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COMPARATIVE ANALYSIS OF COMPRESSIVE STRENGTH OF CONCRETE PRODUCED WITH COARSE AGGREGATES FROM DIFFERENT PARENTAL ROCKS

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ABSTRACT

This research work aims at comparing the compressive strength of concrete produced with coarse aggregates from igneous, sedimentary and metamorphic rocks. Coarse aggregates samples were obtained from the three named parenting rocks. Slump test was carried out on concrete produced with coarse aggregates from the three selected rocks to determine their workability and water cement ratio. The igneous, sedimentary and metamorphic rocks gave the following average slump 80mm, 71mm and 62mm respectively. Concrete cubes of 150mmX150mmX150mm, mixing ratio 1:2:4 with water cement ratio 0.65 were prepared and cured by immersion in clean water for different ages (7days, 14days, 21days, and 28days). The compressive strengths of these cubes were determined and compared with one another. The compressive strength of concrete produced with coarse aggregates from igneous, sedimentary and metamorphic rocks varied from 11.N/mm^2 to 25.04N/mm^2, 10.08N/mm^2 to 24.11N/mm^2 and 7.61N/mm^2 to 22.03N/mm^2 respectively. Also, the density of concrete produced with coarse aggregates from igneous, sedimentary and metamorphic rocks gave the following values 2439kg/m^3, 2403kg/m^3 and 2379kg/m^3 respectively. The compressive strength of concrete produced from each rock increased as the curing days increase. Concrete from igneous rock gave the highest compressive strength, followed by sedimentary rock and metamorphic rock.

KEYWORDS: Compressive strength, concrete, coarse aggregate, igneous, sedimentary, metamorphic, rock, parenting, workability, slump, density.

INTRODUCTION

Concrete is a construction materials which consists of the mixture of fine aggregates, coarse aggregates, cement which is proportionally mixed with certain percentage of water (Ayodele & Ayeni, 2015). It is regarded as the most widely used man-made material in the world, second only to water as the world's most utilized substance (Jackson, 1981, Lalonde & James1961 & Neville, 2004). It is a strong, durable building material that can be formed into many varied shapes and sizes ranging from a simple rectangular column, to a slender curved dome or steel, if the constituent materials are carefully selected (Taylor, 1994). The principal consistent of concrete is the binding medium used to bind the aggregate particles together to form a very hard composite material. The most common used binding medium is the product formed by the chemical reaction between cement and water (Rajput & Barry, 1999) The future of concrete looks even brighter because for most purposes it offers suitable engineering properties at low cost.

A good knowledge of properties of cement, aggregates and water is required in understanding the behavior of concrete, in ordinary structural concrete the aggregate occupies 70-75% of the volume of hardened mass and in similar vein it occupies 90% or more in asphalt cement concrete (Gambir, 2006 & Sherry, 2005). It is inevitable that a constituent occupying such a large percentage of mass should have an important effect on the properties of both the fresh and hardened concrete. One of the constituents of concrete as pointed out before is aggregate. Aggregate is a material such as broken stones, clay, gravel or sand which when held together by binding agent forms concrete, asphalt or coated macadam (Jackson & Dhir, 1988, BS 882, 1973). Aggregate can be classified as fine or coarse aggregate. Fine aggregate is generally natural sand is graded from particles 5mm in size. Coarse aggregate is natural graded of crushed stone usually larger than 5mm (BS 882, 1993). In this research, the emphasis will be on coarse aggregate. Coarse aggregate is used primarily for the purpose of providing bulk to the concrete. Its use also improves both the volume stability and durability of the reacting concrete. Its physical and chemical characteristics affect the properties of both fresh and hardened concrete (Jackson & Dhir, 1988, BS 882, 1973). Crushed stones are obtained by mining rock and breaking it down to a preferred size. Its source could be igneous, sedimentary or metamorphic. This research work aims at comparing the compressive strength

of concrete produced with coarse aggregates from igneous, sedimentary and metamorphic rocks.

MATERIALS AND METHODS

Materials

Cement: Portland cement was used for this research work and it was found to confirm with the requirement of BS (EN- 1008, 2002).

Water: The water used for this work is portable, clean and free from any visible impurities. It confirmed to BS (EN 197, 2000).

Fine Aggregate: The fine aggregate used is sourced from Ado- Ekiti, Ekiti State. It was sharp sand.

Coarse Aggregates: 20mm size coarse aggregate were used. These coarse aggregate were from igneous, sedimentary and metamorphic rocks. The igneous rock (granite) was obtained from a quarry site in Ikere-Ekiti, Ekiti State, Nigeria. The sedimentary rock (Limestone) was obtained from Ewekoro, Ogun State, Nigeria. The metamorphic rock (Quartzite) was obtained from Itawure, Efon Alaye, Ekiti State, Nigeria.

Methods

The following tests carried out on these materials are; slump test and compressive strength. The procedure used in carrying out the tests confirmed to that of (BS 1377, 1990).

Slump Test: This test is used to determine the workability of concrete. It measures the resistance of concrete to flow under its weight. The apparatus used is a hollow cone shaped mould test.

Compresive Strength Test: The compressive strength of concrete is one of the most important and useful properties of concrete. The mixing ratio used is 1:2:4 with water cement ratio 0.65. Cement cubes produced with coarse aggregates from igneous, sedimentary and metamorphic rock with the same fine aggregate, cement and water were subjected to this test to determine variations in strength. The concrete cubes were cured by immersion in water for 7, 14, 21 and 28 days. The concrete cubes were crushed using universal testing machine.

RESULTS AND DISCUSSION

Table 1: Average slump value for concrete (slump test)

Source of coarse aggregates	Average slump (mm)
Igneous Rock	80
Sedimentary Rock	71
Metamorphic Rock	62

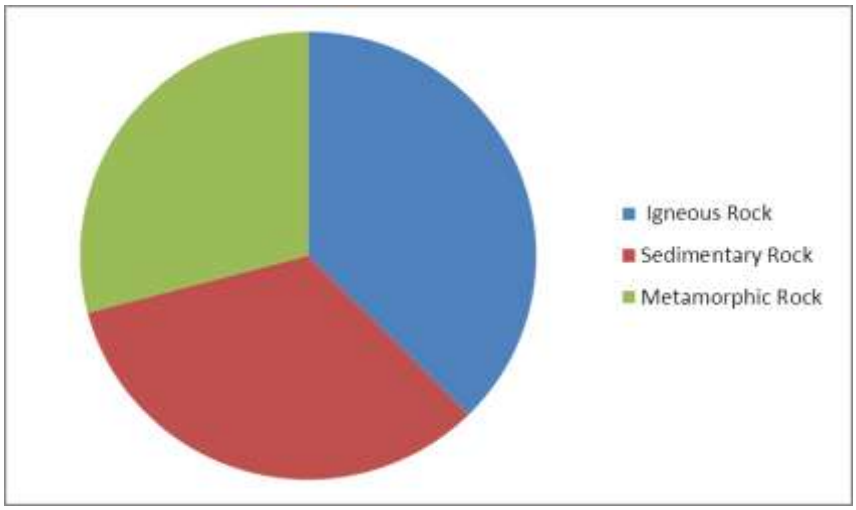

Fig. 1: A pie chart showing the average slump.

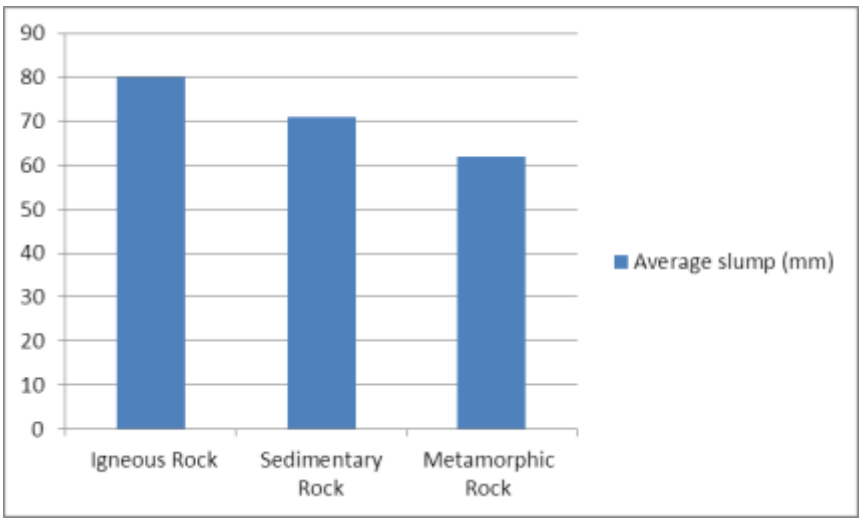

Fig. 2: A bar chart showing the average slump.

From the above figures (pie and bar charts), concrete produced with coarse aggregates from igneous rock gave the highest average slump which shows that it has best workability followed by concrete produced with coarse aggregates from sedimentary rock. Concrete produced from coarse aggregates from metamorphic rock gave the least average slump value which shows that it has least workability.

Table 2: Compressive Strength of concrete.

Source	Compressive Strength (N/mm^2)			
	7days	14days	21days	28days
Igneous	11.58	14.24	19.65	25.04
Sedimentary	10.08	12.67	18.44	24.11
Metamorphic	7.61	10.82	15.8	22.03

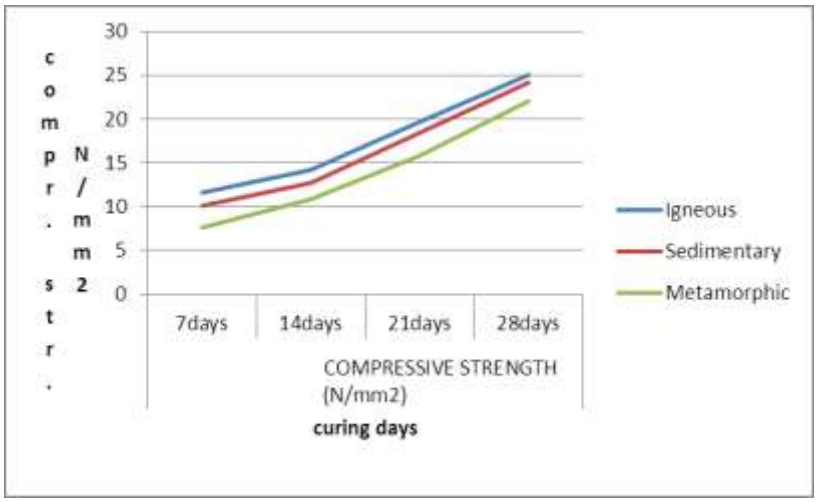

Fig. 3: A graph of compressive strength against curing age.

From the figure 3 above, the concrete produced with coarse aggregates from igneous rock gave the highest compressive strength at each curing age followed by sedimentary rock and metamorphic rock. Igneous rock is strongest and toughest among the three, followed by sedimentary rock and metamorphic rock. Compressive strength of concrete produced from these rocks increased as the curing days increased which shows that they followed the same pattern but at different rate.

CONCLUSIONS

The following conclusions can be drawn based on the results obtained from this research work:

Igneous rock gave the highest average slump value which shows that its concrete is of best workability. Also, its concrete gave the highest compressive strength at all curing days, this is as a result of the fact that igneous rock is very strong and tough with adequate resistance to abrasion. The particles that made up igneous rock are well compacted and firmed.

Sedimentary rock gave higher average slump value than metamorphic rock which means that its concrete is of better workability. Also, its concrete gave higher compressive strength than

metamorphic rock at all curing days. This means that sedimentary rock is stronger than metamorphic rock.

Metamorphic rock gave the least average slump value which shows that its concrete is of least workability. Its concrete also gave the least compressive strength at all curing days.

RECOMMENDATIONS

The concrete produced from the three different rocks (igneous, sedimentary and metamorphic rocks) performed satisfactorily as good sources of coarse aggregates in concrete production. Coarse aggregates from them can be used in concrete production though depending on the design strength of concrete, type of structure, availability of coarse aggregates and cost.

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