A Study on Effective Utilization of Stone Dust as a Partial Replacement for Fine Aggregate and Determining Strength Parameters using Polypropylene Fiber as an Additive

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Abstract— Cement concrete is one of the most extensively used building construction material in the field of civil engineering which is used in almost all construction works around the world thus making it a most versatile material. Cement concrete is basically a composite mixture of cement, coarse aggregate and well graded fine aggregate including water for mixing purpose. Today the world is witnessing a rapid increase in the construction activities all around which has resulted in the excess manipulation of natural resources such as rocks, clays and naturally available sand etc. Increase in the demand for cement concrete has led to increase in cost, excessive extraction and pollution to the environment. As a result of this material such as natural sand is depleting at an alarming rate. now it is necessary to find some alternative material which includes Crushed stone dust in the production of concrete. This study mainly deals with the partial replacement of fine aggregate by waste by-product obtained from quarry that is crushed stone dust with addition of artificially available fiber such as polypropylene fiber in M25 grade cement concrete. Here in this study we conduct Two set of trials are conducted in the first set of trial fine aggregates replaced by crushed stone dust(at interval of 10%) up to 50% by keeping PF(0.5%)constant and results obtained as compressive strength (35.133N/mm2), split tensile strength(3.712N/mm2)and Flexural strength(5.238N/mm2), similarly in the second set of trial crushed stone dust is kept constant and fiber % is varied at an interval of (0.5%) compressive strength(38.031N/mm2), Splittensilestrength (4.499N/mm2) and Flexural strength (5.786N/mm2). Study is based on 28 days curing period. From this experimental investigation we can conclude that crushed stone dust can be effectively utilized as a partial replacement to Fine aggregate with addition of poly propylene fiber.

Key words: Stone Dust, Polypropylene Fiber

I. INTRODUCTION

A. Perspective of the Study

In today's period of time, due to the modernization of the society all around has resulted in rapid intensification of the construction activities, which includes mainly the procurement of cement concrete and technological alterations have yielded magnificent turnover in the construction field and in construction way of executions

So there is a necessary to shift focus on such materials which could be used as substitute to aggregates used in concrete production, ultimately the crushed stone as a fine aggregate obtained from a quarry can be a best substitute for fine aggregate to certain percentage.

properties of reinforced concrete fiber have shown increase on its formability and bending strength are invariably advantageous when used in concrete.

When a fresh concrete is placed and its surface water evaporation is more than its paste emulsion movement in concrete it result in formation of fractures on surface, now negative pressure is formed in the capillaries which further forms tension stress due to this tension concrete gets cracked, where stress is more than the concrete strength. Thus cracks are formed during first hours after concrete pouring. Such concrete leads to critical points further making concrete so sensitive that attaching harmful materials to internal parts finally results in corrosion and damage to the materials of concrete. It is because of hydrophobic nature of fiber which makes efficiently prevent such cracks which are caused by paste, further polypropylene fibers has no effect on quantity of water required for concrete.

Making use of fibers into concrete has resulted favorably in preventing plastic shrinkage cracking and it is found effective in inhibiting micro cracking. Fibers decreases amount of permeability and enhance durability considerably research also shown increased flexural characteristics

II. LITERATURE REVIEW

Veera reddy, [1] (2010) In his paper entitled "Investigation on stone dust and ceramic scrap as a aggregate replacement in Concrete", to determine utility of stone dust and ceramic scrap replacement in concrete. Scholar suggested preventing of problem arising due to the disposal of waste material such as stone dust and ceramic scrap he used river sand as fine aggregate. The specific gravity of sand taken 2.65 and fineness modulus taken 2.54 and scholar procured ceramic scrap from a local ceramic insulator industry, broken pieces with hammer. He concluded the suitability of stone dust as a fine aggregate and ceramic scraps as a coarse aggregate Nagabushana, et al., [2] (2003) In their paper entitled "Use of crushed rock powder as replacement of fine aggregate in mortar and concrete". utilization of crushed stone by substituting it with fine aggregate in cement mortar and concrete, they have used it and replaced with 20%, 40%, 60%, 80% and 100% of crusher stone dust by natural sand . The results were investigated by replacing fine aggregates (natural sand) by crushed stone powder at replacement levels of 20%, 30% and 40%.

Tasnia Hoque, et al., [3] (2013), In their paper entitled "Influence of Stone Dust as Partially Replacing Material of Cement and Sand on Mechanical Properties of Mortar". Scholar have researched on the effect of stone dust on the cement sand mortar by using stone dust as a partial

replacement to natural sand, the scholars made a study to determine the possibility of replacing natural fine aggregate with stone dust they investigated replacing 25% and 50% of fine aggregate and also 5% of cement by artificial stone quarry dust out of which specimens were casted and tested after 3, 7, and 28 days, this study shows positive results at 25% replacement level which shows higher strength , this research emphasis more on the comparison in between fresh mortar and modified mortar this research indicate that natural sand could be confidently replaced by the stone dust, the results pertaining to the addition of stone dust at 25% of the total volume found higher strength results than that of mortar containing conventional river sand.

Er. Lalith kumar, et al., [4] (2003) In their research paper entitled "A study On The Strength Of concrete Using Crushed Stone Dust as Fine Aggregate". investigated the possibility of procuring stone dust as a fine aggregate at a different grades of concrete compositions, they have chosen two mixes for natural fine aggregate to obtain concrete of grade of M25 and M30, further fine aggregate replaced with quarry stone dust for the same mixes, this research properties of concrete such as flexural strength found enhanced. The cubes were tested in compressive testing machine at 7 and 28 days respectively their study conclusion includes. The strength parameters like compressive strength, flexural strength and split tensile for M25 and M30 grade concrete with stone dust as a fine aggregate found to be similar to the concrete made with natural sand. Increase in strength parameters of concrete with replacement of 20% and 50% of fine aggregate with waste stone dust is observed to be increased to 8 to 10% they assessed that stone dust could be used effectively in the cement concrete.

Priyanka A. Jadhav, et al., [5] (2015) In their paper entitled "Effect of Replacement of Natural Sand by Manufactured Sand on The Properties of Cement Mortar", Scholars researched on the effect of replacement of natural sand by manufactured sand on the characteristics of cement mortar, they investigated the effect of water cement ratio on hardened properties of cement mortar, mortar mix that having proportion as 1:2, 1:3 and 1:6 with water cement ratio of 0.5 and 0.55. Strength parameters are evaluated using mortar cube specimen, they assessed that the mortar exhibits good strength with 50% natural sand replacement. The objectives of this research is to determine the strength properties of concrete with water cement ratio of 0.5 and 0.55 and to replace natural sand by manufactured sand by 50% and 100% respectively. Scholars kept mix 1 as a reference with 0% of manufactured sand, mix 2 with a 50% replacement of fine aggregate by manufactured sand. Further mix 3 with 100% replacement of natural sand with manufactured sand.

III. OBJECTIVES OF THE STUDY

The following are the objectives:

1) To obtain a mix proportion grade of M25 cement concrete by using crushed stone dust as a partial replacement of fine aggregate with addition of polypropylene fiber and assess the feasibility of usage in cement concrete mix.
2) To determine the workability properties of M25 grade plain cement concrete at various level of replacement of crushed stone dust in addition with polypropylene fiber
3) To obtain mean target strength of M25 grade of cement concrete with partial replacement of fine aggregate by crushed stone dust with addition of fiber (polypropylene fiber).
4) To assess the combined effect of crushed stone dust and polypropylene fiber on M25 grade cement concrete.
5) To determine effective use of polypropylene fiber in the concrete to assess high strength, stiffness and thermal resistance

IV. MATERIALS AND METHODOLOGY

A. Cement

In this project work Ultratech cement is used of PPC grade (Portland pozzolana cement) confirming IS: 1489 part-1(1991), it is fly ash based cement,test carried out on the cement physical properties are given in table1 below3.1

Sl. No	Properties of Material	Cement Test Results
1.	Initial Setting Time	44 minutes
2.	Final Setting Time	312 minutes
3.	Standard Consistency	36%
4.	Fineness	5%
5.	Specific gravity	2.62

Table 1:

B. Fine Aggregate

Natural river sand, which is obtained from Bhima river of shahpur town is used as a fine aggregate in this study. Physical properties shown in table below 3.2

Sl. No	Material Properties	Natural River Sand
1.	Specific Gravity	2.60
2.	Water Absorption	2.3%
3.	Fineness modulus	2.7
4.	Zone	III
5.	Moisture Content	4.73%
6.	Bulk Density (Loose)	1.412 gm/ml
7.	Bulk Density (Compacted)	1.588 gm/ml
8.	Bulking of Sand	6.34%

Table 2:

C. Water

Potable water is used for mixing and curing of specimens as per standards in Accordance with IS: 456-2000 guidelines.

V. RESULTS AND DISCUSSION

A. Slump Cone Test Results

Slump Cone Test Results for M25 Grade Cement Concrete

Sl no.	% of replacement of C.D	Addition of % of polypropylene fiber	Slump in mm
1.	0	0.5	74
2.	10	0.5	76
3.	20	0.5	79
4.	30	0.5	82
5.	40	0.5	81
6.	50	0.5	78

Table 3: Slump Cone Test Results for M25 Grade Cement Concrete

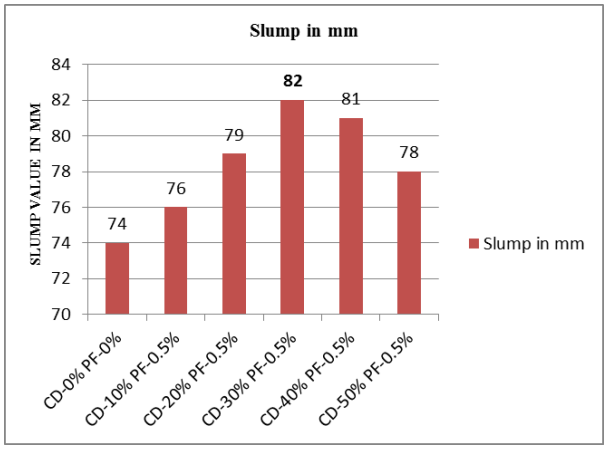

Fig. 1: M25 grade cement concrete slump cone test results for different levels of Replacemen

B. M25 Grade Cement Concrete Compressive Strength Test Results for Cube Specimen

S L. no	proportions	% of replacements of C.D	% Of addition of P.F	Compressive strength results for 28 days strength in N/mm^2			
				1	2	3	Avg
1.	Normal concrete	0	0	31.845	30.921	31.654	31.473
2.	CC with CD and PF	10	0.5	32.849	32.924	32.025	32.599
3.	CC with CD and PF	20	0.5	33.692	32.845	33.452	33.329
4.	CC with CD and PF	30	0.5	35.231	35.244	34.924	35.133
5.	CC with CD and PF	40	0.5	34.844	34.682	33.924	34.473
6.	CC with CD and PF	50	0.5	33.102	33.345	33.126	33.191

Table 4:

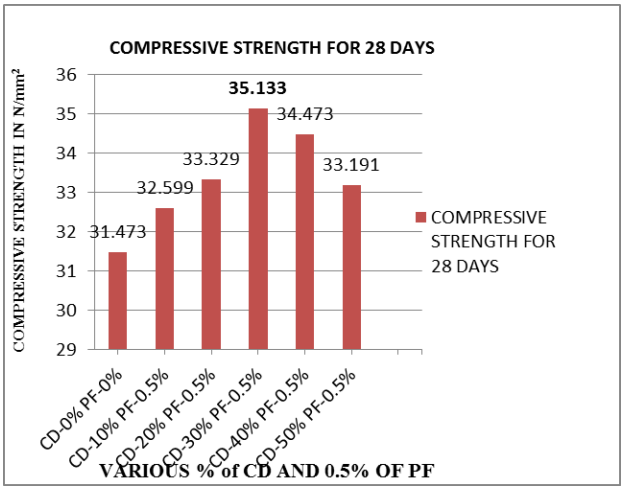

Fig. 2: M25 grade cement concrete compressive strength test results for Cube Specimen

C. M25 Grade Cement Concrete Split Tensile Test Results for Cylinder Specimen

Sl no.	proportions	(%) of replacement of C.D	(%) of addition of P.F	Split tensile strength for 28 days in N/MM^2			
				1	2	3	Avg
1.	Normal cement concrete	0	0	2.713	2.814	2.682	2.736
2.	CC with CD and PF	10	0.5	2.917	2.823	2.814	2.851
3.	CC with CD and PF	20	0.5	3.426	3.394	3.410	3.410
4.	CC with CD and PF	30	0.5	3.731	3.712	3.695	3.712
5.	CC with CD and PF	40	0.5	3.546	3.495	3.523	3.521
6.	CC with CD and PF	50	0.5	3.342	3.282	3.314	3.312

Table 5:

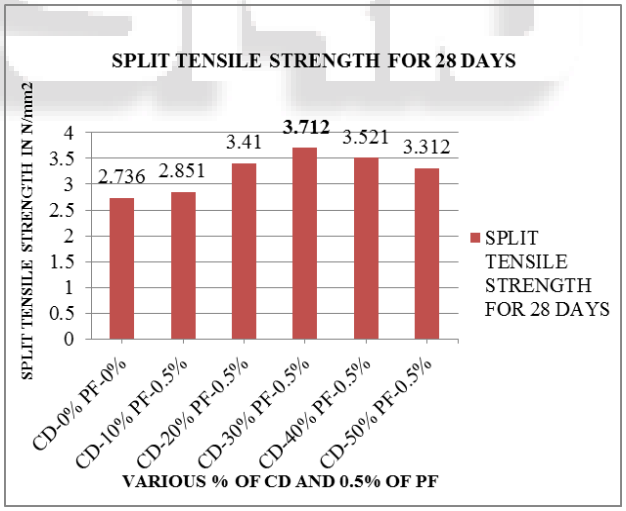

Fig. 3: Split tensile strength test results for M25 grade cement concrete cylinder Specimen of 28 days.

D. Prism Specimen Flexural Strength Test Results for 28 Days Curing Period of M25 Grade Cement Concrete

S L no.	proportions	(%) of replacement of C.D	(%) of addition of PF	Flexural strength test results for 28 days strength in N/mm^2			
				1	2	3	Avg
1.	Normal cement concrete	0	0	4.102	4.213	4.164	4.159

	e						
2.	CC with CD and PF	10	0.5	4.455	4.390	4.510	4.451
3.	CC with CD and PF	20	0.5	4.729	4.734	4.694	4.719
4.	CC with CD and PF	30	0.5	5.238	5.122	5.355	5.238
5.	CC with CD and PF	40	0.5	4.924	4.810	4.940	4.891
6.	CC with CD and PF	50	0.5	4.432	4.512	4.445	4.463

Table 6:

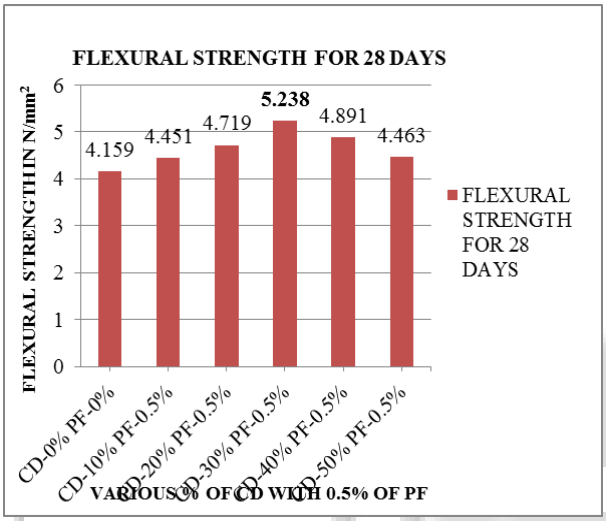

Fig. 4: Prism specimen Flexural strength test results for 28 days curing period of M25 grade cement concrete.

Determination of strength characteristics by changing fiber variations with previously obtained optimum strength values

Sl.no	proportions	% of replacements of C.D	% of addition of P.F	Compressive strength results for 28 days strength			
				1	2	3	Avg
1.	Normal cement concrete	0	0	31.845	30.921	31.654	31.473
2.	CC with C.D and P.F	30	0.5	35.231	35.244	34.924	35.133
3.	CC with C.D and P.F	30	1	36.881	35.921	36.674	36.493
4.	CC with C.D and P.F	30	1.5	38.011	37.962	38.122	38.031
5	CC with C.D and P.F	30	2.0	37.8	36.9	37.8	37.5
.				64	44	14	40

Table 7: M25 grade cement concrete compressive strength test results for Cube specimen with varying fiber content

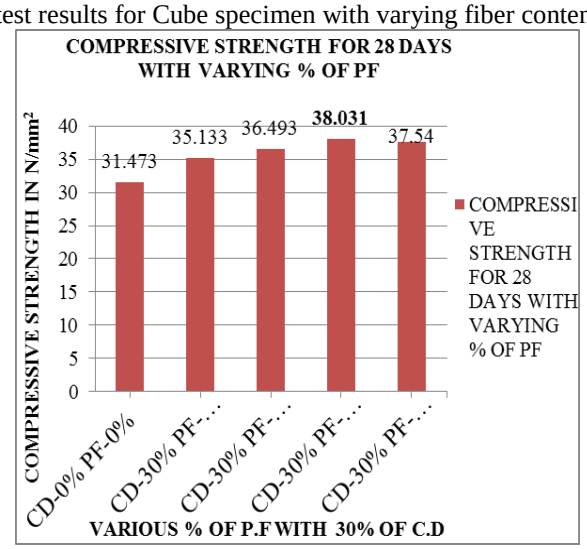

Fig. 5: M25 grade cement concrete compressive strength test results for cube specimen with varying fiber content:

E. M25 Grade Cement Concrete Compressive Strength Test Results for Cube Specimen with Varying Fiber Content

Sl.no	proportions	(%) of replacements of C.D	(%) of addition of P.F	Split tensile strength test results for 28 days in N/mm²			
				1	2	3	Avg
1.	Normal Cement concrete	0	0	2.713	2.814	2.682	2.736
2.	CC with C.D and P.F	30	0.5	3.731	3.712	3.695	3.712
3.	CC with C.D and P.F	30	1	4.011	4.121	4.012	4.048
4.	CC with CD and P.F	30	1.5	4.516	4.486	4.495	4.499
5.	CC with C.D and P.F	30	2.0	4.314	4.217	4.344	4.291

Table 8: M25 grade cement concrete Split tensile strength test results for Cylinder specimen with varying fiber content

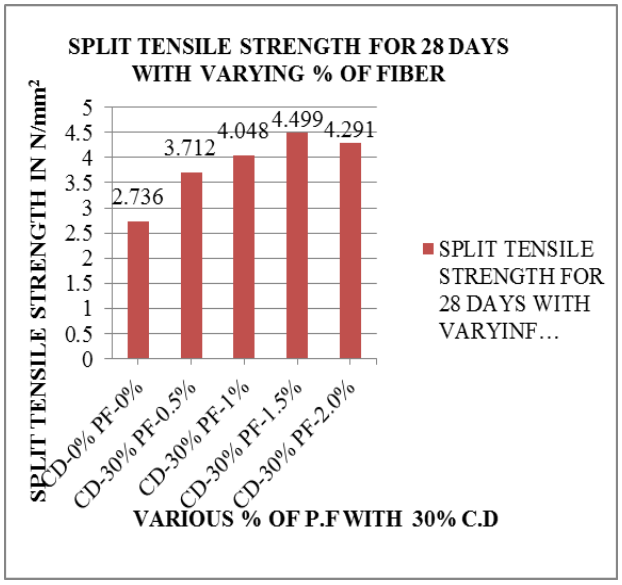

Fig. 6: M25 grade cement concrete Split tensile strength test results for Cylinder Specimen with varying fiber content:

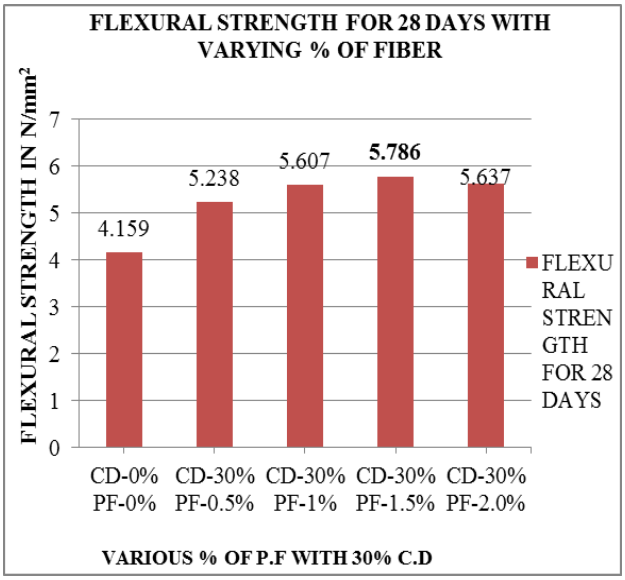

Fig. 7: Prism specimen Flexural strength test results for 28 days curing period of M25 Grade cement concrete with varying fiber content

F. Prism Specimen Flexural Strength Test Results for 28 Days Curing Period of M25 Grade Cement Concrete with Varying Fiber Content

Sl. No	proportions	(%) of replacements of C.D	(%) of addition of P.F	Flexural strength test results for 28 days strength in N/mm²			
				1	2	3	Avg
1.	Normal Cement concrete	0	0	4.102	4.213	4.164	4.159
2.	CC with C.D and P.F	30	0.5	5.238	5.122	5.355	5.238
3.	CC with C.D and P.F	30	1	5.614	5.583	5.624	5.607
4.	CC with C.D and P.F	30	1.5	5.814	5.782	5.768	5.786
5.	CC with C.D and P.F	30	2.0	5.712	5.586	5.614	5.637

Table 9:

VI. CONCLUSIONS

1) This study assess the mix proportion for M25 grade concrete, by using waste crushed stone dust as a partial replacement for a fine aggregates along with the addition of polypropylene fiber.
2) From this study we can assess that natural sand as a fine aggregate can be replaced by crushed stone dust which shows similar characteristics as that of natural sand up to 30% for manufacturing of concrete without any altering in structural stability
3) From the workability test result Slump value of 30% replaced crushed stone dust to natural river sand along with fiber is 82mm and that of 40% replaced mix is 81mm this shows that mixes are highly workable.
4) With this study, mean target strength of M25 grade cement concrete of 31.473 N/mm^2 obtain with partial replacement of natural fine aggregate by crusher stone dust along with addition of Polypropylene fiber.
5) From the workability test result Slump value of 30% replaced crushed stone dust to natural river sand along with fiber is 82mm and that of 40% replaced mix is 81mm this shows that mixes are highly workable.
6) Study shows that strength characteristics such as compressive strength (35.13 N/mm^2), split tensile strength (3.712N/mm^2) and flexural strength (5.238N/mm^2) of cement concrete indicates optimum result at 30% replacement of natural fine aggregates by crushed stone dust with the addition of polypropylene fiber
7) From the above experimental investigation, strength characteristics of cement concrete shows a reduction in strength parameters as the replacement of fine aggregate by crushed stone dust exceeds 30% with a constant addition of fiber (PF)
8) From the above experimental investigation, the combined effect of C.D as a fine aggregate and Polypropylene fiber as a additive can be used

successfully for gaining the strength in the M25 grade cement concrete.

9) From this study we can conclude that use of crushed stone dust as a partial replacement for fine aggregate gives better results when used along with fibers such as polypropylene fiber in terms of higher bondage, flexibility, plastic shrinkage resistance etc.
10) This study emphasis more on eco-friendly concrete production by avoiding over extraction of natural resources such as natural sand, also to make concrete more sustainable and productive by addition of artificial fibers such as polypropylene fibers.

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