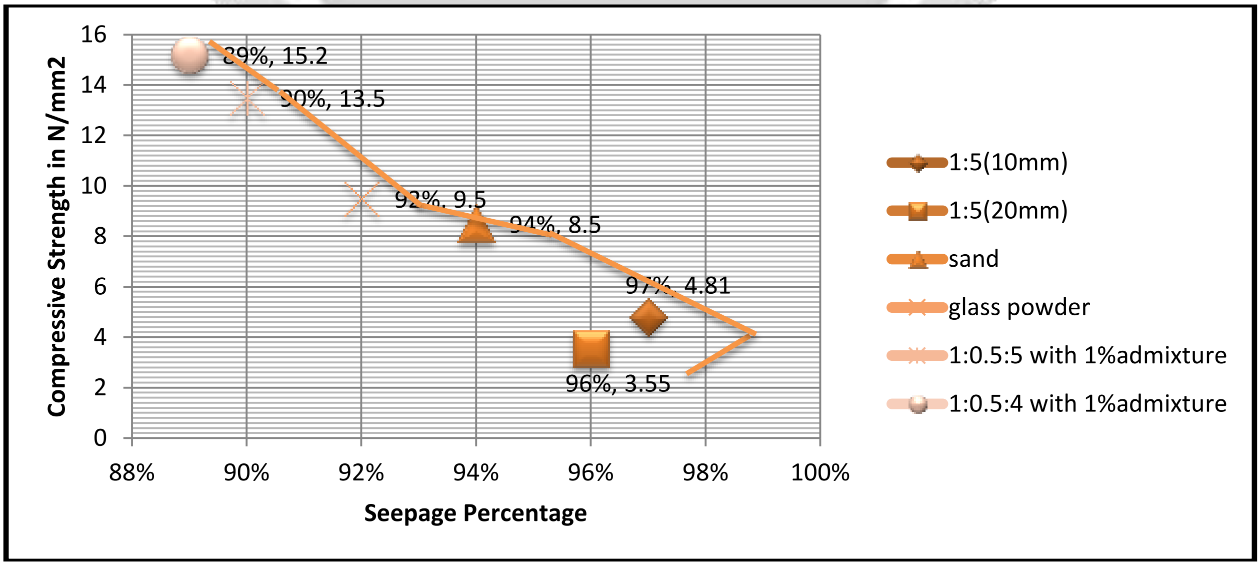

Fig 5 Compressive strength v/s seepage percentage

CONCLUSIONS:

The storm water management is essential to prevent erosion of agricultural land and flooding of inhabited urban or rural areas. Both cases can cause severe damages and contaminations to environment at the same time to preserve precious natural resource water it is very necessary to have an effective system to manage storm water and store it for useful purposes.

We can conclude that use of porous concrete for storm water management can provide a best alternative solution ,as porous concrete not only help to control flood water but also it will increase the ground water level by percolating water through its pore space. Traditional storm water management was mainly to drain high peak flows away. This only dislocates high water loads. Modern approaches aim to rebuild the natural water cycle i.e. to store runoff water to recharge ground water and to use the collected water for irrigation or house hold supply.

From the tests on 6 porous concrete sample in this project a conclusion arises that porous concrete using admixtures (water reducer) and a little amount of fines gives best results in terms of strength as well seepage.

By increasing the strength of such porous concrete it can also be applied for porous pavements and other wide range applications for effectively managing the storm water. In terms of construction the porous concrete pavement eliminates the requirement of storm water drains or side drains as the storm water percolates into the pavements itself. This will help in utilizing urban land more effectively where the cost of land is normally high and reduces the cost of construction and maintenance of side drain.

FUTURE ASPECTS:

Porous concrete can be implemented in metropolitan cities in parking lots, driveway, sidewalks, road platform etc. The roads around the apartment and the surfacing inside the compound can be made with porous concrete. Another significant advantage is that much of the pervious concrete can be laid manually without using heavy machinery, so this can be placed in lower cost even in rural areas.

Porous concrete pavement is a unique and effective way to capture storm water and allow it to seep into the ground thus recharging groundwater and reduces storm water runoff. This pavement technology creates more efficient land use by eliminating the need for retention ponds and other storm water management devices. Porous surface treatments retain the water into subsurface as it gradually infiltrates into the soil, holding storm water in multiple air voids and also assisting in water quality through degradation of hydrocarbons into carbon dioxide and water.

In future with increase urbanization, diminishing ground water level and focus on sustainability technologies such as porous concrete are likely to become more popular as compared to conventional concrete .

Porous concrete has another scope as a sound barrier. The open structure of porous concrete causes a difference in arrival time between direct and reflected sound waves. This difference causes the sound level to have a lower intensity causing porous concrete to absorb sound. Thus we can reduce noise level.

REFERENCES:

1. Shashi Kumara S.R, "An Experimental Study on Application of Pervious Concrete Effective rainwater harvesting System", Volume V, Issue V, May 2016
2. Dania M. Abdel-Aziz, Dua O. Al-Maani, Wael Al-Azhari Ph.D. "Using pervious concrete for Managing Storm Water Runoff in Urban Neighbhourhoods", American International Journal of Contemporary Research, Vol 5, No.2, April 2015
3. M. Harshavarthana Balaji, M.R.Amarnaath, R.A.Kavin, S. Jaya pradeep DESIGN OF ECO FRIENDLY PERVIOUS CONCRETE International Journal of Civil

Engineering and Technology (IJCIET), ISSN 0976 – 6308 (Print), ISSN 0976 – 6316(Online), Volume 6, Issue 2, February (2015), pp. 22-29

4. Mr.V. R. Patil Prof. A. K. Gupta Prof. D. B. Desai,” Use Of Pervious Concrete In Construction Of Pavement For Improving Their Performance”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684, PP: 54-56
5. Agouridis, C., Villines, j., 2011, "Permeable Pavement for Storm Water Management." Lexington, KY : University of Kentucky College.
6. Park, S., Tia, M., 2004, "An Experimental Study on the Water-purification Properties of Porous Concrete." Cement and Concrete Research, Vol. 34, pp. 177-184.
7. Prema Kumar W, Ananthayya M , Vijay K,” Effect Of Partial Replacement Of Cement With Waste Glass Powder On The Properties Of Concrete”, ISSN 2319 – 6009 ,Volume 3, No 2, May 2014.
8. Dr. G.Vijayakumar, Ms H. Vishaliny, Dr. D. Govindarajulu.”Studies on Glass Powder as Partial Replacement of Cement in Concrete Production”, International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, Volume 3, Issue 2, February 2013
9. IS 5513:1996 Indian Standard Vicat Appratus-Specification
10. National Ready Mixed Concrete Association(NRMCA), (2004) “What, Why, and How? Pervious Concrete”, Concrete in Practice series, CIP 38, Silver Spring, Maryland, May 2004, 2 pages
11. Ferguson, Bruce K. (1998) Introduction to Stormwater: Concept, Purpose, Design, Wiley, New York.
12. (CG) Schedule of rates for building work(2015).
13. (CG) Schedule of rate for road work(2015).
14. IS 4031 (Part 1): 1996 Determination of fineness by dry sieving.
15. IS: 516 – 1959 Methods of test for strength of concrete
16. Honey Gaur” An Experimental View on Effects on Workability of Glass Fiber Reinforced Concrete by Partial Replacement of Cement and Sand With Industrial By-Products” Vol-4 Issue-1 2018,PP 609-612.