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Experimental Study on Effect of Silt content on the Strength of Concrete

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Abstract
This research work is aimed at establishing the percentage at which silt content in river bed fine sands are not suitable for concrete work. Fine aggregate samples were collected from different locations within namely: Manjara, yejagi& crushed. The percentage silt and clay content present in each sample was examined to be 6.5%, 7.33% and 9%. Afterwards, 18 concrete cube samples of 150 x 150 x 150 mm dimension and 18 beams of size 150 x 150 x 150 mm were cast using a 1: 1.65:2.24 mix ratio and water - cement ratio of 0.42 and cured for 7 and 28 days prior to crushing. In addition, the average compressive strength results of the samples were established. Thereafter, to determine the percentage of silt content not fit for concrete works, samples were thoroughly washed and dried to zero moisture content and thereafter, 18 concrete cube samples of 150 x 150 x 150 mm dimension and 18 beams of size 150 x 150 x 150 mm were cast using a 1: 1.65:2.24 mix ratio and water - cement ratio of 0.42 and cured for 7 and 28 days. From the study, the percentage at which silt content in river bed fine sands is not fit for engineering uses which having more than 8% silt content.
Keywords: *Silt/clay, Fine aggregates, Concrete strength, Compressive strength.*

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I. INTRODUCTION

Silt is granular material of a size between sand and clay, whose mineral origin is quartz and feldspar. Silt may occur as a soil (often mixed with sand or clay) or as sediment mixed in suspension with water (also known as a suspended load) and soil in a body ofwater such as a river. It may also exist as soil deposited at the bottom of a water body, like mudflows from landslides. Silt has a feel. Silt usually has a floury feel when dry, and a slippery feel when wet. Silt can be visually observed with a hand lens.Silt particles range between 0.0039 and 0.0625 mm, larger than clay but smaller than sand particles. ISO 14688 grades silts between 0.002 mm and 0.063 mm. In actuality, silt is chemically distinct from clay, and unlike clay, grains of silt are approximately the same size in all dimensions; furthermore, their size ranges overlap. Clays are formed from thin plate-shaped particles held together by electrostatic forces, so present cohesion. According to the U.S. Department of Agriculture SoilTexture Classification system, the sand-silt distinction is made at the 0.05 mm particle size. The USDA system has been adopted by the Food and Agriculture Organization (FAO). In the Unified Soil Classification System (USCS) and the AASHTO Soil Classification system, the sand-silt distinction is made at the 0.075 mm particle size (i.e., material passing the #200 sieve). Silts and clays are distinguished mechanically by their plasticity.

II. AIM AND OBJECTIVES

- To study the amount of silt, clay or other fine dust that may be present in a sand sample (FA).
- To study the strength of concrete in presence of silt.
- To study the Feasibilty of Fine Aggregate in concrete and to conduct following test :
  - Compressive Test
  - Flexural test
- To Investigate and study the strength of concrete of different types fine Aggregate and compare its strength.

III. MATERIALS AND METHODS

Cement: Portland cement was used for this research work and it was found to confirm with the requirements of BS EN 197-1(2000).
Water: The water used for this work is potable, clean and free from any visible impurities. It confirmed to BS EN 1008(2000).

Coarse aggregates: Granites were used for this work of size 20 mm. They are free from debris and other impurities. They are angular in shape.

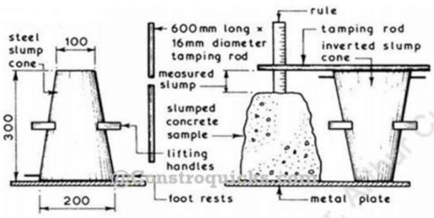
Fig. 2 Coarse Aggregate

Fine Aggregates: The fine aggregates used were sourced from five different locations within AdoEkiti, Ekiti State. One of the sources is a quarry site within Ado-Ekiti, the fine aggregates from quarry is stone dust with 0% of silt/clay content.

Fig. 3 Fine Aggregate

The following tests carried out on these materials are sieve analysis, slump test and compressive strength. The procedure used in carrying out the tests conformed to that of British Standard 1881, parts 108 and 116.

Slump Test : Slump refers to the measure or an indicator of workability of concrete. It is the most widely Lown lest to evaluate the workability of fresh concrete which is inexpensive and simple to perform. The workability of the fresh concrete was measured using the standard apparatus for each mix in all the series in order to show the concrete consistency.



Compressive Strength Test

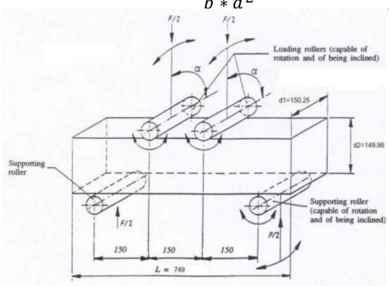
The compressive strength of concrete is one of the most important and useful properties of concrete. The primary purpose for design concrete is to resist compressive strength in structural members. Hence it is the role of a concrete designer to specify the expected characteristics strength of concrete/mix proportion to enable it resist external force. Concrete cubes produced from unwashed and washed fine aggregates samples with the same coarse aggregates, cement and water ratio were subjected to this test to determine variation in strength as regards the different percentage of silt and clay present in unwashed samples fine aggregates and partial replacement of washed fine aggregate with processed silt and clay, to determine silt and clay tolerance limit in concrete. The concrete cubes were cured by immersion in water. The concrete cubes were crushed using Universal testing machine.

$$F = \frac{P}{A^2}$$

Fig CTM

Flexural Strength Test
Flexural strength test is an indirect method often used to determine the tensile strength of concrete. It is often expressed as concrete modulus of rupture. Specimens were tested to failure using universal testing machine shown in figure 28-day curing age respectively.

$$Fcf = \frac{P * L}{b * d^2}$$



Sieve Analysis
The process of dividing a sample of aggregate into fractions of same particle size is known as sieve analysis. The purpose is to determine the grading of size distribution of the aggregate. In practice each fraction contains particles between the openings of the standard test sieves. The grading of aggregates is expressed in terms of percentages by weight retained on a series of sieves. Test sieves used for concrete aggregates have square openings and described by the size of the opening.

IV. RESULT AND DISCUSSION

So following table shows the percentage of silt content :

1) Manjara Sand Sample :

Description	Sample		
	Sample - 1	Sample - 2	Sample - 3
Volume of Sample V_1 (ml)	100	100	100
Volume of Silt after 3 hrs V_2 (ml)	6	7	6.5
% of Silt By Volume = $(V_2/V_1)*100$	6	7	6.5

Table Silt Content for Manjara Sand

Avarage of Silt Content in Manjara Sand : **6.5 %**

2) Yejagi Sand Sample :

Description	Sample		
	Sample - 1	Sample - 2	Sample - 3
Volume of Sample V_1 (ml)	100	100	100
Volume of Silt after 3 hrs V_2 (ml)	7	7.5	7.5

% of Silt By Volume = $(V_2/V_1)*100$	7	7.5	7.5

Table Silt Content for Yejagi Sand

Avarage of Silt Content in Yejagi Sand : **7.33 %**

3) Crushed Sand Sample :

Description	Sample		
	Sample - 1	Sample - 2	Sample - 3
Volume of Sample V_1 (ml)	100	100	100
Volume of Silt after 3 hrs V_2 (ml)	9	9.5	9
% of Silt By Volume = $(V_2/V_1)*100$	9	9.5	9

Table Silt Content for Crushed Sand

Avarage of Silt Content in Crushed Sand : **9 %**

Following tables shows the compressive strength of concrete for 7days and 28days:

1) Compressive Strength of Manjara Sand :

Day	Cube (Compressive Strength) Mpa	
	Without Silt	With Silt
7 Days	23.36	22.24
28 Days	34.46	33.29

TableCompressive Strength of Cube (Manjara)

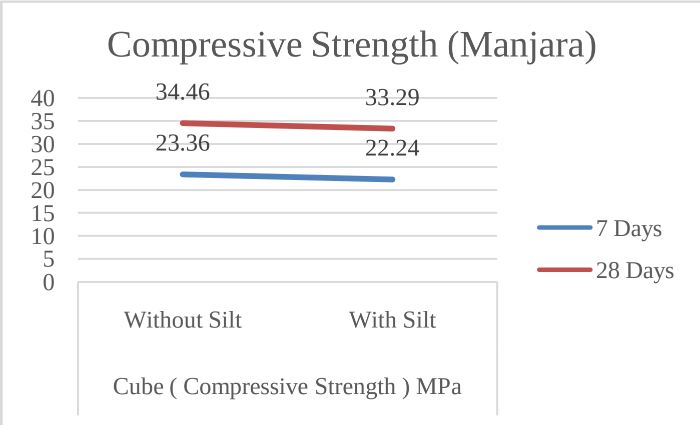


Fig Line chart of CS of Cube (Manjara)

2) Compressive Strength of Yejagi Sand :

Day	Cube (Compressive Strength) MPa	
	Without Silt	With Silt
7 Days	22.15	21.68
28 Days	33.52	32.23

TableCompressive Strength of Cube (Yejagi)

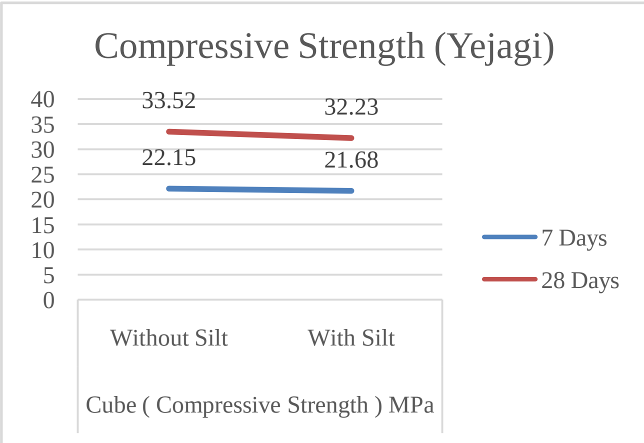


Fig Line chart of CS of Cube (Yejagi)

3) Compressive Strength of Crushed Sand :

Day	Cube (Compressive Strength) MPa	
	Without Silt	With Silt

7 Days	21.22	20.92
28 Days	32.34	31.50

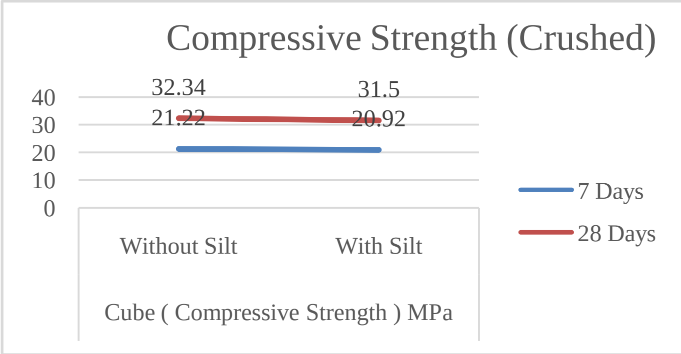


Table Compressive Strength of Cube (Crushed) **Fig** Line chart of CS of Cube (Crushed)

Following table shows the test results conducted on beams :

1) Flexural Strength of Manjara Sand :

Day	Beam (Flexural Strength)	
	Without Silt	With Silt
7 Days	3.5	3.2
28 Days	4.9	4.8

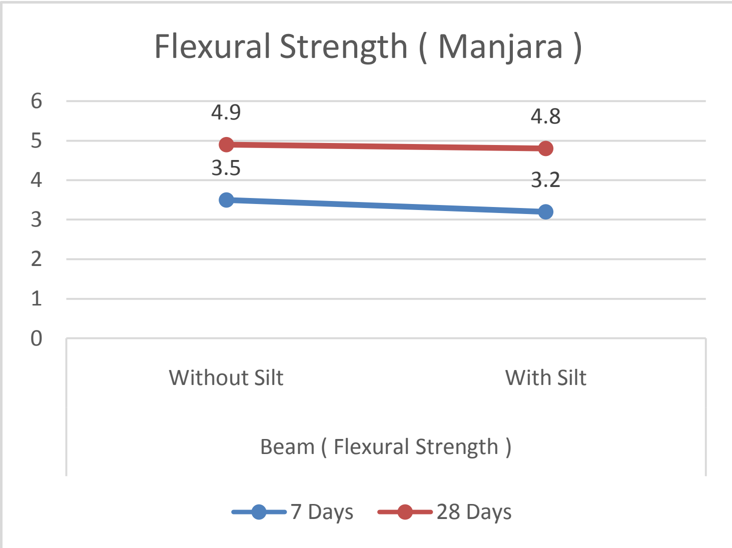


Table Flexural Strength of Beam (Manjara)

Fig Line Chart of FS of beam (Manjara)

2) Flexural Strength of Yejagi Sand :

Day	Beam (Flexural Strength)	
	Without Silt	With Silt
7 Days	2.9	2.8
28 Days	4.5	4.2

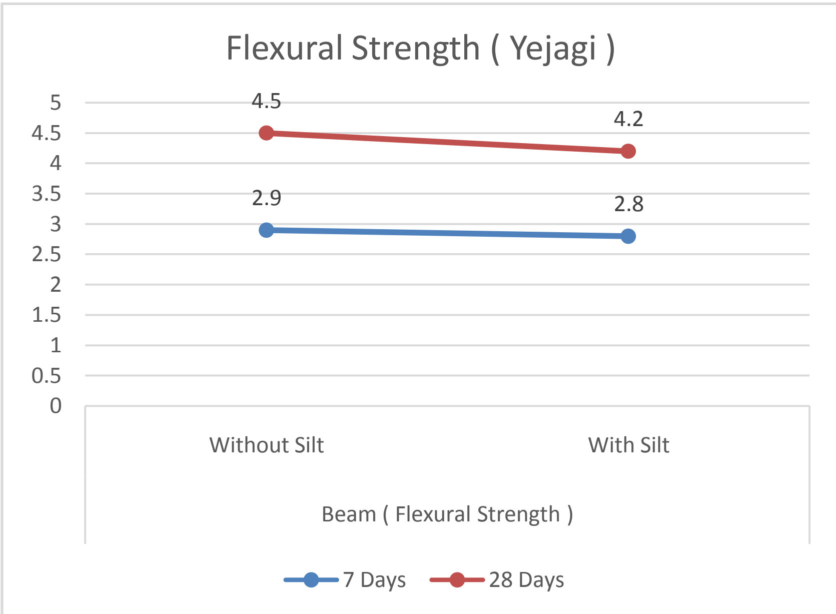


Table Flexural Strength of Beam (Yejagi)

Fig Line Chart of FS of beam (Yejagi)

3) Flexural Strength of Crushed Sand:

Day	Beam (Flexural Strength)	
	Without Silt	With Silt
7 Days	2.9	2.5
28 Days	4.1	4.0

Table Flexural Strength of Beam (Crushed)

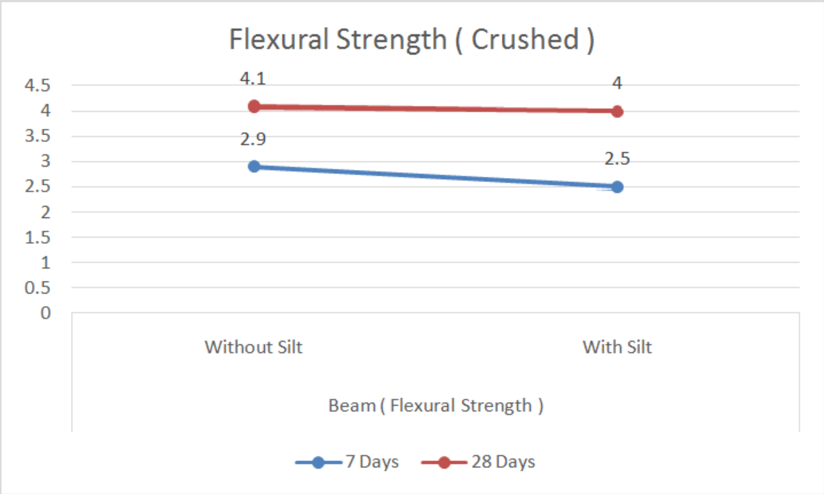


Fig Line Chart of FS of beam (Crushed)

V. CONCLUSION

1) Experimental investigation is done by taking different types of sand& checked percentage of silt content and check the following types of strengths :

A) Manjara sand available silt content is 6.5% whose :

- Compressive strength at 7 days is 22.24 MPa with silt content as compare to without silt content is 23.26 MPa. So it is observed that strength of with silt content sand is decreased by **4.1%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.
- Compressive strength at 28 days is 33.29 MPa with silt content as compare to without silt content is 34.46 MPa. So it is observed that strength of with silt content sand is decreased by **3.4%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.
- Flexural strength at 7 days is 3.2 MPa with silt content as compare to without silt content is 3.5 MPa. So it is observed that strength of with silt content sand is decreased by **6.1%** as Compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.
- Flexural strength at 28 days is 4.8 MPa with silt content as compare to without silt content is 4.9 MPa. So it is observed that strength of with silt content sand is decreased by **2.1%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.

B) Yejagi sand available silt content is 7.33% whose :

- Compressive strength at 7 days is 21.68 MPa with silt content as compare to without silt content is 22.15 MPa. So it is observed that strength of with silt content sand is decreased by **2.2%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.
- Compressive strength at 28 days is 32.23 MPa with silt content as compare to without silt content is 33.52 MPa. So it is observed that strength of with silt content sand is decreased by **3.8%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.
- Flexural strength at 7 days is 2.8 MPa with silt content as compare to without silt content is 2.9 MPa. So it is observed that strength of with silt content sand is decreased by **3.2%** as Compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.
- Flexural strength at 28 days is 4.2 MPa with silt content as compare to without silt content is 4.5 MPa. So it is observed that strength of with silt content sand is decreased by **3.7%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.

C) Crushed sand available silt content is 9% whose :

- Compressive strength at 7 days is 20.92 MPa with silt content as compare to without silt content is 21.22 MPa. So it is observed that strength of with silt content sand is decreased by **2.4%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.
- Compressive strength at 28 days is 31.50 MPa with silt content as compare to without silt content is 32.34 MPa. So it is observed that strength of with silt content sand is decreased by **2.9%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.
- Flexural strength at 7 days is 2.5 MPa with silt content as compare to without silt content is 2.9 MPa. So it is observed that strength of with silt content sand is decreased by **6%** as Compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.

- Flexural strength at 28 days is 4.0 MPa with silt content as compare to without silt content is 4.1 MPa. So it is observed that strength of with silt content sand is decreased by **2.4%** as compare to without silt content sand by using w/c = 0.42 & a/c = 3.89.

2) Compressive Strength at 7 days of Manjara sand is 23.36 MPa , Yejagi sand is 22.15 MPa & Crushed Sand is 21.22 MPa. On comparing strengths, Manjara sand has **6.1%** greater than Yejagi & Yejagi sand has **4.2%** greater than Crushed sand.

Compressive Strength at 28 days of Manjara sand is 34.46 MPa , Yejagi sand is 33.23MPa & Crushed Sand is 32.34 MPa. On comparing strengths, Manjara sand has **6.5%** greater than Yejagi & Yejagi sand has **2.8%** greater than Crushed sand.

3) Flexural Strength at 7 days of Manjara sand is 3.5 MPa , Yejagi sand is 2.9 MPa & Crushed Sand is 2.9 MPa. On comparing strengths, Manjara sand has **8%** greater than Yejagi & Yejagi sand has same as Crushed sand.

Flexural Strength at 28 days of Manjara sand is 4.9 MPa , Yejagi sand is 4.5 MPa & Crushed Sand is 4.1 MPa. On comparing strengths, Manjara sand has **8.2%** greater than Yejagi & Yejagi sand has **9.6%** greater than Crushed sand.

4) So we conclude that fine aggregate having silt content 0 - 9% whose strength is more than 30 MPa which satistfy the condition of concrete mix design of M30 & it is suitable for use.

5) When we compare fine Aggregates, we got the result that Manjara sand has less silt content than Yejagi & Crushed sand **6.5%< 7.33% < 9%**.

6) On Comparison of Strengths of concrete we Conclude that the strength of Manjara Sample is more than Yejagi and crushed sand i.e **(34.46 > 33.52 > 32.34) MPa** and **(4.9 > 4.5 > 4.1) MPa.**

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