International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 5, Sept-Oct-2020, ISSN (Online): 2395-566X

Alternative Strengths to Concrete by Stone Dust and Ceramic Scrap and Effective Utilisationof Solid Waste

Kiran Niveditha
Dept of Civil Engineering, CIT, Gubbi, Tumkur, India

***Abstract*-The compressive strengths of concrete using natural sand and quarry dust were measured in the laboratory. Compressive strength was found to increase with ages for normal concrete. Results show that with partial replacement of stone dust with 05% and 05% Ceramic waste coarse aggregate, flexural strength increased by 20, 48 and 40% at the age of 28 days as compared to referral concrete. Compressive strength of concrete made using 05 % ceramic waste aggregate and 05 % stone dust as replacement of coarse aggregate and fine aggregate respectively, is about 20% more than that of referral concrete at 28 days. However, compressive strength at 05% recycled aggregate and 05% stone dust is marginally than that of conventional concrete. The compressive strength of 05% stone dust and ceramic waste sample is in close proximity of the referral concrete. Thus, it can be concluded that stone dust up to 05% with 05% ceramic waste aggregate is satisfactory for use. Observing the above results, strength aspects of ceramic waste aggregate concrete is well within the permissible limits and ideal replacement level of ceramic waste is 20% and 40%.Water absorption of ceramic waste aggregate was 0.18% higher than that of natural aggregate (0.10%), due to the opening of pore structure during crushing and chiselling. Even after crushing and chiselling, few cracks were observed on surface of ceramic waste. For these reasons water absorption was little more than that of the natural aggregate. Both compressive and split tensile strengths decrease as the quantity of ceramic waste aggregate increases.**

***Keywords*-Ceramic, concrete, disposal of solid waste, strength.**

I.INTRODUCTION

If some of the waste materials are foundsuitable in concrete making, not only cost of construction can be cut down, but also safedisposal of waste materials can be achieved.Concrete is vital component used for all types of structuresto mitigate the construction cost and quantity of building materials we have to go for alternate materials. Concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, motorways/roads, runways, parking structures, dams, pools or reservoirs, pipes, footings for gates, fences and poles and even boats. Combining water with a cementations material forms a cement paste by the process of hydration.

The cement paste glues the aggregate together, fills voids within it, and makes it flow more freely. A conventional concrete is becoming costlier owing to the non-availability of the fine aggregate in the vicinity of the site of construction. Hence an investigation is carried out on alternative building material. Aggregate is one of the important constituents which has effect in strength development in the theory that the gaps of coarse aggregate is filled by the fine aggregate and the gaps of fine aggregate is filled by the binding materials. In addition the strength of concrete mainly depends on water/cement ratio, aggregate gradation, and aggregate size and shape, cement quality, mixing time, mixing ratios, curing etc. Concrete must be both strong and workable, a careful balance of the cement to water ratio is required when making concrete. Fine aggregate are basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. For concrete sand fineness modulus range is 2.3-3.1. Among these ingredients river sand is commonly used as fine aggregate in concrete which is becoming scarce and hence expensive due to excessive cost of transportation from natural sources.

The large scale depletion of these sources creates serious environmental problems. So Governments are restricting the collection of river sand from river bed. In such a situation the crusher dust can be an economical alternative to river sand. Crusher dust is a byproduct generated from quarrying activities involved in the production of crushed coarse aggregate. The residue from stone crusher is further washed with water to remove the excess fines so that the fraction confirming to the IS 383 – 1970 specifications can be extracted.

1. Need of stone dust as a fine aggregate

The alternative material should be waste materials in the aspects of reduction in environmental load and waste

International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 5, Sept-Oct-2020, ISSN (Online): 2395-566X

management cost, reduction of production cost as well as augmenting the quality of concrete. Hence crushed sand has been identified as a substitute for river sand thereby solving the issue of mining of sand from river beds and improving the quality of fine aggregate. Quarry dust has been used for different activities in the construction industry such as road construction, and manufacture of building materials such as light weight aggregates, bricks and tiles.

Availability of good quality Natural River sand due to depletion of resources and restriction due to environmental consideration has made concrete manufactures to look for suitable alternative fine aggregate. One such alternative is “stone dust”.Fine aggregate is often obtained from river beds. This became very scarce as the Government of Tamil Nadu has imposed ban on the mining of the same due to the environmental hazards. The quality of the river sand normally depends on its source and most of the time it varies quite a lot. As the use of fine aggregate in concrete is more than 30% of the composite, its mechanical properties affect the quality of concrete.

Crushed rock aggregate quarrying generates considerable volumes of quarry fines, often termed “quarry dust”. The finer fraction is usually smaller than according to Chaturanga et al., [25] is desirable because of the benefits such as useful disposal of a by-product, reduction of river sand consumption and increase instrength. Quarry dust has rough, sharp and angularparticles, and as such causes a gain in strength due tobetterinterlocking.Quarry dust has been identified as possiblereplacement for sharp sand in concrete works.Jayawardena and Dissanayake [5, 6] in their paper “Use ofquarry dust instead of river sand for future constructions inhornblende and hypersthenes as the major minerals Sri Lanka” identified quartz, feldspar, biotitic mica,presentin fresh rock which shows mica percentages between 5%and 20%. They added that mica percentages in charnockticgneiss and granitic gneiss are always less than 5%, similarto sand and therefore suitable for use in civil engineeringconstruction.

1.1. Advantages of Stone dust

- Have no impurities like silt, clay and pebbles.
- Possess less curing time.
- Have no wastage, no additional labour cost for sieving and saves 15% to 20% on cost.
- Provides 40% additional durable and strength compared to other sand (6).
- Is supplied throughout the year in all monsoon season.
- Is natural rock cursed stone sand.
- Can be used as by product for producing eco-friendly blocks, pavers and fly ash bricks.

Table 1 Physical properties of quarry rock dust and natural sand.

Property	Quarry rock dust	Natural sand	Test method
Specific gravity	2.54-2.60	2.60	IS 2386 (Part III) 1963
Bulk relative density (kg/m^3)	1720-1810	1460	IS 2386 (Part III) 1963
Absorption (%)	1.20-1.50	Nil	IS 2386 (Part III) 1963
Moisture content (%)	Nil	1.50	IS 2386 (Part III) 1963
Fine particles less than 0.075mm (%)	12-15	06	IS 2386 (Part I) 1963
Sieve analysis	Zone II	Zone II	IS 383 - 1970

Table 2 Chemical compositions of quarry rock dust and natural sand.

Constituent	Quarry rock dust (%)	Natural sand (%)	Test method
SiO_2	62.48	80.78	[10]IS: 4032-1968
Al_2O_3	18.72	10.52	
Fe_2O_3	06.54	01.75	
CaO	04.83	03.21	
MgO	02.56	00.77	
Na_2O	Nil	01.37	
K_2O	03.18	01.23	
TiO_2	01.21	Nil	
Loss of ignition	00.48	00.37	

2. Ceramic scrap

Now a day’s disposal of solid waste is the major problem in the world wide, because of land for disposal of this waste is .Recycled aggregates can be defined as the result of waste treatment and management where, following a process of crushing to reduce size, sieving and laboratory analysis, the waste complies with technical specifications for use in the construction sector and civil engineering.

According to Ignacio (2007) it is not possible to carry out an exhaustive characterization of all kinds of recycled aggregates. Therefore, this topic will be discussed in more general terms by looking at concrete aggregates, asphalt agglomerate aggregates and other recycled aggregates which incorporate aggregates from clean ceramic material waste and aggregates from mixtures. As mentioned previously, one of the objectives of the new waste reuse and recycling policies in the construction and industrial sectors is to use recycled aggregates as a substitute for conventional natural aggregates, with the aim of reducing both use of natural resources and environmental impact caused by dumping.

International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 5, Sept-Oct-2020, ISSN (Online): 2395-566X

2.1. Ceramic Waste

As a result, recent years have witnessed rising social concern about the problem of waste management in general, and industrial waste and waste from the construction industry in particular. This problem is becoming increasingly acute due to the growing quantity of industrial, construction and demolition waste generated despite the measures which havebeen taken in recent years at European Community, national and regional levels aimed at controlling and regulating waste management, in accordance with sustainable development policies and the Kyoto Protocol.

2.2. Advantages of Ceramic Waste

- High Electrical and thermal insulating property.
- Chemically stable and high melting temperature.
- Brittle and virtually no ductility.
- High temperature stability.
- More resistance to fire hazarder.

2.3. Objectives

The following are the objectives of ceramic waste and stone dust are

- The effective utilization of solid waste such as ceramic scrap waste as a coarse aggregate.
- The effective utilization of rock waste such as stone dust used as a fine aggregate.
- The alternative usage of stone dust and ceramic waste should reduces some considerable amount of cost
- In order to improve the solid waste disposal
- Minimization of cost of construction materials

II. EXPERMENTAL STUDY

1. Materials

It is quite obvious that the strength of concrete depends upon the strength of its constituents. Therefore it is very necessary to know the characteristics of the materials used in any concrete. The materials used in the study includes ordinary Portland cement (53grade), fine aggregate (Natural sand and stone dust), Ceramic scrap, Portable water for mixing and curing.

The properties of these materials are represented in the following section.

1.1. Cement

Cement is a fine powder, which when mixed with water and allowed to set and harden can join different components or members together to give a mechanically strong structure. Cement can be used as a binding material with water for binding solid particles of different sizes like bricks, stones or aggregates to form a monolith.

There are two different requirements that any cement must meet:

- It must develop the appropriate strength and
- It must exhibit appropriate rheological behaviour among the chemical constituents of cement.

The predominant type of cement used in modern concrete is Portland cement, other types of cement available include; Blended cement, which is similar to Portland cement but may contain materials such as fly ash slag or silica fume; High early strength cements, which as the name suggests gains strength a lot quicker then Portland or blended cements; Low heat cements, used when limits are placed on the heat of hydration of the concrete; Shrinkage limited cements; Sulphate resisting cements, Coloured cements; Masonry cement.

The cement used in all mixtures of the study was an ordinary Portland cement of 53 grade. The physical and chemical properties of the cement used are listed in table. All the results meet the requirement of ASTMC150 specification [37] and IS: 12269, 1987.The Table 3.1 shows the physical characteristics of the cement used.

Table 3 Physical Properties of OPC of 53 grades.

Sl. No.	Details	Results	As per IS 12269-1987
1.	Fineness (%)	3.0	Should not be > 10%
2.	Normal Consistency (%)	30	_
3.	Specific Gravity	3.10	_
4.	Setting Time(in minutes) Initial Setting Time Final Setting Time	 28 min 538 min	Should not be less than 30min < 600min

1.1.2.Compressive Strength of Cement

The result obtained on test the cubes of cement mortar, after three days and seven days were 17.36N/mm2 and 24.6 N/mm2 respectively. Corresponding results of IS code are 115 and 175 N/mm2 respectively which confirms that quality of cement used in investigation was good. Properties of Portland cement as per IS specifications.

1.2. Fine Aggregate

The fine aggregate used in mixtures are natural sand and stone dust. Locally available river sand which is the natural sand and stone dust from the quarry passing through 4.75 mm sieve and retained on 75 micron sieve is

International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 5, Sept-Oct-2020, ISSN (Online): 2395-566X

used. The gradation of bothsand confirm to Zone II, of IS 383-1970. Sieve analysis and properties of fine aggregate is shown in the table 4

Table 4 Sieve Analysis of Fine Aggregates.

Sieve Size (in mm)	N-Sand	Stone dust	Zone II Gradation Specification
4.75	98.63	99.40	90 – 100
2.36	92.91	98.425	75 – 100
1.18	57.38	69.605	55 – 90
0.60	28.45	41.855	35 – 59
0.30	7.43	12.835	8 – 30
0.15	1.144	1.560	0 – 10
0.075	0.254	0.935	0-5
Remarks	coarse	coarse	Coarse

1.3. Coarse Aggregates
1.3.1. Conventional Coarse Aggregate:

Machine crushed granite obtained from a local Quarry was used as coarse aggregate.
Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. The aggregates occupy 70 to 80 % of volume of concrete. The aggregates between 4.75 mm to 50 mm are classified as coarse aggregate, except for the mass concrete which may contain up to 150 mm size aggregate. The properties of the aggregate affect the water demand, workability and cohesion of concrete in plastic state and strength, density, durability and porosity of hardened concrete.

Table 5 Properties of Coarse Aggregate.

Property	Crushed aggregate
Specific gravity	2.47
Water absorption %	0.10
Impact value %	26.67
Crushing value %	32.67
Abrasion value %	14.25

1.4. Ceramic Scrap:
The ceramic scrap was obtained from a local ceramic insulator industry. The ceramic insulators are initially broken into pieces with hammer in to required size.

Table 3.4 Properties of Ceramic waste Aggregate.

Property	Ceramic waste aggregate
Specific gravity	2.42
Water absorption %	0.18
Impact value %	21.0
Crushing value %	25.0
Abrasion value %	10.25

Fig-1 Ceramic waste after crushing to 20 mm down size.

Table 6 comparison of crushed and ceramic waste aggregates.

Property	Crushed aggregate	Ceramic waste aggregate
Specific gravity	2.68	2.50
Water absorption %	0.10	0.18
Impact value %	18.60	22.0
Crushing value %	15.30	20.0
Abrasion value %	14.25	19.0
Bulk density		
Loose condition	1219	1069
Dense condition	1425	1188

1.5. Preparation of Specimens
For each mix the test specimens were cast for the compressive strength and flexural strength at 3,7 and 28 days and also split tensile strength at 28 days.

The following table gives the details of number of control specimen used for each proportion and also their sizes.

Shape	Size	No of specimens per proportion
Cube	150mmx150mmx150mm	9
Cylinder	Dia=150mm, H=300mm	2
Beam	100mmx100mmx500mm	6

Total number of specimen=17

1.6. Mixing

The cement and Quarry dust are accurately weighed as per calculations for each proportions and were mixed together until a uniform colour was obtained. Then this mix is mixed with required quantity of sand and maintain uniform colour. This dry mix of cement, Quarry dust and

International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 5, Sept-Oct-2020, ISSN (Online): 2395-566X

sand is placed over a stack of required quantity of stone aggregates and the whole mixed dry turning at least three times to have uniform mix. Water according to the water cement ratio is added slowly and gradually with a water-can while being mixed, to give a plastic mix of the required workability. The whole shall be mixed thoroughly turning at least three times to give a uniform concrete.

Compaction: Compactions were done by mechanical device. The moulds were placed on a clean platform and mixture was added in the mould and the device is vibrated to avoid any honey combing in specimen. After the compaction was over, the top surface of the specimen was finished smooth with the help of a trowel.

Curing:Curing was done in a tank containing water. After casting, the specimens were immersed in water until the start of tests. Tests were conducted after 3,7and 28 days. Drying: After the specimens were removed from the curing tank, they were allowed to dry in Air. After drying from the outside this casted specimens are tested for obtaining the corresponding strength. Testing: The cubes and cylinders were tested for compression in compression testing machine and the beams is tested Flexural strength in Universal Testing Machine.

III. TEST ON SPECIMENS

1. Compressive Strength Test

The compression test is quite resourceful since most of the desirable characteristic properties of porous concrete are qualitatively related to its compressive strength. The compression test is carried out on the specimens of cubical or cylindrical shapes. For the present investigation cubical specimen is preferred. The compression test was conducted on cubes at 3 days, 7 days and 28 days of curing according with IS 521-1959 using the formula.

$Fc = P / A$

Where Fc - compressive strength of concrete
P - Maximum load applied to the specimen
A - Cross-sectional area of the specimen

Fig 2 Experimental set of cube specimen.

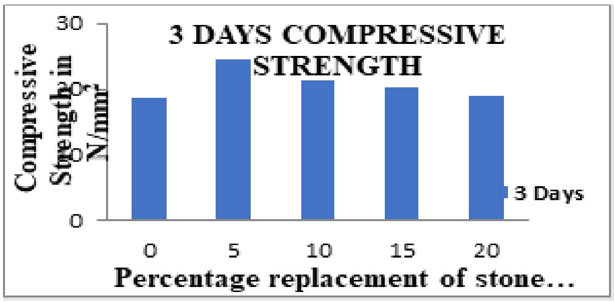

Fig3 Variation of 3 days Compressive strength.

From the experimental analysis, it is evident that at age of 3days the Compression Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%. For further increase in the percentage of stone dust and ceramic wastethe compressive strength decreases.

Table 7 compressive strength of stone dust and ceramic scrap concrete.

Sl No	Percentage of replacement		Average 7 days compressive strength N/mm^2
	Stone dust	Ceramic scrap	
1	0	0	23.70
2	**5**	**5**	**31.85**
3	10	10	28.66
4	15	15	24.88
5	20	20	24.15

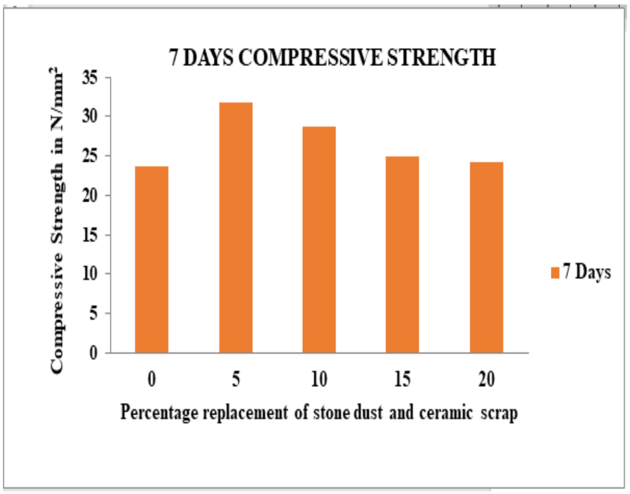

Fig 4 Variation of 7 days Compressive strength.

From the experimental analysis, it is evident that at age of 7days the Compression Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%. For further increase in the percentage of stone dust and ceramic wastethe compressive strength decreases.

Table 8 compressive strength of stone dust and ceramic scrap concrete

Sl No	Percentage of replacement		Average 28 days compressive strength N/mm²
	Stone dust	Ceramic scrap	
1	0	0	36.14
2	**5**	**5**	**43.33**
3	10	10	38.81
4	15	15	33.63
5	20	20	32.00

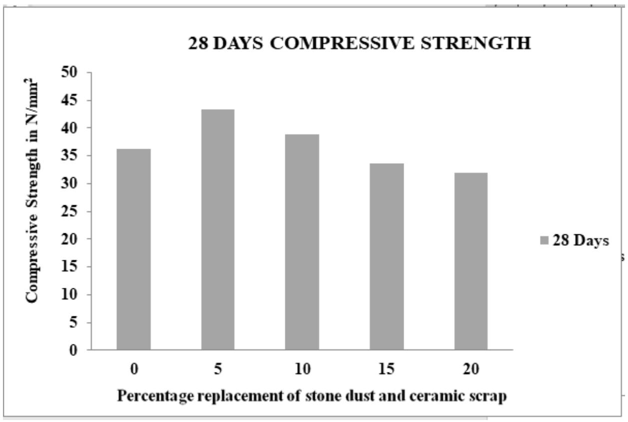

Fig 5 Variation of 28 days Compressive strength.

From the experimental analysis, it is evident that at age of 28days the Compression Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%. For further increase in the percentage of stone dust and ceramic wastethe compressive strength decreases.

Table 9 compressive strength of stone dust and ceramic scrap concrete

Sl No	Percentage of replacement		Average 3 days compressive strength N/mm²	Average 7 days compressive strength N/mm²	Average 28 days compressive strength N/mm²
	Stone dust	Ceramic scrap			
1	0	0	18.75	23.70	36.14
2	**5**	**5**	**24.57**	**31.85**	**43.33**
3	10	10	21.42	28.66	38.81
4	15	15	20.35	24.88	33.63
5	20	20	18.88	24.15	32.00

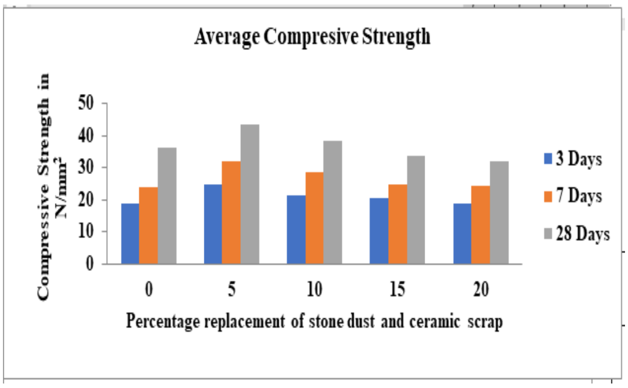

Fig 6 Variation of 3, 7& 28days Compressive strength.

From the experimental analysis, it is evident that at age of 3, 7 and 28days the Compression Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%. For further increase in the percentage of stone dust and ceramic wastethe compressive strength decreases.

Table 10 Flexural strength of stone dust and ceramic scrap concrete

Sl No	Percentage of replacement		Average 3 days Flexural strength N/mm²
	Stone dust	Ceramic scrap	
1	0	0	2.32
2	**5**	**5**	**4.27**
3	10	10	3.23
4	15	15	3.00
5	20	20	2.85

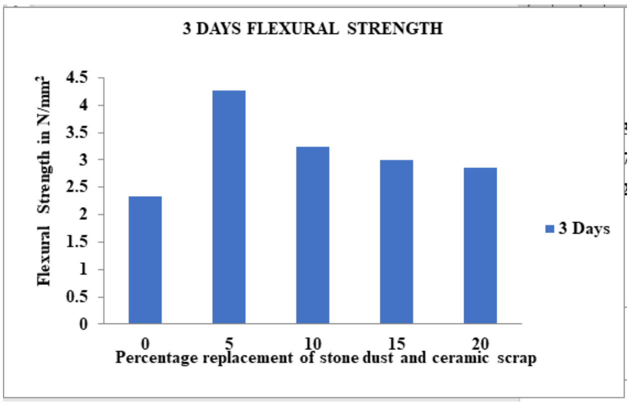

Fig 7 Variation of 3 days Flexural strength.

From the experimental analysis, it is evident that at age of 3days the Flexural Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%.

International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 5, Sept-Oct-2020, ISSN (Online): 2395-566X

For further increase in the percentage of stone dust and ceramic wastethe Flexural strength decreases.

Table 11 Flexural strength of stone dust and ceramic scrap concrete

Sl No	Percentage of replacement		Average 7 days Flexural strength N/mm²
	Stone dust	Ceramic scrap	
1	0	0	3.07
2	**5**	**5**	**3.90**
3	10	10	3.30
4	15	15	3.10
5	20	20	2.82

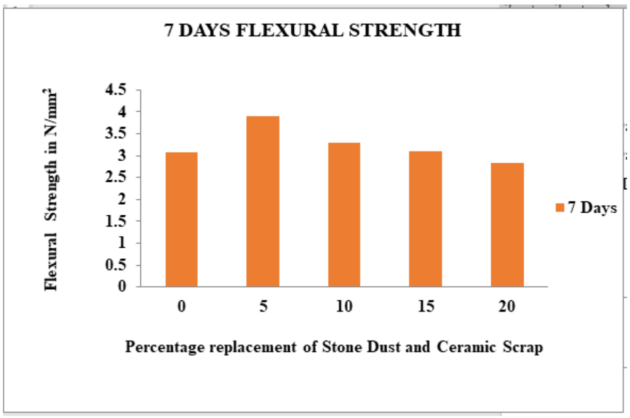

Fig 8 Variation of 7 days Flexural strength.

From the experimental analysis, it is evident that at age of 7days the Flexural Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%. For further increase in the percentage of stone dust and ceramic wastethe Flexural strength decreases.

Table 12 Flexural strength of stone dust and ceramic scrap concrete

Sl No	Percentage of replacement		Average 28 days Flexural strength N/mm²
	Stone dust	Ceramic scrap	
1	0	0	3.37
2	**5**	**5**	**4.96**
3	10	10	4.50
4	15	15	4.27
5	20	20	3.30

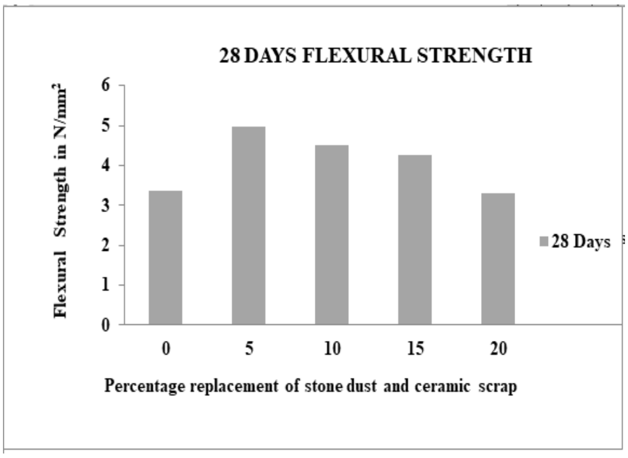

Fig 9Variation of 28 days Flexural strength.

From the experimental analysis, it is evident that at age of 28days the Flexural Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%. For further increase in the percentage of stone dust and ceramic wastethe Flexural strength decreases.

Table 13 Flexural strength of stone dust and ceramic scrap concrete

Sl No	Percentage of replacement		Average 3 days Flexural strength N/mm²	Average 7 days Flexuralstrength N/mm²	Average 28 days Flexuralstrength N/mm²
	Stone dust	Ceramic scrap			
1	0	0	2.32	3.07	3.37
2	**5**	**5**	**4.27**	**3.90**	**4.96**
3	10	10	3.23	3.30	4.50
4	15	15	3.00	3.10	4.27
5	20	20	2.85	2.82	3.30

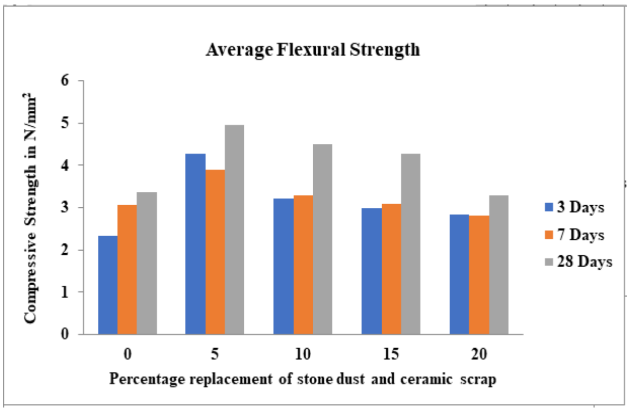

Fig 10 Variation of 3, 7 & 28 day's Flexural strength

From the experimental analysis, it is evident that at age of 3,7 and 28days the Flexural Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%. For further increase in the percentage of stone dust and ceramic wastethe Flexural strength decreases.

Table 14 Split tensile strength of stone dust and ceramic scrap concrete

Sl No	Percentage of replacement		Average 28 days split tensile strength N/mm^2
	Stone dust	Ceramic scrap	
1	0	0	3.55
2	**5**	**5**	**4.94**
3	10	10	4.47
4	15	15	4.36
5	20	20	4.19

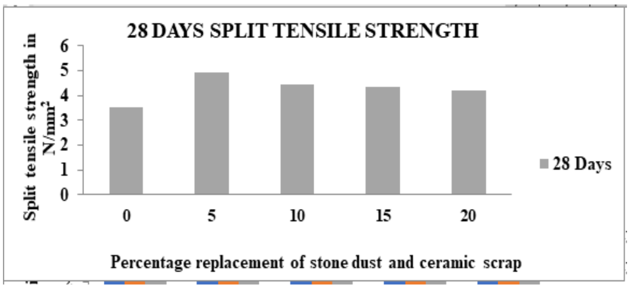

Fig 11Variation of 28 days split tensile strength.

From the experimental analysis, it is evident that at age of 28 days the Split tensile Strength increases as a percentage of stone dust and ceramic waste (as replacement material for fine and coarse aggregate respectively) increase up to 5%. For further increase in the percentage of stone dust and ceramic wastethe Split tensile strength decreases.

IV. RESULTS AND DISCUSSIONS

1. Compressive strength:

The result of compressivestrength with replacement of stone dust and Ceramic scrap for 3, 7 and 28 daysare presented in Table 6 and its graphical representationas shown in Fig. 1. From the results, compressive strength of concrete with 5% replacement of stone dustas a fine aggregate and Ceramic scrap as a coarse aggregate havethe highest 3, 7 and 28 days strength which reaches24.57 N/mm2 31.85 N/mm2 and 43.33 N/mm2respectively.Results shows that with 5% replacement of fineaggregate with stone dust and 5% replacement ofcoarse aggregate with Ceramic waste as a coarse aggregate, thecompressive strength of concrete increased by 20%at the age of 28 days compared to referral concrete. It can be seen that compressive strength is increased withreplacement of stone dust and Ceramic scrap up to the 5% and further more replacement of these materials, the corresponding compressive strength was decreased.

2. Flexural strength:

The flexural strength of specimen wasdetermined 4.280, 3.90 and 4.970 N/mm2 at 3,7 and 28 days respectively (Table 7). The variation offlexural strength with replacement level is shown inFig. 2. It was observed that the flexural strength increases with 5% replacement of stone dust and ceramic scrap and further more % replacement these materials, the strength was decreased at 3,7 and 28 days compared with referral concrete mix. Results shows that with 5% replacement of fine aggregate with stone dust and 5% replacement of coarse aggregate with Ceramic waste aggregate, the flexural strength of concrete increased by 48% at the age of 28 days compared to referral concrete mix.

3. Split Tensile strength:

From the experimental analysis, it is evident that at age of 28days the Split tensile strength increases with 5% replacement of stone dust and ceramic waste as a fine and coarse aggregate. For further increase in the percentage of stone dust and ceramic waste, the split tensile strength was decreases. The results were absorbed that with 5% replacement of fine aggregate with stone dust and 5% replacement of coarse aggregate with Ceramic waste aggregate, the split tensile strength of concrete increased by 40% at the age of 28 days compared to referral concrete mix.

REFERENCES

[1] Veera Reddy.M,Volume 1, No 3, [2010] International journal of civil and structural engineering, Investigations on stone dust and ceramic scrap as aggregatereplacement in concrete
[2] Siddesha H, Vol. 1 No. 1 [September-November 2011],Experimental Studies on the Effect of Ceramic fine aggregate on the Strength properties of Concrete
[3] IJ. Karthick, T.Rama, N.ManiBharathi,Vol. 1, Issue 1 [July - Sept. 2014],An Experimental Study on Usage of Quarry Rock Dust as Partial Replacement for Sand in Concrete
[4] Sudarsana Rao hunchate1, Giridhar Valikala2, Vaishali. G. Ghorpade3Vol. 2, Issue 11, [November 2013], The Present paper investigates the influence of water absorption of ceramic waste aggregate on strength properties of ceramic aggregate concrete.
[5] Dhavamani Doss Sa* and D. Gobinatha, Accepted 02 August 2013, Available online 10 August 2013, Vol.3, No.3 [August 2013],Chemical resistance of concrete with ceramic waste aggregate.
[6] Andrés Juan*, César Medina*, M. Ignacio Guerra*, Julia Mª Morán*,Pedro J. Aguado*, Mª Isabel Sánchez de Rojas**, MoisésFrías** and Olga Rodríguez**,

*Escuela Superior y Technical de IngenieríaAgraria. U of León (León) "Re-use of ceramic wastes in construction"

[7] Babu Shankar, N. and Md.Ali, [1992]. Engineering Properties of Rock Flour.National Conference on Cement and Building Materials from Industrial Waste, pp 167172.

[8] Rao. S. P., Seshagiri Rao. M.V and Sravana, [2002], Effect of crusher stone dust on some properties of concrete. National conference on advances in construction materials, ACIM, Harmipur, H.P, Pp 196201.

[9] M.V. Reddy, C.N.V.S. Reddy, "An experimental study on use of Rock flour and insulator ceramic scrap in concrete," Journal of theInstitution of Engineers, India, 88, pp 47-50, 2007.

[10] Riyanka.A.Jadhav and Dilip K. Kulkarni "An Experimental investigation on the properties of concrete containing Manufactured sand", International Journal of Advanced Engineering Technology, Vol III/ Issue II/[April-June 2012]/ 101-104.

[11] DR. T. SEKAR, N. GANESAN1 Studies on strength characteristics on utilization of waste materials as coarse aggregate in concrete