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STUDY THE EFFECT OF STONE DUST & STEEL FIBRE ON STRENGTH PROPERTIES OF CONCRETE

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ABSTRACT

Nowadays, there's associate increasing interest within the development of eco-friendly materials. The properties of Stone dust and Sand are almost same so it can be easily used as partial replacement of sand in concrete . Steel Fiber is also added to the concrete that it increases the crack resistance, ductility, energy absorption or toughness of concrete. Thus, this paper addresses the results of change of Stone dust and Steel fiber on the strength properties of concrete. The replacements are done at 0%, (30%, 1%), (40%, 1%), (50%, 1%) of fine aggregate with Stone dust and addition of Steel fiber 1% by the weight of cement. Design mix is prepared on M30 grade of concrete. The result showed that at fixed W/C ratio (0.40) the strength and durability increased initially at small percentages and the cost for production is also cheaper.

Key words: Stone Dust, Steel fibre, Destructive test , Non-Destructive test.

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1. INTRODUCTION

Stone dust is a waste material and is generated during blasting and aggregate crushing. The damping of these waste material is also a big problem by using these waste material in construction work it is very easy to dispose these waste material. These wastes produce different type of pollutions like air pollution, water pollution, land pollution, etc. Due to these pollutions various types of diseases are produced to the life on the earth. These pollutions are increasing day-by-day due to this waste production so the disposal of these wastes is an serious issue and also the matter of concern.

The demand of river sand is very high in construction work so Stone dust can be a solution for this problem. By using stone dust it can reduces the demand of sand on site and environmental pressure on solid waste disposal. Stone dust is generally formed during

blasting and also during conversion of rock into coarse aggregate and has particle size range from 4.5 mm to (<0.075 mm).

Steel fiber is also added to the concrete that it act as reinforcing material which provides certain advantages in comparison with traditional reinforcement. Steel fibres are made from different wire materials, designed to provide concrete with ultimate load bearing capacity with temperature and shrinkage crack control, enhanced flexural reinforcement, improved shear strength and increase the crack resistance of concrete.

Thus, this paper addresses the results of an investigation on the aspect of stone dust, residue from the production of crushed aggregates, on the strength properties of concrete that is reinforced with the steel fibres.

2. LITERATURE REVIEW

Engr. Muritala Ashola (2013) have investigated that the Compressive strength and slump tests were performed on fresh concrete using two nominal mixes of 1:1:2 and 1:1½: 3 with the sand being partially replaced with Crushed Granite Fines. Compressive strength values above 30 N/mm2 and 35 N/mm2 were obtained for nominal mixes of 1:1:2 and 1:1½: 3 respectively when sand was partially replaced with 25–37.5% Crushed Granite Fines. it is recommended that partial replacement of sand with 25–37.5% Crushed Granite Fines be used in concrete production.

Sandeep Kumar Singh, Vikas Srivastava, V.C. Agarwal, Rakesh Kumar and P.K. Mehta (2014) have analysed the replacement level of the fine aggregate (30, 40, 50, 60 and 70%) by stone dust was investigated. It is observed that the compressive strength is not affected by replacement up to 40%; however, the flexural strength at all ages improved significantly at all the replacement levels. Replacement of fine aggregate with stone dust does not affect the compressive strength up to the replacement level of 40%, irrespective of the number of days.

Franklin Eric kujur*, Vikas Srivastava, V.C. Agarwal, Anjelo F. Denis and Ehsan Ali (2014) In this study experimental program was conducted using 30%, 40%, 50%, 60% and 70% partial replacement of fine aggregate with stone dust has been taken for concrete of M25 grade with 0.46 w/c ratio. In this study, set of cubes and beams were casted for compressive and split tensile strength respectively. Concrete specimens were tested after 7 and 28 days moist curing. It has been observed that 40% replacement of fine aggregate with stone dust is adaptable.

Md Mahboob Ali, Prof. S.M.Hashmi (2014) in this study M_{30} grade concrete is used for which the marble powder is replaced by 0%, 5%, 10%, 15%, 20% by weight of cement. For all the mixes compressive, flexural and split tensile strengths are determined at different days of curing. In addition to this, sand is replaced with stone dust by 10%, 20% and 30% along with cement is replaced with MP by 0%, 10% and 20% by weight for M_{30} grades of concrete. Thus we found out the optimum percentage for replacement of marble powder with cement and sand with stone dust it is almost 10%.

A. Suribabu, Dr U.Rangaraju , Dr.M. Ravindra Krishna (2015) have studied that Quarry rock dust can be an economic alternative to the sand. Quarry Rock Dust as 100% substitutes for Natural Sand in concrete. Mix design has been developed for M25 and M40 grades using design approach IS for both conventional concrete and quarry dust concrete. For M40 grade concrete the strength gradually increases for 1% to 1.6% super plasticizer whereas in quarry stone dust the strength decreases from 1% to 1.3% super plasticizer and then increases at 1.6% super plasticizer.

Syed Yaqub Abbas, Vikas Srivastava, V.C.Agarwal (2015) in this study M25 grade of concrete is taken for a final mix proportion of 1:1.65:3 at w/c ratio of 0.50. The replacement

levels of natural fine aggregate with stone dust were 30- 70% at an interval of 10%. The compressive strength of specimens (100mm cubes) cast for different proportions of stone dust was determined. Compressive strength of concrete make using stone dust at 50% replacement level is comparable to that of referral concrete both at 7 and 28 days.

Venkata Ramana N (2017) have examined that the coarse aggregate is replaced by marble stone waste aggregate in the proportion of 25, 50, 75 and 100%. Crimpled steel fibres are added to the marble stone waste aggregate Concrete by 1 and 2% volume of specimen. Crimple steel fibre volume with 1% volume fraction can be used effectively, up to 75% replacement without affecting design strength of mix. The Maximum permissible limit for replacement of Marble stone waste aggregate content with 2% steel fibre volume is 100%.

Charles K Kankam, Bismark K. Meisuh, Gnida Sossou, Thomas K. Buabin(2017) presents results of study on concrete using quarry dust to replace sand at levels of 0%, 25%, and 100% by weight. Design mixes were prepared to achieve concrete grades C25, C30, C35, C40 and C45 for each of the three replacement levels. Generally, diagonal crack patterns were observed in all prismatic specimens tested to study the stress-strain behaviour. However, the crack patterns in specimens with 0% and 25% sand replacement levels were somewhat conical in nature. The average ratio of prism compressive strength to the cube compressive strength is marginally higher for concrete with 25% sand replacement compared with that of 0% replacement.

Aditya S. Dubewar, Sumedh S. Shinde(2018) have examined that Partial Replacement of Cement with Fly Ash and Sand with stone quarry dust Used in Concrete by 5, 10, 15, 20% and 30 % respectively to produce Concrete. Concrete is tested for Compression, split tension and flexural strengths. Up to 10% replacement of cement by fly ash and 30% replacement of sand by stone quarry dust with 0.5% super plasticizer is recommended for M30 grade of concrete.

K Soundhirarajan, T Abirami (2018) have investigated that there were total five mixes prepared for the investigation, gradually increasing the replacement percentages from 0-100% with sawdust and robo sand in proportion. The optimum mix found to produce M20 grade of concrete is 10% of saw dust and 40% of robo sand, totally 50% replacement of river sand. The compressive strength obtained for the replacement of fine aggregate by 50% totally with sawdust 10% and robo sand 40%was proved to be the optimum mix to get M20 grade of Concrete.

3. MATERIAL & COLLECTION

3.1. Stone Dust

Stone dust is used in this study and brought from stone crusher near chandigarh university (gharuan).

Table 1 Physical properties of Stone dust:-

Properties	Quarry rock dust
Properties	2.54-2.60
Density (kg/ m^3)	1720-1810
Absorption (%)	1.20-1.50
Moisture content (%)	Nil
Particle size less than 0.075 mm	12.15
Sieve analysis	Zone II

3.2. Steel Fiber

Steel fiber is also used in this study and bought from B & B Enterprises Ludhiana. There are different types of steel fibers so in this study Crimpled Flat Fiber is used.

Table 2 Physical properties of Crimpled Flat fiber :-

Properties	Values
Fiber length	50mm
Fiber Diameter	1.0mm
Aspect ratio	50
Tensile strength	600 N/mm^2
Deformation	Continuously deformed

3.3. Cement

According to Indian Standard 8112 : 2013 Ordinary Portland cement of Grade-43 is used in this study because the strength and setting time of this cement is good as per requirement.

3.4. Fine Aggregate

Normal size of fine aggregate used in this study is 4.75mm according to IS: 383-1970.

3.5. Coarse Aggregate

20 mm size coarse aggregate is used in this study.

4. METHODOLOGY

The proportioning of the mix was done as per IS 10262:2009 for mix design. M30 grade of concrete is used in this study. The first mix was the control mix prepared in accordance to the mix design and in other three mixes partial replacement of sand with stone dust was carried out in percentages of 30%, 40%, 50%.respectively. The concrete was tested after 7 days ,14 days and 28 days by Destructive and Non- Destructive tests.

Table 4.1 Mix proportion M30 grade of concrete

S. No.	Mix	Stone dust (%)	Cement (kg/m^3)	Sand (kg/m^3)	Coarse Aggregate (kg/m^3)	Stone dust (kg/m^3)	Steel Fibres (g)	Water (Ltr)
1	M0	0	492.5	630	1082	*0*	*0*	197
2	M1	30	492.5	441	1082	*189*	*4925*	197
3	M2	40	492.5	378	1082	*252*	*4925*	197
4	M3	50	492.5	315	1082	*315*	*4925*	197

5. EXPERIMENTAL PROGRAM AND RESULTS:

5.1. Tests on Concrete

Various tests were conducted to determine the strength of concrete. The Destructive and Non-destructive tests are performed on concrete at 7days, 14days & 28days.

Table 5.1 Compressive Strength

Mix	7 Days Compressive Strength (N/mm^2)	14 Days Compressive Strength (N/mm^2)	28 Days Compressive Strength (N/mm^2)
M0	20.82	25.72	33.30
M1	24.88	31.68	37.52
M2	27.80	32.06	42.31
M3	26.26	27.75	35.43

The experimental investigations after 7 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the compressive strength increases by 19.5% also when partially replaced sand (40%) and addition of steel fibre (1% of cement content) it increased up to 33.5% also when the sand is partially replaced by (50%) and addition of steel fibre (1% of cement content) it increases the compressive strength by 26.12%.

The experimental investigations after 14 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the compressive strength increases by 23.17% also when partially replaced sand (40%) and addition of steel fibre (1% of cement content) it increased up to 24.65% also when the sand is partially replaced by (50%) and addition of steel fibre (1% of cement content) it increases the compressive strength by 7.89%.

The experimental investigations after 28 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the compressive strength increases by 12.67% also when partially replaced sand (40%) and addition of steel fibre (1% of cement content) it increased upto 27.05% also when the sand is partially replaced by (50%) and addition of steel fibre (1% of cement content) it increases the compressive strength by 6.39%.

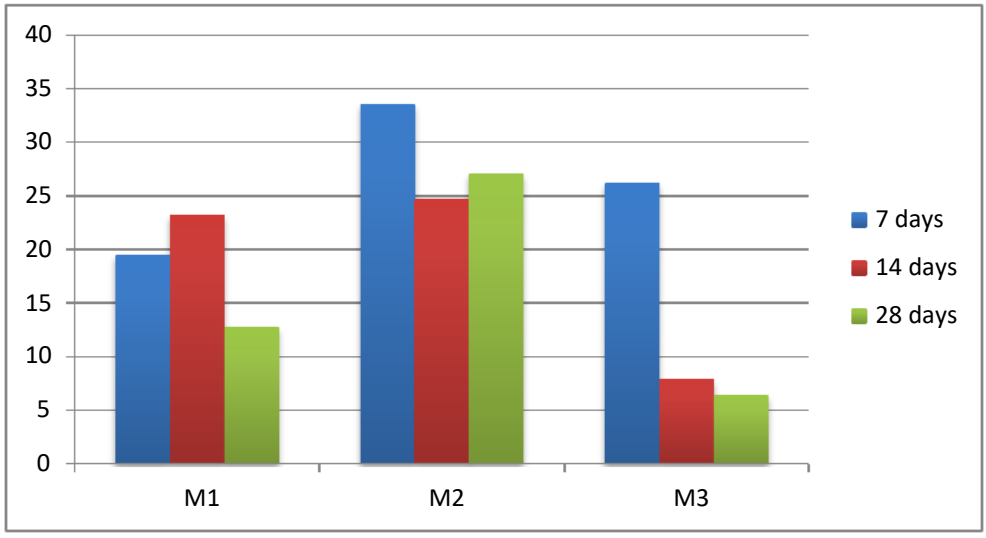

Figure 5.1 Percentage change in Compressive strength

Table 5.2 Split Tensile Strength

Mix	7 Days Split Tensile Strength (N/mm2)	14 Days Split Tensile Strength (N/mm2)	28 Days Split Tensile Strength (N/mm2)
M0	2.05	2.70	3.12
M1	2.42	2.95	3.31
M2	2.50	3.25	3.44
M3	2.46	3.09	3.29

The experimental investigations after 7 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the split tensile strength increases by 18.04% also when partially replaced sand (40%) and addition of steel fibre (1% of cement content) it increased upto 21.95% also when the sand is partially replaced by (50%) and addition of steel fibre (1% of cement content)it increases the split tensile strength by 20%.

The experimental investigations after 14 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the split tensile strength increases by 9.25% also when partially replaced sand (40%) and addition of steel fibre (1% of cement content) it increased up to 20.37% also when the sand is partially replaced by (50%) and addition of steel fibre (1% of cement content) it increases the split tensile strength by 14.44%.

The experimental investigations after 28 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the split tensile strength increases by 6.08% also when partially replaced sand (40%) and addition of steel fibre (1% of cement content) it increased up to 10.25% also when the sand is partially replaced by (50%) and addition of steel fibre (1% of cement content) it increases the split tensile strength by 5.44%.

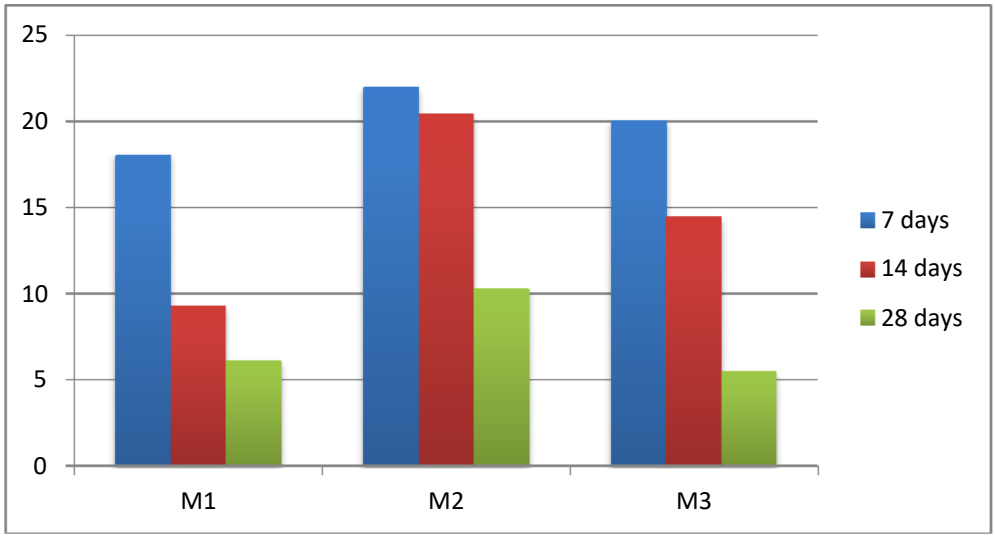

Figure 5.2 Percentage change in Split tensile strength

Table 5.3 Flexural Strength

Mix	7 Days Flexural Strength (N/mm2)	14 Day Flexural Strength (N/mm2)	28 Days Flexural Strength (N/mm2)
M0	3.20	3.54	4.03
M1	3.49	3.93	4.28
M2	3.70	4.02	4.55
M3	3.58	3.68	4.16

The experimental investigations after 7 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the flexural strength increases by 9.06% also when partially replaced sand (40%) and addition of steel fibre (1% of cement content) it increased upto 15.62% also when the sand is partially replaced by (60%) and addition of steel fibre (1% of cement content) it increases the flexural strength by 11.87%.

The experimental investigations after 14 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the flexural strength increases by 11.01% also when partially replaced sand (40%) and addition of steel fibre (1% of cement

content) it increased upto 13.55% also when the sand is partially replaced by (50%) and addition of steel fibre (1% of cement content) it increases the flexural strength by 3.95%.

The experimental investigations after 28 days show that by the partial replacement of sand (30%) and addition of steel fibre (1% of cement content) the flexural strength increases by 6.20% also when partially replaced sand (40%) and addition of steel fibre (1% of cement content) it increased upto 12.90% also when the sand is partially replaced by (50%) and addition of steel fibre (1% of cement content) it increases the flexural strength by 3.22%.

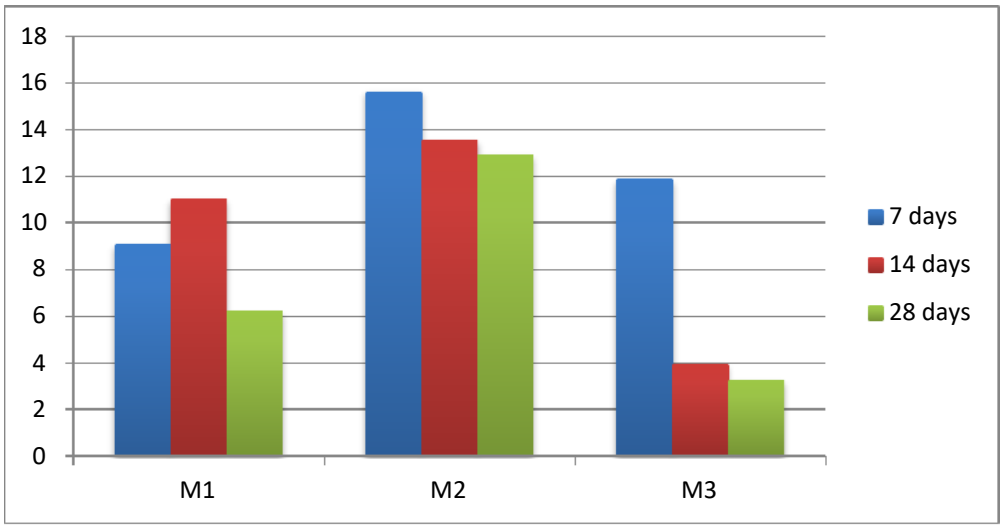

Figure 5.3 Percentage change in Flexural strength

Table 5.4 Ultrasonic pulse velocity test

Mix	28 Days Pulse velocity (km/sec)
M0	4.24
M1	4.90
M2	4.98
M3	4.71

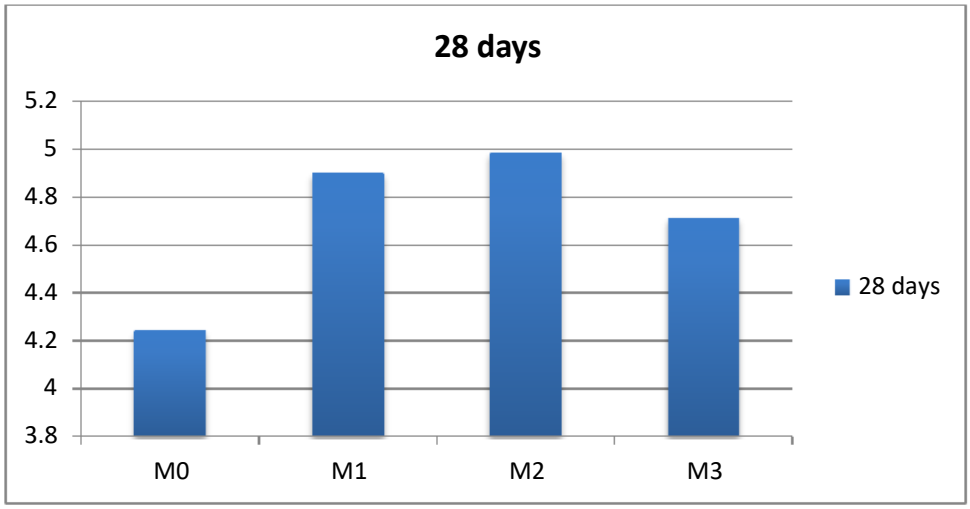

Figure 5.4 change in pulse velocity

Table 5.5 Rebound Hammer test

Mix	7days Rebound no.	14 days Rebound no.	28 days Rebound no.
M0	26.33	28.21	32.41
M1	28.74	30.02	38.56
M2	29.06	35.18	40.92
M3	27.02	34.27	40.65

6. CONCLUSIONS

- In this work, Stone dust is used in this study and it is examined it is a better replacement for sand.
- The research has shown that the partial replacement of sand with stone dust in M-30 mix grade of concrete by 40% with addition of 1% of steel fibres increases strength of the concrete for 7 day, 14 day and 28 day testing.
- For 30% replacement of fine aggregate by stone dust the compressive strength is almost equal to target mean strength. For 50% replacement of sand with stone dust the compressive strength still above than target mean strength. Further increase in stone dust content reduces the strength.
- During ultrasonic pulse velocity test on concrete at 28 days it shows for M0 mix concrete quality is good but in other mixes concrete quality is Excellent.
- According to the results it can be recommended that the optimum replacement of sand with stone dust is 40% and addition of steel fibre (1% of cement content) in concrete for M30 mix.

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