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PARTIAL REPLACEMENT OF CEMENT IN CONCRETE BY STEEL SHOT DUST

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ABSTRACT

Leaving the waste materials to the environment can cause various environmental problems. Hence the attention is on the reuse of the waste material. Waste can be used to produce new products or can be used as admixtures so that there is more use of natural resources and the environment is protected from waste deposits. Automobile industries produce both solid and liquid waste products.The waste product which we are using is also a solid waste product, namely Steel Shot Dust. Steel Shot Dust is a very fine powder of steel shots. This dust is produced in the process of shot blasting. There are very limited recycling solutions available for steel shot dust, that too on an experimental phase only. Also, the options available for recycling are big-budgeted, whereas the recycling we are experimenting on doesn't involve any type of extra expenditure. We are using this waste to prepare the blocks of concrete of grade M25 with the replacement at 5%, 10% and 15% percentages. The compression test is applied to the blocks at 7 days and 28 days respectively.

KEYWORDS: Industrial waste, Concrete, Steel shot dust, Ordinary Portland cement.

INTRODUCTION

The advancement in concrete technology may reduce the consumption of natural resources and lessen the burden of pollutants on environment. Presently large amounts of steel shot dust are generated in automobile industry with an important impact on environment and humans. This experiment describes the feasibility of using the steel shot dust in concrete production as partial replacement of cement. Test results show that upon using this steel shot dust; this industrial by-product is capable of improving hardened concrete performance. The compressive strength of concrete was measured for 7 days and 28 days respectively. The main motive behind this experiment is to study the influence of partial replacement of cement with steel shot dust, and to compare it with the compressive strength of ordinary M25 concrete. We are also trying to find the percentage of steel shot dust replaced in concrete that makes the strength of the concrete maximum. So, by partially replacing cement with steel shot dust, we are presenting a method that can help in reducing pollution to a great extent.

MATERIALS AND METHODS

Cement

The cement is a binding material that sets and hardens and used to bind other materials together. Cement is a grey powdery substance made by calcining lime and clay, it is mixed with water to form mortar or mixed with sand, gravel and water to make concrete. The types of cements used in construction can be classified as hydraulic or non-hydraulic, depending upon the ability of cement to set in the presence of water. **Non-hydraulic cement** will not set in moist conditions or underwater; whereas, it sets as it dries and reacts with carbon dioxide in the air. **Hydraulic cements** (e.g., Portland cement) sets and harden and become adhesive due to a chemical reaction between the dry ingredients and water. The chemical reaction produces mineral hydrates as by-products, that do not dissolves in water easily and so are quite durable in water and safe from chemical attack. This helps cement to set in moist conditions or underwater and further protects it from chemical attack.

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The most widely used type of Portland Cement in construction is Ordinary Portland cement. It is used generally where special properties are not required. It is mainly used for the reinforced concrete buildings, flyovers and where soil conditions are normal. It is also used for most of concrete masonry units and for all uses where the concrete needs to be protected from special sulfate hazard or where the heat generated by the hydration of cement is not objectionable. It shows great resistance to cracking as well as shrinkage but has less resistance to chemical attacks.

OPC of grade 43 is used in present work.

Fig. 1 Cement

Contents	%
CaO	60-67
SiO_2	17-25
Al_2O_3	3-8
Fe_2O_3	0.5-6.0
MgO	0.5-4.0
Alkalis	0.3-1.2
SO_3	2.0-3.5

Table 1 Chemical composition of cement

Fine Aggregate (Sand)

Sand is a naturally occurring material that is the result of breaking down of sandstones. It is categorized by size, being finer than gravel and coarser than silt. It is a loose granular substance, typically pale yellowish brown, forming a major constituent of beaches, river beds and deserts. Low-costing natural sand which is easily available was used in the experiment. Being cubical rounded and of smooth texture it gives good workability. Sand which is used here is taken from Narmada River. Particle of this sand have smooth texture and are yellowish brown. The tests conducted on sand are Sieve Analysis for finding out the fineness modulus.

Fig. 2 Sand

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Sieve Size	Weight Retained (gm)	Cumulative Mass Retained (gm)	Cumulative % Mass Retained	Cumulative % Mass Passed
4.75 mm	6.63	6.63	1.32	98.68
2.36 mm	15.72	22.35	4.47	95.53
1.18 mm	44.80	67.15	13.43	86.57
600 µm	151.73	218.88	43.77	56.23
300 µm	221.63	440.51	88.10	77.90
150 µm	52.69	493.20	98.64	1.36

Table 2: Sieve Analysis of Fine Aggregate

Coarse Aggregate

The aggregates are granular materials made up of the rocks; irregular, flaky or round in shape and are coarser than sand or crushed stone. They are essential ingredient in concrete which provides strength to it. For a good concrete mix, aggregates need to be clean, hard, strong particles which are free from any chemical or clay coatings and other fine materials that could cause the deterioration of concrete. Coarse aggregates are gravel which has been crushed, washed and sieved so that the particles greater than 4.75mm, coarse aggregate is particles vary from 5 up to 50 mm in size.

Sieve Size	Weight Retained	% Retained	% Passing
20 mm	0	0	100
13 mm	4	0.3	99.7
10 mm	18	1.2	98.5
6.3 mm	119	8	90.5

Table 3: Sieve Analysis of Coarse Aggregate

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Steel Shot Dust

Steel shots are spherical grains which are made up of molten steel through granulation process, available in different sizes and hardness. Steel shot is used in cleaning applications for the removal of loose material from the metal surfaces. This type of cleaning is widely used in automobile industry (motor blocks, cylinder heads, etc.). Surface preparation is a series of operations including cleaning and physical modification of a surface. Steel shot is used in surface preparation process for cleaning metal surfaces which are covered with mill scale, dirt or rust and for enhancing the metal surface such as creating roughness for better application of paint and coating. The steel shots are generally employed in shot blasting machines. In shot peening process the steel shots are repeatedly striked on the metal surface. These multiple impacts produce a deformation on the metal surface but also improve the durability of the metal part. The spherical shots are used as they are more resistant to the fracture which happens due to the striking impact. Steel shots are used in blasting process, which then converts into dust.

SR. NO.	ELEMENTS	CONTENT
1.	Carbon	0.8 – 1.2 %
2.	Silicon	0.5 – 1 %
3.	Manganese	0.6 – 1 %
4.	Sulphur	< 0.05 %
5.	Phosphorus	< 0.05 %

Table 4: Chemical composition of Steel Shot Dust

Fig. 3 Steel Shot Dust

Methodology

Specimen details and Material Used

The experimental program consists of casting and testing 24 cubes of size 150mm X 150 mm X 150mm. The concrete is obtained by mixing solid constituents consisting of Steel Shot Dust(5%, 10% and 15%) of total mass of binder, coarse aggregate and fine aggregate.

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Mixing, Casting, Curing and Testing

The pan mixer is used in dry and wet mixing of ingridients based on conventional methods. Fresh concrete is subjected to vibration for 10 seconds. The side forms of moulds were striped after 24 hours after casting and then left for pond curing for 7 Days and 28 Days. The specimens were then tested in compression testing machine of 2000 kN capacity. The load was applied using a hydraullic testing machine and the specimens were tested under pure axial compression.

RESULTS AND DISCUSSION

The main objective of the research was to understand the compressive strength of concrete obtained using steel shot dust as partial replacement for cement. In order to achieve the objectives of present study, an experimental program was planned to investigate the effect of steel shot dust on compressive strength of concrete. The experimental program consisted of casting, curing and testing of controlled concrete and concrete mix with proportion of 5%, 10% and 15 % of steel shot dust, at the ages of 7 and 28 days.

% Replaced	1st Specimen	2nd Specimen	3rd Specimen	Average	Compressive Strength (MPa)
0%	17.23	16.44	16.92	16.86	16.86
5%	22.64	21.06	21.98	21.89	21.89
10%	24.63	23.80	25.10	24.51	24.51
15%	20.44	22.22	21.65	21.43	21.43

Table 5: Compressive Strength – 7 Days

% Replaced	1st Specimen	2nd Specimen	3rd Specimen	Average	Compressive Strength (MPa)
0%	24.21	23.48	25.26	24.42	24.42
5%	43.11	38.96	37.26	41.44	41.44
10%	36.80	37.35	36.25	36.80	36.80
15%	34.16	33.52	33.19	33.67	33.67

Table 6: Compressive Strength – 28 Days

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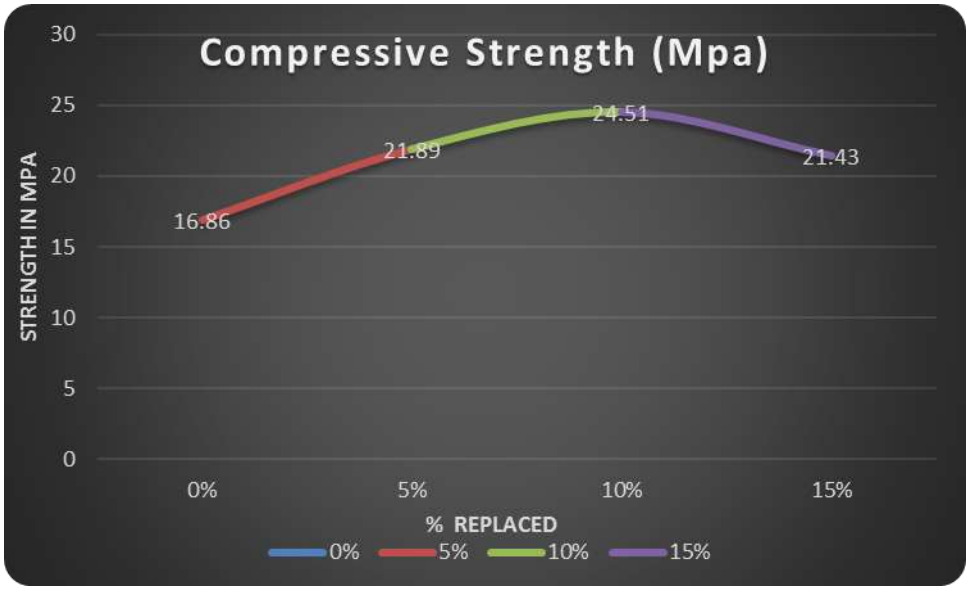
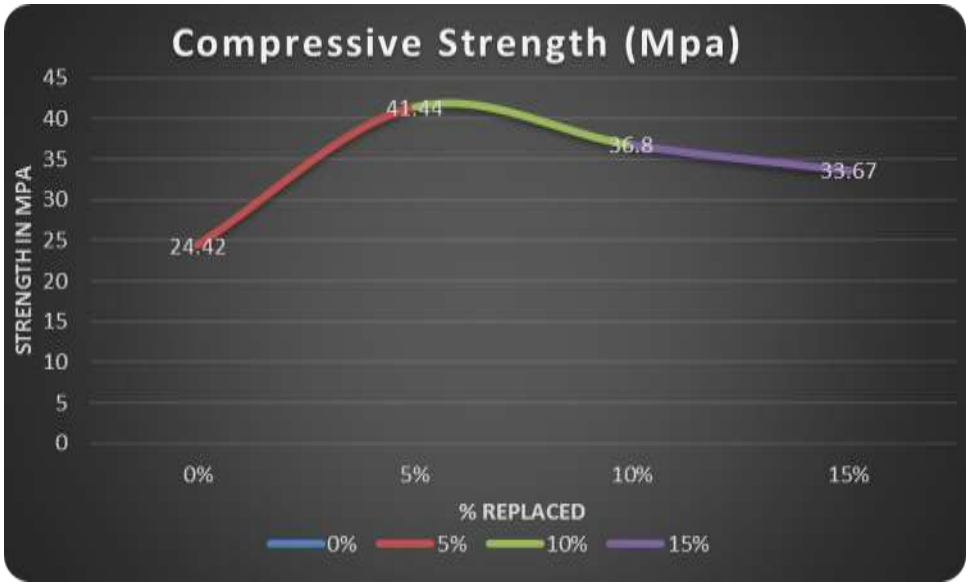


Graph 1: Compressive Strength after 7 days of curing (MPa)



Graph 2: Compressive Strength after 28 days of curing (MPa)

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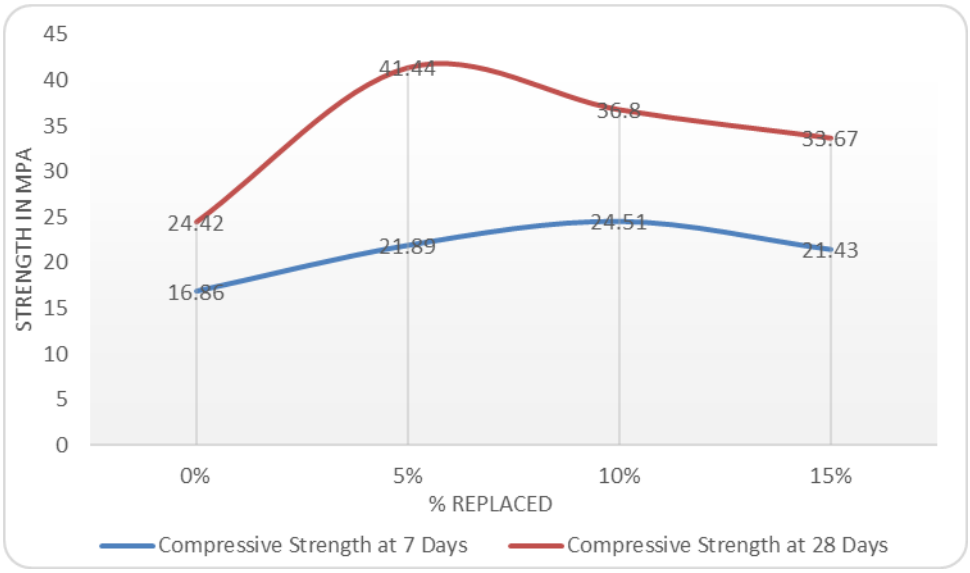

Graph 3: Comparison of Compressive Strength after 7 days and 28 days of curing (MPa)

Results:

Mechanical behavior of concrete cubes prepared without chemical admixtures was studied by compressive tests (Grade M25 and curing time of 7 and 28 days). It can be noticed that the replacement of cement with steel shot dust in mild condition is showing increase in compressive strength.

As observed, the replacement of cement with 5% shows maximum increase in compressive strength after 28 days of curing and at 15% the strength again starts to decrease comparatively.

So we can conclude that the best suitable result was observed at 5% replacement of cement by steel shot dust.

CONCLUSION

Due to steel shot dust, it proved to be very effective and it ensures very good cohesiveness of mortar and concrete. From the above study, it is concluded that the steel shot dust can be used as a replacement material for cement; and 5% replacement of steel shot dust gives a promising result in strength aspect and quality aspect and it is better than the control concrete.

From our test results it can be concluded that this industrial waste is capable of improving hardened concrete performance, enhancing fresh concrete behavior and can be used in plain concrete. So after this hit and trial experiment, we can also conclude that different % variation can show variation in result.

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