

## International Journal of Innovative Research in Science, Engineering and Technology

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# An Investigation on Self Compacting Concrete Using Light Weight Material as a Partial Replacement of Fine Aggregate

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**ABSTRACT:** Almost all countries in the world are facing an acute decline in the availability of skilled labour in the construction industry, and hence the need of Special Concretes becomes very essential in this world where the use of concrete is just next to the water. In design of concrete structures, light weight concrete plays a prominent role in reducing the density and to increase the thermal insulation. Thermocol has high thermal insulation makes it an excellent material to use in the construction of walls and ceilings and it has high sound absorption makes it the ideal choice for sound proofing. Cost analysis was also made for various mixes to assess economic mix. From the experimental study, fine aggregate is replaced with various percentage of Thermocol (0.2 %, 0.3%, and 0.4%). The workability properties of mix are evaluated by workability tests such as slump flow test, J Ring test, V-funnel test, L-Box tests. From the experimental test results, it was found that concrete mix with super plasticizer and 0.3% of thermocol yielded better workability, density and strength.

**KEYWORDS:** Thermocol, Fine aggregate, Coarse aggregate, Cement, Super plasticizer.

### I. INTRODUCTION

Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete. The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration. The improved construction practice and performance, combined with the health and safety benefits make SCC a very attractive solution for both precast concrete and civil engineering construction. Self-compacting concrete (SCC) contains a large amount of powder (particles < 0.125mm) which is required to maintain adequate yield value and viscosity of the fresh mix, therefore reducing bleeding, segregation and settlement. Since, the use of a large amount of cement increases cost and results in greater temperature rise, the use of thermocol could increase the slump of the concrete mix without increasing its cost.

The main objectives of this report are

1. To achieve SCC as light weight of high density concrete and also maintain strength compared to Normal concrete.
2. To compare mechanical properties (compressive strength, splitting tensile strength, flexural strength) of SCC with Normal concrete (NC).

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Vol. 6, Issue 5, May 2017

3. To investigate the influence of thermocol on acid curing.

## II. MATERIAL PROPERTIES

### 2.1 Cement

OPC 53 grade of cement (RAMCO) is used.

### 2.2 Fine Aggregate

Washed natural sand is collected from river source used as fine aggregate in this investigation whose maximum size is 4.75 mm.

### 2.3 Coarse Aggregate

Machine crushed stone angular in shape was used as coarse aggregate. Size of coarse aggregate used in this investigation is one 20 mm passing through 12.5 mm retained.

### 2.4 Thermo col

Thermocol is rigid and tough closed cell foam. It is usually white and made of pre-expanded polystyrene beads. It offers a non-hydroscopic, odourless, rigid, closed cell. Application is made possible because of Thermocol light weight, water resistance, dimensional stability and inert nature

### 2.5 Plasticizer (Conplast X421IC)

Maintains compressive strength equal to control concrete or mortar and can even improve on strength property if full advantage of water reduction potential is utilised. No significant effect on setting time of concrete or mortar. Can be used with all types of cements, including pozzolonic but not High Alumina Cement.

### 2.6 Water

Potable water available in the campus is used for mixing and curing.

The properties of materials used are

Specific gravity of cement = 3.15

Specific gravity of fine aggregate = 2.60

Specific gravity of coarse aggregate = 2.70

Specific gravity of thermocol = 0.5

Fineness modulus of coarse aggregate = 7.36

Fineness modulus of fine aggregate = 2.90

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Vol. 6, Issue 5, May 2017

Table 1 properties of thermocol

Sl.No	Specifications	Values
1	Compressive strength	0.8-1.6Kg/cm
2	Tensile strength	3-6 kg/cm
3	Density range	15-30 kg/cm
4	Melting range	100-200°c
5	Thermal conductivity	low
6	Sound absorption	high
7	Moisture absorption	low

### III. LITERATURE REVIEW

**Jeevetha et al. (2014)** concluded that at 5% replacement (powder content of 530kg/m<sup>3</sup>) of micro silica the mix shows good workability and compressive strength. With further increase in replacement percentage the compressive strength decreases gradually. **Subhan Ahmad et al. (2016)** compressive and splitting tensile strength of SCC was found to be slightly higher than the corresponding properties of NC. 0.6kg/m<sup>3</sup> of glass fibre slightly reduced the fresh properties of SCC. **SaeidHesami et al. (2016)** Addition of fibre up to the optimum content of 0.1% increases the compressive strength. For instance, 15% sand replacement with rubber resulted in a 14.29% decrease in the compressive strength. **Reza BaniArdalean et al (2016)** the Portland cement was partially replaced from 10% to 50% by pumice, fly ash and slag. Mixtures with pumice replacement of 30% had the highest compressive strength compared with control concrete. **ShahidIqbal et al. (2015)** show that there is strong influence on the workability of SHLSCC with steel fibre content of 1% or more. There is around 12% reduction in compressive strength, 37% and 110% increase in splitting tensile strength and flexural strength respectively. **Mastali et al. (2016)** considering different fibre volume fractions of 0.5%, 1%, 1.5%, and 2% recycled carbon fibre volume fraction and length enhances mechanical properties and impact resistance of the reinforced mix compositions, while reduces the workability.

### IV. MIX PROPORTION

Determination of mix design for this research to obtain SCC was performed based on EFNARC (2002). One control and three SCC mixes with different replacements of mineral admixture were prepared and examined to quantify the properties of SCC. The replacement was carried out at levels of 0.2%, 0.3 % & 0.4 % of sand content. After iterative trial mixes the water/powder mass ratio (w/p) was selected as 0.45. Some design guidelines have been prepared from the acceptable test methods.

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Vol. 6, Issue 5, May 2017

## V. WORKABILITY TEST

Tests on concrete were performed to study the workability of SCC. The tests conducted are followed below:

- |                                    |                                   |
|------------------------------------|-----------------------------------|
| 1. Slump flow test                 | 4.V- funnel test                  |
| 2. T <sub>50</sub> Slump Flow Test | 5. V funnel at T <sub>5mins</sub> |
| 3. J Ring Test                     | 6. L box test                     |

Table 2 The acceptance criteria for the fresh properties of SCC

S.No	Method	Unit	Typical Ranges Of Volume	
			Minimum	Maximum
1	Slump flow test	mm	650	800
2	T <sub>50cm</sub> slump flow	sec	2	5
3	V- funnel flow test	sec	8	12
4	V-funnel T <sub>5mins</sub>	sec	0	+3
5	L-box test	h <sub>2</sub> /h <sub>1</sub>	0.8	1.0
6	J- ring test	mm	0	10

## VI. RESULT & DISCUSSION

The results of various workability test are evaluated. The values should be in acceptance criteria as per EFNARC

Table 3 Workability Result

Trials	T1	T2	T3
Slump Flow(mm)	701	680	662
T <sub>50cm</sub> Slump Flow (sec)	5	4.43	5
J Ring (mm)	8	6	8
V Funnel At T <sub>5 Mins</sub> (sec)	1.91	1	1.91
V Funnel (sec)	11	9	11
L Box	0.96	0.82	0.75

As per EFNARC specification, T1 satisfies the workability properties.T2 at 0.3 % replacement of thermocol the workability property slightly decreases compared to T1.

### 6.1 Compressive test

Compressive strength test was carried out on cube specimen of dimensions 150x150x150mm.The compressive strength test specimens were cured and tested for 7 days and 28 days in compressive testing machine.

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Vol. 6, Issue 5, May 2017

Table 4 Compressive Strength result

Trials	Compressive Strength (N/mm <sup>2</sup> )	
	7 Days	28 Days
1	23.88	37.45
2	19.99	35.48
3	15.90	31.52

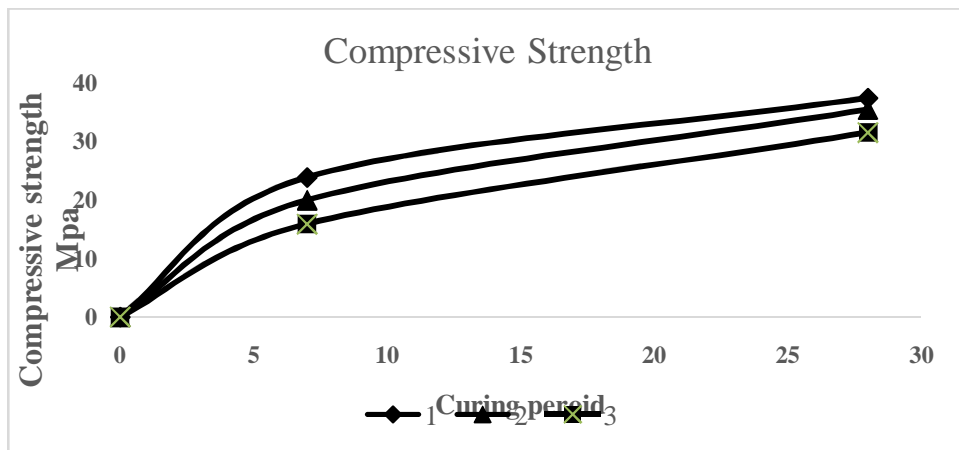


Fig 1.Compressive strength of concrete after 7 & 28 days

## 6.2 Splitting tensile test

Splitting tensile test was carried out on cylinders size of specimen is 300mm length with 150 mm diameter. The specimens were cured and tested for 28 days in compressive testing machine.

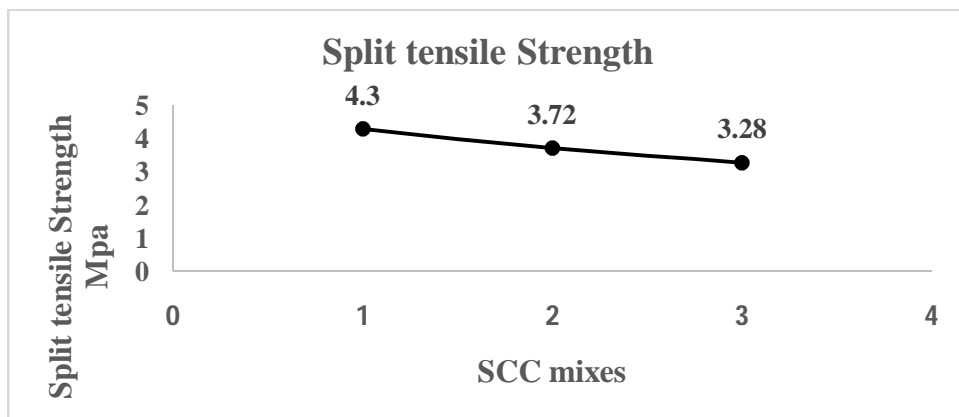


Fig 2 Splitting tensile strength of concrete after 28 days

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Vol. 6, Issue 5, May 2017

### 6.3 Flexural test

Flexural test was carried out on prism size of specimen is 100x100x500. The specimens were cured and tested for 28 days in compressive testing machine.

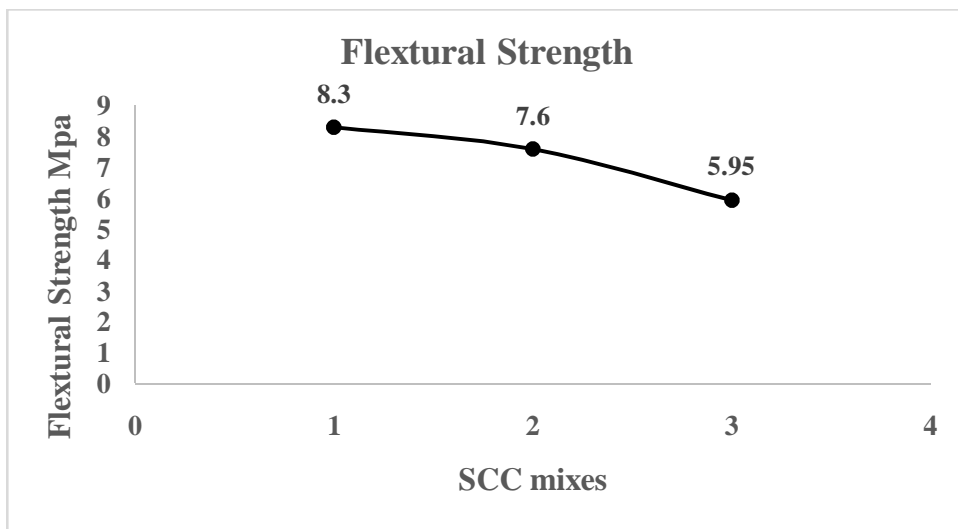


Fig 3 Flexural strength of concrete after 28 days

### 6.4 Durability test resistance against acid attack

For acid attack the test concrete cube of size 150x150x150 are prepared for various percentages of thermocol addition. The specimen are cast and cured in mould for 24 hours, after 24 hours all the specimen are demoulded and kept in curing tank for 7 days. After 7 days specimens are immersed in 5% HCL solution for 28 days. The pH value was maintained at 0.35.

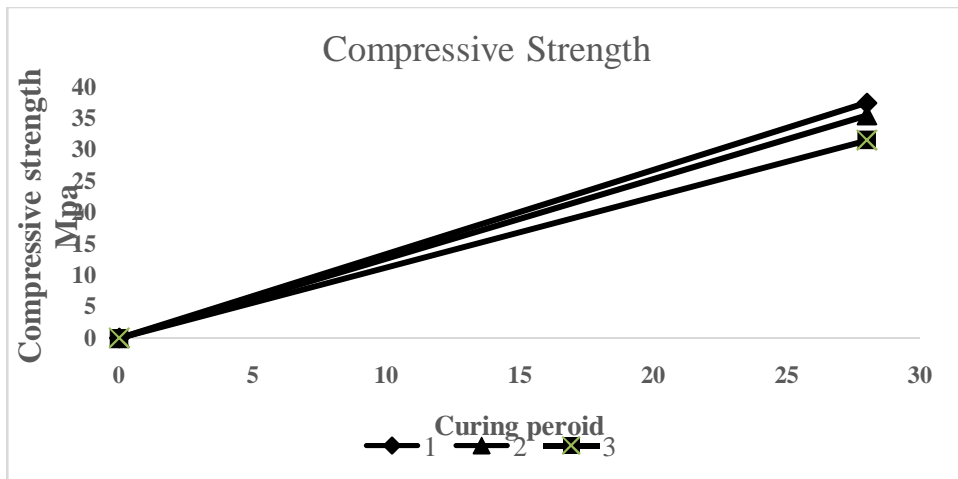


Fig 5 Compressive strength of concrete against acid attack after 28 days

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Vol. 6, Issue 5, May 2017

### 6.5 Density

Density reduced by increasing the percentage replacement of thermocol in place of sand it was found that it was reached up to 12 % when fine aggregate was replaced with thermocol from 0.2% to 0.4 %. This is because of thermocol has high density and lower specific gravity than sand.

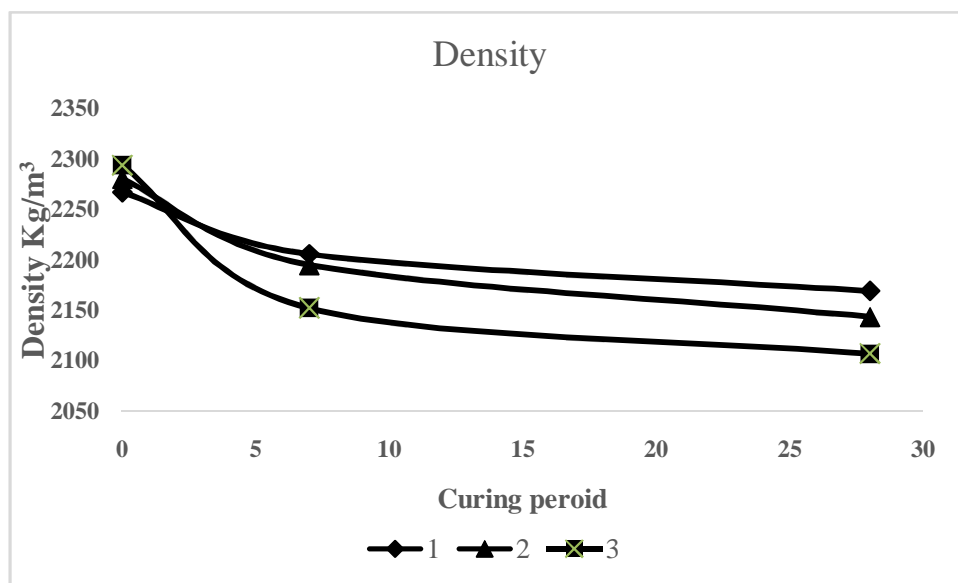


Fig 6 Density of concrete after 7 & 28 days

## VII. CONCLUSION

Based on the test results obtained from the experimental programme of this work, the following major conclusions are arrived from workability, compressive strength test, splitting tensile strength, flexural strength and durability against acid attack.

1. From the workability test results the value increases for concrete mix containing thermocol when compared with reference concrete mix (R).
2. From the experimental test results, the compressive strength of concrete mix after 7 days curing having 0.2% thermocol (T1) has the highest strength of 23.88 N/mm<sup>2</sup>. From the test results, the compressive strength of concrete mix after 28 days curing having 0.2% thermocol (T1) has the highest compressive strength of 37.45 N/mm<sup>2</sup>.
3. From the test results, the splitting tensile strength of concrete mix after 28 days curing having 0.2% thermocol (T1) has the highest strength of 4.3 MPa. From the test results, the flexural strength of concrete mix after 28 days curing having 0.2% thermocol (T1) has the highest strength of 8.3 MPa.
4. Density reduced by increasing the percentage replacement of thermocol in place of sand it was found that it was reached up to 12 % when fine aggregate was replaced with thermocol from 0.2% to 0.4 %.
5. Consequently, it is concluded that concrete mix having 0.2 % thermocol (T1) is better mix and has the highest strength for compressive, splitting tensile and flexural strength test results.

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Vol. 6, Issue 5, May 2017

## Scope for further work

1. Study on the flexural strength of the concrete beams can be taken up by using proper percentage of Thermocol.
2. Experiments can be performed for various combinations of water cement ratios to arrive at compressive strength and split tensile strength for different mix proportion of SCC mix.
3. Durability studies such as chloride permeability, alkali-silica reaction and freeze–thaw resistance tests can be carried out.

## REFERENCES

1. HardikUpadhy, Pankaj Shah, Elizabeth George .,“Testing and Mix Design Method of Self-Compacting Concrete”, National Conference on Recent Trends in Engineering & Technology, 2011.
2. P.A. Ganeshwaran, Suji, S. Deepashri ., “Evaluation Of Mechanical Properties Of Self Compacting Concrete With Manufactured Sand And Fly Ash”, Vol. 3,pp. 60-69, 2012.
3. PrajapatiKrishnapal , R.K. Yadav, Chandak Rajeev., “Rheological Characteristics Of Self Compacting Concrete Containing Flyash” , Vol .5,pp. 137 – 146, 2013.
4. Dhiyaneshwaran. S, Ramanathan. P, Baskar.I, Venkatasubramani.R ., “Study On Durability Characteristics Of Self-Compacting Concrete WithFly Ash”, Vol. 7, pp. 342-353, 2013.
5. PrajapatiKrishnapal, Yadav R.K, ChandakRajeev ., “Strength Characteristics of Self Compacting Concrete Containing Flyash” Vol. 2, pp. 1-5,2013.
6. S.SeshaPhani ,Dr.SeshadriSekhar T , Dr.SrinivasaRao ,Dr.Sravana ., “Evaluation of Relationship Between Mechanical Properties of High Strength Self Compacting Concrete”, Vol .2, pp. 67 – 71,2013.
7. PrashantBhuva, Anant Patel, Elizabeth George, DarshanaBhatt . , “Development Of Self Compacting Concrete Using Different Range Of Cement Content” , National Conference on Recent Trends in Engineering & Technology,2011.
8. YoujunXie, Baoju Liu, JianYin ,Shiqiong Zhou ., “Optimum Mix Parameters of High Strength Self – Compacting concrete With Ultrapulverized Fly Ash” ,pp.477 – 480,2001.
9. Tarun R. Naik, Yoon-moon Chun, Rakesh Kumar, and Bruce W. Ramme . , “Development of High-Strength Self-Consolidating Concrete” ,pp. 508 – 536,2004.
10. Khaled S. Ragab and Ahmed S. Eisa ., “Torsion Behavior of Steel Fibered High Strength Self Compacting Concrete Beams Reinforced by GFRB Bars” , Vol:7 ,No 9, pp. 218 -228,2013.