Performance Study on Utilisation of Dry Precipitate as Fine Aggregate in Concrete

Vigneshkannan Suresh¹, Rangaraj Arumugam², Kanchidurai Settu³, Prakash Neelamegam¹, Anto Joseph Thatheyus ¹

¹ K. Ramakrishanan College of Technology, Trichy, Tamilnadu, India.
² M. Kumaraasamy College of Engineering, Karur, Tamilnadu, India.
³ Sastra deemed to be University, Thanjavur, Tamilnadu, India.

vignesh29kannan11@gmail.com , rangaraj.m.e@gmail.com , kanchudurai@civil.sastra.edu ,civilshine@gmail.com, antojebas6@gmail.com

Abstract. The objective of the research work is to produce a concrete with the use of dry precipitate as replacement of fine aggregate with optimum dosage of mineral admixture that enhances the mechanical properties of concrete thereby eliminating the early shrinkage occurring in hardened concrete. A dry precipitate encourage is viewed as the build-up delivered by the STP, amid which fluids and solids are being isolated. Thus, the solid can be further dried into a coarse powdered form. This powdered form of similar property satisfies the fine aggregate. To Study the strength, conduct of fine aggregate by supplanting of 0, 5%, 15% and 20.0% in M35 grade of concrete then determination of fine aggregate to examination this proposition on impact of fine aggregate at different laboratory tests as for compressive strength test, flexural strength test and split tensile strength test at various phases of restoring 7th and 28th days will be breaking down. When the added dry precipitate as fine aggregate which is a sewage treatment plant disposal waste is used in concrete and our nation to become saved from land pollution and also good produces an Ever “greener concrete: to Civil field”.

Key words: dry precipitate, ecological confinements, sewage treatment plant, fine aggregate, green concrete

1. Introduction

1.1. General
Among the various methods and technologies, aerobic/anaerobic stabilization appears as the most common method in Europe, with applications in 24 out of 27 countries. Composting is also widely used, but as a final sludge disposal method. Sludge drying plants also met increasing interest, especially in Germany, Italy, UK, and France.
The selection of the proper disposal method for the dried sludge is based on the following criteria (EEA, 1997):

I. Environmental: sludge quality and quantity characteristics, adequacy of treatment, infrastructures for sludge storage, and transportation.
II. Economical: capital cost, annual operation cost, income from the exploitation of the commercial value of the final product through reuse.
III. Technical: assessment of flexibility, simplicity, and reliability of each alternative.
IV. Social: informing the public and stakeholders on the proposed alternatives, presenting the measures taken and the rights and obligations of stakeholders in order to ensure social acceptance. (Kelesidis Stasinakis et al 2014) [1].

In the industrial, mining, municipal, agricultural and other processes currently in India about 960 million tons of solid waste is being generated annually as by product out of which around 350 million tones are organic, around 290 million tons are inorganic from industrial and mining sector and around 4.5 million tons are hazardous in nature. The technology advancement has helped in using alternative construction materials as a substitute to traditional materials for manufacturing of bricks, concrete blocks, tiles, aggregates, ceramics, cements, limes etc. At the same time to safeguard the environment the efforts are being made for recycling different wastes and to utilize them in value added applications (Pappu et al, 2007) [2].

1.1.1 Advantages. Having no direct contact between combined heat and power waste gas and the dryer system results in simple safety management and fast and easy switch online from combined heat and power mode to burner mode without impairing product quality, efficient heat recovery

2. Literature review

The experimental investigation was conducted by Jayraj Vinod Sinh Solanki et al (2013), to study the feasibility of using fly ash and hypo precipitate as cement in concrete. There are two test groups constituted with the partial replacement percentage of 0%, 10%, 20% and 30% taken. Thus, the results show that effect of fly ash and hypo precipitate on concrete specimen have a significant amount of increase of the flexural strength. An investigation of the specimen the utilization of Hypo Precipitate as supplementary cementitious materials and also compare with fly ash concrete and ordinary concrete [7].

Based on characteristics of waste water from the textile industries coagulation and adsorption treatments are common procedure. Due to its chemical content sludge generated during treatment is hazardous in nature (Senthilkumar et al 2008) [3].

In India, the costs of construction material have increased four times in last two decades. Further high transportation costs of raw materials are making situation worser. Increasing demand and environmental restrictions, necessities to the find functional substitutes for conventional building materials in construction industry (Pappu et al, 2007) [2].

3. Methodology

The usage of dry precipitate as fine aggregate will reduce the cost of construction. In order to make effective use of the disposal. Usage of huge amounts of waste material places strain on landfill site. To minimize the concrete industry usage of vast amounts of natural sand as fine aggregate [4]. To observed an initial laboratory experiments as well as the future research to be performed. To note the performance of dry precipitate. On the basis of identified knowledge, an initial laboratory investigation was conducted. To offer an economical concrete in our field. Minimize the maximum demand for sand [8].
4. Material used and its specifications

4.1. Materials used

Cement is the best binding material and in ordinary portland cement, 43 Grade conforming to IS:8112-1989 part 4 was used. Fine aggregate is second most ingredients to make fresh concrete and it locally available river sand conforming to Grading zone II of IS: 383 1970 part 5 was used. Coarse aggregate is the maximum volume occupied by the fresh concrete and it locally available crushed granite stones conforming to graded aggregate of nominal size 20 mm were used. Dry precipitate is a locally available sewage treatment plant disposal of sludge from collected [5]. (refer Table 2 and Table 3 chemical test report from local sewage treatment plant)

4.2. Preliminary test results

| Description of ingredients used | Values |
|--------------------------------|--------|
| Cement Specific gravity        | 3.22   |
| Fineness                       | 6.5%   |
| Initial setting time           | 30 mins|
| Fine aggregate Fineness Modulus| 2.765  |
| Specific gravity               | 2.67   |
| Water absorption               | 1.0%   |
| Dense bulk density             | 1641.55kg/m³ |
| Loose bulk density             | 1490.86kg/m³ |
| Coarse aggregate Specific gravity| 2.71    |
| Water absorption               | 0.9%   |
| Impact value                   | 7.29%  |
| Dense bulk density             | 1651.17kg/m³ |

Table 2. Effluent Properties of STP

| Units          | Values |
|----------------|--------|
| Colour         | Dark green |
| $E_c$ (m s.cm⁻¹) | 1798   |
| pH             | 7.5    |
| BOD (mg/L)     | 1210   |
| COD (mg/L)     | 2000   |
| TSS (mg/L)     | 1390   |
| Phosphate (mg/L) | 59    |
| Nitrate (mg/L) | 9.9    |
| Sulfate (mg/L) | 173    |
Table 3. Local treatment plant chemical wet sludge characteristics (after digestion)

| Units     | Values |
|-----------|--------|
| pH        | 7.0    |
| BOD       | mg/l   | 110   |
| COD       | mg/l   | 188   |

The fineness rate of dry precipitate was measured by is sieve 45 microns. Thus, the Results shown that 50.5% of dry precipitate retained on the sieve.

5. Mix design ratio
The concrete mix is designed for m25 grade as per is 10262-2009 and is 456-2000. It shows that Ingredients for Concrete. (refer the Table 4 for mix proportion of ingredients)

Table 4. Mix proportion of ingredients

| Ingredients     | Proportion       |
|-----------------|-----------------|
| Cement          | 1               |
| Fine aggregate  | 2.04            |
| Coarse aggregate| 2.86            |
| Admixture       | 0.96 (0.3% of weight of cement content) |
| w/c ratio       | 0.46            |

6. Preparation and casting of specimen
Cube mould of size 150 X 150 X 150 mm (Figure 1. a. casting of cube) and cylinder mould of size 300mm height and 150mm diameter (Figure 1. b. casting of cylinders) and prism of 500mm X 100mm X 100mm (Figure 1. c. casting of prism) were used the mould to be used in cleaned properly with dry cloth and oil were applied before casting. The quantity of cement, fine aggregate, coarse aggregate and dry precipitate were measured based on desired mis proportion and they were well mixed on water tight platform at room atmosphere. Water added gradually till all the materials has been sufficiently, mixed together to form a homogeneous mix. Concrete were filled in moulds and compacted using standard tamping rod.
7. Results and discussions

7.1. Fresh Concrete Test
Fresh concrete tests were being conducted to examine the properties of the freshly mixed concrete materials. The results obtained are given in the tabulation (Table 6 refers to be the fresh concrete test results) done by the laboratory. Fresh concrete test is to determine the workability of the concrete mix being used. Workability is used to find out the water cement ratio. High workability is found by the maximum water content in the concrete mix.

Table 5. Fresh concrete test results

| Name of fresh concrete test                  | values |
|---------------------------------------------|--------|
| Flow table test for fresh concrete          | 26.6%  |
| Slump cone test for fresh Concrete          | 1.88mm |
| Oven dry density                            | 2470kg/m³ |

7.2. Testing of control specimen – compressive strength test
Compressive strength test (Figure 2. a show the compressive strength test setup) performed on a concrete specimen of size 150mm X 150mm X 150mm on control mix for 7 days and 28 days strength were determined. Compressive strength test results for various specimens were observed that Figure 2. b shows the compressive strength results of cubes for 7th days (results for concrete 15.11 N/mm²) and also 28th days (results for concrete 37.11 N/mm²) respectively in control specimens are tested. Among the 3-control specimen were optimized to refer the Table 6.
7.3. Testing of control specimen – split tensile strength test

Split tensile strength (Figure 3. a represents the Split Tensile Strength Test setup) of the cylinder is taken for the specimen of length 300mm and diameter 150 mm made for control mix and tested and the results for 7 days and 28 days strength and Figure 3. b shows the split tensile strength of the cylinder for 7th days (result for concrete 1.981 N/mm²) and 28th (results for concrete 3.227 N/mm²) days respectively in control specimens are tested. Among the 3-control specimen were optimized to refer the Table 6.

7.4. Testing of control specimen – flexural strength test

Flexural strength of the prism is taken for the specimen of length 500mm and cross section as 100 X 100 mm made for control mix and tested and the results for 7 days and 28 days strength and Figure 4 shows the split tensile strength of prism for 7th days (result for concrete 5.2 N/mm²) and 28th (results for concrete 9.95
N/mm²) days respectively in control specimens are tested. Among the 3-control specimens were optimized to refer to Table 6.

![Figure 4. Flexural Strength Test results of prism for control specimens](image)

| Table 6. Optimized the control specimens’ results |
|-----------------------------------------------|
| Hardened concrete test | At 7\textsuperscript{th} Days (N/mm\(^2\)) | At 28\textsuperscript{th} Days (N/mm\(^2\)) |
| Compressive strength test | 15.11 | 37.11 |
| Split tensile strength test | 1.981 | 3.227 |
| Flexural strength test | 5.2 | 9.95 |

7.5. Test Results for Concrete with Partial Replacement of Fine Aggregate with Dry Precipitate

![Graph](image)
Figure 5. Comparison % of dry precipitate as fine aggregate in concrete Vs conventional specimen a) Compression strength test results b) Spilt tensile strength test results c) Flexural strength test results

From above results, In compressive strength, split tensile strength and flexural strength test results are shows that 15 % of dry precipitate as fine aggregate in concrete and also slight near the increasing the 20 % of dry precipitate as fine aggregate in concrete Compressive strength test, flexural strength test, split tensile strength test on control mix were conducted [6]. Based on the test results of compressive strength, flexural strength test, split tensile strength test the following conclusions were drawn.
8. Conclusion
In this research work, concluded

- The partial replacement of fine aggregate in the sense of to reduce sand in the concrete and also to save the construction costs.
- It has been observed that 15% replacement of dry precipitate gives good compressive strength to the concrete. The optimum dosage of Dry Precipitate is 15% for M35 grade concrete. The concrete mix of 15% has the maximum compressive strength, Split tensile strength and Flexural Strength.
- The experimental test results show that reduction of compressive strength results was observed 20% of dry precipitate as fine aggregate in concrete, dry precipitate was collected from locally available STP.
- It can be save our nation from landfill in a dump yard and minimize the cost of construction as a fine aggregate quantity in concrete.it produces a “green concrete”.
- Finally, thus the replacement of dry precipitate as fine aggregate satisfied the compressive strength requirements of Indian Standard.

9. Reference

[1] Alexandros Stefanakis, Christos S, Akratos, Vassilios A Tsihrintzis 2014 Vertical Flow Constructed Wetlands pp 315-363
[2] Pappu A, Saxena M and Asolekar S R 2007 Solid waste generation in India and their recycling potential in building materials Journal of Building and Environment 42 pp 2311-2320
[3] Sentholkumar K, Shivakumar V and Akilamudhan P 2008 Experimental studies on disposal of various industrial solid wastes Journal of Modern applied science 2 pp 128-132
[4] Kulkarni G J, Dwivedi A K, Jahgirdar S S and Orchid N K 2012 Textile Mill Precipitate as Fine Aggregate in Concrete Global Journal of Researches in Engineering Industrial Engineering 12 pp 21-25
[5] Bahoria B V, Parbat D K and Naganaik P B 2013 Replacement of Natural Sand in Concrete By Waste Products A State of Art Journal of Environmental Research and Development 7 pp 1651-1656
[6] Jayeshkumar Pitroda, Zala L B, Umrigar F S 2013 Innovative Use Of Paper Industry Waste (Hypo Sludge) In Design Mix Concrete International Journal of Advanced Engineering Technology 4 pp 31-35
[7] Jayraj Vinodsinh Solanki and jayakumar Pitroda 2013 Study of Modulus of Elasticity of Concrete with Partial Replacement of Cement by Hypo Sludge Waste from Paper Industry 2 pp 40-41
[8] Jamshidi M, Jamshidi A and Mehrdad N 2012 Application of sewage dry precipitate in concrete mixture 13 pp 365-375