# Different Gradation of Aggregates on Ultra High Strength Concrete

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***Abstract-*** *The construction of high-rise buildings and mega projects around the world, and the increasing demands of owners and designers have led to the increasing demand on Ultra-High Strength Concrete (UHSC). Progress in concrete materials science and technology during the last 30 years has far exceeded that made during the previous 150 years.The technology development of concrete and demand for high strength construction materials give momentum to the development of Ultra-High Strength Concrete (UHSC). This new type of concrete is characterized with very high compressive strength i.e., strength higher than 100 MPa. Current UHSC preparation methods require costly materials and relatively sophisticated technology. In this project, study on Ultra-High Strength Concrete has been made. Concrete mix design and experimentation on Ultra-High Strength concrete have been carried out. The mechanical properties such as compressive strength, split tensile strength, modulus of elasticity and flexural strength of ultra-high strength concrete have been researched.*

***Keywords***- Superplasticizer, Silica Fume, Flexural Strength, Modulus Of Elasticity, Strain Gauge.

## I. INTRODUCTION

New types of concrete such as High Strength Concrete (HSC), High Performance Concrete (HPC), Self Compacting Concrete (SCC), Ultra High Performance Concrete (UHPC) and Ultra-High Strength Concrete (UHSC) are being constantly developed in order to meet the increasing demand for improved mechanical properties and durability. The properties of such concrete show a substantial improvement over conventional concrete of low or medium strength.

The concrete which has compressive strength greater than 100MPa is called as Ultra- High Strength Concrete (UHSC). Ultra-High Strength Concrete is a concrete which has an extremely low water to cement ratio (i.e. less than 0.26), higher binder content, optimum packing density to eliminate capillary pore and provide an extremely dense matrix. It is a high strength material formulated from a special combination of combination of constituent materials which include

Portland cement, silica fume, fine aggregate, coarse aggregate, high- range water reducer and water. The material has the capability to sustain deformation and resists flexural and tensile forces, even after initial cracking.

## II. OBJECTIVE

To review the literature regarding

1. Mix proportions of ultra-high strength concrete
2. Properties of ultra-high strength concrete
3. Four different concrete mixes are tried to get ultra-high strength concrete and the properties of these concretes in the fresh and hardened states are experimentally studied.

## III.EXPERIMENTAL INVESTIGATION

### 3.1Test on fresh concrete

#### 3.1.1Analysis of slump test results

The slump cone test was conducted on the three concrete mixes. The results obtained are presented in Table 1.

Table 1 Test results of slump of fresh concrete

| S.no | Mix Name | Slump Value |
|---|---|---|
| 1 | Mix | 0 |
| 2 | Mix | 0 |
| 3 | Mix | 0 |
| 4 | Mix | 0 |

**Discussion:**

The UHSC concrete had zero slump value.

### 3.2. Tests on hardened concrete

#### 3.2.1. Analysis of compressive strength test results

Compressive strength test was conducted on UHSC cubes at different curing ages of 3, 7 and 28 days and the results obtained are presented in Tables 1.2 to 5.13.

Size of the cube: 100mm x 100mm x 100mm

Table 2: Test results of Compressive strength of cubes at the age of 3 days

| S.NO | MIX | Age of curing (days) | Specimen | Weight of cube (kg) | Compressive strength ($N/mm^2$) |
|---|---|---|---|---|---|
| 1 | Mix-1 | 1 | A1 | 2.48 | 33.35 |
| 2 | Mix-2 | 1 | B1 | 2.48 | 38.26 |
| 3 | Mix-3 | 1 | C1 | 2.56 | 42.18 |
| 4 | Mix-4 | 1 | D1 | 2.56 | 53.96 |

Table 3 Test results of Compressive strength of cubes at the age of 7 days

| S.no | Mix | Age of curing | Specimen | Weight of cube (kg) | Compressive Strength ($N/mm^2$) |
|---|---|---|---|---|---|
| 1 | Mix- | 7 | A | 2.48 | 21.58 |
| 2 | Mix- | 7 | B | 2.48 | 58.86 |
| 3 | Mix- | 7 | C | 2.56 | 62.78 |
| 4 | Mix- | 7 | D | 2.56 | 68.67 |

Table 4 Test results of Compressive strength of cubes at the age of 28 days

| S.NO | MIX | Age of curing (days) | Specimen | Weight of cube (kg) | Compressive strength ($N/mm^2$) |
|---|---|---|---|---|---|
| 1 | Mix-1 | 2 | A3 | 2.4 | 19.62 |
| 2 | Mix-2 | 2 | B3 | 2.4 | 86.83 |
| 3 | Mix-3 | 2 | C3 | 2.5 | 95.16 |
| 4 | Mix-4 | 2 | D3 | 2.5 | 109.9 |

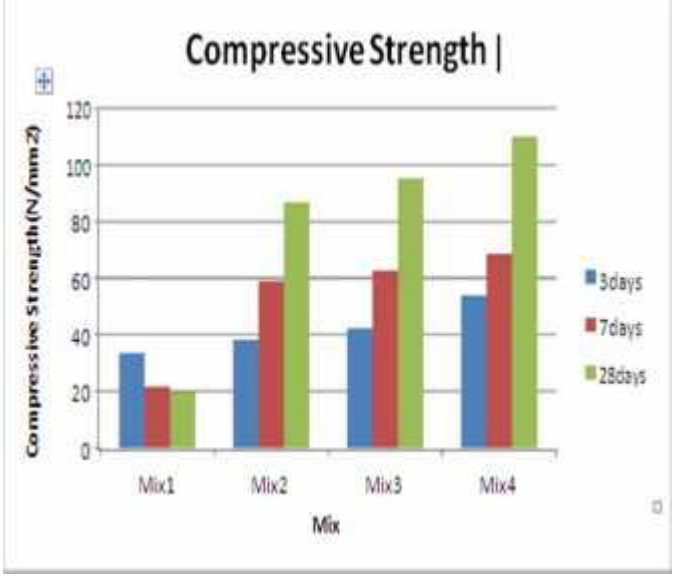



Fig 1 Compressive strength of cubes for mixes – 1,2,3,4 at age of 3 days, 7days and 28 days for saturated aggregate of 6mm grade size

### 3.2.2. Analysis of split tensile strength test results

Table 5 Test results of Split tensile strength at the age of 3 days

| S. No. | Mix | Age of curin | Specimen | Weight (kg) | Split strength ($N/mm^2$) |
|---|---|---|---|---|---|
| 1 | Mix-1 | 3 | A1 | 12.44 | 1.67 |
| 2 | Mix-2 | 3 | B1 | 12.56 | 2.16 |
| 3 | Mix-3 | 3 | C1 | 12.68 | 2.32 |
| 4 | Mix-4 | 3 | D1 | 12.72 | 2.99 |

Table 6 Test results of Split tensile strength at the age of 7 days

| S. No. | Mix | Age of curing (days) | Specimen | Weight (kg) | Split strength ($N/mm^2$) |
|---|---|---|---|---|---|
| 1 | Mix-1 | 7 | A2 | 12.44 | 2.36 |
| 2 | Mix-2 | 7 | B2 | 12.56 | 2.87 |
| 3 | Mix-3 | 7 | C2 | 12.68 | 3.01 |
| 4 | Mix-4 | 7 | D2 | 12.72 | 3.8 |

Table 7 Test results of Split tensile strength at the age of 28 days

| S. No. | Mix | Age of curin | Specimen | Weight (kg) | Split strength ($N/mm^2$) |
|---|---|---|---|---|---|
| 1 | Mix- 1 | 3 | A1 | 12.44 | 1.67 |
| 2 | Mix- 2 | 3 | B1 | 12.56 | 2.16 |
| 3 | Mix- 3 | 3 | C1 | 12.68 | 2.32 |
| 4 | Mix- 4 | 3 | D1 | 12.72 | 2.99 |

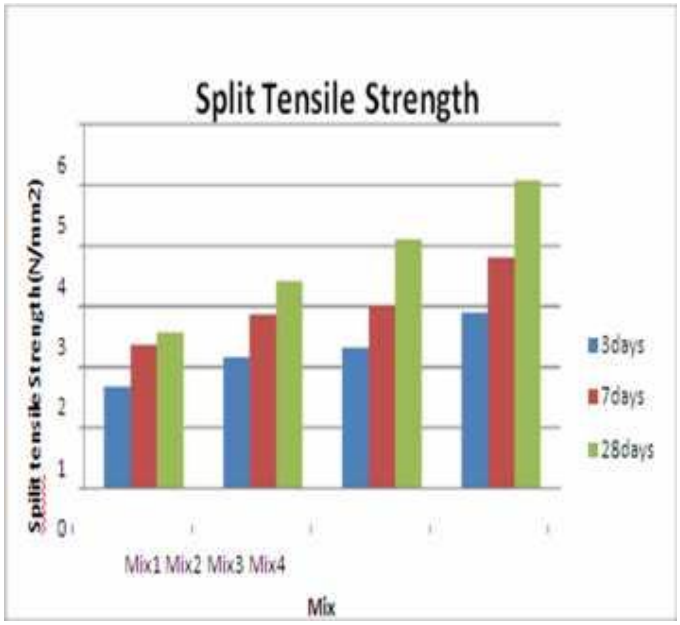


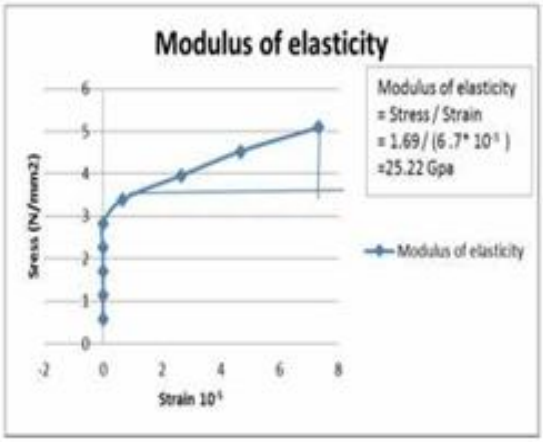

Fig. 2 Split tensile strength for mixes – 1, 2 and 3 at 28 days strength

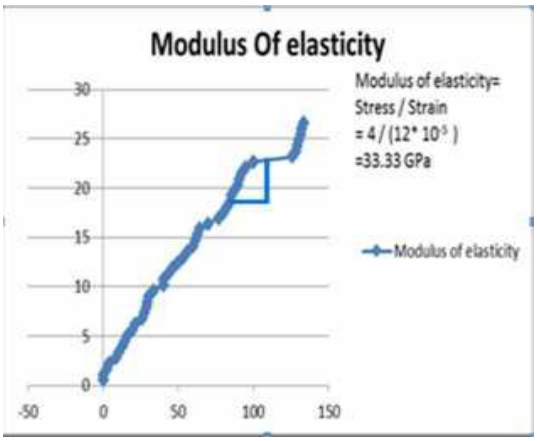
### 3.2.3 ANALYSIS FOR MODULUS OF ELASTICITY

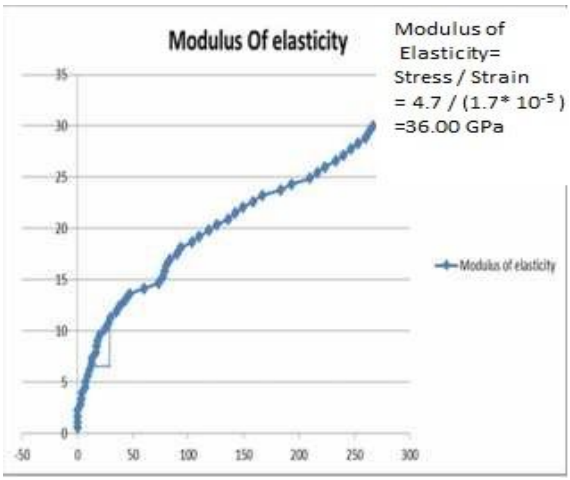
The Young's modulus of elasticity test was conducted on UHSC cylinders at the age of 28 days

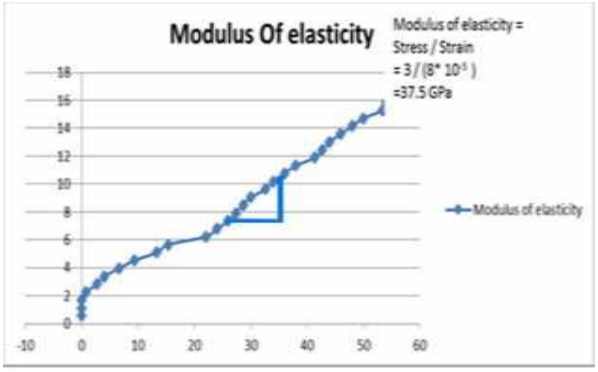
Table 8 Modulus of Elasticity of concrete

| S. No. | Mix | Age of curing (days) | Specimen | Modulus of elasticity (GPa) |
|---|---|---|---|---|
| 1 | 1 | 28 | A | 25.22 |
| 2 | 2 | 28 | B | 33.33 |
| 3 | 3 | 28 | C | 36.00 |
| 4 | 4 | 28 | D | 37.50 |



### 3.2.4 Analysis of flexural strength test results

The flexural strength test was conducted on UHSC prisms at the age of 3, 7, 28 days and the results obtained are presented in Table 9

Size of the prism: 100mm x 100mm x 500mm

Table 9 Test results of flexural strength at the age of 3 days

| S.NO | MIX | Age of curin | Specimen | Weight (kg) | Flexural strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | Mix-1 | 28 | A | 12.77 | 4.86 |
| 2 | Mix-2 | | B | 12.78 | 11.35 |
| 3 | Mix-3 | | C | 12.80 | 13.28 |
| 4 | Mix-4 | | D | 12.87 | 14.38 |

Table 10 Test results of flexural strength at the age of 7days

| S.NO | MIX | Age of curing (days) | Specimen | Weight (kg) | Flexural strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | Mix- | 3 | A | 12.77 | 9.72 |
| 2 | Mix- | | B | 12.78 | 7.15 |
| 3 | Mix- | | C | 12.80 | 8.17 |
| 4 | Mix- | | D | 12.87 | 10.22 |

Table 11 Test results of flexural strength at the age of 28 days

| S.NO | MIX | Age of curing (days) | Specimen | Weight (kg) | Flexural strength (N/mm²) |
|---|---|---|---|---|---|
| 1 | Mix-1 | 7 | A | 12.77 | 4 |
| 2 | Mix-2 | | B | 12.78 | 11.35 |
| 3 | Mix-3 | | C | 12.80 | 13.28 |
| 4 | Mix-4 | | D | 12.87 | 14.38 |

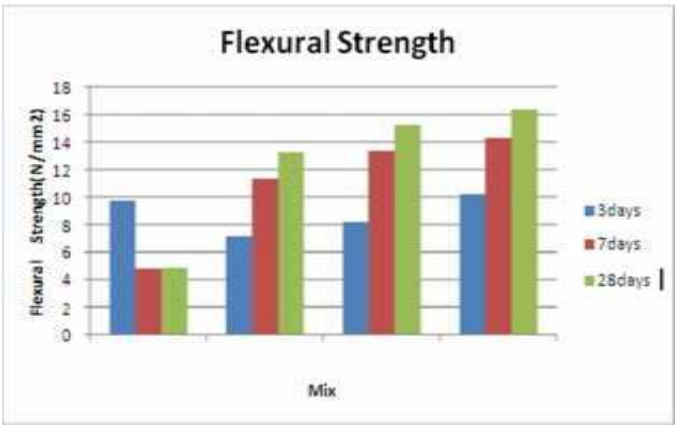



Fig. 3 Flexure tensile strength for mixes – 1, 2 and 3 at 28 days strength

## IV. CONCLUSIONS

In this project, study has been made on the development of Ultra-High Strength Concrete. Four different concrete mixes have been used to get Ultra-High Strength Concrete. Cubes, cylinders and prisms have been cast using this four different mixes and their properties in fresh and hardened states have been experimentally found out. Based on the experimental investigation, thefollowing conclusions could be drawn:

The first mix with 30% silica fume (based on literature) has been found to be yield very low strength (less than 35mpa) Hence this much percentage of silica fume Should not be used.

Compressive strength upto 110 MPa has been obtained for cube with 10% silica fume which is found to be higher than mixes with 12% and 14% silica fume.

The stress – strain curves of concrete obtained using these four types of mixes are linearup to failure hours. The other major point to be considered is to carry out the work during the proper season and avoiding the rainy season too.

Concrete mix with the following constituents has been found to yield the highest compressive strength 0f 110 Mpa

| Materials (Kg/m$^3$) | Quantity |
|---|---|
| Cem | 8 |
| Fine aggregate | 4 |
| Coarse Aggregate | 8 |
| W | 1 |
| Silica fume | 1 |
| Super plasticizer | 1 |
| w/b | 0 |

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