International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 13
October 2017

# A Review on Comparison of M15, M20, M25 Grades of Pervious Concrete with Conventional Concrete

**Ms.Muppala Vaishnavi & Mr. VIJAY AMRITHRAJ A**
1 PG Student, Dept. Of Structural Engineering , SKR College Of Engineering & Technology, AP
2 Asst. Professor, Dept. Of Structural Engineering, SKR College Of Engineering & Technology,AP

**Abstract:** Pervious concrete is a type of concrete with high porosity. It is used for concrete flatworks application that allow the water to pass through it, thereby reducing the runoff from a site and allowing ground water recharge. The high porosity is attained by a highly interconnected void content. Typically pervious concrete has water to cementisious material ratio of 0.28 to 0.4.The mixture is composed of cementisious materials, coarse aggregates and water with little to no fine aggregates. Addition of a small amount of fine aggregates will generally reduce the void content and increase the strength. The present project deals with the study and comparison of mechanical properties, workability and density of different grades of pervious concrete(M15,M20,M25).

**Keywords:** Pervious Concrete, No Fines, Hyper Plasticizer.

## 1. INTRODUCTION

Cement is a composite material made for the most part out of water, total, and bond. The fancied physical properties of the completed material can be accomplished by incorporating added substances and fortifications in the blend. A liquid mass that is effectively shaped into shape can be framed by combining these fixings in specific extents. Over the time, a hard network framed by bond ties whatever remains of the fixings together into a stone-like strong material with numerous utilizations, for example, Famous solid structures like the Hoover Dam, the Pannama Canal and the Roman Pantheon. The solid innovation was utilized before on huge scale by the old Romans, and the solid was exceedingly utilized as a part of the Roman Empire. The Colosseum was assembled to a great extent of cement in rome, and the solid vault of the patheon is the World's biggest unreinforced concrete . After the fall of Roman Empire in the mid-18 th century the innovation was re-spearheaded as the utilization of cement has got to be uncommon. Today, the generally utilized man made material is concrete. (measured by tonnage).

One of the disadvantages of concrete is the high self weight of concrete. Density of normal concrete is in the order of 2200 to 2600 kg/m$^3$. This heavy self weight will make it to some extent an uneconomical structural material. Attempts have been made in the past to reduce the self weight of concrete to increase the efficiency of concrete as a structural material. The light weight concrete density varies from 300 to 1850 kg/m$^3$.

Light weight concrete has become more popular in recent years and have more advantages over the conventional concrete.

Pervious concrete is nothing but no fines concrete, which is also known as porous, gap graded or permeable concrete mainly consists of normal Portland cement, CA, water. In which FA are not existent or present in very small amount i.e < 10% by weight of the total aggregates.

In general, for making porous concrete, we will use the aggregates of size which passes through 12.5mm sieve and retained on 10mm sieve. In this project we have taken single size aggregates i.e 12.5mm. the single size aggregates make a good no-fines concrete, which addition to having large voids and hence light in weight, also offers architecturally attractive look.

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 13
October 2017

**Fig 1: test specimens**

Common applications for pervious concrete are parking lots, side walls, path ways, tennis courts, slope stabilization, swimming pool decks, green house floors, drains, highway pavements. Generally which is not used for concrete pavements for high traffic and heavy wheel loads. structural advantages.

## 2. Aim and Objectives

The aim of the research is to study the strength, durability and permeability of pervious concrete for different grades (M15, M20, M25). The objectives include

- To study the workability of concrete.
- To study the density of concrete.
- To study the mechanical properties such as compressive, tensile and flexural strength of concrete.
- To study the durability of concrete by sulphate attach (by using MgSo4 curing).
- To study the permeability of concrete.

## 3. Materials

The present investigation the following materials were used:

- Ordinary Portland Cement of 53 Grade cement conforming to IS: 169-1989
- Fine aggregate and coarse aggregate conforming to IS: 2386-1963.
- Water.
- Hyper plasticizer (ECMASHP-902)

### 3.1 Cement

Ordinary Portland Cement of 53 Grade of brand name Ultra Tech Company, available in the local market was used for the investigation. Care has been taken to see that the procurement was made from single batching in air tight containers to prevent it from being effected by atmospheric conditions. The cement thus procured was tested for physical requirements in accordance with IS: 169-1989 and for chemical requirement in accordance IS: 4032-1988. The physical properties of the cement are listed in Table –

**Table 1:** Properties of cement

| Sl. No | Properties | Test results | IS: 169-1989 |
|---|---|---|---|
| 1. | Normal consistency | 0.32 | |
| 2. | Initial setting time | 60min | Minimum of 30min |
| 3. | Final setting time | 320 min | Maximum of 600min |
| 4. | Specific gravity (a) | 3.14 | |

### 3.2 Fine Aggregates

River sand locally available in the market was used in the investigation. The aggregate was tested for its physical requirements such as gradation, fineness modulus, specific gravity in accordance with IS: 2386-1963.The sand was surface dried before use.

**Table 2:** Properties of Fine Aggregates

| | |
|---|---|
| Fineness modulus | 2.4 |
| Specific Gravity of fine aggregate | 2.55 |
| Free moisture | 2% |

### 3.3 Coarse Aggregates

Crushed aggregates of less than 12.5mm size produced from local crushing plants were used. The aggregate exclusively passing through 12.5mm sieve size and retained on 10mm sieve is selected. The aggregates were tested for their physical requirements such as gradation, fineness modulus, specific gravity and bulk density in accordance with IS: 2386-1963. The individual aggregates were mixed to induce the required combined grading. the particular gravity and water absorption of the mixture are given in table.

**Table 3:** Properties of coarse aggregates

| | |
|---|---|
| Specific Gravity of coarse aggregate | 2.60 |
| Water absorption | 1% |

### 3.4 Water

Potable water fit for drinking is required to be used in the concrete and it should have pH value ranges between 6 to 9.

### 3.5 Hyper Plasticizers

Hyper plasticizers are standard chemical admixtures for concrete employed in the reduction of water to cement quantitative relation while not moving workability, and to avoid particle saggregation within the concrete

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 13
October 2017

mixture. These are called high vary water reducers (HRWR), fluidifiers, and dispersants as these are capable of reducing water to cement quantitative relation by forty.0%. These chemical admixtures are additional within the concrete simply before the concrete is placed. These admixtures facilitate to enhance strength and flow characteristics of the concrete. In this project we used ECMASHP-902 as admixture with an amount of 0.2% by weight of cement.

**Mix proportions as Per ACI 211.1-91**

**Table 4:** Mix proportions for M15 grade of concrete

| materials | Proportions for Conventional $(kg/m^3)$ | Proportions for No fines concrete $(kg/m^3)$ |
|---|---|---|
| Cement | 277.7 | 277.7 |
| Fine aggregates | 642.04 | 0 |
| Coarse aggregates | 1193.94 | 1193.94 |
| Water cement ratio by mass | 0.3 | 0.3 |
| Admixture(ml) | 55.54 | 55.54 |

**Table 5:** Mix proportions for M20 grade of concrete

| materials | Proportions for Conventional $(kg/m^3)$ | Proportions for No fines concrete $(kg/m^3)$ |
|---|---|---|
| Cement | 380 | 380 |
| Fine aggregates | 563.06 | 0 |
| Coarse aggregates | 1113.75 | 1113.75 |
| Water cement ratio by mass | 0.3 | 0.3 |
| Admixture(ml) | 76 | 76 |

**Table 6:** Mix proportions for M25 grade of concrete

| materials | Proportions for Conventional $(kg/m^3)$ | Proportions for No fines concrete $(kg/m^3)$ |
|---|---|---|
| Cement | 452.38 | 452.38 |
| Fine aggregates | 503.2 | 0 |
| Coarse aggregates | 1113.75 | 1113.75 |
| Water cement ratio by mass | 0.3 | 0.3 |
| Admixture(ml) | 90.47 | 90.47 |

**4 Sulphate Attack**

To determine the resistance of various concrete mixtures to sulphate attack, the residual compressive strength of concrete mixtures of cubes immersed in alkaline water having 5% of Magnesium sulphate ($MgSO_4$) by weight of water was found. The concrete cubes which were cured in $MgSO_4$ were removed from the curing tank and allowed to dry for one day. The weights of concrete cube specimen were taken.. The resistance of concrete to sulphate attack was found by the % loss of weight of specimen and the % loss of compressive strength on immersion of concrete cubes in 3-5% magnesium sulphate water.

**5 Experimental Results**

**5.1 Workability:** Results obtained from compaction factor test showing that the workability of concrete

**Table 7:** Compaction factor for conventional concrete and No fines concrete

| Grades Of Concrete | Compaction Factor | |
|---|---|---|
| | Conventional Concrete | No Fines Concrete |
| M15 | 0.8 | 0.85 |
| M20 | 0.84 | 0.89 |
| M25 | 0.87 | 0.92 |

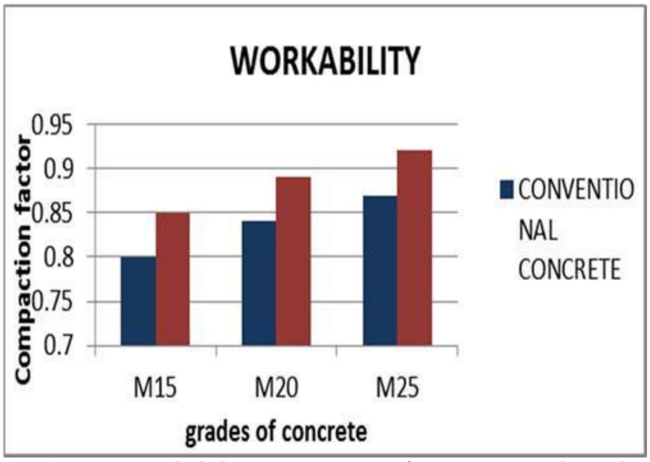



**Fig 2:** Workability variation of conventional and pervious concrete for different grades

**5.2 Compressive Strength**

These results are obtained by testing the total 6 specimens for 7 days and 28 days and by considering the average of the test results and that are tabulated in table

**Table 8:** compression strength of No fines concrete cubes cured in water and cured in MgSo4.

| Grades Of Concrete | Compressive Strength$(N/mm^2)$ | | | |
|---|---|---|---|---|
| | Cured In Water | | Cured In MgSo4 | |
| | 7 Days | 28 Days | 7 Days | 28 Days |
| M15 | 11.02 | 16.32 | 8.96 | 15.1 |

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 13
October 2017

| | | | | |
|---|---|---|---|---|
| M20 | 14.98 | 20.79 | 12.82 | 18.74 |
| M25 | 19.86 | 24.4 | 17.2 | 25.53 |

**Table 9:** compression strength of conventional concrete cubes cured in water and cured in MgSo4.

| Grades Of Concrete | Compressive Strength(N/MM$^2$) | | | |
|---|---|---|---|---|
| | Cured In Water | | Cured In MgSo4 | |
| | 7 Days | 28 Days | 7 Days | 28 Days |
| M15 | 14.6 | 19.1 | 13.03 | 18.8 |
| M20 | 17.26 | 25.44 | 15.6 | 24.03 |
| M25 | 21.3 | 30.88 | 19.3 | 28.87 |

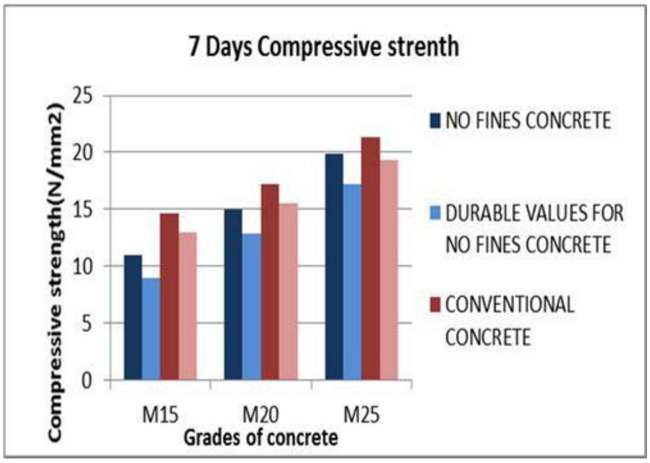



**Fig 3:** Seven days compressive strength variation of conventional and No fines concrete cured in water and cured in MgSo4.

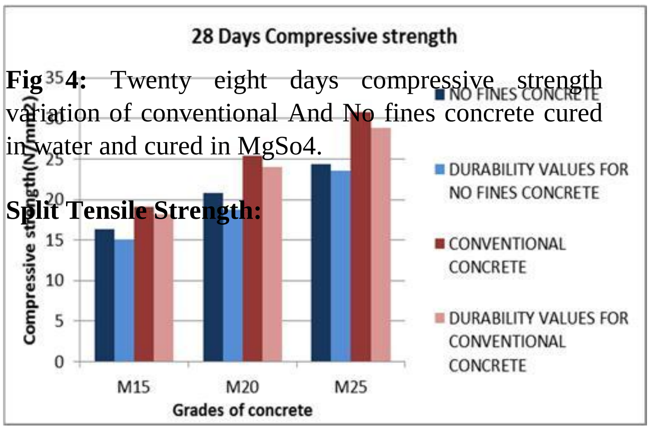



**Fig 4:** Twenty eight days compressive strength variation of conventional And No fines concrete cured in water and cured in MgSo4.

**Split Tensile Strength:**

These results are obtained by testing the total 6 specimens for 7 days and 28 days and by considering the average of the test results that are tabulated in table

**Table 10:** Split tensile strength of No fines concrete cylinders cured in water and cured in MgSo4.

| Grades Of Concrete | Split Tensile Strength(N/mm$^2$) | | | |
|---|---|---|---|---|
| | Cured In Water | | Cured In MgSo4 | |
| | 7 Days | 28 Days | 7 Days | 28 Days |
| M15 | 0.98 | 1.22 | 0.84 | 1.08 |

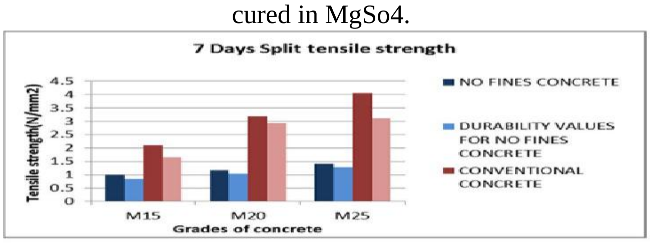
| Grades Of Concrete | Flexural Strength(N/mm$^2$) | | | |
|---|---|---|---|---|
| | Cured In Water | | Cured In MgSo4 | |
| | 7 Days | 28 Days | 7 Days | 28 Days |
| M15 | 3.79 | 5.18 | 3.13 | 4.91 |
| M20 | 6.68 | 7.36 | 6.09 | 7.06 |
| M25 | 8.89 | 10.28 | 8.26 | 9.92 |

| | | | | |
|---|---|---|---|---|
| M20 | 1.17 | 1.57 | 1.04 | 1.39 |
| M25 | 1.41 | 2.05 | 1.29 | 1.82 |

**Table 11:** Split tensile strength of conventional concrete cylinders cured in water and cured in MgSo4.

| Grades Of Concrete | Split Tensile Strength(N/mm$^2$) | | | |
|---|---|---|---|---|
| | Cured In Water | | Cured In MgSo4 | |
| | 7 Days | 28 Days | 7 Days | 28 Days |
| M15 | 2.11 | 3.26 | 1.65 | 2.92 |
| M20 | 3.19 | 4.7 | 2.93 | 3.99 |
| M25 | 4.04 | 5.2 | 3.11 | 4.82 |

**Fig 5:** Seven days split tensile strength variation of conventional And No fines concrete cured in water and cured in MgSo4.



**International Journal of Research**
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 13
October 2017

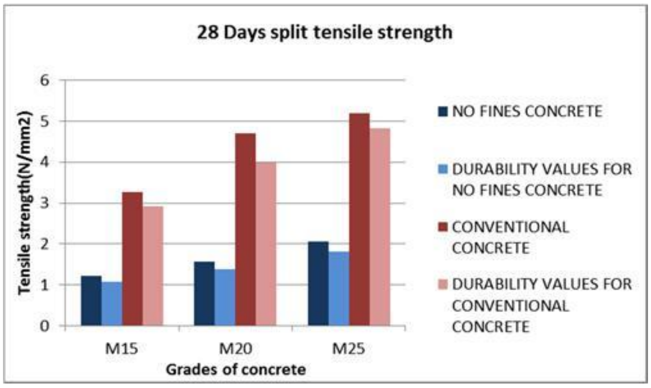



**Fig 6:** Twenty eight days split tensile strength variation of conventional And No fines concrete cured in water and cured in MgSo4.

### Flexural Strength

These results are obtained by testing the total 6 specimens
for 7 days and 28 days and by considering the average of the test results that are tabulated in table

**Table 12:** Flexural strength of No fines concrete beams cured in water and cured in MgSo4.

| Grades Of Concrete | Flexural Strength(N/mm$^2$) | | | |
|---|---|---|---|---|
| | Cured In Water | | Cured In MgSo4 | |
| | 7 Days | 28 Days | 7 Days | 28 Days |
| M15 | 3.79 | 5.18 | 3.13 | 4.91 |
| M20 | 6.68 | 7.36 | 6.09 | 7.06 |
| M25 | 8.89 | 10.28 | 8.26 | 9.92 |

**Table 13:** Flexural strength of conventional concrete beams cured in water and cured in MgSo4.

| Grades Of Concrete | Flexural Strength(N/mm$^2$) | | | |
|---|---|---|---|---|
| | Cured In Water | | Cured In MgSo4 | |
| | 7 Days | 28 Days | 7 Days | 28 Days |
| M15 | 5.43 | 7.1 | 4.51 | 6.37 |
| M20 | 8.44 | 10.12 | 7.32 | 9.55 |
| M25 | 10.37 | 12.57 | 9.03 | 11.12 |

| Grades Of Concrete | Flexural Strength(N/mm$^2$) | | | |
|---|---|---|---|---|
| | Cured In Water | | Cured In MgSo4 | |
| | 7 Days | 28 Days | 7 Days | 28 Days |
| M15 | 5.43 | 7.1 | 4.51 | 6.37 |
| M20 | 8.44 | 10.12 | 7.32 | 9.55 |
| M25 | 10.37 | 12.57 | 9.03 | 11.12 |

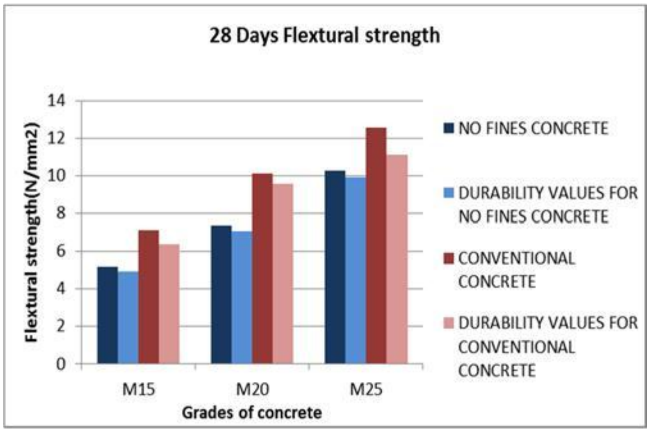



**Fig 8:** Twenty eight days flexural strength variation of conventional And No fines concrete cured in water and cured in MgSo4.

### Density of Concrete

The density of concrete cubes for different grades of conventional and no fines concrete are shown below.

**Table 14:** Density of conventional concrete and No fines concrete

| Grade Of Concrete | Density Of Concrete (kg/m$^3$) | |
|---|---|---|
| | Conventional Concrete | No Fines Concrete |
| M15 | 2340 | 1612 |
| M20 | 2375 | 1656 |
| M25 | 2394 | 1685 |

### Permeability Test

These results are obtained by testing the total 9 specimens for conventional and no fines concrete by varying the pressure differences and the results are tabulated in the table.

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 13
October 2017

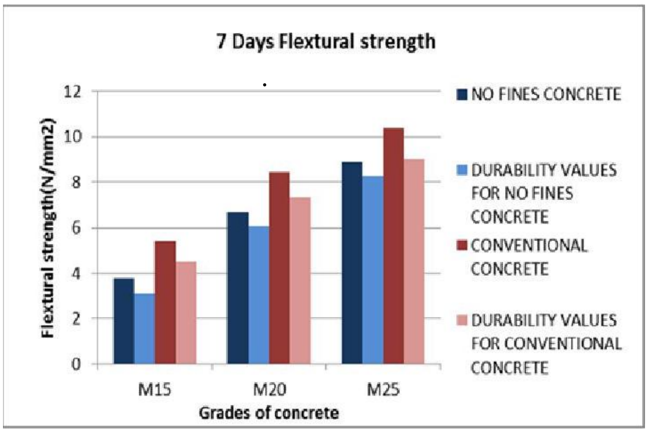



**Table 15:** Permeability of conventional concrete and No
fines concrete

**Fig 7:** Seven days flexural strength variation of conventional
And No fines concrete cured in water and cured in MgSo4

| Pressure Difference | Permeability Of Conventional Concrete(cm/sec) | | | Permeability Of No Fines Concrete (cm/sec) | | |
|---|---|---|---|---|---|---|
| (Pa) | M15 | M20 | M25 | M15 | M20 | M25 |
| 5 | $5.6X10^{-14}$ | $3.2X10^{-14}$ | $1.39 X10^{-14}$ | $6.6 X10^{-3}$ | $1.01X10^{-3}$ | $9.42 X10^{-4}$ |
| 10 | $1.8X10^{-14}$ | $9.48 X10^{-15}$ | $7.47 X10^{-15}$ | $1.2 X10^{-3}$ | $8.2 X10^{-4}$ | $6.01 X10^{-4}$ |
| 15 | $8.6X10^{-15}$ | $6.23 X10^{-15}$ | $3.25 X10^{-15}$ | $8.9 X10^{-4}$ | $5.4 X10^{-4}$ | $2.9 X10^{-4}$ |

## Discussion

### Compressive Strength

A decrease in the compressive strength of M**15**,M**20** and M**25** grades of no fines concrete by 18.2%, 14.5% and12.6% respectively is found compared to the conventional concrete. The computed values of the compressive strength of both conventional and no fines concrete establish that compressive strength of no fines concrete is less than that of conventional concrete.

### Split Tensile Strength

It is evident from the study that the tensile strength of M**15**, M20 and M25 grades of no fines concrete is decreased by 40. 2%, 38.4% and 36.2% respectively in comparison with the conventional concrete.

The calculated split tensile strength values of both conventional and no fines concrete prove that the tensile strength of no fines concrete is less than that of conventional concrete.

### Flexural Strength

Observations conclude that the flexural strength of M**15**, M20 and M25 grades of no fines concrete is decreased by 29.9%, 27.6% and 24.6% respectively when compared to the conventional concrete.

Illustrative computation of flexural strength values of both conventional and no fines concrete prove that flexural strength of no fines concrete is less than that of conventional concrete.

### Density of Concrete

It is observed that the density of M**15**, M20 and M**25** grades of no fines concrete is decreased by 31.1%, 30.2% and 29.6% as against that of conventional concrete.

The computed density of no fines concrete is noted to have decreased in comparison with that of conventional concrete.

### Permeability

It has been observed that coefficient of permeability of M**15**, M**20** and M**25** grades of no fines concrete is increased by 82. 4%, 79.6% and 72.8% respectively in comparison with the conventional concrete.

Computations establish that the coefficient of permeability values is more for no fines concrete than the conventional concrete.

### Workability

Form the calculated workability values it is observed that for M**15**, M**20** and M**25** grades of no fines concrete are increased by 5.8%, 5.6% and 5.4% respectively when compared to the conventional concrete.

### Durability by Sulphate Attack

**Compressive Strength:**

**(A) No Fines Concrete**

The compressive strength of M**15**, M20 and M**25** grades of no fines concrete is decreased by 15.5%, 16.2% and 12.8%.

**(B) Conventional Concrete**

The spilt tensile strength of M**15**, M20 and M**25** grades of no fines concrete is decreased by 14.8%, 13.7% and 15.05%respectively.

**Split Tensile Strength**

**(A) No Fines Concrete**

The spilt tensile strength of M**15**, M20 and M25 grades of no fines concrete is decreased by 11.4%, 11.46% and 11.21% respectively.

**(B) Conventional Concrete**

The spilt tensile strength of M**15** M**20** and M**25** grades of no fines concrete is decreased by 10.42%, 11.5% and 9.4% respectively.

**Flexural Strength**

**(A) No Fines Concrete**

The flexural strength of M**15**, M20 and M25 grades of no fines concrete is decreased by 11%, 10.1% and 8.2% respectively.

**(B) Conventional Concrete**

The spilt tensile strength of M**15**, M20 and M25 grades of no fines concrete is decreased by 10.28%, 8.5% and 11.5% respectively.

**Conclusions**

The following conclusions are drawn based on the experimental investigations on compressive strength, split tensile, flexural, durability, permeability considering the "environmental aspects" also:

- Pervious concrete has less strength than conventional concrete by 18.2% for M15, 14.5% for M20 and 12.6% for M25.
- Similarly the tensile and flexural strength values are also comparatively lower than the conventional concrete by 30%.
- Though the pervious concrete has low compressive, tensile and flexural strength it has high coefficient of permeability hence the following conclusions are drawn based on the permeability, environmental effects and economical aspects.
- It is evident from the project that no fines concrete has more coefficient of permeability. Hence, it is capable of capturing storm water and recharging the ground water. As a result, it can be ideally used at parking areas and at residential areas where the movement of vehicles is very moderate.
- Further, no fines concrete is an environmental friendly solution to support sustainable construction. In this project, fine aggregates as an ingredient has not been used. Presently, there is an acute shortage of natural sand all around. By making use of FA in concrete, indirectly we may have been creating environmental problems. Elimination of fines correspondingly decreases environment related problems.
- In many cities diversion of runoff by proper means is complex task. Use of this concrete can effectively control the run off as well as saving the finances invested on the construction of drainage system. Hence, it can be established that no fines concrete is very cost effective apart from being efficient.

**References**

1. Aguado A. he told that highly permeable materials provide drainage and noise-absorption properties that are useful in pavement top layers, 1999.
2. Yang J, Jiang G. In this paper, a pervious concrete pavement material used for roadway is introduced. Using the common material and method, the strength of the pervious concrete is low, 2003.
3. Mulligan AM. This thesis investigated prior studies on the compressive strength on pervious concrete as it relates to water-cement ratio, aggregate-cement ratio, aggregate size, and compaction, 2005.
4. Valavala S, Montes F. They concluded that Pervious concrete is an alternative paving surface that can be used to reduce the nonpoint source pollution effects of storm water runoff from paved surfaces, 2006.
5. Suleiman M, Kevern J. this paper summarizes a study performed to investigate the effects of compaction energy on pervious concrete void ratio, compressive strength, tensile strength, unit weight, and freeze-thaw durability, 2007.
6. Wolfersberger C. in this paper, Pervious concrete usually requires much less maintenance. But inspection and some attention will keep it working for many years, 2008.
7. Wang K. This paper describes the current state of practice in pervious concrete placement methods and presents results from a laboratory-based study to compare various placement practices and develop QA/QC criteria, 2008.
8. Meininger RC. in this paper Conclusions are drawn regarding the percentage of air voids needed for adequate permeability, the optimum water-cement ratio range, and the amounts of compaction and curing required, 2009.

## Author's Details:

**Ms.Muppala Vaishnavi** received Btech in Civil Engineering from Audisankra Institute of Technology(ASIT) affiliated to the Jawaharlal Nehru technological university Anathapur in 2014, and pursing M. Tech in Structural Engineering from SKR College of Engineering affiliated to the Jawaharlal Nehru technological university Anantapur in 2016, respectively.

**Mr. VIJAY AMRITHRAJA** Working As Assistant Professor Dept of Civil Engineering SKR College of Engineering affiliated to the Jawaharlal Nehru technological university Anantapur .