TO STUDY THE BEHAVIOR OF CONCRETE WITH THE REPLACEMENT OF FINE AGGREGATE BY QUARRY DUST USING RECYCLED COARSE AGGREGATES

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Abstract - *Concrete plays the key role and a large quantum of concrete is being utilized in every construction practices. Natural river sand is one of the key ingredients of concrete, is becoming expensive due to excessive cost of transportation from sources. Also large scale depletion of sources creates environmental problems. To overcome these problems there is a need of cost effective alternative and innovative materials. Quarry dust is a waste obtained during quarrying process. It has very recently gained good attention to be used as an effective filler material instead of fine aggregate. Also, the use of quarry dust as the fine aggregate decreases the cost of concrete production in terms of the partial replacement for natural river sand. Design mix of M25grade concrete with replacement of 0%, 20%, 25%, 30%, and 35% of quarry dust organized as M1, M2, M3, M4 and M5 respectively have been considered for laboratory analysis viz. slump test, compaction factor test, compressive strength ,split tensile strength and flexural strength of hardened concrete. In the present paper, the hardened properties of concrete using quarry dust were investigated. The amount of construction waste has been dramatically increased in the last decade, and social and environmental concerns on the recycling of the waste have consequently been increased. Waste concrete is particularly crucial among the construction wastes. Recent technology has also improved the recycling process. In this rapid industrialized world, recycling construction material plays an important role to preserve the natural resources.*

Key Words: QUARRY DUST, RECYCLED COARSE AGGREGATES.

1. INTRODUCTION

Waste arising from construction and demolition (C & D) constitutes one of the largest waste streams. Of this a large proportion of potentially useful material disposed of as landfill. The environmental and economic implications of this are no longer considered sustainable and, as a result, the construction industry is experiencing more pressure than ever before to overcome this practice. On the other hand, in recent years the wisdom of continued wholesale extraction and use of aggregates from natural resources has been questioned at an international level. This is mainly because of the depletion of quality primary aggregates and greater awareness of environmental protection. The results of an extensive experimental project aimed at examining the performance of Portland-cement concrete produced with recycled aggregates and Quarry dust. The effects of up to 100% coarse recycled concrete aggregate on a range of fresh, engineering and durability properties have been established and assessed its suitability for use in a series of designated applications.

Concrete is the world's second most consumed material after water, and its widespread use is the basis for urban development. It is estimated that 25 billion tons of concrete are manufactured each year. Twice as much concrete is used in construction around the world when compared to the total of all other building materials combined. In India, 27% of the total waste generated is construction and demolition waste (C&DW), and of this concrete represents 25%, i.e. 7% of the total waste. Many countries have recycling schemes for C & DW to avoid dumping to landfill, as suitable landfill sites are becoming scarce particularly in heavily populated countries. Charges or levies on landfill dumping often make recycling concrete aggregate a preferred option.

The reuse of hardened concrete as aggregate is a proven technology; it can be crushed and reused as a partial replacement for natural aggregate in new concrete construction. The hardened concrete can be sourced either from the demolition of concrete structures at the end of their life – recycled concrete aggregate, or from left over fresh concrete which is purposefully left to harden – left over concrete aggregate. Alternatively fresh concrete which is left over or surplus to site requirements can be recovered by separating out the wet fines fraction and the coarse aggregate for reuse in concrete manufacture – recovered concrete aggregate. Additionally, waste materials from other industries such as crushed glass can be used as secondary aggregates in concrete. All these processes avoid dumping to landfill whilst conserving natural aggregate resources, and are a better environmental option. Recycling or recovering concrete materials has two main advantages - it conserves the use of natural aggregate and the associated environmental costs of exploitation and transportation, and it preserves the use of landfill for materials which cannot be recycled. Whilst crushed concrete can be used as a sub-base material for pavements and civil engineering projects, this Best Practice Guide outlines its use as a higher grade resource - as aggregate in new concrete. However, recycled concrete aggregate that is significantly contaminated may not be economical to decontaminate for use as concrete aggregate, whereas it may be suitable 'as is' for use as sub-base material. Green building schemes such as Green Star India recognize C&DW reuse and provide credits for the use of recycled materials including recycled concrete aggregate. Because waste minimization and reducing the burden on landfills is a global issue, extensive research has been carried out worldwide on the use of recycled aggregate in concrete. Globally the concrete construction industry has taken a responsible attitude to ensuring its natural resources are not over exploited. In some cases the preservation of dwindling natural aggregate sources is a significant issue driving the use of recycled aggregates. Reduction in the impact of aggregate cartage on cost and environmental issues is also a factor where material processed from the demolition phase of a project, using a portable aggregate processing plant, can be reused in concrete for the construction phase of the project. This is a better option than transporting natural aggregates from quarries which through urbanization are located at an ever increasing distance from city areas.

1.1 NEED FOR UTILIZATION OF CRUSHED CONCRETE AS COARSE AGGREGATE AND QUARRY DUST AS FINE AGGREGATE

Rapid industrial development causes serious problems all over the world such as depletion of natural aggregate sand creates enormous amount of waste material from construction and demolition activities. One of the ways to reduce this problem, is to utilise recycled concrete aggregate (RCA) in the production of concrete. Many significant researches have been carried out to prove that recycled concrete aggregate could be are liable alternatives aggregate in production of concrete. As widely reported, recycled aggregates are suitable for non-structural concrete applications. RCA is the main component of old concrete and for many reasons there is a need to re-use them. Such recycling operations have the added benefit of reducing landfill disposal, while conserving primary resources and reducing transport costs. There are large amount of concrete wastages during construction and demolition stages in India. RCA can be obtained from these wastages for the production of new concrete.

2. MATERIALS AND MATERIAL TESTING

2.1 MATERIALS USED

The materials used are cement, fine aggregates, coarse aggregates, quarry dust, recycled coarse aggregates and water.

2.2 MATERIAL TESTING

The tests were conducted during the project are as follows:

Table -1: Tests on Cement

Physical properties of Cement			
Sl No.	**Test Conducted**	**Results**	**Specification as per (IS 1890-1970)**
1.	Fineness of Cement	3%	Should not exceed 10%
2.	Specific Gravity of Cement	2.85	-----
3.	Setting Time of Cement i) Initial Setting time ii) Final Setting Time	120Min 365Min	Not less than 30 minutes Not more than 10 hours
4.	Standard Consistency	35%	-----
5.	Soundness of Cement	1 mm	<10mm

Table -2: Tests on Sand

Physical properties of Sand			
Sl.No	**Tests**	**Result obtained**	**Requirements as per (IS 383-1970)**
1	Specific gravity	2.62	2.6 - 2.7
2	Fineness modulus	3.3	2.2 – 3.3
3	Bulking	24 %	< 40 %
4	Surface moisture	0.28 %	< 4 %
5	Water absorption	0.85%	---
6	Bulk density A)Loose state	1.555gm/cc	---

	B)Dense state	1.653gm/cc	---
7	Percentage of voids A)Loose state B)Dense state	 41.99 % 38.34 %	 --- ---
8	Zone	Zone – II	----

Table -3: Physical properties of coarse aggregate are as shown below

Physical properties of Coarse aggregate			
Sl.No	**Tests**	**Result obtained**	**Requirements as per (IS 383-1970)**
1	Specific gravity	2.65	2.6 – 2.7
2	Fineness modulus	6.84	---
3	Surface moisture	0.55%	< 4 %
4	Water absorption	0.63%	---
5	Bulk density A)Loose state B)Dense state	 1.376 gm/cc 1.563 gm/cc	 --- ---
6	Percentage of voids A)Loose state B)Dense state	 48.07 % 41.01 %	 --- ---

Table -4: Physical properties of quarry dust are as shown below

Sl.No	Tests	Result obtained
1	Specific gravity	2.56
2	Fineness modulus	3.2
3	Surface moisture	Nil
4	Water absorption	1.5%
5	Bulk density A)Loose state B)Dense state	 1.72 gm/cc 1.81 gm/cc
6	Percentage of voids A)Loose state B)Dense state	 32.81% 29.29%

Table -5: Physical properties of recycled coarse aggregates are as shown below

Sl.No	Tests	Result obtained
1	Specific gravity	2.47
2	Fineness modulus	7.57
3	Surface moisture	1.16%
4	Water absorption	4.91%
5	Bulk density A)Loose state B)Dense state	 1225.52 kg/m³ 1416.66 kg/m³
6	Percentage of voids A)Loose state B)Dense state	 50.2 % 42.5 %

2.3 MIX PROPORTIONS FOR VARIOUS REPLACEMENTS

Mix trial	Mix design	Coarse aggregate	Recycled aggregates	Quarry dust
M1	M30	100%	0%	0%
M2	M30	0%	100%	25%%
M3	M30	0%	100%	50%
M4	M30	0%	100%	75%
M5	M30	0%	100	100%

2.4 MATERIALS USED PER CUBIC METER OF CONCRETE

Sl.No	Mix quantity (kg/m³)	M 0% CA 100% RCA 0%	M 25% CA 0% RCA 100% QD 25%	M 50% CA 0% RCA 100% QD 50%	M 75% CA 0% RCA 100% QD 50%	M 100% CA 0% RCA 100% QD 0%
1	Cement	438	438	438	438	438
2	Fine aggregate	641	480.75	320.5	160.25	0
3	Coarse aggregate	1102	0	0	0	0
4	Recycled coarse aggregate	0	1102	1102	1102	1102
	Quarry	0		320.5	480.75	641

5	dust		160.25			
6	Water/cement ratio	0.46	0.46	0.46	0.46	0.46

2.5 CASTING OF CONCRETE CUBES

Table-6: Results of slump test

Mix trials	Mix Proportion	w/c	Slump
M1	1: 1.46: 2.51	0.46	120mm
M2	1: 1.46: 2.51	0.46	115mm
M3	1: 1.46: 2.51	0.46	105mm
M4	1: 1.46: 2.51	0.46	90mm
M5	1: 1.46: 2.51	0.46	85mm

Table-7: Compressive strength of concrete cubes with different percentages of mix proportions.

Mix trials	Average compressive strength for 7days. (N/mm²)	Average compressive strength for 14 days. (N/mm²)	Average compressive strength for 28days. (N/mm²)
M1	28.6	37.29	39.45
M2	24.86	32.29	34.84
M3	23.088	27.26	32.219
M4	19.98	24.44	28.88
M5	18.66	22.22	27.55

Table-8: Percentage of increase in strength with respect to days

Mix trials	7-14 days	14-28 days
M1	30.38%	5.79%
M2	29.88%	7.89%
M3	18.069%	18.19%
M4	22.22%	18.16%
M5	19.07%	23.98%

Table-9: Tensile strength of concrete cylinder with different percentages of mix proportions.

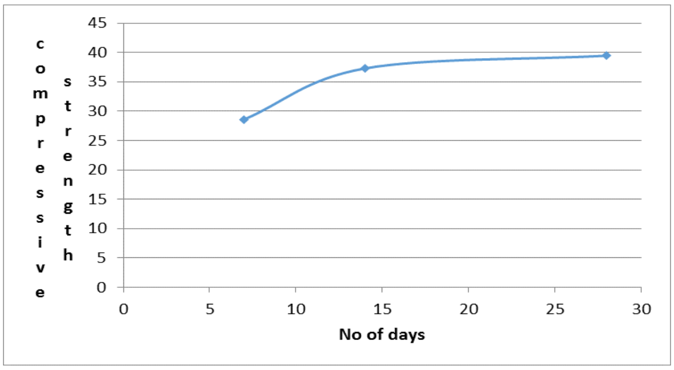
Mix trials	Average tensile strength for 7days. (N/mm²)	Average tensile strength for 14 days. (N/mm²)	Average tensile strength for 28days. (N/mm²)
M1	1.90	2.54	2.95
M2	1.76	2.40	2.80
M3	1.55	2.10	2.47
M4	1.25	1.92	2.17
M5	1.18	1.82	2.06

Table-10: Percentage of increase in strength with respect to days

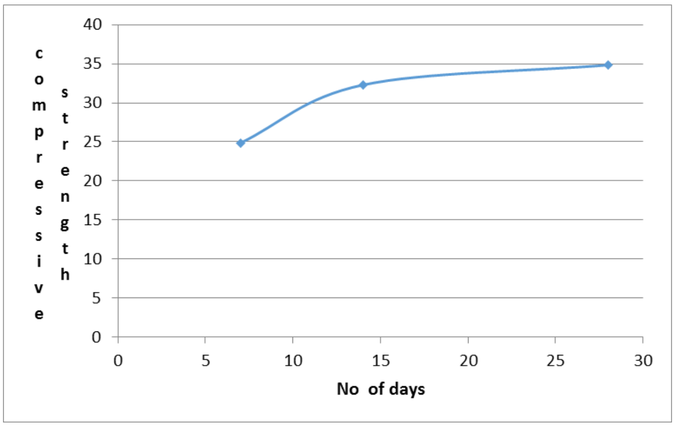
Mix trials	7-14 days	14-28 days
M1	33.68%	16.14%
M2	36.36%	16.66%
M3	35.48%	17.61%
M4	53.6%	13.02%
M5	54.23%	13.18%

2.6 GRAPHS

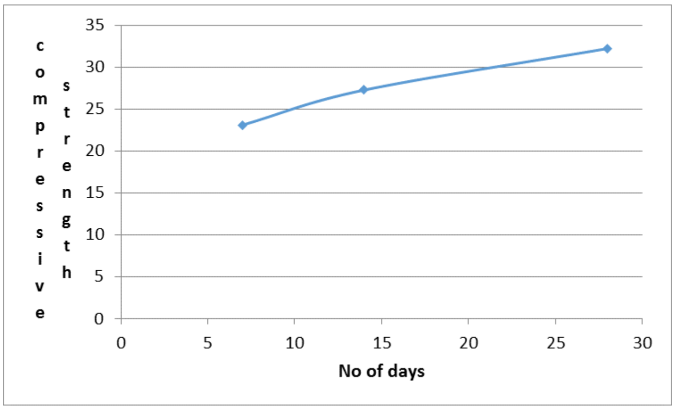
2.6.1 COMPRESSIVE STRENGTH v/s DAYS



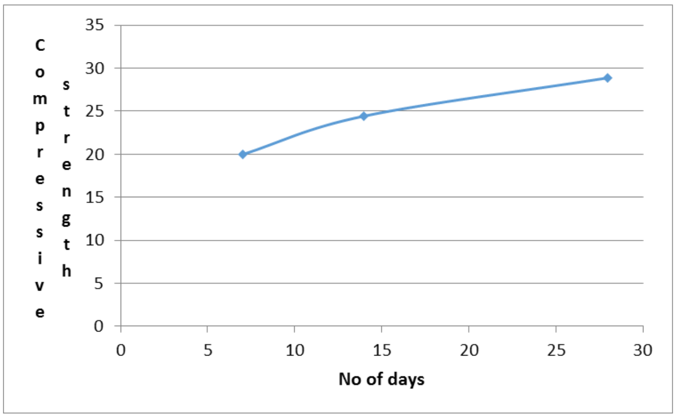
Variation of Compressive strength with number of days for 0% replacement



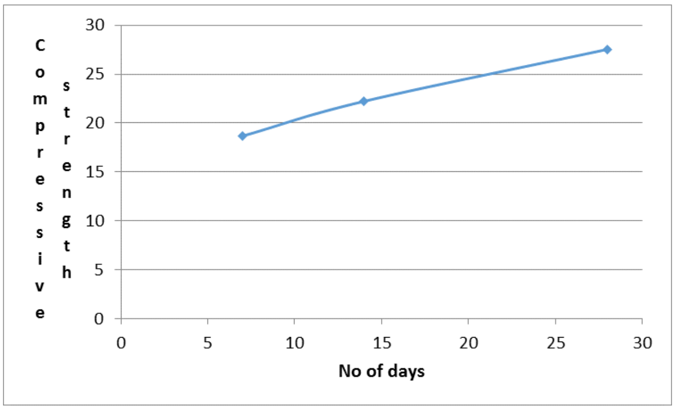
Variation of Compressive strength with number of days for 25% replacement with RCA.



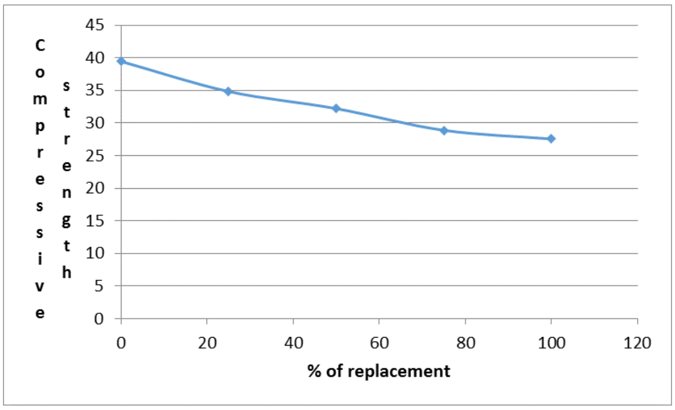
Variation of Compressive strength with number of days for 50% replacement with RCA.



Variation of Compressive strength with number of days for 75% replacement with RCA

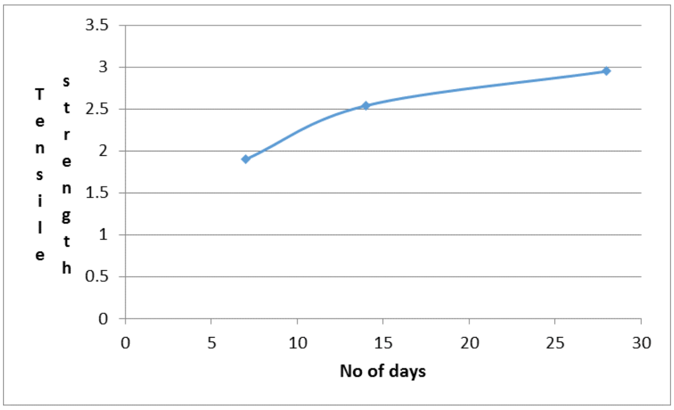


Variation of Compressive strength with number of days for 100% replacement with RCA.

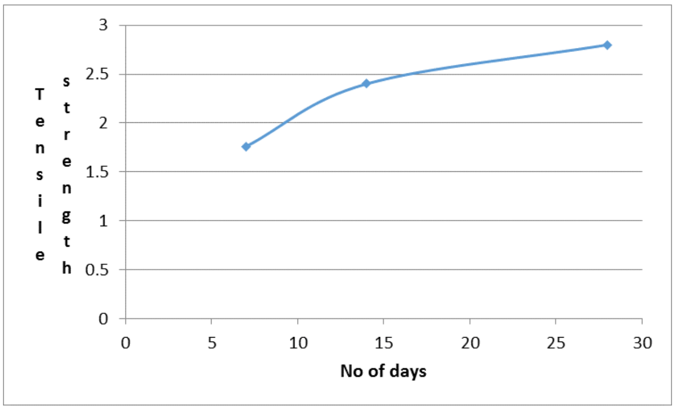


Variation of Compressive strength with different mix proportions.

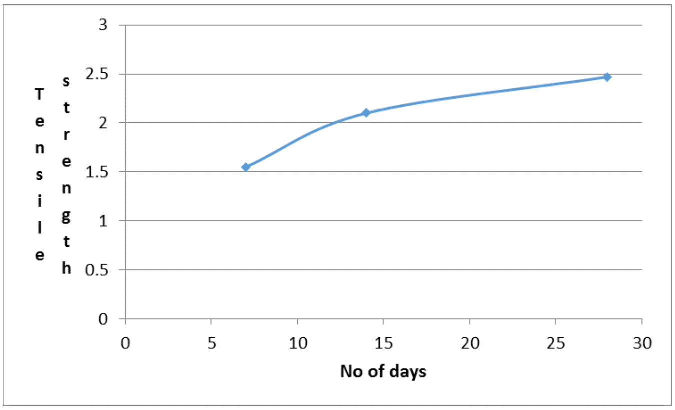
2.6.2 TENSILE STRENGTH v/s DAYS



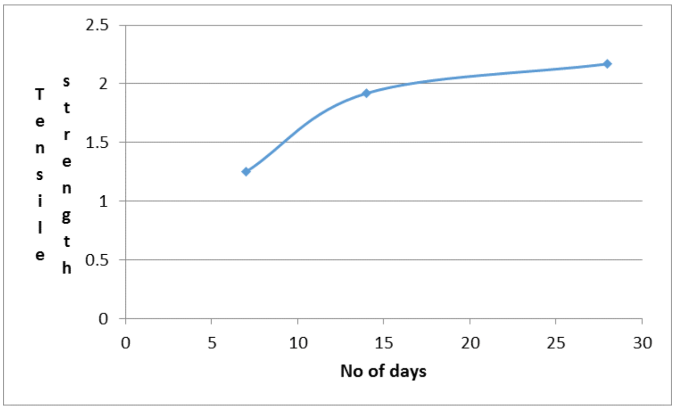
Variation of tensile strength with number of days for 0% replacement.



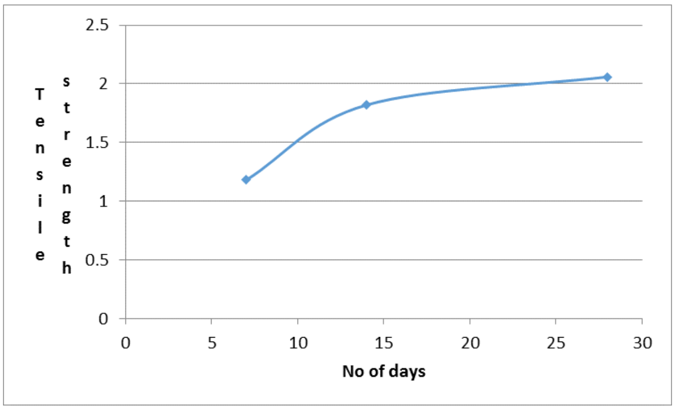
Variation of tensile strength with number of days for 25% replacement with RCA.



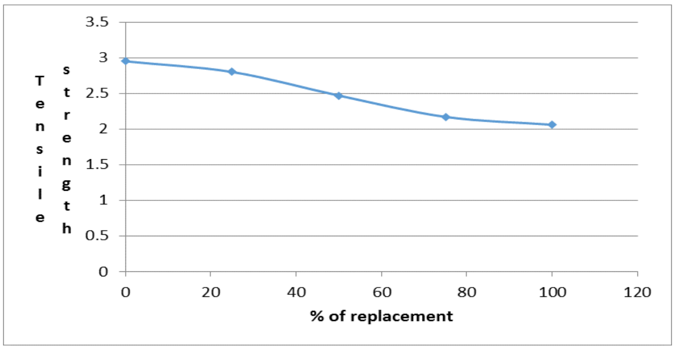
Variation of tensile strength with number of days for 50% replacement with RCA.



Variation of tensile strength with number of days for 75% replacement with RCA.



Variation of tensile strength with number of days for 100% replacement with RCA.



Variation of tensile strength with different mix proportions.

3. CONCLUSIONS

After conducting various tests on concrete after replacing coarse aggregate by recycled crushed aggregate and fine aggregate by quarry dust the following observations and conclusions can be drawn.

1. As the replacement of the sand with quarry dust increases the workability of the concrete is decreasing due to the absorption of the water by the quarry dust.
2. The physical and mechanical properties of recycled concrete aggregates and quarry dust are the important factors governing strength characteristics of concrete and these properties are governed by parent source.
3. Compressive strength of Concrete with recycled concrete aggregates and quarry dust shows decrease in compressive strength and thus can't be recommended. However further studies with help of admixtures can make the concrete effective for lower grade applications.
4. Recycled concrete aggregate and quarry dust in concrete can prove to be better however in less quantity and can be recommended for lower grade applications.
5. Recycled concrete and quarry dust can be used for non-structural application like pavement median, sidewalks, parking lot etc.

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