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EXPERIMENTAL STUDY OF CONCRETE WITH EXCAVATED SOIL AS A FINE AGGREGATE

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Abstract - *Sand plays the important role in the production of concrete. In recent years, the ban on river sand highly impacted the construction industry. Increasing demand for sand has led to excessive mining on river sand; it develops the severe ecological imbalance. Due to the sand crisis, it is a need to find some substitute to natural river sand. In this experimental study, the fine aggregate in concrete will be fully replaced by the excavated soil. Initially, Sieve analysis was carried out for excavated soil and river sand to know the grain size distribution of materials. The mix proportion of 1:1.3:2.58 was adopted for the concrete using excavated soil. Standard test specimens were cast separately for conventional concrete and excavated soil using concrete. The compressive strength test, flexural strength test and split tensile strength test was conducted for the specimens as per IS 516(1959), IS 5816(1999) to evaluate mechanical strength properties of concrete. Comparison was made between the results of conventional concrete and excavated soil concrete. Finally, the excavated soil is found suitable for concrete.*

Key words: Concrete, Fine aggregate, Excavated soil, Testing, Mechanical properties

1. INTRODUCTION

Concrete is the most commonly used construction material in construction industry. Concrete is used for many applications such as superstructures, sub structures, waste water and water treatment facilities, parking structures, floor construction and exterior surface. Fine aggregate is the basic component for making concrete. Mining of river sand causing many problems deepening of the river courses, loosing water retaining sand strata, disturbs the aquatic life, lowering the underground water table etc. Nowadays good sand is not readily available. It is transported from long distance due to the scarcity of river sand and no guarantee for its consistent supply. So it is a time to find some substitute to natural river sand. The alternatives for river sand are granite powder, iron powder, copper slag, wood waste, fly ash, waste foundry sand, brick waste, quarry waste, crushed concrete waste etc. The idea of the investigation is to use the excavated soil available at a construction site and unused soil as a fine aggregate in concrete because this will conserve the natural resources and protect the ecological imbalance on environment. The excavated soil is taken from the Anna University campus, Tirunelveli, Tamilnadu. Concrete of 25 Mpa with mix proportion of 1:1.3:2.58 and water cement ratio of 0.4(as per IS 456: 2000) was adopted for the excavated soil concrete. Mix design was evaluated as per IS 10262:2009. Cubes, cylinders and beams were cast for conventional concrete and excavated soil concrete. The specimens were tested after 28 days of water curing to evaluate the strength of the concrete. The compression strength test, flexural strength test and split tensile strength test was conducted for the concrete specimens. The main objective of the study is to investigate the mechanical properties of excavated soil concrete.

2. EXPERIMENTAL PROGRAMME

The investigation involves with following works. It shows how the investigation was conducted and how the strength of concrete was evaluated.

2.1 Materials

The materials cement, river sand, coarse aggregate and excavated soil was used in this investigation. The ordinary Portland cement of grade 43 and crushed stone aggregates of 20 mm size were used. The specific gravity of sand and excavated soil is 2.68 and 2.52. The fineness modulus of sand and excavated soil is 2.98 and 3.434. Potable fresh water is used for making concrete.

Fig 1: River sand and Excavated soil

2.2 Sieve analysis

The grading and size of aggregates is important parameters in concrete mix. The sieve analysis was conducted to determine the particle size distribution of excavated soil and river sand. The sieve analysis test was conducted as per IS 383 (1970). The Chart 1 represents the gradation curve of soil and river sand. The graph shows that the gradation curve of excavated soil is similar to the curve of river sand. The fineness modulus of the excavated soil is 3.434 and classified in zone II grading.

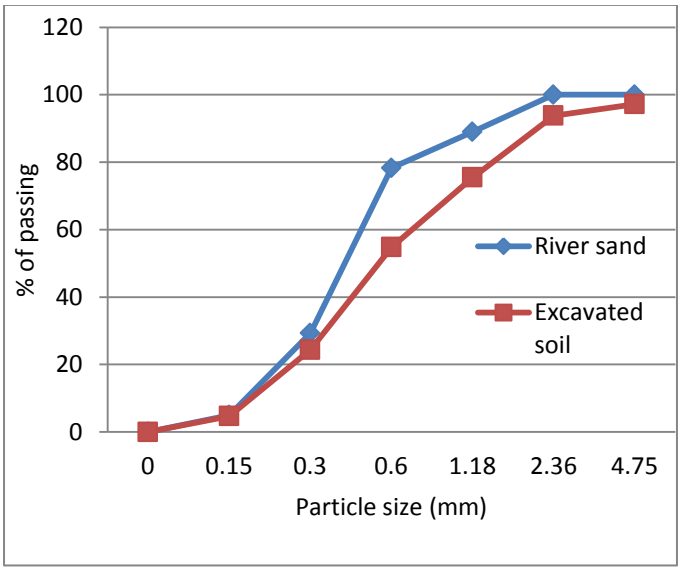

Chart – 1: Gradation curves of soil and sand

2.3 Preparation of specimens

The conventional concrete mix and excavated soil mix was prepared. In the excavated soil mix, the river sand is fully replaced by the excavated soil. The various concrete specimens based on the test and trial basis were cast for the cube of size 150 mm ×150 mm × 150 mm, cylinder of size 150mm diameter, 300 mm long and beam size of 150mm x 150 mm x 700 mm. The samples were cured by water for 28 days. After curing the specimens were taken from the water and the surface was wiped out. The testing was conducted on the various concrete specimens.

2.4 Testing of specimens

The compressive strength test, flexural strength test and split tensile strength test was conducted for normal concrete and excavated soil concrete specimens as per IS 516(1959), IS 5816(1999). Compressive strength was taken for the 7, 14 and 28 days cured cubes and it is done in compression testing machine (CTM). Split tensile strength test also done in CTM for 28 days cured cylinders. Flexural strength test was conducted for the 28 days cured beams in flexural testing machine.

3. RESULTS AND DISCUSSION

The following results will show the strength of conventional concrete and excavated soil used concrete.

3.1 Compressive strength test

The compressive strength results of various concrete specimens for 7, 14 and 28 days were shown in table 1. The average compressive strength of conventional concrete and excavated soil used concrete for 28 days is 21.92 MPa and 29.29 MPa respectively. From the graph plotted in chart 2 & 3, it is clear that the compressive strength was increased in excavated soil used concrete.

Table –1: Compression test result on concrete – Trial 1

Days	Maximum load (kN)		Compression strength (MPa)	
	Plain concrete	Excavated soil concrete	Plain concrete	Excavated soil concrete
7	470	512	20.88	22.75
14	481	615	21.37	27.33
28	490.5	653	21.8	29.02

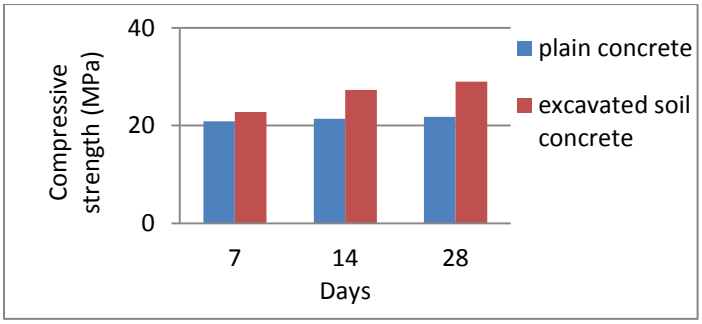

Chart – 2: Compression test results – Trial 1

Table –2: Compression test result on concrete – Trial 2

Days	Maximum load (kN)		Compression strength (MPa)	
	Plain concrete	Excavated soil concrete	Plain concrete	Excavated soil concrete
7	463	516	20.5	22.93
14	484	621	21.5	27.6
28	496	665	22.04	29.55

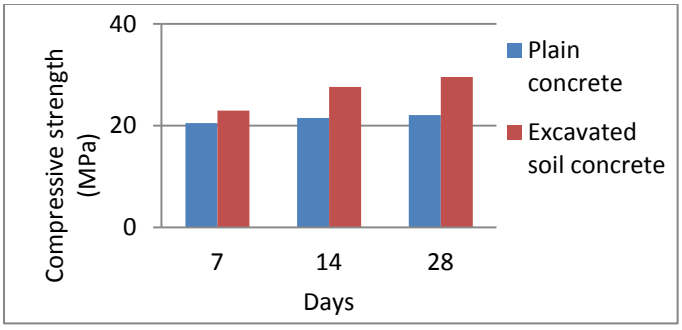

Chart – 3: Compression test results – Trial 2

Fig 2: Compression testing on cubes

3.2 Flexural strength test

The flexural strength test was taken for the 28 days cured beams. The flexural strength results for plain and excavated soil concrete are shown in table 3. The flexural strength of excavated soil used concrete is 5.33 MPa and 5.87 MPa for trial 1 and trial 2. The chart 4 shows the comparison of results taken for the normal concrete and excavated soil concrete specimens.

Table – 3: Flexural test results on concrete

Trial	Maximum load (kN)		Flexural strength (MPa)	
	Plain concrete	Excavated soil concrete	Plain concrete	Excavated soil concrete
1	25	30	4.4	5.33
2	24	33	4.27	5.87

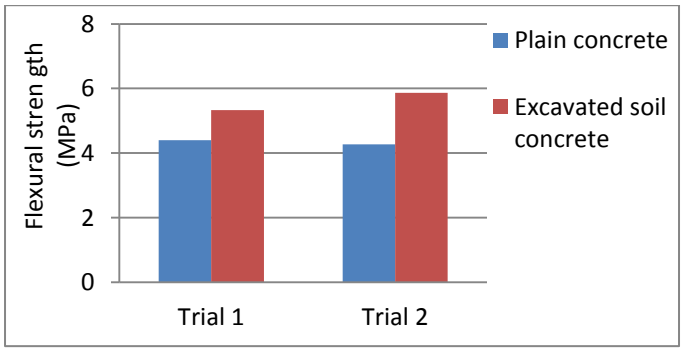

Chart – 4: Flexural test results

Fig 3: Flexural testing on beam

3.3 Split tensile strength test

The table 4 shows the split tensile strength of plain concrete and excavated soil concrete. The split tensile strength is done in compression testing machine. The average split tensile strength of plain concrete and excavated soil concrete is 2.79 MPa and 3.0 MPa. The chart 5 represents the increase in split tensile strength when using excavated soil as a fine aggregate.

Table – 4: Split tensile test results on concrete

Trial	Maximum load (kN)		Split tensile strength (MPa)	
	Plain concrete	Excavated soil concrete	Plain concrete	Excavated soil concrete
1	199.5	210.5	2.82	2.98
2	195	207	2.76	2.93

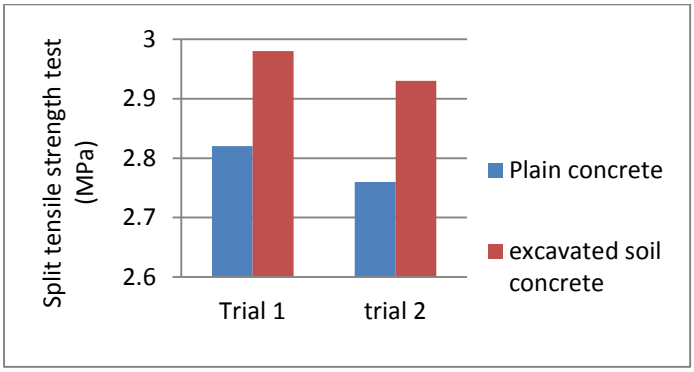

Chart – 5: Split tensile strength test results

Fig 4: Split tensile strength testing on cylinder

4. CONCLUSIONS

Based on the results of this study, the following conclusions can be made.

1. The excavated soil concrete showed good workability similar to normal concrete mixes.

2. The compressive strength of the concrete is increased when river sand is fully replaced by the excavated soil, as a fine aggregate. The increase in compressive strength is 21% compared to strength of conventional concrete.

3. The flexural strength values of excavated soil mixed concrete is 5.33 – 5.87 MPa. Excavated soil used concrete gives good significant improvement in strength.

4. The split tensile strength value of excavated soil used concrete is 3 MPa. The split tensile strength is increased 7.5% compared to strength of conventional concrete.

5. From this investigation, the excavated soil gives good mechanical strength in concrete. Durability is important for the use of this material and will be investigated in a future study.

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