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Performance assessment of fly-ash aggregates in concrete

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***Abstract*---**In recent year's construction process is vigorous and never ending process due to the exponential growth of population in the countries like India. It's necessary to search for the alternative building materials and there are so many research work has been carried out to find the alternative material. Concrete is one the commonly used construction material. In previous research works carried out to find the fly-ash aggregates as alternative aggregates for coarser aggregate and found some draw backs in shape factor, impact, and compression and abrasion tests. In this study an effort is made to overcome those drawbacks. A work has been carried out to examine the behaviour of aggregates manufactured with the combination of cement, Fly ash and stone dust with various proportions and the aggregates are prepared by the process of pelletisation and finger moulding. The properties of the manufactured aggregates are compared with the conventional aggregates and the performance of fly-ash aggregates in concrete is assessed by replacing the conventional coarse aggregates by manufactured aggregates in concrete. These

aggregates performed better and proven to be an alternative coarse aggregate in concrete in future.

***Keywords*---**Fly-ash Aggregates, Pelletisation, Finger Moulding, Concrete.

1. Introduction

Concrete is the most consumed material in construction activities which is the combination of coarser and finer aggregates along with cement as the binding material. Coarse aggregates is the major composite of concrete and these coarse aggregates are obtained from mining, these natural resources are depleting very fast, which is a major concern of environment and also lack of availability of these aggregates may affect the construction industry in future. It is necessary for alternative coarse aggregates.

In this country for most of the industries like iron industry, thermal power plant coal is burnt in more number. Thus a more amount of Coal ash is generated in our country and it becomes a hazard to our society as fly-ash is threat to our health. Coal ash (Fly Ash) is the waste product generated in thermal power plant which creates a problem in two ways. Disposing of this material also effects the environment and these flying particles pollute air and also water. Approximately in India around 184MM tons of coal ash is produced every year from all the thermal power stations. Presently fifty to sixty percent of the coal is used and remaining is still a problem for society. In order to solve this problem fly- ash is nowadays using for dumping the low-land and it is also using in making of coal-ash bricks. But there is an alternative option to utilize the fly-ash is to manufacture fly ash aggregates as an alternative for coarser aggregates.

There are many research activities going on in finding the alternative coarse aggregates, Fly ash aggregate is the one of the alternative aggregates researchers are been working on. In the previous studies lot of work has done in identifying the optimum methodology and mix for the preparation of manufactured aggregates. The aggregates are prepared with various proportions of coal ash with cement by pelletisation technique. In all the studies the aggregates are giving better strength in concrete with cent percent alternative of conventional aggregates. Manufactured aggregates are passing through the test like Specific Gravity, Water Absorption and Grading and are failing in Impact test, compression test, abrasion test and Shape factor [1-4].These aggregates perform better than conventional aggregates in concrete and helps in reduction of self weight of concrete [5], [7].In Previous research work, alternative aggregates are manufactured with a combination of coal ash and cement with different ratios of 90:10, 85:15 and 80:20. In this study an experiments are carried out to overcome these drawbacks.

Finger moulding is adopted in order to overcome shape factor and Stone Dust is utilized in the mix to improve Impact, Compressive and Abrasion strengths of aggregate. Finger Moulding is a new technique adopted, once the wet mix of fly ash: Cement: Stone Dust is prepared by fingers that mix is moulded randomly in

the shape of triangles and allowed to dry and cured for 28 days. Certainly it helped to overcome the drawbacks of the shape factor. Even though finger moulding cannot be adopted in mass production it gave an idea so the machine moulding can be adopted for mass production.

2. Objectives

- Optimization of mix for preparation of coal-ash based manufactured aggregates
- Characterizing the manufactured aggregates prepared by pelletisation and finger moulding
- Finding the behaviour of manufactured aggregates in concrete

3. Methodology

3.1 Preparation of manufactured aggregates

- Coal Ash and Stone dust are selected in different proportions by percentage of mass required by keeping cement content constant. i.e., (FA: Stone Dust: Cement) 55:30:15 and 45:40:15.
- The proportions are dry mixed thoroughly in concrete mixer.
- For a dry mix water is sprinkled continuously with simultaneous rotation of mixer until the formation of pellets.
- Dry mix is mixed with optimum water percentage (obtained from pelletisation) and aggregates are formed in triangular shape by finger moulding.
- Once the aggregates are formed, they are allowed a day to achieve green strength.
- Aggregates are water cured for 28 days.

3.2 Segregation of manufactured aggregates

- After curing, manufactured aggregates were segregated in to finer and coarser on the basis of pellets size by sieving.
- The aggregates retained in 4.75mm as coarse aggregates and aggregates passing 4.75mm as fine aggregates.
- Properties of manufactured aggregates are assessed.
- The aggregates size lesser than 20mm were used in the preparation of concrete.

3.3 Preparation of concrete specimens

- For M20 grade concrete, Cement, Finer and coarser aggregates (Manufactured Aggregates) were taken in the ratio of 1:1.5:3 respectively.
- All the ingredients were mixed in dry condition to make the homogeneous mix after that required amount of water is added and mixed well before casting specimens.
- Then mix is poured in to the specimen moulds and allowed to achieve green strength for a day.
- The concrete specimens are water cured for 28 days.

4. Materials

a) Cement: Portland Pozzolonic Cement is used which is obtained from local market.
b) Fly-ash: Class-F coal-ash is used in this work which is bought from KPCL Raichur.
c) Stone Dust: The crushed stone powder is used and obtained from locally available market.
d) Water: Potable water was used.

5. Experimental Work

5.1 Tests on Fly-ash Aggregates (Pelletisation)

Tests on Fly-ash aggregates are successfully conducted for the two different Proportions, 55:30:15, 45:40:15 and results are tabulated in Table 1.The results obtained from this proportionate sample are compared to the Standard Values recommended by the IS code.

Table 1. Test results of fly-ash aggregates for two different proportions using pelletistion technique

Test	55:30:15	45:40:15	Code Specifications	Remarks
Specific Gravity	1.78	1.847	As per IS 2386-3(1963) Specific Gravity value should lies between 2.6 to 2.7.	Hence obtained aggregates are Light in Weight.
Crushing Value	13.35 %	15.20 %	As per IS 383-1970, Crushing value <45% for other than wearing surface and <30% for wearing surfaces.	Hence Satisfactory for both the Proportions.
Impact Value	37.33 %	25.09 %	As per IS 383-1970, Impact value <45% for other than wearing surface and <30% for wearing surfaces.	45:40:15 mix ratio satisfies the code specification.
Angularity Number	14No	12No	As per IS 2386 – part 1 – 1963, angularity number generally lies between 0 to 11.	Hence not Satisfactory for both the Proportions.
Flakiness Index	17.7%	17.7%	As per BIS 812 Part 1, Flakiness Index < 30% for binder course and <25% for surface course.	Hence Satisfactory for both the Proportions.
Elongation Index	41.43 %	41.43 %	As per BIS 812 Part 1, Flakiness Index < 30% for binder course and <25% for surface course.	Hence not Satisfactory for both the Proportions.

The fly-ash aggregates formed by pelletisation technique yielded satisfactory results by considering the better values, 45:40:15 (FA: Stone Dust: Cement) ratio is selected as optimum ratio. Since even in this ratio the aggregates were not satisfactory in elongation property, the finger moulding methodology is adopted to overcome the drawback of elongation parameter. Finger moulding is a technique, where wet mix is moulded in shape of triangle by using fingers to overcome the shape factor problems of the aggregates formed by pelletisation technique and results are tabulated in table 2.

Table 2: Test Results Of Fly-Ash Aggregates For 45:40:15 Ratios Using Finger Moulding Method

Test	45:40:15	Code Specifications	Remarks
Angularity Number	11No	As per IS 2386 – part 1 – 1963, angularity number generally lies between 0 to 11.	Hence Satisfactory
Elongation Index	11.47%	As per BIS 812 Part 1, Flakiness Index < 30% for binder course and <25% for surface course.	Hence Satisfactory

Figure 1(a): fly –ash aggregates (pelletisation)
1(b): fly –ash aggregates (finger moulding)

5.2 Tests on Concrete With complete substitution of Conventional Aggregates with manufactured Aggregates

The Fly-ash aggregates prepared with Optimum ratio 45:40:15 (FA: Stone Dust: Cement) prepared by finger moulding are used in concrete by completely replacing

the coarse aggregates for a mix ratio of 1:1.5:3 (M20 Grade concrete) and shown in table 3.

Table 3. Comparison between concrete with complete substitution of conventional aggregates with manufactured aggregates

Sl. No	Tests On Concrete	Test on Concrete With Fly Ash Aggregates for 28 days in N/mm^2	Test on Concrete with Conventional Aggregates for 28days in N/mm^2	Remarks
1	Compressive Strength Value	19.85	20	Satisfactory
2	Split Tensile Strength Value	2.77	2 - 3	Satisfactory
3	Flexural Tensile Strength Value	2.91	3.13	Satisfactory

6. Conclusion

1) It was found that 45:40:15 ratio (FA: Stone Dust: Cement) is passing all test parameters of coarse aggregates.
2) Specific gravity of artificial fly ash aggregates is obtained to be less compared to that of conventional aggregate hence obtained light weight aggregates.
3) Physical and mechanical properties of fly ash aggregates with optimum ratio 45:40:15 (FA: Stone Dust: Cement) i.e., Impact value, Crushing value, Angularity number, Flakiness Index and Elongation Index of fly ash aggregates are within the permissible limits hence satisfactory.
4) The fly ash aggregates replaced with conventional aggregates in concrete yield good strength.
5) From the above test results and conclusions we can observe that even fly ash aggregates can also perform better in concrete as conventional aggregates.

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