American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-6, Issue-3, pp-79-85
www.ajer.org
Research Paper Open Access

Behavior of Concrete with Agro and Industry Waste as a Replacement for Constitutive Materials

M.Vignesh Kumar[1], Keba Lemessa[2]
[1, 2](*Construction technology and management, College of Engineering/ Wollega University, Ethiopia*)

ABSTRACT: *Partial or full replacement of these raw materials of concrete by waste products may decrease cost, reduce energy consumption and decrease environment pollution as well as protect the environment from industrial and agro wastes such like municipal waste, coal mine, lime sludge, ground nut shell ash, Quarry dust, iron tailing, marble dust, rice husk, lime stone, Hazardous waste, zinc tailing, jute fiber, rice wheat straw, etc., Ground nut shell ash can be used as filler material and helps to reduce the voids content in concrete material. Since the use of quarry dust in concrete can equivalently be used as a replacement of river sand, it has desirable benefits such as useful disposal of by product. In this investigation the workability and strength features of M20 grade concrete with 50% quarry dust replacement for river sand and 5% and 10% ground nut shell ash for cement at 28 days is done using IS mix design method. The concrete compressive strength made of 50% quarry dust and 10% GSA is more than that of the control concrete. When the tensile, split and flexural strength is concerned, they have more or less better result, but the control concrete is more workable than the concrete with 50% quarry dust and 10% GSA replaced. Finally the surface hardness replaced concrete is more or less same to that the control concrete because when Ground nut shell ash mixed with cements and quarry dust, it forms like a gel and make a concrete hard. Therefore, the experimental results showed that the use of quarry dust with ground nut shell ash in concrete improved strength characteristics as depicted above, as well as the results is well attained to be used reasonably.*

Keywords: *GSA-Ground nut shell ash, Quarry Dust, Cement, River Sand, Strength Properties.*

I. INTRODUCTION

Concrete is crucial and well known material in construction industry being vital component in most structures work for its strength, durability and extra factors. But this crucial material has ingredients which need high production energy, high cost and through environmental depletion. Therefore it's inevitable replacing these concrete ingredients with those which need less production energy preferably waste materials without compromising the conventional concrete characteristics. The waste material from rock after processing for different purposes having sizes less than 4.75mm is known as quarry dust which size is equivalent to river sand. Using this quarry dust in alternative to river sand reduce the demand of the latter and protect environmental depletion in fetching same. Similarly in last decade's production of cement needs high heat which has negative impact on global warming [1]. The use of Ground nut Shell Ash will also contribute to the production of concrete of a higher quality at lower cost and reduces the environmental problem [2]. Groundnut shell which is a by-product from agricultural waste cheaper than ordinary Portland cement and available in large qualities in many northern states of Nigeria, the utilization of this product in concrete work would therefore reduce the effect of this agricultural waste acting as an agent of environmental pollution. During and after the harvest of groundnut, the shell is regarded as waste product which when accumulated in large quantity in a particular area will constitute an environmental hazard. In recent times, the knowledge of natural pozzolanas materials use as partial replacement for cement has increased substantially[3].Characteristics strengths revealed that the OPC/GSA concrete of 10% replacement performed better in comparison to the acceptable standard and would be more suitable for mass concrete production [2].Hence along with this are demanded good scientific and technical capabilities for the assessment and substantial development of the country for water resource potential and considering quality particularly the groundwater[4].With these reasons, this work evaluates the feature of strength and performance of the groundnut shell ash (GSA) as a partial replacement (5%, 10%) for cement and 50% quarry dust replacement for sand in concrete. Various percentages of GSA and quarry dust were used to produce the concrete characteristics performance were measured after curing in water for 28 days hydration periods by conducting Compressive and splitting tensile tests on the hardened concretes.

II. MATERIALS USED AND THEIR PROPERTIES

2.1 Cement

Ordinary Portland Cement (43 Grade) with 29 percent normal consistency conforming to IS: 8112-1989 [3] was used. The specific gravity and fineness modulus of cement are 3.15 and 1.2% respectively.

2.2 Ground nut shell ash Preparation

- The collected groundnut shells were processed as listed below,
- Cleaned with potable water
- Particulate materials adhering the top surface of the shell is removed by pressurized air
- Sun dried then Burnt above 500° C in an open environment (to remove carbon from the Groundnut Shell)
- After burnt, we can collect the Groundnut Shell ash as a product
- Ground nut shell ash was observed as finely divided form of ash.

(a) Stage I (30 Minutes) **(b)** Stage II (1hour) **(c)** Stage III (1.30 hours)

Fig.1 GSA Preparation Pictures of various Stages

2.3 Fine Aggregate and Quarry Dust

The material is collected from devathanapatti near periyakulam, theni district, tamilnadu, India. The physical and chemical properties of sand and Quarry Rock Dust obtained by testing the samples as per Indian Standards are listed in Tables 1 and 2, respectively. The properties of sand & quarry dust by conducting tests according with IS 2386 (part-1) – 1963.

2.4 Coarse Aggregate

Crushed stone coarse aggregate conforming to IS 383 – 1987 was used. The values of loose and compacted bulk density values of coarse aggregates were 1600 and 1781 Kg/m^3.

2.5 Water

Water is an important ingredient of concrete as it actively participates in chemical reactions with cement. Clean potable water conforming to IS 456 – 2000 was used for the preparation of concrete mixture.

Table 1: Physical properties of cement, GSA, sand, quarry dust and coarse aggregate

Properties	Cement	GSA	Natural sand	Quarry Dust	Coarse aggregate
Specific gravity	3.15	1.85	2.52	2.41	2.79
Initial Setting Time (min)	45	64	-	-	-
Final Setting Time (min)	240	330	-	-	-
Normal Consistency (%) (by weight of cement)	29	18	-	-	-
Fines modulus	-		2.46	3.77	5.91
Uniformity coefficient	-		1.82	1.28	1.5
Coefficient of curvature	-		0.98	1.06	1.1
Sieve Analysis	-		2.43	3.36	-
Fineness (by sieving)	1.2	1	-	-	-

Table 2: Chemical properties of quarry dust and GSA [REF 1,2]

Constituents	Quarry Dust	Ground nut shell ash
Loss of ignition, (% by mass)	0.74	4.80
Silica as SiO_2 (% by mass)	63.58	16.21
Aluminium as Al_2O_3 (% by mass)	14.97	5.93
Iron as Fe_2O_3 (% by mass)	7.07	-

Titanium TiO_2 (% by mass)	0.64	-
Calcium as CaO (% by mass)	5.36	8.69
Magnesium MgO (% by mass)	3.83	6.74
Sodium Na_2O (% by mass)	2.55	9.02
Potassium as K_2O (% by mass)	1.26	15.73
Sulphite	-	6.21
Ferrous oxide	-	1.80

III. MIX DETAILS

The concrete mix has been designed for M_{20} grade as per IS 10262 – 2009. The specific concrete grade involves the economical selection of relative proportions of cement, Ground nut shell ash, fine aggregate, Quarry dust, coarse aggregate, and water.

Table 3: Details of mix proportions of concrete

INGREDIENTS	MIX DESIGNATION			
	G_0Q_0	G_1Q_1	G_2Q_2	G_3Q_3
Cement (Kg/m^3)	372	372	353.4	334.8
Sand (Kg/m^3)	723.84	361.92	361.92	361.92
Quarry dust(Kg/m3)	0	356.52	356.52	356.52
Coarse aggregate(Kg/m^3)	1044	1044	1044	1044
water(lit/m^3)	186	186	186	186
Ground nut shell ash (kg/ m^3)	0	0	18.6	37.2

G_0Q_0 = Control concrete, G_1Q_1 = Quarry dust concrete 50% replace for sand without GSA,
G_2Q_2 = Quarry dust concrete 50% replace for sand with GSA 5% replace for cement,
G_3Q_3 = quarry dust concrete 50% replace for sand with GSA 10% replace for cement.

IV. RESULTS AND DISCUSSION

4.1 Workability of concrete

The relevant and reasonable tests done to check the workability of concrete are Slump-cone and compaction factor and flow table tests. Even if the speed decrement varies, the value of Slump decreases with the increase in amount of quarry dust and GSA in the concrete samples since water absorption capacity of quarry dust is more. This means that the reductions in workability of concrete are attributable to the properties of fine aggregates. When the percentage of the finer particles is increased then workability decreases since the ratio of the surface area of the particles to their volume increases.

Table 4: Results of workability tests on concrete

Types of concrete	Slump value mm	Compaction Factor	Flow %	Remarks
G_0Q_0	90	0.94	60	More workable
G_1Q_1	82	0.87	50	Workable
G_2Q_2	82	0.86	50	Workable
G_3Q_3	80	0.80	45	Medium Workable

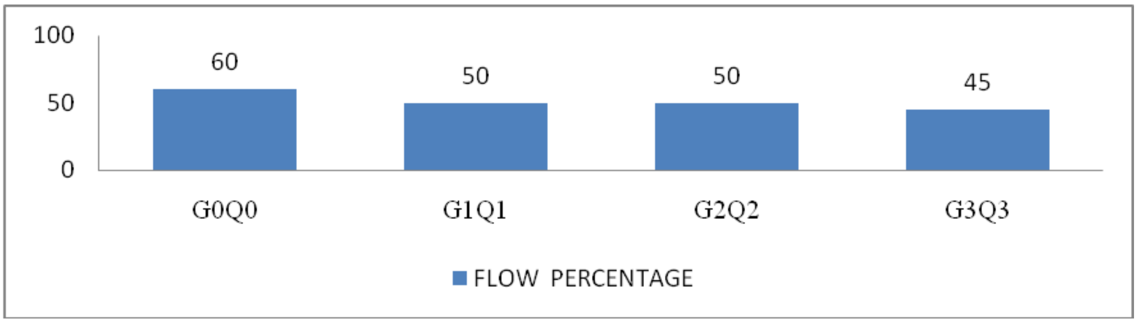

Fig.2 Comparison of Flow Table Test value

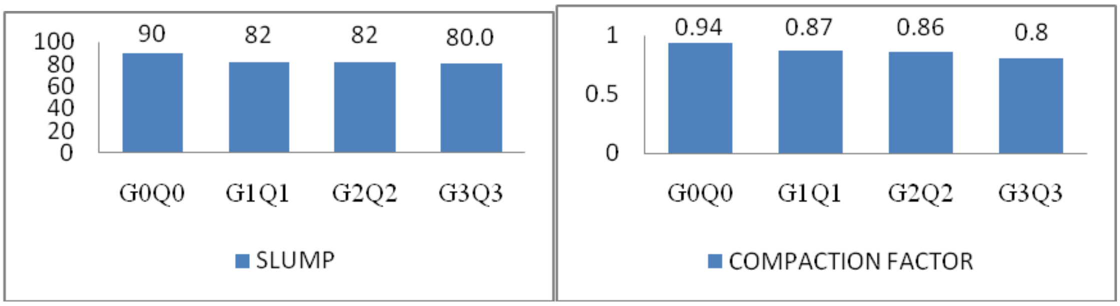

Fig.3 Comparison of Slump & Compaction Factor Test values

4.2 Compressive Strength of Concrete

The compressive strength of hardened concrete is often used as an index of the overall quality of concrete because it is considered one of the most important concrete properties. The compressive strength of cube and cylinder 10% replacement of cement by GSA in quarry dust concrete 50% replace for sand, is little better than control concrete as it can be observed from test results of table 5 and 6.

Fig.4 Specimen for Compressive Strength of Cubes

Fig.5 Failure of compressive cube

Table 5: Test results of cube for compression

Curing days	Average compressive strength in N/mm^2			
	G_0Q_0	G_1Q_1	G_2Q_2	G_3Q_3
3	14	13	13.5	13.7
7	18	16.3	16.55	18.4
14	24	20.8	21	24.6
28	28.2	23	23.5	28.95

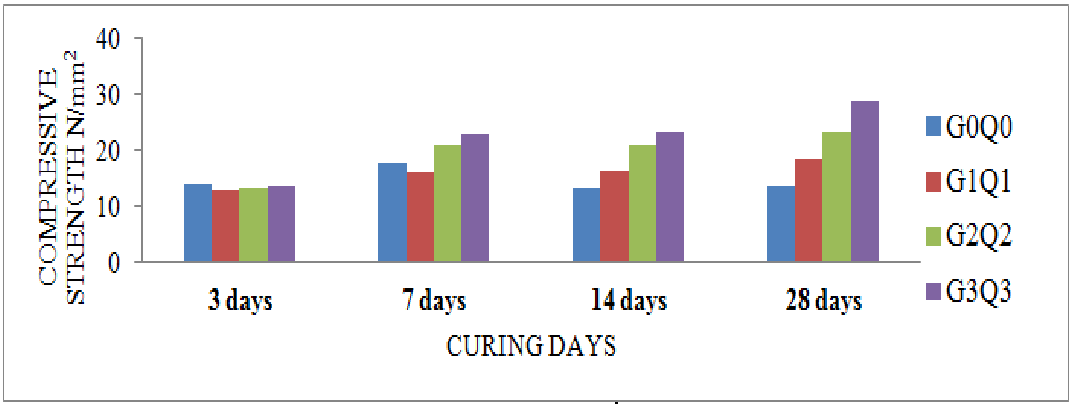

Fig.6 Comparison of Compressive Strength of cube

Fig.7 Specimen for compressive strength of cylinder **Fig.8** Failure of compressive cylinder

Table 6: Test result of cylinder for compression

Curing days	Average compressive strength in N/mm^2			
	G_0Q_0	**G_1Q_1**	**G_2Q_2**	**G_3Q_3**
3	10	8.5	9	12.3
7	13.4	12	12.5	14
14	18	14.5	16	18
28	23	18.95	19	24

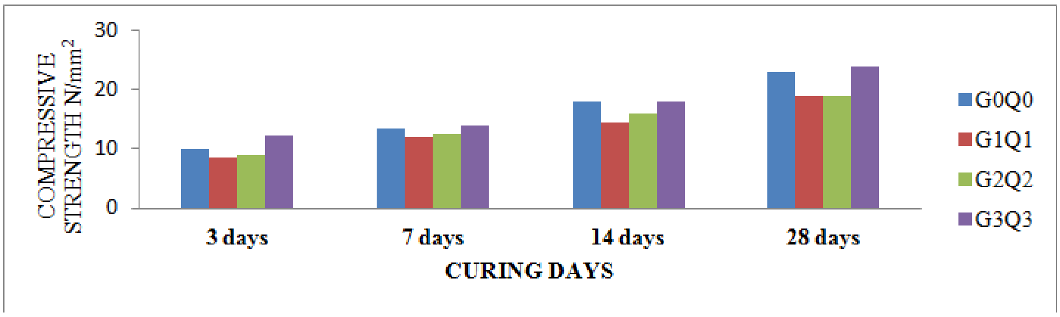

Fig.9 Comparison of Compressive Strength of Cylinder

4.3 Split Tensile Strength of Concrete

The split tensile strength of different fine aggregate concrete with and without GSA has been carried out and results show similar variation to that of compressive strength as can be observed from results in table 7. Therefore Split tensile strength of quarry dust with 10% GSA cylinder concrete is increased, when compared to control concrete.

Fig.10 specimen for split tensile strength of cylinder **Fig.11** Failure of split tensile cylinder

Table 7: Test result of cylinder for split tensile

Curing days	Average split tensile strength of cylinder in N/mm^2			
	G_0Q_0	**G_1Q_1**	**G_2Q_2**	**G_3Q_3**
3	4.4	4	4.10	4.10
7	5.5	5	4.96	5.50
14	7	6.3	6.5	7.40
28	8.15	6.9	7.10	8.20

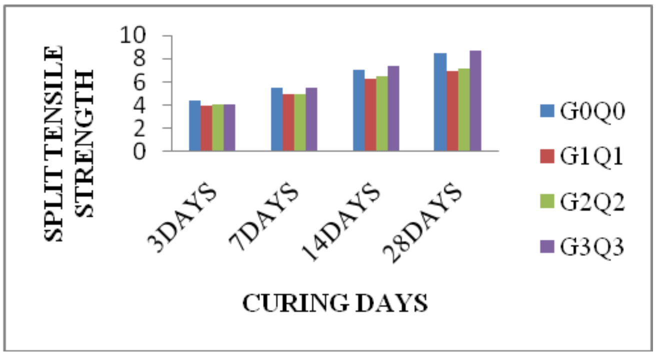

Fig.12 Comparison of split tensile strength of cylinder

4.4 Flexural Strength of Concrete

It can be observed from table 8 that flexural strength of beam plain concrete, made of quarry dust with 10% Ground nut shell ash, is increased when compared with Control concrete.

Table 8: Test Result of Beam for Flexural

Curing days	Average flexural strength of beam in N/mm^2			
	G_0Q_0	**G_1Q_1**	**G_2Q_2**	**G_3Q_3**
3	3	2.8	2.8	3
7	5.6	4.6	4.65	6
14	8.4	7.9	8	10.5
28	13.2	11.2	11.4	14

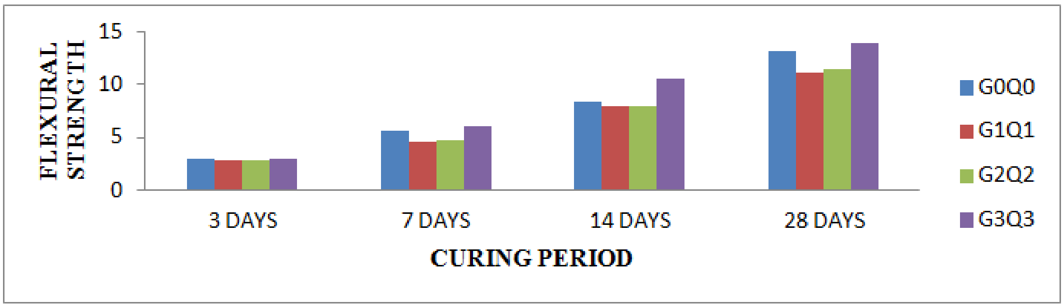

Fig.13 Comparison of flexural strength results

4.5 Rebound Hammer

The surface hardness of concrete can be finding out by using Rebound hammer test, which is related to compressive strength. The surface hardness value of control concrete is higher than that of quarry dust concrete (table 9). Similarly, 50% of Q.D with 10% Ground nut shell ash concrete is increased to control concrete value.

Table 9: Test results of rebound hammer

Type of concrete	Rebound value	Compressive strength(Mpa)
G_0Q_0	14	28.2
G_1Q_1	12	23
G_2Q_2	12	23.5
G_3Q_3	15	28.95

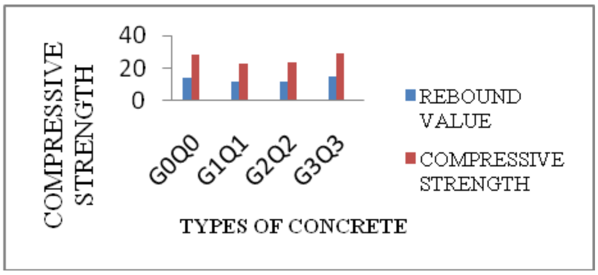

Fig.14 Comparison of rebound and compressive results

V. CONCLUSION AND RECOMMENDATION

- The replaced concrete is less workable than the control concrete
- Compressive strength for cube and cylinder composed of quarry dust of 50% with 10% replacement of cement by GSA is better than the control concrete.

- The split tensile strength of the cylinder, flexural strength of the beam of the replaced concrete is better than that of the control concrete.
- The surface hardness from rebound value of the replaced concrete is more or less same to that the control concrete. When Ground nut shell ash mixed with cements and quarry dust, it forms like a gel and make a concrete hard.
- Therefore it can be concluded that the replaced concrete can be reasonably used instead of the control concrete since their 28days strength is well attained.
- Therefore, the experimental results showed that the use of quarry dust with ground nut shell ash in concrete improved strength characteristics, as well as the results is well attained to be used reasonably.
- Hence we recommend using these replacement materials and preserve environment from agro and industry wastes.

REFERENCES

Journal Papers:

[1]. M.Vignesh Kumar[1], Keba Lemessa[2] Strength Properties of High Grade Concrete Replacing Main Ingredients by Quarry Dust & Silica fume, International Journal of Engineering Science Invention, ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 www.ijesi.org ||Volume 5 Issue 11|| November 2016 || PP. 45-51.

[2]. Buari T.A, Ademola S.A, Ayegbokiki S.T. Characteristics Strength of groundnut shell ash (GSA) and Ordinary Portland cement (OPC) blended Concrete in Nigeria, IOSR Journal of Engineering (IOSRJEN) e-ISSN: 2250-3021, p-ISSN: 2278-8719 Vol. 3, Issue 7 (July. 2013), ||V6 || PP 01-07.

[3]. T.C. Nwofor and S. Sule , stability of groundnut shell ash (GSA)/ordinary Portland cement (OPC) concrete in Nigeria Pelagia Research Library Advances in Applied Science Research, 2012, 3 (4):2283-2287.

[4]. Shayaq Ali1*, Muleta Ebissa1, Diriba A.Gurmu1, M.Vignesh Kumar, Groundwater Quality Assessment of Different Wells in East Wollega Zone – Western Ethiopia, International Journal of Basic and Applied Sciences, 2015, 1(2),28-34, eISSN-2455-331X Shayaq Ali et al., Page No. 28 Research Article.

Books:

[5]. Indian standard code Books IS: 8112-1989, IS 2386 (part-1) – 1963, IS 383 – 1987, IS 456 – 2000, IS 10262 – 2009.