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# Experimental Study of Mechanical Behaviour of an RC Concrete Prepared Using M-Sand along with Chemical Admixtures

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***Abstract: Concrete plays a predominant role in the construction industry and a large quantum of sand is being utilized for various construction of structure. River sand has become expensive due to excessive cost of transportation from natural sources. Also, large- scale depletion of these sources creates environmental problems. So as to overcome, M- Sand can be an economic alternative to the river sand with respect to its availability, cost and environmental impact M-sand a by-product from the stone crushing unit which is released directly into environment can cause environmental pollution. And can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles. Recycling is the key component of modern waste management system and it reduce the consumption of fresh raw materials, reduce energy usage, reducing the need for conventional waste disposal and to lower greenhouse gas emission. To investigate the mechanical properties as compressive strength "Cubes" of size 150 mm x 150 mm x 150 mm are prepared, the Split tensile strength "cylinder" of size 750mm x 150 mm x 150 mm and also load deflection of beam and column are prepared and investigation should be carried out at a regular interval of 7,14 and 28 days. And also, the dynamic behavior is also studied. This present work is an attempt to use M-sand as a replacement (25%, 50%, 75% & 100%) for River Sand in M-30 Grade concrete mix.***

***Keywords: Cement, Fine Aggregate, Coarse Aggregate, Water, Chemical Admixtures, Sulfonated Naphthalene-Formaldehyde Condensates (SNF), Polycarboxylate Derivatives (PC).***

## I. INTRODUCTION

Concrete is the most widely used construction material today. The constituents of concrete are coarse aggregate, fine aggregate binding material and water. The mixture of the materials results in a chemical reaction called hydration and a change in the mixture from plastic to a solid state occurs over a period of time. Rapid increase in construction activities leads to acute shortage of conventional construction materials. It is conventional that sand is being used as fine aggregate in concrete. For the past some years, the escalation in cost of sand and availability due to administrative restrictions in India. Some alternative materials have already been used as a part of natural sand. For example, fly ash, slag, limestone and siliceous stone powder wereused in concrete mixtures as a partial replacement of natural sand. Similarly, quarry waste fine aggregate could be an alternativeto natural sand. It is a by-product generated from quarrying activities involved in the production of crushed coarse aggregates. Quarry waste fine aggregate, which is generally considered as a waste material, causes an environmental load due to disposal problem. Hence, the use of quarry waste fine aggregate in concrete mixtures will reduce not only the demand for natural sand but also the environmental burden. The successful utilization of M-sand as fine aggregate would turn this waste material that causes disposal problem into a valuable resource. The utilization will also reduce the strain on supply of natural fine aggregate, which will also reduce the cost of concrete. For questions on paper guidelines, please contact us via e-mail.

## II. ADMIXTURES USED

### *A. Chemical Admixtues*

Chemical admixtures reduce the cost of construction, modify properties of hardened concrete, ensure quality of concrete mixing/transporting/placing/curing, and overcome certain emergencies during concrete operations. Chemical admixtures are used to improve the quality of concrete during mixing, transporting, placement and curing. Superplasticizers are well known chemical admixtures for concrete used in the reduction of water to cement ratio without affecting workability, and to avoid particle aggregation in the concrete mixture. These are also known as high range water reducers (HRWR), fluidifiers, and dispersants as these are capable of reducing water to cement ratio by 40.0%.

These chemical admixtures are added in the concrete just before the concrete is placed. These admixtures help to improve strength and flow characteristics of the concrete. Flow characteristics and slump of concrete varies with type, dosage, and time of addition of concrete superplasticizer. Superplasticizers can be classified into four types such as,

1) Sulfonated melamine-formaldehyde condensates (SMF),
2) Sulfonated naphthalene-formaldehyde condensates (SNF),
3) Modified lignosulfonates (MLS), and
4) Polycarboxylate derivatives (PC).

### B. *Sulfonated Naphthalene-Formaldehyde Condensates (SNF)*

Naphthalene Sulfonate formaldehyde (Powder & Liquid - 40%, 43% conplast sp430) condensate. Its high purity makes cement particles with high dispersancy, low foaming, high range water reducing and obvious strengthening so that we can get advantages of accelerating project mould turnover and construction speed, and also saving cement, improving cement mobility and workability. NSF is a high range concrete admixture of concrete cast-in-place, prefabricating, pump and curing.

### C. *Polycarboxylate Derivatives (PC).*

Polycarboxylate Ether (Pce-50 % ,Pce 40% & Pce Powder) (High Dispersion– D-50) is a new generation of high performance polymer ,It is a neutral concentrate grade, Polycarboxylate ether (PCE) as a new generation of environmental friendly is mainly used as a major ingredient to produce a high performance water reducers or plasticizers for the following applications hydraulic ,port ,bridge ,railway ,tunnels and highway ,industrial or civil construction, municipal engineering ,water conservancy ,electric power engineering ,road ,metro, etc.

Sulfonated Naphthalene-Formaldehyde Condensates

Polycarboxylate Derivatives

## III. MIX DESIGN

A Mix for M25 Grade of Concrete was Designed as Per Is 10262-2019.

### A. *Design Parameter*

1) Characteristic compressive strength - 25 N/mm².
2) Maximum size of aggregate - 20 mm
3) Degree of workability - 0.9(compaction factor)
4) Degree of quality control - good
5) Type of exposure - mild

### B. *Test Data for Materials*

1) Grade of cement - 53 grade
2) Size of Aggregate - 20 mm
3) Specific Gravity of Cement - 3.1
4) Specific Gravity of F.A. - 2.63
5) Specific Gravity of C.A. - 2.71
6) Specific Gravity of Quarry Dust - 2.69
7) Water Absorption of C.A. - 1.1
8) Sand Confirming Zone as per IS Code – Zone III

### *C. Mix Proportion*

Mix ratio for concrete depends on the properties of materials used in making of concrete. Admixture is added 1% of the weight of the cement in wet mix.

| Materials | Cement | Coarse Aggregate | Fine Aggregate | Water/Cement Ratio |
|---|---|---|---|---|
| Proportion | 1 | 1.86 | 3.06 | 0.48 |
| Quantity kg/m$^3$ | 390 | 737.1 | 1193.4 | 197 |

## IV. CASTING OF SPECIMEN

As per derived mix design ratio, Specimen to be casted are listed below as follows as

*1)* Cube mould (150 x 150x 150 mm)
*2)* Cylinder mould (150 x 300 mm)
*3)* Beam mould (1600 x 100 x 150 mm)

To test mechanical properties of the concrete i.e., hardened concrete test with varying percentage replacement of quarry dust as 0% ,10%, 20%,30%,40%50% ,60%,70 % ,80 %, 90% and 100% with addition of admixture in 1 % to the weight of cement.

| | | |
|---|---|---|
| Q0 | - | Conventional Concrete |
| Q10 | - | 10% Replacement of Sand by M-Sand in Concrete |
| Q20 | - | 20% Replacement of Sand by M-Sand in Concrete |
| Q30 | - | 30% Replacement of Sand by M-Sand in Concrete |
| Q40 | - | 40% Replacement of Sand by M-Sand in Concrete |
| Q50 | - | 50% Replacement of Sand by M-Sand in Concrete |
| Q60 | - | 60% Replacement of Sand by M-Sand in Concrete |
| Q70 | - | 70% Replacement of Sand by M-Sand in Concrete |
| Q80 | - | 80% Replacement of Sand by M-Sand in Concrete |
| Q90 | - | 90% Replacement of Sand by M-Sand in Concrete |
| Q100 | - | 100% Replacement of Sand by M-Sand in Concrete |
| SP (SNF) | - | Super plasticizer (Sulfonated naphthalene-formaldehyde condensates) |
| SP (PC) | - | Super plasticizer (Polycarboxylate derivatives). |


Cube Specimen


Cylindrical Specimen

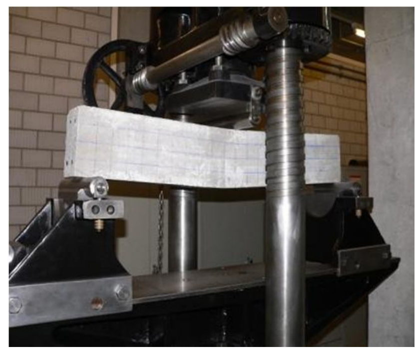
Beam Specimen with Reinforcement

## V. TESTING OF SPECIMEN

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. One of the main purposes of testing hardened concrete is to confirm that the concrete used at site has developed the required strength. Following are the static tests to be carried out on the fresh concrete in order to study the properties and behavior of a fresh concrete that determines the mechanical behavior of the concrete.

Compression Test on Cube

Split Tensile Strength Test on Cylinder

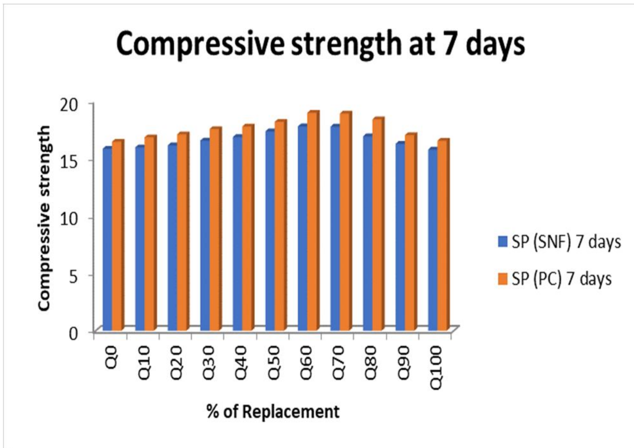


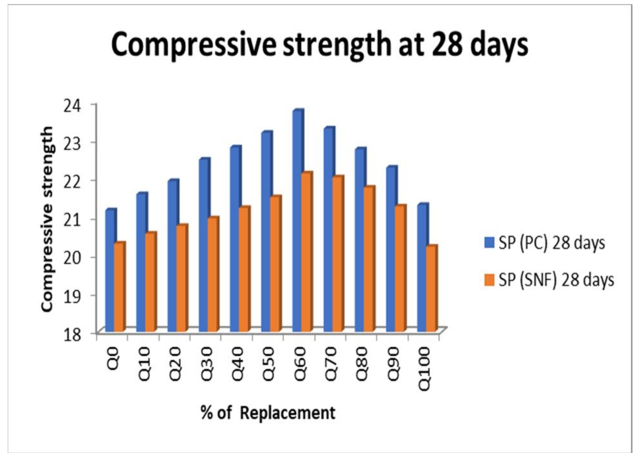
Flexural Strength Test on Beam

## VI. TEST RESULTS

Compression Strength Test Result of Specimens

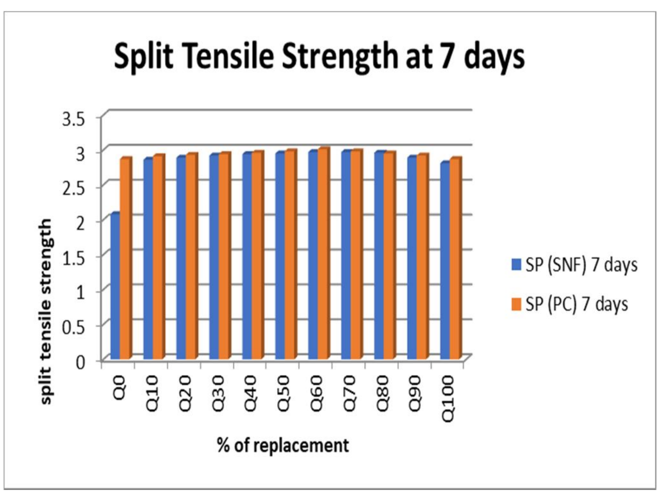
| Q% | SP (SNF) | | SP (PC) | |
|---|---|---|---|---|
| | 7 days | 28 days | 7 days | 28 days |
| Q0 | 15.85 | 20.30 | 16.46 | 21.17 |
| Q10 | 15.97 | 20.56 | 16.84 | 21.59 |
| Q20 | 16.15 | 20.76 | 17.10 | 21.93 |
| Q30 | 16.56 | 20.96 | 17.56 | 22.49 |
| Q40 | 16.87 | 21.23 | 17.78 | 22.81 |
| Q50 | 17.37 | 21.51 | 18.19 | 23.19 |
| Q60 | 17.80 | 22.13 | 18.98 | 23.76 |
| Q70 | 17.78 | 22.03 | 18.91 | 23.30 |
| Q80 | 16.93 | 21.76 | 18.41 | 22.76 |
| Q90 | 16.28 | 21.27 | 17.03 | 22.28 |
| Q100 | 15.78 | 20.22 | 16.54 | 21.31 |

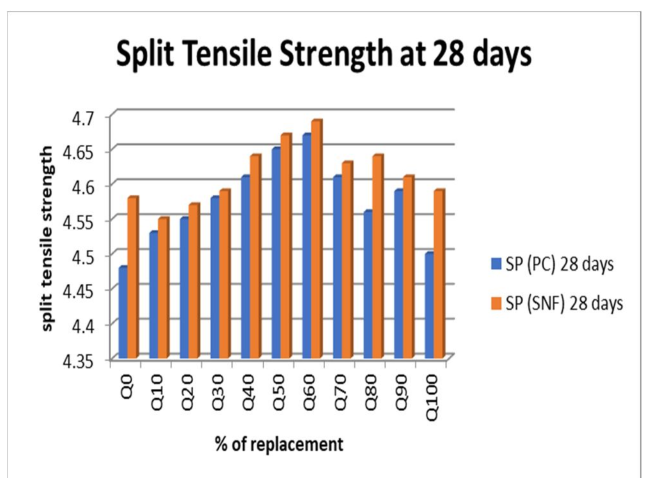



Split Tensile Strength Test Result of Specimens

| % | SP (SNF) | | SP (PC) | |
|---|---|---|---|---|
| | 7 days | 28 days | 7 days | 28 days |
| 0 | 2.08 | 4.58 | 2.87 | 4.58 |
| 10 | 2.86 | 4.55 | 2.91 | 4.55 |
| 20 | 2.89 | 4.57 | 2.93 | 4.57 |
| 30 | 2.92 | 4.59 | 2.94 | 4.59 |
| 40 | 2.94 | 4.64 | 2.96 | 4.64 |
| 50 | 2.95 | 4.67 | 2.98 | 4.67 |
| 60 | 2.97 | 4.69 | 3.01 | 4.69 |
| 70 | 2.97 | 4.63 | 2.98 | 4.63 |
| 80 | 2.96 | 4.64 | 2.95 | 4.64 |
| 90 | 2.89 | 4.61 | 2.92 | 4.61 |
| 100 | 2.81 | 4.59 | 2.87 | 4.59 |




Flexural Strength Test Result of Specimens

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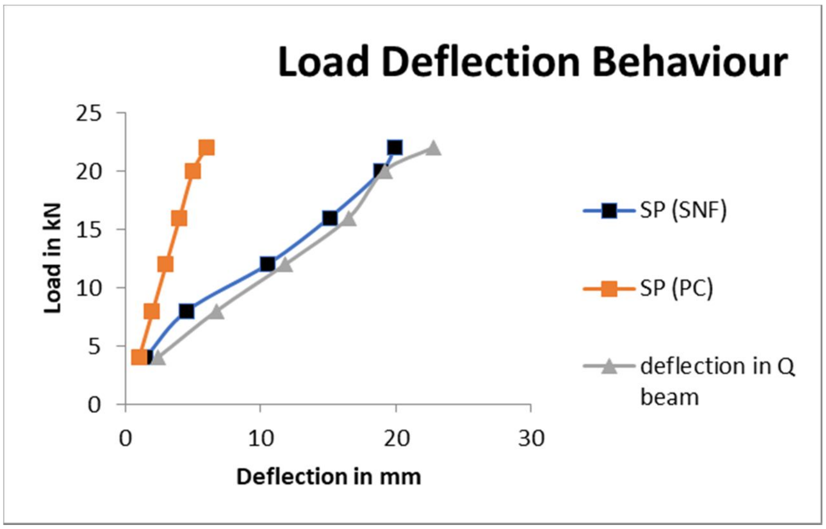
| S.No | Load inkN | Deflection in Q60 rectangular beam | | |
|---|---|---|---|---|
| | | Controlled beam | V | SP (PC) |
| 1 | 4 | 2.43 | 1.51 | 2.12 |
| 2 | 8 | 6.78 | 4.58 | 6.38 |
| 3 | 12 | 11.87 | 10.5 6 | 11..45 |
| 4 | 16 | 16.56 | 15.1 3 | 1.23 |
| 5 | 20 | 19.17 | 18.9 8 | 19.84 |
| 6 | 22 | 22.83 | 19.9 6 | 19.56 |




## VII. CONCLUSION

Concrete acquires maximum increase in compressive strength at 60 % sand replacement by quarry dust. When comparedwith chemical admixture with SP (PC) and SP (SNF) respectively, the amount of increase in strength is 23.76 and 22.13 for M20.Split tensile strength is maximum at 60 % replacement of natural sand by quarry dust, chemical admixture with SP (PC) and SP (SNF) respectively. The percentage of increase with control concrete is 4.69 and4.69 for M20. Maximum flexural strength of RCC beam is obtained at 60% sand replacement by quarry dust.

The derivation gives clear picture that quarry dust can be utilized in concrete mixture as a quality substitute instead of river sand to a high strength at 60% replacement. When the conventional fine aggregate is completely replaced with quarry dustalong with 1 % dosage of super plasticizer increase in the strength. It was observed that the slump value increases with increase in percentage replacement of sand with quarry dust with SP (PC) than SP (SNF). Due to flaky particles shape and higher percentage of fines, concrete does not give adequate workability and the concrete tends to segregate. It was known that the density of concrete increases with increase in percentage of dust content. As expected, the compressive strength increases with increase in density of concrete.

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