International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

PARTIAL REPLACEMENT OF COARSE AGGREGATE BY USING CRUSHED LATERITE STONES IN CONCRETE

Jaseem AC.[1], Muhammed Shuhail MC.[2], Muhammed Mirshad P.[3], Mubeen TP.[4]

Vidyadhar N.[5]

[1,2,3,4] *UG Student, Dept. of Civil Engineering, Anjuman Institute of Technology and Management Bhatkal, Karnataka, India*

[5] *Assistant Professor, Dept. of Civil Engineering, Anjuman Institute of Technology and Management Bhatkal, Karnataka, India*

Abstract - *Concrete is one of the oldest manufactured construction material used in construction of various structures around the world. The increasing utilization of natural aggregate for concrete production has created negative impact towards environment. Thus, investigation on searching for alternative material which has potential to replace the use of coarse aggregate in concrete mix is very much in need. Laterite stone is the most abundant material in some of the hot and wet tropical areas. Coarse aggregates were replaced by crushed laterite stone as 0%, 10%, 20% and 30% by weight. The concrete specimens were tested for compressive strength, splitting tensile strength and flexural strength at 7,28 days of age respectively and the results obtained were compared with those of normal concrete. From this study it is recommended that 30% lateritic aggregate is adequate for partial replacement of coarse aggregate in concrete production for structural lightweight concrete.*

1. INTRODUCTION

The escalating demand from construction industry for concrete production has results in increase of granite aggregate supply from the local quarries which poses the risk for this material to deplete in future. Furthermore, continuous increase of quarrying activities would cause destruction of the habitat for flora and fauna and also reduction of groundwater quality thus giving negative impact to the environment and community. The possible threat of aggregate depletion has been pointed out by a local researcher, extensive use of granite aggregate in construction would disturb the environment and eventually run out this country's granite supply. Therefore, integrating other alternative material as partial replacement of granite aggregate in concrete making is anticipated as one of the approach to reduce the high consumption of granite by concrete industry.

Concrete is one of the oldest manufactured construction material used in constructing of various structures around the world and the most widely used in all types of civil engineering works, including infrastructure, low and high-rise buildings, defence installations, environment protection and local/domestic developments. It is a construction material obtained by mixing a binder (such as cement, lime, mud etc.), aggregate (sand and gravel or shingle or crushed aggregate), and water in certain proportions. Concrete is generally made of aggregate, cement and water. Through this combination of materials, approximately 70 to 80 percent of the volume of concrete is occupied by the aggregate. The aggregate itself is categorized as fine and coarse aggregate. Aggregates for concrete may be obtained from natural sources or may be artificially produced. Since concrete is the most important part in structural construction, the aggregate content should be in a form of good strength for structural purposes. Naturally aggregates have a pronounced influence on the properties of fresh as well as hardened concrete. Concrete is classified in terms of the type and composition of aggregate used. Presently the crushed granite aggregate and river sand concrete system are generally regarded as the conventional concrete.

This paper presents the results of concrete mix with partial replacement of coarse aggregate by laterite stone. The replacement of normal aggregate with lateritic aggregate has influence on engineering properties of concrete. The study discovered that replacement of 10 lateritic aggregate can produce lateritic concrete exhibiting comparable strength with normal concrete. However replacement of lateritic aggregate up to 30 was able to produce lateritic concrete exhibiting the targeted strength of 25 N/mm2. The use of lateritic as partial replacement of coarse aggregates in the concrete resulted in specimens with reduced workability, the workability reduced with increasing addition of lateritic aggregate in the mix. It is possible that some of the mixing water necessary to sustain the strength forming hydration process may have been entrapped or absorbed by the lateritic. The result of the two way analysis of variance also shows that lateritic aggregate and curing age has significant effect on the compressive strength of concrete. From this study it is recommended that 30% lateritic aggregate is adequate for partial replacement of coarse aggregate in concrete production for structural lightweight concrete.

1.1 Objective and Scope of the study.

Following are the objectives of our experimental study.

- To study the properties of fresh concrete by using lateritic aggregates of 10,20,30,40 and 50 % by weight of Coarse aggregate.
- To study the strength properties of hardened concrete by using lateritic aggregates of 10,20,30,40 and 50 % by weight of Coarse aggregate after 7, 28 days curing period.
- To reduce the use of granite aggregates.
- To reduce the overall costs of Construction.
- To produce light weight concrete.
- Sustainable management of natural resources.

2. LITERATURE REVIEW

Many researches on partial replacement of coarse aggregate using laterite aggregate in concrete are done and they have studied the properties of laterite aggregate concrete. Among these some of the important research findings are discussed.

Babitharani H, Amit Gavali. (2019) They performed an experimental study on concrete with laterite aggregate. They concluded that due to rough surface of aggregate, the bonding between cement paste and aggregate will be better and it will effect on the strength and high water required compared with smooth surface of laterite aggregate. The compressive strength of concrete with aggregate was higher than compressive strength of concrete with laterite aggregate, which may be due to the less strength of the laterite aggregate as compared to the natural granite aggregate. The compressive strength of concrete with 10% laterite aggregate (13.69 N/mm2) was relatively the same compared with crushed granite concrete (15.44 N/mm2).

Afolayan. (2019) They carried out an experimental investigation on concrete mixed with laterite aggregates. They observed that the replacement of normal aggregate with lateritic aggregate has influence on engineering properties of concrete. This study discovered that replacement of 10% lateritic aggregate can produce lateritic concrete exhibiting comparable strength with normal concrete. However, replacement of lateritic aggregate up to 30% was able to produce lateritic concrete which met the requirement for use as structural light weight concrete. Which is between 21 – 35 N/mm2 at 28 days of Curing and also the targeted grade strength is 25 N/mm2. The use of lateritic aggregate as partial replacement of coarse aggregates in the concrete resulted in specimens with reduced workability.

Sachin. K. C (2019) They studied the compressive strength of concrete mixed with lateritic aggregates. From this study it was observed that compressive strength initially increases with replacement of coarse aggregate by laterite up to 20% of replacement of laterite is 48.63 N/mm2 (28 Days) and after that there is decrease in compressive strength of concrete as the mix became less cohesive and less workable. And the durability test results indicate that the percentage change in strength and the increase or decrease in weight of the specimen is reasonable for 20% replacement which is due to porous structure of laterite.

M. Venkata Rao. (2016) They studied the results of concrete mix with partial replacement of fine aggregate by quarry dust and simultaneous partial replacement of coarse aggregate by laterite stone aggregate respectively on compressive strength, split tensile strength, flexural strength and workability of concrete. Concrete mixes containing 0%, 10%, 20%, 25 % and 30%, replacement by weight of fine aggregate with quarry dust and simultaneously 25% replacement of coarse aggregate by weight with laterite stone were casted in lab and checked for compressive strength(43.71 MPa, 28 days), split tensile strength (2.73 MPa) ,flexure strength (3.40 MPa). However, replacement of lateritic aggregate up to 30% was able to produce lateritic concrete exhibiting the targeted strength of 25 N/mm2. So by using this as a replacing material we can reduce the cost of construction.

Norul Wahida Kamaruzaman (2012) They studied the engineering properties of concrete containing laterite aggregate as partial coarse aggregate replacement. Granite aggregate has been replaced by 10, 20, 30, 40 and 50% with laterite aggregate. All the specimens were subjected to water curing until it is ready to be tested. Tests on compressive strength, flexural strength and modulus of elasticity were carried out at the age of 7, 14, 28 and 60 days. The results revealed that replacement of laterite aggregate up to 30% able to produce laterite concrete exhibiting the targeted strength which is 30 MPa.

3. MATERIALS

The materials used in this work are The Ordinary Portland cement, fine aggregate, coarse aggregate (20mm downsize), laterite aggregate (20mm downsize).

3.1 Cement

Ordinary Portland cement (simply called ordinary cement) refers to the hydraulic binding material ground by mixing Portland cement clinker, 6% ~ 15% blended materials, and appropriate amount of gypsum. The Ordinary Portland cement 43 Grade is used (Accordance with IS: 12269-1987).

Table 1. Properties of cement

Normal Consistency %	32%
Initial Setting time (min)	135 min
Final Setting time (min)	247 min
Specific Gravity	3

3.2 Fine aggregate

River sand is used as fine aggregate in many cases because it is free from impurities and it also has good property to use as fine aggregate. (The fine aggregate used conforms to zone II, accordance with IS: 383-1970).

Table 2. Properties of fine aggregate

Moisture content %	3.3 %
Specific Gravity	2.58

3.3 Coarse aggregate

Coarse Aggregate are particles greater than 4.75mm IS sieve. In this study, coarse aggregate of 20mm down size are used. Coarse aggregate shall consist of naturally occurring materials such as gravel, or resulting from the crushing of parent rock, to include natural rock, slags, expanded clays and shales (light weight aggregate) and other approved inert materials with similar characteristics, having hard, strong, durable particles, conforming to the specific requirements of this section. The coarse aggregate used in gravel which is obtained locally.

Table 3. Properties of coarse aggregate

Aggregate crushing value %	24.24 %
Water absorption %	1.6%
Specific Gravity	2.68

3.4 Laterite aggregate

Laterite is a highly weathered material rich in secondary oxides of Iron, Aluminium or both. It is nearly devoid of base and primary silicates but may contain large amount of quarts, and Kaolinite. Laterite has been used for wall construction around the world. It is cheap, environmentally friendly and abundantly available building material in the tropical region. They observed that the restriction of laterite building to rural areas is due to lack of accepted standard design parameters for the effective structural application of laterite concrete. Laterite aggregate is sieved in 20mm sieve and the aggregate passing through the sieve is used.

Table 4. Properties of laterite aggregate

Aggregate crushing value %	40 %
Water absorption %	6%
Specific Gravity	2.48

4. RESULTS AND DISCUSSION

The study discovered that replacement of 10 lateritic aggregate can produce lateritic concrete exhibiting comparable strength with normal concrete. However replacement of lateritic aggregate up to 30 was able to produce lateritic concrete exhibiting the targeted strength of 25 N/mm2. The use of lateritic as partial replacement of coarse aggregates in the concrete resulted in specimens with reduced workability, the workability reduced with increasing addition of lateritic aggregate in the mix. It is possible that some of the mixing water necessary to sustain the strength forming hydration process may have been entrapped or absorbed by the lateritic. The result of the two way analysis of variance also shows that lateritic aggregate and curing age has significant effect on the compressive strength of concrete.

4.1 WORKABILITY

For the normal range of concrete the compaction factor lies between (0.8 – 0.92). The value of compactness factor tells us that the workability of concrete is Low but the slump value tells us that the workability is Medium. This variation was due to the reason that when the first test was performed the then apparatus was not made wet which made the reading slightly more. The value of Vee Bee degree tells us that the workability of concrete is Medium.

Table 5. Workability of concrete

Water cement ratio	0.45
Slump Value (mm)	50mm
Compaction factor	0.843
Vee Bee degree	7 seconds

4.2 COMPRESSIVE STRENGTH

From this study it was observed that compressive strength initially increases with replacement of coarse aggregate by laterite up to 20% and after that there is decrease in compressive strength of concrete as the mix became less cohesive and less workable.

However, replacement of lateritic aggregate up to 30% was able to produce lateritic concrete which met the requirement for use as structural light weight concrete. Which is between 21 – 35 N/mm2 at 28 days of Curing and also the targeted grade strength is 25 N/mm2.

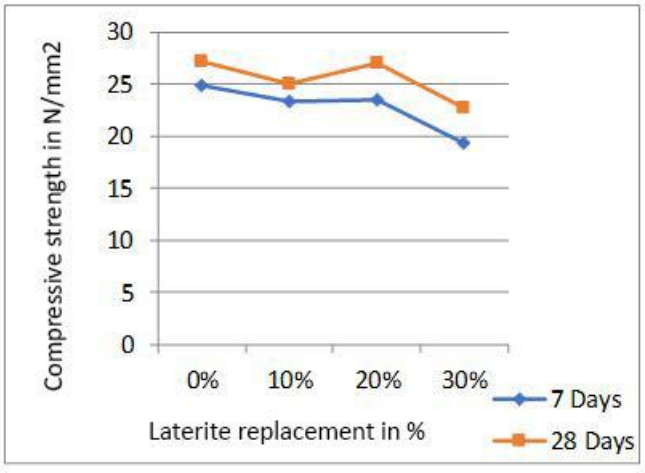


Table 6. Results of compressive strength

SL No.	Laterite %	compressive strength N/mm2	
		7 Days	28 Days
1	0%	24.84	27.23
2	10%	23.31	25.05
3	20%	23.53	27.02
4	30%	19.39	22.66

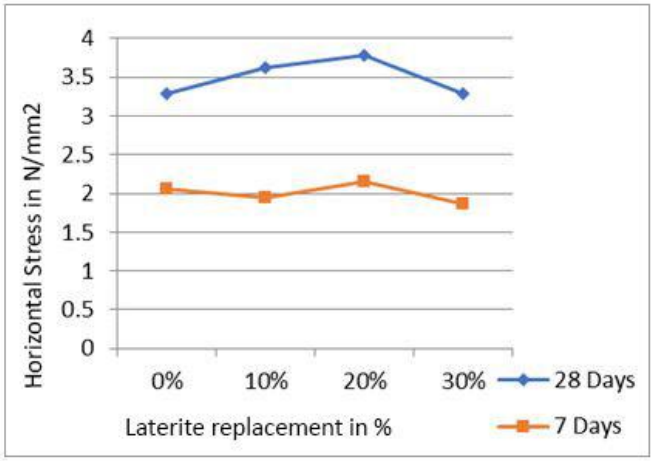
4.3 SPLIT TENSILE TEST

The Split tensile strength of concrete with 0% to 30% replacement by weight of coarse aggregate with laterite stone cured in normal water for 28 days indicates that up to 20% replacement by weight of coarse aggregate with laterite stones there is increase in strength and after 20% replacement by weight of coarse aggregate with laterite stones there is decrease in strength. This shows that 20% replacement of coarse aggregate shows better results.

Split tensile strength of concrete with 20% replacement of coarse aggregate with laterite stone is 3.4% greater than split tensile strength of normal concrete.

Table 7. Results of split tensile test

SL No.	Laterite %	Horizontal Stress in N/mm2	
		7 Days	28 Days
1	0%	2.06	3.28
2	10%	1.94	3.63
3	20%	2.15	3.78
4	30%	1.86	3.28



4.4 FLEXURAL STRENGTH TEST

Up to 20% replacement by weight of coarse aggregate with laterite stones there is increase in flexural strength and after 20% replacement by weight of coarse aggregate with laterite stones there is decrease in strength.

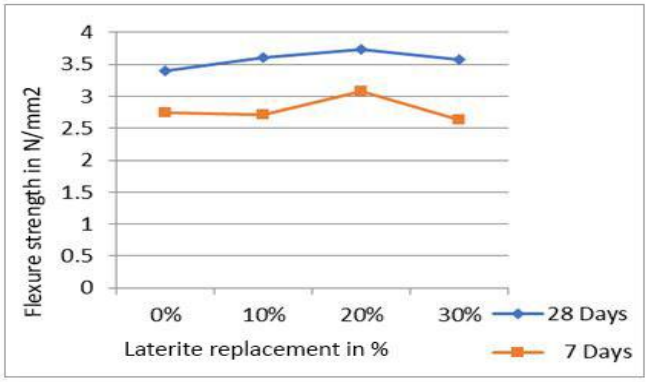


Table 8. Results of flexural strength test

SL No.	Laterite %	Flexure strength in N/mm2	
		7 Days	28 Days
1	0%	2.74	3.4
2	10%	2.71	3.61
3	20%	3.08	3.74
4	30%	2.64	3.58

5. CONCLUSIONS

Based on the various tests conducted on laterite aggregate with varying proportion of coarse aggregate the results were obtained and discussed in previous chapter from which the following conclusions are drawn.

- The compressive strength of concrete initially increases with replacement of coarse aggregate with the laterite up to 20% and after that there is decrease in compressive strength of concrete with further replacement of coarse aggregate as the mix became less cohesive and less workable.
- Replacement of lateritic aggregate up to 30% was able to produce lateritic concrete exhibiting the targeted strength of 25 N/mm2.
- Split tensile strength of concrete with 20% replacement of coarse aggregate with laterite stone is 3.4% greater than split tensile strength of normal concrete.
- Workability is decreased due to increase in water absorption as the replacement level increased. It is possible that some of the mixing water necessary to sustain the strength forming hydration process may have been entrapped or absorbed by the lateritic.
- The result of the two way analysis of variance also shows that lateritic aggregate and curing age (days) has significant effect on the compressive strength of concrete.
- From the result of this study it is recommended that 30% lateritic aggregate is adequate for partial replacement of coarse aggregate in concrete production for structural lightweight concrete.

6. REFERENCES

- Adoga (2017) "Strength of laterite rock concrete." American Journal of Civil Engineering and Architecture, 2016, Vol. 4, No. 2, 54-61 Available online at http://pubs.sciepub.com/ajcea/4/2/3 © Science and Education Publishing DOI:10.12691/ajcea-4-2-3.
- Afolayan. (2019) "Effects of Partial Replacement of Normal Aggregates with Lateritic Stone in Concrete." Vol. 23 (5) 961-966 May 2019, Department of Civil

Engineering, Nigerian Defence Academy, Kaduna, Nigeria.

- Babitharani H, Amit Gavali. (2019) "Partial Replacement of Laterite as a Coarse Aggregate in Concrete" Department of civil engineering, Jain Engineering College. October 2019 | IJIRT | Volume 6 Issue 5 | ISSN: 2349-6002.
- Ephraim (2017) "Structural Design Specifications for Concrete Made with Laterite Rock as Coarse Aggregates." INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT DOI No. : 10.24940/ijird/2017/v6/i7/JUN17048
- M. Venkata Rao, V. Siva Rama Raju. "Strength Characteristics of Concrete with Partial Replacement of Coarse Aggregate by Laterite Stone and Fine Aggregate by Quarry Dust". Int. Journal of Engineering Research and Application ISSN: 2248-9622, Vol. 6, Issue 10, (Part -1) October 2016, pp.39-44.
- N. KRISHNA RAJU, R. RAMAKRISHNAN (1972) "Properties of laterite aggregate concrete." University of Mysore Karnataka Regional Engg. College Karnataka India. Online ISSN 1871-6873.
- Norul Wahida Kamaruzaman "Engineering Properties of Concrete with Laterite Aggregate as Partial Coarse Aggregate Replacement", International Journal of Civil Engineering and Geo-Environmental ISSN:21802742
- Sachin. K. C (2019) "An Investigation on Usage of Crushed Laterite as Partial Replacement for Coarse Aggregate in GGBS Incorporated Concrete." IJSRD| Vol. 7, Issue 04, 2019 | ISSN (online): 2321-0613. 1,2Coorg Institute of Technology, Kodagu, India
- U. Dileep Kumar (2017) "A study on laterite stones as building material" SAHYADRI International Journal of Research. ISSN: 2456-186X. Civil Engineering Dept., Sahyadri College of Engineering & Management, Mangalore.

7. BIOGRAPHIES

Vidyadhar N
Assistant Professor
Dept. of Civil Engineering
AITM, Bhatkal
Karnataka, India

Jaseem AC
Final year B.E Student
Dept. of Civil Engineering
AITM, Bhatkal
Karnataka, India

Muhammed Shuhail MC
Final year B.E Student
Dept. of Civil Engineering
AITM, Bhatkal
Karnataka, India

Muhammed Mirshad P
Final year B.E Student
Dept. of Civil Engineering
AITM, Bhatkal
Karnataka, India

Mubeen TP
Final year B.E Student
Dept. of Civil Engineering
AITM, Bhatkal
Karnataka, India