A Thesis on

COMPARISON OF MECHANICAL PROPERTIES OF CONCRETE USING CONVENTIONAL & NON CONVENTIONAL AGGREGATES

Submitted for partial fulfillment of the requirement for the award of degree

MASTER OF TECHNOLOGY

In

STRUCTURAL ENGINEERING

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DECLARATION

I declare that the research thesis entitled "**COMPARISON OF MECHANICAL PROPERTIES OF CONCRETE USING CONVENTIONAL & NON CONVENTIONAL AGGREGATES**" is the bonafide research work carried out by me, under the guidance of **Mr. Anwar Ahmad Associate Professor, Department of Civil Engineering, Integral University, Lucknow**. Further I declare that this has not previously formed the basis of award of any degree, diploma, associate-ship or other similar degrees or diplomas, and has not been submitted anywhere else.

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CERTIFICATE

It is Certified that the thesis entitled **"COMPARISON OF MECHANICAL PROPERTIES OF CONCRETE USING CONVENTIONAL & NON CONVENTIONAL AGGREGATES"** is being submitted by **Mr. Mohd Muzammil Zaidi (Roll no. : 2001431006)** in partial fulfillment of the requirement for the award of degree of Master of Technology (Specialization) of Integral University, Lucknow, is a record of candidate's own work carried out by him/her under my supervision and guidance.

The results presented in this thesis have not been submitted to any other university or institute for the award of any other degree or diploma.

Mr. Anwar Ahmad

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Chapter 01

INTRODUCTION

1.1 Introduction

Population growth, sustainable industrial development, construction, infrastructure and housing Construction Activities huge amount of C&D waste, therefore, urgent need for waste recycle. Construction is a natural major consumer resources and total global production nearly doubled from 21 billion tons in 2007 to 40 billion tons in 2014. Some recorded some of the strongest increased demand for waste recycling. Therefore, progress depletion of natural resources and growing awareness, sustainable waste management in developed and emerging countries economy, on recycling and reuse of construction and demolition waste in civil engineering projects. Concrete is a composite-material made with the combination of cement, fine aggregate, coarse aggregate and water. With the increasing use of cement in building work, there are as variety of cements are used according their uses. These coarse and fine aggregates are bonded together with cement and hardens as the passage of time. Cement reacts with water, coarse aggregate, fine aggregate to make a homogeneous mixture which binds the material together. Physical properties of wet slurry gets improved by additives such as pozzolana or super-plasticizer.

In Construction industry concrete is the most widely used material because of its mould ability into any required structure form and shape due to its fluidity at early stage. The word concrete comes from the Latin word 'concretus'. Conventional concrete is just normal concrete that we regularly use in India. It is a mix obtained by mixing Coarse aggregate, fine aggregates, water, cement and sometimes admixtures in required proportions. Concrete is a mixture of cement, air, water, sand, and gravel. The typical concrete mix is made up of roughly 10% cement, 20% air and water, 30% sand, and 40% gravel. This is called the 10-20-30-40 Rule–though proportions may vary depending on the type of cement and other factors. Concrete is a composite material composed of coarse granular material (the aggregate or fillers) combined in a hard matrix of material (cement) that fills the space among the aggregate particles and glues them together. The most commonly used mix is cement, aggregates and water in the proportion 1:2:4. The density of this concrete is between 2200 and 2500 kg/cubic metre, whereas its compressive strength is in the range of 200 to 500 kg/square centimeters.

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This research paper focuses on the comparison of the mechanical properties of cement concrete with the help of using conventional aggregate (stone crushed aggregate) and non-conventional aggregates (dolomite and quartzite). Here, we have taken dolomite fine aggregate and quartzite fine aggregate. In this research paper, we have designed a mix design of M-25 grade with the help of IS 10262-2019 with the help of PPC and after designing, we replaced the fine aggregate with dolomite and quartzite in the consecutive percentage of 10%, 15%, 20% & 25%.

In the research work, we have checked the workability by slump test and their cumulative compressive test of the consecutive percentage of the samples taken by replacing the non-conventional aggregate. The results shows that when the conventional fine aggregate is replaced with dolomite, then the workability starts decreasing and the compressive strength of concrete gets decreased by 5%, 20%, 30% & 40%. When the conventional fine aggregate is replaced with quartzite, the slump flow increases by 10 % and the compressive strength of concrete gets increased by 5%, 10%, 15%, 20%.

It has already been found that the main differences between the recycled concrete and conventional fresh concrete is the water absorption of the recycled-aggregate that is used in the production of recycled concrete and water absorption of recycled aggregate is calculated and the amount of variation of water is then calculated and found in increase in the water absorption of recycled concrete more as compared to conventional concrete. It is originally developed to manage the growing shortage of skilled-labour, it is already has been proven that self-compacting concrete is economical in a number of ways including:

- Easier placement of concrete
- Improved durability of concrete
- Greater freedom in designing structures
- Thinner concrete sections can easily be casted
- Reduced noise pollution due to no use of vibrators
- Safer working environment with less machinery and electric motors
- Easier, durable and faster construction
- Reduction in skilled labour and site man-power
- Better surface finishes
- Improved quality of construction

Self-compacting concrete and conventional concrete of same strength have very comparable strength as therefore SCC can be used where normal is used. The compressive strength test of concrete is the most vital test in engineering properties. SCC with a similar water cement ratio as in conventional concrete, it will usually have a slightly higher compressive strength as in comparison to conventional concrete as it is due to the reason that an improved interference between the aggregate and hardened paste due to absence of any external vibrations. So, the compressive strength of SCC developed is comparatively higher. For SCC of any strength, the tensile strength of SCC may be assumed to be same as compared to the normal conventional concrete as the volume of paste (fines + cement + water) which is much more in SCC and it has no significant effect on tensile strength. Infact due to the improvement of denser microstructure, less porous structure, mechanical properties and homogeneity, the tensile strength becomes slightly higher as compared to conventional concrete.

1.2 Social & Economical Impacts

Concrete the most-consumed resource on earth, but it is also one of the most versatile. Concrete can be molded into nearly any shape or use. It is also one of the most sustainable building materials, providing **energy efficiency**,

Global average sea levels have risen since 1993 at the rate of 3.1 mm/year which has a considerable effect on future development. If immediate actions are not taken to reduce the emission of green house gases. (GHG) then the overall costs and risks of climate change will be equivalent to losing more than 5% of global GDP per year from.

Concrete work in a project usually holds the maximum in terms of overall cost and work quantity.

It becomes an important step to calculate the concrete- related costs while preparing a project estimate.

The cost of concrete making depends upon the cost of materials, mix design, workforce, and machinery. Cost of concrete per cum will decrease by using non- conventional stones, basically cost of concrete is very big factor which plays a significant role in project planning in terms of budget.

1.3 BASALT AGGREGATE

Basalt Aggregate reinforces the concrete in a microscopic perspective and acts as a bridge at the cracks with its high elastic modulus and tensile strength. It can inhibit crack propagation, increasing the energy absorption capacity of concrete and improving the toughness of concrete

Aggregate made from basalt rock melted at high temperature. Basalt aggregate reinforced concrete offers more characteristics such as light weight, good fire resistance and strength. In future it is very beneficial for construction industry. Many applications of basalt aggregate are residential, industrial, highway and bridges etc.

1.4 DOLOMITE AGGREGATE

Dolomite, also known as dolostone and dolomite rock, is **a** sedimentary rock composed primarily of the mineral dolomite. Dolomite is found in sedimentary basins worldwide. It is thought to form by the post depositional alteration of lime mud and limestone by magnesium-rich groundwater.

Dolerite is an igneous rock, that is, rock initially molten and injected as a fluid into older sedimentary rocks. The magma, of quartz tholeiite composition, was emplaced as a liquid which rose upwards through the basement rocks into older sedimentary rocks.

Chapter 02

LITERATURE REVIEW

2.1 Review of Literatures

1.Mr. Navnath Raut, Mrs. Urmila Kawade

There are many advantages of light Basalt Aggregate concrete over the normal concrete, one of them being its low density of concrete helps in reduction of dead load. The workability of LWAC gets considerably increased when Basalt Aggregate concrete increases the compressive strength, flexural and tensile strength As the Percentage of Basalt Aggregate in concrete increase's the workability of concrete decreases.

2.S. AISHWARYA, Mr. V. DASS MOHAN

Production of concrete using 2% of basalt aggregate improves the compressive strength values up to 21% and improves the split tensile strength values up to 18% when compared with the conventional concrete. The workability of concrete is seems to be increasing as the percentage of basalt fiber increasing in the mix. For each percentage replacement up to 10% the compressive strength values of the red mud concrete is greater than that of conventional concrete. The red mud can be used for partial replacement of cement in concrete. Workability of concrete is increased.

3. Olesia Mikhailovaa, Grigory Yakovlevb, Irina Maevac, Sergey Senkovd

The mechanical properties such as cube compressive strength, split tensile strength and flexural strength of light weight aggregate concrete is reduced as compared to conventional concrete. 25% dolomite aggregate by weight have the maximal compressive strengths.

4. Vinay Purohit

The both compressive strength and split tensile strength of concrete were strongly influenced by aggregate size distribution. 25% dolomite containing mix with amount increase strength decreases. The strengths increased as the size of the aggregates increased but again decreased with over size of aggregates. Because an addition of excessive sized coarse aggregates resulted in surplus mixing water that resulted in slight segregation that reduced the overall strength.

5. Marija Jelčić Rukavina, Ivan Gabrijel, Dubravka Bjegović

Replacement of aggregate up to 30% was able to produce dolerite concrete exhibiting the targeted strength of 25 N/mm2. At 28 days of curing, mixtures containing fly ash exhibited the lowest values of mechanical properties The result of the two-way analysis of variance also shows that lateritic aggregate and curing age (days) has significant effect on the compressive strength of concrete .

6) Mohammed Ramshad P, Salmanul Faris, Shefin K, Sooraj Regunath, Vidya , & Shajeena

The mechanical properties such as cube compressive strength, split tensile strength and flexural strength. Workability of concrete is increase by 18 However, further additions of copper slag caused reduction in the strength due to an increase of the free water content in the mix.

7. K.Rajasekhar, K.Spandana

It is essential to carry out studies and quantify the real behavior of these parameters for the conditions available at the first moment before the work begins These studies would be in form of analyzes: of the appropriate materials, correct proportions and monitoring of results, the costs of implementing the methodologies for the desired work.

8. S. Rahman & A. Ullah

Conventional concrete mixture with W/C of 0.5 had a relatively high slump of 150mm. Compressive strength and split tensile strength of concrete were strongly influenced by aggregate size distribution.

9. Shuaibu R. , Mutuku R. , Nyomboi . (2014)

Laterite was used as sand substitute in concrete and investigation showed that an enhancement in workability was observed as the proportion of laterite increased in the concreteLaterised concrete have proved good structural properties. Although, laterite soil was seen to yield less workable concrete.

10. Mr. Navnath Raut, Mrs. Urmila Kawade (2017)

It was found that with the increase of corrosion extent, ultimate strength and ductility of the columns will decrease. The composite effect in circular CFST stub column is stronger than that in square one, which makes the strength loss of circular specimen larger than that of square one, provided that the loading and corrosion circumstances are the same.

11. Akram S. Mahmoud Yaseen T. Khaleel Omar H. Jasim (2013)

There are some chemical components in limestone and silica stone have cohesion forces on the surface of smooth particle, but it is difficult to determine the kinds of bond, since there is no acceptable related test. The good bond in smashed concrete must contain completely broken aggregate and some broken particle which is taken from its place. Bond resistance is depending on the cement dough resistance and properties of aggregate surface, so that the bond resistance increases with age of concrete.

12. Basil Johny Prof. M.V George Dr. Elson John (2014)

When workability of Mix with GGBS and recycled coarse aggregates was tested using slump test and compaction factor test, the mix shows adequate workability. (2) Compressive strength, flexural strength and splitting tensile strength values of Mix with GGBS and recycled aggregates were less compared with conventional mix. The most relevant and investigated characteristics are mechanical properties and environmental compatibilities, particularly heavy metal release-related ones The advantages of recycled aggregates rather than common ones in concrete result mainly in the terms of land use, when related to the exploitation of the quarry.

13. Basil Johny Prof. M.V George Dr. Elson John (2013)

Workability of Mix with GGBS and recycled coarse aggregates was tested using slump test and compaction factor test, the mix shows adequate workability. Compressive strength, flexural strength and splitting tensile strength values of Mix with GGBS and recycled aggregates but satisfactorily for M30 grade of concrete.

14. O. M. Ibearugbulem, L. O. Ettu and J. C. Ezeh (2011)

The compressive strength of concrete initially increases with replacement of coarse aggregate with the laterite up to 20% and after that there is decrease in compressive strength of concrete with further replacement of coarse aggregate as the mix became less cohesive and less workable Laterite can be used in combination with PS and RST in making reinforced concrete, but do not allow it to constitute more than 5 9% of the total aggregate.

15. SHANKAR H. SANNI AND SADASHIVAS. KEMBHAVI (2011)

The workability of LWAC gets considerably increased when LECA is used as coarse aggregate Cube compressive strengths achieved for M-15, M20 and M-25 grade of LWAC are 13.08 N/mm2 , 18.60 N/mm2 and 20.20 N/mm2 respectively for 28 days. Low density of concrete helps in reduction of dead load. The densities of conventional concrete and light weight aggregate concrete with LECA was observed that the difference in the densities was around 800-1000 kg/m3.

16K.Rajasekhar , K.Spandana (2016)

The percentage decrease in split tensile strength in pervious concrete is 45 to 50% compared with conventional concrete. The percentage of void ratio is increased to 4% in pervious concrete as compared with conventional concrete. So that the permeability also high. ¬ Density is 30% decreases in pervious concrete compared with conventional concreteCompressive strength of pervious concrete is decreased to 50% to 75% as compared to conventional concrete. It helps in maintaining the water table of surroundings.

17. O. M. Ibearugbulem, L. O. Ettu and J. C. Ezeh

The performance of Dlerite in concrete towards corrosion, acid attack and carbonation is comparable to plain concrete. The results show that laterite concrete has a potential to be used in concrete production commercially. Utilization of dolerite aggregates as partial coarse aggregates replacement would reduce the high dependency of concrete industry on granite aggregates supply, and thus maintain the ecological balance and prolong the existence of granite for future generation.

18. H.M.A.Mahzuz1 , Mushtaq Ahmed2 , Moon Moon Dhar3 and Sumaiya (2009)

This study focuses the relative performance of concrete where coarse aggregate were stone, rattan, wood and bamboo. From laboratory study, it is found that strength of Rattan, Bamboo and Wood concrete was less then concrete of stone. Rattan concrete strength was about 22%-20% of stone concrete, Wood concrete was 14% -11% of stone concrete and . Bamboo concrete was 12% -11% of stone concrete for 1:2:2 and 1:2:3 mix ratios. Therefore such mix ratio can be used for low load bearing members or zero load bearing members like partition wall.

19. SHANKAR H. SANNI AND SADASHIVAS. KEMBHAVI

Quarry dust obtained from Mlolongo quarry graded between 75 µm to 19 mm with a relative density of 2.389 Kg/m2 make good high strength concrete of over 80 N/mm2 at a water cement ratio of 0.32. The concrete manufactured used Sika® ViscoCrete®-HE admixture which is a plasticizer and water reducer to minimize the water requirement and achieve the required slump.

20. K. Rajshekhar, K. Spandana

Mechanical properties' results for SCC and evaluates various estimating models and their applicability to this type of concrete. . In terms of general applicability, the three models evaluated are suitable for the estimating the modulus of elasticity, tensile strength, and modulus of rupture.

21. Angel Vilanova, Jaime Fernández-Gómez, and Galit Agranati Landsberger

It has been observed that the workability of concrete decreases with the addition of Basalt aggregate. But this difficulty can be overcome by using plasticizers or super-plasticizers. Percentage increase of compressive strength of basalt aggregate concrete mix compared with 28 days compressive strength of Plain Concrete is observed as 14%.

22 H.M.A.Mahzuz1 , Mushtaq Ahmed2 , Moon Moon Dhar3 and Sumaiya

Investigations confirmed that finely ground dolerite in fact can be used as cementitious material to produce cement with dolite 5 wt. % and more than 25 wt. % dolomite limestone into cement always rederuces compressive strengths after 14 and 28 days. Specimens containing 25% dolerite limestone powder by weight have the maximal compressive.

23 Joffrey Cheruiyot, Sylvester Ochieng Abuodha, Charles Kabubo

High strength concrete (HPC) using locally available stone dust is possible High strength concrete significantly reduces structural members Mix 9 gave us the minimum value compressive strength 11.19 MPa in 7 days and 14.67 MPa, 28 days. For 25% dolomite containing mix with amount increase in nano silica strength decreases. For nano silica amount 4% containing mix with amount increase in dolomite strength of mix decreases.

24 Angel Vilanova, Jaime Fernández-Gómez, and Galit Agranati Landsberger

Adding of basalt aggregate 2% gives the maximum value 2% of basalt Aggregate improves the compressive strength values up to 21% when compared with the conventional concrete. 2% of basalt fiber improves the split tensile strength values up to 18% when compared with the conventional concrete. 2% of basalt fiber improves the flexural strengthvalues up to 17% when compared with the conventional concrete.

25 Fathima Irine I .A.

The percentage increase of compressive strength of basalt fiber concrete mix compared with 28 days compressive-strength of Concrete is observed as 14%. The percentage decrease in split tensile strength in pervious concrete is 45 to 50% compared with conventional concrete. The percentage of void ratio is increased to 4% in pervious concrete as compared with conventional concrete. So that the permeability also high. Density is 30% decreases in pervious concrete compared with conventional concrete.

2.2 Inference

- The use of basalt fiber, dolerite and dolomite, as partial replacement of coarse aggregates in the concrete resulted in specimens with reduced workability, the workability reduced with increasing addition of non-conventional aggregate in the mix.
- The compressive strength of concrete initially increases with replacement of coarse aggregate with the basalt fiber up to 20% and after that there is decrease in compressive strength of concrete with further replacement of coarse aggregate as the mix became less cohesive and less workable.
- Excessive use of conventional stone and digging effects the environmental scenario and it can't be reused that's why we will prefer natural stones such as dolomite, dolerite & basalt aggregate, for nominal concreting.
- The use of Dolomite as partial replacement of coarse aggregates by weight in the concrete resulted in specimens with reduced workability, the workability reduced with increasing addition of Dolomite in the mix.
- The compressive strength of concrete initially increases with replacement of coarse aggregate with the basalt fiber up to 20% and after that there is decrease in compressive strength of concrete with further replacement of coarse aggregate as the mix became less cohesive and less workable.
- The use of Basalt aggregate as partial replacement of coarse aggregates in the concrete resulted in specimens with increased the strength with increasing addition basalt aggregate in the mix.

2.3 Research Gap

As per as findings from literature review its has been concluded that Excessive use of conventional stone and digging effects the environmental scenario and it can’t be reused that’s why we will prefer natural stones such as dolomite, basalt fiber, dolerite, for nominal concreting.

For further design mix analysis it can be used in several ratio (10%,20%,30% …) and then analyzed for compressive strength of designed concrete. By the study we found use of non conventional stone we are not able to get high strength concrete but it is useful in terms of natural resources.

It has to be evaluated .

2.4 Objective

To determine:

- Compressive Strength
- Workability
- Mix Design
- Rate Analysis
- Sustainable Construction

2.5 Methodology

Casting of nominal mix concrete with use of conventional stones and testing of cubes at 7 days, 14 days and 28 days.

Use of non conventional stones such as basalt fiber, dolerite and dolomite by 3.65%, 5.75%, and 7.85%. By the study we found use of non conventional aggregates we are not able to get high strength concrete but it is useful in terms of natural resources.

Chapter 03

MATERIALS USED

The different class of concrete materials and experiments are conducted in the research. Cement, fine aggregate, coarse aggregate & water are the main materials which are used in the experimental works. The properties of material and its specifications which are used in this research work are as:

3.1 Cement

Portland Pozzolana Cement as per IS 1489(1991) part 1 with using fly ash and a carboxylate super-plasticizer was used with viscosity modifying agent (VMA) that gives more outcomes of controlling segregation when the powder content is limited. In this research work Ultra Tech cement is used with a compressive strength of 37.20 Mpa at 7days, initial setting time of 170 minutes, final setting time 250 minutes & standard consistency of 31.75%.

Properties of PPC Cement Used	
Properties	Test Results
Fineness	367
% of Fly Ash addition	34.27
Standard Consistency (%)	31.75
Initial Setting Time (minutes)	170
Final Setting Time (minutes)	250

Properties of PPC Cement used

Table No. 1

3.2 Fine-Aggregates

All common concrete sands are suitable for SCC. Crushed or round sand can be used. Either siliceous or calcareous sand can be used. The amount of fine powder should be less than 0.125 mm are considered powder for the study of rheology of SCC. It must contain a minimum quantity of fines (from binder and sand) to avoid segregation/isolation. The fine aggregate take here is Zone-II.

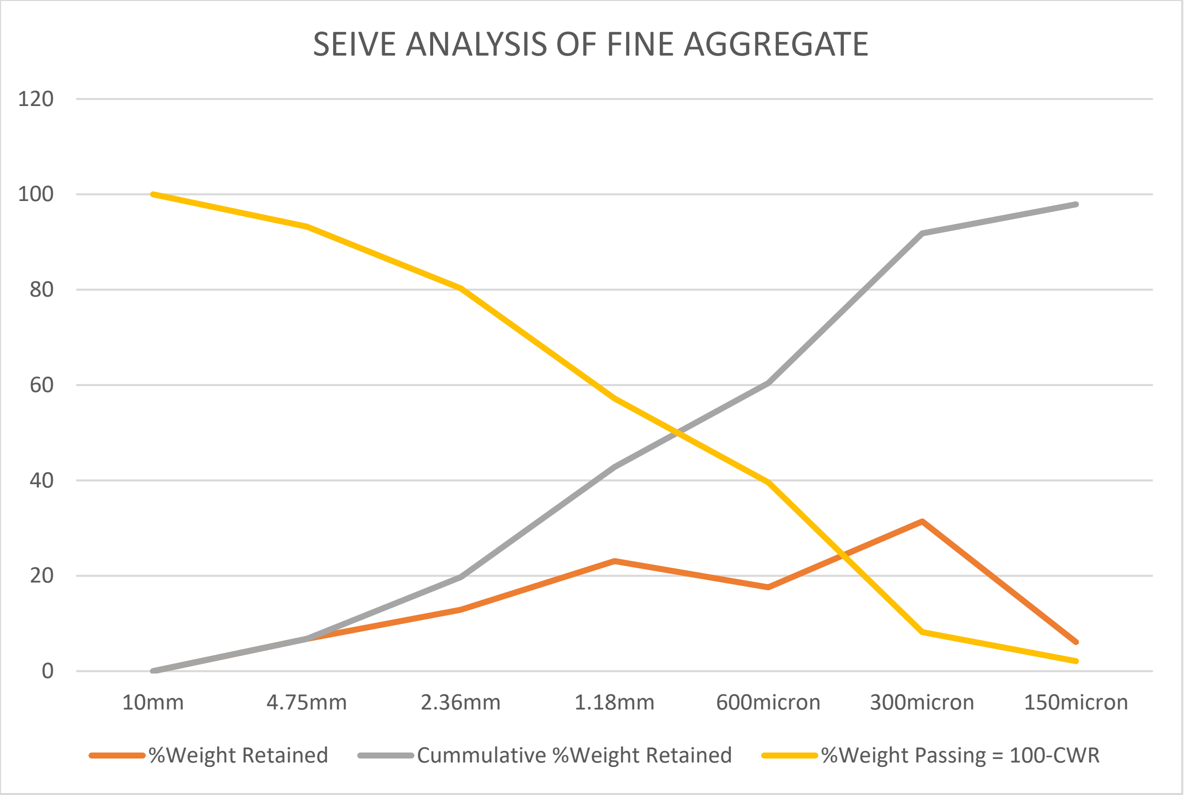
Weight of sample = 1.0 Kg.

IS Sieve Size	Weight Retained (grams)	%Weight Retained	Cummulative %Weight Retained	%Weight Passing = 100-CWR
10mm	0	0	0	100
4.75mm	68	6.8	6.8	93.2
2.36mm	129	12.9	19.7	80.3
1.18mm	231	23.1	42.8	57.2
600micron	176	17.6	60.4	39.6
300micron	314	31.4	91.8	8.2
150micron	61	6.1	97.9	2.1

IS Sieve Analysis results of fine aggregates

Table No. 2

The sample taken is found to be zone II.



Sieve Analysis of Fine Aggregate

Fig. No. 1

3.3 Coarse-Aggregate

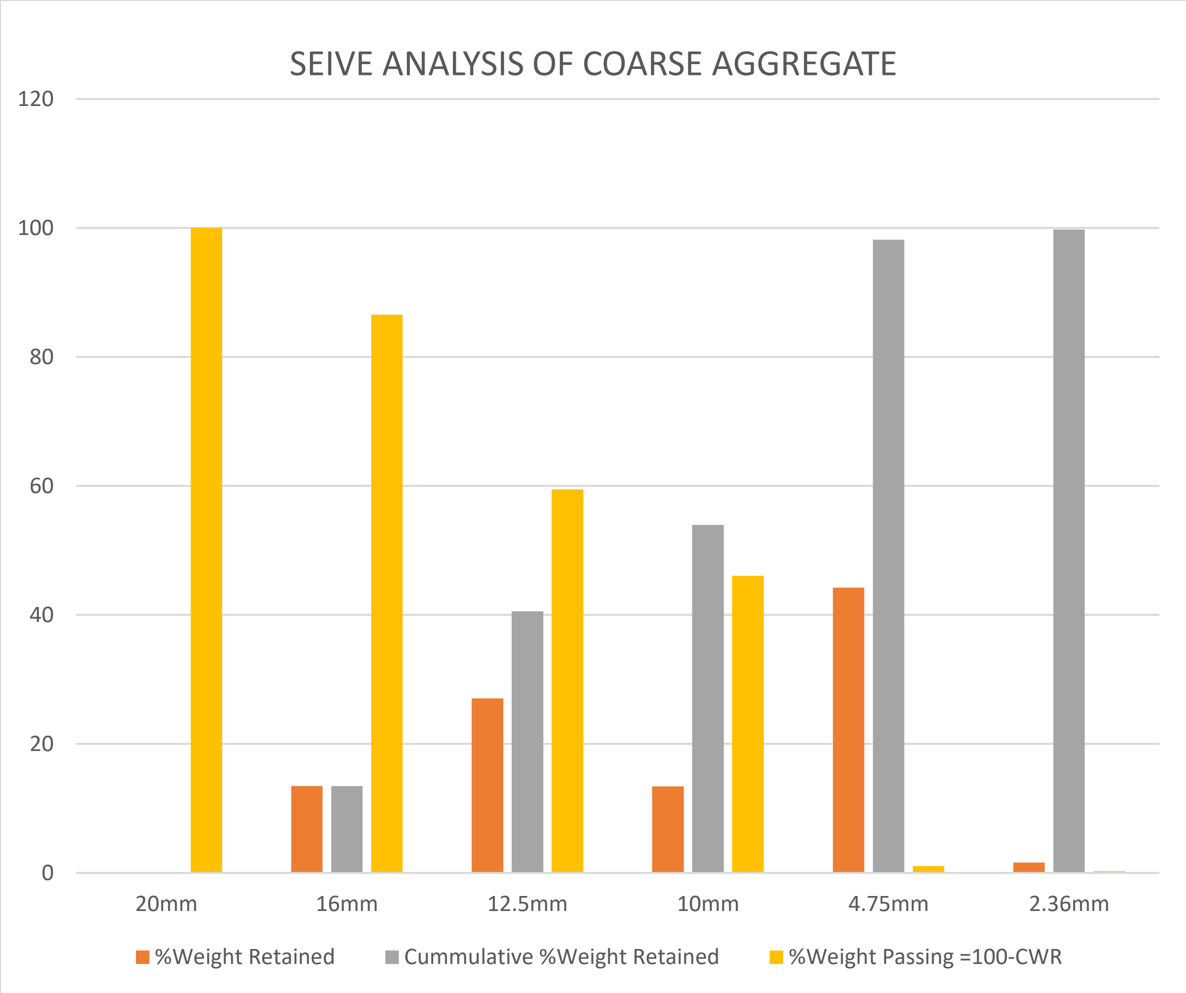
All types of aggregates are suitable. The normal maximum size is generally 10 mm. However, the particle sizes up to 20 mm is used in SCC. According to the characteristics of different types of aggregates, crushed aggregates tend to improve strength due to interlocking of angular particles, while circular aggregates improve flow because of lower internal friction. Gap graded aggregates are generally better than continuously graded aggregates, which may experience greater internal friction and reduced flow. The fine in the coarse aggregate taken is 0.8%.

IS Sieve Size	Weight Retained 1(grams)	Weight Retained 2(grams)	Weight Retained 3(grams)	Average	%Weight Retained	Cummulative %Weight Retained	%Weight Passing =100-CWR
20mm	-	-	-	-	-	-	100
16mm	659	680	682	673	13.46	13.46	86.54
12.5mm	1325	1347	1363	1354	27.08	40.54	59.46
10mm	671	666	674	670	13.4	53.94	46.06
4.75mm	2209	2205	2220	2211	44.22	98.16	1.04
2.36mm	88	76	75	79	1.58	99.74	0.26

IS Sieve Analysis results of coarse aggregates

Table No. 3

The coarse sand taken is found to be graded aggregate.



Sieve Analysis results of coarse aggregates

Fig. No. 2

3.4 Water

The water used shall be colour-less, odour-less & free from any organic impurities.

3.5 Quartzite-stone

In this experiment, the quartzite used is in the form of fine aggregate with a specific gravity of 2.80 is used.

3.6 Dolomite-stone

Dolomite is a carbonate material composed of calcium magnesium carbonate CaMb(C). In the experiment, the dolomite is also used as a fine aggregate and its specific gravity is 2.86 is used.

3.7 Fly Ash

When fly ash is added in SCC, it starts providing an increment in the cohesion and reduced sensitivity as due to the change in water content. The fly ash used in this work has a specific gravity of 2.43 as it relevant to IS 3812 2007.

CHAPTER 4

EXPERIMENTAL WORK & TESTS

4.1 Mix Design

The mix design is carried out for M25 grade of concrete by IS: 10262-2019 for 20mm maximum nominal size of aggregate, Pozzolana Portland Cement (PPC) confirming to 1489(Part-I) 1991, workability of 75-100mm slump, exposure condition is moderate, crushed angular aggregate is used and having a mix proportion of 1:1.48:2.62 with a constant water-cement ratio of 0.47. The fine aggregate is initially replaced by dolomite fine aggregate by volume of concrete with consecutive ratios of 10%, 15%, 20%, & 25% with Pozzolana Portland Cement (PPC) without adding any admixtures in the design mix. After this, again, the fine aggregate is replaced by Quartzite fine aggregate as usual with their consecutive percentage of 10%, 15%, 20% & 25% without the use of any chemical admixture.

4.2 MATERIAL TESTING

4.2.1 Fine Aggregate

Sieve analysis – As per IS 383 : 2016.

Weight of aggregate sample = 1 kg

S.No	IS SIEVE DESIGNATION	Wt. RETAIN (g)	CUMMULATIVE Wt. RETAIN	% RETAINE D	PASSING %
1.	10 mm	0	0	0	100
2.	4.75 mm	85	85	8.5	91.5
3.	2.36 mm	125	210	21.0	79.0
4.	1.18 mm	156	366	36.6	63.4
5.	600 micron	145	511	51.1	48.9
6.	300 micron	378	889	88.9	11.1
7.	150 micron	98	987	98.7	1.3
8.	75 micron	12	999	99.9	0.1

Cummulative Weight retained & passing of fine aggregates

Table No. 4

It lies in Zone 2**.**

4.2.2 Coarse Aggregate

Sample A

Weight of Sample A taken -5kg

The Aggregate is poor Graded.

Sample B

Sieve analysis – As per IS 383 2016

Weight of Sample B taken -5kg

The aggregate is well Graded

Sample

S.No	IS SIEVE DESIGNATION	Wt. RETAIN (g)	CUMMULATIVE Wt. RETAIN	% RETAINED	CUMMULATIVE %	PERCENT PASSING
1.	20mm	356	356	7.12	7.12	92.88
2.	16 mm	4058	4414	81.16	88.28	11.72
3.	12.5 mm	309	4723	6.18	94.46	5.54
4.	10 mm	149	4872	2.98	97.44	2.56
5.	pan	123	4995	2.46	99.99	0.01

% Passing of Coarse Aggregate

Table No. 5

RESULT :GRADED

4.3 MATERIAL TESTING RESULTS

4.3.1 Coarse Aggregate

Specific Gravity = 2.61

Water Absorption = 0.29

Seive Analysis = Graded Aggregate

4.3.2 Fine Aggregate

Specific Gravity = 2.52

Water Absorption = 1.2

Seive Analysis = Zone – II

Percentage of fines = 0.8 %

4.3.3 PPC Cement

Specific Gravity = 3.15

Chapter 5

MIX DESIGN FOR GRADE M-25

Mix proportioning for a concrete of M25 grade.

Required data

a) Grade designation : M25

b) Type of cement : PPC Grade conforming IS 12269

c) Maximum nominal size of aggregate : 20mm

d) Minimum cement content : 300 kg/m3 (IS 456:2000)

e) Maximum water-cement ratio : 0.50 (Table 5 of IS 456:2000)

f) Workability : 75-100mm Slump

g) Exposure condition : Moderate (For Reinforced Concrete)

h) Method of concrete placing : Hand placing

j) Degree of supervision : Good

k) Type of aggregate : Crushed Angular Aggregates

TEST DATA FOR MATERIALS

a) Cement used : PPC Grade conforming IS 12269

b) Specific gravity of cement : 3.15

c) Specific gravity of

1) The aggregate most of which are required on the 4.75mm IS sieve and contain only that much of fine material as is permitted by the specifications are termed as coarse aggregate

Total weight of coarse aggregate taken = 2000 gm

1. A1 = wt. of aggregate + weir bucket in water = 2354 gm
2. A2 = wt. of bucket in water 1115 gm
3. B = wt. of aggregate in saturated surface dry condition = 1994 gm
4. C = wt. of oven dry aggregate = 1990.5 gm

Specific gravity = $\left(\frac{C}{B-(A1-A2)}\right)$

Specific gravity coarse aggregate is found to be **2.61 g/cc.**

2) Specific gravity is defined as the ratio of unit weight of substance to the standard substance at standard temperature i.e. 4^oC. This test is performed with the help of pycnometer.

1. A = wt. of pycnometer + water = 1530 gm
2. B = wt. of pycnometer + wt. of fine aggregate + water = 1846 gm
3. C = saturated surface dry wt. = 500 gm
4. D = wt. of oven dry aggregate = 488 gm

Specific gravity = $\frac{D}{C-(B-A)}$

Specific gravity of fine aggregate is found to be **2.52 g/cc**

d) Water absorption:

1) B = wt. of aggregate in saturated surface dry condition = 1994 gm

C = wt. of oven dry aggregate = 1990.5 gm

Water absorption = ($\frac{B-C}{C}$)*100

Water absorption of Coarse aggregate is found to be 0.29%

2) C = saturated surface dry wt. = 500 gm

D = wt. of oven dry aggregate = 488 gm

Water absorption = ($\frac{C-D}{D}$)*100

Water absorption of fine aggregate is found to be 1.2 %

e) Free (surface) moisture:

1) Coarse aggregate : Nil (Absorbed Moisture also Nil)

2) Fine aggregate : Nil

g) Sieve analysis:

1) Coarse aggregate : Conforming to all in aggregates of Table 2 of IS 383

2) Fine aggregate : Conforming to Grading Zone II of Table 4 of IS 383

TARGET STRENGTH FOR MIX PROPORTIONING

Target average compressive strength at 28 days **(*f'ck*)** = characteristic strength at 28 days **(*fck*)**+ 1.65 multiplied by Standard Deviation **(S)**

f'ck =fck + 1.65 S

where ,

f'ck = target average compressive strength at 28 days,

fck = characteristics compressive strength at 28 days, and

S = standard deviation.

From Table I of IS 10262:2009, Standard Deviation, s = 4 N/mm^2.

Therefore, target strength = 25 + 1.65 x 4 = **31.6 N/mm^2**.

SELECTION OF WATER-CEMENT RATIO

Adopted maximum water-cement ratio = 0.47.

From the Table 5 of IS 456 for Very severe Exposure condition maximum Water Cement Ratio is 0.50

0.47 < 0.50 Hence ok.

SELECTION OF WATER CONTENT

From Table 2 of IS 10262:2009, maximum water content for 20 mm aggregate = 186 Kg

(for 25 to 50 mm slump range)

Estimated water content for 100 mm slump = 186+ (6/186) = **197 Kg**

CALCULATION OF CEMENT CONTENT

Adopted w/c Ratio = 0.47

Cement Content = 197/0.47 = **419 kg/m3 > 300 kg/m3**

Hence ok.

PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT

From Table 3 of (IS 10262:2009) Volume of coarse aggregate corresponding to 20 mm size aggregate and

fine aggregate (Zone II) for water-cement ratio of 0.50 = 0.62 .

As the water-cement ratio is lower by 0.06. The proportion of volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01 for every ± 0.05 change in water-cement ratio).

Therefore, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.47 = 0.63

Volume of fine aggregate content = 1 – 0.57= **0.43 m^3**.

MIX CALCULATIONS

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = **1.0 m^3**

b) Volume of cement = [Mass of cement] / {[Specific Gravity of Cement] x 1000}

= 419/{3.15 x 1000}= **0.133 m^3**

c) Volume of water = [Mass of water] / {[Specific Gravity of water] x 1000}

= 197/{1 x 1000}= **0.197 m^3**

d) Volume of all in aggregate = [a-(b+c)]

= [1-(0.133+0.197)] = **0.67 m^3**

e) Mass of coarse aggregate = e x Volume of Coarse Aggregate x Specific-Gravity of Fine Aggregate x 1000

= 0.67x0.63x2.61x1000 = **1101.68 kg/ m^3**

g) Mass of fine aggregate = e x Volume of Fine Aggregate x Specific Gravity of Fine Aggregate x 1000

= 0.67x0.37x2.52x1000 = **624 kg/ m^3**

Mix-proportioning for conventional M-25 grade of concrete	
Cement	419.0 Kg/m^3
Water	197.0 Kg/m^3
Fine-Aggregate	624.0 Kg/m^3
Coarse-Aggregate	1101.0 Kg/m^3

Mix-proportioning for conventional M-25 grade of concrete

Table No. 6

After the normal testing of M-25 grade of conventional concrete, we start analyzing the behaviour of concrete after replacing the fine aggregate with 10%, 20% & 30% with the dolomite fine aggregate with their suitable percentages and eight cube samples of size 150mm X 150mm X 150mmare made for the compressive strength test at 7th day & 28th day. The trial mixes formed for the experimental analyzing is given below:

Mix-proportioning for M-25 grade of concrete when conventional fine aggregate is replaced by dolomite fine aggregate			
Dolomite percentage taken	10% Dolomite	20% Dolomite	30% Dolomite
Cement	419.0 Kg/m^3	419.0 Kg/m^3	419.0 Kg/m^3
Water	197.0 Kg/m^3	197.0 Kg/m^3	197.0 Kg/m^3
Fine-Aggregate	624.0 Kg/m^3	624.0 Kg/m^3	624.0 Kg/m^3
Dolomite fine aggregate	62.40 Kg/m^3	124.80 Kg/m^3	187.20 Kg/m^3
Coarse-Aggregate	1101.0 Kg/m^3	1101.0 Kg/m^3	1101.0 Kg/m^3

Mix-proportioning for M-25 grade of concrete when conventional fine aggregate is replaced by dolomite fine aggregate

Table No. 7

After the above analysis, we start our experimental test on the quartzite fine aggregate replacement with the conventional fine aggregate and eight cube samples of size 150mm X 150mm X 150mmare made for the compressive strength test at 7th day & 28th day. The trial mix formed for the experimental is given below:

Mix-proportioning for M-25 grade of concrete when conventional fine aggregate is replaced by quartzite fine aggregate			
Quartzite percentage taken	10% Quartzite	20% Quartzite	30% Quartzite
Cement	419.0 Kg/m^3	419.0 Kg/m^3	419.0 Kg/m^3
Water	197.0 Kg/m^3	197.0 Kg/m^3	197.0 Kg/m^3
Fine-Aggregate	624.0 Kg/m^3	624.0 Kg/m^3	624.0 Kg/m^3
Quartzite fine aggregate	62.40 Kg/m^3	124.80 Kg/m^3	187.20 Kg/m^3
Coarse-Aggregate	1101.0 Kg/m^3	1101.0 Kg/m^3	1101.0 Kg/m^3

Mix-proportioning for M-25 grade of concrete when conventional fine aggregate is replaced by quartzite fine aggregate

Table No. 8

Chapter 06

COMPRESSIVE STRENGTH TEST RESULTS & SLUMP TEST

In this research paper, the slump test is performed on concrete in the initial stages of this research to analyze the workability of conventional and non-conventional concrete and its comparison between them for the research analysis.

In this experiment, the concrete is prepared with the replacement of different consecutive percentages of dolomite & quartzite under normal conditions as per recommendations of IS codes amd are tested at 7 days and 28 day and all the samples are cured as per indian standards and compression test is done to determine the compressive strength. We have made sample cubes of dimensions 150mm X 150mm X 150mm are casted to check the compressive strength of concrete at 7^{th} day & 28^{th} day and compared with the test results of conventional concrete.

EXPERIMENTAL TEST RESULTS FOR COMPRESSIVE STRENGTH

Test results with the replacement of Dolomite

Percentage of Dolomite replacement with fine-aggregate	Average Compressive Strength at 7^{th} Day (in N/mm^2)	Average Compressive Strength at 28^{th} Day (in N/mm^2)
10%	13.16	25.86
15%	11.73	21.13
20%	11.13	20.76
25%	11.60	19.80

Test results with the replacement of Dolomite

Table No. 9

It is clear from this table that the compressive strength obtained from concrete with the replacement of dolomite as fine aggregate is comparatively lower than the compressive strength obtained from the compressive strength obtained from normal conventional concrete.

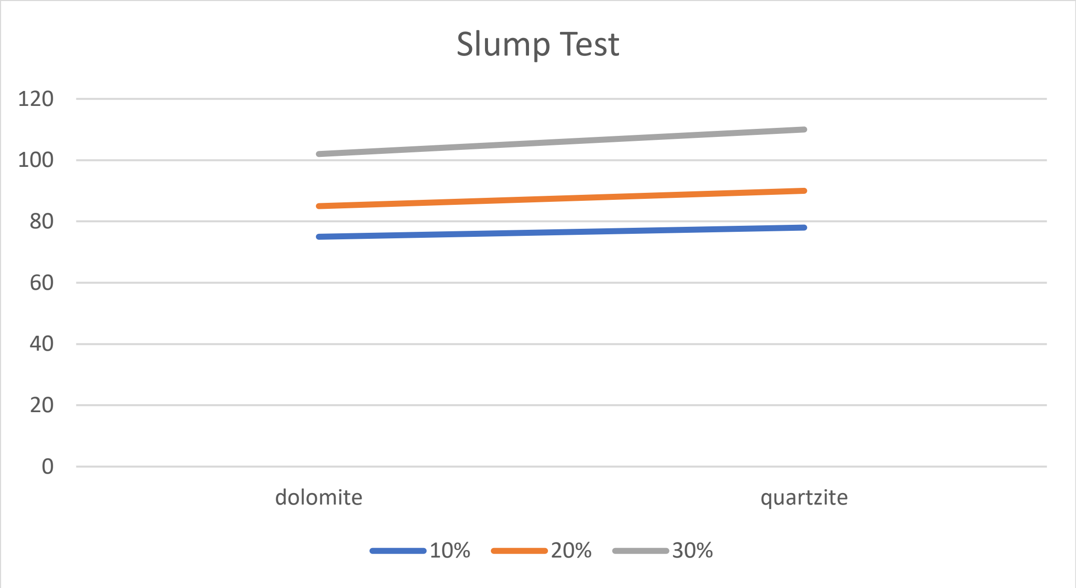
Test Results with the replacement of Quartzite

Percentage of Quartzite replacement with fine-aggregate	Average Compressive Strength at 7^{th} Day (in N/mm^2)	Average Compressive Strength at 28^{th} Day (in N/mm^2)
10%	21.80	35.76
15%	21.66	32.80
20%	20.56	29.76
25%	12.66	20.43

Test Results with the replacement of Quartzite

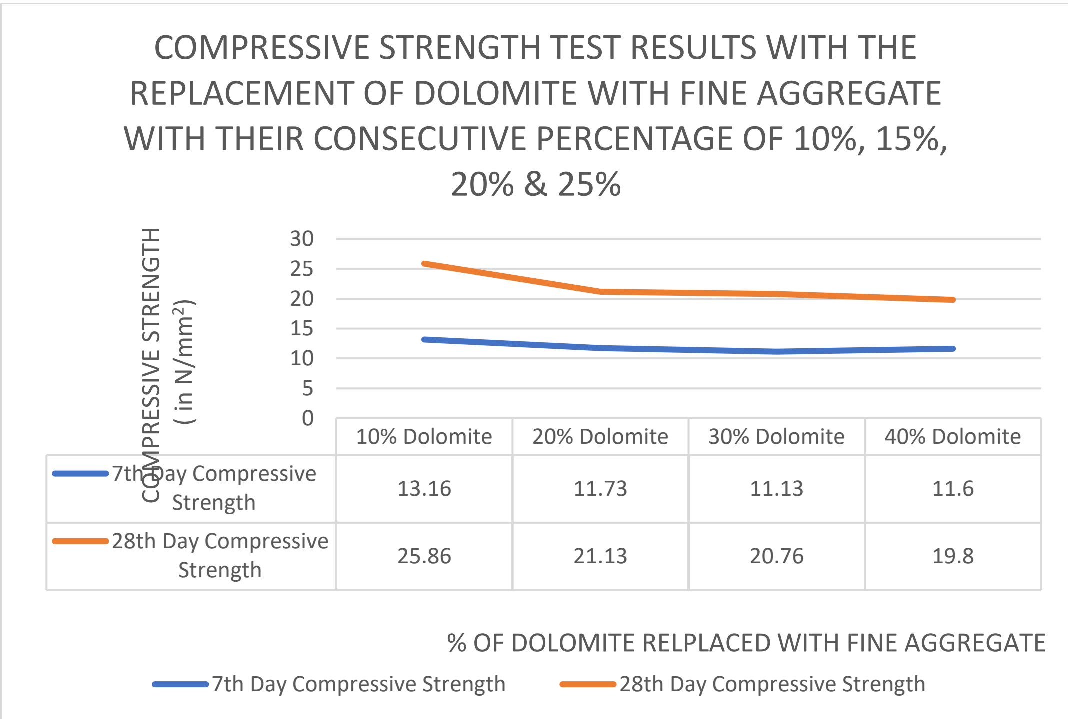
Table No. 10

It is clear from this table that the compressive strength obtained from concrete with the replacement of quartzite as fine aggregate is comparatively higher than the compressive strength obtained from the compressive strength obtained from normal conventional concrete by about 5% to 10%.



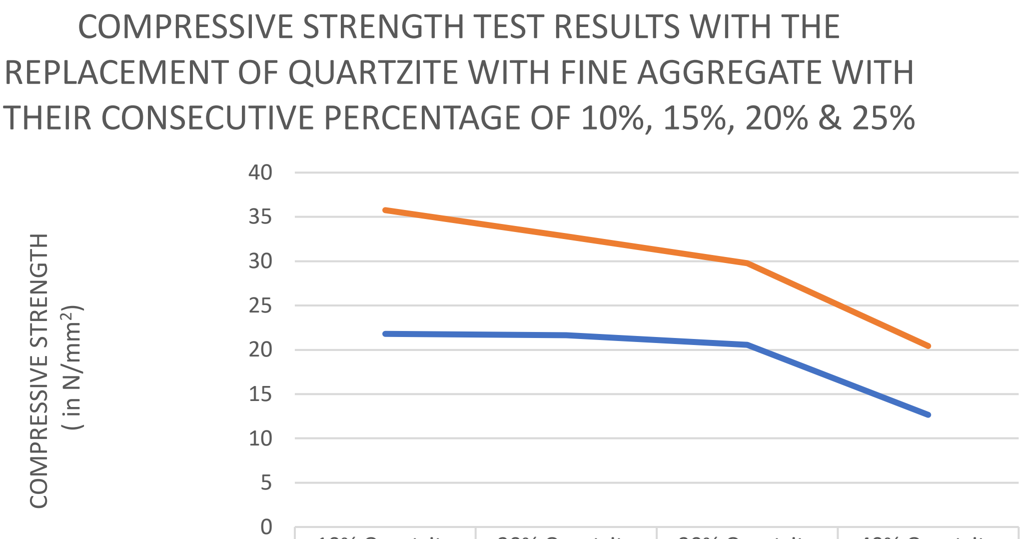
Slump Test Results

Figure No. 3



COMPRESSIVE STRENGTH TEST RESULTS WITH THE REPLACEMENT OF DOLOMITE WITH FINE AGGREGATE WITH THEIR CONSECUTIVE PERCENTAGE OF 10%, 15%, 20% & 25%

Figure No. 4



	10% Quartzite	20% Quartzite	30% Quartzite	40% Quartzite
7th Day Compressive Strength	21.8	21.66	20.56	12.66
28th Day Compressive Strength	35.76	32.8	29.76	20.43

COMPRESSIVE STRENGTH TEST RESULTS WITH THE REPLACEMENT OF QUARTZITE WITH FINE AGGREGATE WITH THEIR CONSECUTIVE PERCENTAGE OF 10%, 15%, 20% & 25%

Figure No. 5

Chapter 07

CONCLUSION

In this research work, we have worked on the analysis on the comparison of mechanical properties of conventional concrete and with the replacement of fine aggregate with non-conventional aggregate (dolomite & quartzite stone). After the many trial mixes, we get to analyze that when we replace conventional fine aggregate with dolomite fine aggregate, the test results shows that the slump flow starts increasing when we increase the percentage of dolomite aggregate from 10% to 30% as the flow get increased and workability also gets increased and the compressive strength test is also done on eight cube samples at 7^{th} day & 28^{th} day and found that the compressive strength of samples starts getting decreasing as the percentage of dolomite is increased in the trial mix and shows that dolomite can only be used upto a percentage of 2% to 5% to make conventional concrete economical but dolomite can not be used above 5% by volume as this may result in the failure of mechanical properties of non-conventional concrete.

When we analyze the properties of quartzite as fine aggregate and in experiment and mix design, we have replaced the percentage of conventional fine aggregate with quartzite fine aggregate. In the test results, we found that the workability of non-conventional concrete starts getting increased as we increase the quartzite fine aggregate in the trial mix and the workability is also increased. In analyzing the compressive strength of non-conventional concrete samples, when the percentage of quartzite fine aggregate is increased from 10% to 30%, the compressive strength starts getting increased by 5% to 8%, and found that when quartzite fine is aggregate is increased it gives us a better increased workability and increased compressive strength of the trial mix made as per IS 10262-2019.

As analysed in the experiments and testings , it is found when we are replacing the quantity of fine aggregates with cumulative percentage (10% , 15% , 20% , 25%) of **dolomite** , it is observed that the compressive strength of cubes get decreased after the replacement of fine aggregate with dolomite aggregate and the workability is also studied and analysed that by the replacement of dolomite in the cumulative percentage with fine aggregate , the workability gets decreased , as a result , segregation and bleeding is occurred in the observation of the experiment .

It is also been analysed in the experiments and testings , it is found when we are replacing the quantity of fine aggregates with cumulative percentage (10% , 15% , 20% , 25%) of **quartz** , it is observed that the compressive strength of cubes get increased by 15% to 20 % after the replacement of fine aggregate with quartz aggregate and the workability is also studied and analysed that by the replacement of dolomite in the cumulative percentage with fine aggregate , the workability also gets increased , as a result , segregation and bleeding is occurred in the observation of the experiment .

Chapter 06

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