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Study on Compressive Strength of Different Grades of Concrete Using Laterite Sand

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Abstract: *Laterite a soil type rich in iron and aluminium formed under hot and wet tropical conditions, due to its cost effectiveness and energy efficiency than that of conventional modern materials can be used as a substitute of fine aggregate. This paper is part of a study investigating the structural characteristics of concrete using various combinations of laterite sand and M-sand as complete replacement for conventional river sand fine aggregate. The samples of concrete were made using varying contents of laterite and M-sand as fine aggregate. The quantity of laterite was varied from 0% to 100% against M-sand at intervals of 25%. The samples of concrete cubes are made in two different grades, namely M30 and M45. The results compared favourably with those of conventional concrete and optimum replacement of laterite as fine aggregate in concrete will be found out.*

Keywords: *concrete, compressive strength, laterite sand, M-sand.*

I. Introduction

In developing countries like India, there is the need for locally manufactured building materials because there is an imbalance between the demands for construction and expensive conventional building materials coupled with the depletion of traditional building materials. To address this situation, attention has been focused on low-cost alternative building materials. The use of abundantly available materials to replace normal aggregates in concrete for structural purposes would prove to be economical in developing nations provided a reliable design data base on concrete produced with such materials is to be established. One of such materials is laterite, naturally occurring soil widely spread in the tropics and subtropics. Laterite is a residual ferruginous rock commonly found in tropical regions and has close genetic association with bauxite. The mineralogical & chemical composition of laterite depends on their parent rock. The term 'laterite' was originally used for highly ferruginous deposits first observed in Malabar Region of coastal Kerala and Dakshina Kannada & other parts of Karnataka. It is a highly weathered material, rich in secondary oxides of iron, aluminium or both. It is either hard or capable of hardening on exposure to moisture and drying. This material has been satisfactorily used in Kerala as a fill for foundation and as a base course for highway construction. The natural form of laterite blocks is used as load bearing walls in house construction throughout the state. The application of this cheap and readily available material in concrete work in the Kerala regions where there are large deposits could lead to a significant reduction in the cost of concrete. In addition to easy availability, laterite has the advantage of requiring no specialized skilled labour for its production.

As per Indian Minerals Yearbook 2016 (Part- III : Mineral Reviews) 51st Edition, the total resources of laterite is 471 million tonnes. Out of these, 24.7 million tonnes are the reserves and 446.12 million tonnes are the remaining resources. Major share of about 87.5% resources was distributed in two states namely Madhya Pradesh (61%) and Rajasthan (26%). The remaining 13% of resources are spread over in the states of Andhra Pradesh, Kerala, Gujarat, Maharashtra and Jharkhand.

II. Previous studies

Awoyera et al., [1] studied the micro structural characteristics, porosity and strength development in ceramic-laterite concrete. A laterite concrete mix containing both 90% of ceramic fine and 10% of laterite as fine aggregate provided the optimal strength out of all the modified mixes. Although, the strength reduction was about 9% when compared with the reference case, however, this reduction in strength is acceptable, and does not compromise the use of these alternative aggregates in structural concrete.

Biju Mathew et al., [2] conducted experiment to determine the suitability of partial replacement of sand with laterite soil and manufactured sand in 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 and 40% replacement of sand by manufactured sand shows maximum strength.

Benny Joseph et al., [3] conducted experiment on Study physical properties of aggregate with varying replacement of laterite from 5 % to 20% level in both natural sand and manufactured sand. The specific gravity and particle size distribution were investigated. The specific gravities obtained for M-sand and sand with the replacement of fine aggregate by laterite soil lies in the range 2.77-2.72, 2.6-2.54 respectively. There is no variation in the zone even after the replacement of fine aggregate with laterite soil.

Jayaraman et al., [4] studied the compressive and tensile strength of concrete using lateritic sand and lime stone filler as fine aggregate. The concrete are made using varying contents of lateritic and lime stone filler as fine aggregate. The quantity of laterite is varied from 0% to 100% against lime stone filler at intervals of 25%. Samples of concrete are made in three different grades, namely M15, M20 and M25. It was found that 0.55 water/cement ratio produced higher compressive strengths, tensile strength and better workability for M20 mix proportion.

Olubunmi et al., [5] conducted experiment to investigate the performance of laterite concrete exposed to drying-wetting cycles of sulphate environment. The effect of sulphate attack on laterite concrete comprising of 4 days of full immersion and 3 days of drying at ambient temperature at two concentrations (3%and 5%) of magnesium sulphate solution for a total exposure period of 24 weeks. The compressive strength decreased significantly between 10% and 50%, with increasing sulphate concentration, laterite content and exposure period.

Festus Adeyemi Olutoge [6] carried out experiments to investigate the ultimate strength behavior of laterite concrete beam. For mix ratio of 1:2:4 ,five classes of specimens incorporating 0, 10, 20, 30, and 40% laterite as replacement by weight of sand were prepared. The analyse show that laterite concrete beam specimens give satisfactory performance compare to normal concrete beam specimens when the content of laterite in the concrete as partial replacement for sand does not exceed 25%.

Ettu et al., [7] conducted experiments to study the suitability of using Laterite as Sole Fine Aggregate in Structural Concrete. A good number of the mix ratios had compressive strengths higher than that of 25N/mm2 (0.55:1:1.25:1.25, Compressive cube strength =25.04 N/mm^2, (0.55:1:1.375:1.375, Compressive cube strength = 26.89 N/mm^2).

III. Experimental investigation

M30 and M45 grade concrete mix proportion containing laterite as a replacement for M-sand was studied. The replacement level of M-sand by laterite considered was 25%. Control concrete (concrete without laterite) were also produced for reference purpose. Six standard 150mm x 150mm x 150mm concrete cubes were cast for each mix ratio. There were totally 12 cubes produced for the different replacements. These were cured for 7 days and 28 days, then weighed and crushed to determine their compressive strength at the respective ages.

IV. Results and discussions

In order to achieve the objective of this work, various laboratory tests were conducted on the laterite and M-sand in concrete for its physical, fresh and hardened properties. Below is a detailed discussion on the results obtained.

4.1 Physical properties of materials

The results of physical properties of laterite and M-sand are first presented in this chapter followed by those of both fresh and hardened concrete produced using laterite and M-sand concurrently as fine aggregates. The fineness modulus of materials namely: sand, M-sand and laterite were shown in Table 4.1.1. The gradation curve for sand M-sand and Laterite have been plotted in Fig 4.1.1.The specific gravity and Loose bulk density of materials have been shown in Table 4.1.2.

Table 4.1.1 Fineness modulus

Material	Fineness modulus
Sand	2.67
M-sand	3.01
Laterite	2.66

Table 4.1.2 Specific gravity and Loose bulk density

Test	Results
Specific gravity of sand	2.651
Specific gravity of M-sand	2.6
Specific gravity of laterite	2.824
Specific gravity of coarse aggregate	2.63
Loose bulk density of M-sand	1345.41kg/m^3
Loose bulk density of laterite	1494.17kg/m^3

4.2 Workability

Slump test for control M30 and M45 grade concrete was found to be 90 mm and 80 mm. The slump value for M30 grade concrete with 25% replacement of M-sand by laterite was found to be 80 mm. Similarly for M45 grade concrete with 25% replacement of M- sand by laterite was found to be 70 mm shown in Fig.4.2.1

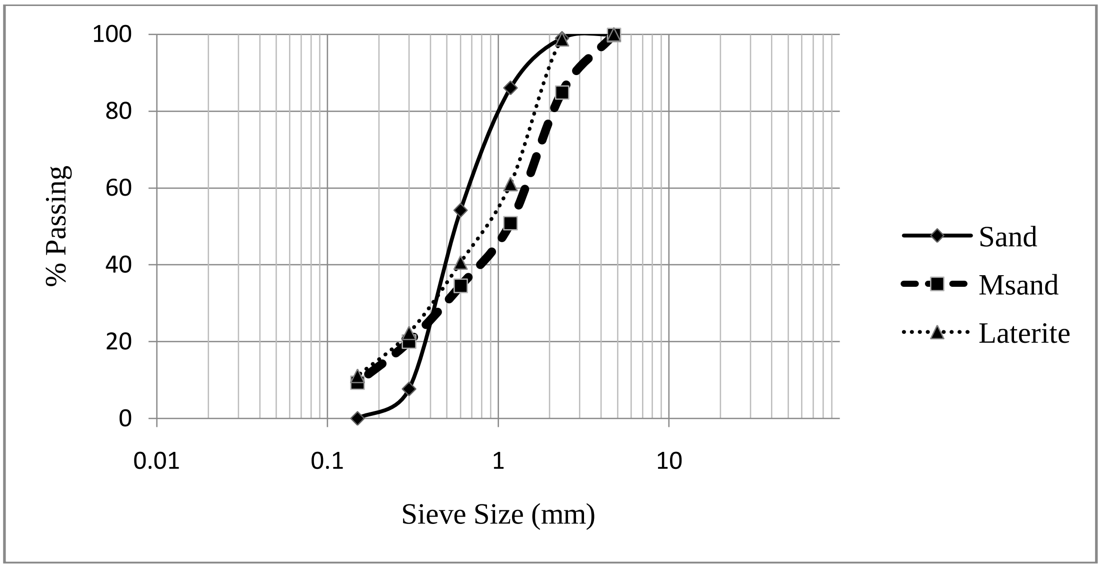


Fig. 4.1.1 Gradation Curve for Sand M-sand Laterite

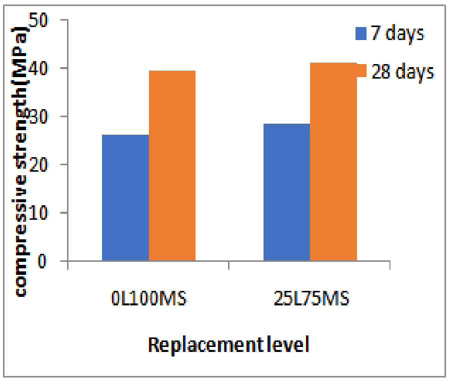
4.3 Compressive Strength of Concrete

Standard compressive test on hardened concrete for control M30 and M45 grade concrete has been found out and Compressive strength test has been carried out for 25% laterite replaced concrete in M30 and M45 grade concrete. Table 4.3.1 represents the strength of M30 and M45 grade concrete with 25% replaced laterite.

Fig.3.2.1 Slump test

Fig.4.2.1 Slump test

Fig 4.3.1Compressive strength of cube



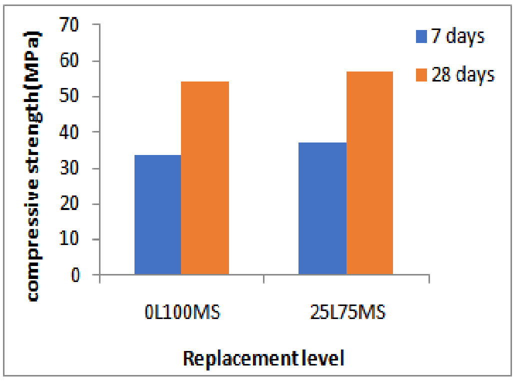


Fig 4.3.2 compressive strength result for M30 and M45 grade concrete

V. Conclusion

From the literature review it was observed that 25% replacement of sand by laterite has shown encouraging results. The concrete containing laterite possesses higher water absorbing capacity. Hence, super plasticizer is used to enhance higher resistance to water absorption and to obtain higher compressive strength at lower water/cement ratio.

In the current project, the physical properties of river sand, M-sand and laterite have been examined. The compressive strength test for control mixes of M-30 and M-45 grade concrete using M-sand has been performed. Furthermore, the replacement of M-sand by 25%, laterite have been performed. There has been 4.27%increase in compressive strength incase ofM30 grade concrete and 4.95%increase in compressive strength in case of M45 grade concrete

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