International Journal of Recent Trends in Engineering & Research
ISSN (ONLINE) : 2455 – 1457 IMPACT FACTOR : 4.101

# A STUDY ON PARTIAL REPLACEMENT OF SAND WITH SANDSTONE POWDER AND COMPARATIVE ANALYSIS OF MECHANICAL PROPERTIES OF CONCRETE FOR M30 GRADE

**Mr. Prateek Agarwal[1] Er. Mahendra Saini[2] Mr. Rohan Bhomia[3]**
[1]*Scholar,M.Tech Structural Engineering, K.I.T.E. Jaipur*
[2,3]*Assistant Professor, Department of Civil Engineering, K.I.T.E. Jaipur*

**Abstract:-**In this study, For M30 grade concrete, sand was replaced by sandstone powderfrom 5% to 30% at the interval of 5%.The factorson which control mix design and unified mixes were tested and related were workability, flexural strength,compressive strength,split tensile strength, densityand water absorption. For concrete cubes, beams and cylinders in hardened state, compressive strength, flexural strength, split tensile strength, water absorption and density tests were performed whereas workability test was done for concrete in fresh state. The effective utilization of the sandstone powder in concrete could help in reducing substantial amount of landfill problem, it could facilitate in easing off the burden of excessive mining of natural river sand from the rivers and also offer animportantresource of accompanyingfine aggregate castoff in the manufacture of cement concrete causative to the general sustainability.

## I. INTRODUCTION

Concrete is durable, easily prepared and is widely castoff in almost all kinds of structural schemes. The global challengeabletoday in front of the civil engineers is to appreciate projects in concord with thethought of sustainable growth and itcontains the usage of great performance supplementary materials such as ground granulated blast furnace slag, silica fumes, fly ash, etc. which are industrial wastesavailable at sensible cost having the lowest probabilityof environmentalimpact.

### 1.1 Sandstone Powder

The type of sedimentary rock which is poised of quartz, feldspar and further minerals is called the Sandstone.Quartz and feldspar are the greatestshared minerals in the Earth's crust and they are originate in most of the sandstones regardless of the area. Through sedimentation from air or wind shadowed by the compacting pressure of superimposing deposits and cementationby precipitation of minerals, Sandstones are formed.Depending on their composition and the resultant concrete produced from it may possess diversity of mechanicalpossessions, the geological properties of sandstone may differ.

## II. LITERATURE REVIEWS

**Kumar Sanjeev et. al. (2018)**studied the conceivableuse of sandstones in cement concrete. The compressive strength pattern for quartz sandstone was studied for a period of 28 days for water-cement proportionsof 0.35, 0.40 and 0.45.The concrete specimens showcased a reduction in weight at 80% and 100% substituted of sandstone aggregates. The all-out weight loss of 8.42% was noted at 100% replacement for water-cement ratio 0.45 when concrete samples were exposed to sulphuric acid.

**ShrivastavaSandeep et. al.(2017)**in M30 grade concrete, utilizedquartz-dominatedsandstone wastes.Thermogravimetric outcomespresented a diminution in the percentage ofweight damageas the quartz sandstone aggregate wassubstituted by conventional aggregates,. Against the action of fire,concrete made with quartz sandstones performed well. Depending on the preferred strength of concrete samplesto be attained, dosages of quartz sandstone may be taken up to 60%.

**Kumar Sanjeev et. al. (2016)**made M30 grade of concrete with water-cement proportion of 0.4 and studied the in effect use of sandstone trashes in concrete. Control mix designof 0% quartz sandstoneandreplacementby coarse aggregates was done for 0–100%, in the many times of 20% was prepared. The compressive strength decreased with increase in quartz sandstone as coarse aggregate. The results pattern showcased a maindiminution in flexural strength at 60%, 80% and 100% replacements. The depth of abrasion is increased irrespective of the water-cement ratios with the upsurge in the percentage of quartz sandstone aggregate.

**Gupta Ramesh Chandra et. al. (2016)**micro-structuralevaluation was completetovisualize the textural evidence of aggregates. This evaluationdiscovered the occurrence ofelongation effectandsharp cleavages which affected the rheology of concrete while castingandby adding super plasticizersthis phenomenon was overcome. From morphologicalstudy, it can be observed that sandstones whose framework isdominated by quartz and are moderately sorted with grains of various sizes occurring together, whose particles are normally rounded tosub-round.Compressive strength results presentedcumulative trend till 55:45 (20 mm: 10 mm) for natural aggregateand the same thing was noticed in quartz sandstoneaggregate till 60:40 (25 mm: 10 mm).The diminution in compressivestrength results after attaining a precise gradation was noticed due to separationand upsurge in void universes because of the usage of superiorshaped and sized aggregates.

## III. MATERIALS PROPERTIES AND SAMPLE PREPARATION

### 3.1 Description of Materials

Cement used in the experiemental procedure was a Portland Cement 43-Grade as per IS 8112:2013. Coarse aggregates of size 10mm and 20mm were used in this study. The coarse aggregates used were obtained from Hathipura, Jaipur. The specific gravity, Fineness Modulus, Water Absorption and Bulk Density of 20mm aggregates were 2.64, 7.08, 0.45% and 1475kg/m$^3$ respectively. The specific gravity, Fineness Modulus, Water Absorption and Bulk Density of 10mm aggregates were 2.63, 5.83, 0.52% and 1500 kg/m$^3$ respectively. The sieve analysis of coarse aggregates were done as per guideliens of IS: 2386 (Part I) – 2016. The fine aggregates were obtained from Banas river, Tonk, Rajasthan. The specific gravity, Water Absorption, Bulk Density and Fineness Modulus of fine aggregates were 2.68,1.41%, 1650 kg/m$^3$ and 2.67 respectively. Grading zone of fine aggregate was determined as per specfications of IS-383:2016. The sandstone powder used in this work is taken from Vishwas Exports Enterprises, Vishwakarma Industrial Area, and Jaipur.The Bulk density, Fineness modulus, Water absorption and Specific Gravity of sandstone powder was 1639 Kg/m$^3$, 2.8, 10.12% and 2.51 respectively. Superplasticizers used in this study has been taken from Shalimar Chemicals Private Limited, Jaipur confirming to IS 9103:1999.

### 3.2 Preparation of samples

In this study, For M30 grade concrete, sand was replaced by sandstone powderfrom 5% to 30% at the interval of 5%.The blended mixes prepared were designated asSP5, SP10, SP15, SP20, SP25 and SP30 in which sand was replaced by sandstone powder in different proportions of 5%, 10%, 15%, 20%, 25% and 30% respectively.For M30 grade of concrete Control Mix was also prepared in which there is no partial replacement of sandstone powder..

### 3.3 Mix proportions of fresh concrete

The mix proportions of Control mix and other mixes with partial replacement of sand with sandstone powder i.e. SP5, SP10, SP15, SP20, SP25 and SP30 are given in the table below

*Table 1. Mix Proportions of fresh concrete*

| Mix | Cement ($kg/m^3$) | Coarse Aggregate 20mm ($kg/m^3$) | Coarse Aggregate 10mm ($kg/m^3$) | Fine Aggregate ($kg/m^3$) | Sandstone Powder ($kg/m^3$) | Water | Admixture | w/c ratio |
|---|---|---|---|---|---|---|---|---|
| Control Mix | 356 | 695 | 483 | 722 | - | 169 | 3.57 | 0.47 |
| SP5 | 356 | 695 | 483 | 686 | 36 | 169 | 3.57 | 0.47 |
| SP10 | 356 | 695 | 483 | 650 | 72 | 169 | 3.57 | 0.47 |
| SP15 | 356 | 695 | 483 | 614 | 108 | 169 | 3.57 | 0.47 |
| SP20 | 356 | 695 | 483 | 578 | 144 | 169 | 3.57 | 0.47 |
| SP25 | 356 | 695 | 483 | 541 | 181 | 169 | 3.57 | 0.47 |
| SP30 | 356 | 695 | 483 | 505 | 217 | 169 | 3.57 | 0.47 |

## IV. LABORATORY TESTS AND DESCRIPTION

### 4.1 Slump test

As per the guidelines of IS: 1199-1959. The slump cone of 100mm×200mm×300mm mould is filled in four layers by scoop, each layer of approximately one-quarter of the height (300mm) of the mould.Each layer is tampered 25 times by tamping rod and care is taken to distribute strokes evenly over the entire cross-section of slump cone.

### 4.2 Compressive strength test

The compressive strength of hardened concrete is determined with the help of this test.IS 516:1959 is used for determining compressive strength of concrete. The size of specimen used was150mm × 150mm × 150mm. After 7days and 28 days of deep curing, the specimens were tested.

### 4.3 Flexural strength test

IS 516:1959 is used for testing flexural strength of concrete. The dimensions of beam are 700mm × 150mm × 150mm. After deep curing for 28 days, the specimens were tested. For testing, the central point loading method was used.

### 4.4Split tensile test

IS 5816:1999 is used to determine splitting tensile strength of concrete. Cylinder having dimensions of are 300mm (length) × 150mm (diameter) is used to conduct the test. The specimens were tested after curing for 28 days,.

### 4.5 Density test

Three cube specimens having dimensions of 150mm ×150mm ×150 mm of concrete were cured for 28 days. After 28 days of curing these concrete specimens were kept in an oven for 24 hours and weighed after cooling.

### 4.6Water Absorption test

The quality of concrete can also be determined by the water absorbed. As per guidelines prescribed by IS 15658:2006, the test for water absorption was conducted.

## V. RESULTSAND DISCUSSIONS

### 5.1 Slump test

To determine workability of concrete in fresh state,this test was done. For M30, after conducting slump test,the results obtained for blend mix i.e. SP5, SP10, SP15, SP20, SP25 and SP30 mixes for

M30 grade were 101mm, 91mm, 84mm, 72mm, 61mm and 54mm respectively. For M30, the control mix had a slump of 117mm.

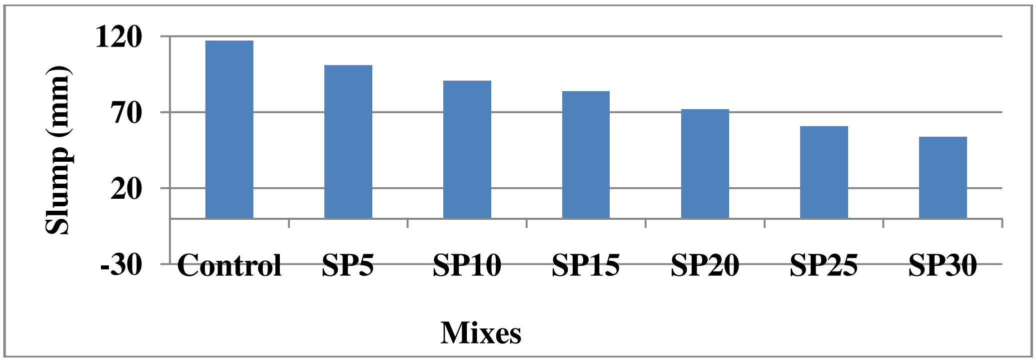


*Fig. 1.Variation in slump with enhancement of sandstone powder*

### 5.2 Compressive strength test

For M30 grade, the compressive strength after 7 days for blended mix i.e. SP5, SP10, SP15, SP20, SP25 and SP30was 24.95, 22.52, 20.87, 17.65, 13.79 and 10.78MParespectively. The compressive strength after 28 days for blended mix i.e. SP5, SP10, SP15, SP20, SP25 and SP30 was 39.89, 38.43, 35.27, 33.13, 30.47 and 26.29MPa respectively. For M30, the compressive strength of control mix after 7 and 28 days was26.43 and 41.35MPa respectively.Initially the sandstone powder resulted in achievement of target strength till 10% of partial replacement of sand with sandstone powder i.e. SP10. But beyond 10%, as the quantity of partial replacement of sand with sandstone powder increased, the rate of water absorption increased and with time water evaporated, leaving behind the pores which are responsible for decline in compressive strength.

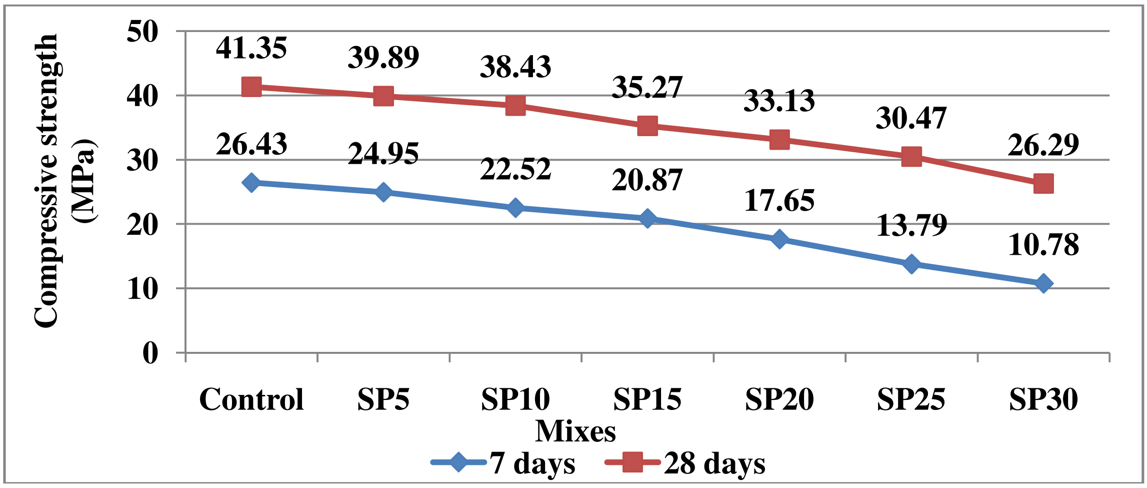


*Fig.2. Variation in compressive strength with enhancement of sandstone powder*

### 5.3 Flexural strength test

By using centre point loading method, the flexural strength of the concrete was obtained. For M30 grade, the flexural strength for blended mix SP5, SP10, SP15, SP20, SP25 and SP30 was 4.31, 3.90, 3.05, 2.76, 2.37 and 1.83MPa respectively. After 28 days of curing the flexural strength of Control Mix was 4.97MPa for M30.Due to the fact that sandstone powder has high rate of water absorption and as the rate of sandstone powder increased in concrete, it led to more absorption of water and with time water absorbed was evaporated leaving behind the pores. These pores contributed to the decline in strength.

 

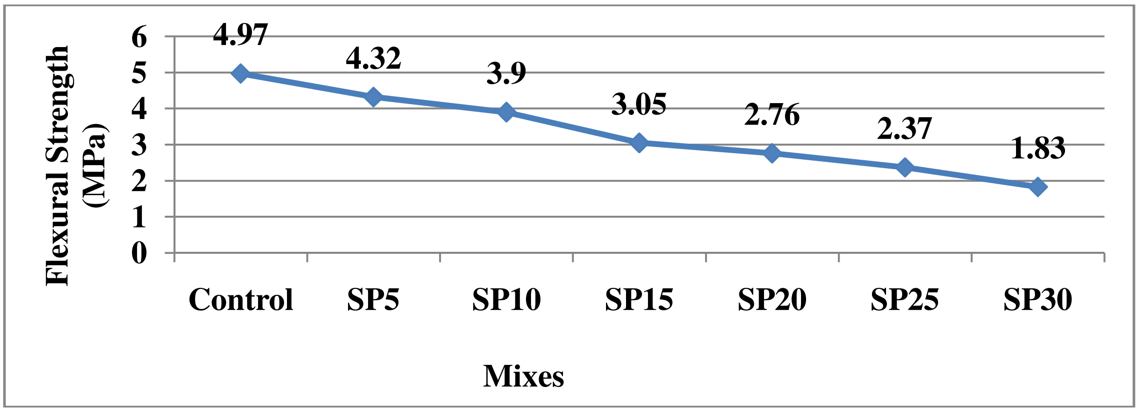


*Fig.3. Flexural strength with enhancement of sandstone powder*

### 5.4 Split tensile test

The split tensile strength for blend mixes prepared with sandstone powder i.e. SP5, SP10, SP15, SP20, SP25 and SP30 was 3.19, 2.87, 2.16, 1.74, 1.29 and 1.03MPa respectively. Due to its fineness and angularity, with increase in percentage of sandstone powder in concrete the rate of water absorption became high and which ultimately led to development of pores after evaporation of the water. So, as the percentage of sandstone powder in concrete increased, the split tensile strength reduced steadily.

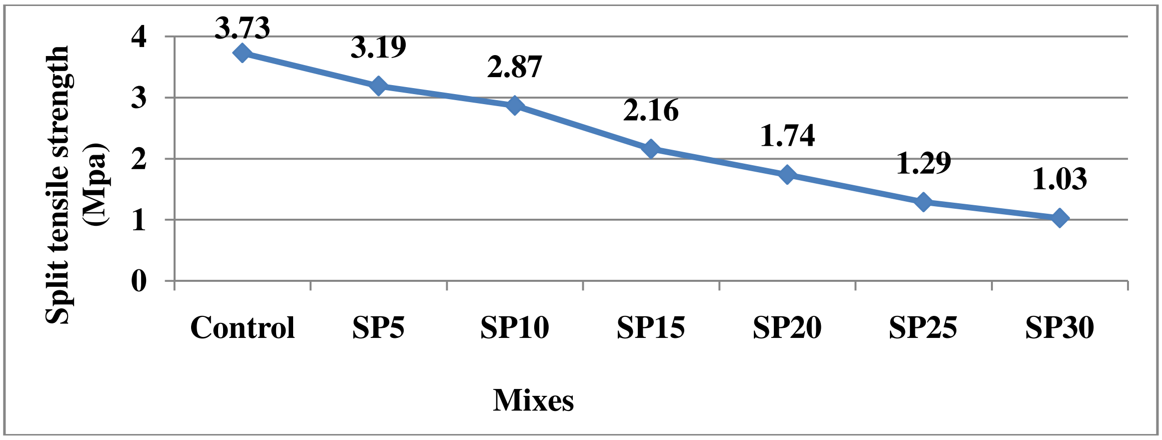


*Fig.4. Split tensile strength with enhancement of sandstone powder*

### 5.5 Density test

The density of M30 obtained for blended mix SP5, SP10, SP15, SP20, SP25 and SP30 was 2473, 2454, 2439, 2410, 2395 and 2383 kg/m$^3$ respectively. For control mix the density was 2487 kg/m$^3$for M30 grade concrete. After 28 days of curing and oven drying for 24 hours,this test was done. The specific gravity of sandstone powder is less than the specific gravity of sand that's why with increase in percentage of sandstone powder the density reduced at a steady rate.

 

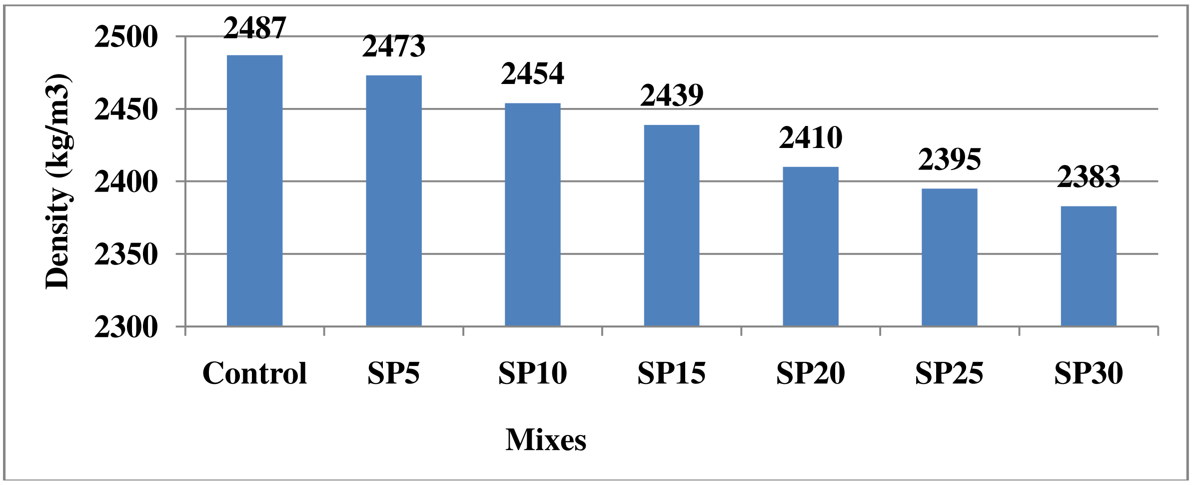


*Fig. 5. Variation in density with enhancement of sandstone powder*

### 5.6 Water Absorption test

Water absorption test is done to determine the percentage of moisture absorbed by the concrete in 24 hours. For M30 grade concrete, the water absorbed for blended mix i.e. SP5, SP10, SP15, SP20, SP25 and SP30 after curing and oven drying for 24 hours was 11.56, 12.13, 12.86, 13.92, 14.87and 16.18% for respectively. The water absorbed by control mix was 11.27% for M30 grade.

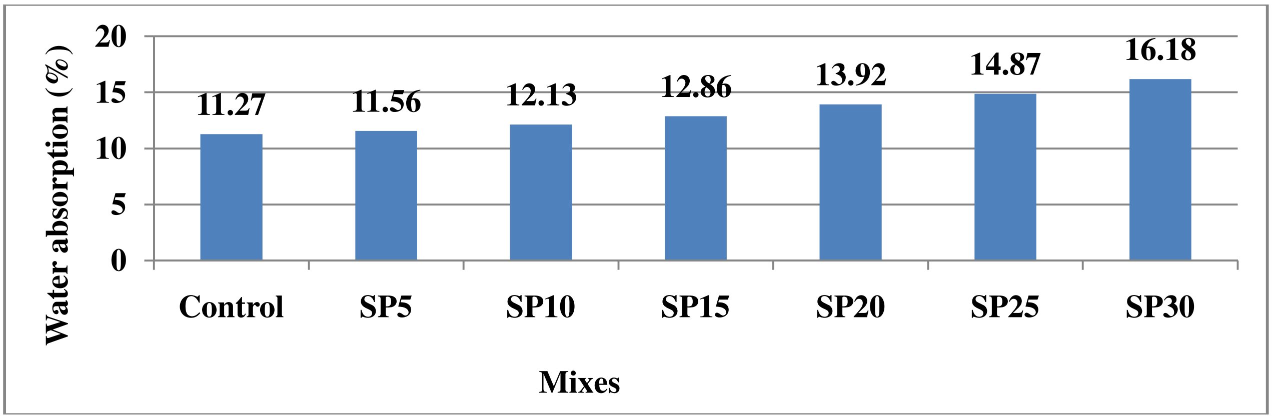


*Fig. 6. Variation in water absorption with enhancement of sandstone powder*

## VI. CONCLUSION

1) As the sandstone powder is more fine than natural river sand and is also angular in shape. So, it absorbs more amount of water and with constant water-cement ratio and admixture dosage, the slump of Control Mix was found to be 117mm and it decreased successively with increase in percentage of sandstone powder till 54mm.
2) For M30, the blend mix SP10 showcased the highest 28 days compressive strength i.e. 38.43 MPa. Initially the sandstone powder resulted in achievement of target strength till 10% of partial replacement of sand with sandstone powder i.e. SP10. But beyond 10%, as the quantity of partial replacement of sand with sandstone powder increased, the rate of water absorption increased and with time water evaporated, leaving behind the pores which are responsible for decline in compressive strength. So from blend mix SP15 onwards, with increase in percentage of sandstone powder the target strength of 38.25 MPa could not be achieved and the compressive strength declined at a steady rate.
3) For M30, the flexural and split tensile strength for Control Mix were 4.97 and 3.73MPa respectively and declined steadily due to increase in percentage of partial replacement of sand

with sandstone powder. The mix SP30 with highest percentage of partial replacement of sandstone powder had flexural and split tensile strength of 1.83 and 1.03Mpa respectively.

4) The resourcefulutilization of the sandstone wastes in concrete can reduce substantial amount of landfill problem also could also provideanimportantresource of supplementary aggregate which could be used in the production of concrete thereby facilitatingin overall sustainability.
5) The specific gravity of sandstone powder is less than the specific gravity of sand that's why with increase in percentage of sandstone powder the density reduced at a steady rate. The density of Control mix and mix SP30 was 2487 and 2383kg/$m^3$ respectively.
6) Water absorption of sandstone powder is more than the natural fine aggregate as they very fine and angular in shape, so with the increase in percentage of sandstone powder, the water demand kept on increasing and so water absorption increased. The Water absorption of mix SP5 and SP30 were found to be 11.56 and 16.18 respectively.

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