Study on Strength of Concrete by Partial Replacement of Fine Aggregate with M-Sand and Laterite with Super plasticizers

Biju Mathew[#1], Dr Freeda Christy C[*2], Souyma C [#3], Dr. Benny Joseph

[#1]*Reserach Scholar, Karunya University and HOD, Vimal Jyothi Engineering college , Kerala , India*
**2 Associate profeesor, school of civil engineering, Karunya University, Coimbatore, India*
**3 P.G student, Department of civil Engineering, Vimal Jyothi engineering college , Chemperi*
**4 Principal, Vimal Jyothi engineering College, Chemperi, Kannur, Kerala , India*

Abstract: *This paper presents a study conducted to determine the suitability of partial replacement of sand with laterite soil and manufactured sand in M20 grade concrete. The first phase is to find the maximum percentage of sand can replace with lateritic soil and manufactured sand for both M20 grade concrete. Concrete mixes containing 0,10,20,30, 40% sand replacement levels were cast, with super plasticizer. Split tensile strength, compressive strength test and flexural strength were conducted in accordance to the existing standard. Results show maximum of 20% replacement levels of sand by laterite attained workable concrete with satisfactory strength beyond that lateritic concrete is not workable And 40% replacement of sand by manufactured sand shows maximum strength. Mix proportion is taken as 1:1.5:3 based on the design result.*

Keywords- *Laterite, Manufactured sand, Fine aggregates, Super plasticizers.*

I. INTRODUCTION

The global consumption of natural sand is very high, due to the extensive use of concrete[1]. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructural growth, in this situation developing country like India facing shortage in good quality natural sand. Particularly in India, natural sand deposits are being depleted and causing serious threat to environment as well as the society[1]. On this basis, manufactured sand offers viable alternative. It is purpose made fine aggregate produced by crushing and screening or further processing i.e. washing, grading, classifying of quarried rock, cobbles, boulders or gravels from which natural fine aggregate had been removed[2].

Natural sand (Fine aggregate), which is one of the constituents used in the production of concrete, has become expensive and scarce[1]. So there is large demand for alternative materials[2]. This soil is readily available in Malabar area and constitutes one of the locally and readily available material[5]. Its neglect as a structural engineering material in associated with the uncertainty of its strength and other structural characteristics[5]. In India they cover a total area of about 248,000 sq. kilometers. Laterite has been used in building construction for thousands years and approximately 30% of the world's present population still lives in laterite[2]. In Kerala -more than 60% of the state is covered by laterite blanket over various crystalline rocks.

In past decade the use of natural sand as fine aggregate are increases the cost of construction[7]. In this situation research began for inexpensive and easily available alternative material to natural sand[6]. Some alternatives materials have already been used as a part of natural sand e.g. fly ash; slag limestone and siliceous stone powder were used in concrete mixtures as a partial replacement of natural sand. However, scarcity in required quality is the major limitation in some of the above materials[8]. Now a day's sustainable infrastructural growth demands the alternative material that should satisfy technical requisites of fine aggregate as well as it should be available abundantly[6].

There are several local materials are available to use instead of natural sand. One such material is the fines of laterite (particle sizes < 10mm) known to have some similar physical characteristics as conventional sand[1].

II MATERIALS

A. *Cement*

Ordinary Portland cement of 53 grade is used for this study. The standard consistency, initial and final setting time, and compressive strength are determined from the laboratory tests.

Table 1 Properties of Cement

Properties	Observation
Fineness	3%
Standard consistency	33%
Initial setting time	55 minute
Final setting time	420 minute
Specific gravity	3.16

Compressive strength (7 day)	36.33 pa

B. Fine aggregate

Fine aggregates can be natural or manufactured. The grading must be uniform throughout the work[3]. The moisture content or absorption characteristics must be closely monitored. Particles smaller than 0.125 mm i.e. 125 micron size are considered as fines which contribute to the powder content[4]. A minimum amount of fines (arising from the binders and the sand) must be achieved to avoid segregation.River sand confirming to IS: 2386-1975 is used.

Table 2 Properties of fine aggregate

Properties	Observation
Fineness	2.34
Water absorption	1.92
Moisture content	0.657

C. Manufactured sand

Table 3 Properties of manufactured sand

Properties	Observation
Fineness	2.88
Water absorption	8.16%

D. Coarse aggregate

The maximum size of coarse aggregate is generally limited to 20 mm. Aggregate of size 10 to 12mm is desirable for structures having congested reinforcement[3]. As with conventional concrete construction, the maximum size of the coarse aggregate depends upon the type of construction[5]. Wherever possible, size of aggregate higher than 20mm could also be used. Well graded cubical or rounded aggregates are desirable. Aggregates should be of uniform quality with respect to shape and grading.

Table 4 Properties of coarse aggregate

Properties	Observation
Fineness	7.33
Water absorption	.4 %
Moisture content	1.01%
Specific gravity	2.84

E. Super Plasticizer

Super plasticizer is essential .The job of SP is to impart a high degree of flow ability and deformability; however the high dosages generally associate with SCC can lead to a high degree of segregation. Super plasticizer is a chemical compound used to increase the workability without adding more water i.e. spreads the given water in the concrete throughout the concrete mix resulting to form a uniform mix. SP improves better surface expose of aggregates to the cement gel. Super plasticizer acts as a lubricant among the materials. Generally in order to increase the workability the water content is to be increased provided a corresponding quantity of cement is also added to keep the water cement ratio constant, so that the strength remains the same.

III EXPERIMENTAL INVESTIGATION AND RESULTS

A Compression Test of concrete cubes

For each percentage of sand replacement mix three cube specimens, each of size 150mm×150mm×150mm were tested according to the IS 516:1959 specifications, on 7th& 28th day of casting and the values obtained The reduction in strength is justified as, when the percentage of laterite in the particular mix increases, the workability is affected, aggregate has lower stiffness and more porous compared to granite aggregate. This factor causes lower bonding strength between aggregate and cement as well as increase water requirement for workable concrete which in turn reduce the ability of concrete to sustain larger load[10]. Maximum of 20% replacement levels of sand by laterite attained workable concrete with satisfactory strength without super plasticizer. With addition super plasticizer up to 40% replacement of sand with laterite got minimum compressive strength

Table 5 compressive strength test results

	Laterite		M.sand	
Replacement of sand (%)	7 days N/mm^2	28 days N/mm2	7 days N/mm2	28 days N/mm2
0	14.44	22.47	19.5	26.33
10	14.44	22.47	19.5	26.53
20	11	20	18.9	25
30	21.1	27.1	21.1	27.1
40	13.09	22.18	18	28.12
50	12.9	21.35	24.8	35

Fig.1 cube specimen

B. Split tensile strength

The splitting tests are well known indirect tests used for determining the tensile strength of concrete sometimes referred to as split tensile strength of concrete[9]. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. Due to the compression loading a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter as obtained from an elastic analysis[10].

Tensile stress= $2P/\pi dl$

Table 6 split tensile strength test results

	Laterite		M..sand	
Replacement of sand (%)	7 days N/mm^2	28 days N/mm2	7 days N/mm2	28 days N/mm2
0	2.84	4.24	2.98	3.7
10	2.5	5.9	1.3	1.8
20	3.96	7.96	1.8	2.4
30	2.81	3.98	3.25	4.24
40	2.91	5.8	3.96	5.8
50	2.84	4.24	2.98	3.7

Fig.2 cylinder specimen

C. Flexural strength test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of unreinforced concrete beam or slab to resist failure in bending. It is measured by loading concrete beams with a span length at least three times the depth. The flexural strength is expressed as Modulus of Rupture and is determined by standard test methods.

Table 3.1.3 .Flexural Strength Test results

	Laterite		M.sand	
Replacement of sand (%)	7 days N/mm^2	28 days N/mm2	7 days N/mm2	28 days N/mm2
0	4.06	6.33	6.33	6.15
10	3.56	5.4	5.4	4.4
20	5.33	8	8	5.56
30	2.9	6.8	4.8	6.06
40	2.4	4.8	6.8	8
50	2.38	4.20	6.4	7.8

Fig.3 beam specimen

Conclusion

The main objective of the present investigation to experimentally study the maximum amount of sand can replace with laterite fine aggregate and manufactured fine aggregate for M20 grade concrete The fresh and hardened properties of laterized concrete as well as manufactured concrete specimens were also studied and compared the results with that of ordinary concrete

- The compressive strength with 20% replacement of natural sand by laterite sand reveals higher strength.
- The split tensile strength with 20% replacement of natural sand by laterite sand reveals higher strength.
- The flexural strength with 20% replacement of natural sand by laterite sand reveals higher strength.
- hence overall strength of M20 grade concrete increases with 20% of natural sand by laterite sand
- The compressive strength with 40% replacement of natural sand by manufactured sand reveals higher strength
- The split tensile strength with 40% replacement of natural sand by manufactured sand reveals higher strength
- The flexural strength with 40% replacement of natural sand by manufactured sand reveals higher strength

REFERENCE

[1] Asiedu Emmanuel, Agbenyega Allan (2014) "Suitability of Laterite Fines as a Partial Replacement for Sand in the Production of Sandcrete Bricks**".** ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 10

[2] A.Jayaraman , 2013). "Experimental Study on Partial Replacement of Natural Sand with M- Sand and Cement with Lime Stone Powder". International Journal of ChemTech Research Vol.6, No, April-June 2014

[3] A.Jayaraman1, V.Senthilkumar2, M.Saravanan(2012) "compressive and tensile strength of concrete using lateritic

sand and lime stone filler as fine aggregate". IJRET: International Journal of Research in Engineering and Technology, Department of Civil Engineering Bannari Amman Institute of Technology, Sathamangalam-638401, India

[4] Joseph O. Ukpata, Maurice E.Ephraim and GodwinA. Akeke.(2012). "Compressive strength of Concrete using Lateritic Sand and Quarry Dust as Fine Aggregate."Arpn Journal of Engineering and Applied Sciences, Junuary 2012.Volume 7,No.1.

[5] Kasthurba. A. K, (2012) "Characteristics of Malabar Laterite as a Building Material Field and Laboratory Studies". International journal of earth secience. ISSN 0974-5904, Volume 05, No. 03 (01)

[6] Khairunisa Muthusamy, Norul Wahida Kamaruzaman, Saffuan Wan hmad and Fadzil Mat Yahaya(2015**)** "Effect Study on Durability Performance of Concrete Containing Laterite Aggregate."vol 6 (2) – june 2015

[7] Priyanka A. Jadhava and Dilip K. Kulkarni(2008) "An experimental investigation on the properties of concrete containing manufactured sand." International Journal of Advanced Engineering Technology E-ISSN 0976-3945

[8] Stefania Grzeszczyk ,Piotr Podkowa,(2009) "The Effect of Limestone Filler on the Properties of Self Compacting Concrete". Annual transactions of the nordic rheology society, vol. 17, 2009

[9] T.PhaniMadhavi, .Sampathkumar, P.Gunasekaran(2005): " Partial replacement of cement and fine aggregate by using fly ash and glass aggregate". IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163

[10] T.Shanmugapriya, R.N.Uma,(2012)."Optimation of Partial Replacement of M-Sand by Natural sand in High Performance Concrete With Silica Fume." International Journal of Engineering Sciences & Emerging Technologies, June 2012.Volume 2, pp:73.-80 , IJESET