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"UTILIZATION OF QUARRY DUST BY PARTIALLY REPLACING THE FINE AGGREGATE FOR EXAMINING THE STRENGTH OF CONCRETE"

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Abstract: Because of the increase in construction activity, the accessible sources of natural sand are becoming depleted as a result of the use of sand in construction. High-quality sand can be transported over long distances, causing economic hardship. As a result, the quality of the structure is completely reliant on the partial or complete replacement of alternate material with natural sand. The effect of quarry dust on the mechanical properties of concrete has been experimentally studied and reported in this research work. The concrete was made by partially replacing sand content 20% and 30% by weight with quarry dust. In first stage, concrete with no sand replacement of grade M20 is prepared so as to compare with the other trial cases of concrete having partial quarry dust. 150 mm cube specimens were prepared for the two replacement levels of 20% and 30% to obtain the compressive strength at 28 days. Total no of 9 specimens were made for this research work. From the results, it was observed that the flexural strength of concrete with 20% and 30% quarry dust were higher compared with concrete with no quarry dust. It was found that incorporating quarry dust in concrete improves its compressive strength.

Keywords: Sand, Quarry Dust, Compressive

1. Introduction

Sudhir S.Kapgate and S.R.Satone (2013) investigated the use of quarry dust as a partial replacement for sand in concrete. They discovered that increasing the dust content by up to 30% increases the compressive strength of concrete; however, increasing the dust content by more than 30% gradually decreases the compressive strength. **Titiksh and Wanjari (2021);** concluded that the samples containing 100 % FA showed a noticeable increase in the 28-days compressive strength of 15 % when contrasted with the control blend. By and large, every one of the preliminaries displayed worthy strength properties according to the codal prerequisites of IS 456: 2000, empowering us to reason that total substitution of river sand in concrete with FA within the sight of NSPs is a maintainable option in contrast to the conventional mix design approach. **Talukder et al. (2020);** observed that because of slower rate of hydration of fly ash at earlier ages, strength of OPC (Ordinary Portland Cement) concrete was higher than those of cement-fly ash mixed concrete. Overall test results reveal that blended concrete of cement-fly ash mix ratio 45:55 & 35:65 provides better result in terms of strength and chloride penetration after 90 days. **Sun et al.(2019);** concluded that HVFA concrete exhibited much higher water absorption than that of the control concrete at 28 days. With 28 to 90 days of curing, the pozzolanic reaction of FA progresses significantly and consumes large amounts of CH with producing additional secondary C-S-H gels, resulting in denser and more compact microstructure, thus decreasing the amount of water absorption of HVFA concrete. **Chen et al. (2019);** concluded that the concrete with a higher amount of total binder (S30 series), higher fly ash substitution ratio (>50%) and high-LOI (8%) fly ash (FA2) tended to have higher air content. However, except for S30F80-2, the air content of the remaining concrete (2.1% to 3.7%) was still within acceptable limits. Under the same substitution ratio, the setting time of the S30 series high-LOI loss (8%) fly ash (FA2) concrete was longer than that of the low-LOI (5%). The fly ash (FA1) concrete took seven hours to reach initial setting and more than nine hours to the final setting. **Das and Gattu (2018)** suggested the suitability of quarry dust as alternative material for the river sand in concrete manufacturing. The physical properties of quarry dust namely specific gravity; water absorption; silt content; and fineness modulus were measured using standard tests which was followed by compression, split tensile and bending tests on cubes, cylinders and RC beams respectively to study the strength of concrete made of quarry rock dust. The results showed that with increasing proportion of quarry dust, the strength increased to peak value.

2. Material

The raw materials used in this research work are collected from different parts of Raipur, Chhattisgarh. Each material has such physical properties which are to be studied for the production of concrete blocks. The ingredients used in this study are Portland pozzolana cement, FlyAsh, Sand, Quarry Dust, Coarse Aggregate.

Fig. 1 Materials Used in this Study (a) Cement (b) Sand (c) Aggregate (d) Quarry Dust (e) Fly Ash

3. Methodology

3.1 Test Stipulation required for Mix-Design

The test Stipulation required for Mix-Design for the sand, cement and coarse aggregate are such that the determination of consistency of cement according to IS 4031:1988 is done and found to be 32.5% and the specific gravity of cement as per IS 4031:1988-Part 11 is 2.35 using flask apparatus.

3.2 Sieve Analysis of Aggregates

The sieve analysis test is done based on IS 383 are as follows-

Table 1 Sieve Analysis of Fine Aggregate

Sieve Sizes	Mass Retained	Percentage Retained	Percentage Cumulative Retained	Percentage Fine	Avg. Percentage Passing
10 mm	0	0	0	100	100
4.75 mm	13	2	2	98	98.06
2.36 mm	55	8.45	10.45	89.55	89.63
1.18 mm	97	14.9	25.35	74.72	74.72
600 µm	204	31.34	56.68	43.36	43.32
300 µm	159	24.42	81.11	18.88	18.89
150 µm	91	13.98	95.08	4.94	4.94

Fineness Modulus = Fineness Modulus = Sum (Cumulative percentage retained)/100 = **2.704.** Based on the above result, we can say as per IS 383 that the fine aggregate is in Zone-II**.**

3.3 Mix-Design for Conventional M20 Grade concrete

- The Target Mean Strength for Mix Proportioning is given by $f'_{ck} = f_{ck} + 1.65S \ or \ f'_{ck} = f_{ck} + X\ , whichever\ is\ higher$ where,f'ck = target avg compressive strength after twenty-eight days of curing, fck = characteristic compressive strength at twenty-eight days of curing, S = standard deviation for M20 grade = 4 N/mm^{2}given in IS 10262:2019, table 2.Therefore, **target strength= 20 + 1.65 x 4= 26.6 N/mm^2**
- The air entrapped in concrete varies based on size of aggregate given in table 3, IS 10262:2019. The approximate entrapped air in this case is considered to be 1 percent for 20 mm size of CA.
- The maximum free water-cement ratio as given in IS456:2000 table 5is 0.5 under severe condition. The actual free water-cement ratio for target strength of 26.6 N/mm^{2}and curve 1 as per figure 1 given IS 10262:2019 **is0.4**. This value is lower than the maximum.
- The selection of water content is given in table 4 of IS 10262 based on 20 mm maximum size of aggregate and 50 mm slump value is 186 kg. Here, for 120 mm slump value the following water content is increased by 3 percent for each 25 mm slump which is equal to **186 + (186*9)/100 = 202.74 kg.**
- Super plasticizers are utilized to reduce the water content hence the above value is reduced for 23 % on trial based while utilization of super plasticizer is 1% by weight of cement.

  Therefore, the final water content = 202.74 X 0.77 = 156.11 kg = 156 kg
- The calculation of cement content = $(Water\ content)/(Water - Cement\ ratio)$ = 156/0.40 =**390 Kg/m^3.** The minimum cement content as per Table 5 in IS 456:2000 is **320 kg/m^3** in severe exposure condition. Hence, the calculated value is greater than the recommended value.
- For mix-portioning of concrete, increase in Cementitious content is considered based on trials and experience. Here, an increase of 10 % cementitious material is been considered = **390 X 1.10 = 429 Kg/m^3**
- Water-cementitious ratio = $Water\ content/Cementitious\ Content$ = **156 /429 = 0.363**
- For mix-portioning of concrete having fly ash, the current trail has 30 percent fly ash of total cementitious content. Hence, fly ash content = **429 X 0.30 = 128.7 Kg/m^3 = 129 Kg/m^3**
- Cement content = 429 – 129 = **300 Kg/m^3**
- The minimum cementitious content as per Table 5 IS 456:2000 is **320 kg/m^3** in severe exposure condition. Hence, the calculated value is greater than the recommended value (i.e., 429 kg/m^3).
- The volume of coarse aggregate corresponding to Table 5, IS 10262:2019 for 20 mm seize of aggregate and sand of zone II for W/c of 0.50 is **0.62**. At present trial W/c is **0.40**, there is a decrease in W/c ratio by **0.22**, the proportion of volume of CA is increased by **0.044** (i.e., at the rate of ± 0.01 for every ± 0.05 change in water-cement ratio). Therefore, the modified proportion of volume of CA for the water-cement ratio of 0.40 **= 0.62 + 0.044 = 0.666**.
- Volume of sand content = Total Volume of aggregate – Volume of CA = **1- 0.666 = 0.334.**
- Determination of mix per unit volume of concrete are as follows -

Concrete volume = 1 m^3

Entrapped Air Volume = 0.01 m^3

Volume of Cement = $\frac{Mass\ of\ Cement}{Specific\ Gravity\ of\ Cement} X \frac{1}{1000} = \frac{300}{2.35} X \frac{1}{1000}$= **0.127 m^3**

Volume of Fly Ash = $\frac{Mass\ of\ Fly\ Ash}{Specific\ Gravity\ of\ Fly\ Ash} X \frac{1}{1000} = \frac{129}{2.1} X \frac{1}{1000}$ = **0.0614 m^3**

Volume of Water = $\frac{Mass\ of\ Water}{Specific\ Gravity\ of\ Water} X \frac{1}{1000} = \frac{156}{1} X \frac{1}{1000}$ = **0.156 m^3**

Volume of Super plasticizer (where 1% by mass of cementitious material is used)

$= \frac{Mass\ of\ Chemical\ Admixture\ (Superplasticizer)}{Specific\ Gravity\ of\ Admixture} X \frac{1}{1000}$

$$= \frac{4.29}{1.145} X \frac{1}{1000} = \mathbf{0.0037m^3}$$

Volume of all in aggregate = [(Total Volume – Volume of air entrapped) – (Volume of Cement + Volume of Fly Ash + Volume of Water + Volume of Super plasticizer)] = [(1-0.01) - (0.127+ 0.0614 + 0.156 + 0.0037)] = **0.6419 m^3.**

Mass of CA= Volume of all in aggregate X Volume of CA X Specific Gravity of CA X 1000 = 0.6419 X 0.666 X 2.785 X 1000 = **1190.6 = 1191 kg.**

Mass of FA = Volume of all in aggregate X Volume of FA X Specific Gravity of FA X 1000 = 0.6419 X 0.334 X 2.669 X 1000 = **572.2 = 572 kg.**

The proportions required after the mix -design for 1 cube (150 mm) is given in table below-

Table 2 Proportion of Concrete Mix Trials for 1 cubic meter

Case ID	Cement (kg/m^3)	Fly ash(kg/m^3)	Coarse Aggregate (kg/m^3)	Sand(kg/m^3)	Quarry Dust (kg/m^3)	Water(kg/m^3)
CC20	1.0125	0.4353	4.0196	1.9305	-	0.5265
Q2020	1.0125	0.4353	4.0196	1.5457	0.3847	0.5265
Q2030	1.0125	0.4353	4.0196	1.35	0.5805	0.5265

4.Compressive Strength Reports for M20 concrete cases

As per the guidelines of the compressive test of concrete in IS 516:1959, the following trail case study are evaluated by experimental techniques for twenty-eight days. Below table shows the compressive strength data for M20 concrete having quarry dust partially replaced by 20 percent and 30 percent. The case trials are tested such that each case has three cube specimens ranging from specimen 1 to 9 for maintaining accuracy and elimination of errors. Thus, here nine cube specimens (i.e., Specimen 1 to Specimen 9) are utilized for the M20 concrete trial cases.

Table 3 Test result of compressive strength for M20 concrete cases

Case ID	Case Trials	Area (mm2)	Load (KN)	Compressive Strength after 28 days curing (N/mm2)	Average Compressive Strength (N/mm2)
CC20	Specimen 1	22500	705.6	31.36	31.73
	Specimen 2	22500	725.4	32.24	
	Specimen 3	22500	711	31.6	
Q2020	Specimen 4	22500	690.3	30.68	30.95
	Specimen 5	22500	707.6	31.45	
	Specimen 6	22500	691.2	30.72	
Q2030	Specimen 7	22500	657	29.2	29.2
	Specimen 8	22500	666	29.6	
	Specimen 9	22500	648	28.8	

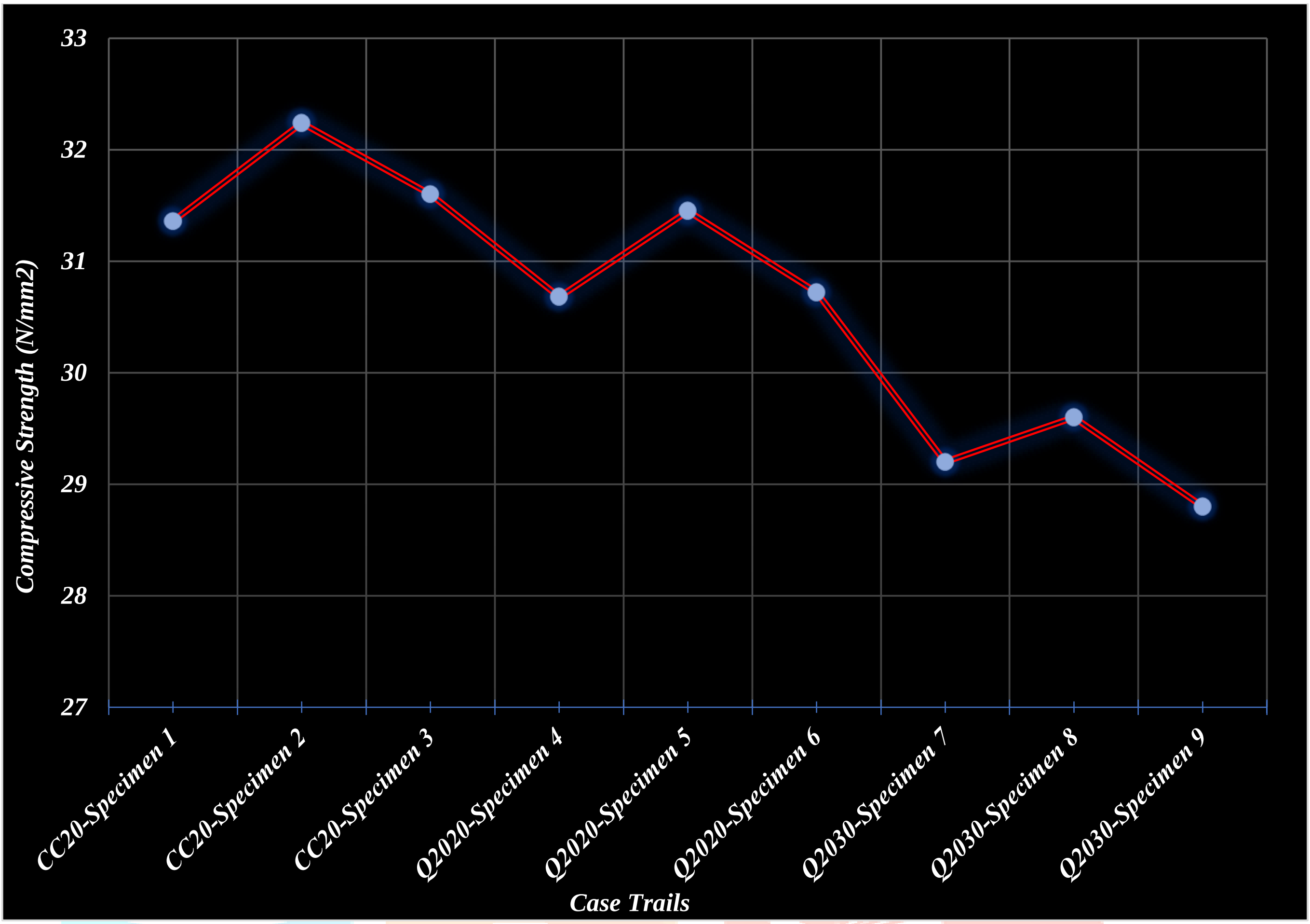

Fig. 2 Compressive Strength for Case Trials for M20 concrete

From the above experimental investigation, the average compressive strength for CC20 shows value of 31.73 Newton per squ. mm. which is very close to Q2020 samples. The average compressive strength for Q2020 is 30.95 N/mm^2 while the compressive strength for Q2030 is 29.2 N/mm^2.However, both material of Q2020 & Q2030 are 3 % and 8 % approximately less than the conventional concrete sample CC25. The addition of twenty percent quarry dust showing very much similar compressive strength when compared to conventional CC20 concrete.

5. Conclusions

- The concrete specimen of carrying quarry dust exhibits better workability than conventional cement concrete.
- The CC20 trial case is exhibiting better compressive strength as compared to Q2020 and Q2030 trial case.
- It is been seen that addition of quarry dust in place of sand is giving better performance and can be used for load bearing structures.

References

1) **S. Talukder, E. Roy, M. S. Islam, S. Sakib (2020),** ***"A Study on the Performance of High-Volume Fly Ash in Concrete"***International Conference on Advances in Civil Engineering (ICACE-2020) , 21-23 December 2020.
2) **Sudhir S.Kapgate and S.R.Satone,** "EFFECT OF QUARRY DUST AS PARTIAL REPLACEMENT OF SAND IN CONCRETE", 2013.
3) **Biswaprakash Das, Mahendra Gattu**, ***"Study on Performance of Quarry Dust as Fine Aggregate in Concrete",*** International Conference on Advances in Construction Materials and Structures (ACMS-2018) IIT Roorkee, Roorkee, Uttarakhand, India, March 7-8, 2018.
4) **IS: 456:2000**, Indian Standard Code for Plain and reinforced concrete-code of practice, 4th Revision, BIS, New Delhi, 2000.
5) **IS 4031: Part11**, Methods of physical tests for hydraulic cement, Bureau of Indian Standard, 1988.
6) **IS 383:2016**,"Coarse and Fine Aggregate for Concrete Specification", Bureau of Indian Standard,Third Revision, 2016.
7) **IS 10262:2019**, Concrete Mix Proportioning - Guidelines, Bureau of Indian Standard,Second Revision, 2019.