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Strength and Workability Assessment of Cement and M25 Grade Concrete using Tandur Stone Slurry Powder and Fly Ash

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Abstract **- Tandur Stone is a polished limestone available in Tandur town, Telangana State, India.**

Tandur Stone Slurry Powder (TSP) is the powder that is being obtained upon drying of slurry while polishing Tandur stones which is lying as a waste at Tandur town outskirts. And Fly Ash is obtained from coal as it is a residual of coal.

In this investigation cement is replaced with TSP and TSP with fly ash. In the previous investigation strength and workability parameters were studied by replacing cement with Tandur stone slurry powder alone by 20%, 40% and 60%. So far, it was found out that concrete and cement yielded maximum strength when replaced by 20% TSP by weight. Presently in this experimental investigation, this 20% TSP is further replaced by 20%, 40%, 60% fly ash which is called as TSF in short.

In this experimental investigation, parameters like workability, compressive strength and split tensile strength of M25 grade concrete along with compressive strength of cement were studied when cement is replaced by TSP and Fly Ash (TSF).

Standard cubes of 150mm x 150mm x 150mm and standard cylinders of 150mm diameter x 300mm height are considered for 7, 14 and 28 days Compressive Strength and Split Tensile Strength of concrete respectively. Slump Cone is used to measure workability of concrete. 7.06 cm cube moulds are considered for compressive strength of cement.

This investigation is done to find out whether cement can be replaced with TSP and fly ash (TSF) or not so that cost of cement can be reduced.

NOTATIONS USED

TSF ------ Mixture of Tandur Stone Slurry Powder and Fly Ash

TSF-Concrete ------ Concrete having TSF as partial cement replacement

TSF-Mortar ------- Cement mortar having TSF as partial cement replacement

ACKNOWLEDGMENT

The involvement and contribution by Miss M V M Teja and Mr E Ram Prasad, 4th year Civil Engineering students is also very much appreciated without which the completion of the project would have been impossible.

INTRODUCTION

Previously cement and concrete of M25 grade yielded maximum strength when cement was replaced by 20% TSP by weight. Workability was also fair at the above said percentage.

Now, in this experiment the 20% TSP is further replaced by 20%, 40% and 60% Fly Ash to see whether there is any further improvement in strength and workability.

FIGURE 1 TSP at Tandur

FIGURE 2 Polished Tandur Stones

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The chemical analysis of TSP was done at Sagar Cements laboratory and the below table shows its composition.

TABLE 1 Chemical composition of TSP

NAME OF CHEMICAL	Percentage
CO_3 (total carbonate)	85.22
$Mgco_3$ (Magnesium carbonate)	3.36
LOI (loss on ignition)	36.98
SiO_2 (silicon dioxide)	10.84
Al_2O_3 (aluminum trioxide)	1.14
Fe_2O_3 (ferrous trioxide)	1.60
Cao(calcium oxide)	48.23
TOTAL	98.79

LITERATURE REVIEW

TSP has been extensively used in Chalk industry, but so far not much work or research has been carried on TSP regarding its use in construction industry.

Many people have done extensive research work on replacing cement by fly ash, limestone powder, marble powder, marble slurry, rice husk ash, copper slag, blast furnace slag, etc. (see References).

But very few people have worked on replacement of cement by TSP as follows:

S Sivacharan, Associate Professor, found that Compressive Strength, Split Tensile Strength and workability of Ordinary Concrete and Self-Compacting Concrete of M25 Grade increased when cement was replaced by 20% TSP by weight.

Ritica Thakur et.al, while guiding her students over a project, found that at 20% replacement of cement by TSP, Compressive strength, Split tensile strength and workability was found to be increasing. But beyond 20% replacement the strength kept on decreasing and workability was also decreasing. The work was carried on Ordinary Concrete of M20 grade.

M Anitha, while doing her MTech thesis, found that optimum compressive strength and split tensile strength for Ordinary Concrete of M25 grade was obtained at 12% replacement of cement by TSP.

WORK DONE IN THIS INVESTIGATION

In this current investigation, 53 grade cement and M25 grade concrete is considered. Compressive strength for both cement and concrete, split tensile strength, workability of concrete in terms of slump are determined when 20% TSP is further replaced by 20%, 40% and 60% fly ash (TSF).

MATERIALS, EQUIPMENT AND METHODS

TSP (Tandur Stone Slurry Powder)

As already discussed, TSP, a product of limestone, readily available in plenty of quantity at Tandur town outskirts as a waste is used in this project to replace cement partially. TSP is basically obtained upon drying of liquid Tandur stone (limestone) slurry while polishing Tandur stones.

Cement

Ordinary Portland Cement (OPC) of 53 grade from Sagar Cement Industry is used in this work.

Fine Aggregate

The sand used for the experimental investigation was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The properties of sand like specific gravity, water absorption, fineness modulus, etc. were already determined and used in the experimental work for carrying out mix design.

Coarse Aggregate

Rounded crushed coarse aggregate of 20 mm maximum size obtained from the local crushing plant, at a quarry near Raja Nagaram, East Godavari District, Andhra Pradesh, India is used in the present study. The physical properties of coarse aggregate like specific gravity, bulk density, gradation and fineness modulus are tested in accordance with IS : 2386.

Water

In the present experimental investigation, potable tap water is used for casting and curing.

Fly Ash

Fly ash, used as partial replacement of TSP in the present experimental work is as per specifications IS: 3812-1981. In the present investigation work, the fly ash used is obtained from Vijayawada Thermal Power Station in Andhra Pradesh.

TABLE 2 Chemical composition of Fly Ash

Compounds	**Percentage**
SiO2	38-63
Al2O3	27-44
TiO2	0.4-1.8
Fe2O3	3.3-6.4
MnO	0.1-0.5
MgO	0.01-0.5
CaO	0.2-8
Na2O	0.07-0.43
LOI	0.2-5.0
P^H	6-8
K2O	0.04-0.9

Concrete Pan Mixer (Machine Mixing)

Mixing of concrete was carried out by machine. Machine mixing is not only efficient but also economical. This mixer is used to mix TSF-concrete.

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Slump Cone

A slump cone is used to measure the workability or fluidity of concrete. In this study, Slump Cone is used to measure the workability of TSF-Concrete.

Moulds

The TSF-Mortar is cast in to 7.06 cm cube moulds and TSF-Concrete is cast in to cube moulds of size 150mmX150mmX150mm for Compression Strength Test, and cylindrical moulds of 300 mm height ×150 mm diameter are used for Split Tensile Strength Test.

Vibrating Table (Compaction of Concrete)

Compaction of TSF-Concrete is done by using vibrating table. By this, the air voids are filled and maximum density is occurred.

Hand Compaction

A tamping rod of 60 cm long and 16 mm diameter is used to tamp 25 times each layer of TSF-Mortar in the cement mortar mould. The mix is filled in the mould in three layers and each layer is compacted as discussed above.

Curing Tank

The curing tank used in this study is a rectangular tank of size 2.0 X 1.5 X 1.5 m.

Compression Testing Machine (CTM)

The CTM is used to determine the Compressive strength of both TSF-Concrete and TSF-Mortar and Split Tensile strength of TSF-Concrete.

Mix Design for Ordinary Concrete

The mix design of M25 grade concrete was carried out according to IS 10262: 2009.

RESULTS

TABLE 3 Compressive Strength of TSF-Mortar

S.NO	% of Fly ash replaced in TSP	Compression strength(Mpa) of TSF-Mortar		
		7 days	14 days	28 days
1	0	30.27	37.26	55.10
2	20	32.18	38.57	59.73
3	40	29.21	33.95	53.46
4	60	28.15	30.76	51.34

FIGURE 3 Graph between % of fly ash replaced in TSP and Compression Strength of TSF-Mortar

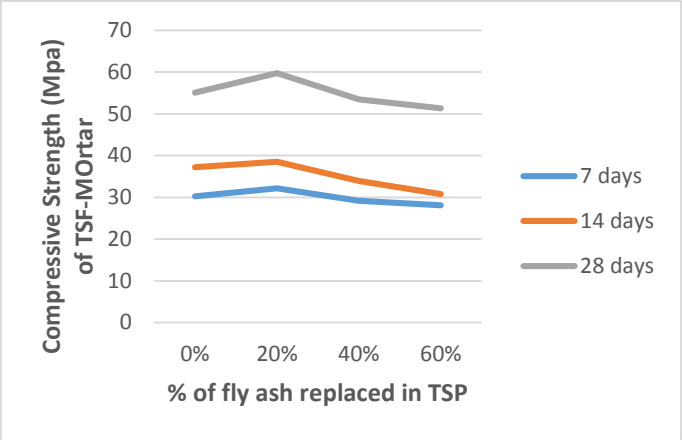

TABLE 4 Slump Values of TSF-Concrete

S.No	Mix details	% of fly ash replaced in TSP	Slump value (mm)
1	1: 1.59 : 2.72	0	50
2	1: 1.59 : 2.72	20	52
3	1: 1.59 : 2.72	40	55
4	1: 1.59 : 2.72	60	60

FIGURE 4 Graph between % of fly ash replaced in TSP and Slump Values of TSF-Concrete

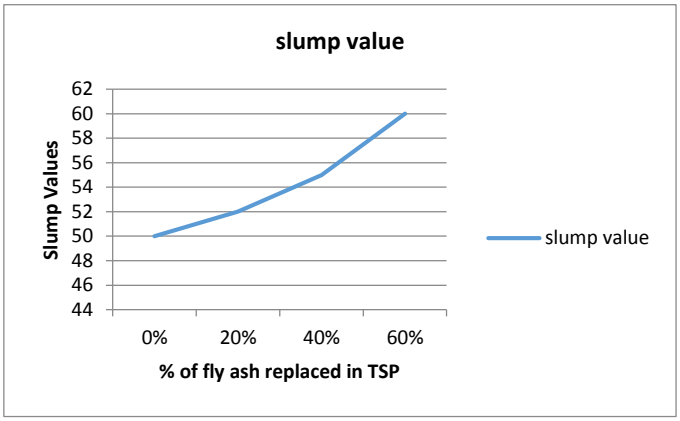

TABLE 5 Compressive Strength of TSF-Concrete

S.No	% of fly ash replaced in TSP	Compression strength(Mpa)		
		7 Days	14 Days	28 Days
1	0	25.52	30.21	36.45
2	20	25.96	32.01	40.01
3	40	24.42	29.89	35.11
4	60	20.86	25.70	34.36

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FIGURE 5 Graph between % of fly ash replaced in TSP and Compressive Strength of TSF-Concrete

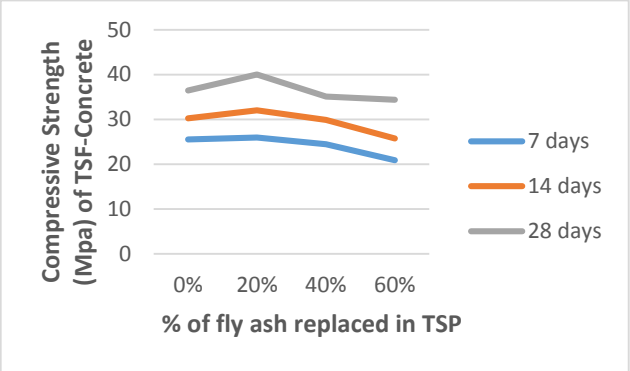
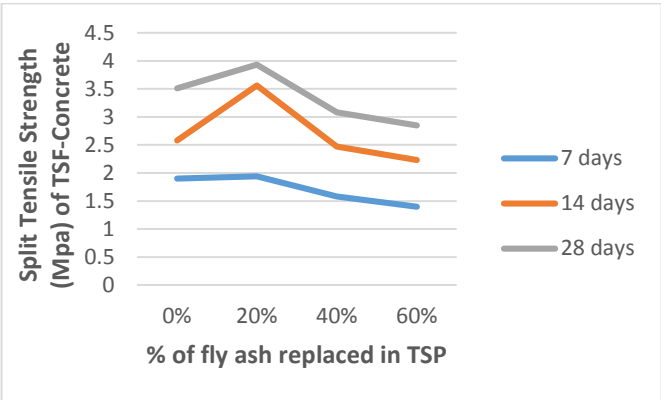


TABLE 6 Split Tensile Strength of TSF-Concrete

S.No	% of fly ash replaced in TSP	Split Tensile strength (Mpa)		
		7 Days	14 Days	28 Days
1	0	1.90	2.58	3.51
2	20	1.94	3.56	3.93
3	40	1.58	2.47	3.08
4	60	1.40	2.23	2.85

FIGURE 6 Graph between % of fly ash replaced in TSP and Split Tensile Strength of TSF-Concrete



CONCLUSIONS AND DISCUSSIONS

- When TSP is further replaced by 20% fly ash, the cement mortar having the above mixture (TSF) has produced increased compressive strength when compared to the mix having TSP alone as partial replacement of cement.
- When the percentage of fly ash replaced in TSP was increasing, the workability of M25 grade concrete in terms of slump had kept on increasing.
- When TSP is replaced by fly ash by 20%, the compressive strength of concrete had reached maximum and it kept on decreasing beyond 20% replacement. This value at 20% fly ash replacement is more than the value obtained when replacement is done by TSP alone.
- The split tensile strength of concrete had reached a maximum value when TSP is replaced by 20% fly ash and its value is more than the value obtained when replaced by TSP alone. The split tensile strength again kept on decreasing beyond 20% replacement of TSP by fly ash.

SCOPE FOR FUTURE RESEARCH

- Durability tests on TSF-Mortar and TSF-Concrete can be carried out in future at 20% replacement of TSP by fly ash to know whether they can withstand long term effects or not.
- Cost analysis to be carried out for TSF-Mortar and TSF-Concrete at optimum strength at 20% replacement of TSP by fly ash to know how much money and quantity of cement can be saved when cement is replaced by TSF.
- The quantity and cost of fly ash that has to be added can be worked out in future.
- The quantity of TSP that can be added to the mix can be worked out and the cost of TSP need not to be considered as TSP is available for free of cost.
- Chemical analysis to be carried out on TSF-Mortar and TSF-Concrete to find out the compounds formed during chemical reaction between cement, TSP and fly ash at 20% replacement of TSP by fly ash.
- Further research has to be carried on the reasons for increased workability, increased compressive strength and tensile strength up to 20% fly ash replacement and decreased compressive strength and tensile strength beyond 20%.
- Tests to be carried out on the high temperature effects of TSF-Mortar and TSF-Concrete at optimum strength.

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