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# Strength and Permeability Properties of No-Fines, Light Weight Concrete: An Experimental Study

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***Abstract:*** **Due to the day by day innovations and developments in construction field, the global consumption of normal concrete is very high, which gives more self-weight to the structure. To reduce this self-weight lightweight concrete mixes are being adopted where weight saving is an important factor. Lightweight concrete is made by either omitting the fine aggregate from the mix (or) by replacing some (or) all the normal weight aggregate with light weight aggregate. Another way for making concrete light by inclusion of air.**
**In this experimental study we are going to study the compressive, tensile and flexural strength, durability properties of lightweight concrete which is achieved by eliminating the fine aggregate content. No-Fines Concrete is a method of producing light weight concrete by omitting the fines from conventional concrete. Concrete manufacturing involve consumption of ingredients like cement, coarse aggregate, water, chemical admixtures like WRA/HRWR, mineral admixtures like fly ash, ground granulated blast furnace slag (GGBS) etc. Coarse aggregate of size passing through 20mm and retained on 12.5mm is used. Using the above material lightweight aggregate concrete of M40 grade is being manufactured and tested against strength and durability properties. The Mix design is based on BIS method and the ingredients are batched on volumetric basis.**

***Keywords:*** **No-Fines Concrete, GGBS, fly ash, compressive, tensile and flexural strength, durability.**

## 1. INTRODUCTION

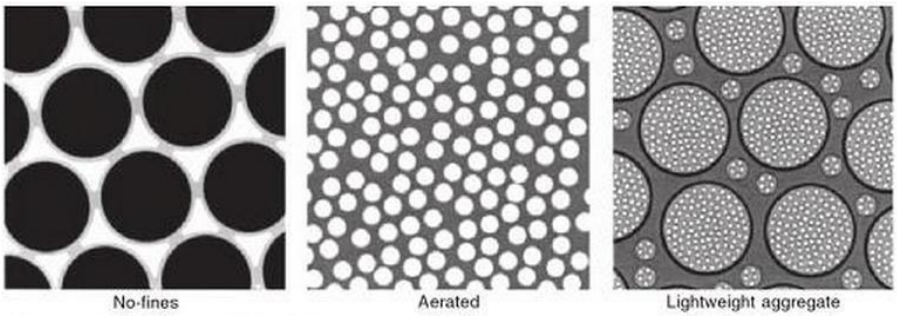
### *1.1 Methods of Light Weight Concrete:*

Basically there is only single method for preparing concrete light i.e., by introducing air in concrete. This has been achieved in practice by three different ways:

a) Replace the usual mineral aggregate by light-weight aggregate.

b) By introducing air bubbles in mortar (Aerated concrete).

c) By omitting sand fraction from the aggregate (No-fines concrete).



### *1.2 Introduction to No-Fines Concrete:*

No-Fines Concrete is a method of producing light weight concrete by eliminating the fines from ordinary concrete. No-fines concrete, when conventional aggregates are used, may show a density of about 1600-1900kg/$m^3$, but when no-fines aggregate is made by using light weight aggregate the density may come to about 360 kg/$m^3$.

The properties of this type of concrete are it does not segregate, the density varies with the grading of aggregates, w/c ratio of no fines concrete varies from 0.38 to 0.52, its strength increases with time, there is very less cohesive, necessitate longer duration of form work removal, shrinkage of this concrete is less than conventional concrete and its thermal expansion is about 0.6 to 0.8 of normal concrete.

**Table I: Properties of Fly Ash**

| S. No | Major Components | Cement | Fly Ash |
|---|---|---|---|
| 01 | Silicon Dioxide $SiO_2$ | 20.0% | 55.59% |
| 02 | Aluminium Oxide $Al_2O_3$ | 4.90% | 26.64% |
| 03 | Ferric Oxide $Fe_2O_3$ | 2.30% | 9.50% |
| 04 | Calcium Oxide CaO | 65.0% | 2.30% |
| 05 | Magnesium Oxide MgO | 3.10% | 0.60% |
| 06 | Sodium Oxide $Na_2O_3$ | 0.20% | 0.23% |
| 07 | Potassium Oxide $K_2O$ | 0.40% | 0.40% |
| 08 | Sulphur Oxide $SO_3$ | 2.30% | 0.44% |
| 09 | Loss of Ignition | 2.40 | 4.30 |

The usage of lightweight concrete using no-fine concrete permits reducing dead load, greater design flexibility, cost savings, longer spans, better fire ratings, less reinforcing steel, lower foundation costs, Weight of lightweight concrete is typically 25% to 35% lighter but its strengths is comparable to normal weight concrete.

**Table II: Properties of GGBS**

| S. No | Chemical Constituent | GGBS |
|---|---|---|
| 1. | Calcium Oxide CaO | 40% |
| 2. | Silicon Dioxide $SiO_2$ | 35% |
| 3. | Aluminium Oxide $Al_2O_3$ | 10% |
| 4. | Magnesium Oxide MgO | 8% |

## 2. EXPERIMENTAL PROCEDURE

***General***

The experimental program was carried out on cubes, cylinders and beams. The details of the materials Used for these specimens and testing procedure incorporated in the test program are presented in the subsequent sections.

### 2.1 Tests on coarse Aggregate:

The coarse aggregate passing through 20mm size sieve and retaining on 10mm sieve as shown in given table.

**Table III: Properties of Coarse Aggregate**

| S. No | Property | Value |
|---|---|---|
| 1 | Crushing value | 14.36% |
| 2 | Impact value | 2.7% |
| 3 | Abrasion value | 11% |
| 4 | Specific gravity | 2.67 |
| 5 | Water absorption | 0.5% |

### 2.2 Tests on fine Aggregate:

The fine aggregate passing through 4.75mm sieve is tested as per IS: 2386(part III) and the properties are Listed below,

**Table IV: Properties of Fine Aggregate**

| S. No. | Property | Value |
|---|---|---|
| 1 | Sieve analysis | Zone II |
| 2 | Specific gravity | 2.52 |

**2.3 Tests on Cement:**

**Table V: Properties of Cement**

| S. No. | Property | Value |
|---|---|---|
| 1. | Fineness test | 7.4% |
| 2. | Setting time<br>a)initial<br>b)final | <br>45 min<br>260 min |
| 3. | Specific gravity | 3.15 |
| 4. | Soundness test | 4.5 Mm |

**2.4 Materials:**

In this experimental study, there is a replacement of some pozzolanic materials like fly ash, GGBS to cement where fly ash is kept constant for 10% and GGBS is varied with 10%, 20%,30% and the values are checked. Again the fly ash is kept constant for 20% and GGBS is varied with 10%, 20%,30% and the values are checked.

**2.5 Mixing**

Mixing shall be done in mechanical mixers only. If we choose drum mixer it is advisable to add some water into the drum before the dry material is added. After that the measured quantity of aggregates and cement shall be introduced in to the drum of mixer while it is revolving. The rest of the water shall be added slowly up to the necessary quantity and wet mixing of the batch shall be continued for minimum one minute till a uniform mix is obtained.

**2.6 Transporting:**

Concrete shall be transported from the batching plant to the site by various methods which will prevent separation or loss of any of the ingredients and maintain the necessary workability. It should not be allowed to set and then used with the adding water to give workability. During hot or cold weather conditions concrete should be transported in large containers.

**2.7 Placing**:

The concrete should be poured in layers taking place continuously around the structure. Concrete cannot be allowed to pile up at a slope in the form work while until further deliveries, this practice results in a diagonal line of weakness.

Care should be taken while laying the cement slurry doesn't separate out and all the ballast is uniformly coated with a cement layer. After mixing the concrete should be placed as soon as possible.

**2.8 Compaction**

Vibrators should not be used for the compaction of no-fines concrete. No-fines concrete is compacted by gentle ramming or rod. Water should not be added during ramming. Ramming shall be done by more than one lines of men arranged across the width of the concrete with a tangential space of not more than 0.5 m.

**2.9 Curing**

If curing is inadequate, then no fines cement concrete will lose its water contents resulting in complete dehydration of cement which will cause collapse of concrete. Fresh concrete is highly sensitive to intense sunshine, wind and should be protected by damp sheet covers and by sprinkling with plenty water; sprinkling should not be started too early since it may dust off the cement from the surface. Sprinkling must be maintained for a minimum time of seven days.

**2.10 Methods of Testing:** Cubes, beams and cylinders are tested at two stages of curing (after 7 and 28 days) to determine the strength and permeability properties of no fines concrete.

**Variation between Conventional concrete & No-fines concrete Compressive strength**

| Conventional Concrete | Compressive Strength | | Density (Kgs) | `Permeability Property (mm/h) |
|---|---|---|---|---|
| | 7 days ($N/mm^2$) | 28 days ($N/mm^2$) | | |
| | 32.36 | 50.48 | 8.8 | – |
| **No-fines concrete 3:1** | 1.19 | 2.08 | 5.46 | 920 |

## 3. TESTING RESULTS & VALUES

### *3.1 Compressive Strength:*

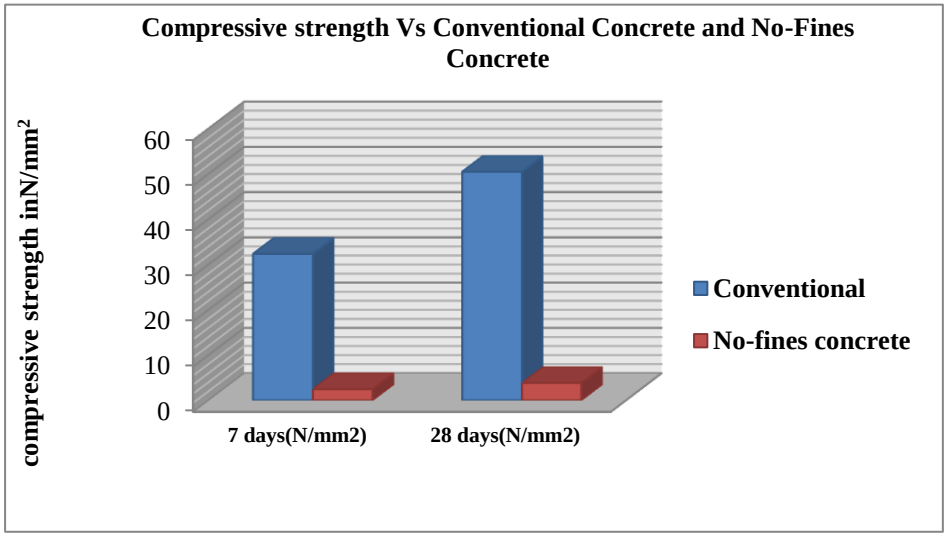
The cubes are tested in a compression testing machine to verify the compressive strength of the cubes. The specimen is placed in the center of the machine and the load is applied continuously and uniformly without any shock. The increasing of load on specimen till it is failed and records the maximum load carrying by the each specimen during the test. The testing of specimens is done for 7and 28 days.

**Compressive Strength Tables: (Cubes)**

- By using aggregate/cement ratio 3:1 light weight is not obtained. No-fines concrete is generally obtained from 6:1 to 10:1 so by adopting 6:1 aggregate/cement ratio the experiment is continued.
- Permeability property is low when the aggregate/cement ratio is 3:1 when compared to 6:1.
- By keeping fly ash 10% constant 10%, 20%, 30% GGBS is varied and again keeping fly ash 20% constant 10%,20%,30% GGBS is varied and following values are obtained.

**Variation between Conventional concrete & No-fines concrete Compressive strength**

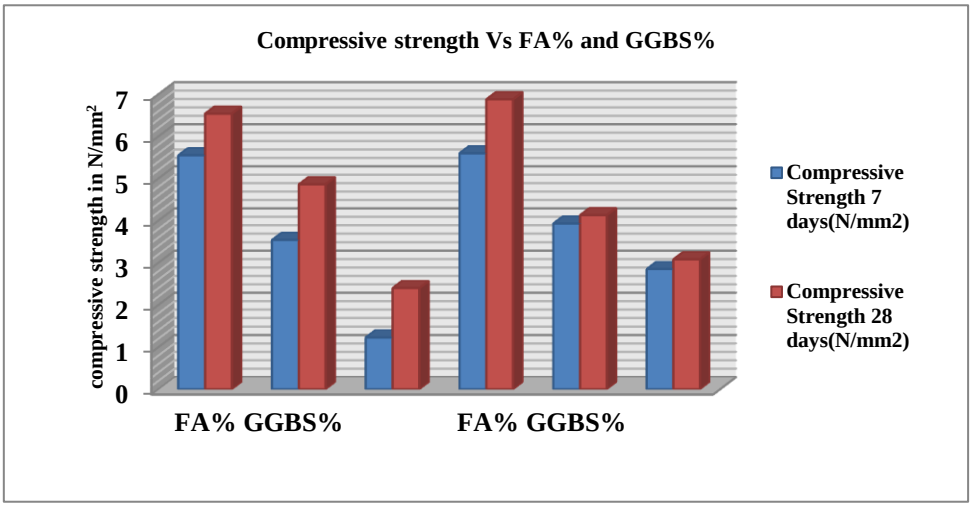
| Conventional Concrete | Compressive Strength | | Density(Kg) | Permeability Property (mm/h) |
|---|---|---|---|---|
| | 7 days($N/mm^2$) | 28 days($N/mm^2$) | | |
| | 32.36 | 50.48 | 8.8 | - |
| **No-fines concrete 6:1** | 2.49 | 3.84 | 5 | 1290 |




**Graph 1: Compressive strength results for 7days and 28days of conventional concrete and No-fines concrete.**

**Table VI: Compressive Strength Tables: (Cubes)**

| COMBINATION | COMPRESSIVE STRENGTH | | |
|---|---|---|---|
| FA (%) | GGBS (%) | 7 days (N/mm$^2$) | 28days (N/mm$^2$) |
| 10 | 10 | 5.55 | 6.54 |
| | 20 | 3.54 | 4.86 |
| | 30 | 1.23 | 2.40 |
| 20 | 10 | 5.60 | 6.88 |
| | 20 | 3.93 | 4.13 |
| | 30 | 2.85 | 3.08 |

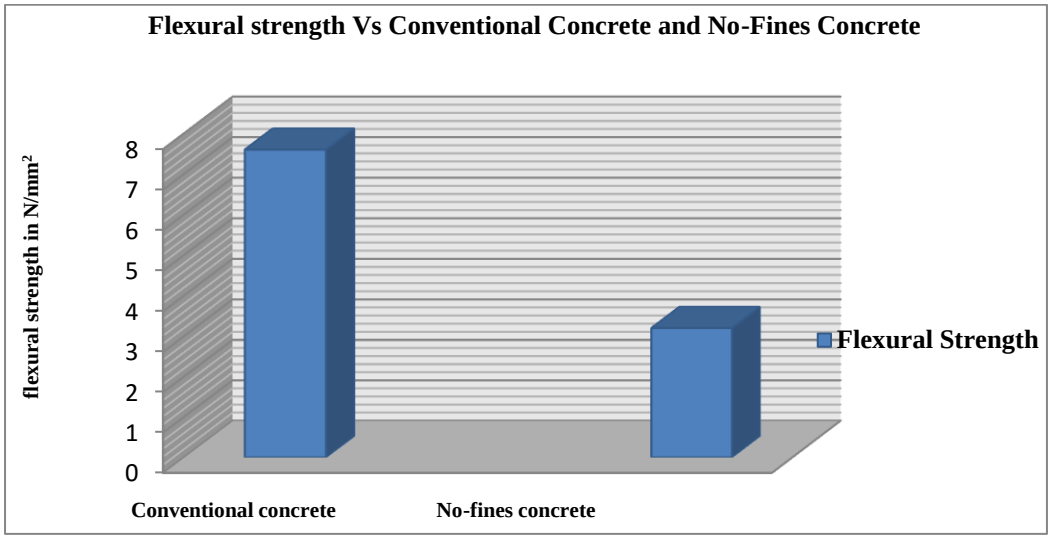



**Graph 2: Compressive strength results for 7days and 28days of combination of FA% & GGBS%.**

**Fig. 1: Compressive strength test**

**Table VII: Flexural Strength Table: (Beams)**

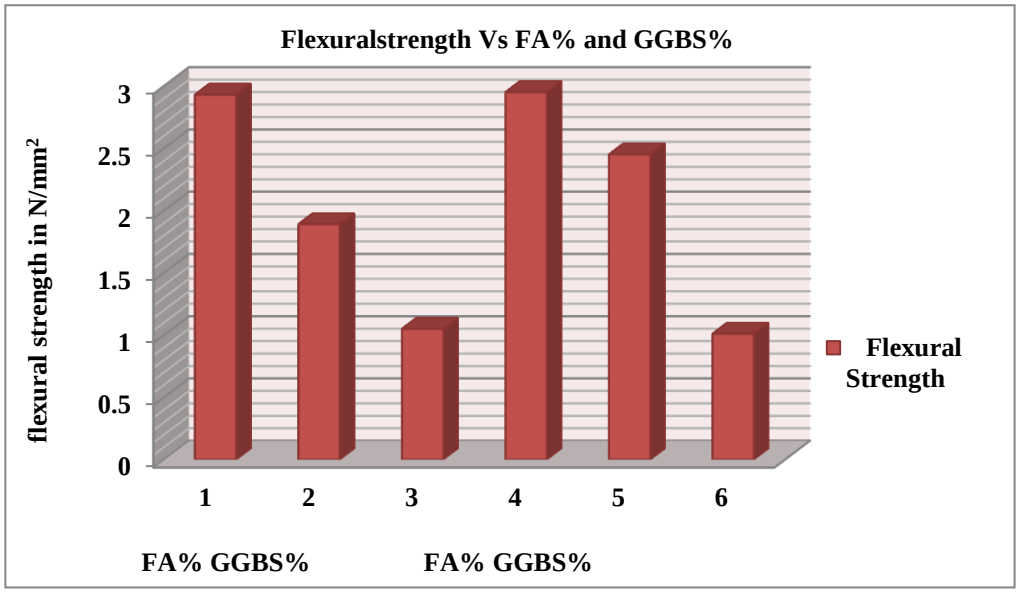
| | Flexural Strength 28 days(N/mm$^2$) | Density(Kg) |
|---|---|---|
| **Conventional Concrete** | 7.6 | 13.87 |
| **No-fines concrete** | 3.2 | 10.90 |




**Graph 3: Flexural strength results for 28days of conventional concrete and No-fines concrete.**

**Table VIII: Flexural Strength Table: (Beams)**

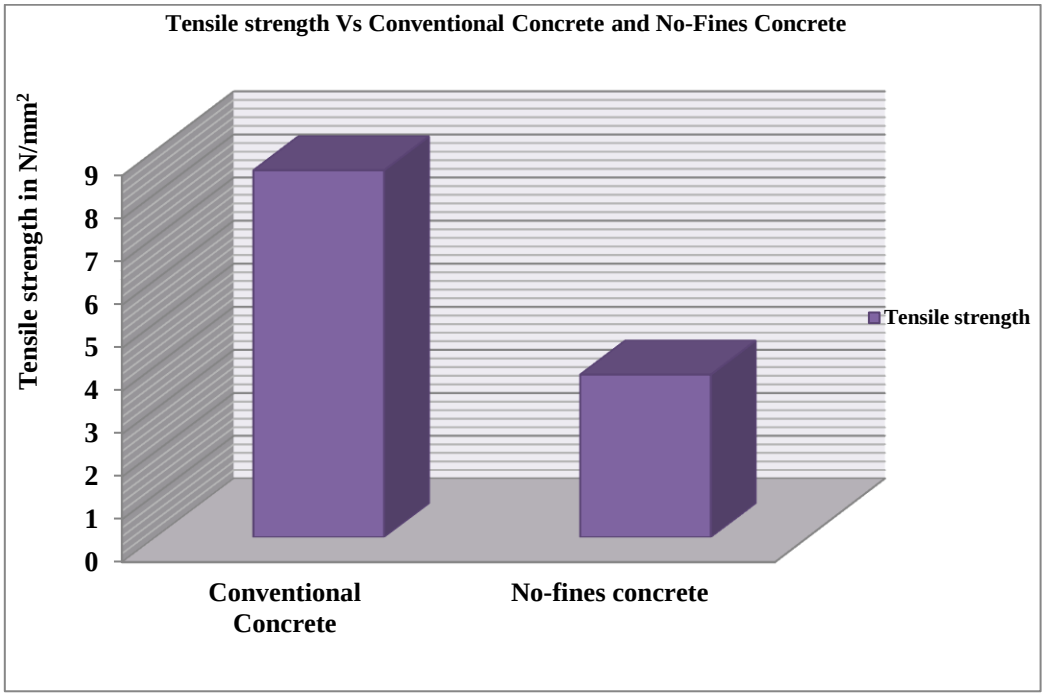
| Combination | | Flexural Strength 28 days(N/mm$^2$) | Density(Kg) |
|---|---|---|---|
| FA (%) | GGBS (%) | | |
| 10 | 10 | 2.93 | 9.82 |
| | 20 | 1.89 | 10.34 |
| | 30 | 1.05 | 10.94 |
| 20 | 10 | 2.95 | 9.23 |
| | 20 | 2.45 | 10.24 |
| | 30 | 1.01 | 10.50 |




**Graph 4: Flexural strength results for 28days of combination of FA% & GGBS%.**

**TABLE IX: Split Tensile Strength Tables: (Cylinders)**

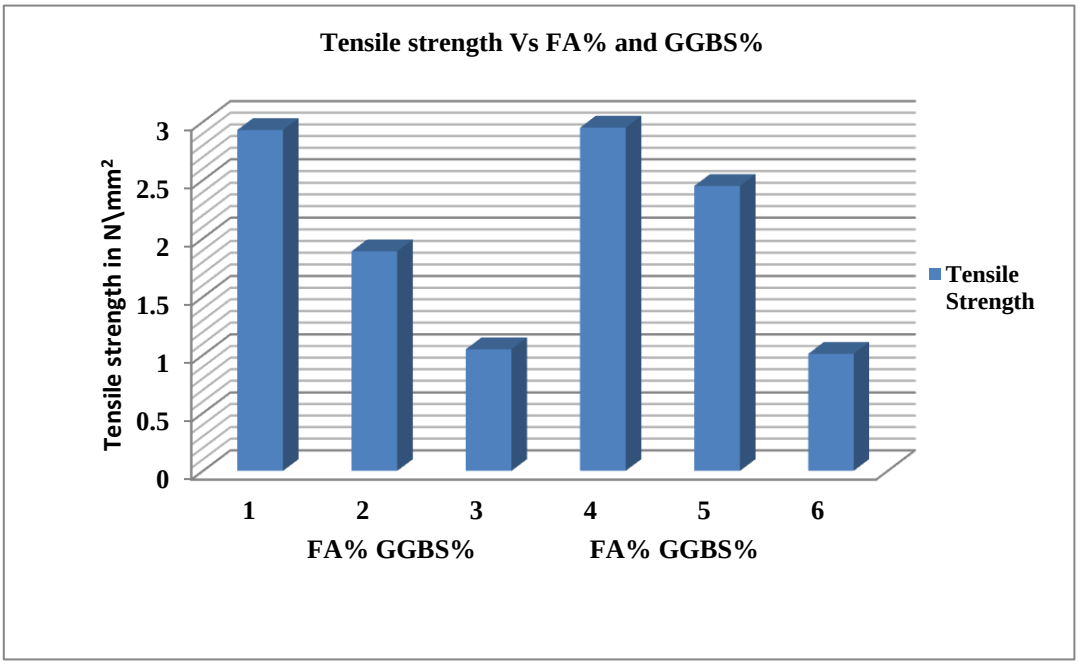
| | Tensile Strength 28 days(N/mm$^2$) | Density(Kg) |
|---|---|---|
| Conventional Concrete | 8.54 | 14 |
| No-fines concrete | 3.8 | 11 |




**Graph 5: Split tensile strength results for 28days of conventional concrete and No-fines concrete**

**TABLE X: Split Tensile Strength Tables: (Cylinders)**

| Combination | | Tensile Strength 28 days(N/mm$^2$) | Density(Kg) |
|---|---|---|---|
| FA (%) | GGBS (%) | | |
| 10 | 10 | 2.93 | 9.82 |
| | 20 | 1.89 | 10.34 |
| | 30 | 1.05 | 10.94 |
| 20 | 10 | 2.95 | 11.00 |
| | 20 | 2.45 | 10.50 |
| | 30 | 1.01 | 10.24 |




**Graph 6: Split tensile strength results for 28days of combination of FA% & GGBS%.**

**Fig. 2: Split Tensile Strength Test**

## 4. APPLICATIONS

It is applicable for

a) Low-volume traffic pavements.

b) Sidewalks and pathways

c) Parking areas

d) Drive ways

e) Tennis courts

f) Tree grates in side walks

g) Floors for green houses

h) Swimming pool decks

## 5. CONCLUSION

1. Based on the study conducted within the scope of the research, the following specific and general conclusion can be drawn.
2. $M_{40}$ grade no fines concrete with a density of about 1480 kg/m3 can be obtained by the following mix proportions. Aggregate/cement ratio - 6 : 1
3. Coarse aggregate: 20 mm passed and 10 mm retained size aggregates Water to cement ratio: 0.46
4. In building applications, the aggregate-cement ratio used is leaner, usually ranging from 6:1 to 10:1 where strengths ranges from 5 MPa to 15 MPa. This mix ensures that the void ratio is more and avoids capillary transport of water. However, in pavement applications the concrete strength is more vital and aggregate-cement mixes as low as 3:1 has to be used. This less ratio ensures that an adequate amount of bonding is there between the aggregate and cement to withstand the higher loads.
5. When compared to normal concrete no-fines concrete is having low strength so it is used for low-volume traffic pavements, sidewalks and pathways, parking areas.
6. Due to high permeability of no-fines concrete it is used in tennis courts, Tree grates in sidewalks, Floors for green houses, Swimming pool decks.
7. No-fines concrete is cost efficient due to less amount of cement and elimination of fine aggregate.

## REFERENCES

[1] Dr.M.Mageswari, M.P.Karthikeyan, S.Pavitharan, M.Rajkumar, R.Govindarajan "High Strength Permeable Pavement Using No Fines Concrete"

[2] Thushara Priyadarshana, Thilak Jayathunga, Ranjith Dissanayake. "Pervious Concrete – A Sustainable Choice In Civil Engineering And Construction"

[3] Sirile Eathakoti, Navya Gundu, Markandeya Raju Ponnada "Innovative No-Fines Concrete Pavement Model"

[4] Arshan S. Shah, Jayeshkumar Pitroda "An Experimental Study On Durability And Water Absorption Properties Of Pervious Concrete"

[5] T Abadjieva And P Sephiri "Investigations On Some Properties Of No-Fines Concrete."

[6] Francesca Tittarelli, Alessandra Mobili, Chiara Giosuè, And Maria Letizia Ruello. "Sustainable Durable No-Fines Concrete For Vertical Applications

[7] Amjad A. Yasin "Investigation Of Mechanical And Physical Properties Of No-Fines Concrete"

[8] Darshan S. Shah , Jayeshkumar Pitroda"An Experimental Study On Durability And Water Absorption Properties Of Pervious Concrete"