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# *Experimental Investigation on Compressive Strength of M20&M40 Grade Concrete by Full Replacement of Different Aggregates*

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***Abstract***

*This project describes the effect of type aggregate on compressive strength of high strength and normal strength concrete. High strength concrete is a type of high-performance concrete generally with a compressive strength of 40 N/mm2 or greater and normal strength concrete of 20N/mm2 compressive strength of concrete an experimental program is carried out. The different types of coarse aggregate like White Granite, Basalt, and Quartzite are used in this project. Natural sand as fine aggregate and ordinary Portland cement as binding material are used for making concrete mixer. To assess the influence of type of aggregate on compressive strength of concrete cubes of size 150mm x 150mm x 150mm are casted and tested in compression testing machine at the age of 7days,21days and 28 days.*

***Keywords:*** *Compression, M20 grade, M40 grade.*

## INTRODUCTION

The advantages of using High Strength Concrete have been described in various researches. These include a reduction in member size, reduction in the self-weight and super-imposed Dead load with the accompanying saving due to smaller foundations, reduction in form-work area and cost construction of high-rise buildings with the accompanying savings in real estate costs in congested areas, longer spans and fewer beams for the same magnitude of loading, reduction in the thickness of floor slabs supporting

beam sections which are a major component of the weight and cost of the majority of structures, dynamic and fatigue loading, low creep and shrinkage.

Achieving high strength concrete by using different aggregates the subject of research and different design mix methods and trial mix approaches have been proposed for the development of high strength concrete.

The various parameters that govern the strength of concrete like the constituent materials required, properties of constituent materials, proportions in which they are to be used and specifications for the production and curing technique to be used and specifications for the production and curing technique to be used for the development of high strength concrete are also being a subject of continuous research for the development of high strength concrete which is now being seen as a logical development of concrete because of the numerous advantages that it is supposed to provide.

Aggregates are as important as cement to form a concrete that is very useful in the construction of buildings. These materials are granular material ingredients of cement and mixes. The same materials constitute about 85% of concrete mixes, by weight. With these characteristics, it is necessary for the material engineer to exercise a responsible selection of these materials to acquire a study and durable mixture. Concrete is a result of a hardened product of carefully proportioned mixture of aggregates, cement, and water.

In order to be useful in construction the product must meet minimum compressive and requirements which are determined through a Mechanical Test of Concrete with Aggregates mechanical test; and to check the strength of the concrete used for bridges, buildings, and other structures where the principal stresses are compressive cube samples were obtained and tested in compression testing machine. In this study, the standard specification from the Compression Testing Machine (CTM) will be used as a minimum compressive strength of 140 kg/cm2 per minute.

In our project we made a cube of different aggregates like Basalt, White Granite and Quartzite are used and we tested for 7days, 21days and 28 days in compressive testing machine.

But our Kadapa district is rich in White Granite, Basalt stone and Quartzite stone and they are easily available.

**A). Objectives:**

This study generally focused on the mechanical test such as the compressive and Strength of concrete with different aggregates which were available in our local quarry sites.

***The study specifically we had the following objectives***:

1. To determine the compressive strength of concrete with different aggregates like White Granite is available in GUVVALACHERUVU, and Basalt is available in YERRAMASU PALLI QUARY SITE, Quartzite is available in KOTHA ROAD BIDIKI.

2. To determine the compressive of concrete cubes were prepared with different source of aggregates.

3. To determine the compressive strength of concrete with aggregates is tested under compressive testing machine.

4. The results of compressive strength of concrete cube samples between the source of different aggregates after 7days, 21days, and 28 days of OPC.

## MATERIALS & METHODOLOGY

***A). Materials.***

**i). Cement.**

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. English masonry worker "Joseph Asp din" patented Portland cement in 1824. It was named because of the similarity of its colour to Portland limestone, quarried from the English Isle of Portland and used extensively in London architecture. It consists of a mixture of oxides of calcium, silicon and aluminium. Portland cement and similar materials are made by heating limestone (a source of calcium) with clay and grinding this product (called clinker) with a source of sulphate (most commonly gypsum)

***Table-1: Cement Properties***

| S.No. | Parameter | Result |
|---|---|---|
| 1 | Normal consistency test | 31% |
| 2 | Fineness of cement | 8.89% |
| 3 | Specific gravity of cement | 3.15 |
| 4 | setting time (Initial) | 35 min |
| 5 | setting time (Final) | 220min |
| 6 | Soundness of cement | 6 mm |

**ii). Fine Aggregate**

Sand is an important building material used in the preparation of mortar, concrete, etc. Sand particles consist of small grains of silica (Si02). It is formed by the decomposition of sand stones due to various effects of weather. The shape and surface structure of fine aggregate has a greater influence on water demand of concrete than because fine aggregates contain a much higher surface area for a given weight. Rounded and smooth fine aggregate particles are better from the view point of workability than sharp and rough particles.

**iii). Coarse Aggregate**

The aggregates used, in our project order to know the compressive strength of aggregates are:

1. White Granite, 2. Basalt 3. Quartzite.

***1. White Granite:***

Granite is a common type of intrusive, felsic, igneous rock which is granular and phaneritic in texture. This rock consists mainly of quartz, mica, and feldspar. Occasionally some individual crystals are larger than the groundmass, in which case the texture is known as porphyritic. A granitic rock with a porphyritic texture is sometimes known as porphyry. By definition, granite is an igneous rock with at least 20% quartz by volume. Granite is nearly always massive (lacking internal structures), hard and tough, and therefore it has gained widespread use as a construction stone. The average density of granite is between 2.65 and 2.75 g/cm³, its compressive strength usually lies above 200 MPa.

***Properties***

- Granite is an igneous rock.
- It has an interlocking texture.
- Hardness is 5.5 - 6.5.
- Crystal system is “Cubic”.
- It is rich in silica.
- It will not become weak in presence of water.
- It has dense massive appearance & durable.

***2. Basalt:***

Basalt is a common extrusive igneous (volcanic) rock formed from the rapid cooling of basaltic lava exposed at or very near the surface of a planet or moon. By definition, basalt must be an aphanite igneous rock with less than 20% quartz and less than 10% feldspathoid by volume, and where at least 65% of the feldspar is in the form of plagioclase. (In comparison, granite has more than 20% quartz by

volume.) Basalt is usually grey to black in colour, but rapidly weathers to brown or rust-red due to oxidation of its mafic (iron-rich) minerals into rust.

It almost always has a fine-grained mineral texture due to the molten rock cooling too quickly for large mineral crystals to grow, although it can sometimes be porphyritic, containing the larger crystals formed prior to the extrusion that brought the lava to the surface, embedded in a finer-grained matrix. Basalt with a vesicular or frothy texture is called scoria and forms when dissolved gases are forced out of solution and form vesicles as the lava decompresses as it reaches the surface.

***Properties:***

- Most commonly available igneous rock.
- It appears in black & grey.
- Hardness value is 6.
- It has high durability and high bearing ratio.
- Crystal system is "Triclinic".
- It is used as a concrete aggregate.

**3. *Quartzite*:**

Quartzite are formed through the metamorphism of quartz-rich sandstones. Their basic component is the mineral Quartz. Quartzite adds a fashion statement when it is used for tiles and wall stones owing to its glittery surface and beautiful colour.

The sugary texture of quartzite gives a very dramatic look to the exteriors. Because of its glass like lustre and appealing colours, it's often used as gems in jewellery. Quartzite is less expensive and more readily available than semi-precious stones, so it's often used in costume jewellery Quartzite is a common raw material in the glass and ceramic industries. Its glassy appearance may make it seem like a fragile, breakable material but in actual it's so hard that it's often used to produce abrasive tools such as grinding stones.

***Properties:***

- Uniform coloured, generally white or red in appearance.
- It is very hard.
- Highly resistant to weathering.
- The silica content present in the rock makes it durable.
- Does not affect by acids.
- Hardness vale is 7.
- Crystal system is "Hexagonal".
- It is used as a good road metal.

**iv. Water:**

Combining water with a cementation's material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it, and makes it flow more freely. A lower water to concrete ratio will yield a stronger, more durable concrete; while more water will give a free-flowing concrete with a higher slump. Impure water used to make concrete can cause problems when setting or in causing premature failure of the structure. Hydration involves many different reactions, often occurring at the same time. As the reactions proceed, the products of the cement hydration process gradually bond together the individual sand and gravel particles and other components of the concrete, to form a solid mass.

***B. Methodology***

***a). Mix Design***

The mix design adopted to obtain M20 & M40 grade concrete is in accordance with IS: 10262 - 2009. The mix proportion obtained for nominal M20 grade is 1: 1.45: 2.93 with a w/c ratio of 0.48. and the mix proportion obtained for nominal M40 grade is 1: 0.87: 2.24 with a w/c ratio of 0.31.

***b). Process of Mixing:***

Water used for mixing concrete, actually its impurities, may affect the concrete Strength, setting time, efflorescence (deposits of white salts on the surface of concrete), and the corrosion of reinforcing and prestressing steel.

***Table-2: The M20 mix proportion becomes***

| Water | Cement | Fine Aggregate | Coarse Aggregate |
|---|---|---|---|
| 186 | 387.5 | 563.85 | 1137.27 |
| 0.48 | 1 | 1.45 | 2.93 |

***Table-3: The M40 mix proportion becomes***

| Water | Cement | Fine Aggregate | Coarse Aggregate |
|---|---|---|---|
| 165 | 532.25 | 468.14 | 1196.37 |
| 0.31 | 1 | 0.87 | 2.24 |

The most of concrete mixtures Specifications have the requirement regarding the quality of water included: water should be potable, as municipal drinking waters seldom contain dissolved solids in excess of 1000 ppm (parts per million). In this way, by having low content of impurities, it is provided that mixing water itself is rarely a factor in concrete strength. It does not mean that water that is unsuitable for drinking is not appropriate for concrete mixing. Slightly acidic, alkaline, salty, brackish, coloured, or water characterized by inadequate smell should not be rejected outright. This is important because of the water shortage in many Areas of the world. Recycled waters from cities, mining, and many industrial operations can be safely used as mixing waters for concrete. The best way to determine the suitability of water is to compare the setting time of cement and the strength of mortar cubes when Specimens are made with water with non-specified characteristics and with reference water that is specified as clean. The cubes made with water that is tested should have 7- and 28-day compressive strengths equal to or at least 90 percent of the strength of reference Specimens made with clean water; the quality of mixing water should not affect the setting Time of cement to an unacceptable degree. Influence of the concrete slump on compressive strength Seawater, which contains about 35,000 ppm dissolved salts, is not harmful to the strength of plain concrete. However, with reinforced and prestressed concrete it increases the risk of steel corrosion; therefore, the use of seawater as concrete-mixing water should be avoided under these circumstances. The presence of excessive amounts of algae, oil, salt, or sugar in the mixing water should be considered a high-risk factor.

## TEST RESULTS

### *A). Compression strength results*

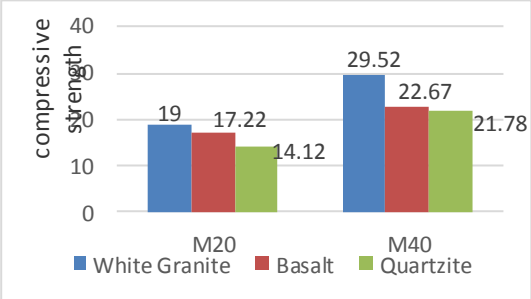
The cubes of standard size 150x150x150 mm are used to find the compression strength of concrete.

***Table-4: Compressive Strength of Concrete at 7 days for M20:***

| s.no | Type Of Aggregate Used | Sample-1 | Sample-2 | Avg force | Compressive Strength |
|---|---|---|---|---|---|
| 1. | White Granite | 420 | 435 | 427.5 | 19 |
| 2. | Basalt | 380 | 395 | 387.5 | 17.22 |
| 3. | Quartzite | 320 | 315 | 317.5 | 14.12 |

***Table-5: Compressive Strength of Concrete at 7 days for M40:***

| s.no | Type Of Aggregate Used | Sample-1 | Sample-2 | Avg force | Compressive Strength |
|---|---|---|---|---|---|
| 1. | White Granite | 658 | 670 | 664 | 29.52 |
| 2. | Basalt | 510 | 510 | 510 | 22.67 |
| 3. | Quartzite | 485 | 495 | 490 | 21.78 |



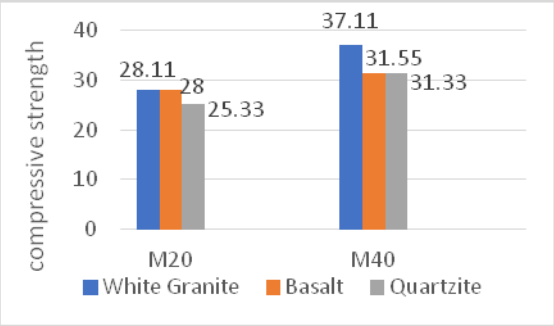

***Graph-1: comparison of compressive strength results at 7 days***

***Table-6: Compressive Strength of Concrete at 21 days for M20:***

| s.no | Type Of Aggregate Used | Sample-1 | Sample-2 | Avg force | Compressive Strength |
|---|---|---|---|---|---|
| 1. | White Granite | 640 | 625 | 632.5 | 28.11 |
| 2. | Basalt | 640 | 620 | 630 | 28 |
| 3. | Quartzite | 580 | 560 | 570 | 25.33 |

***Table-7: Compressive Strength of Concrete at 21 days for M40:***

| s.no | Type Of Aggregate Used | Sample-1 | Sample-2 | Avg force | Compressive Strength |
|---|---|---|---|---|---|
| 1. | White Granite | 810 | 860 | 835 | 37.11 |
| 2. | Basalt | 810 | 600 | 710 | 31.55 |
| 3. | Quartzite | 730 | 680 | 705 | 31.33 |




***Graph-2: comparison of compressive strength results at 21 days***

***Table-8: Compressive Strength of Concrete at 28 days for M20:***

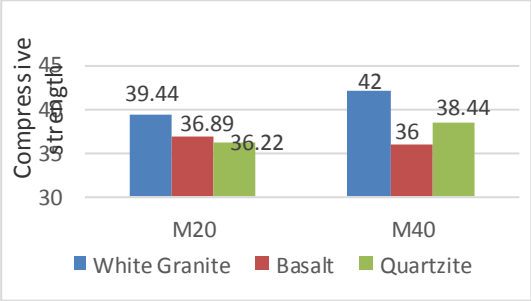
| s.no | Type Of Aggregate Used | Sample-1 | Sample-2 | Avg force | Compressive Strength |
|---|---|---|---|---|---|
| 1. | White Granite | 860 | 900 | 880 | 39.44 |
| 2. | Basalt | 850 | 810 | 830 | 36.89 |
| 3. | Quartzite | 850 | 780 | 815 | 36.22 |

***Table-9: Compressive Strength of Concrete at 28 days for M40:***

| s.no | Type Of Aggregate Used | Sample-1 | Sample-2 | Avg force | Compressive Strength |
|---|---|---|---|---|---|
| 1. | White Granite | 1010 | 880 | 945 | 42 |
| 2. | Basalt | 720 | 900 | 810 | 36 |
| 3. | Quartzite | 800 | 930 | 865 | 38.44 |

***Table-10: Final Compressive Strength For M20 & M40 At 28 Days.***

| S.NO | Type of aggregate | M20 | M40 |
|---|---|---|---|
| 1 | White Granite | 39.44 | 42 |
| 2 | Basalt | 36.89 | 36 |
| 3 | Quartzite | 36.22 | 38.44 |




***Graph-3: comparison of compressive strength results at 28 days***

## CONCLUSIONS

- Aggregate type has effect on the compressive strength of concrete. Highest compressive strength was achieved from concrete containing crushed granite, followed by the concrete containing crushed basalt. Concrete containing crushed quartzite shows the least strength developed at all stages of ages. Linear polynomial model as a function of age at curing is adequate to account for the variability in the compressive strength data. It is suggested that crushed granite may be employed for concrete work in places where concrete partitions have variety of choices available.
- the aggregate like white granite can be used in high rise buildings, skyscrapers.
- Basalt can be used as a building material in construction of residential buildings and road material.
- Quartzite can be used in foundation and also in flooring purpose.

## SCOPE OF FURTHER STUDY

***The following aspects can be taken up for further investigation***.

1) Similar studies can be carried out on other concrete like metakoline, rice husk etc. to access and analyze the effect of chemical admixture substances on the compressive strength, split tensile, flexural strength with a special attention on the durability.

2) The effect of other similar different chemical dosage and biological substance, which are not covered in this research, on the setting properties of cement and strength of concrete can be investigated.

3) The effect of the above substances on the compressive strength, split tensile,

flexural strength of cement concrete with a special attention on durability of concrete beyond 60 days and also 90 days can be also be studied.

4) The effect of different treated industrial effluent water can be tested to utilize the waste for cement construction with certain limitations.

5) Similar studies can be carried out on other engineering properties of concrete like shear strength.

6) Similar studies can be carried out on the engineering properties of cement concrete like compressive strength, tensile strength, shear strength and flexural behaviour.

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