PERFORMANCE OF SELF COMPACTING CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH ROOF TILE POWDER

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ABSTRACT

Concrete occupies a unique position among modern building materials, concrete is a material used in a building structure consisting of a hard, chemically inert particulate substance known as aggregate (usually produced for different types of sand and gravel), thus combines cement and water. Bad reinforcement concrete work could cause building failures after an earthquake. Casting and compaction of concrete densely reinforced structural member and beam column joint are difficult. A suitable solution for this the problem is the use of self-compacting concrete, which has the ability to flow, filling ability and passing ability. Traditional roof tile waste is available in Indian villages. The use of traditional roofing tile powder in self-compacting concrete is an effort to recycle waste and a new development in the field of environmentally friendly concrete material technology. This research aims to understand the contribution of traditional powder to the development of workability and strength of self-compacting concrete. Roof tile powder percentage for the SCC replacement is varied as 0%, 5%, 10%, and 15%, This paper will discuss the behavior and effect of the SCC where the cement is partially replaced by Roof tile powder. When SCC compared with nominal Concrete, there is significant increase in workability and compressive strengths.
Mix Design for concrete M25 is done as per Indian Standard Code IS: 10262-1982.

Keywords: *Admixture , Hardened properties , Roof tile powder, Self compacting concrete.*

I. INTRODUCTION

Cement is the most active component of concrete and usually has the highest unit cost, its selection and correct use is very important to obtain economic concrete and concrete with desired properties. Widespread use of cement will increase carbon dioxide emissions and create a greenhouse effect. The potential of solid waste in the construction industry as alternative materials is already well established. The use of pozzolanic materials as supplementary cementitious materials has become a major research interest in recent decades. Due to the properties of ceramics, its waste, such as broken tiles, should be included in concrete as a substitute for conventional building material. This will help solve problems such as cost, scarcity and other environmental problems that may arise from improper disposal of such waste. In this paper, the potential of waste construction waste Roof tile powder as a partial replacement material for cement in mortar is investigated.

SCOPE OF WORK

Self-compacting concrete (SCC) conventionally consists of powder (Portland cement, silica fume, and fly ash), fine and coarse aggregates, super plasticizer, and water. On this research, powder component is rather different with the conventional SCC. Recycled traditional roof tile powder from local production waste and residential waste is used as powder component to replace fly ash in conventional SCC.
There are two major reasons to select traditional roof-tile powder as powder component in SCC. First, this powder available as residential waste in India, and the use this waste as recycled material give positive impact to its environment. Second, this waste has silica content then potentially could be used as pozzolanic material. As pozzolanic material, this waste could be a good binder and also good filler agent. With suitable trial mix composition, traditional roof-tile powder could improve quality and flow ability of self compacting concrete.

Development on concrete strength is also determined in this research by observe the 7, 28, 56 and 90 days concrete compressive strength, Split-tensile strength and flexure strength.
The Mix Design for concrete M25 grade is being done as per the Indian standard code IS: 10262-1982.

OBJECTIVE OF WORK

- The objective of present work is to identify the three key properties of self-compaction concrete i.e. filling ability, passing ability and segregation resistance.
- To decrease the permeability and to reduce the shrinkage in self-compacting concrete and finding out the right workability for construction work.
- To find the best suitable dosage of Roof tile powder for SCC.
- The influence of Roof tile powder on fresh and hardened properties of SCC.
- To determine the percentage growth rate in hardened properties like compressive strength, split tensile strength and flexural strengths.

II. LITERATURE REVIEW

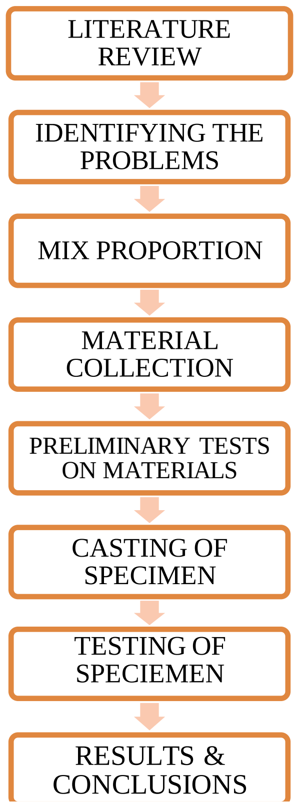
Since OZAWA et al. first reported the development of SCC in Japan in 1988, they used super plasticizers and viscosity agents, and again in 1992 determined self-compaction factors, i.e. the content of coarse and fine aggregates and published papers at the CANMET ACI International Conference (1992) spread the concept of SCC worldwide.

B. Chandana, M. Durga Rao (2018) The objective of this study was to evaluate the use of OPC (53-grade) mixing mineral additives fly ash and microsilica (substitutes) in cement concrete. This study investigated the performance of M-30 concrete in terms of compressive strength and splitting tensile strength at 7, 14 and 28 days. The project included self-compacting concrete with fly ash replacement levels of OPC 15%, 20% and 25% and silica fume replacement levels of OPC 6%, 9% and 12% by weight.

R. Elavarasans, S. Adhitja, K. Akila, P. Amarthyasen, cand.mag Bhavadharani (2020) discusses the behavior of SCC when fine aggregate is partially replaced by Granite powder. This is not only economically beneficial, but also facilitates the safe disposal of industrial waste, thus protecting the precious earth from pollution, and ambient curing also saves energy required for oven curing. The greenhouse gas emission potential will be reduced by up to 90% compared to conventional Portland cement.

Rajesh vipparthi, R. Abhishek, Dhondi roshitha, Vamshi Krishna (2021) This study investigated the mechanical properties of concrete composites containing nano-silica for more ductile and high strength concrete. For this purpose, various amounts of nano-silicon powder are added to the concrete. The mechanical properties and morphology of the samples were studied. Mechanical properties such as flexural strength, tensile strength and compressive strength are greatly improved by incorporating nano-silica.

III. METHODOLOGY



MATERIALS USED :

The Materials used for the study are :
i) Cement
ii) Fine Aggregate
iii) Coarse Aggregate
iv) Roof Tile powder
v) Superplasticizer
vii) Water

i) Cement

Ordinary Portland Cement (OPC) grade 53 as per IS:12269:1999 was used in this study. The physical properties of the cement conform to IS: 12269:1999 and have been tested at the Concrete Laboratory of Anamacharya Institute of Technology and Science, Kadapa.

ii) Fine Aggregate

Nowadays, good sand is not only a gift.. The fine aggregate used in this test is locally available river sand and care should be taken to ensure that the sand is free of impurities and gray stones and that it is clean. The sand used conforms to the requirements of IS: 383-1970.

iii) Coarse Aggregate

Aggregate is a granular material such as sand, gravel, crushed stone, crushed stone hydraulic cement concrete used with a hydraulic cementing agent to produce concrete or mortar.Aggregates are divided into many classifications based on their sizes. Crushed stone with 12 mm aggregate is used as coarse aggregate in the concrete mix.

iv) Roof tile powder

Powder has particle dimension of 0.125 mm and potentially has capabilities to be a inder and filler. The physical properties of Roof tile powder is given in table 1.

Table 1 Properties of Roof Tile Powder

Physical property	Results
Fineness (retained on 90 microns sieve)	7 %
Specific gravity	2.0

v) Admixture

Polycarboxylic ether based super plasticizers with viscosity modifying admixtures supplied by BASF India Limited under the trade name Master Glenium SKY 8630/8632 is used in this research work. Master Glenium SKY 8630/8632 is a new generation admixture based on modified polycarboxylic ethers for the production of smart dynamic concrete/self-compacting concrete with built-in viscosity modifying additives. The super plasticizer level for all mixes was 2% cement by weight.

vi) Water

The water used for mixing the concrete components, casting and curing the samples shall not contain impurities which, if present, may adversely affect the strength of the concrete as per IS:3025:1964 (Parts 22 and 23) and IS:456: 2000.

Detailed description of the materials used and their physical properties has been presented. The mix design for M25 grade of concrete according to IS: 10262-1982 has been designed.

Table 2 Mix design for M25 SCC

Cement	F.A	C.A	Water	S.P
524.31 kg	672.36 kg	928.08 kg	199.24	10.49
1	1.28	1.77	0.38	2 %

IV. EXPERIMENTAL INVESTIGATION

The following steps are included in this phase

1. Design of concrete mix
2. Mixing of concrete
3. Test Specimens
4. Preparation of Moulds
5. Harden properties of SCC
6. Observations and Test Results

1. Design of concrete mix

The mix design for M25 SCC mix is explained in the (Mix Design).

2. Mixing of concrete

Fig 1. Mixing of concrete

The European guidelines for self compacting concrete were the first to codify the various testing methods on SCC. As there is no specific test method suggested by BIS for SCC, They are as follows :

A. Slump Flow Test
B. V-funnel Test
C. L-shaped box Test
D. U-box Test

3. Test specimens

Fig 2. Test specimens

4. Preparation of moulds

Fig 3. Preparation of moulds

5. Hardened properties of SCC

The compressive strength, tensile strength and flexural strengths of the used samples was measured with a compressive testing machine and flexure beam apparatus.

V. RESULTS & DISCUSSIONS

The results completed in the present investigation are reported in the form of tables and graphs for various fresh properties and harden properties of SCC for various percentage of Roof Tile powder as a partial replacement to cement in SCC by 0%, 5%, 10%, and 15% are worked out and tabulated in the table below.

FRESH PROPERTIES OF SCC

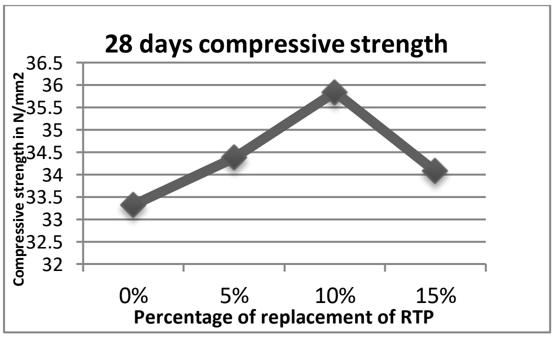
Following table gives the results of test conducted on fresh SCC such as Slump flow and T50cm slump flow, V-Funnel and V-funnel T5min, L-box and U-Box test for various replacement of Roof Tile powder for cement in SCC.

HARDENED PROPERTIES OF SCC

The following are the tables give the test results of Self compacting concrete, when cement is partially replaced by Roof tile powder, for Compressive strength, Split tensile strength and Beam flexure strength.

COMPRESSIVE STRENGTH RESULTS

The Compressive strength results for various replacement levels of Roof Tile Powder by Cement (0-15%) at an increment of 5% for 7-days, 28-days and 56-days are tabulated below in tables.

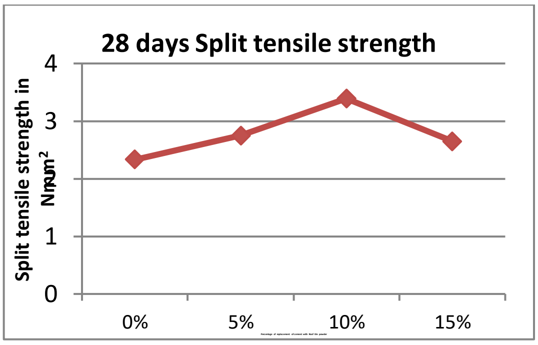


Observations :

From the above graph it has been observed that 28-days Compressive strength for various replacement of cement by roof tile powder the optimum compressive strength is at 10% replacement.

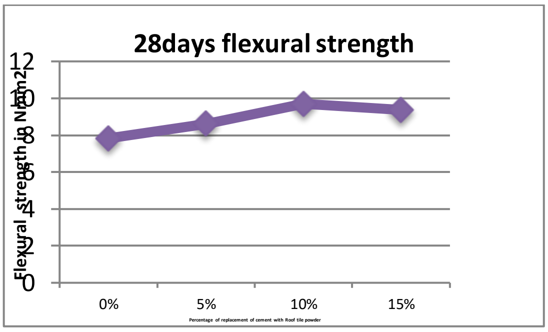
SPLIT TENSILE STRENGTH RESULTS

The Split-Tensile strength results for various replacement levels of Roof Tile Powder by Cement (0-15%) at an increment of 5% for 7-days, 28-days,56-days and 90-days.



BEAM-FLEXURE STRENGTH RESULTS

The Beam-Flexure strength results for various replacement levels of Roof Tile Powder by Cement (0-15%) at an increment of 5% for 7-days, 28-days and 56-days are tested and 28 days shown below.

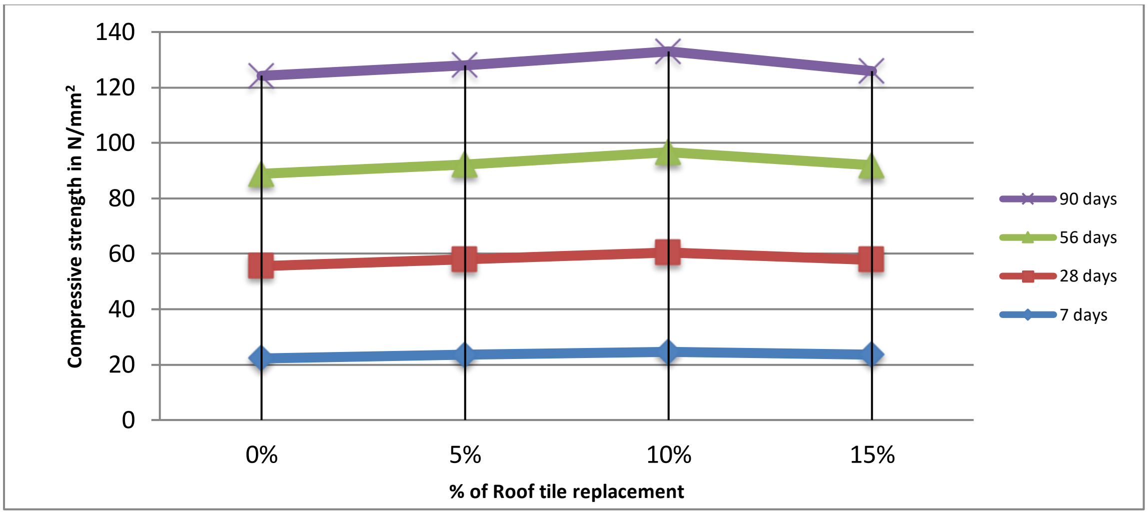


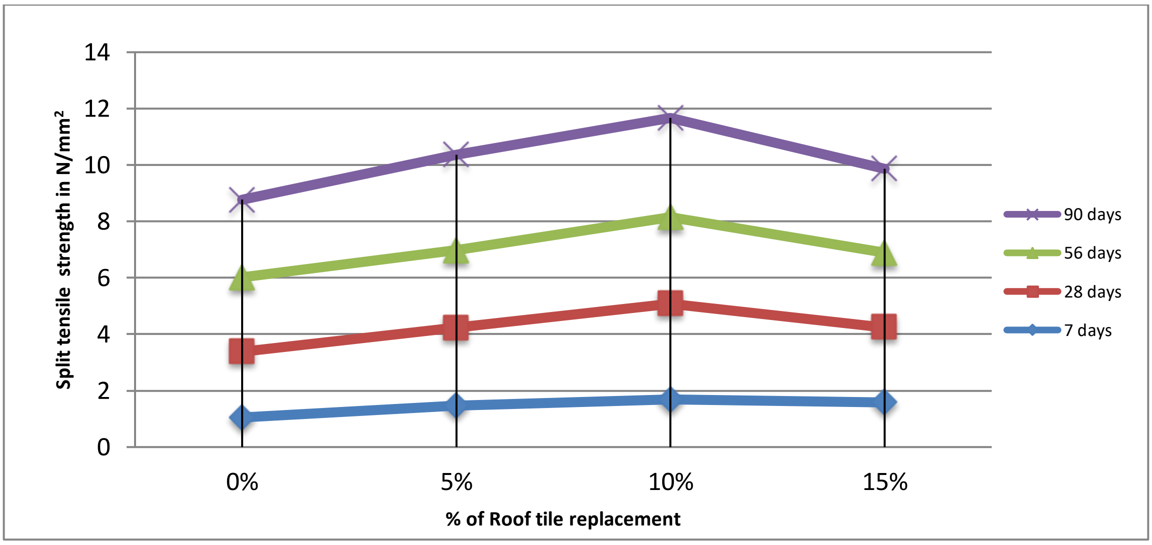
From above , it has been observed that 28-days Beam-Flexure strength for various replacement of cement by roof tile powder the flexural strength is at 10% replacement. After that the strength goes on decreasing.

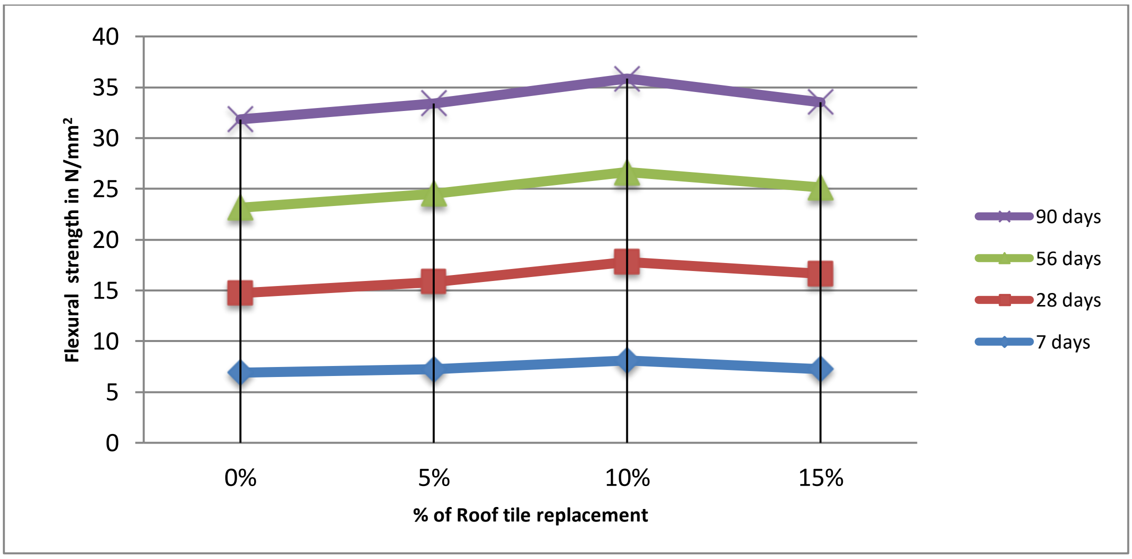
Above charts gives the comparison of Compressive strength, split-tensile strength and beam flexure strength for 28-days for replacement to cement by Roof tile powder in SCC. Optimum strength is achieved at 10% replacement and Roof tile powder can be effectively used as replacement up to 10% by weight of cement, without decreasing the strength compared to controlled concrete, thereby reducing the consumption of cement, with turn reduces the cost. And 28 days and 56 days strengths are almost same.

DISCUSSIONS

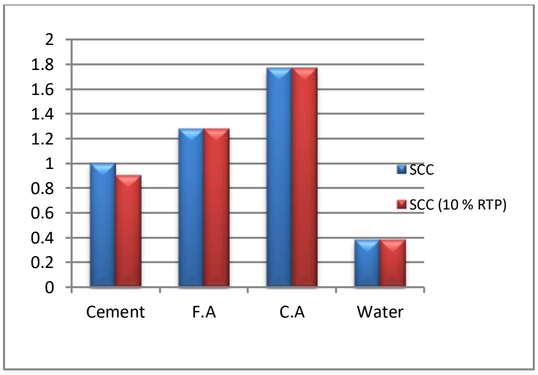
Following chart gives the variation of compressive strength, split tensile strength and flexural strengths for different % replacement of Roof tile in SCC at 7, 28, 56 and 90 days.







The below graph show the details about quantity of materials used in the mix design In the first column comparison of cement in conventional cement and self compacting concrete.
In this comparison about 10% of the cement is replaced by roof tile power so that we can reduce the cost of construction.
In this comparison about 2% of the cement is replaced by super plasticizers so that we can increase the flow ability of the concrete.
In this comparison the same percentage of water and course aggregate is used for both self compacting concrete and conventional concrete. In this comparison 12 mm coarse aggregate is used in self compacting concrete where as in convention concrete we can use any type of coarse aggregate based on design.



VI. CONCLUSIONS

Based on the investigation conducted for the study of behavior of self compacting concrete the following conclusions are arrived.

- The process of mix design as per IS: 10262 along with EFNARC guidelines is suitable for SCC Mix design and can be adopted further in construction industry with modification and requirement as per grade of concrete to be designed.
- Trail mixes have to be made for maintaining flow ability, self compatibility and obstruction clearance.
- Self compacting concrete mixes can make, with Roof tile powder, without sacrificing the strength.
- Self compacting concrete mix requires high powder content and all most equal quantity of coarse and fine aggregate.
- Super plasticizers are necessary to full fill the fresh property of SCC.
- Roof tile powder can be effectively used as replacement up to 10% by weight of cement, without decreasing the strength compared to controlled concrete, thereby reducing the consumption of cement, with turn reduces the cost.
- Increase the percentage of Roof tile powder (0%, 5%, 10%, 10%, and 15%) reduces the flow of concrete.
- Self compacting concrete with 10% replacement of cement with Roof tile powder showed good results.
- It can be seen from fresh properties results of SCC with Roof tile powder improves the filling ability and segregation resistance compare to controlled concrete.
- One possible reason for improved behavior of RTP mortars is due to the presence of C-S-H gel obtained from pozzolanic reaction. The low permeability of these mortars prevents the sulphates from entering into the cementitious matrix.

RECOMMANDATIONS FOR FURTHER WORK

- Since a rational mix design method and an appropriate acceptance testing method at the job site have both largely been established for self compacting concrete, the main obstacles for the wide use of self compacting concrete can be considered to have been solved.
- The next task is to promote the rapid diffusion of the techniques for the production of self compacting concrete and its use in construction.
- The same work is extended on SCC for the development of regular nominal mixes viz: M20 and M30, by making use of locally available industrial and agro by products.
- The feasibility of the developed mixes should be studied appropriately for all the rheological properties in the laboratory as per relevant guide lines.

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