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Strength and Workability Assessment of Ordinary Concrete and Self-Compacting Concrete using Tandur Stone Slurry Powder – A comparison

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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.

An attempt has been made to assess the strength and workability behavior of ordinary concrete of M25 grade and Self-Compacting concrete of M25 grade by replacing cement with Tandur Stone Slurry Powder (TSP), to know the possibility of replacing cement by TSP in both Ordinary Concrete and Self-Compacting Concrete.

In this present experimental investigation, the behavior of Ordinary Concrete and Self-Compacting Concrete in terms of Workability and Strength is observed by replacing 0%, 20%, 40% and 60% of cement with TSP.

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 respectively.

In case of Ordinary Concrete, Slump Cone is used to test Workability whereas V-Funnel is used to test filling ability and L-Box is used to test filling and passing ability of Self-Compacting Concrete.

A comparison is made between the results thus obtained and traditional concrete. Also, the results are compared between TSP-replaced Ordinary Concrete and TSP-replaced Self-Compacting Concrete.

ABBREVIATIONS USED

OPC : Ordinary Portland Cement
IST : Initial Setting Time
FST : Final Setting Time
CTM : Compression Testing Machine
SCC : Self-Compacting Concrete
TSP : Tandur Stone Slurry Powder
TSPC : Tandur Stone Slurry Powdered Cement
TSPOC : Tandur Stone Slurry Powdered Ordinary Concrete
TSPSC : Tandur Stone Slurry Powdered Self-Compacting Concrete

INTRODUCTION

The idea of carrying out this experimental investigation is to see whether cement can be replaced by TSP or not and by what percentage it can be replaced so that Tandur town and its surroundings can be made clean and environmental friendly when this entire powder is transported to construction industries.

The idea also sprang up, when considerable amount of Calcium Oxide (CaO) is found in the chemical composition of TSP which is responsible for binding.

FIGURE 1 TSP at Tandur

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

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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:

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 CARRIED ON THIS CURRENT INVESTIGATION

In this current investigation, Ordinary Concrete and Self-Compacting Concrete of M25 grade is considered. Compressive strength, split tensile strength, workability in terms of slump, filling and passing ability of the above said mixes were determined and compared at 0%, 20%, 40% and 60% replacement of cement by TSP.

MATERIALS, EQUIPMENT AND METHODS

TSP

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.

FIGURE 2 Polished 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, Keesera Gutta, Hyderabad 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 additional powder in Self-compacting concrete 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.

Conplast SP 430ES2 (Admixture)

In the present investigation, the super plasticizer namely *Conplast* SP 430ES2 is used for developing Self-Compacting Concrete and obtained from UNITED ENGINEERING (India) Pvt. Ltd., Hyderabad. It is a high performance concrete super plasticizer based on modified polycarboxylic ether.

Le-Chatelier's Flask

Le-Chatelier's flask is used to determine the specific gravity or density of powdered materials like hydraulic cement, lime and slag and TSP.

Vicat Apparatus

Vicat Apparatus is used to find consistency, initial setting time and final setting time of cement and TSP.

Le-Chatelier's Apparatus

Le-Chatelier's Apparatus is used for determining the expansion of cement and TSP.

90 Micron Sieve

90 micron sieve is used to fine the fineness of Cement and TSP.

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 both Tandur Stone Slurry Powdered Ordinary Concrete (TSPOC) and Tandur Stone Slurry Powdered Self-Compacting Concrete (TSPSC).

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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 Tandur Stone Slurry Powdered Ordinary Concrete (TSPOC).

Moulds

The cement mortar is cast in to 7.06 cm cube moulds and 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 concrete is done by using vibrating table. By this, the air voids are filled and maximum density is occurred.

Curing Tank

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

V-Funnel

The V funnel test is used to determine the filling ability (flowability) of the concrete with a maximum aggregate size of 20 mm. In this study, this apparatus is used to measure the filling ability of Tandur Stone Slurry Powdered Self-Compacting Concrete (TSPSC).

L-Box

The L Box assesses the flow of the concrete, and also the extent to which it is subject to blocking by reinforcement. In this study, this apparatus is used to assess the flow of Tandur Stone Slurry Powdered Self-Compacting Concrete (TSPSC).

Compression Testing Machine (CTM)

The CTM is used to determine the Compressive strength and Split tensile strength of both TSPOC and TSPSC specimens.

Mix Design for Ordinary Concrete

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

Mix Design for Self-Compacting Concrete

EFNARC (European Federation of National Trade Associations) guidelines were followed for the mix design of M25 grade Self-Compacting Concrete.

RESULTS AND COMPARISONS

TABLE 2 Comparison of Physical Properties between OPC and Pure TSP

TEST PERFORMED	CEMENT (OPC, 53 GRADE)	Pure TSP
Specific Gravity	3.15	2.56
Consistency	31.6%	23%
Initial Setting Time (IST)	40 min	1 hr 35 min
Fineness	9%	6%
Compressive Strength	53MPa	Nil
Soundness	4mm	Nil

TABLE 3 Comparison of Physical Properties between Pure TSP and TSPC

SNo	Property	Pure TSP	TSPC**	Comments
1	Specific Gravity	2.56	2.48 (20%) 2.32 (40%) 2.71 (60%)	Though less than that of OPC, sp.gravity of TSPC increased from 20% to 60% when compared to TSP
2	Consistency	23 %	29.5 % (20%) 30.5 % (40%) 31.5 % (60%)	Consistency of TSPC is much better than TSP nearly equal to that of OPC for all percentages.
3	Initial Setting Time (IST)	95 min	120 min (20%) 130 min (40%) 180 min (60%)	IST for both TSP and TSPC increased compared to OPC, but it kept on increasing for TSPC with the addition of TSP.
4	Final Setting Time(FST)	Nil	>15 hrs (20%) >15 hrs (40%) >15 hrs (60%)	Unable to get FST of TSP even after 3 days. The FST of TSPC was found to be more than 15 hours.
5	Soundness	Nil	2mm (20%) 2mm (40%) 2mm (60%)	Unable to get Soundness value for TSP as the mass couldn't retain its shape and soundness values of TSPC are more than TSP and constant.
6	Fineness	6%	10.06 % (20%) 22.1 % (40%) 34.88 % (60%)	% fineness of TSP is less than that of OPC, but % fineness of TSPC kept on increasing with addition of TSP compared to PureTSP.
7	Compressive Strength (Mpa) 28 days Strength	Nil	51.65 (20%) 36.66 (40%) 25 (60%)	Unable to get Compressive strength for TSP as it was unable to retain its shape, but the compressive strength of TSPC is more than TSP and kept on decreasing with the addition of TSP and nearly equal to that of OPC at 20%.

** Percentage shown in parenthesis is the percentage of cement replaced by TSP by weight.

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TABLE 4 Comparison of Physical Properties between TSPOC and TSPSC

SNo	Property	TSPOC	TSPSC**	Comments
1	Workability	(Slump value) 55 cm (0 %) 50 cm (20%) 45 cm (40%) 40 cm (60%)	(V-Funnel Values) 11 sec (0 %) 10 sec (20%) 06 sec (40%) 04 sec (60%) (V-Funnel @ T5 Values) 13 sec (0 %) 09 sec (20%) 07 sec (40%) 05 sec (60%) (L Box values) 1 (0 %) 0.8 (20%) 0.8 (40%) 0.6 (60%)	The slump value kept on decreasing with the addition of TSP to TSPOC and V-Funnel and L Box values also kept decreasing with the addition of TSP to TSPSC.
2	Compressive Strength (Mpa) 28 days strength	31.60 (0 %) 33.00 (20%) 26.66 (40%) 21.33 (60%)	49.99 (0 %) 49.62 (20%) 34.66 (40%) 21.55 (60%)	The compressive strength in both the cases is nearly equal or more than the traditional concrete(without TSP) strength at 20% TSP and kept on decreasing from 20% TSP to 60% TSP
3	Split Tensile Strength (Mpa) 28 days strength	2.78 (0%) 2.80 (20%) 2.25 (40%) 1.65 (60%)	2.35 (0 %) 2.98 (20%) 2.03 (40%) 1.2 (60%)	The split tensile strength in both the cases is nearly equal or more than the traditional concrete (without TSP) strength at 20% TSP and kept on decreasing from 20% TSP to 60% TSP

**Percentage shown in parenthesis is the percentage of cement replaced by TSP by weight.

CONCLUSIONS AND DISCUSSIONS

- Pure Tandur Stone Slurry Powder (TSP) on its own, without addition of any cement, was unable to retain its shape due to lack of bonding, when in contact with water.
- Since it was unable to retain its shape, it was not possible to obtain compressive strength, Soundness of Pure TSP.
- The remaining properties of Pure TSP like Specific gravity, Consistency and Initial Setting Time were found to be inferior when compared to OPC.
- Due to lack of hardening of Pure TSP, even after three days, it was not possible to get Final Setting Time.
- Only percentage fineness of Pure TSP was found to be better than OPC.
- But, when Cement is partially replaced by TSP, the TSPC thus obtained is giving satisfactory results at 20% TSP
- Compressive Strength and consistency of TSPC at 20% TSP gave satisfactory results, but from 20% TSP to 60% TSP, compressive strength of TSPC kept on decreasing.
- The Specific gravity and consistency of TSPC kept on increasing from 20% TSP to 60% TSP.
- The soundness of TSPC at all percentages of TSP was satisfactory and constant.
- The Initial Setting Time of TSPC was satisfactory at 20% TSP, but kept on increasing from 20% TSP to 60% TSP.
- The Final Setting Time of TSPC was found to be greater than 15 hours which is too long and it's a matter of concern.
- The workability of Tandur Stone Slurry Powdered Ordinary Concrete (TSPOC) was satisfactory at 20% TSP and got improved from 20% TSP to 60% TSP.
- The workability (both V-Funnel and L Box values) of Tandur Stone Slurry Powdered Self Compacting Concrete (TSPSC) was satisfactory at 20% TSP and got improved from 20% TSP to 60% TSP.
- The compressive strength of both TSPOC and TSPSC is satisfactory and is equal to or slightly greater than that of the traditional concrete (without TSP) at 20% TSP.
- But from 20% TSP to 60% TSP, the compressive strength of TSPOC and TSPSC got decreased.
- Similarly, the Split Tensile Strength of both TSPOC and TSPSC is satisfactory and is equal to or slightly greater than that of the traditional concrete (without TSP) at 20% TSP.
- But from 20% TSP to 60% TSP, the split tensile strength of TSPOC and TSPSC got decreased.
- Over all, all the tests performed on TSPC, TSPOC and TSPSC has shown that the results obtained were satisfactory with respect to consistency, workability, compressive strength and split tensile strength, when cement is replaced by 20% TSP.
- The compressive strength is maximum for TSPC, TSPOC and TSPSC at 20% TSP. Similarly, the Split Tensile Strength is maximum for TSPOC, TSPSC at 20% TSP.

SCOPE FOR FUTURE RESEARCH

- Further research can be carried out to find the reasons of absence of binding property in PURE TSP.
- Further work can be carried out on PURE TSP so that whether PURE TSP can be used as Admixture in the Construction industry
- As far as current findings are concerned, TSPC at 20% replacement is sufficient to attain maximum compressive strength, however further research could be carried out to obtain optimum strength by taking in the following % levels of TSP (by reducing percentage intervals) like 5, 10, 15, 25, 30 and 35 percentage, hoping that optimum strength may lie anywhere between 0 to 20% & 20 to 40%.

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- From the research on TSPC, the FST values are more than 10hrs, further work to be carried out for reducing the FST values at optimum strength by using Accelerators (Chemical Admixture).
- Chemical analysis to be carried out on TSPC at optimum strength, to find the chemical compounds formed during chemical reaction between PURE TSP and Cement
- Cost analysis to be carried out for TSPC at optimum strength to know how much money and quantity of cement can be saved when cement is replaced by TSP.
- Further research has to be carried on the reasons for decreased workability, increased compressive strength and tensile strength up to 20% TSPOC and decreased compressive strength and tensile strength beyond 20% TSP.
- Tests to be carried out on the durability characteristics of TSPOC at optimum strength.
- Tests to be carried out on the high temperature effects of TSPOC at optimum strength.
- Tests to be carried out on the shrinkage and the creep properties of TSPOC at optimum strength.
- Cost analysis to be carried out for TSPOC at optimum strength to know how much money and quantity of cement can be saved when cement is replaced by TSP.
- Further research has to be carried on the reasons for increased compressive strength and tensile strength up to 20% TSPSC and decreased compressive strength and tensile strength beyond 20% TSPSC.
- Tests to be carried out on the durability characteristics of TSPSC at optimum strength.
- Tests to be carried out on the high temperature effects of TSPSC at optimum strength.
- Tests to be carried out on the shrinkage and the creep properties of TSPSC at optimum strength.
- Cost analysis to be carried out for TSPSC at optimum strength to know how much money and quantity of cement can be saved when cement is replaced by TSP.

REFERENCES AND BIBLIOGRAPHY

[1] "Effective Utilization of Waste Tandur Stone Powder in Concrete Mix to overcome Waste Disposal Problems" by Ritica Thakur, ISSN 2321 – 7758, International Journal of Engineering Research – Online, Volume–4, Issue–3, 2016.

[2] "Optimum Strength Evaluation of Cement and Ordinary Concrete by Using Tandur Stone Slurry Powder" by M Anitha, ISSN No: 2348-4845, International Journal and Magazine of Engineering and Technology, Management and Research, Volume-2, Issue-11, 2015.

[3] Er: Raj.p.singh kushwah, Prof (Dr.) Ishwar Chand Sharma, Prof (Dr.) PBL Chaurasia (2015) Utilization of "Marble Slurry" In Cement Concrete Replacing Fine Aggregate. American Journal of Engineering Research (AJER) ISSN: 2320-0847 ISSN: 2320-0936 Volume-04, Issue-1, pp-55-58.

[4] Bahar Demirel, The Effect of the using Waste Marble Dust as Fine Sand on the Mechanical Properties of the Concrete ISSN 1992 - 1950 ©2010, International Journal of the Physical Sciences Vol. 5(9), pp. 1372-1380, 18 August, 2010.

[5] Baboo Rai, Khan Naushad H , Abhishek Kr, Tabin Rushad S, Duggal S.K, The effect of using marble powder and granules as constituents of fines in mortar or concrete INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING Volume 1, No 4, 2011.

[6] Hassan A. Mohamadien, The effect of marble powder and silica fume as partial replacement for cement on mortar INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING, Volume 3, No 2, 2012.

[7] Noha M. Soliman, Effect of using Marble Powder in Concrete Mixes on the Behavior and Strength of R.C. Slabs, International Journal of Current Engineering and Technology ISSN 2277 - 4106 Vol.3, No.5 (December 2013).

[8] V. M. Sounthararajan and A. Sivakumar, Effect of The Lime Content in Marble Powder for Producing High Strength Concrete. ARPN Journal of Engineering and Applied Sciences, VOL. 8, NO. 4, APRIL 2013 ISSN 1819-6608.

[9] Animesh Mishra, Abhishek Pandey, Prateek Maheshwari, Abhishek Chouhan, S. Suresh, Shaktinath Das, Green Cement For Sustainable Concrete Using Marble Dust, Department of Chemical Engineering, Maulana Azad National Institute of Technology, (MANIT) Bhopal, Madhya Pradesh India, Research CODEN(USA): IJCRGG ISSN : 0974-4290 Vol.5, No.2, pp616-622, April-June2013.

[10] Prof. Veena G. Pathan, Prof. Md. Gulfam Pathan, Feasibility and need of use of waste marble powder in concrete production IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)

[11] M. Shahul Hameed,"Properties of green concrete containing quarry rock dust and marble sludge powder as fine aggregate," ARPN Journal of Engineering and Applied Sciences, page: 83-89,vol. 4, no. 4, June 2009.

[12] P.A. Shirule, AtaurRahman, Rakesh D. Gupta, "Partial Replacement of Cement with Marble Dust Powder,"International Journal of Advanced Engineering Research and Studies, ISSN2249–8974.

[13] Patel N. et al "Marble Waste: Opportunities for Development of Low Cost Concrete" Global research analysis, Journal of construction and building material, Volume: 2 | Issue: 2 Feb 2013, ISSN No 2277 – 8160.

[14] Ali A. Aliabdo et al. "Re-use of waste marble dust in the production of cement and concrete" construction and building material 50(2014)28-41 September 2013.

[15] Kursat Esat Alyamaç et al. "A preliminary concrete mix design for SCC with marble powders" Construction and Building Materials 23 (2009) 1201–1210.

[16] Bouziani Tayeb et al " Effect of Marble Powder on the Properties of Self-Compacting Sand Concrete" The Open Construction and Building Technology Journal, 2011, 5, 25-29

[17] V.M.Shelke et al. "Effect of marble powder with and without silica fume on mechanical properties of concrete" IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE) ISSN: 2278-1684 Volume 1, Issue 1 (May-June 2012), PP 40-45

[18] Hassan A. Mohamadien " The Effect of marble powder and silica fume as partial replacement for cement on mortar" INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING Volume 3, No 2, 2012

[19] Noha M. Solimana "Effect of using Marble Powder in Concrete Mixes on the Behavior and Strength of R.C. Slabs" International Journal of Current Engineering and Technology ISSN 2277 - 4106 December 2013

[20] Shazim Ali Memon et al "Production of Low Cost Self Compacting Concrete Using Rice Husk Ash" Advancing and Integrating Construction Education, Research & Practice" August 4-5, 2008, Karachi, Pakistan First International Conference on Construction in Developing Countries.

[21] IS 10262-2009 Code for Mix Design of Concrete.

[22] The European guidelines for self-compacting concrete specification, Production and use Feb 2002 and May 2005.

[23] EFNARC (European Federation of National Trade Associations) guidelines for viscosity modifying agents and Mix Design of SCC.

[24] A text book on "Concrete Technology, Theory and Practice" by MS Shetty, S Chand Publishing.