SVR ENGINEERING COLLEGE

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EXPERIMENTAL INVESTIGATION OF SELF HEALING CONCRETE WITH DOLOMITE POWDER AND CRYSTALLINE ADMIXTURE

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ABSTRACT

- The main aim of this experimental investigation is to focus on the possibilities of utilizing Dolomite powder and Crystalline Admixture in cement and concrete production.
- Dolomite powder has some similar properties as like of cement. Use of dolomite powder in concrete can minimize the cost of concrete and may also increase the strength to some extent. The replacement percentages tried were 0%, 10%, 20%, 30% by weight of cement.
- Crack formation is very common phenomenon in concrete structure which allows the water and different type of chemical into the concrete through the cracks and decreases their durability, strength and which also affect the reinforcement when it comes in contact with water, CO2 and other chemicals.
- For repairing the cracks developed in the concrete, it requires regular maintenance and special type of treatment which will be very expansive.
- So, to overcome from this problem autonomous Self-healing mechanism is introduced in the concrete which helps to repair the cracks by producing calcium carbonate crystals which block the micro cracks and pores in the concrete.
- The Compression Strength results of 7, 28 days curing indicates that partial replacement of cement with dolomite powder has increased when compared with those of the reference specimens.
- By adding Crystalline admixtures to cement, the results of 7, 28 days Compressive Strength curing indicates the cracks formed in cubes has been repaired and gained strength.

INTRODUCTION

- Concrete is extremely very good material to withstand the compressive load to a limit however if the load applied on the concrete is greater than their restriction of resisting load, it leads to the strength reduction of concrete by means of producing the cracks in the concrete and the remedy of the cracks is very expensive.
- Concrete structures are usually afflicted with cracking which leads too much earlier deterioration when compared with designed service life.
- Self-healing of concrete is the best solution for the demand of sustainable concrete due to its ability of self-repair and durability.
- Now a days high strength and high performance concrete are extensively used around the world and to develop them it is necessary to reduce the water/binder ratio and also improve the binder content.
- Cracking is considered as a natural feature of reinforced concrete structures. Cracks may be triggered by loading of a structure itself or different mechanisms.

OBJECTIVE

- The objectives of the study are as follows:-
- To study the self healing capability of high strength concrete (M_{25}) with Dolomite powder with and without crystalline admixture in water immersion.
- To determine the regained compressive strength after healing process at 7&28 days.

LITERATURE REVIEW

- **Marta Roig Flores et al. (2016)** [19] have analyzed the self-healing attributes of early-age concretes, engineered utilizing a CA (4% by the weight of cement), by computing the permeability of damaged specimens and their crack width. Two concrete classes (standard concrete C30/37 and precast concrete C45/55) as well as three healing exposure circumstances have been reviewed: water immersion at 15ºC and 30ºC and wet/dry cycles. Specimens were pre-cracked at 2 days, to values of crack width in the range of 0.10-0.40 mm. The final results demonstrate virtually best recovery capacity for specimens recovered under water immersion at 30ºC, much better than for specimens recovered under water immersion at 15ºC, while inadequate for the wet/dry exposure.

- **G. Anil Kumar Reddy (2017)**[52] the author studied the self -healing capability of High strength concrete (M70) with Silica fume and Crystalline admixture in four types of environmental exposures i.e. Water Immersion, Wet/Dry Cycles, Water contact and Air Exposure. . The percentage replacement of cement with silica fume were: 5%, 10%, 15% and with the addition of 1.1 % crystalline admixture.

. The specimens were pre -cracked at 28 days, in the range of 0.10 - 0.40 mm and the time set for healing was 42 days. The result shows that all the mixes have considerable amount of closing ability and strength regaining capability for all exposure conditions. The concrete with 10% Silica Fume (SF) and 1.1% Crystalline Admixture (CA) has complete crack closing ability and 100% strength regained capability for WI and W/D conditions.

Ravi Teja (2018) [53] have studied cracks can autogenously heal under a certain conditions besides the traditional passive repair with a deliberate external intervention. For underground concrete structures, the presence of water, as a necessity for chemical reactions of the healing additives, is beneficial to healing concrete. In this paper, a natural healing method by mineral additives was developed according to the chemical and physical characteristics of underground environment. The healing capacity of three different crystalline mineral materials classified namely, carbonate, calcium sulphoaluminate expansive agent and natural metakaolin due to permeation-crystallization, expansion and pozzolanic reaction, has been assessed from the mechanical properties, referring to the relative elastic modulus, the strength restoration, and the water permeability of the healed specimens.

MATERIALS

- **Cement**: Bharthi OPC cement Fifty Three grade cement which is confirming to IS 12269: 2013 used throughout the work. The cement used were fresh, lump free & dry.
- **Fine Aggregate:** River sand were used as an fine aggregate. The specific gravity of sand is found to be 2.56.
- **Coarse Aggregate:** The size of coarse aggregate is 20mm.
- **Water:** Locally available Potable water confirming to IS 456-2000 is found to be satisfactory for making concrete. For the present investigation the water drawn from drinking water source was used for making concrete and curing. Water is being added to concrete mainly for hydration and for workability of PH 6 to 8.
- **Dolomite Powder[CaMg(C03)2] :** Dolomite is a carbonaceous or carbonate material which is composed of calcium and magnesium and Specific gravity of 2.85.
- **Crystalline admixture :** Xypex Admix C-2000 NF is available in 30 lb. (13.6 kg) repulpable bags. Only 1% of Xypex admix is added by the weight of cement used.

OPC 53 grade Cement

Fine aggregate

Coarse aggregate

Crystalline admixture

Dolomite powder

Mix Proportions

1. Mix Proportion For 3 cubes of M25 Grade Concrete :

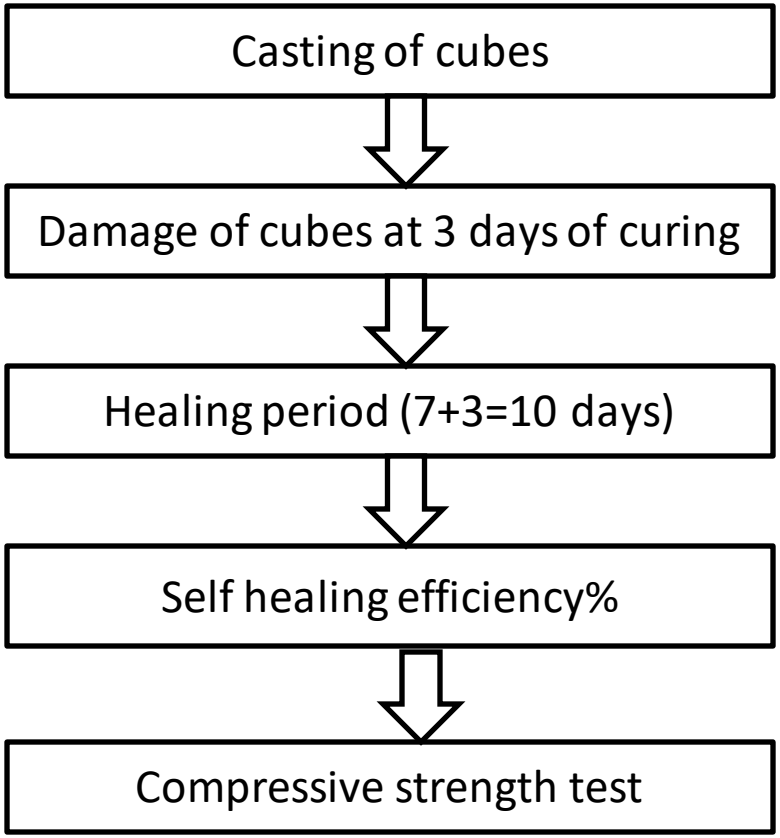
Cement	Fine Aggregate	Coarse Aggregate	Water
4.6kg/m3	8.6kg/m3	14.4kg/m3	2.26litre

2. Details of different types of Mix:

Sl.No	Mix Identification	Description of Identification of Mix
1	M1	0% Dolomite + 100% cement
2	M2	10% Dolomite + 90% cement
3	M3	20% Dolomite + 80% cement
4	M4	30% Dolomite + 70% cement

3. Crystalline admixture : Xypex Admix C-2000 NF is available in 30 lb. (13.6 kg) repulpable bags. Only 1% of Xypex admix is added by the weight of cement used.

Flow Chart


Casting of cubes
Damage of cubes at 3 days of curing
Healing period (7+3=10 days)
Self healing efficiency%
Compressive strength test

Self Healing Efficiency

- Crystalline admixture is the second type of mixture, comprising proprietary mix of active chemicals. The high hydrophilic nature makes it a suitable carrier of sand and it is capable to retort with cement particles, water and also with cement hydration products (CaOH2) of soluble phase forming C-H-S (calcium silicate hydrates) and rest precipitates of pore blockage (R).
- Xypex Admix C-2000 NF is available in 30 lb. (13.6 kg) repulpable bags. Only 1% of Xypex admix is added by the weight of cement used.

COMPRESSIVE STRENGTH TEST

- This test is performed on 150mm×150mm×150mm size cube specimens to determine compressive strength of concrete at 7&28 days of curing.
- Load should be applied gradually at the rate of 140kg/cm² per minute till the specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Compressive strength of concrete is calculated using following

$$C = P/A$$

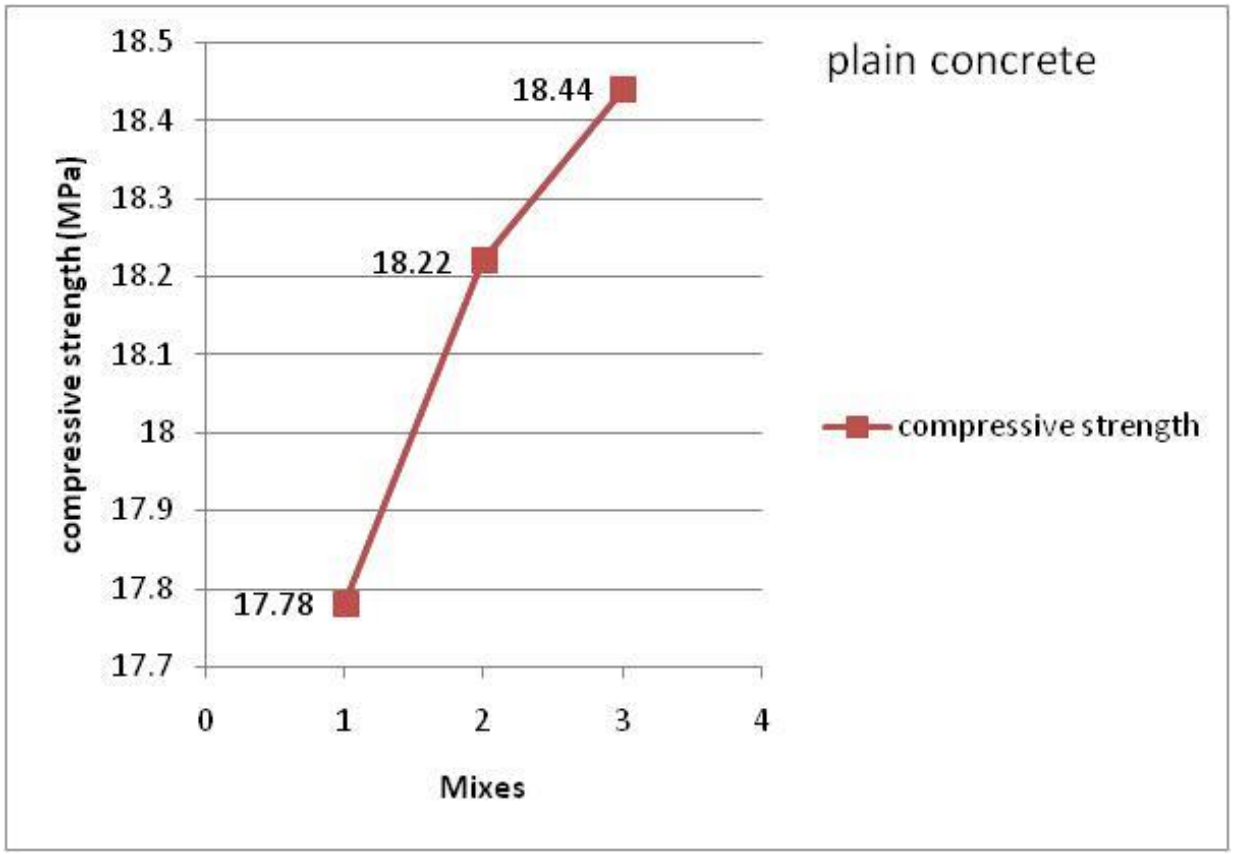
Where, **P** is the maximum load at failure in N

A is the area of the Cube specimen in mm^2

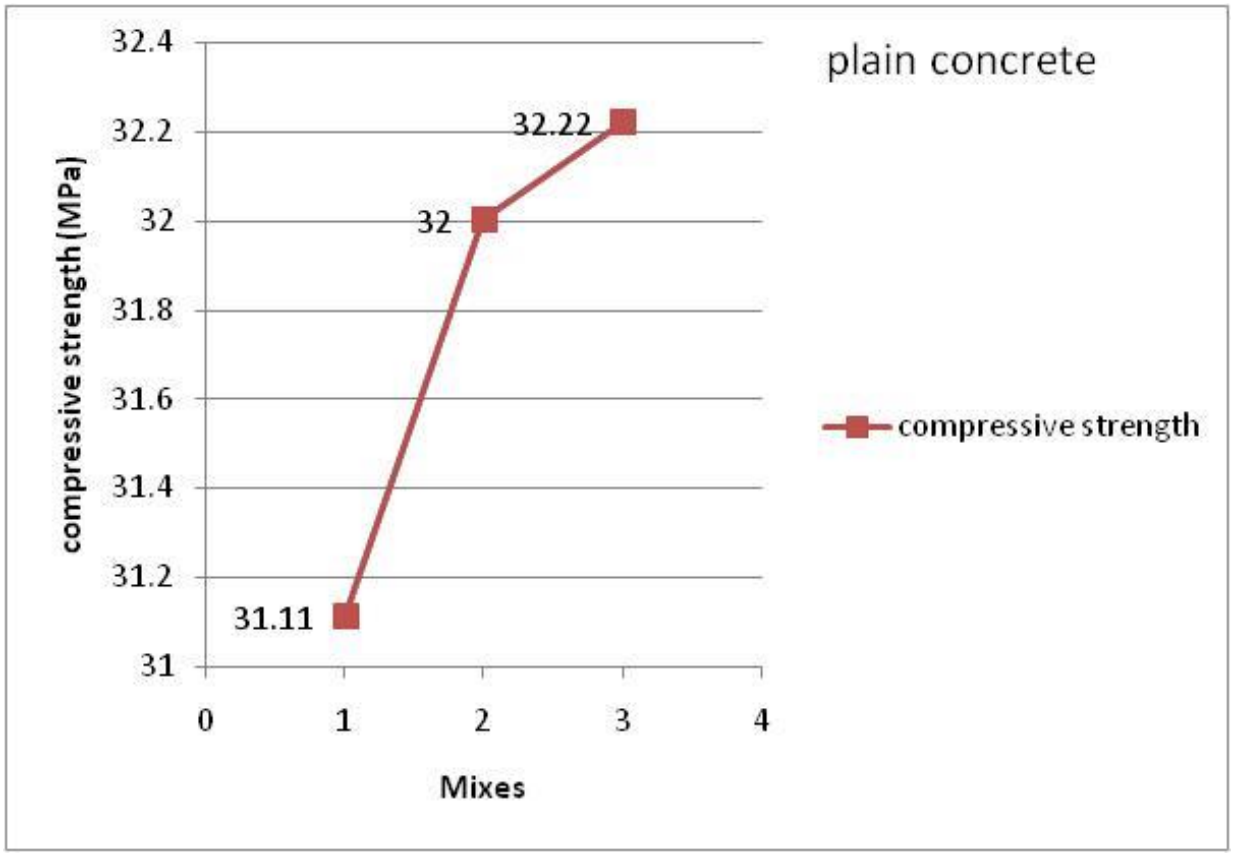
COMPRESSIVE STRENGTH TEST

Plain Concrete Reference Mix:

Mixes	Compressive strength for 7 days in N/mm2	Compressive strength for 28 days in N/mm2
Cube1	17.78	31.11
Cube2	18.22	32.00
Cube3	18.44	32.22
Average strength	**18.14**	**31.66**



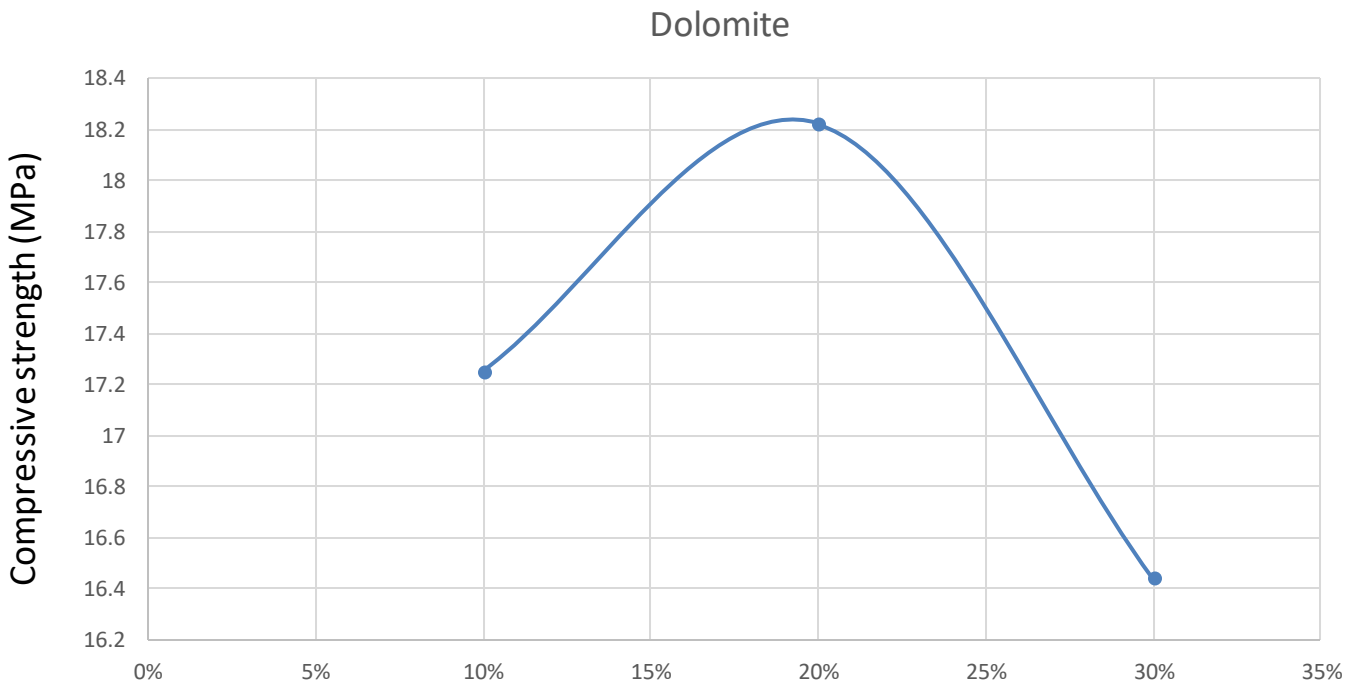
Compressive strength of plain concrete mix for 7 days



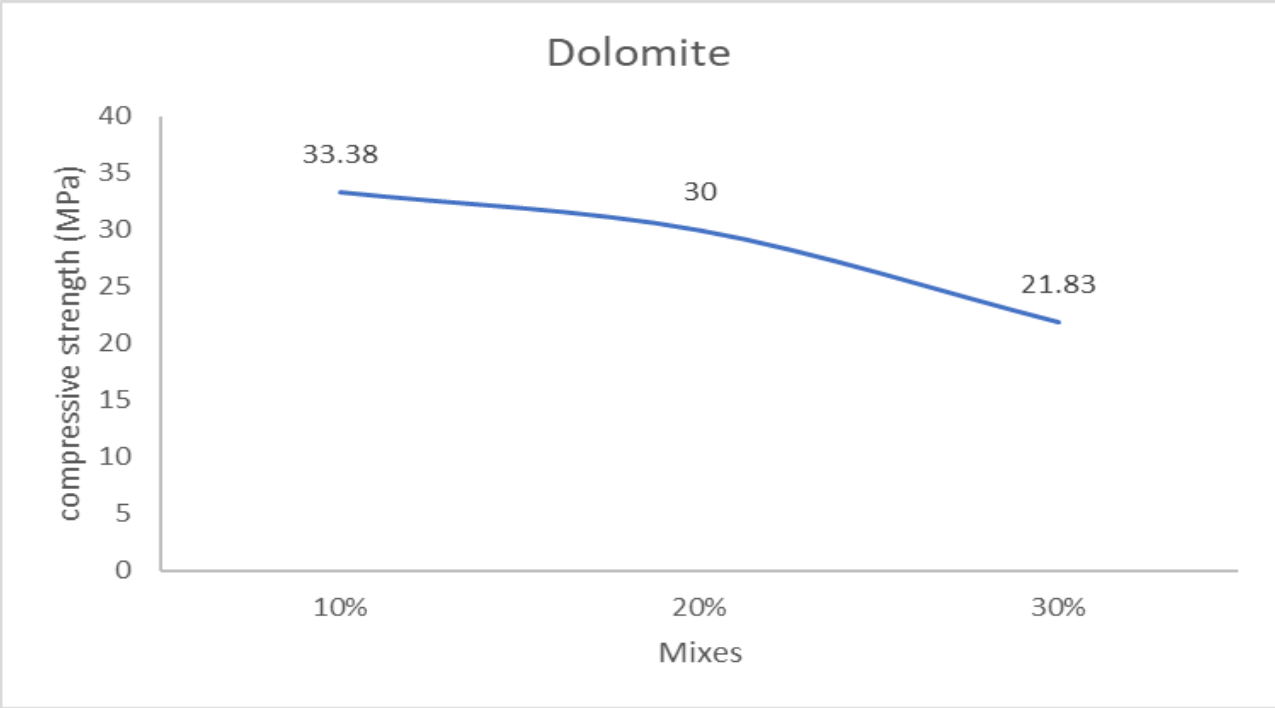
Compressive strength of plain concrete mix for 28 days

Dolomite Powder Mix:

Compressive Strength for 7 days in N/mm2				
Dolomite	Cube 1	Cube 2	Cube 3	Average strength
10%	18.67	18.22	17.78	**18.22**
20%	18.00	17.33	16.44	**17.25**
30%	17.33	16.89	15.11	**16.44**

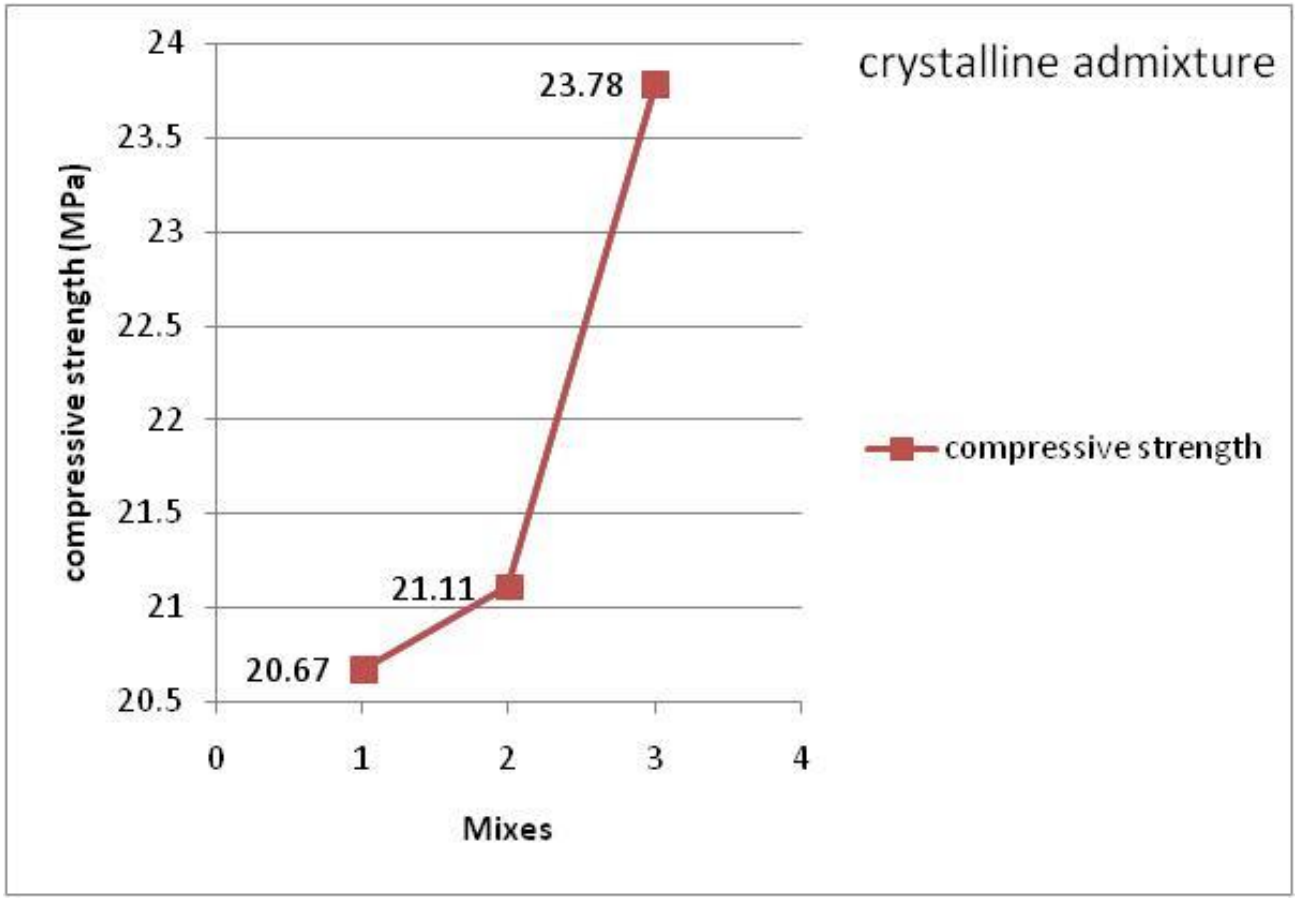


Compressive Strength for 28 days in N/mm2				
Dolomite	Cube 1	Cube 2	Cube 3	Average strength
10%	35.36	34.92	29.88	**33.38**
20%	31.20	30.85	27.97	**30.00**
30%	25.31	21.92	18.27	**21.83**

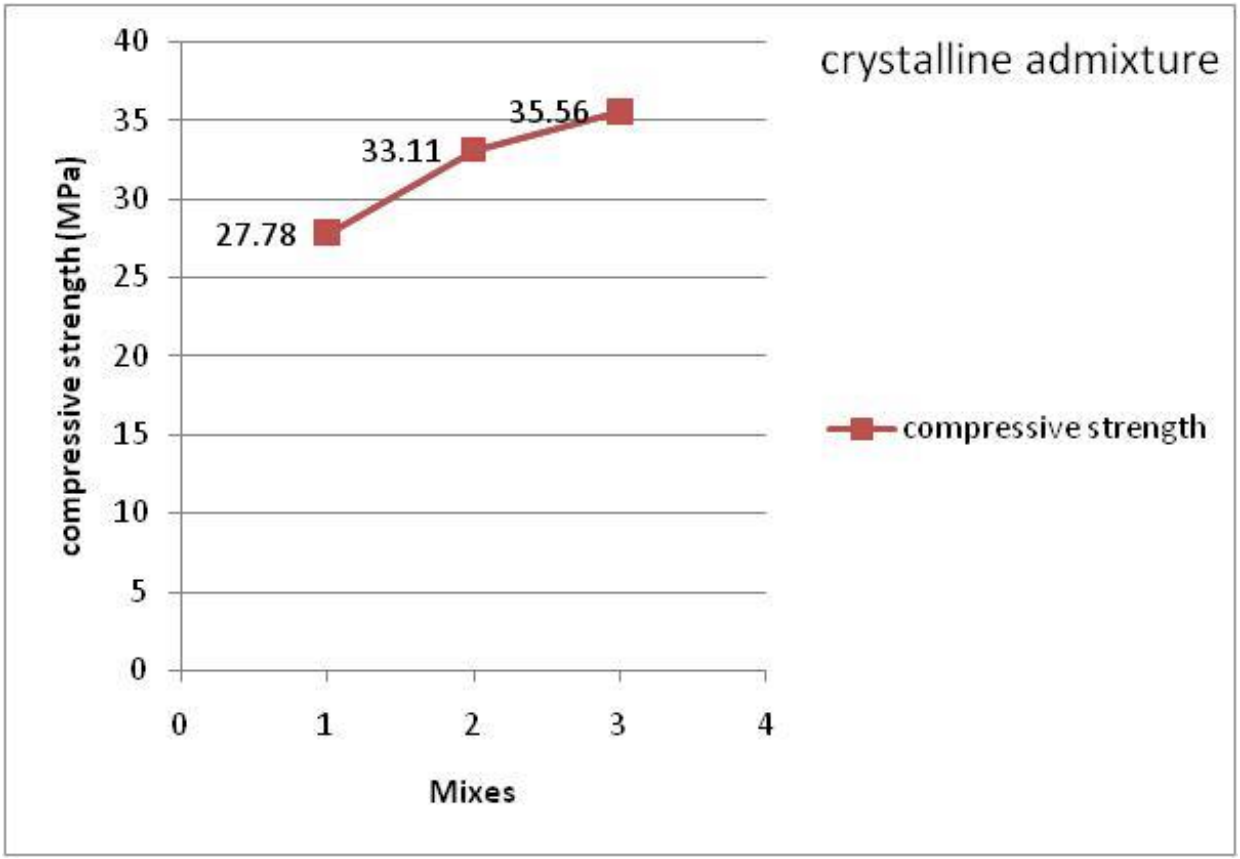


Crystalline Admixture Mix:

Mixes of Crystalline	Regained Compressive strength for 7 days in N/mm2	Regained Compressive strength for 28 days in N/mm2
Cube1	20.67	27.78
Cube2	21.11	33.11
Cube3	23.78	35.56
Average strength	21.92	32.15



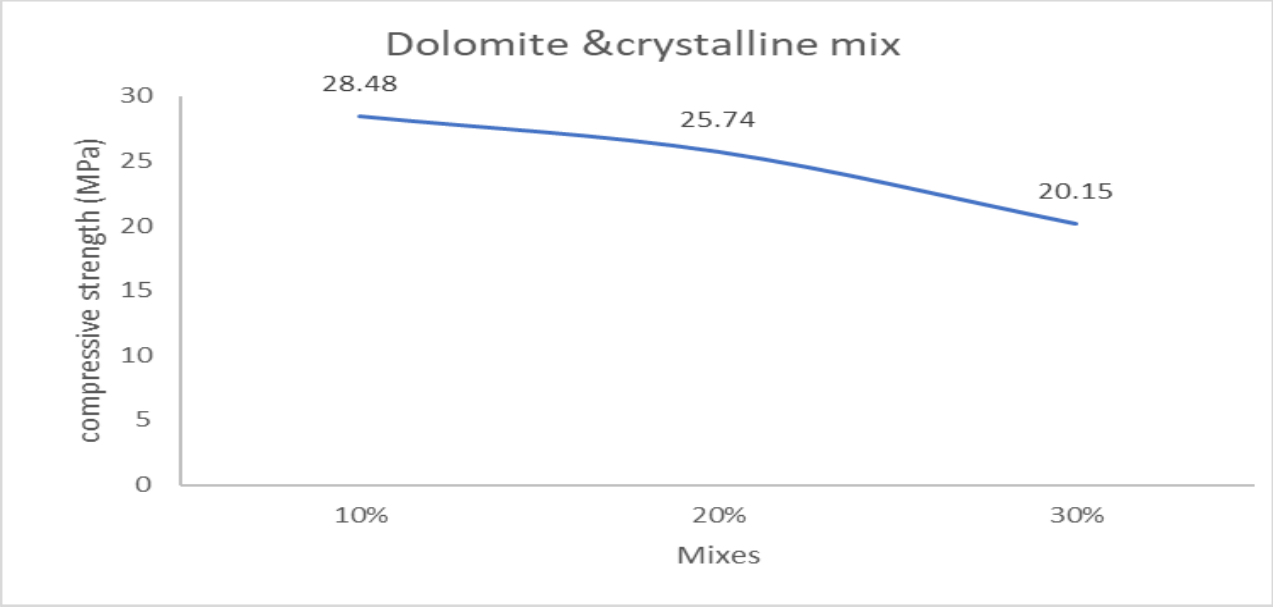
Regained Compressive strength of crystalline mix at 7 days



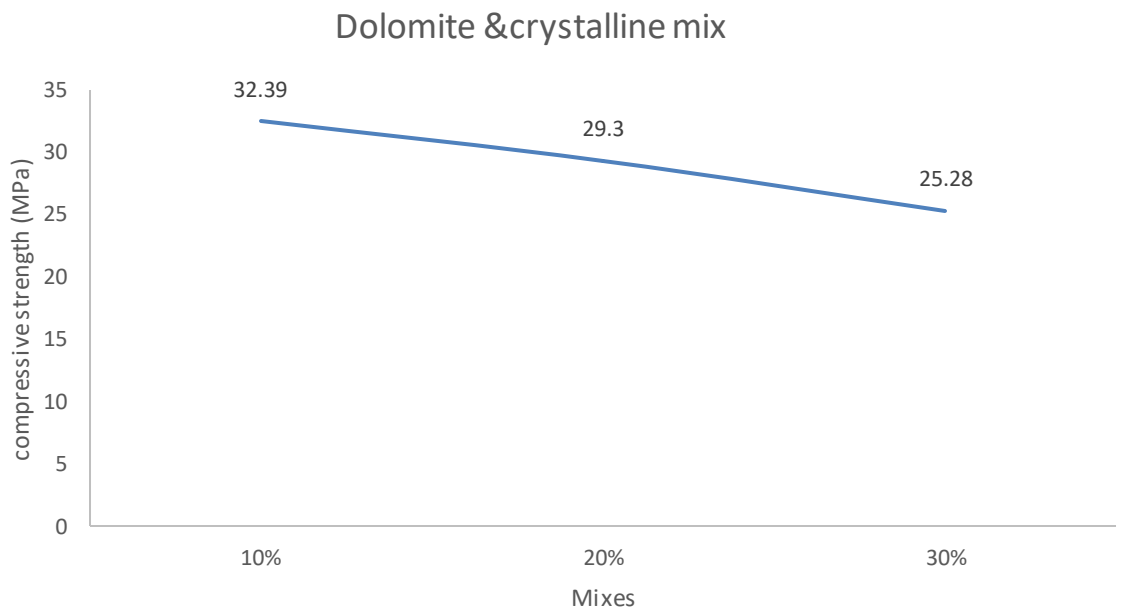
Regained Compressive strength of crystalline mix at 28 days

Dolomite and Crystalline Admixture Mix:

Regained Compression strength for 7 days in N/mm2				
Dolomite	Cube1	cube2	cube3	Average strength
10%	24.64	29.56	31.24	**28.48**
20%	23.53	26.81	26.90	**25.74**
30%	20.71	20.09	19.65	**20.15**



Regained Compression strength for 28 days in N/mm2				
Dolomite	Cube4	cube5	cube6	Average strength
10%	27.73	38.11	31.33	**32.39**
20%	26.47	28.38	33.05	**29.30**
30%	27.16	25.38	23.32	**25.28**



CONCLUSION

1. Self-healing of concrete is the best solution for the demand of sustainable concrete due to its ability of self-repair and durability. The cracks in cubes are healed by using 1% Xypex Admix C-2000NF after 28 days of curing is studied from this experiment.

2. The Compressive strength of Cubes are increased with addition of dolomite powder up to 10% replaced by weight of cement & further any addition of dolomite powder the compressive strength decreases.

3. The maximum compressive strength of 31.66N/mm^2 is obtained for Plain concrete mix for 28 days curing.

4. The maximum compressive strength of 33.38 N/mm^2 is achieved for 10% replacement of Cement by dolomite powder at 28 days curing.

5. The maximum compressive strength of 32.15 N/mm^2 is obtained for concrete mix with 1% of crystalline admixture (CA) for 28 days curing.

6. The best healing exposure condition is water immersion. The maximum regained compressive strength attained for concrete with 10% dolomite powder and 1% crystalline admixture is 32.39 N/mm^2 after 28 days healing under water immersion.

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THANK YOU