International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 09 Issue 10 ǁ 2021 ǁ PP. 36-40

Effective Utilization of Crusher Dust for Creating Sustainable Concrete

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ABSTRACT: *In the current scenario dire expenses are growing abundant and waste material is being produced through processing units of stone industry, there is a dire need to increase awareness among people by utilizing economical substitutes in order to solve the problem of this waste. The utilization of crusher dust as fine aggregate for concrete has achieved more attention in recent year due to scary of natural river sand. Today continues effort are being made for finding the substitute of natural resources. Research is therefore needed to reduce the environmental damages and to attain sustainable construction. This study deals with how crusher dust would be utilized for delivering new items as an additive for sustainable concrete. This study professed latest research on use of crusher dust as a replacement of sand in concrete. Effect on fresh and hardened properties of concrete with crusher dust is discussed in this paper.*
Keywords: *Crusher dust, sand, compressive strength, workability.*

Date of Submission: 17-10-2021 Date of acceptance: 01-11-2021

I. INTRODUCTION:

Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. The usage of concrete, worldwide, is twice as much as steel, wood, plastics, and aluminium combined.

Concrete's use in the modern world is only exceeded by the usage of naturally occurring water. The economy, efficiency, durability, moldability and rigidity of reinforced concrete make it an attractive material for a wide range of structural applications.

Concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, motorways/roads, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats. Combining water with a cementitious material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it, and makes it flow more freely.

Aggregate is one of the important constituents which has effect in strength development in the theory that the gaps of coarse aggregate is filled by the fine aggregate and the gaps of fine aggregate is filled by the binding materials. In addition, the strength of concrete mainly depends on water/cement ratio, aggregate gradation, and aggregate size and shape, cement quality, mixing time, mixing ratios, curing etc. Concrete must be both strong and workable, a careful balance of the cement to water ratio is required when making concrete.

Fine aggregate are basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. For concrete sand fineness modulus range is 2.3-3.1.

Among these ingredients river sand is commonly used as fine aggregate in concrete which is becoming scarce and hence expensive due to excessive cost of transportation from natural sources. The large-scale depletion of these sources creates serious environmental problems. So, Governments are restricting the collection of river sand from river bed. In such a situation the crusher dust can be an economical alternative to river sand. Crusher dust is a byproduct generated from quarrying activities involved in the production of crushed coarse aggregate. The residue from stone crusher is further washed with water to remove the excess fines so that the fraction confirming to the IS 383 – 1970 specifications can be extracted. It is possible to use such manufactured sand as fine aggregate in concrete which will reduce not only the demand for natural river sand but also the environmental burden. All along India, we have been using natural sand. The volume of concrete manufactured in India has not been much, when compared to some advanced countries. The infrastructure development such as express highway projects, power projects and industrial developments have started now. Availability of natural sand is getting depleted and also it is becoming costly. Concrete industry now will have to go for crushed sand or what is called manufactured sand.

So far, crushed sand has not been used much in India for the reason that ordinarily crushed sand is flaky. Badly graded rough textured and hence result in production of harsh concrete for the given design parameters. We have been not using super plasticizer widely in our concreting operations to improve the workability of harsh mix. For the last about 4 to 5 years the old methods of manufacturing ordinary crushed sand have been replaced by modern crushers specially designed for producing, cubical, comparatively smooth textured, well graded sand, good enough to replace natural sand.

II. MATERIALS USED:

1. CEMENT: Pozolana Portland cement (PPC) confirming to IS 1489-1991 part-1was used in this study .PPC is prepared by dry manufacturing process .It is more workable and high durable. It has high heat of hydration. Physical properties of cement are shown in Table 1.

2. FINE AGGREGATES: Fine aggregate are basically sands. Fine aggregates generally consist of natural sand obtained from river.

3. COARSE AGGREGATES: These are the particles having size greater than 4.75mm, but generally range between 9.5 mm to to37.5 mm. Coarse aggregates of 10 mm and 20 mm size and natural sand confirming to zone III was used.

4. CRUSHER DUST: Crusher Dust is very fine and is sometimes called tailings. It is used mostly for walkways as it is very easy to walk on. Bike trails and paths are usually finished with crusher dust. It can also be used as the final layer between crusher run and the top pavers or patio stones. Crusher Dust for this study was procured locally.

5. WATER: Water absorbed by aggregates is excluded from mixing water. Besides its quantity, the quality of mixing water used in concrete has important effects on fresh concrete properties, such as setting time and workability; it also has important effects on the strength and durability of hardened concrete. For this project we take portable drinking water.

III. EXPERIMENTAL PROGRAMME:

1. WORKABILITY: Workability is a property of freshly mixed concrete, and a concrete is a mixture of cement, aggregate, water & admixture. Due to this all the properties of concrete, whether in fresh state or hardened state, is affected by these ingredients and their proportions. In this study we have done workability test through the slump cone.

a). SLUMP: The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for different loads of concrete under field conditions.

A separate test, known as the flow table, or slump-flow, test, is used for concrete that is too fluid (workable) to be measured using the standard slump test, because the concrete will not retain its shape when the cone is removed

2. COMPRESSIVE STRENGTH TEST: For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used. The cubical specimens in the project with size 15cm x 15cm x 15cm were used.

This concrete was poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds were removed and test specimens were put in water for curing. The top surface of this specimen should be made even and smooth. This was done by putting cement paste and spreading smoothly on whole area of specimen

These specimens were tested by compression testing machine after 7 days, 14 days and 28 days curing. Loads were applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Table 1: Physical properties of cement

S.NO	PARTICULARS	TEST RESULT	Requirements of IS:1489-1991 (Part 1)
1	Normal Consistency (%)	35.5 %	-

2	Setting Time (minutes) a. Initial b. Final	41 min 455 min	>30 min <600 min
3	Compressive Strength (MPa) a. (3 days) b. (7 days) c. (28 days)		16 MPa 22 MPa 33MPa

Table 2: Specific gravity of materials

Particulars	Specific Gravity
Cement	3.15
Crusher Dust	2.65
Sand	2.58
Coarse Aggregate (20 mm)	2.93

Cement content 1.54 kg/m3, sand 2.31 kg/m3, aggregates 4.62 kg/m3 and water content 0.54 kg/m3.The replacing agent used in this study was crusher dust in the percentage of 10%, 15%, 20%.
Design Mix: In this study we choose the sample in the ratio 1:1.5:3 with Cement content 1.54 kg/m^3, sand 2.31 kg/m^3, aggregates 4.62 kg/m^3 and water content o.54 kg/m^3.The replacing agent used in this study was crusher dust in the percentage of 10%, 15%, and 20%.

Table 3: Mix proportion of materials

Sr. No.	Mix Type	W/C ratio	Replacement (%)	Cement (Kg/m^3)	Sand (Kg/m^3)	Crusher Dust (Kg/m^3)	Aggregates (Kg/m^3)
1	S1	0.54	0	1.54	2.31	0	4.62
2	S2		10		2.079	0.231	
3	S3		15		1.9635	0.3465	
4	S4		20		1.848	0.462	

IV. RESULTS AND DISCUSSIONS:

1. FRESH PROPERTIES OF CONCRETE: The results of Slump cone test are given in Fig. 1.

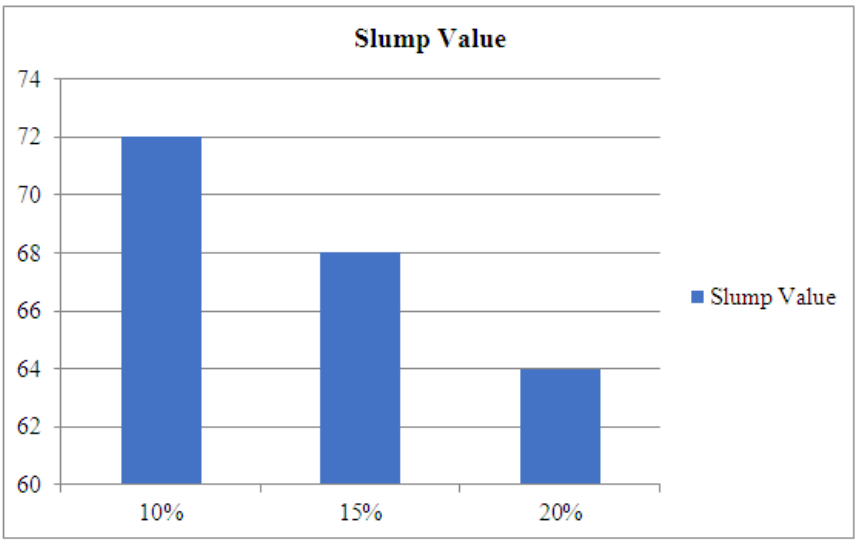

Fig. 1: Slump value of concrete at 10%, 15% and 20% replacement.

Observation: Slump value increases at 10% replacement, as we increased the replacement the slump valve decreases and at 20% it becomes very low.

2. HARDENED PROPERTIES OF CONCRETE: The Results of compressive strength test at different replacements are shown in Table 4 and Fig.2.

Table 4. Compressive strength test results

Sr. No.	Mix Type	W/C ratio	Replacement (%)	Compressive strength		
				7 days	14 days	28 days
1	S1	0.54	0	14.82	19.63	25.16
2	S2		10	16.93	21.04	28.88
3	S3		15	15.36	18.01	22.12
4	S4		20	13.15	16.63	19.12

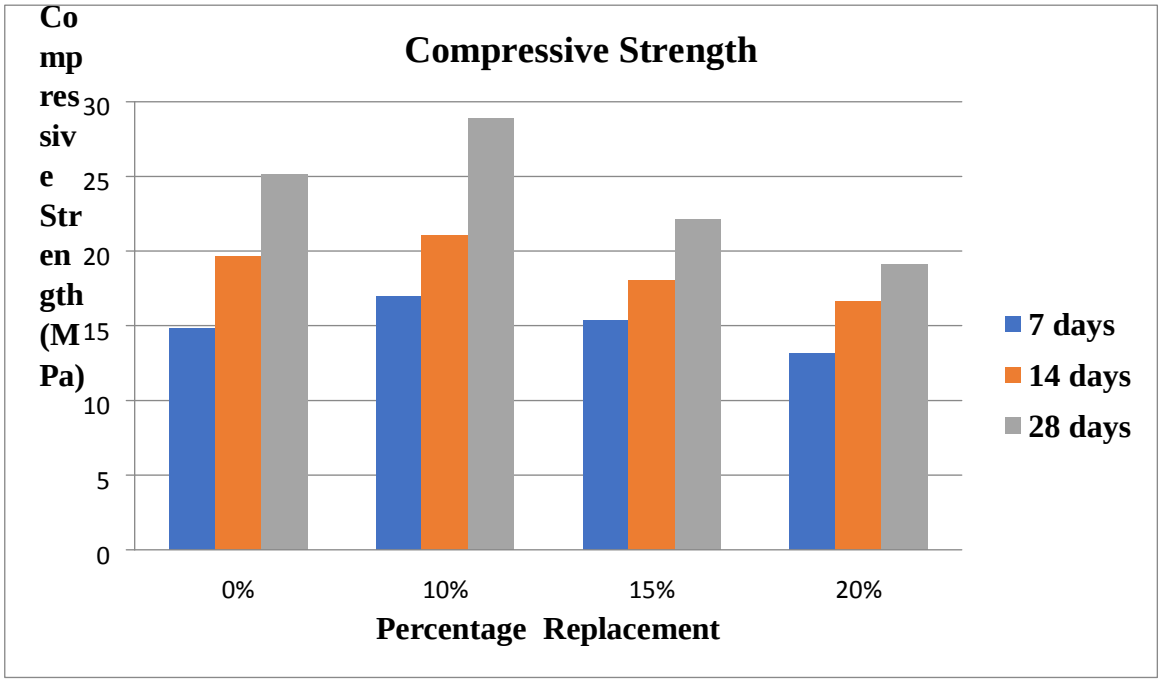

Fig. 2: Compressive strength test results at 10%, 15% and 20% replacement.

Observation: compressive strength increases after 7 days 14 days and 28 days for 10% replacement and after that it gets on decreasing as we increase the percentage.

V. CONCLUSIONS:

1. Maximum increase in compressive strength of concrete occurs at 10% of replacement of sand with crusher dust.
2. It results in good for environment as a cleaning agent as well as for economy.
3. We can use it for small replacements only because at large replacements it results in reduced strength.

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