COMPOSITION AND BEHAVIOUR OF THERMAL INSULATING CONCRETE(TIC)

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ABSTRACT

In Today's Era due to Global Worming the Atmospheric Temperature increases and the use of Air-conditions are getting more and more. So, for Energy saving purpose I would like to do work on Thermal Insulating Concrete which reduces the cost and optimisation of Energy.

Calcium silicate Insulating Powder (CSIP) was developed for Energy conservation. In General Observation of buildings consume more than 30% of Energy and Major Consumption of Energy nowadays is meant to increase comfort. The Large part of country is not able to afford Air conditioners. So, it is necessary for us to develop and enhance building products which can help in reducing Energy consumption and giving comfort inside and outside of Environment.

As a Student I am Excited to Analyse more about CSIP, So that in Future I can understand the value of better Concrete with good performance by the way of Thermal Insulating Concrete (TIC).

In My Project I will do the Experimental work on TIC with the M-20 grade of concrete and for different TIC proportions like 10%, 20%, 30% & 40% replacement. Casting of Cube specimens for different Experiments and Mix proportions.

Keyword: - *Concrete,Calcium Silicate Insualtion Powder, Thermal Insulationg Concrete etc….*

1.0 General

Calcium Silicate Insulation slows down the rate of heat flow and minimizes losses. In face of increasing energy costs, we have to minimise the cost of energy production. Calcium Silicate insulation cuts energy costs and helps in achieving this goal.

The need for efficient thermal insulation has increased with increased energy cost. An ideal thermal insulation has low mass, high strength and low thermal conductivity coupled with high service temperature. It reduces heat loss and thereby saves energy significantly and serves several functions such as:

The control of temperature would be better compare to other materials.The Heat Reduction in production batch process. The production rate would been Increase by using CSIP.

It provides Fire protection or Fire Resistance.The working conditions should be better with this material.It provide Reduction in thermal spalling in refractory lining, etc.

Conventional insulation like Vermiculite and Mica bricks with a bulk density about 1000 kg/m3 have high strength but poor insulating characteristics. Flexible Insulation such as Mineral Wool and Ceramic Wool, has low mass and thermal conductivity (equivalent to Calcium Silicate) but no inherent strength and is compressible.

Calcium Silicate insulation is a unique and versatile insulation offering the thermal efficiency of flexible insulation and the strength of Conventional Insulation Bricks up to 1000 °C temperature. It has a long life and once installed requires hardly any maintenance. As a thumb rule, wherever refractory bricks are being used, CSI may be used as a backup layer.

M/s. Saurashtra Cement Ltd., Ranavav, Gujarat state, has insulated their plant equipment using this Calcium Silicate insulation Materials. They have reported saving of fuel and electrical energy value Rs.11 cr. per annum (1998-99).
M/s. SCL have been presented the National Award for best improvements in thermal energy performance for the year 1998-99 at the 7th NCB international seminar on Cement and Building Materials held on 21.11.2000 at Delhi6.

1.1 Salient Features

CSIP has Low Thermal Conductivity and Light Weight material. It has Good Mechanical Strength. The Fire Resistivity of CSIP is good. It has Low Specific Heat and Low Shrinkage. CSIP is Non Combustible material and Non Corrosive material. It has Low Maintenance Cost and Easily Workable.

1.2 Chemical Properties

CSIP is Non-Reactive, Alkaline, Amorphous and Long Life.CSIP has Low Thermal Conductivity = 0.045 W/m ˚K. It has High Porosity = >82%. It has Low Bulk Density = 280 Kg / Cu. M.The size of particles is fine.High Water Adsorption = > 240% Water.High Surface Area = > 40 Sq. M / Gm.Sound (Acoustic) Reduction.

1.3 Insulating Properties of CSIP

Thermal Conductivity (K) is the time rate of heat flow (Q) through Unit area (A) and Unit Thickness (L) of Homogeneous material under steady state conditions when unit temperature difference (dT) is maintained In the direction perpendicular to the area.	K, W/m˚K at Mean Temperature : 100˚C K, Btu, in /ft^2 hrs. ˚C at 212 ˚F	**0.050** **0.347**
Thermal Resistance(R) is reciprocal to Thermal Conductivity, is the property of the material that opposes the passage of heat flow through. m˚K/W	R = L / K R = 1 / 0.347 R = 2.88	**2.88**
Thermal Transmission (U) is the Temperature difference between 2 surfaces.	U = 1 / R U = 1 / 2.88	**0.347**
Temperature reduction for 1" Thickness	**O. S. T. = 50˚C**	**I.S.T.=30˚C**

Non Combustible	**Fire Proof**	**4 hour rating**

1.4 Characteristics

Light-weight (Low bulk density-90 kg./m³)High Oil Adsorption (up to 320%)**.** High Water Adsorption (up to 400%)**.** Free from health hazardous substances (can be used as food additive)**.** High Surface Area (130 m²/gm.)**.** Excellent Flow ability. Fine Particle Structure (less than 10 mili micron)

1.5 Advantages of TIC

Low Thermal Conductivity (Max. 0.09 W / m ˚K at 600 ˚C)**.** Light Weight (Max. Density 280 Kg / M^3)**,** High Compressive Strength (Min 18 Kg / Cm^2)**.** Fire Resistant**.** Low Specific Heat**.** Low Shrinkage**.** Non Combustible**.** Non Corrosive**.** Easily Workable (Cuts Easily)**.** Low Maintenance Cost**.** Re-Usable & Long Life Span.

1.6 Applications of CSIP

The Applications in brief as follows:

1.6.1 Thermal Insulating Concrete:

Concrete mixture with Calcium Silicate Insulation Powder (CSIP) is lighter.It has Long Life & Provides better Thermal (Heat) comfort in the Building. A Layer of mix applied on the top layer of Terrace / Roof / Wall reduces heat flow inside the building.The mix Keeps the Building cool in summer and reduces Air Conditioning cost (Save Power) above 40%.

1.6.2 Plaster, Roof & Floor Fills

The Lighter the weight of the Mixture, The Better the Insulating Properties.

Cement	CSI	Sand 0.5 mm	Water	Density Range (M^3) (Kg./M^3)	Compressive Strength Average	Thermal Conductivity Average
(Kg.)	(M^3)	(M^3)	(M^3)	(+/- 50)	(Mpa)	(W/m ˚K)
Nil	1	Nil	--	280	--	0.04
200	1	Nil	0.30	400	0.6	0.06
300	1	Nil	0.35	500	2.0	0.08
400	1	0.35	0.40	1100	9.5	0.24
600	1	1	0.45	1500	12	0.50

It offers minimum 8-12℃ Temperature difference inside. Means it decrease 8-12 ˚C temperature inside the room.

1.6.3 Wall Putty

It is a light filler cum Extender increasing surface (Volume Coverage).It offers many Advantages beyond its weight.It Provides following:

A. Thermal Insulation which reduces air Conditioning cost above 40%.
B. Sound (Acoustic) Reduction.
C. Increases Fire Resistance.

1.6.4 Thermal Insulation Paint (TIP)

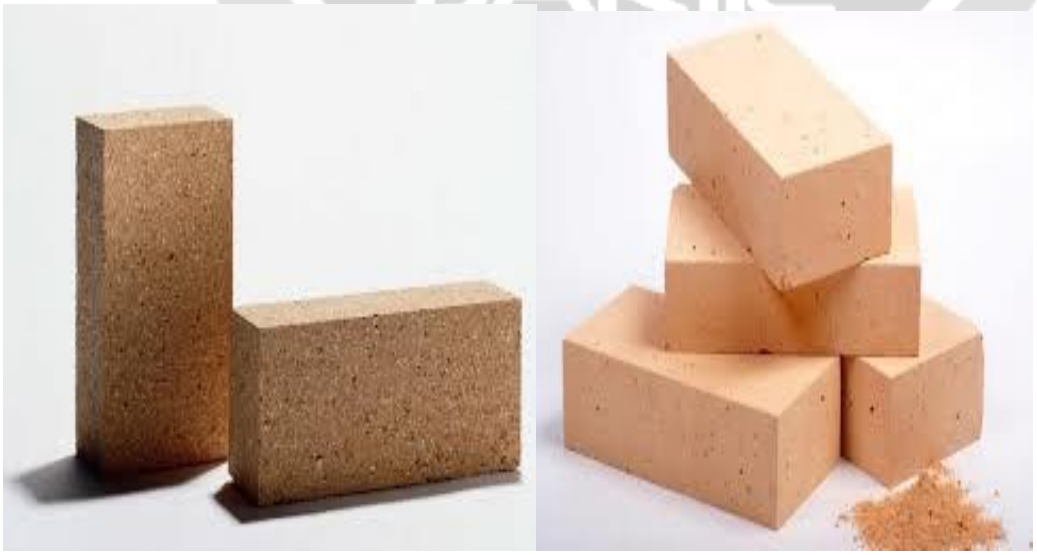
Calcium Silicate Insulation makes best Thermal Insulating Paint with 2 Coats of Thermal Insulation Paint.By Applying It on any Outside or Atmospheric Surface, It reduces the Inside Surface Temperature above 40%.Proper Mixture should be provided for the Best and Ideal Result, Which is necessary.

1.6.5 Thermal Insulation Tile

It reduces Weight.Provides better Thermal Insulation.Reduces Air Conditioning Cost above 40%.Noise (Sound) Reduction.Increases the Fire Resistance.

1.6.6 Thermal Insulation Brick

Cost Effective.Reduces Temperature Compared to Outside surface by 8-12˚C.The Standard Size of Brick is 19 x 9 x 9 cm, which is suites best.The Compressive Strength is 75 Kg/Cm^2, Which is more than Twice of the Ordinary Brick.It has Cohesion Bearing Sound.



1.6.7 Agricultural (Horticultural) Applications

CSI is a component of Soil less growing mixes.It provides Aeration and maximum Moisture Retention.It is alkaline ph.It is sterile and weed-free.Its Light weight makes it ideal for use in container growing.Other uses are as a carrier for fertilizer, Herbicides & pelletizing seed.It can be used with equal success in green House growing, Land-Scalping applications and in the Home in House Plants.

1.7 Chemical Composition

Chemical	Percentage (%)
CaO	38 % min
SiO_2	41 % min
E – fibre Glass	7 %
H_2O (Chemically combined)	14 % max
Iron	20 ppm. Max
MgO , Al_2O_3	Negligible

1.8 Cost Estimation

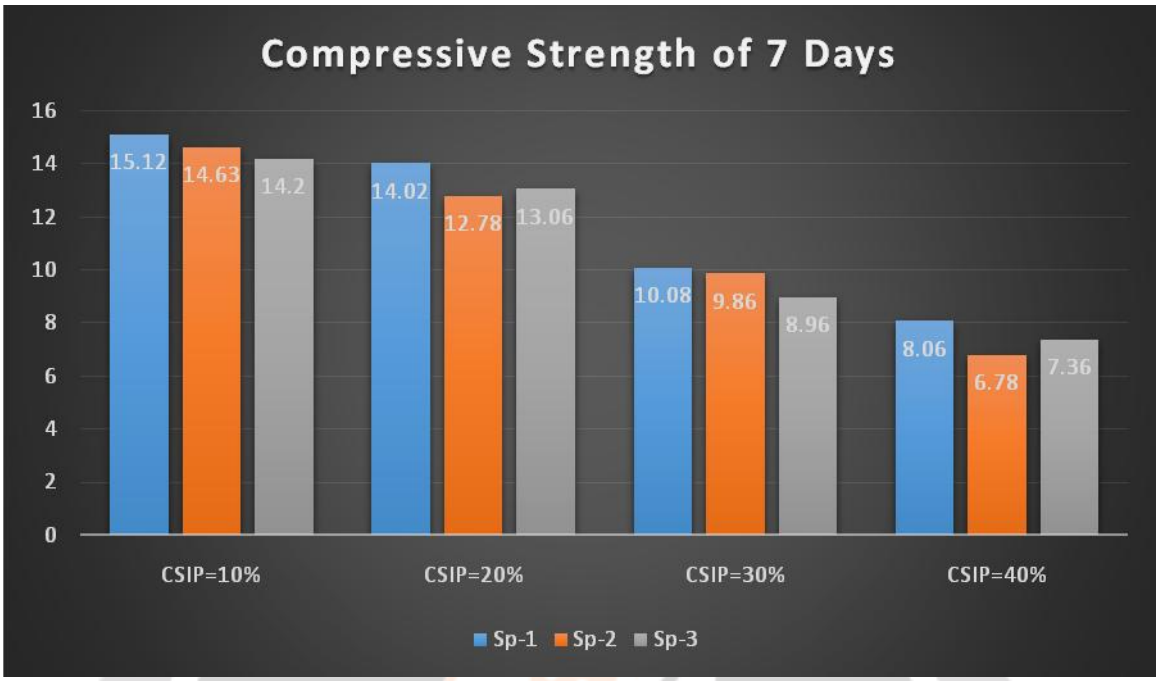
- Even in 50 mm layer thickness, I got min 8˚C Temperature difference.

Cost of Heat Energy	Thickness of Layer	Cost in Rs. / M^2
Calcium Silicate Insulation	50 mm	650
Calcium Silicate Insulation	100 mm	1248
Calcium Silicate Insulation	150 mm	1755
Calcium Silicate Insulation	200 mm	2236

4.1 Compressive Strength:

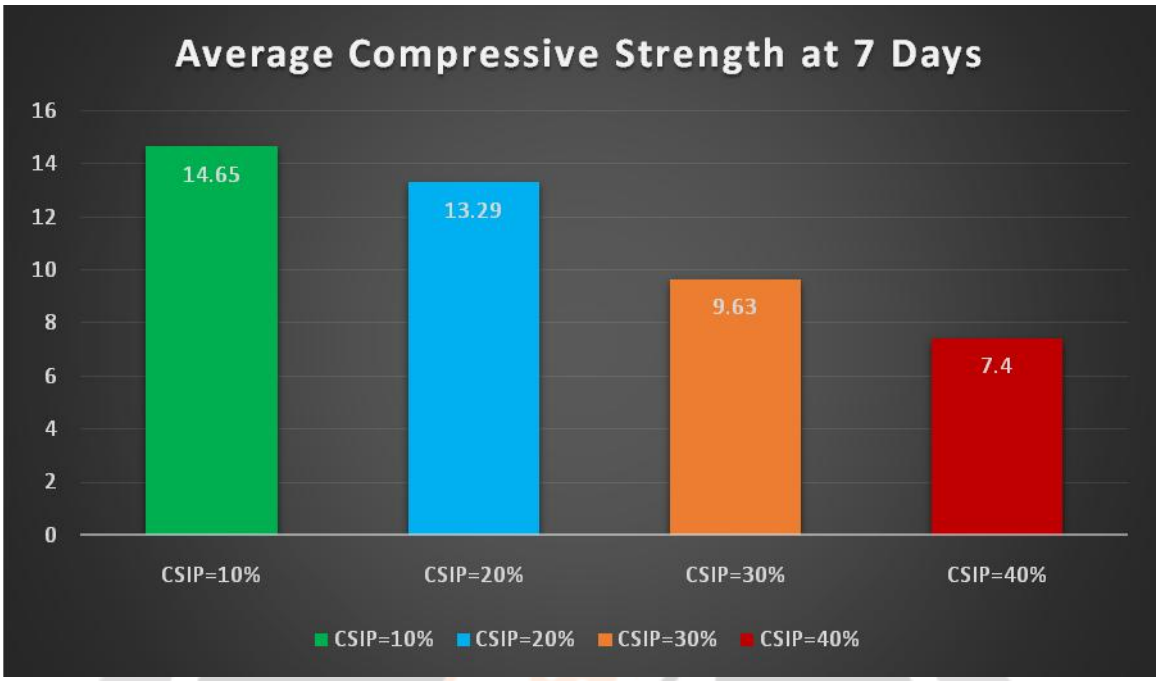
4.1.1 At 7 Days:

Specimen No.	CSIP-10%	CSIP-20%	CSIP-30%	CSIP-40%
1	15.12	14.02	10.08	8.06
2	14.63	12.78	9.86	6.78
3	14.2	13.06	8.96	7.36



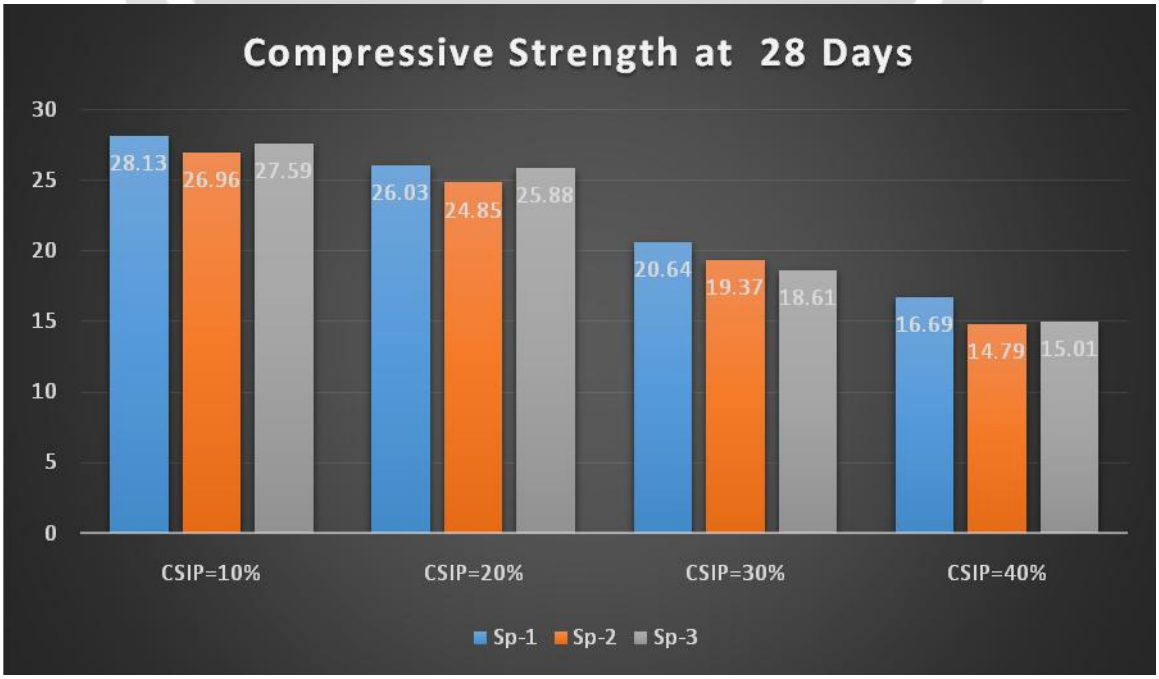
4.1.2 Average Compressive Strength at 7 Days:

Content	Average Compressive Strength at 7 Days
CSIP-10%	14.65
CSIP-20%	13.29
CSIP-30%	9.63
CSIP-40%	7.40



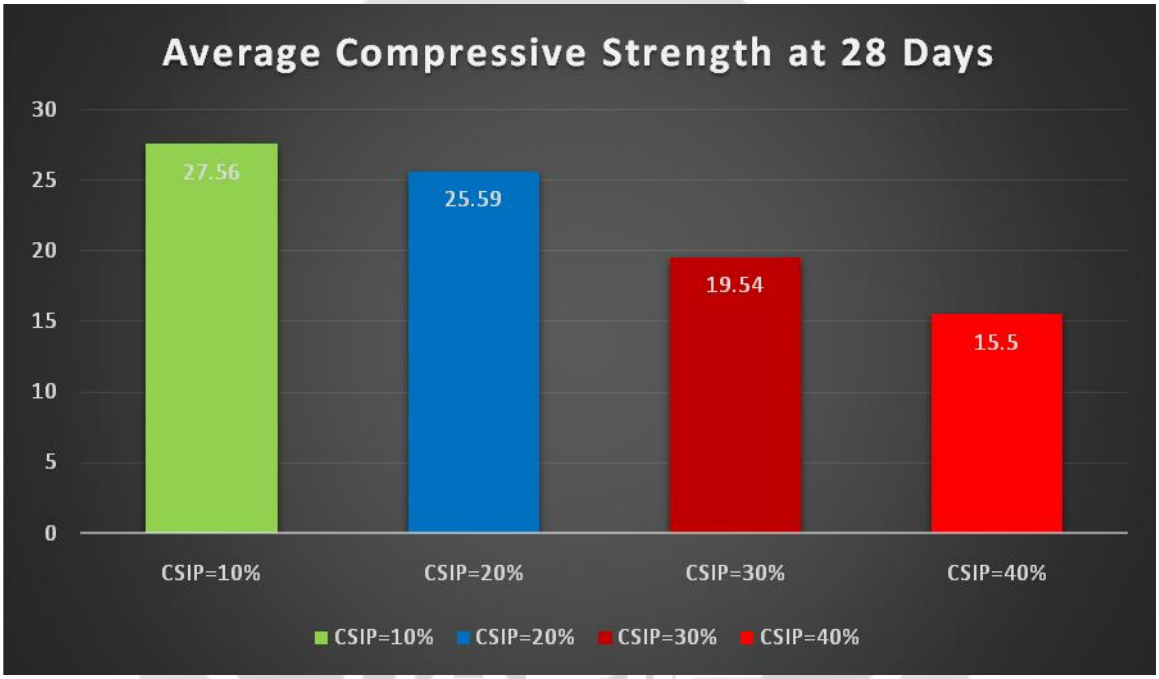
4.1.3 At 28 Days:

Specimen No.	CSIP-10%	CSIP-20%	CSIP-30%	CSIP-40%
1	28.13	26.03	20.64	16.69
2	26.96	24.85	19.37	14.79
3	27.59	25.88	18.61	15.01



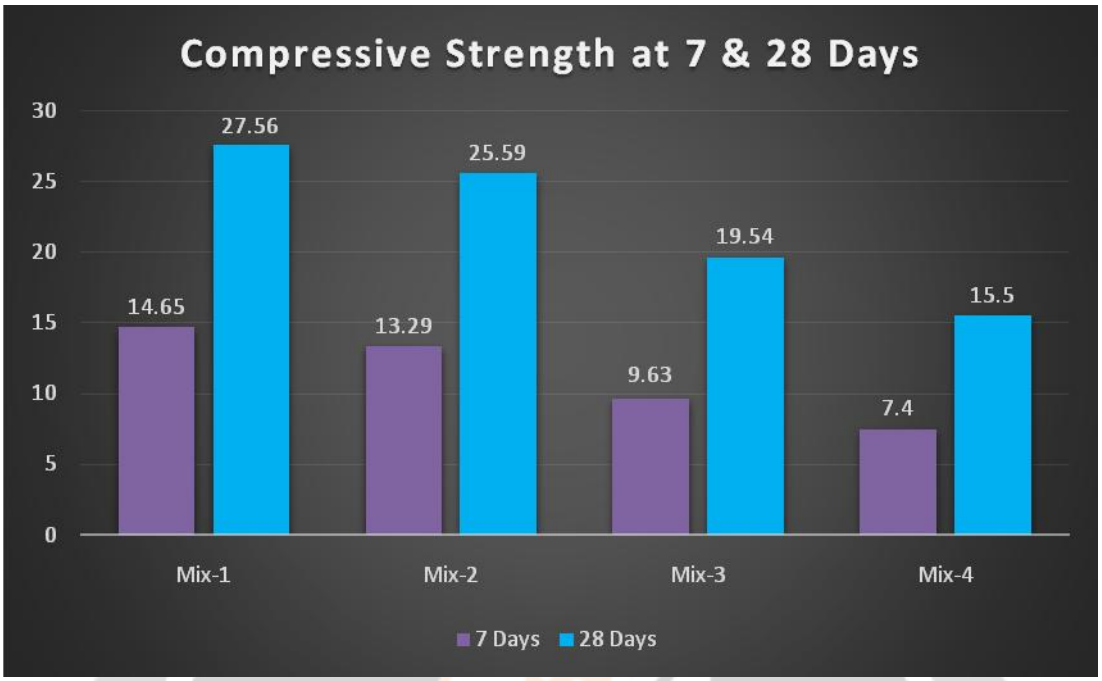
4.1.4 Average Compressive Strength at 28 Days:

Content	Average Compressive Strength at 28 Days
CSIP-10%	27.56
CSIP-20%	25.59
CSIP-30%	19.54
CSIP-40%	15.5



4.1.5 Compressive Strength at 7 & 28 Days:

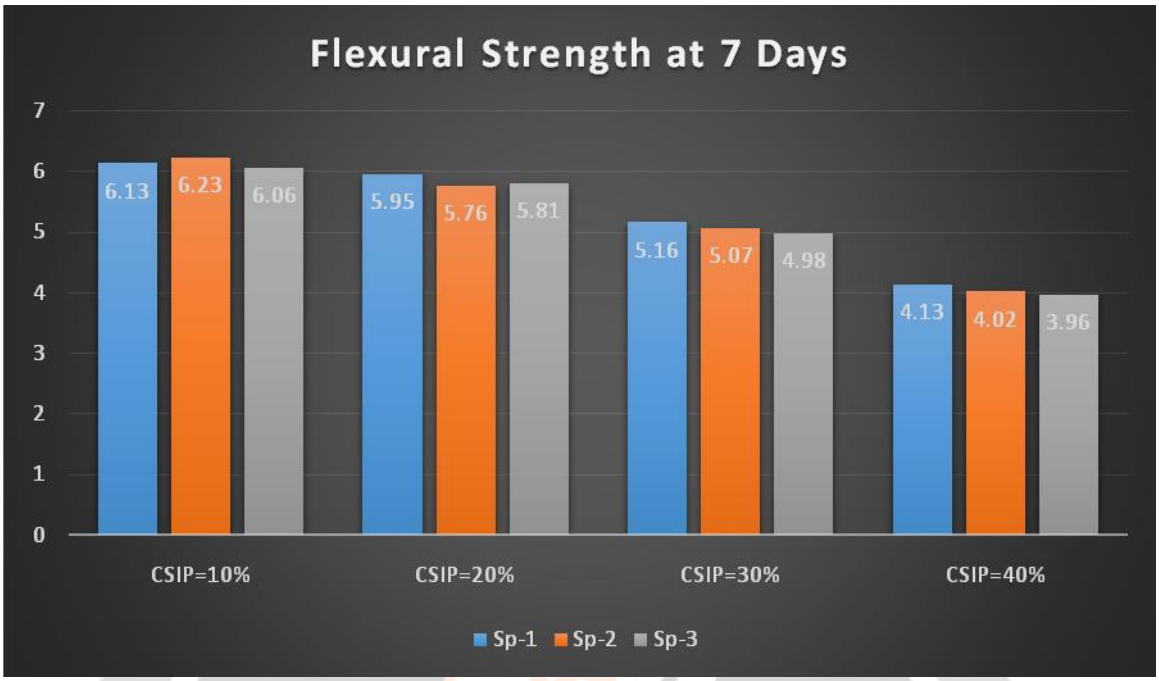
Content	CSIP	7 Days	28 Days
Mix Design-1	10%	14.65	27.56
Mix Design-2	20%	13.29	25.59
Mix Design-3	30%	9.63	19.54
Mix Design-4	40%	7.4	15.50



4.2 Flexural Strength:

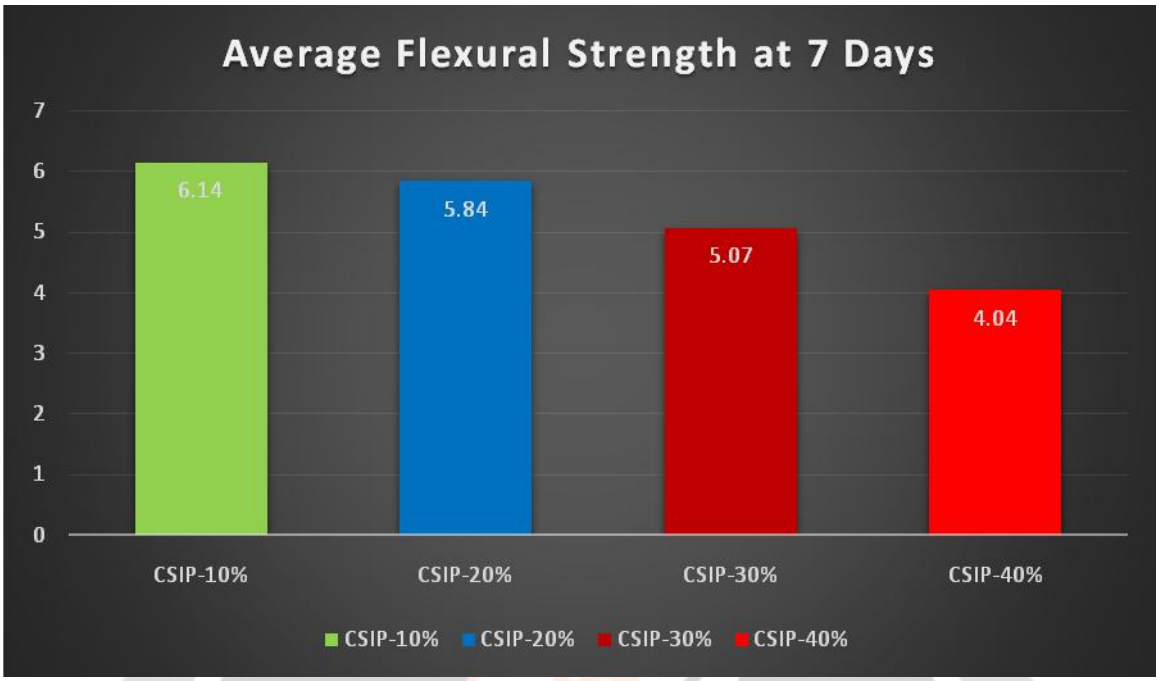
4.2.1 At 7 Days:

Specimen No.	CSIP-10%	CSIP-20%	CSIP-30%	CSIP-40%
1	6.13	5.95	5.16	4.13
2	6.23	5.76	5.07	4.02
3	6.06	5.81	4.98	3.96



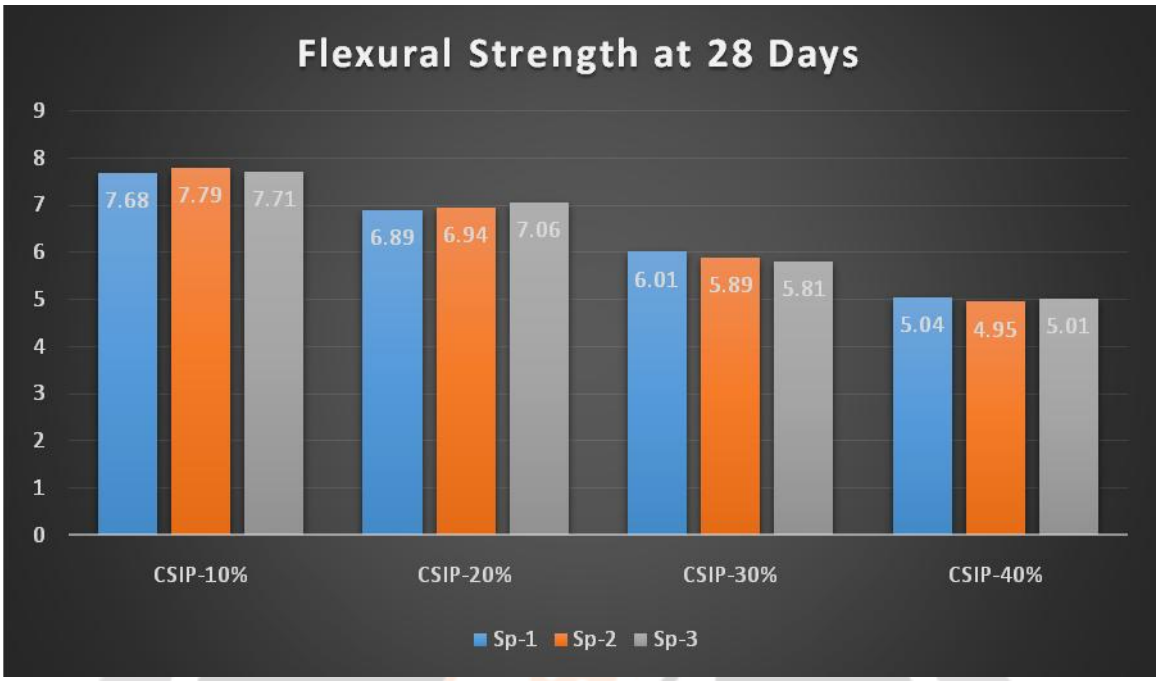
4.2.2 Average Flexural Strength at 7 Days:

Content	Average Flexural Strength at 7 Days
CSIP-10%	6.14
CSIP-20%	5.84
CSIP-30%	5.07
CSIP-40%	4.04



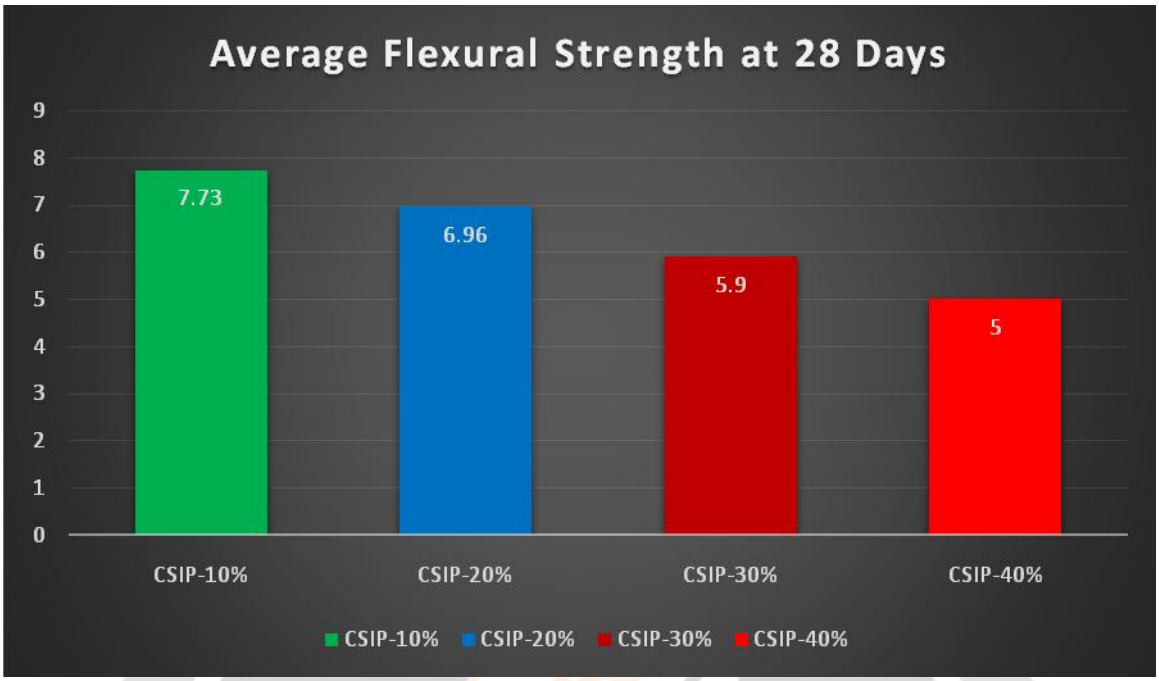
4.2.3 At 28 Days:

Specimen No.	CSIP-10%	CSIP-20%	CSIP-30%	CSIP-40%
1	7.68	6.89	6.01	5.04
2	7.79	6.94	5.89	4.95
3	7.71	7.05	5.81	5.01



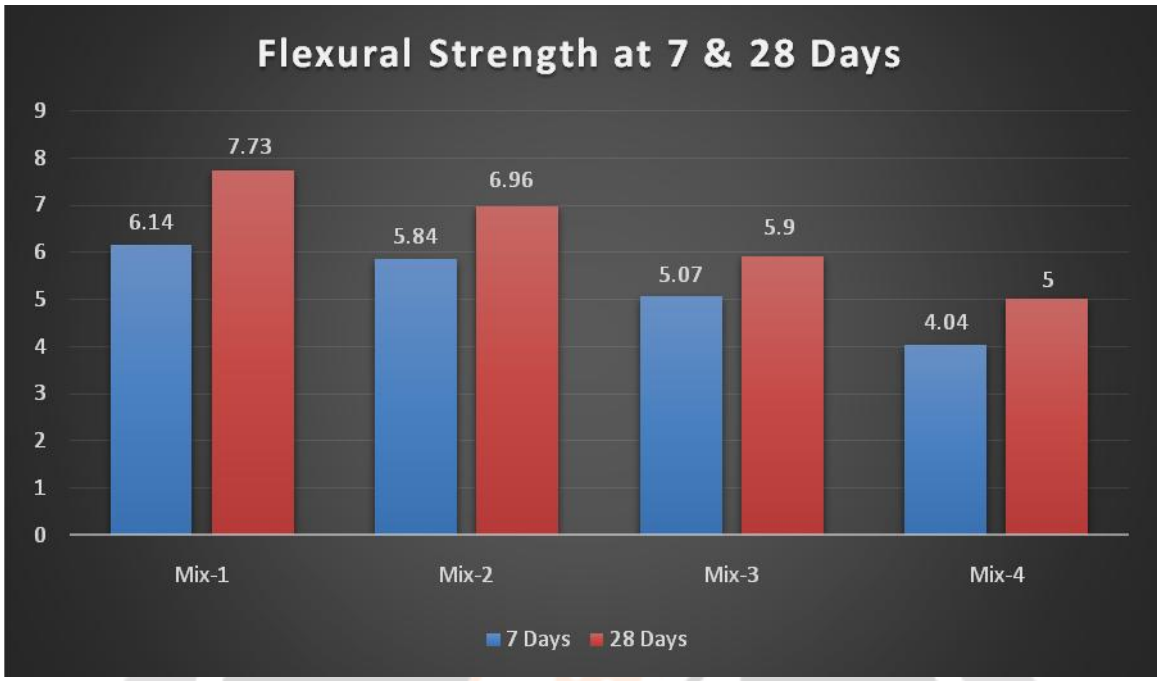
4.2.3 Average Flexural Strength at 28 Days:

Content	Average Flexural Strength at 28 Days
CSIP-10%	7.73
CSIP-20%	6.96
CSIP-30%	5.9
CSIP-40%	5.0



4.2.4 Flexural Strength at 7 & 28 Days:

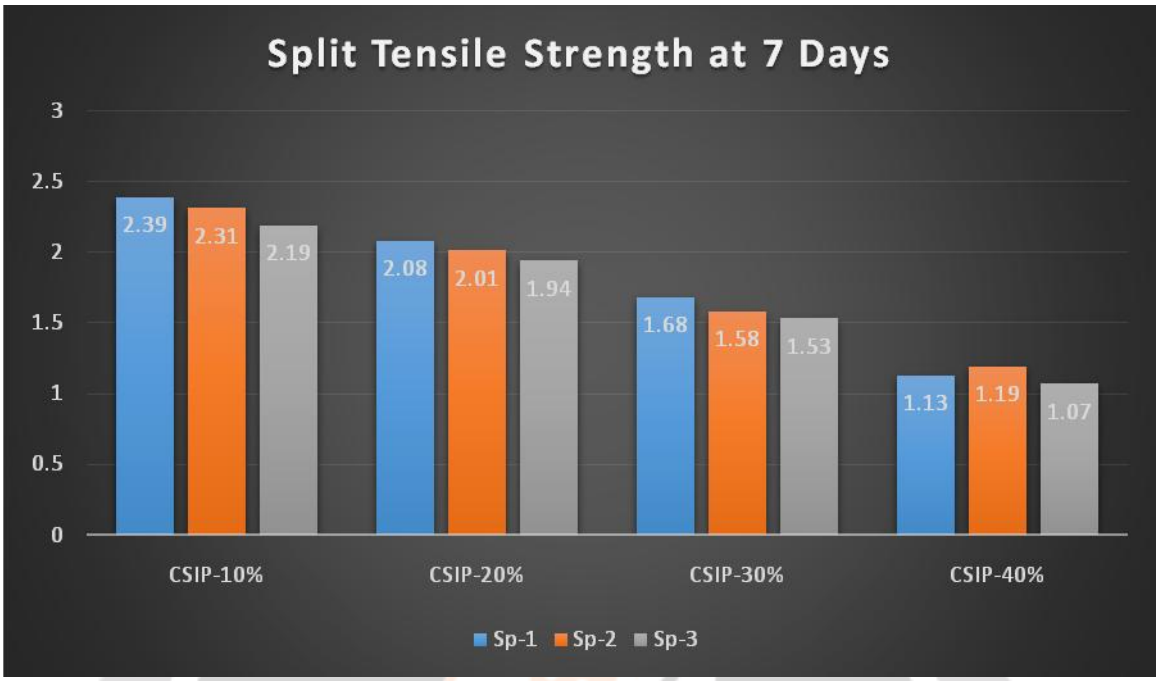
Content	CSIP	7 Days	28 Days
Mix Design-1	10%	6.14	7.73
Mix Design-2	20%	5.84	6.96
Mix Design-3	30%	5.07	5.90
Mix Design-4	40%	4.04	5.00



4.3 Split Tensile Strength:

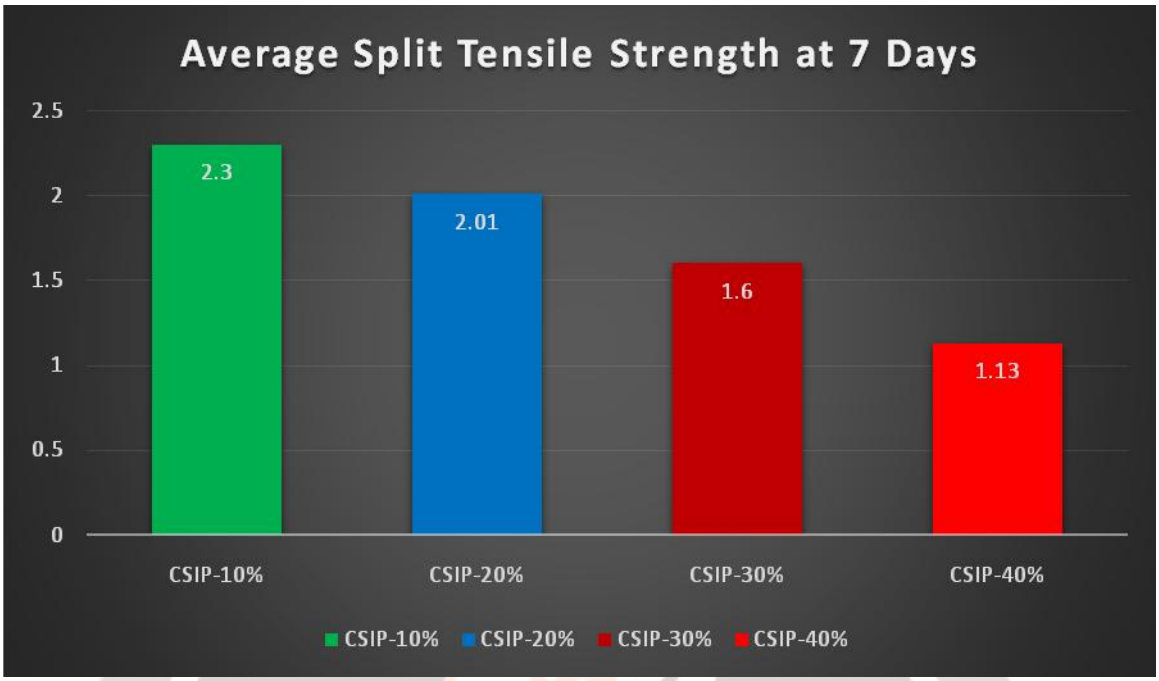
4.3.1 At 7 Days:

Specimen No.	CSIP-10%	CSIP-20%	CSIP-30%	CSIP-40%
1	2.39	2.08	1.68	1.13
2	2.31	2.01	1.58	1.19
3	2.19	1.94	1.53	1.07



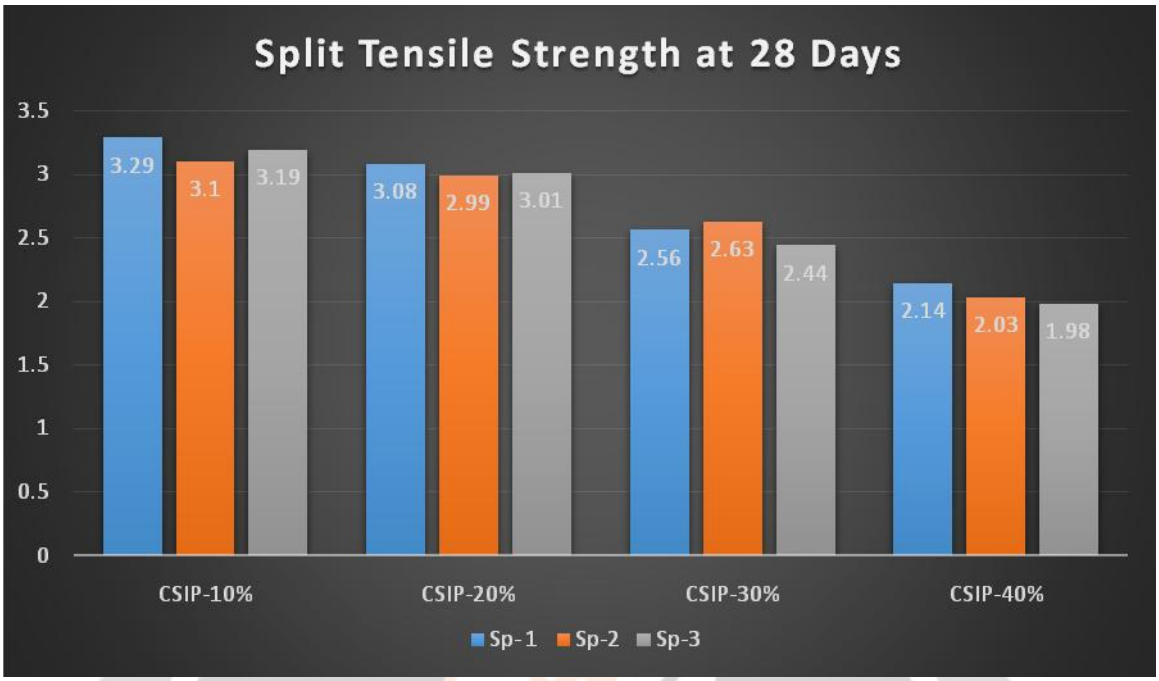
4.3.2 Average Split Tensile Strength at 7 Days:

Content	Average Split Tensile Strength at 7 Days
CSIP-10%	2.3
CSIP-20%	2.01
CSIP-30%	1.60
CSIP-40%	1.13



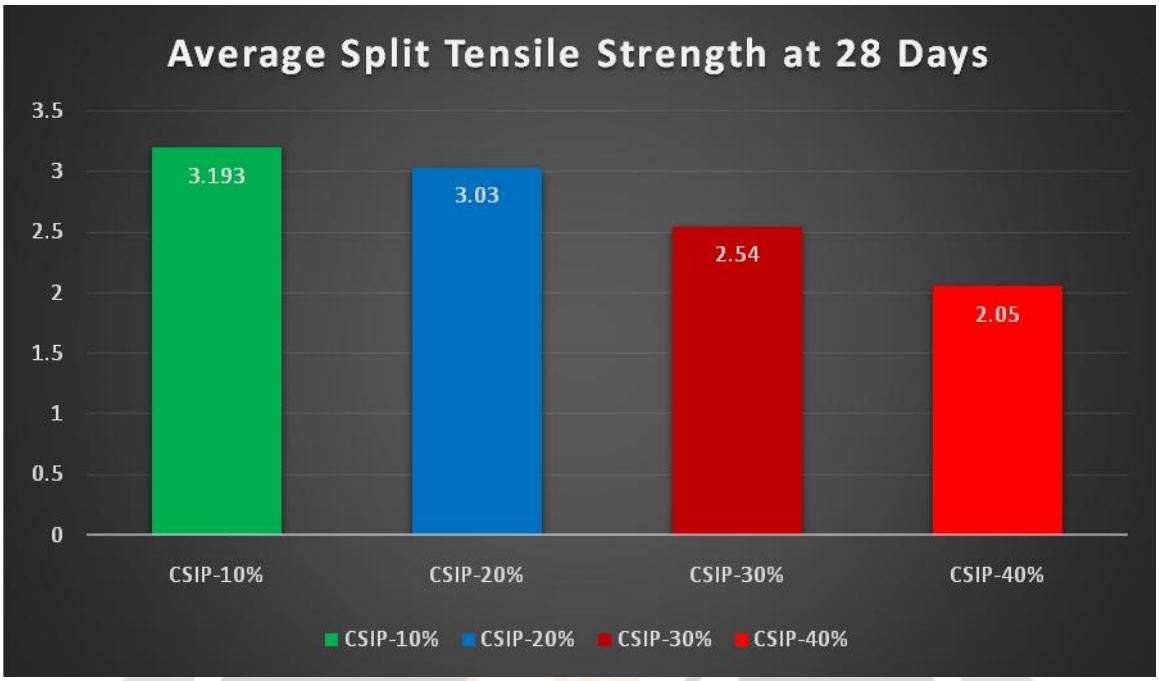
4.3.3 At 28 Days:

Specimen No.	CSIP-10%	CSIP-20%	CSIP-30%	CSIP-40%
1	3.29	3.08	2.56	2.14
2	3.10	2.99	2.63	2.03
3	3.19	3.01	2.44	1.98



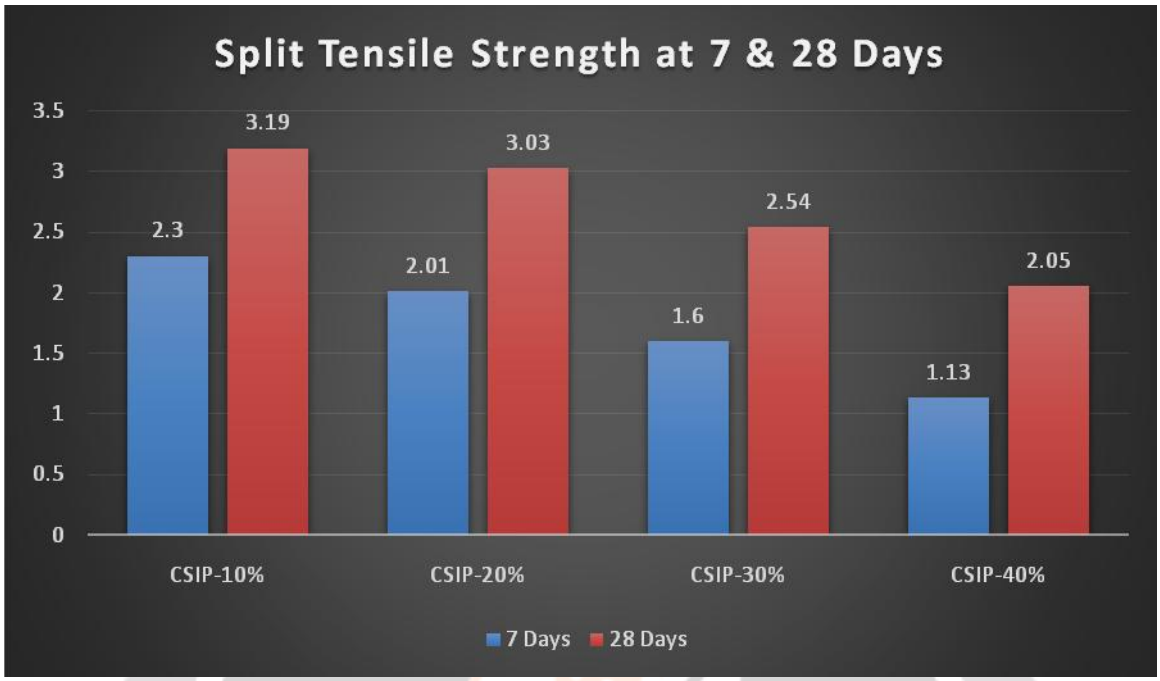
4.3.4 Average Split Tensile Strength at 28 Days:

Content	Average Split Tensile Strength at 28 Days
CSIP-10%	3.193
CSIP-20%	3.03
CSIP-30%	2.54
CSIP-40%	2.05



4.3.5 Split Tensile Strength at 7 & 28 Days:

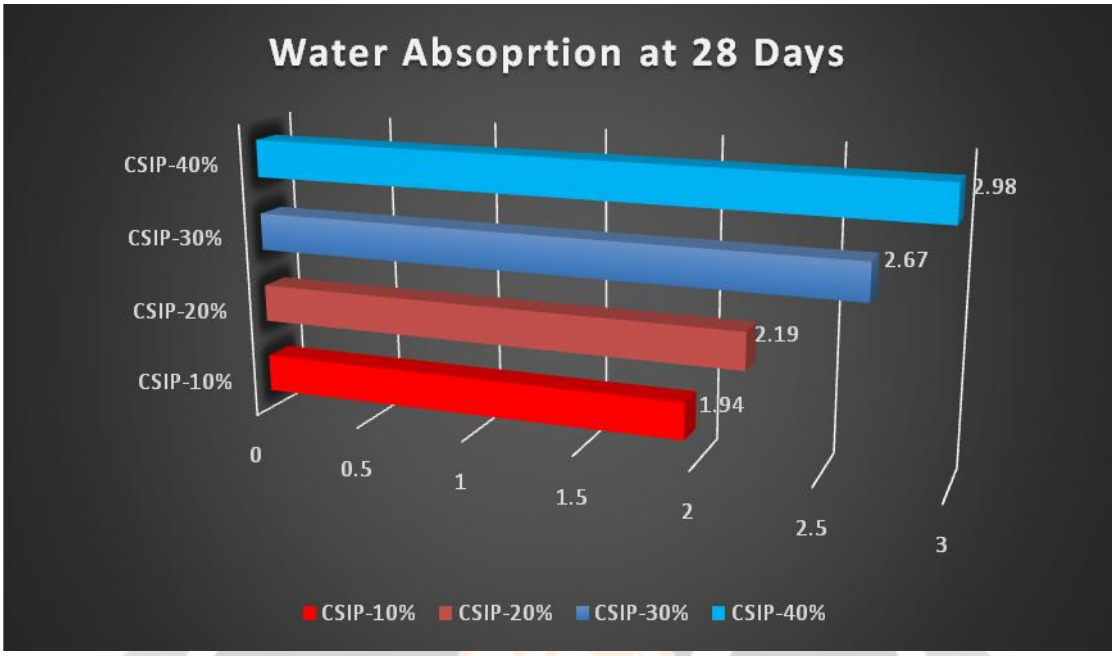
Content	**CSIP**	**7 Days**	**28 Days**
Mix Design-1	10%	2.30	3.19
Mix Design-2	20%	2.01	3.03
Mix Design-3	30%	1.60	2.54
Mix Design-4	40%	1.13	2.05



4.4 Durability Test:

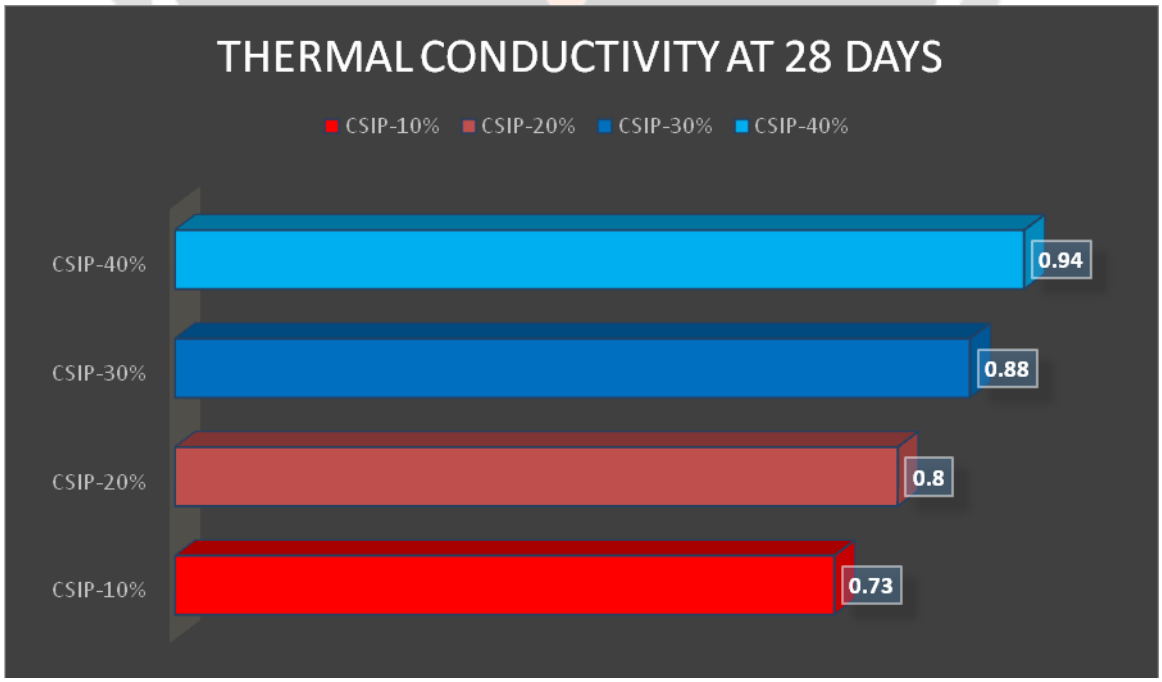
4.4.1 Water Absorption Test at 28 Days:

Content	Water Absorption Test at 28 Days (W/C)
CSIP-10%	1.94
CSIP-20%	2.19
CSIP-30%	2.67
CSIP-40%	2.98



4.5 Thermal Conductivity Test at 28 Days:

Content	CSIP	28 Days (W/m K)
Mix Design-1	10%	0.73
Mix Design-2	20%	0.80
Mix Design-3	30%	0.88
Mix Design-4	40%	0.94



4. CONCLUSIONS

- The compressive strength, Flexural Strength and Split Tensile Strength of the concrete reduced with increasing percentage of the Calcium Silicate Insulation Powder replacement.
- The Replacement of CSIP more than 20% caused failure in gaining its strength as well as required workability.
- The replacement is possible up to 20%.

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