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EFFECT ON PERFORMANCE OF CONCRETE BY PARTIAL REPLACEMENT OF SAND WITH QUARRY DUST ALONG WITH THE APPLICATION OF WATER REDUCING ADMIXTURE

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Abstract
With rapidly increasing population and India's focus on infrastructure development, the increase in sand demand for construction purpose has rocketed up. If this exploitation or sand mining continues to take place at such a large level then erosion, shrinking and collapse of river banks, altering of river beds, harm to the sub structures of bridge and other structures situated near of rivers, intrusion of saline water into land, reduction of biodiversity, filtration property of river is affected which results in poor quality of water will take place. Thus, there is need of a substitute material preferably, waste which can replace sand and hence addresses the difficulties inevitable in the utilization of sand as fine aggregate. Stone quarry dust, a waste from quarrying process of rocks, when released directly into surroundings can cause air pollution and environmental pollution and quarry dust is non-biodegradable alsoand hence, the disposal problem of stone quarry dust is also resolved by using quarry dust in place of sand partially. In such situations, quarry dust will be an ecofriendly and economical substitute to natural river sand. Moreover, sand and quarry dust have similar chemical properties. In this, we have analyzed the performance of M 20 and M 25 grade of concrete by partial replacement of sand with quarry dust and sand is replaced by quarry dust by 0%, 15%, 25%, 35%, 40% and 50%. Compressive Strength of concrete at 7, 14 and 28 days are found out. Finally, we found that cost of construction decreases and technique is environment friendly as well.

Keywords: Quarry Dust, Slump, Workability and Compressive Strength.

1. Introduction

Concrete is one of the extensively used building materials worldwide due to its adaptability, strength, fire resistance along with high durability. Fine aggregate is a crucial element of concrete. Generally, used fine aggregates is natural river sand. Natural river sand requirement in the construction sector has tremendously raised due to the large-scale use of concrete material resulting in the decrease of river sand sources and rise in river sand price. Formation of natural sand takes thousands of years and it cannot replenish also. Limited availability of sand and large cost of transportation from river bed are two main causes for the sky rocketing of natural sand cost. The diminution of natural sand sources on large level also creates environmental problems. Erosion, shrinking and collapse of river banks, altering of river beds, harm to the sub structures of bridge and other structures situated near of rivers, saline water gets intruded in the land and reduction of biodiversity are some of the detrimental effects due to the river sand extraction. Therefore, it becomes necessary to explore the other options which can be used as substitute for sand to reduce river sand extraction. Thus, an analysis is required to identify the suitable substitute which is environment friendly and economic and need of a substitute material preferably waste which can replace sand and hence addresses the difficulties inevitable in the utilization of sand as fine aggregate. In such situations, quarry dust will be an ecofriendly and economical substitute to natural river sand. Quarry dust is left over obtained from quarrying process of stones. Stone quarry dust when released directly into surroundings can cause air pollution and environmental pollution. The negative impact of the stone quarry dust on humans, animals and surroundings can be minimized by use of stone quarry dust in place of concrete there by natural resources are used effectively and efficiently and also not causing any harm to environment as well. In this way, the stone quarry dust can be a good substitute for fine aggregate and will be a promising element in concrete preparation.

2. Objectives

The main objectives of the project are as follows:

- The qualities offered by stone quarry dust to be incorporated in concrete and to lessen exploitation of river bed due to the sand extraction, and form the basis for designing of the mix proportions of different grade of concrete.
- Utilizing stone quarry dust, a waste material and thereby reducing cost of construction and environmentally friendly also.
- Stone quarry dust when released directly into surroundings can cause air pollution and environmental pollution. The negative impact of the stone quarry dust on humans, animals and surroundings will be minimized by use of stone quarry dust as admixture in concrete such that the natural resource is used effectively and efficiently and also not causing any harm to environment as well.
- To observe impact of stone quarry dust proportions on the strength in compression and tension and workability of concrete and comparison of quarry dust with sand.

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3. Materials Used

1. Cement: Ordinary Portland cement was used in this project and grade was 43.
2. Fine aggregate: Sand is used as fine aggregate and as per sieve analysis and grading limit, sand sample is conforming to zone III.
3. Coarse aggregate: Coarse aggregate of nominal size 20 mm is used in this project.
4. Water: Normal water is used.
5. Quarry Dust: Quarry dust is a byproduct obtained by process of crushing of stones and is available in abundant from stone quarries.
6. Water reducing admixture: These helps in the water reduction for a specific given workability or help in attaining higher workability at same water content.

4. Methodology

Step 1. Samples of fine aggregate, quarry dust, coarse aggregate, cement and water is collected.
Step 2. Basic tests on materials are performed to ensure quality.
Step 3. Designing of mix of concrete as M 20 grade, 1:1.5:3 and M 25 grade, 1:1:2 (cement: fine aggregate: coarse aggregate).
Step 4. The cement, quarry dust, fine aggregate, coarse aggregate and water are mixed and concrete mix is prepared.
Step 5. Slump test is done to check the workability of concrete.
Step 6. Concrete is filled in cubical moulds of 15 cm size with proper compaction by vibrator.
Step 7. After one day, cube is detached from mould and kept in water tank for curing.
Step 8.3 Cubes are tested for compressive strength by gradually applying load at the rate of 140 kg/cm2 till cube collapses at 7^{th}, 14^{th} and 28^{th} days.

5. Results and Discussions:

S.N.	Name of experiment	Obtained Value
1.	Fineness of cements	10 %
2.	Standard consistency test	34 %
3.	Initial setting time	105 min
4.	Final setting time	197 min
5.	Compressive strength at 28 days	46.34 M Pa

Table 1: Result of tests on cement

S.N.	Name of experiment	Obtained value
1.	Bulking of sand	4.2 %
2.	Fineness modulus of sand	3.13
3.	Fineness modulus of quarry dust	3.03
4.	Specific gravity of sand	2.1
5.	Specific gravity of quarry dust	2.4
6.	Water absorption of sand	1.5 %
7.	Water absorption of quarry dust	0.5 %

Table 2: Result of tests on fine aggregate

S.N.	Name of experiment	Obtained value
1.	Water absorption test	0.56 %
2.	Impact value test	12.89 %
3.	Abrasion value test	31.78 %
4.	Crushing value test	23.54 %
5.	Specific gravity test	2.9

Table 3: Result of tests on coarse aggregate

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Results on concrete:

MATERIALS USED IN M 20 & M 25 GRADE CONCRETE:

REPLACEMENT PERCENTAGE OF SAND BY QUARRY DUST (%)	WT. OF CEMENT (IN KGS)	WT. OF SAND(IN KGS)	WT. OF COARSE AGGREGATE (IN KGS)	WT. OF QUARRY DUST (IN KGS)	WT. OF WATER REDUCING ADMIX (IN ML)
0	3.5	5.25	10.5	0	0
15	3.5	4.46	10.5	0.79	21
25	3.5	3.94	10.5	1.31	21
35	3.5	3.41	10.5	1.84	21
40	3.5	3.15	10.5	2.1	21
50	3.5	2.625	10.5	2.625	21

Table 4: Amount of materials used in M20

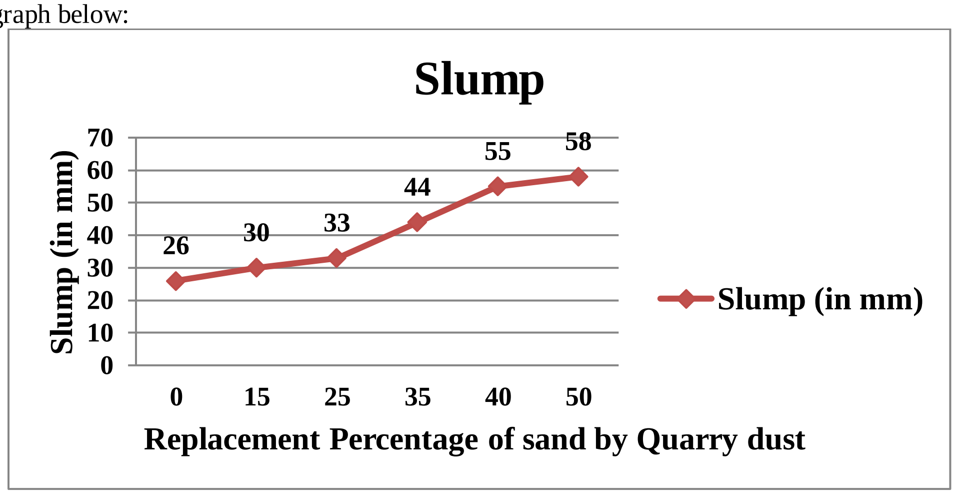
REPLACEMENT PERCENTAGE OF SAND BY QUARRY DUST (%)	WT. OF CEMENT (IN KGS)	WT. OF SAND (IN KGS)	WT. OF COARSE AGGREGATE (IN KGS)	WT. OF QUARRY DUST (IN KGS)	WT. OF WATER REDUCING ADMIX (IN ML)
0	3.5	3.5	7	0	0
15	3.5	2.975	7	0.525	21
25	3.5	2.625	7	0.875	21
30	3.5	2.45	7	1.05	21
35	3.5	2.275	7	1.225	21
40	3.5	2.1	7	1.4	21

Table 5: Amount of materials used in M25

SLUMP OBSERVATIONS:

Variation of slump along with percentage of quarry stone dust has been shown clearly in the graph. It can be inferred that on increasing replacement percentage of natural sand, the slump value also increases keeping water cement ratio to be constant. Increased fineness of quarry dust requires more water for mixing to have good & closer packing which consequently reduces workability.

Slump value measured for concrete having quarry stone dust with fixed water content ratio w /c = 0.5 for M 20 and M 25 grades of concrete as shown in graph below:



Graph 1: Slump variation for M20

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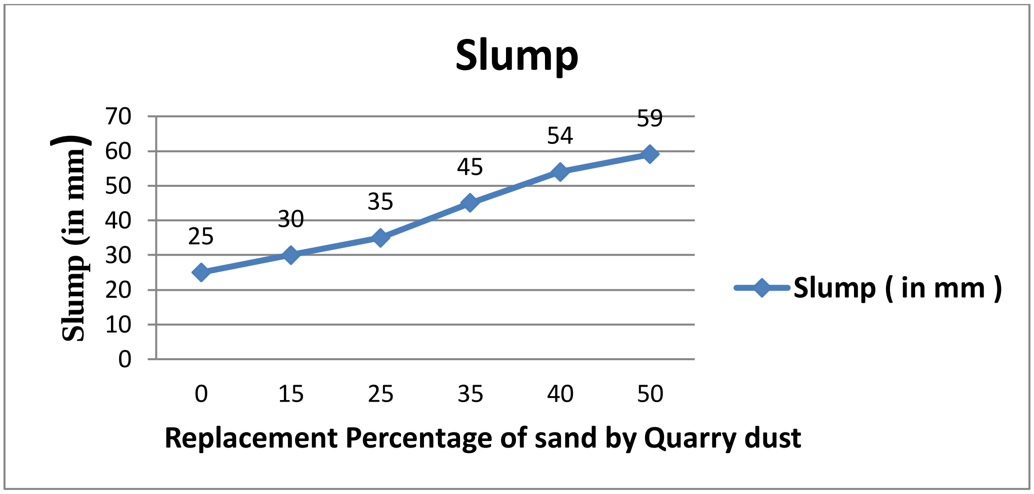

Graph 2: Slump variation for M25

S.NO	REPLACEMENT PERCENTAGE OF SAND BY QUARRY DUST	COMPRESSIVE STRENGTH (M Pa)		
		7DAYS	14 DAYS	28 DAYS
CS1	0	11.78	18.98	21.52
CS2	15	12.12	19.95	22.51
CS3	25	12.67	20.39	22.88
CS4	35	12.96	20.61	22.98
CS5	40	12.10	18.72	20.64
CS6	50	11.96	18.34	20.31

Table 6: Compressive Strength of M20 grade Concrete

It is clearly visible from graph that compressive strength of cube at 28 days for control mixture (CS1) is 21.52 M Pa for M20 grade concrete. At the 35 % replacement of sand, maximum compressive strength i.e., 22.98 is achieved.

Compressive strength decrement takes place as the dust content becomes more than 35 %. For the cubes casted with dust content ranging between 0 % and 25%, particles are not sufficient to fill the voids between aggregate particles and cement resulting in lesser values of compressive strength in comparison to cubes casted with 35 % dust content.

Compressive strength of cube at 28 days for CS1 is 21.52 M Pa and the strength increases by 4.6%, 6.31% and 6.79% for mix CS2, CS3 & CS4 respectively but for CS5, CS6 the strength decreases by 4.1% and 5.62% in comparison to CS4.

Overall, we can say that compressive strength increases on partially replacing natural sand with the quarry dust up to the 35 % replacement.

Possible reason for compressive strength decreases after replacement percentage exceeded 35 %:
When the dust particles exceed 35 %, higher quantity of dust require more water as the quarry dust absorbs more water and consequently workability decreases. Segregation occurs due to increase in number of voids (water from concrete dries up leaving voids when setting of concrete occurs) which finally results in the decreased compressive strength.

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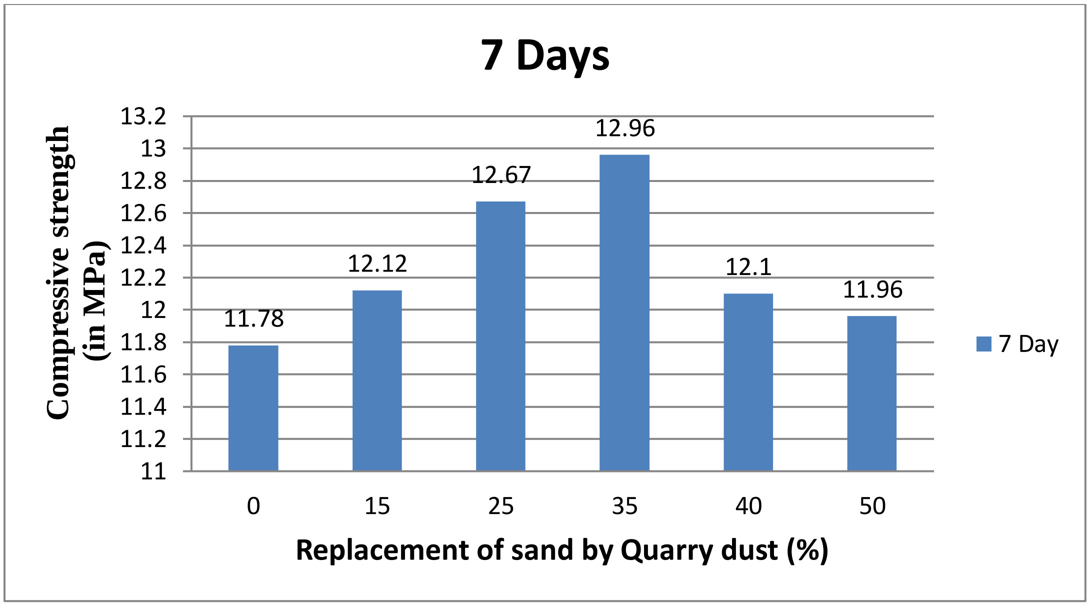
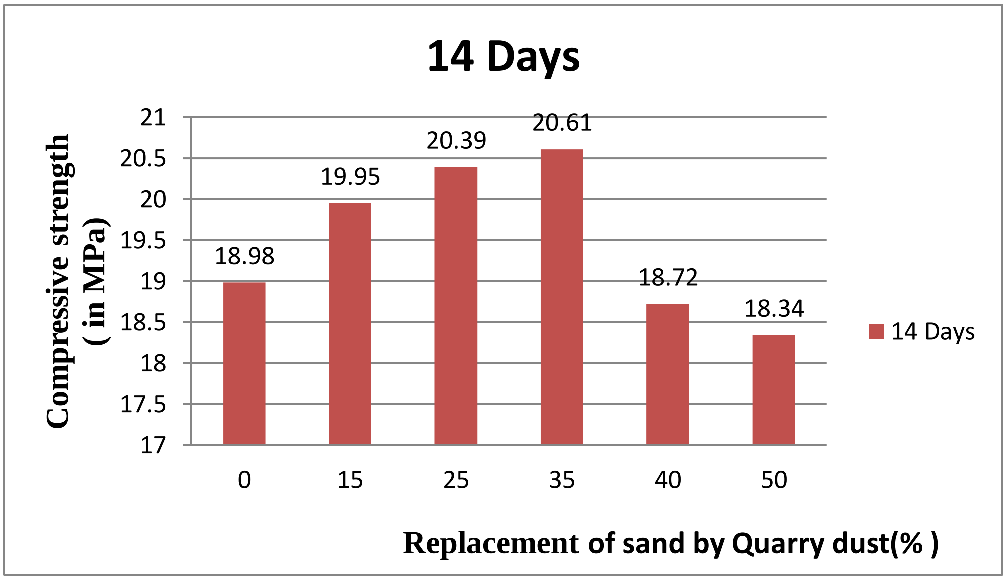


Graph 3: Strength in compression of M20 grade concrete at 7 days



Graph 4: Strength in compression of M20 grade concrete at 14 days

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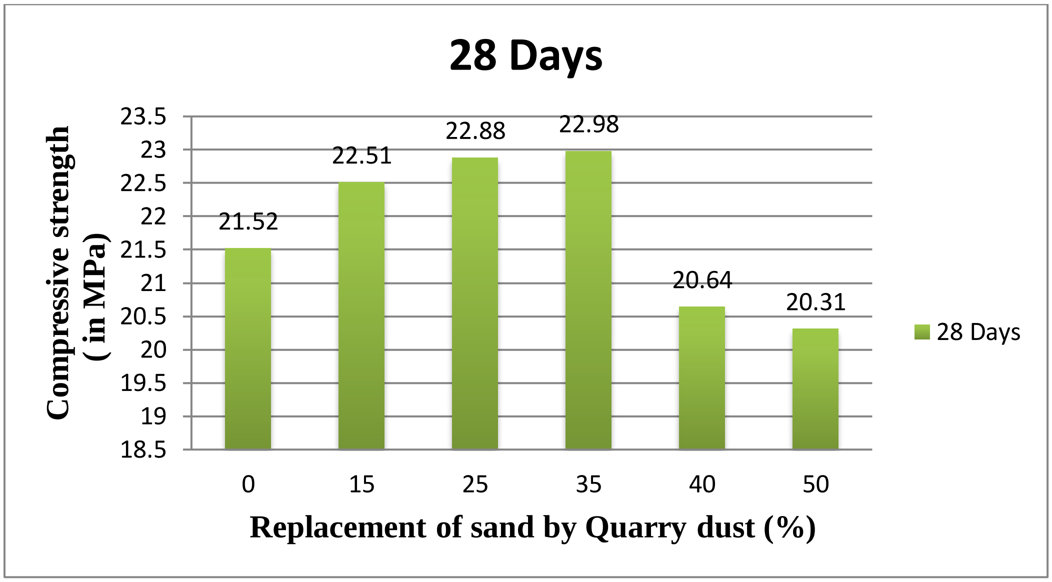
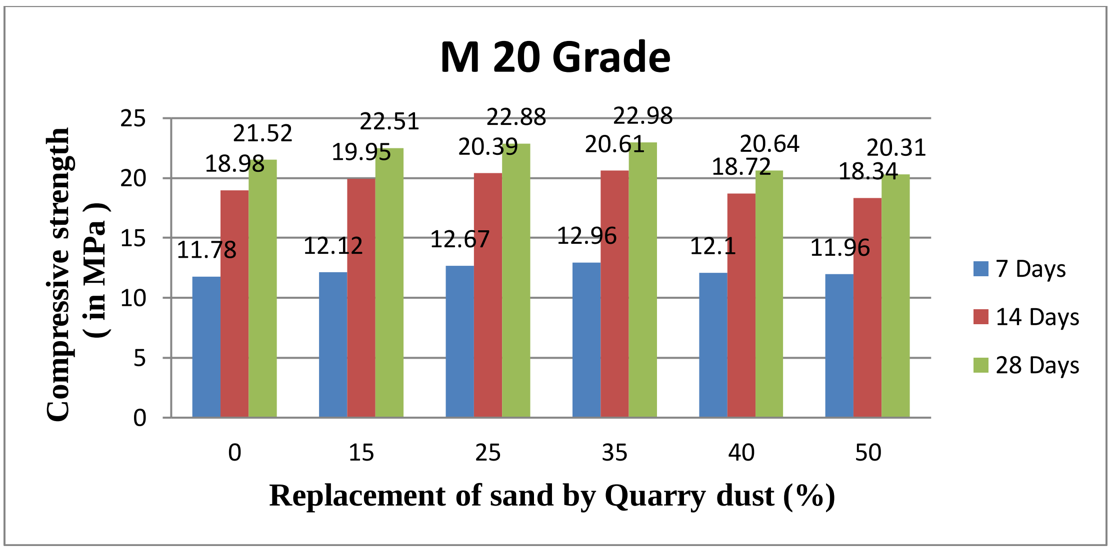


Graph 5: Strength in compression of M20 grade concrete at 28 days



Graph 6: Strength in compression of M20 grade concrete

S.NO.	REPLACEMENT PERCENTAGE OF SAND BY QUARRY DUST	COMPRESSIVE STRENGTH (M Pa)		
		7DAYS	14 DAYS	28 DAYS
CS1	0	13.20	22.2	25.21
CS2	15	14.51	24.1	27.40
CS3	25	14.90	24.45	27.77
CS4	35	15.36	25.21	27.94
CS5	40	14.70	23.32	25.90
CS6	50	14.15	22.41	25.27

Table 7: Compressive Strength of M25 grade Concrete

Results of strength in compression of cubes for 7, 14 and 28 days are as shown above in stable. Compressive strength of cubes at 28 days for control mixture (S1) is 24.86.M Pa for M25 grade. Compressive strength reduces as the replacement percentage is increased

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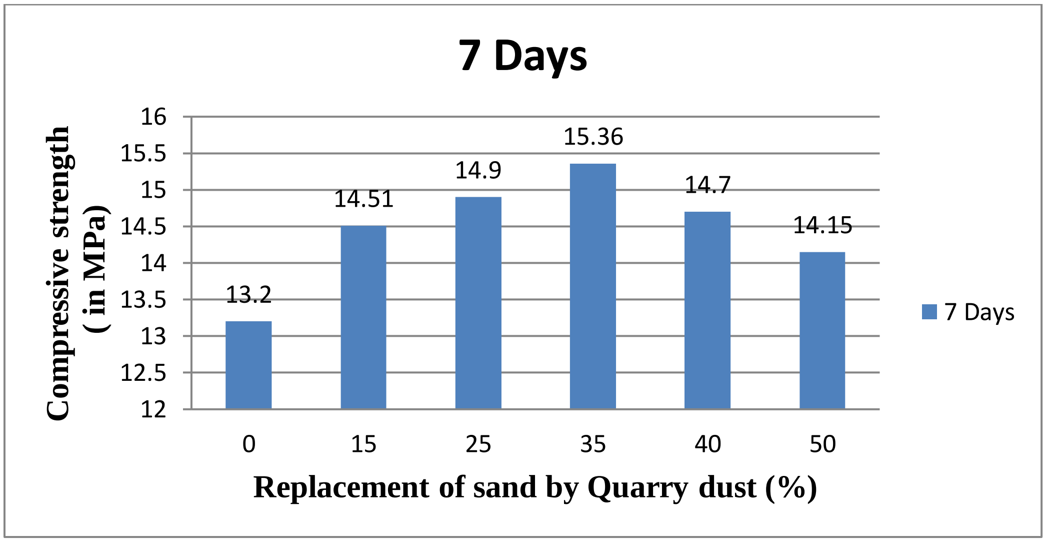
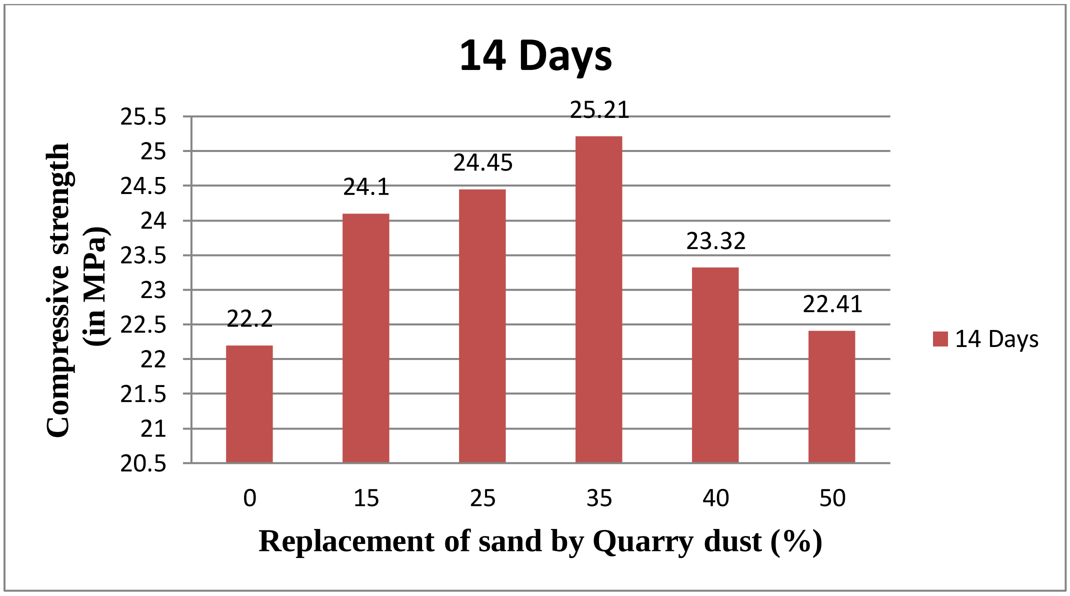
above 35 %. For the cubes casted with dust content ranging between 0 % and 25%, particles are not sufficient to fill the voids between aggregate particles and cement resulting in lesser values of compressive strength in comparison to cubes casted with 35 % dust content.

The best compressive strength of M 25 grade concrete is obtained at the 35 % replacement of sand by quarry dust like M 20 grade of concrete as discussed earlier.



Graph 7: Strength in compression of M25 grade concrete at 7days



Graph 8: Strength in compression of M25 grade concrete sat 14 days

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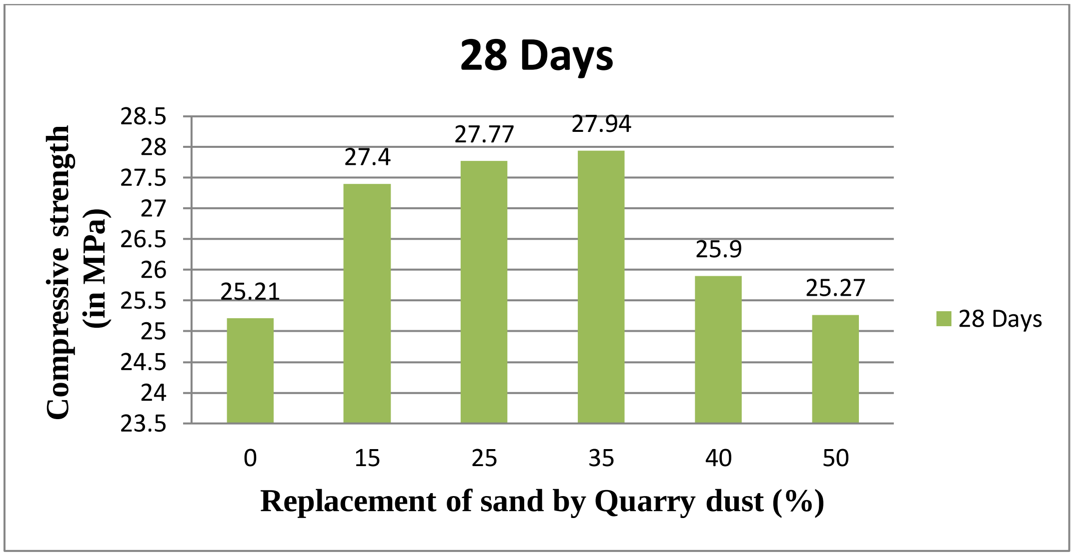
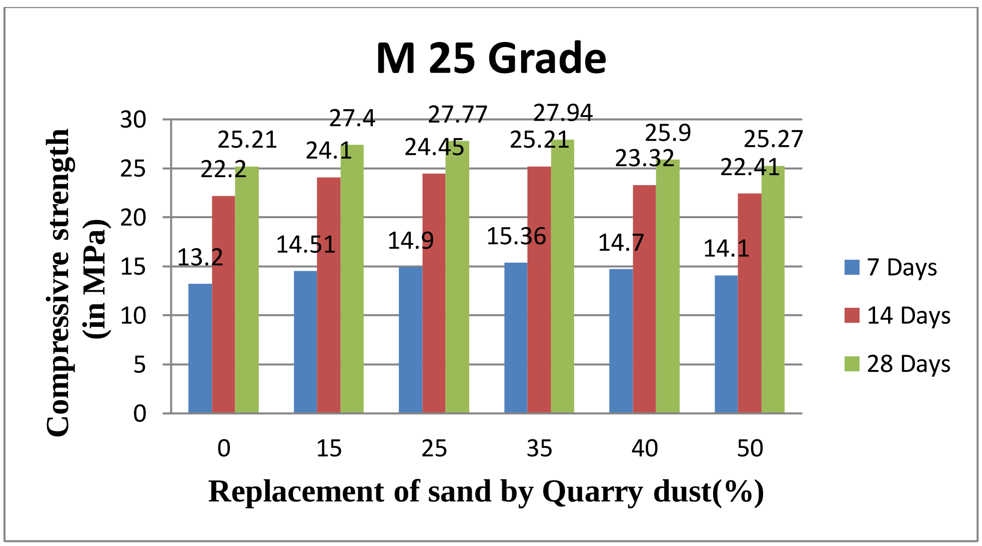


Graph 9: Strength in compression of M25 grade concrete at 28 days



Graph 10: Strength in compression of M25 grade concrete

6. Conclusions

- On replacing sand with quarry dust by 35 %, the maximum compressive strength is achieved for M 20 and M 25 grade of concrete
- It reduces the amount of space (land fill area) required for the disposal of quarry dust and the cost associated with it.
- By using quarry dust in the field of construction in place of sand partially leads to reduction in the amount of natural sand there by reducing over exploitation of rivers for the extraction of sand.
- By reducing the extraction sand, the filter bed of river is maintained thus the filtration property of sand is not harmed and the extra cost incurred while development of water treatment plant is also reduced. Thus, the method is environment friendly.
- By using quarry dust in the field of construction, the cost of construction up to a great extent can be reduced it means construction using this replacement is economical.

References

1. ConcCelik T, Marar K (1996). Effects of crushed stone dust on some properties of concrete, Cement Concrete Res., 26(7):1121-1130.
2. K.Subramanian and A. Kannan "An Experimental study On Usage of Quarry Dust as Partial replacement for sand in Concrete and Mortar", Australian Journal of Basic and Applied Sciences, 7(8): 955 – 967, 2013.

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Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: 10th June - Publication Date:30th June 2021

3. Ahmed, E. Ahmed. and Kourd., A.E., (1989), Properties of concrete incorporating natural and crushed stone very fine sand. ACI Material Journal, 86 (4), 417-424.
4. Dr.P.B.Sakthivel, C.Ramya and M.Raja "An Innovative Method of Replacing River sand by Quarry Dust waste in Concrete for Sustainability", International Journal of Scientific & Engineering Research Volume 4, Issue 5, May 2013.
5. Joseph O. Ukpata, Maurice E.Ephraim and Godwin A.Akeke "Compressive Strength Of Concrete Using Lateritic Sand And Quarry Dust As Fine Aggregate", ARPN Journal of Engineering and Applied Sciences, Volume 7, No.1, Jan2012.
6. G.Balamurugan, Dr.P.Perumal "Use of Quarry Dust to Replace Sand in Concrete – An Experimental Study", International Journal of Scientific and Research Publications, Volume 3, Issue 12, December 2013 ISSN 2250-3153.
7. Akshay C. Sankh, Praveen M. Biradar, Prof. S. J Naghathan, Manjunath B. Ishwargol "Recent Trends in Replacement of Natural Sand with Different Alternatives", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 59-66.
8. IS codes:
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   IS Code: 2386 part-4-1963 – (aggregate impact value)
   IS Code: 4031-part-1-1996 – (Fineness of cement)
   IS code 4031-part-4-1988 – (Normal consistency of cement)
   IS Code 4031-part-5-1988 – (Initial and final setting time of cement)
   IS Code -1199-1959- (slump test of concrete)