ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

PARTIAL REPLACEMENT OF CEMENT AND FINE AGGREGATE WITH STONE DUST IN CONCRETE

CH. SANTOSH KUMAR
Assistant Professor
KSRM College of Engineering, Kadapa, AP.

ABSTRACT
Concrete is the most used construction material having basic ingredients as binding material, fine aggregate, coarse aggregate, and water in required proportion, all the ingredients are homogeneously mixed to obtain resulting mixed of desired strength. Aggregates generally occupy 60 to 80% of the volume of concrete and greatly influence its properties, mix proportions and economy. This project is taken by the study of different journals. There are so many projects and journals regarding to the partial replacement of fine aggregate with stone dust and partial replacement of cement with stone dust. But no project is done on STONE DUST AS THE PARTIAL REPLACEMENT FOR BOTH CEMENT AND FINE AGGREGATE. To fill this GAP, we have taken this investigation.

In the present investigation, stone dust, a waste material obtain from crusher plant is used as partial replacement of fine aggregate. Every year 250-400 tons of stone wastes are generated on site. The stone cutting plants are dumping the powder in any nearby pit or vacant spaces. This leads to serious environmental and dust pollution and occupation of vast area of land. The wastage of stone dust can be effectively used for the concrete strength.M25 grade of concrete was taken for this investigation with a final mix proportion of 1:1.79:2.92 at w/c ratio of 0.50. The replacement levels of cement and fine aggregate with stone dust were 5%, 10%, 15%. The compressive strength and tensile strength of specimens cast for different proportions of stone dust was determined and compare the same with referral concrete.

Introduction

CEMENT APPLICATIONS

In the present era of development due to very advanced techniques and materials available and growing standards of living being the construction activities are increasing exponentially with time .It is mainly due to the effect of technology in now days .The increasing construction activities consumes the available natural resources heavily and posing serious environmental problem. However construction activities are leading to the development in social and economic aspects cannot be stopped or reduced for the sake of conservation of natural resources.

Concrete is the most used construction material in worldwide. In India about 370 million cubic meter concrete is used in construction industry annually.

Cite this article as: Ch. Santosh Kumar, " Partial Replacement Of Cement And Fine Aggregate With Stone Dust In Concrete", International Journal & Magazine of Engineering, Technology, Management and Research (IJMETMR), ISSN 2348-4845, Volume 8 Issue 7, July 2021, Page 9-19

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

The same quantity is expected to increase 30 million m3/ year. As concrete is the good building material used worldwide in various structural members such as slabs, beams, columns, foundation, etc., Concrete has been used as a major construction material. Construction activities are taking place on huge scale all over the world.

STONE DUST

Stone dust is a waste material obtain from crusher plants during the process of making of coarse aggregate of different sizes, about 175-million-ton stone dust is produced every year, which is kept in abundance. This used quantity of stone dust requires a suitable disposal site for its easy and safe disposal a large land area is required to accomplish the requirement which would again be a great problem in a country of heavily populated like India. Stone dust, being final part of a coarse aggregate is an inert material and can be used in concrete making as partial replacement of cement and fine aggregate

MATERIAL SELECTION

Cement

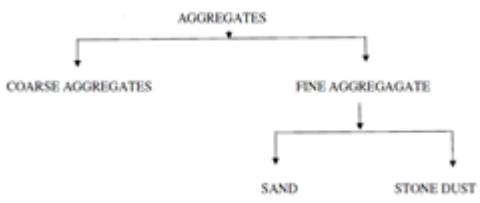
Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel together Cement used in construction can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water. We have the different types of cement as follows:

Types Of Cements:

- Ordinary Portland cement
- Ordinary Portland cement 33 Grade
- Ordinary Portland cement 43 Grade
- Ordinary Portland cement 53 Grade
- Rapid hardening cement
- Portland slag cement
- Sulphate resisting cement
- Quick setting cement
- Low heat cement
- Portland pozzalona cement
- Air entraining cement
- Coloured cement
- Hydrophobic cement
- Masonry cement
- Oil well cement
- Rediset cement
- High alumina cement

Among these types we have used ordinary Portland cement 53 Grade (PRIYA BRAND).

AGGREGATES



ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

COARSE AGGREGATES

Aggregates are important constituents in concrete. They give body to the structure. Reduce shrinkage and effect economy. Aggregate occupy 70 to 80% of concrete volume. They exhibit chemical bond at the interface of aggregate and paste, We used the coarse aggregates as in the percentages of 60% of 20mm and 40% of 10 mm of locally available aggregates

TESTS

Test for determination of specific gravity and water absorption

Specific gravity = C/ (B-A)

Water absorption = (100× (B-C))/C

Where,

A = the weight in gram of the saturated aggregate in water (A1-A2)

B = the weight in gram of the saturated surface dry aggregate in air and

C = the weight in gram of the oven dried aggregate in air.

TESTS ON CEMENT

I). Normal consistency of cement

- Apparatus
- Needle
- Movable Rod
- Graduated Scale
- Vicar mould

II) Initial setting time:

- Apparatus
- Vicat apparatus
- Balance
- Gauging trowel
- Glass plate
- Tray

Procedure to find out specific gravity

Using Le Chertier Flask method, we can determine this value. This is an experiment conducted at the site level.

Object

To find specific gravity of cement value

Required Materials & Apparatus

- Ordinary Portland Cement
- Kerosene
- Le-Chatelier Flask capacity of 250 ml or Specific Gravity Bottle / Pycnometer (100ml)
- Weighing balance with 0.1 gm accurate

Calculation

$$S_g = \left(\frac{W2 - W1}{(W2 - W1) - (W3 - W4) \times 0.79} \right)$$

Specific gravity of kerosene is 0.79 g/cc

Types of mixes

1.Nominal mixes

In the past the specifications for concrete prescribed the proportions of cement, fine and coarse aggregate. These mixes of fixed cement-aggregate ratio which ensures adequate strength are termed nominal mixes. These offer simplicity and under normal circumstances, have a margin of strength above that specified. However, due to the

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

variability of mix ingredients the nominal concrete for a given workability varies widely in strength.

2.Standard mixes

The nominal mixes of fixed cement-aggregate ratio (by volume) vary widely in strength and may result in under-or-over rich mixes. For this reason, the minimum compressive strength has been included in many specifications. these mixes are termed as standard mixes.

IS 456-2000 has designated the concrete mixes into a number of grades as M10, M15, M20, M25, M30, M35 and M40.In this designation the letter M refers to the mix and the number to the specified 28-day cube strength of mix in N/mm2.

For Example

THE MIXES OF GRADES AND THEIR PROPORTIONS AS FOLLOWS:

M10 - 1:3:6

M15 – 1:2:4

M20 – 1:1.5:3

M25 – 1:1:2

PARTIAL REPLACEMENT OF CEMENT AND FINE AGGREGATE WITH STONE DUST IN CONCRETE

3.Designed mixes

In these mixes the performance of the concrete is specified by the designer, but the mix proportions are determined by the producer of concrete, except that the minimum cement content can be laid down. This is most rational approach to the selection of mix proportions with specific materials in mind possessing more or less unique characteristics. The approach results in the production of concrete with the appropriate properties most economically. However, the designed mix does not serve as a guide since this does not guarantee the correct mix proportion for the prescribed performance. For the concrete with undemanding performance nominal or standard mixes may be only used for very small jobs, when the 28-day strength of concrete does not exceed 30 N/mm2.No control testing is necessary reliance being placed on the masses of the ingredients.

4.Conventional concrete mix design

The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratio of cement, fine and coarse aggregate. For e.g. a concrete mix of proportions 1:2:4 means that cement, fine and coarse aggregate are in the ratio 1:2:4 or the mix contains one part of cement, two parts of fine aggregate and four parts of coarse aggregate. The proportions are either by volume or by mass. The water-cement ratio is usually expressed in mass.

5.Preparation of replaced concrete mix

The method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratio of cement, fine and coarse aggregate. In our investigation we got the mix design values as 1:1.79:2.92(cement: fine aggregate: coarse aggregate) with water cement ratio was kept 0.5 and M25 grade concrete is used.53 grade of ORDINARY PORTLAND CEMENT is used and river sand of 2.36mm size is taken and the coarse aggregate is taken in two ratios of 60:40(60% of 20mm coarse aggregate:40% of 10mm coarse aggregates.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

PARTIAL REPLACEMENT OF CEMENT AND FINE AGGREGATE WITH STONE DUST IN CONCRETE

Both cement and fine aggregate is replaced with stone dust in concrete as for the replacement of cement, tone dust is sieved with 75µ sieve and for the replacement of fine aggregate, stone dust is sieved with 2.36 mm sieve to achieve the fineness properties of both cement and fine aggregate. After taking the suitable weights of all the materials we mixed these materials thoroughly with the adding of w/c ratio of 0.5. After the proper mixing of cement, fine aggregate, coarse aggregate, stone dust and water. The concrete is poured into the mound in 3 layers by 25 strokes with tamping rod. The cast specimens are removed after 24 hours and these are immersed in a sump. After curing 7 and 28, days the specimens were removed and these are tested for Compression, and Split tensile strength is found out for concrete which was replaced with stone dust in the proportion of 5%, 10%, 15%. This was to be partial replacement of fine aggregate and cement with stone dust. The results compared with conventional concrete. The final mix will get and then it is placed into moulds of cubes and cylinders.

RESULTS AND DISCUSSION

Slump cone

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for different loads of concrete under field conditions.

Procedure

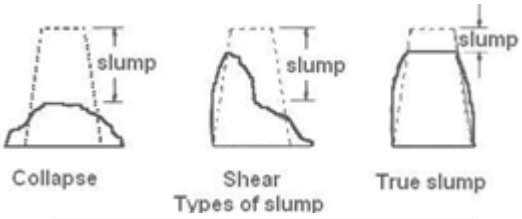
The test is carried out using a metal mould in the shape of a conical frustum known as a slump cone that is open at both ends and has attached handles. The tool typically has an internal diameter of 100 millimeters at the top and of 200 millimeters at the bottom with a height of 300 milli metres.This cone is filled with fresh concrete in three stages. Each time, each layer is tamped 25 times with tamping rod of 600mm long and 16mm diameter. At the end of the third stage, the concrete is struck off flush with the top of the mould. The mould is carefully lifted vertically upwards, so as not to disturb the concrete cone.

INTERPOLATION OF RESULTS

The slumped concrete takes various shapes and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump. If a shear or collapse slump is achieved, a fresh sample should be taken, and the test repeated. A collapse slump is an indication that the mix is too wet. Only a true slump is of any use in the test. A collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which the slump test is not appropriate. Very dry mixes having slump 0 – 25 mm are typically used in road making, low workability mixes having slump 10 – 40 mm are typically used for foundations with light reinforcement, medium workability mixes with slump 50 – 90 mm, are typically used for normal reinforced concrete placed with vibration, high workability concrete with

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

slump > 100 mm is typically used where reinforcing has tight spacing, and/or the concrete must flow a great distance.

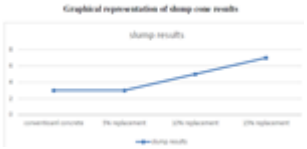


Types of slump

Collapse	Shear	True
In a collapse slump the concrete collapses completely.	In a shear slump the top portion of the concrete shears off and slips sideways.	In a true slump the concrete simply subsides, keeping more or less to shape.

Result of slump cone test

Concrete mix	Slump value
Conventional concrete	3mm
5% replacement	3mm
10% replacement	5mm
15% replacement	7mm



Compaction factor

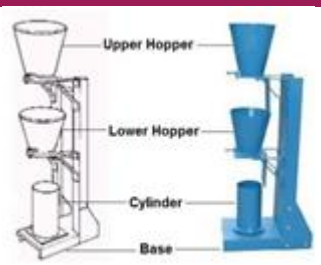
Compaction factor test is the workability test for concrete conducted in laboratory. The compaction factor is the ratio of weights of partially compacted to fully compacted concrete. It was developed by Road Research Laboratory in United Kingdom and is used to determine the workability of concrete.

Apparatus

Compaction factor apparatus consists of trowels, hand scoop (15.2 cm long), a rod of steel or other suitable material (1.6 cm diameter, 61 cm long rounded at one end) and a balance.

Sampling

Concrete mix is prepared as per mix design in the laboratory.



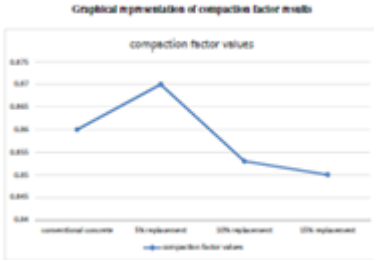
Compaction Factor Test on Concrete

Calculation of Compaction Factor Value

The compaction factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. It shall normally to be stated to the nearest second decimal place.

Compaction Factor Value= (W1-W) / (W2-W)

The Compaction factor values ranges from 0.7 to 0.95.



Curing of Cubes

The test specimens are stored in moist air for 24 hours and after this period the specimens are marked and removed from the moulds and kept submerged in clear fresh water until taken out prior to test.

Procedure for Cube Test

(I) Remove the specimen from water after specified curing time and wipe out excess water from the surface.

(II) Take the dimension of the specimen to the nearest 0.2m

(III) Clean the bearing surface of the testing machine

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

(IV) Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.

The compressive strength of different mixes for 7 and 28 days are determined.
Conventional concrete and different mixes of partial replacement of cement and fine aggregate with stone dust in concrete.

By following the above procedure of compressive strength of concrete. We get the values as follows:

Results of compressive strength of concrete for 7 days

Concrete Mix	7 days(N/mm2)
Conventional concrete	25.8
5% replacement	30.48
10% replacement	25.42
15% replacement	24.34

Graphical representation of compressive strength results for 7 and 28 days

Concrete Mix	28 Days(N/mm2)
Conventional concrete	34.26
5% replacement	39.63
10% replacement	34.31
15% replacement	31.31

Properties of cement (method of test refers to IS: 1489:1985)

Properties	Experimental	Codal requirement [IS 1489 (pt-1)-1985]
Normal consistency	31%	
Initial setting time	30 min	(not less than 30 minutes)
Final setting time	10 hours	(not less than 600 minutes)
Fineness of cement (% retained on 75 microns IS sieve)	8.75%<10 %	10%
Specific gravity of cement	3.14	15

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Sieve analysis for fine aggregate

sl.no	Sieve size	Weight retained (gms)	Cumulative weight retained	Cumulative percentage weight retained	Passing %	Standard % weight passing for zone II
1.	4.75mm	6	6	0.6	99.4	100
2.	2.36mm	63	69	6.9	93.1	75-100
3.	1.18mm	153	222	22.2	77.8	55-90
4.	600mm	543	765	76.5	23.5	35-59
5.	300µ	140	905	90.5	9.5	8-30
6.	150µ	80	985	98.5	9.5	0-10
7.	75 µ	4	989	98.5	7.5	0-10
8.	Pan	4	993	99.3	0.7	0

Fineness modulus=394.1/100=3.94

Result of slump cone test

Concrete mix	Slump value
Conventional concrete	3mm
5% replacement	3mm
10% replacement	5mm
15% replacement	7mm

Results of compaction factor

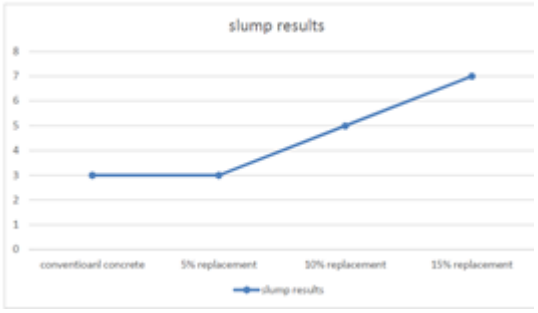
Concrete mix	Compaction factor
Conventional concrete	0.86
5% replacement	0.87
10% replacement	0.853
15% replacement	0.85

Results of compressive strength of concrete for 7 days

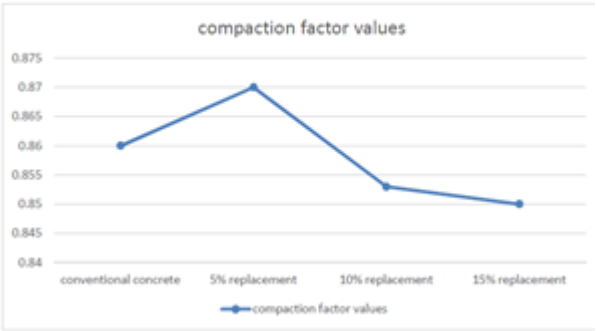
Concrete mix	7 days(N/mm2)
Conventional concrete	25.8
5% replacement	30.48
10% replacement	25.42
15% replacement	24.34

Graphs

Graphical representation of slump cone results

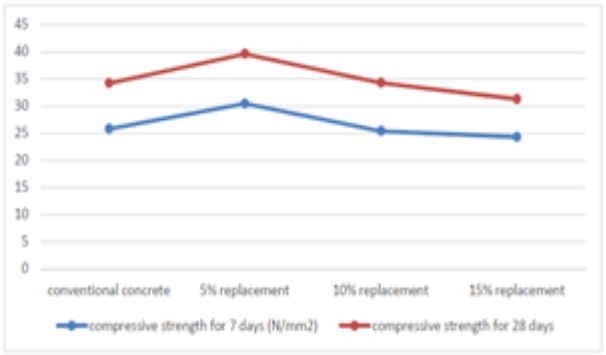


Graphical representation of compaction factor results



ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Graphical representation of compressive strength for 7 days and 28 days



Results and Discussion

It is evident from the table that compressive strength is decreased while using stone dust as partial replacement of cement and fine aggregate up to 10%. This may be due to the fact that replaced fine particles may not be sufficient to fill the voids resulting in comparatively in less dense concrete as compare to the referral concrete. However, strength is comparable at 5% replacement level and slightly more at 10% replacement than that of referral concrete. Again, compressive strength increasing beyond 10% replacement level may be due to the change of matrix composition. We got the maximum compressive strength and split tensile strength at 5% level of replacement

CONCLUSION

Applications -The investigation indicated that stone crusher dust has potential as fine aggregate in concrete structures with a reduction in the cost of concrete by about 20 percent compared to conventional concrete. Crusher dust not only reduces the cost of construction but also the impact on environment by consuming the material generally considered as a waste product with few applications.

Conclusions –

1. Stone dust is to be used as partial replacement of cement and natural fine aggregate in concrete. The use of stone dust in concrete is beneficial in different manner such as environmental aspects, non-availability of good quality of fine aggregate, strength criteria etc.
2. Workability of concrete decreases with the use of stone dust.
3. Stone dust can be used as an alternate material of fine aggregate both in lean concrete as well as in high strength concrete.
4. It is concluded that stone dust increases the strengthen properties of concrete. However other parameters like temperature, humidity, climate conditions, airentrapped etc. also effects the same.
5. Compressive strength of concrete make using stone dust as partial replacement for both cement and stone dust at 5% ,10% and 15% replacement levels is comparable to that of referral concrete both at 7 and 28 days.
6. At 5% replacement level, maximum compressive strength is obtained both at 7 and 28 days.
7. At 10% replacement level compressive strength is slightly higher than that of referral concrete and lower than 5% replacement at both 7 and 28 days.
8. Split Tensile strength of concrete make using stone dust as partial replacement for both cement and stone dust at 5%,10% and 15% replacement level is comparable to that of referral concrete both at 7 and 28 days.
9. At 5% replacement level, maximum split tensile strength is obtained both at 7 and 28 days.
10. At 10% replacement level split tensile strength is slightly higher than that of referral

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

concrete and lower than 5% replacement at both 7 and 28 days.

11. Both cement and fine aggregate can be effectively replaced by the stone dust for effective results of compressive strength and tensile strength.

Future scope - We have taken the equal proportions of stone dust as partial replacement of cement and fine aggregate. They may vary if the proportion of stone dust changes. In this investigation we got the maximum compressive strength and split tensile strength at the replacement level of 5% of stone dust for both cement and fine aggregate. With this investigation we are providing the information that different permutations and ombinations can be taken for the effective use of stone dust as partial replacement of both cement and fine aggregate in concrete for the further future usage of getting high strength.

REFERENCES

[1] SYED YAQUB ABBAS, VIKAS SRI VASTAVA, V.C. AGARWAL (2015) has stated that, they studied by taking M25 grade concrete using stone dust as partial replacement at different mix proportions like 10%,20%,30%,40%,50%,60% to the total weight of fine aggregate. They got the maximum compressive strength at 50% replacement. The aim of their project is to study the strength parameters of concrete

[2] SANDEEP KUMAR SINGH, VIKAS SRI VASTAVA (2014) has stated that, they taken M25 grade concrete using stone dust as partial replacement at different mix

[3] VIKAS SRI VASTAVA, V.C AGARWAL AND ESHAN ALI (2014) has stated that, they taken M25 grade concrete using stone dust as partial replacement at different mix proportions like 10%, 20%, 30%, 40%, 50% and 60% to the total weight of fine aggregate. They got the maximum compressive strength at 40% replacement.

[4] K. SHYAM PRAKASH AND CH. HANUMANTHA RAO (2016) has stated that, they taken M30 grade of concrete using quarry dust as partial replacement at different proportions like 20%, 30%, 40%, 50% and 60% to the total weight of fine aggregate. They got the maximum compressive strength at 40% replacement.

[5] R.MAHADEVI, BINOYMATHEWSAM, ILAVARASAN.K, MOHANKUMAR.P,RAMACHANDRAM.M (2017) has stated that, they taken M25 grade concrete using marble powder and quarry dust as partial replacement for cement at different proportions like 20%, 25%, and 30% to the total weight of cement. They got the maximum compressive strength at 20% replacement.

[6] Mr. LOKESH KUMAR AND Prof. GAUTAM BHADORIYA (2015) has stated that, with 25% cement replacement with fly ash and 40% fine aggregate replacement with stonedust gives the maximum compressive strength of concrete.

[7] IS: 516-1959. Indian Standard Methods of Test for Strength of concrete. Bureau of Indian Standards, New Delhi.

[8] R. MAHADEVI, MOHANKUMAR.P, RAMACHANDRAM.M (2017) has stated that, they taken M25 grade concrete using marble powder and quarry dust as partial replacement for cement at different proportions like 20%, 25%, and 30% to the total weight of cement. They got the

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

maximum compressive strength at 20% replacement.

[9] UTKARSH K. YADAV, P.S. MAHAR, V.K. VERMA (2016) has stated that, they taken M25 grade concrete using stone dust as partial replacement of cement at different mix proportions like 10%, 20%, 30%, 40% and 50% to the total weight of cement. They got the maximum compressive strength at 20% replacement.

[10] G. BALA MURUGAN, Dr. PERUMAL (2013) has stated that, they taken both M20 and M25 grades of concrete using quarry dust as partial replacement at different mix proportions like 0% to 100% to the total weight of fine aggregate. They got the maximum compressive strength and tensile strength at 50% replacement.