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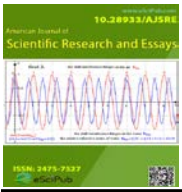

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Concrete Strength Variations of Unwashed and Processed Coarse Aggregate Sizes

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ABSTRACT

This project aims to determine the effect of different coarse aggregate sizes and type on the compressive strength of concrete. The most important property of concrete is its compressive strength. The exceeding strength of concrete is as a result of the presence of coarse aggregate. Normal concrete is being produced from different types of aggregate and size and this imparts different property to the resulting concrete. The research has established that the coarse aggregates and their sizes play critical roles in the development of adequate strength in concrete. Fine aggregate is normal sand obtained from a borrow pit. Preliminary laboratory investigation was conducted to ascertain the suitability of using the aggregates for construction work. Tests conducted include sieve analysis, bulk density, and specific gravity. From the graph of the sieve analysis for fine and coarse aggregate, the coefficient of uniformity calculated was 1.5 and 3.45 respectively. It was observed that with proper mixing, the slump test results did not witness shear or collapse type of slump rather there were true slump in all cases of the test. The result of the slump test for 12.5mm, 19.5mm, and 25mm coarse aggregate were 60, 100, and 90. The workability decreased with slight differences when the coarse aggregate size was increased. Three different sizes of coarse aggregates with 25mm maximum size for both processed (granite) and sand stone (Local stone) were employed in the investigation, namely; 12.5mm, 19.5mm and 25mm. The grading and relative densities of the aggregates were studied. The mix ratio and water / cement ratio adopted for the study was 1:2:4 and 0.5 respectively. Twelve concrete cubes (72 total) (150mm× 150mm×150mm) were cast for each coarse aggregate size and type of which three were crushed at each maturity age namely; 7, 14, 21 and 28 days. The 28 day strength of the concrete made with granite and sand stone of 12.5mm, 19.5mm 25mm were 26.1N/mm^2 , 25.1N/mm^2, 25.2N/mm^2 for processed (granite) and 19.12N/mm^2, 19.10N/mm^2 and 19.90N/mm^2 for sand stone respectively. Consequently, the result confirmed that using processed (granite) as coarse aggregate yield higher strength compared to local stone coarse aggregate.

Keywords:
Aggregate, Concrete, Cement, Compressive strength, Sieve.

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INTRODUCTION

It is recognized that coarse aggregate plays an important role in concrete. Coarse aggregate typically occupies over one-third of the volume of concrete and research indicates that changes coarse aggregate sizes can change the strength of concrete. To predicts the behavior of concrete under general loading regards on understanding of the effects of aggregate sizes. This understanding can only be gained through extensive testing and observation. The extent to which a given concrete resists the compressive stresses to which it is subjected depends largely on the compressive strength of the concrete which in turn depends on the quality of the concrete. Since seventy five percent (75%) of concrete is made up of aggregates, its types, quality and general properties determine the quality and strength of concrete.

There is strong evidence that coarse aggregate type and sizes is a factor in the strength of concrete. Ezeldin and Aitcin (1991) compared concretes with the same mix proportions containing four different coarse aggregate types. They include that in high strength concrete, higher strength coarse aggregates typically yield higher compressive strength.

There is much controversy concerning the effects of coarse aggregates sizes on concrete. Some research (strange and Bryant 1979, Nallathumbi, Karihalco and Heaton 1954) has shown that there is an increase in toughness with an increase in aggregate sizes. Test by Zhou, Barrunolydon (1995) show that compressive strength increases with an increase in coarse aggregate size.

In light of the controversy, this report describes work that is aimed at improving the understanding of the effects of coarse aggregate sizes on compressive strength of concrete. The coarse aggregate sizes works on in this report on mainly 25mm, 12.5mm and 19mm for both granite and local stones.

There is always a confusion on which aggregate to use in construction works, whether granite or local crushed stone and the actual sizes of the aggregate that will give maximum compressive strength. This controversy prompted me to work on the comparison of the effect of coarse aggregate sizes of granite and local crush stones so as to know the aggregate whether granite or local crushed stone and also the actual size of the aggregate that will give the highest compressive strength thereby been the most suitable to use in construction purpose.

The role of coarse aggregate in concrete is central to this report. While the topic has been under study for many years, an understanding of the effect of coarse aggregate has become increasingly more important with the introduction of high strength concretes, since coarse aggregate plays a progressively more important role in concrete behavior as strength increases. Effect of aggregate sizes on the compressive strength of concrete, the aggregate sizes are 1 inch, ½ inch and ¾ inch for limestone (chippings) and local crush stone of the same sizes. The local crush stone is gotten from Agu-Awka in Anambra State while the chippings are gotten from Ebonyi State.

Aim and Objective of the Study

The aim of this research work is to investigate the effect of coarse aggregate sizes on concrete strength. A comparison of processed (granite) and local crush stone.

The objectives of this project are as follows:

(i) To compare the strength of granite and sand stone (Local stone) of the same sizes

(ii)To help local concrete workers know the most suitable aggregate size and type to choose for a particular project.

(iii) To find out the workability of the concrete mix at the same water / cement ratio as the coarse aggregate size increases.

(iv) To determine the best coarse aggregate type and size for construction works.

(v) To verify how suitable sand stone (Local stone) can be used to replace granite in a construction work.

Scope of the Work.

This research was based on series of experiments conducted in the laboratory using coarse aggregate of varying size which are

1. 25mm
2. 19mm
3. 12.5mm

These aggregate sizes are for processed (granite) and local crushed stone. Comparing this sizes is important to know their various strength and the possibility of replacing one with another.

These aggregate are both for chippings and local crushed stone gotten from Abakaliki gravel granny, Ebonyi State and Agu-Awka in Anambra State.

Limitation and research hypothesis

The limitations of this research work are;

i. Lack of finance for the purchase of materials.
ii. Lack of machines to carry out the experiment.
iii. Unavailability of crushing machine.
iv. Limited time to source for materials and carry out the experiment.

LITERATURE REVIEW

Concrete is a very important material in the Nigerian construction industry as over 90% of her storey buildings are made from reinforced concrete (Joshua et al., 2013a). In the same vein, Tiwari, et al. (2016) posits that the annual global concrete consumption is estimated to be about 25 billion tonnes. Recent studies by Olajumoke and Lasisi (2014), Ode and Eluozo (2016), and Sulymon, et al. (2017) have demonstrated that the quality of concrete is affected by the choice of coarse aggregate used in its production. Aggregates account for about 60- 75% of the total volume of concrete mix and 70-85% of weight with coarse aggregate contributing to about 45-55% of the total mass (Bamigboye, et al. 2016a, Aginam, Chidolue and Nwakire, 2013). The significance of aggregate as noted by Alexander and Mindess (2010) include not only being a filler material but has important physiognomies in improving the workability of a fresh concrete. Additionally, the properties of hardened concrete such as volume stability, unit weight resistance to destructive environment, strength, thermal properties are major roles of coarse aggregate in Portland cement concrete production. Thus, the choice of aggregate in concrete production can significantly affect the performance of a concrete.

The high cost of building materials has led to a clamor for alternative materials. The challenge for the use of locally source materials for the construction of building is as a result of such clamor and has been linked to strategies to reduce the cost of buildings and construction. This could be achieved by the use of materials that are indigenous to the construction location, hence reducing haulage and importation cost of sourcing construction materials from other places.

However, the adoption of locally sourced coarse (gravel) is not prohibitive once their engineering properties are known.

Empirical studies have been conducted on mechanical properties of concrete made from locally sourced gravel in Nigeria. Aginam, et al. (2013) investigates various coarse aggregate impacts on the compressive strength of concrete in South-East Nigeria. The experimental study revealed that unwashed gravel produced the least compressive strength of 16.9kN/m2 compared to 20.0kN/m2 of washed gravel. They deduced that there is a positive relationship between concrete strength and internal structure, surface nature and shape of aggregates. In the same vein, Olajumoke and Lasisi (2014) evaluated the strength of concrete made with dug-up gravel available in Ile-Ife area of South-west Nigeria. The study showed that there was significant increase in compressive strength when the gravel used was washed. In determining the compressive strength of washed and unwashed gravel at different mix ratio, Ode and Eluozo (2016), found out that impurities on gravel impacts on the compressive strength of concrete prepared with unwashed gravel. They inferred that there is a positive relationship between strength, stiffness and fracture energy of concrete and type of coarse aggregates.

Properties of Concrete

The most important properties of concrete:

- Workability
- Durability
- Strength
- Volume change
- Air entrainment
- Density

All of these affect the finished product and knowledge of these properties is essential to produce a quality final product.

Workability

Workability is one of the most important of these properties. The degree of workability necessary in a concrete mix depends entirely upon the purpose for which it is used and the methods and equipment used in handling and placing it in the work. Inspectors must use their best judgment in determining the workability of the concrete and must make any adjustments to the mix that is necessary to improve the workability in accordance with instructions in this Manual and the Specifications.

The factors that affect the workability of concrete are size distribution of the aggregate, shape of the aggregate particles, gradation and relative proportions of the fine and coarse aggregate, plasticity, cohesiveness, and consistency of the mix. These factors were all given careful study and investigation at the time the design procedure now in use was established. The proportions of

the fine and coarse aggregate are determined from the shape of the aggregates and the gradation. For instance, a large rock size coarse aggregate that is mainly crushed will permit the use of larger size sand particles and maintain good workability. Well-rounded gravel will have better workability with finer sand, which is needed to fill the smaller void areas. These ideal conditions are seldom found and the mix design requires adjustments to compensate for variations from the ideal conditions. The consistency of the mix, relative to the wetness or dryness, will affect the workability to a large degree. Do not increase the water content beyond the tolerance allowed in Specification 2461.3J without adjustment in the mix design. Adding water in any amount with no control will produce poorer concrete, lowering its strength and durability.

Durability

The ultimate durability is the most important property of concrete. To ensure a high degree of durability, it is essential that clean, sound materials and the lowest possible water content are used in the concrete, together with thorough mixing. Good consolidation during placement of the concrete is important, as are proper curing and protection of the concrete during the early hardening period, which assure favorable conditions of temperature and moisture. Cure concrete properly for a minimum of three days in order to develop good durability.

While strength is always an indicator of quality concrete, it does not necessarily correlate to durable concrete. A low w/c ratio is a good indicator of durable concrete. A general characteristic of a low w/c ratio is that an acceptable strength is usually inherent. The overall voids left in the concrete by excess water are kept to a minimum by keeping the batch water and any add water to a minimum. This gives a more dense concrete along with a more durable and stronger mix.

Strength

The strength of concrete is the next important property to consider. With a fixed amount of cement in a unit volume of concrete, the strongest and most impermeable concrete is one that has the greatest density, i.e., which in a given unit volume has the largest percentage of solid materials. The use of the absolute minimum quantity of water required for proper placement ensures the greatest strength from the concrete.

It is essential that freshly mixed concrete be thoroughly consolidated to eliminate air pockets and secure maximum density in the structure. The Engineer must prevent the occurrence of loosely textured or porous concrete matrix called “honeycombing” to achieve maximum strength and density. The degree of curing and protection afforded after placement is highly important to the final strength attained by the concrete. It is known that the strength increases rapidly at early ages and the rate of strength gain gradually decreases. Concrete will continue to gain strength indefinitely if conditions are favorable. It is therefore, very important that curing is provided at the correct time and for the proper duration of time.

Density

The value of high density was addressed indirectly in connection with other related properties in concrete.

The factors that contribute to high density for all types of concrete are:

• Use of well-graded aggregate of the largest possible maximum size.

• Minimum water content consistent with good workability.

• Minimum air content consistent with adequate durability.

• Thorough consolidation during placement.

Methodology

A total of 72 concrete cubes were considered in this project and all were cured in fresh water. A maximum of 12 cubes were cast for each coarse aggregate size. The concrete cubes were tested and crushed at ages 7, 14, 21 and 28 days. The test specimens were casted using an ordinary Portland cement (Dangote 3x). The mix ratios were 1:2:4 with processed (granite) and local stones used as aggregates. The maximum nominal size of the coarse aggregate used was 25mm. The water cement ratio taken was 0.50. The fresh water used for the mixing and curing the concrete specimens was drinking water. A target slump of 50-100mm was selected for all mixes and all the required materials for preparing concrete were weighed as per the required proportions. All dry materials were placed in the pan and mixed until uniform. All the specimens were demoulded after 24hours of casting and were kept in curing liquid up to the testing dates.

Constituent Materials of Concrete

The materials used for the production of concrete test specimen include:

Aggregate

Aggregates constitute a skeleton of concrete. Approximately three-quarters of the volume of conventional concrete are occupied by aggregate. It is inevitable that a constituent occupying such a large percentage of the mass should contribute important properties to both the fresh and hardened product. Aggregate is usually viewed as an inert dispersion in the cement paste. However, strictly speaking, aggregate is not truly inert because physical, thermal, and, sometimes, chemical properties can influence the performance of concrete (Neville and Brooks, 1990). Aggregate can be divided into two, namely:

- **Fine aggregate:** Aggregates passing through a No. 4 (4.75mm) sieve and predominately retained on a No. 200 (75µm) sieve are classified as fine aggregate. River sand is the most commonly used fine aggregate. In addition, crushed rock fines can be used as fine aggregate. However, the finish of concrete with crushed rock fines is not as good as that with river sand. The river sand used in the experiment was obtained from school gate block moulding site.

- **Coarse aggregate:** Aggregates predominately retained on a No. 4 (4.75-mm) sieve are classified as coarse aggregate. Generally, the size of coarse aggregate ranges from 5 to 150mm. For normal concrete used for structural members such as beams and columns, the maximum size of coarse aggregate is about 25mm. For mass concrete used for dams or deep foundations, the maximum size can be as large as 150mm. the coarse aggregate are the crushed stones or granite (chippings). The crushed granite can be found in many quarry site spread around the country but for the purpose of the experiment the granite used was obtained from stone quarry site in Anambra state.

Portable Cement (Ordinary Portland cement)

Portland cement (PC) concrete is the most popular and widely used building material, due to the availability of the basic raw materials all over the world, and its ease of use in preparing and fabricating all sorts of shapes. It functions as the binder in the concrete mix holding the particles of the mix to form a strong bond. According to the ASTM standard, there are five basic types of Portland cement:

- **Type I:** regular cement, general use.
- **Type II:** moderate sulfate resistance, moderate heat of hydration
- **Type III:** increase C3S, high early strength
- **Type IV:** low heat Type V high sulfate resistance

Water

Water is an important ingredient of concrete, and a properly designed concrete mixture, typically with 15 to 25% water by volume, will possess the desired workability for fresh concrete and the required durability and strength for hardened concrete. The total amount of water in concrete and the water-to-cement ratio may be the most critical factors in the production of good-quality concrete. Too much water reduces concrete strength, while too little makes the concrete unworkable. Because concrete must be both strong and workable, a careful selection of the cement-to-water ratio and total amount of water are required when making concrete (Popovics, 1992). Mixing water is the free water encountered in freshly mixed concrete. It has three main functions:

- It reacts with the cement powder, thus producing hydration products;
- It acts as a lubricant, contributing to the workability of the fresh mixture; and
- It secures the necessary space in the paste for the development of hydration products.

The amount of water added for adequate workability is always greater than that needed for complete hydration of the cement in practice. There is a simple rule concerning the acceptability of mixing water: if water is potable, that is, fit for human consumption, with the exception of certain mineral waters and water containing sugar, it is also suitable for concrete making.

RESEARCH METHODOLOGY

- A total of 72 concrete cubes were considered in this project and all were cured in fresh water. A maximum of 12 cubes were cast for each coarse aggregate size. The concrete cubes were tested and crushed at ages 7, 14, 21 and 28 days. The test specimens were casted using an ordinary Portland cement (Dangote 3x). The mix ratios were 1:2:4 with processed (granite) and local stones used as aggregates. The maximum nominal size of the coarse aggregate used was 25mm. The water cement ratio taken was 0.50. The fresh water used for the mixing and curing the concrete specimens was drinking water. A target slump of 50-100mm was selected for all mixes and all the required materials for preparing concrete were weighed as per the required proportions. All dry materials were placed in the pan and mixed until uniform. All the specimens were remoulded after 24hours of casting and were kept in curing liquid up to the testing dates.

- ❖ Constituent materials of concrete
- ❖ Aggregate
- ❖ Cement
- ❖ Water

TEST EQUIPMENT

The basic equipment used to carry out the test include; shovel, trowel, 150mm by 150mm mould, curing components/materials, set of sieves, sieve brush, mechanical sieve shaker, water supply system, weighing balance, tamping rod, compressive test machine e.tc.

Preliminary Test

1) Sieve Analysis
2) Sieve Analysis of fine aggregate
3) Sieve Analysis of coarse aggregate
4) Water absorption test on coarse aggregate
5) Bulk density of coarse aggregate

RESULT AND ANALYSIS

- ❖ This comprises the results and analysis of tests done in the process of this project. This includes particle size analysis, workability test, specific gravity and compressive strength test.

Particle size distribution

- ❖ Tables (4.1 and 4.2) reveals the particle size distribution analysis carried out on both fine and coarse aggregate in accordance with the guidelines specified by BS 1377; part 2 1990.

Table 4.1Particle size distribution analysis for fine aggregate

Sieve size (mm)	Weight retained (kg)	Cumulative retained	Cumulative % retained	Cumulative % passing
2.00	4.73	4.73	1.58	98.42
1.18	28.63	33.36	11.12	88.88
0.60	108.62	141.98	47.33	52.68
0.425	72.08	217.06	72.35	27.65
0.30	52.86	269.92	89.97	10.03
0.15	27.28	297.19	99.06	0.94
0.075	2.39	299.58	99.86	0.14
Tray	0.42	300.00	100.00	0.00

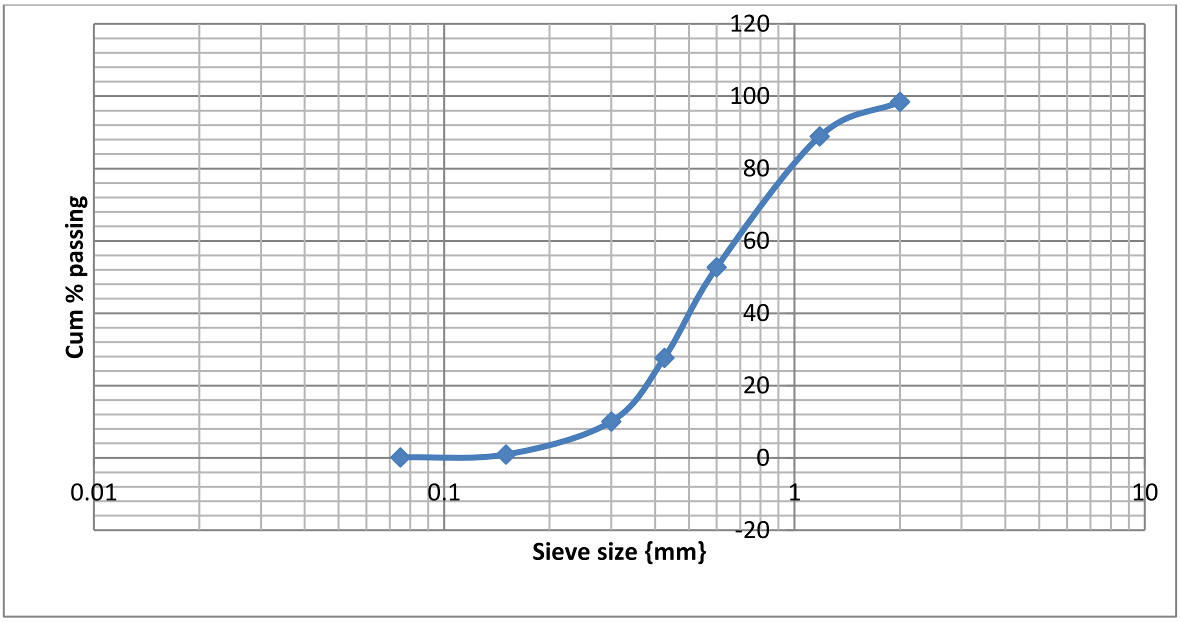

Figure 4.1 Particle size distribution curve for fine aggregate

Table 4.2 Particle size distribution analysis for coarse aggregate

Sieve size (mm)	Weight retained (kg)	Cumulative retained	Cumulative % retained	Cumulative % passing
31.00	0.03	0.03	0.00	100.00
26.5	67.00	67.03	8.38	91.62
19.00	487.25	554.28	69.29	30.72
14.00	229.98	784.26	98.03	1.97
10.00	15.27	799.53	99.94	0.06
4.75	0.05	799.58	99.95	0.05
Tray	0.42	800.00	100.00	0.00

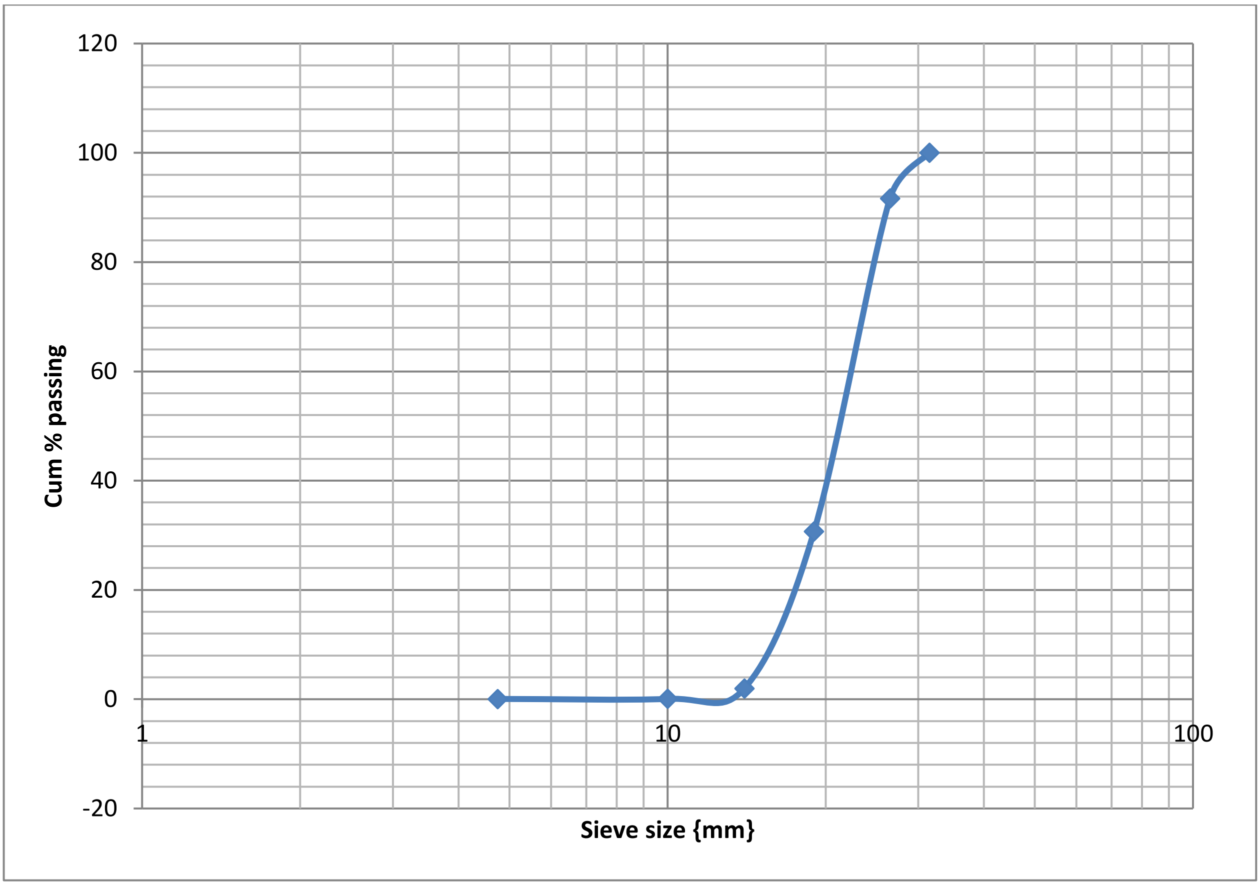

Figure 4.2Particle size distribution analysis for coarse aggregate

The figure (figure 4.1 and 4.2) above reveals the particle size distribution of fine and coarse aggregate. In which a graph of sieve size was plotted against cumulative percentage passing.

Using uniformity coefficient Cu=D60/D10

If the Cu>4 For well graded gravel

Cu>6 for well graded sand

Cu<4 for uniformly graded soil containing particles of the same size

For the coarse aggregate, coefficient of uniformity Cu=D60/D10=23.00/17.00=1.35

For the fine aggregate, coefficient of uniformity Cu=D60/D10=0.69/0.20=3.45

It shows that coarse and fine aggregates is uniformly graded sample containing particles of the same size.

Table 4.6 compressive strength of 12.5mm Granite

S/N	PARAMETER	AGE/PERIOD											
		7DAYS			14DAYS			21DAYS			28DAYS		
1	CROSS SECTIONAL AREA(mm2)	22500	22500	22500	22500	22500	22500	22500	2250 0	2250 0	22500	22500	2250 0
2	MASS OF CUBE(kg)	9.30	9.25	9.00	9.35	9.20	9.10	9.35	9.30	9.20	9.35	9.20	9.25
3	MAXIMUM CRUSHING LOAD(KN)	389.1	379.8	382.5	435.8	453.4	445.2	487.2	498.0	490.5	592.4	569.0	575.0
4	COMPRESSIVE STRENGTH (N/mm2)	17.2	16.8	17.2	19.3	20.1	19.8	21.6	22.1	21.9	26.3	25.2	26.8
AVERAGE COMPRESSIVE STRENGTH (N/mm2)		17.2			19.7			21.9			26.1		

Table 4.7 Compressive strength of 19.5mm Granite

S/N	PARAMETER	AGE/PERIOD											
		7DAYS			14DAYS			21DAYS			28DAYS		
1	CROSS SECTIONAL AREA(mm2)	2250 0	2250 0	22500	22500	22500	2250 0	22500	22500	2250 0	22500	2250 0	22500
2	MASS OF CUBE(kg)	9.30	9.25	9.00	9.35	9.20	9.10	9.35	9.30	9.20	9.35	9.20	9.25
3	MAXIMUM CRUSHING LOAD(KN)	490	503	498	495	520	530	538	540	531	575	568	545
4	COMPRESSIVE STRENGTH (N/mm2)	21.8	22.4	22.1	23.1	22.6	23.3	23.9	24	23.6	25.6	25.2	24.2
AVERAGE COMPRESSIVE STRENGTH (N/mm2)		22.1			23.5			23.9			25.1		

Table 4.8 Compressive strength of 25mm Granite

S/N	PARAMETER	AGE/PERIOD											
		7DAYS			14DAYS			21DAYS			28DAYS		
1	CROSS SECTIONAL AREA(mm2)	22500	22500	22500	22500	22500	22500	2250 0	2250 0	22500	2250 0	225 00	225 00
2	MASS OF CUBE(kg)	9.10	9.25	9.15	9.20	9.15	9.10	9.00	9.15	9.20	9.00	9.15	9.25
3	MAXIMUM CRUSHING LOAD(KN)	358.9	366.4	389.1	406.8	424.2	445.2	466.4	490.9	490.5	580.4	558. 6	575. 0
4	COMPRESSIVE STRENGTH (N/mm2)	15.9	16.2	17.4	18	18.8	18.4	20.7	21.8	20.2	25.7	24.8	25.2
AVERAGE COMPRESSIVE STRENGTH (N/mm2)		16.5			18.4			20.9			25.2		

Table4.9 Compressive strength of 12.5mm local stone

S/N	PARAMETER	AGE/PERIOD											
		7DAYS			14DAYS			21DAYS			28DAYS		
1	CROSS SECTIONAL AREA(mm2)	225 00	22500	22500	22500	2250 0	22500	22500	2250 0	22500	22500	2250 0	22500
2	MASS OF CUBE(kg)	8.65	8.60	8.58	8.95	8.90	8.65	8.90	8.60	8.70	8.60	8.50	8.65
3	MAXIMUM CRUSHING LOAD(KN)	261. 4	288.3	275.2	339.6	350.5	345.6	376	383.2	375	428.2	442.1	435
4	COMPRESSIVE STRENGTH (N/mm2)	11.6	11.4	12.6	15.0	14.9	15.3	16.6	16.4	16.9	18.9	19.4	19.0
AVERAGE COMPRESSIVE STRENGTH (N/mm2)		12			15.1			16.63			19.12		

Table4.10 Compressive strength of 19.5mm Local Stone

S/N	PARAMETER	AGE/PERIOD											
		7DAYS			14DAYS			21DAYS			28DAYS		
1	CROSS SECTIONAL AREA(mm2)	22500	22500	22500	22500	22500	22500	22500	2250 0	2250 0	22500	22500	22500
2	MASS OF CUBE(kg)	8.65	8.60	8.58	8.95	8.90	8.65	8.90	8.60	8.70	8.60	8.50	8.65
3	MAXIMUM CRUSHING LOAD(KN)	336	360	340	369	375	370	435	452	435	479	465	460
4	COMPRESSIVE STRENGTH (N/mm2)	14.9	16.0	15.9	16.4	16.7	16.4	18.4	17.9	17.5	18.8	18.6	19.8
AVERAGE COMPRESSIVE STRENGTH (N/mm2)		15.5			16.6			17.9			19.10		

Table 4.11 Compressive strength of 25mm Local Stone

S/N	PARAMETER	AGE/PERIOD											
		7DAYS			14DAYS			21DAYS			28DAYS		
1	CROSS SECTIONAL AREA(mm2)	22500	22500	22500	22500	22500	22500	22500	2250 0	2250 0	22500	22500	2250 0
2	MASS OF CUBE(kg)	8.90	8.95	8.89	8.95	9.00	8.65	9.00	9.10	9.00	9.00	9.05	9.65
3	MAXIMUM CRUSHING LOAD(KN)	302.6	281.0	295.5	369.9	378.5	398	414.3	406.9	435	446.1	452.0	460
4	COMPRESSIVE STRENGTH (N/mm2)	12.6	13.2	12.1	16.4	16.2	16.7	18.2	18.4	18.1	19.7	20.0	20.2
AVERAGE COMPRESSIVE STRENGTH (N/mm2)		12.63			16.43			18.20			19.90		

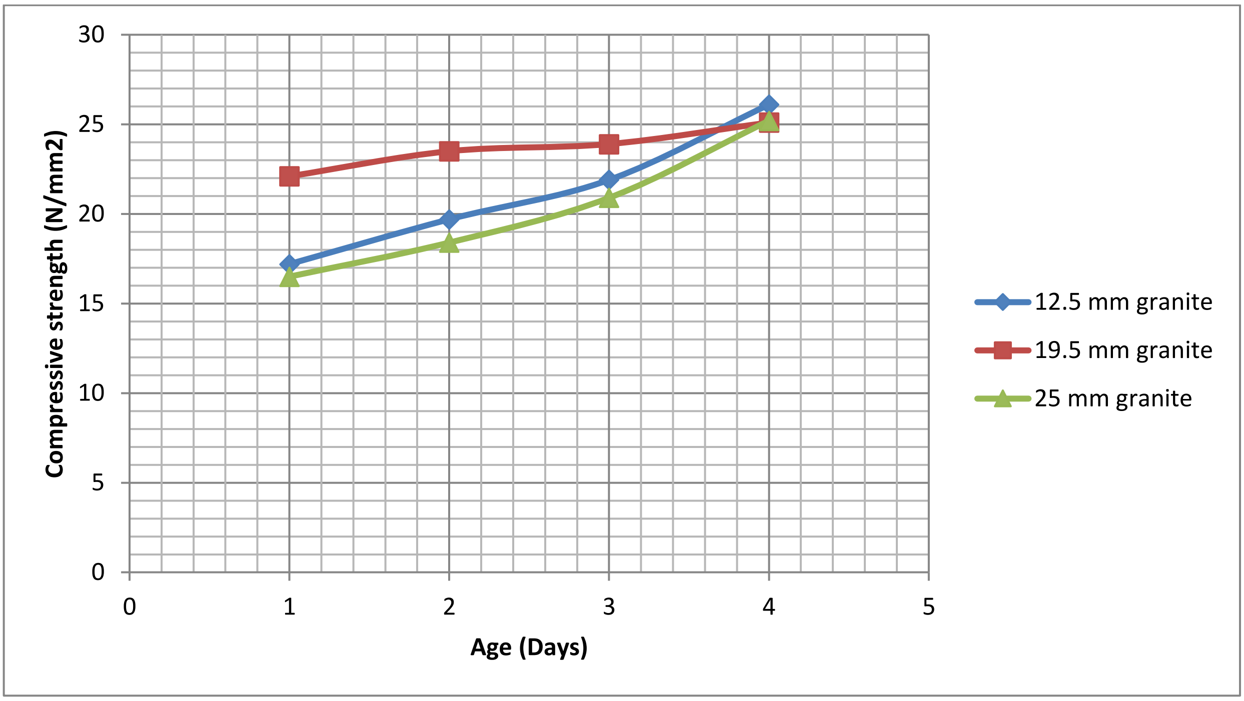

Fig: 4.12 Compressive strength of different granite sizes

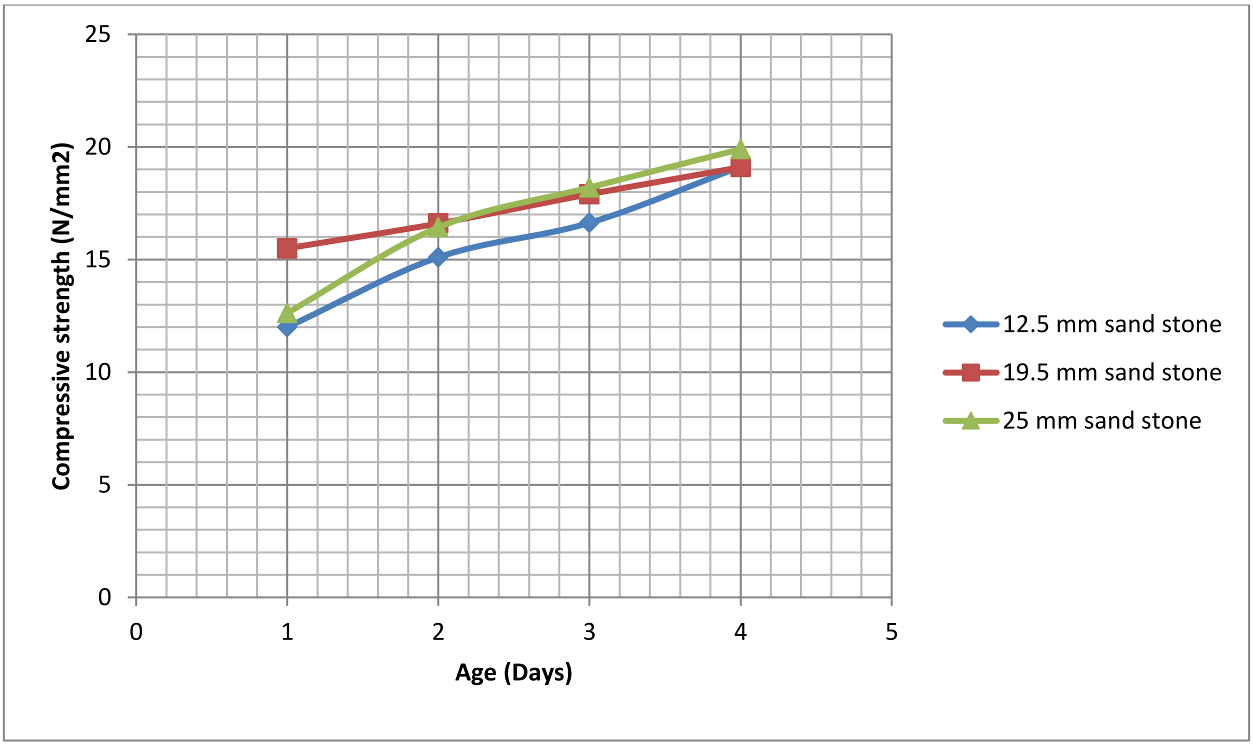

Fig 4.13: Compressive strength of different Sand stone sizes

CONCLUSION

Based on the investigation of the effect of aggregate sizes on the concrete strength, analyzed above, the following conclusions can be drawn:

- Concrete test results to determine the effect of aggregate sizes on comprehensive strength shows that concrete with a 12.5mm ($\frac{1}{2}$ inch) maximum size aggregate yields higher comprehensive strength than concrete with a 19.5mm ($^{3}/_{4}$ inch) and 25mm (1 inch) maximum size aggregate, although the difference between 19.5mm and 12.5mm is not significant for granite.

- Particle size distribution: It shows that fine and coarse aggregate are uniformly graded (CU = 3.45 and 1.35).
- The workability of the different aggregate sizes at the same water-cement ratio of 0.5 decreases as the aggregate size increases.
- The compressive strength of 19.5mm at age of 7 days, 14days and 21 days, yielded more strength than 12.5 yields more strength.
- For sandstone (local stone), it is observed that the compressive strength increases as the coarse aggregate size increases but the difference in the compressive strength especially 19.5mm and 25mm is not too much.
- For my result, it is observed that the strength of granite of different sizes are greater than sand stone of the same size.

Recommendation

1. For major structure, it is advisable to use granite rather than local stone because granite performs best in compression than local stones.
2. For smaller structures, the sand stone (local stone) can be more economical because they can give appreciable strength.
3. Proper compaction of the concrete must be ensured, as compaction is observed to improve the strength of concrete.
4. Investigation should be extended to the effect of washing on the compressive strength of concrete.
5. Investigation should be extended to the effect of mixing different aggregate sizes on the compressive strength of concrete.
6. Investigation should extended to the effect of varying water/cement ratio on the compressive strength of concrete made with varying coarse aggregate sizes.

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