Short Term Effect of Magnesium Sulphate on the Compressive Strength of Superplasticized Laterized Concrete

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ABSTRACT

This study investigated the short term effect of magnesium sulphate on the compressive strength of superplasticized laterized concrete with a view to establishing its suitability for use in aggressive environment. It examined the effect of magnesium sulphate and varying Laterite contents with a constant water-cement ratio on the compressive strength of superplasticized laterized content. The percentage replacements of laterite as substitute in fine aggregate were varied in the increment of 0%, 20% and 30% respectively. All cubes were cast and cured in water for 7, 14, 28 days respectively. The cast superplasticized laterite concrete cube size is 100x100x100mm which were crushed using compression testing machine. During its preparation, Superplasticizer was added to improve workability. Part of the cubes were transferred to magnesium sulphate concentrate solution of 1% and 3% after 28days of curing in water for another 28 days making 56 days. It was observed that the concrete cube decreases in strength when exposed to varying percentages of magnesium sulphate concentrate solution. The study concluded that superplasticized laterized concrete is not suitable for use in magnesium sulphate concentrate environment.

Keywords: Laterized Concrete, Magnesium Sulphate, Superplasticizer.

INTRODUCTION

Materials as a constructional resource and a crucial factor of production constitute a major percentage of cost on any construction work. The cost of building materials continues to increase as the majority of the population continues to fall below the poverty line. It is of great importance to look and consider ways on how the cost of the widely accepted conventional materials such as cement, steel, sand, granite, gravel and wood can be reduced to affordable level without compromising standards. In an attempt to search and give this a solution, the use of readily available local materials or alternative materials suitable for the production of any component of a building were sourced for and developed. Alternative materials must offer more benefits than the conventional materials or system they replace. They must reduce costs, increase design flexibility, enhance sustainability, perform multiple functions, have superior performance characteristics, or meet a market niche (Venkatarama Reddy, 2004). Researching into the use of alternative materials is to develop new materials that can serve multiple functions, increase cost-effectiveness and efficiency, and using more sustainable materials.

The first published work on laterized concrete, according to osunade (2002a) and salau (2003), appears to have been by adepegba (1975a) study in which the strength properties of normal concrete were compared with those of laterized concrete. The conclusion of that study was that a concrete in which laterite fines are used instead of sand, can be used as a structural material in place of normal concrete. In another study, balogun & adepegba (1982) discovered that the most suitable mix of laterized concrete for structural purposes is ($1{:}1^{1}/_{2}{:}3$) with a water/cement ratio of ratio 0.65, provided that the laterite content is kept below 50 percent. According to udoeyo et al., (2006), strength performance of laterized concrete is generally affected but the replacement level of sand and the mix richness. Existing works on durability properties of reinforced laterized concrete by Garba et al. (2024) revealed that the water absorption increased with increase in laterite content which invariably affected the reinforced laterized concrete durability properties. A 10% maximum replacement with laterite was recommended for reinforced laterized concrete production. A deviation from the pattern of findings on laterized concrete was recorded in the findings of Omolaiye et al. (2025) investigating the mechanical and durability properties of concrete produced with Gashua laterite as partial replacement for fine aggregates under sulphate exposure. He reported that a reasonable amount of laterite (10-20%) improved sulphate resistance and mechanical properties without compromising density of the concrete sample produced. In all the recast, besides Lasisi et al., (1990), attentions have not been focused on long term durability performance of laterized concrete with superplasticizer. Further works are needed to be carried out to complement and ascertain the veracity of their findings. This study therefore intends to study sulphate attack on superplasticized laterized concrete.

MATERIALS AND METHODS

The type of cement for the experiment was Limestone Portland Cement (LPC Dangote Brand) which conforms with the requirements in ASTM C150 (2005). The sand, laterite and granite were also purchased from a local supplier in ile-ife, Osun state. The equipment used include wheel barrow, weighing balance, shovel, hand trowel, head pan, bucket, moulds (100mm x 100mm x 100mm cubes), tamping rod, spade, curing tanks, curing tanks, curing rubbers, moulds oil, watering cans, mechanical sieves of varying standard sizes, compressive strength testing machine. Granite stone of 20mm maximum size was used as coarse aggregate. Potable water free from impurities was used in carrying out the experiment. The water-cement ratio used for the study was 0.65.

Production of Concrete Cubes

The moulds (100 x 100 x 100) mm were used in casting the concrete cubes. The specimens were made by mixing the constituent aggregates with varying percentage replacement of sand with laterite and addition of superplastisizer to enhance the workability of the concrete as shown in Table 1. The concrete cubes were cured in water for 28 days. The water absorption rate was determined after 28 days curing age.

Table 1: Laterized concrete samples

Laterite (%)	Sand (%)	Water-cement ratio	Superplasticizer (Kg)	No of cubes
0	100	0.65	0	12
20	80	0.65	0.1	12
30	70	0.65	0.2	12

RESULTS AND DISCUSSION

The result of the residual compressive strength of laterized superplasticized concrete cubes subjected to three regimes of exposure at 0%, 1%, and 3% concentrate of magnesium sulphate solution (after twenty-eight days of full immersion curing in water at ambient temperature) for a period of 56 days are present in Tables 2 and Figures 1 to 3.

It should be noted that all specimens were exposed to the test solutions after initial 28 days curing in water at ambient temperature. According to Ata (2007) based on his results, the immersion in magnesium sulphate solution initially resulted in a slight increase in compressive strength. Though in all cases, specimens continuously stored in water exhibited increasing compressive strength. This decrease in residual compressive strength of specimens exposed to sulphate solution, according to Tian (2000), occurs as result of the pore space in the concrete specimen losing its capacity to accommodate additional amounts of ettringite, therefore leading to generation of potential damaging expansion forces within the concrete specimens. This explains the reason for subsequent reduction in strength as seen in Table 2. Also increase in laterite content and in sulphate concentration leads to a continual decrease of compressive strength of superplsticized laterized concrete and the compressive strength of control reduces only at exposure to sulphate environment.

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Table 2: Residual Compressive strength of superplasticized laterized concrete samples exposed to Magnesium Sulphate concentrate solution at different curing ages.

Percentage Replacement of sand(%) with laterite	Superplasticizer (Kg)	Curing Age (Days)	Compressive strength (N/mm^2) @ 0% $MgSO_4$	Compressive strength (N/mm^2) @ 1% $MgSO_4$	Compressive strength (N/mm^2) @ 3% $MgSO_4$
0%	0	7	14.17		
		14	16.17		
		28	18.50		
		35	20.33	17.67	17.00
		42	22.83	16.33	15.00
		56	25.00	15.33	13.33
20%	0.1	7	8.83		
		14	10.17		
		28	14.33		
		35	15.50	13.83	17.00
		42	16.33	12.83	15.00
		56	18.33	10.33	13.33
30%	0.2	7	6.00		
		14	8.50		
		28	9.83		
		35	10.50	9.67	9.00
		42	11.33	9.00	7.67
		56	13.50	8.00	6.50

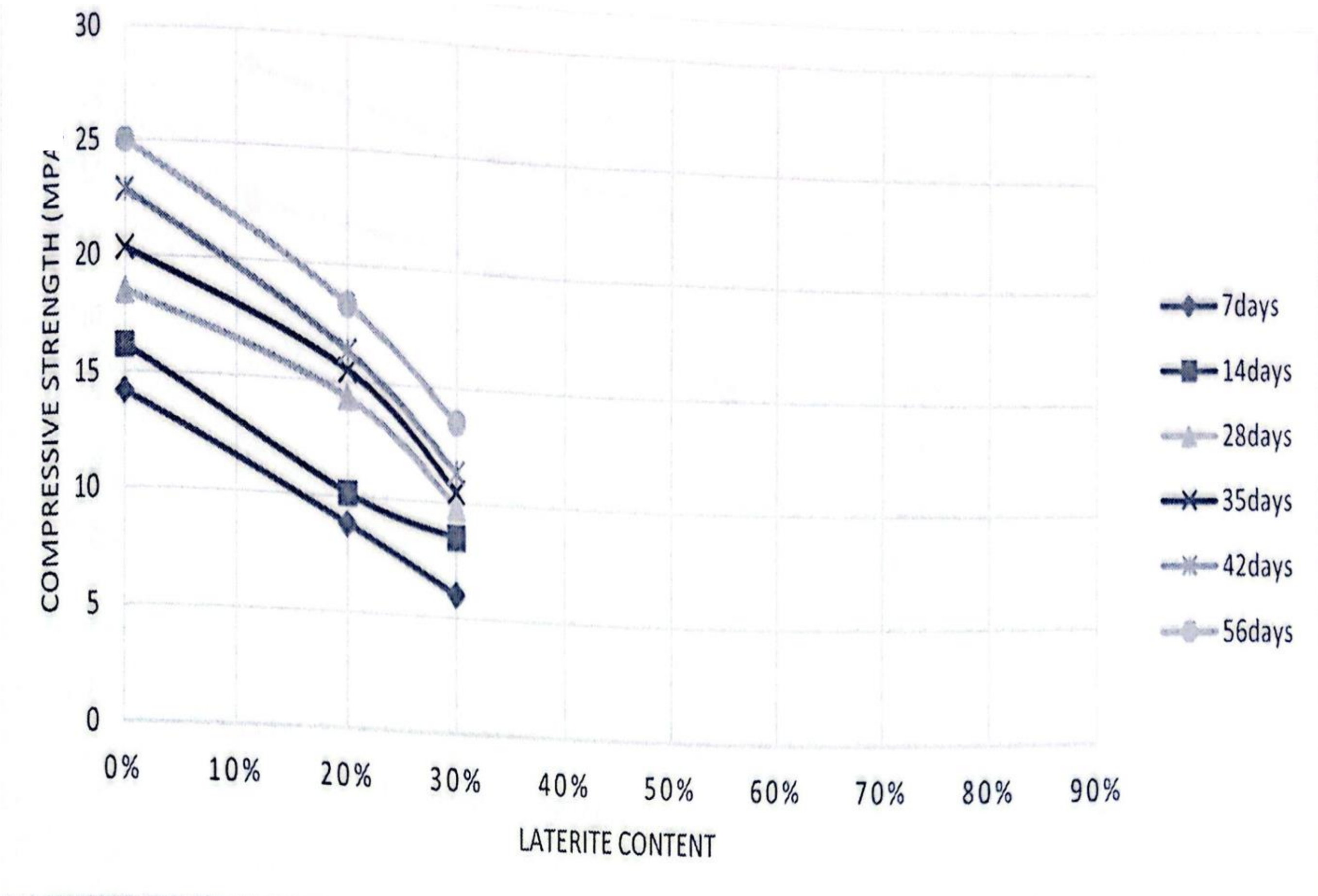

Figure 1: Effect of Laterite content on compressive strength of superplasticized laterized concrete.

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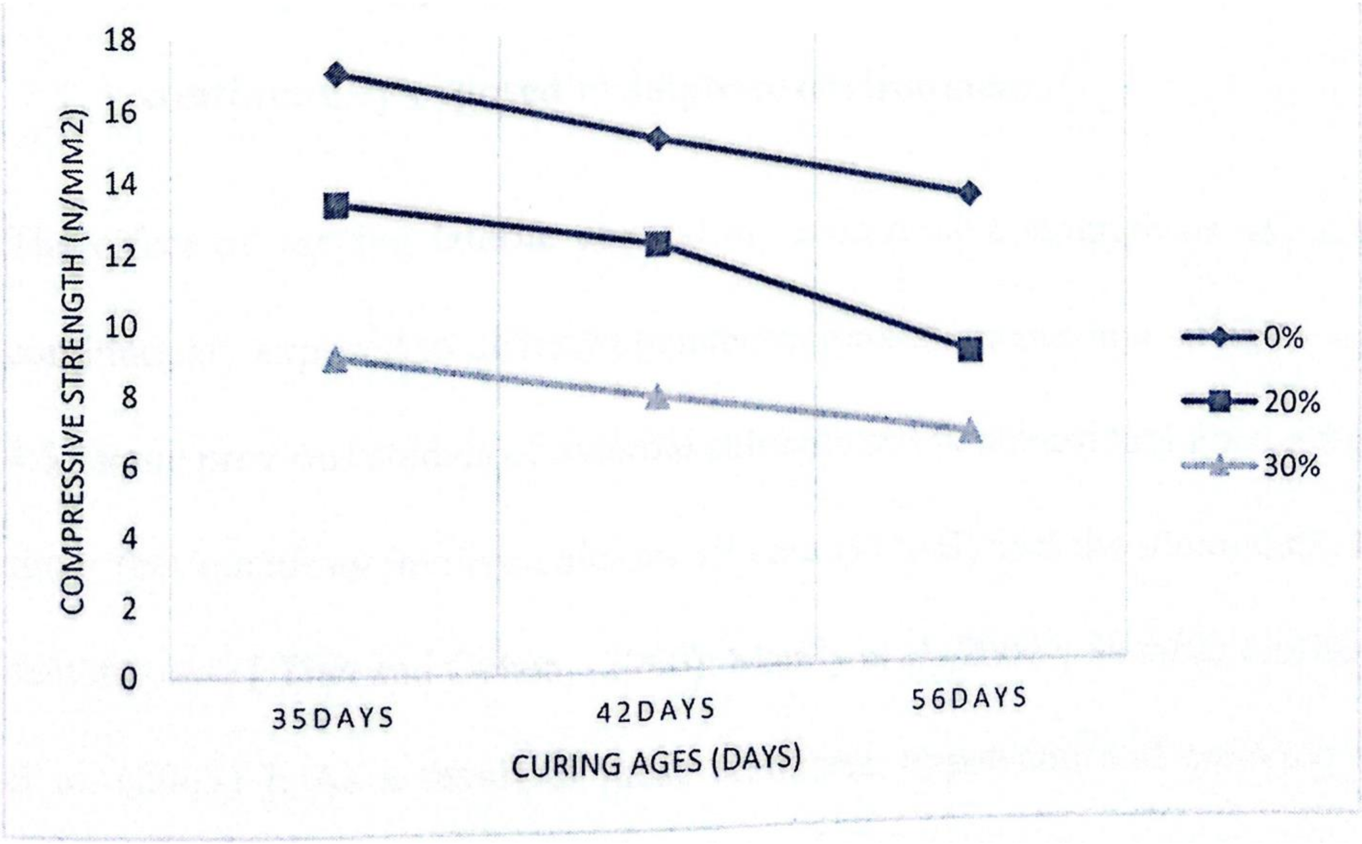

Figure 2 Residual compressive strength of superplasticized laterized concrete exposed to 1% magnesium sulphate concentrate solution.

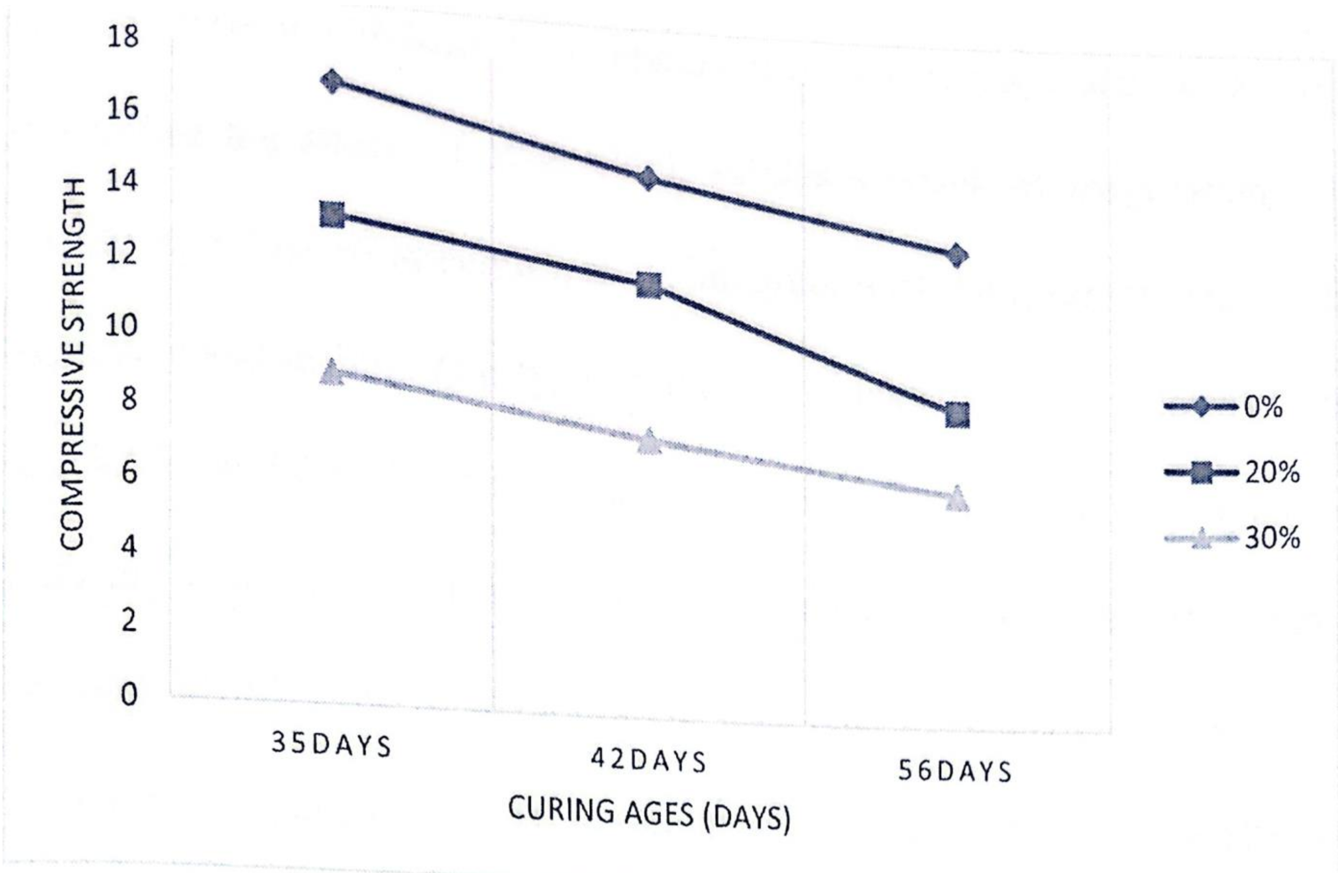

Figure 3: Residual compressive strength of superplasticized laterized concrete exposed to 3% magnesium sulphate concentrate solution.

CONCLUSION

The level of concentration of the sulphate solution influenced the rate of attack on superplasticized laterized concrete. The higher the magnesium sulphate concentration, the faster the rate of attack. Also the higher the percentage laterite content, the faster the rate of sulphate attack in superplasticized laterized concrete.

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