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A Research on the Properties of Self Compacting Concrete–Marble Powder Partially Replaced to Fine Aggregate

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Abstract— Self-Compacting concrete (SCC) is characterized as an exceptionally flowable, non-isolating solid blend that can be put even in the most clogged support by methods for its very own weight, with practically no vibrations. An exploratory investigation was embraced to study the properties of self-compacting concrete (SCC) . In the present examination, the marble powder (MP) were utilized for the substitution of fine-total. The substitution is done incompletely in the extent of 0%, 10%, 20%, 30%, 40% and half and its impact on usefulness of self-compacting cement were examined. The functionality trial of self-compacting cement utilized in this exploration were the droop stream test, T50cm droop stream, V-channel test and L-box test. Droop stream test, T50cm droop stream and V-channel test are utilized to assess the filling capacity of SCC while Compressive quality, Split Tensile Strength and Flexural Strength test were done to discover mechanical properties.

Key Words: Self-Compacting concrete (SCC), marble powder (MP).

I. INTRODUCTION

The strength of the solid is a significant issue and accordingly the making of tough solid structure requires satisfactory number of talented specialists. Somewhere else the quality of the solid will thus get lessen if the work tally decreases. Because of the absence of consistency and complete compaction of cement by vibration investigates at the University of Tokyo began to create SCC. A self-compacting cement is an extraordinary kind of solid which can be compacted into each side of a formwork simply by its very own self weight, with no vibrating compaction. A few European nations perceived the noteworthiness of SCC and prompted the improvement of European Federation and Natural exchange Associations speaking to makers and tools of master building items (EFNARC).

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1.1 SELF COMPACTING CONCRETE

Self-Compacting Concrete is said to be the sort of strong that can stream and join under its own weight, absolutely fill the formwork even in the stopped up fortress, keeping up homogeneity with no external compaction. This sort was furthermore named as High Performance Concrete. It is Considered as the most dynamic improvement in strong advancement for a multi decade.

1.2 MECHANISM

Self compaction can be achieved by the following steps,

i) High deformability paste ortherwise mortar.

ii) Resistance to segregation between coarse aggregates and mortar when it flows through the reinforcing bars.

iii) Less aggregate content.

iv) Low water/powder ratio

v) Usage of Super plasticizer.

1.3 REQUIREMENTS FOR SELF COMPACTING CONCRETE

The main role of SCC are the properties in the fresh state. The workability of SCC is higher than “very high” degree of workability mentioned in IS 456-2000. A concrete mix is said to be self-compacting concrete if it has the following characteristics,

1) Passing ability
2) Filling ability
3) Segregation Resistance

To ensure the properties of SCC several test methods are being developed. The list of tests for workability properties of SCC are mainly based on the EFNARC (European Federation of National Associations Representing for Concrete) specifications and guidelines.

1.4 MATERIALS

1.4.1 Cement

Bond is the unavoidable significant fixing in concrete. Various evaluations of concrete have been said to have distinctive quality advancement attributes and its own conduct because of the varieties in the piece and fineness. Concrete is a coupling material, a substance utilized in development that sets and solidifies and can tie different materials together. Cement delivered from Portland concrete is one of the most adaptable development materials accessible on the planet.

For the present undertaking, customary Portland concrete (Ultratech) of 53 evaluation adjusting to IS 12269-1987. Standard Portland concrete 53 evaluation is utilized. Explicit gravity of bond is 3.15, the fineness and typical consistency are 200 m3/Kg and 28 % separately. 400 grams of bond is taken and consistency test was done

Table -1: Standard consistency of cement

S.NO	w/c ratio	Amount of H_2O added (ml)	Depth of the penetration (in mm)
1	0.25	100	0
2	0.29	112	4
3	0.33	124	6

Standard consistency % = $\frac{\text{weight of } H_2O \text{ added}}{\text{weight of cement}} \times 100$

The standard consistency = 28 %

Table -2: Standard consistency of cement

Trail no	Weight of sample	Weight of residue	% of fineness
1	100	0.2	0.2
2	100	0.2	0.2
3	100	0.3	0.3

% of fineness = $\frac{\text{weight of residue}}{\text{Weight of sample}} \times 100$

% of fineness = (0.2 /100) x 100 = 0.2

The fineness of the cement is 0.2 %

1.4.2 Fine aggregate

Promptly accessible stream sand affirming to IS: 383-1970, Zone-II was used. Explicit gravity and mass thickness are 2.61 and 1510kg/m3 individually. Molecule size appropriation of fine total test is tried. 1000 grams of material is taken then the sifter is orchestrated in the request and the perception was made.

Table -3: Particle size distribution of fine aggregate

Sieve size	Wt. of retained	% of retained	Cumulative % of retained
4.75mm	22	2.2	2.2
2.36mm	22	2.2	4.4
1.18mm	57	5.7	10.1
600µ	335	37.5	43.6
300µ	455	55.5	89.1
150µ	60	6	95.1
		Total Wt	259.5

Model Calculation

Fineness modulus = $\sum$ f/100

Fineness modulus = 259.5 / 100

= 2.59

Fineness modulus = 2.6

1.4.3 Coarse aggregate

All around squashed stone totals fitting in with IS: 383-1970, having 10 mm ostensible most extreme size have been utilized. Explicit gravity and mass thickness of these totals are 2.66 and 1412 kg/m3 separately.

Table - 4: specific gravity of coarse aggregate.

S.NO	Description	Grams
1	Empty weight of basket	2000
2	Weight of coarse aggregate	4100
3	Weight of when immersed basket in water (w2)	1860
4	Weight of saturated aggregate when kept in water(w1)	4500
5	Weight of saturated surface dry aggregate kept in air(w3)	4200
6	Weight of the dried aggregate in oven(w4)	4150

Specific gravity of C.A. (G) = W4 / ((W3 – (W1-W2))

=4750 / ((4200 – (4500- 1860))

Specific gravity of C.A. = 2.66

1.4.5 Marble powder

Marble powder is acquired from the locally available collecting unit in Madurai (T.N.). Marble powder can be used as filler in concrete. The movement of strong development can reduce the utilization of typical resource and imperativeness source and diminishing the heaviness of sullying on to nature. Before long a ton of marble buildup are created in taking care of plants with a noteworthy impact on condition and individuals.

Table - 5: Physical tests of Marble Powder

S.NO	Characteristics	Result
1	Colour	White
2	Form	Powder
3	Specific gravity	3.05

1.4.6 Water

Water is the most basic and huge part . It is required for arrangement of mortar, blending of bond cement and relieving work, and so forth., during progression work. A part of blending water is used in the hydration of stick to plot the coupling framework and the rest of the water fills in as an oils between the fine and coarse total and makes concrete supportive. The pH in surface water is 6.5 to 8.5 and the pH for ground water is 6 to 8.5. Water for blending and restoring of solid models was utilized.

1.4.7 Super plasticizer

Sika viscocrete 20-HE is utilized for the examination and its test. It is a progressive high range water content reducer dependent on poly carboxylate ether (PCE). It is created for the generation of cement with high early quality and brilliant usefulness property.

Table - 6: Properties of Sika Viscocrete 20 HE

S.NO	Charactistics	Result
1	Appearance	Light brownish liquid

2	Chemical base	Powder Modified polycarboxylate
3	Dosage	0.2 % -2% of cemetitious materials

Sikament 1016 NS a high range water reducer, regularly alluded to as a super plasticizer, likewise named Naphthalene Sulphonate Formaldehyde. It is produced using naphthalene, sulfuric corrosive, formaldehyde and fluid salt, through sulfonation, hydrolyzation, buildup and balance response and afterward drying it into powder.

Sikament 1016 NS is a superplasticizer with the expectation of complimentary streaming cement in chunks , floors , establishments with thick fortification , dividers , sections, asphalts and other auxiliary and non basic components is utilized. It creates an all the more consistently strong excellent free streaming cement. It has focal points, for example, higher quality and thickness , improved union , improved solidness and improved water snugness.

Table - 7: Properties of Sikament 1016 NS

S.NO	Characteristics	Result
1	Appearance	Dark brownish liquid
2	Chemical base	Modified Naphthalene Formaldehyde Sulphonate
3	Dosage	0.5 % -2% of cementitious materials

II. MIX DESIGN

The mix design procedure for self-compacting concrete is done by the Nan-Su method.

2.1 NAN-SU METHOD :

Concrete grade = M 50
Total volume = 1000 litres
Assume air content = 2% (20 litres)
Net volume = 980 litres
Let s/a = 0.54
W partially completed = 1412 kg/m3
W fully completed = 1510 kg/m3
Packing factor (P.F.) = $\frac{1510}{1412}$
= 1.07
WC.A. = 1.07 × 1412×(1 – 0.54)
= 694.99 kg
WF.A. = 1.07 × 1510 × 0.54
= 872.48 kg
WC.A. + WF.A. = 694.99 + 872.48
= 1567.47 kg

f_{ck} = 50MPa (Target Mean Strength)
Wcc = f_{ck}× 7
= 50 × 7
= 350 kg

2.2 SPECIFIC GRAVITY :

G C.A. = 2.66
Gc = 3.15
G F.A. = 2.61
Gw = 1.0
w/c = 0.4

Wwc = 350 × 0.4
= 140 litres
Vpf = $1 - \frac{694.99}{1000 \times 2.66} - \frac{872.48}{1000 \times 2.61} - \frac{350}{1000 \times 3.15} - \frac{140}{1000} - 0.02$
Vpf = 0.198
Let w/f = 0.4 say,
(when the flow value of the filler paste is equal to that of the cement)

$$Wc = \frac{0.198 \times 1000 \times 3.5}{1 + (0.4 \times 3.15)}$$

= 295.97 kg
Wwf = 295.97 × 0.4
= 110.39 litres
Ww = Wcc + Wc
= 350 + 110.39
= 625.97 litres
Powder content = Wc + Wf
= 175 + 300
= 475 kg
Total Mass Of Concrete = (Powder + F.A + C.A +Water) content
= 625.97 + 872.48 + 694.99 + 250.39
≈ 2444 kg
Visocrete = 0.7 % cementitious material
Sikament = 1.2 % cementitious material
Mix Proportion = 1 : 1.39 : 1.11

2.3 Preparation of test specimens

2.3.1 Proportioning

The measure of required bond, fine and coarse totals, marble powder, water and superplasticizer for each arrangement of extent is set up according to the structure of self-compacting concrete.

2.3.2 Mixing of concrete

Mixing of bond was finished physically or by the utilization of machine. Machine is positive if there is an event of site works yet for lab testing models it might be done physically as the sum would be lesser appeared differently in relation to that in building site. Machine mixing isn't simply capable yet what's more effective. Before the materials are gathered in the drum around 25 % of the hard and fast measure of water required for mixing is poured in to the blender drum and to maintain a strategic distance from any remaining of security on the bodies or at the base of the drum.

2.3.3 Moulds

The solid is casted in to the 3D square shape 150×150 mm , shaft molds 100×100×500 mm and barrel shaped molds of 300 mm tallness and 150 mm measurement.

2.3.4 Placing of mix in moulds

In the wake of blending the materials which are proportioned, it is taken into container. The solid is set on to the molds (3D shapes, pillars and chambers), which are as of now lubed essentially by methods for hands just without utilizing some other compacting gadgets.

2.3.5 Curing

Following 24 hours, the examples are demoulded from the molds and quickly submerged into the clean new water and kept until taken out before testing .

III. TEST FOR FRESH SELF-COMPACTING CONCRETE

The tests for the self-compacting concrete are listed and explained below,

a) Slump flow and T50 test
b) L-box test
c) V-Funnel and test at T5 minutes
d) U box test

3.1 Slump Flow and T50 test

Droop stream is one of the dependable and typically led SCC tests during present time. That incorporates the usage of droop cone used with standard bonds as delineated in ASTM C 143.The essential difference between the hang stream test and ASTM C 143 is that the droop stream test estimated are the "spread" or "stream" of the strong model once the cone is lifted rather than the regular "droop" of the strong sample.TheT50 test is settled during the hang stream test. It is basically the proportion of time the strong takes to stream to a broadness of 50 cm .Typically, hang stream estimations of around 24 to 30 inches are inside the sufficient range; palatable T50 times go from 2 to 5sec.

1. Soggy droop cone table and droop cone.
2. Setting the cone on the point of convergence of the table that has a circle having an estimation of 50 cm pulled in concentrically for the territory for the cone.
3. Pipe with one individual holding cone down(as to keep up a vital good ways from strong moving itself underneath the cone),continuously fill the cone with test concrete.
4. Stop the arranging contraption when the strong lands at the T50 line and record this time as the T50 regard.
5. Measure the last separation over the bond in two inverse direction. . Record the worth .

Table - 8: Slump cone test results

Mix	Slump cone diameter (mm)	Slump T_{50} (Sec)
Standard values	650 – 800	2 – 5
Nominal mix	675	4.7
10% marble powder	686	3.8
20% marble powder	693	3.6
30% marble powder	716	3.1
40% marble powder	732	2.3
50% marble powder	745	2.1

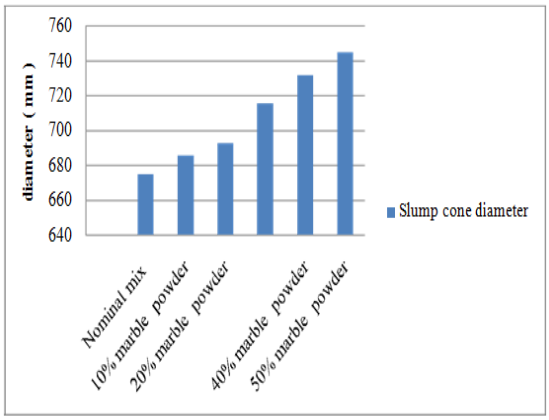

Chart -1: slump cone diameter test

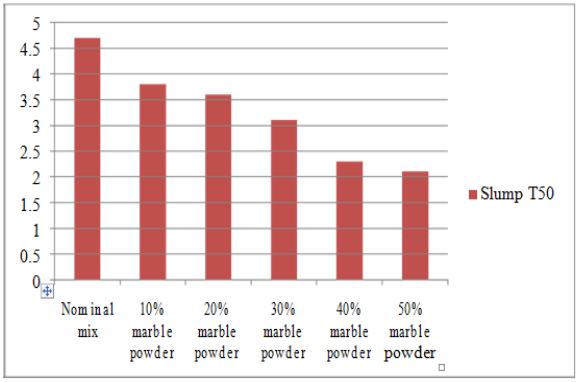

Chart -2: Slump T_{50}

3.2 L-Box test

The L-box worth is the degree of levels of cement at each finish of the case after the test is done at each finish of the compartment after the test is finished. The L-box incorporates a "chimney"segment and a "trough "district after the test is done, the degree of cement inthe stack is recorded as H1,the level of security in the trough is recorded as H2. The L-box value(also proposed as the "L-box degree", "blocking valve", or "blocking ratio")is just H2/H1.Typical great attributes for the L-keep worth are the degree of 0.8 to 1.0.If the solid was splendidly level after the test is done, the L-box worth would be proportionate to 1.0.Conversely, if the solid was too hardened to even consider evening consider night consider gushing far as possible of the trough the Lbox worth would be similar to zero.

Method

1. Hose all surfaces of the L-tie that will be contact with concrete. Assurance that the section is compelled as to maintain a strategic distance from inauspicious development of security through the L-box.
2. Dependably fill the upper segment of the L-box with an agent test concrete from a holder. Screed the solid from the most raised reason for the case as to guarantee the correct extent of cement is inside the contraption.
3. Quickly open/lift the gateway to permit the development of bond through the L-box.

Table - 9: L-Box test results

Mix	L box (sec)
Standard values	0.8 – 1
Nominal mix	0.904
10% marble powder	0.915
20% marble powder	0.932
30% marble powder	0.945
40% marble powder	0.963
50% marble powder	0.971

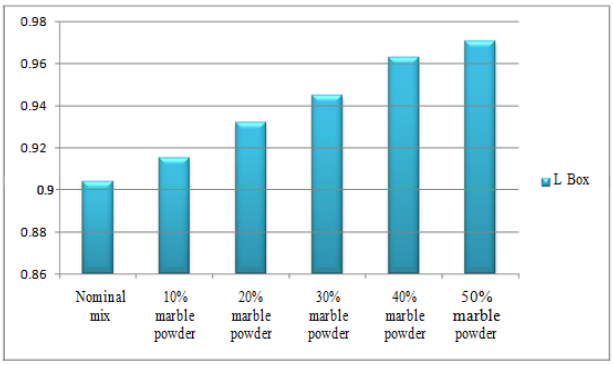

Chart -3: L-Box results

3.3 V-Funnel test and funnel test at t5 minutes

V-FUNNEL test is used to pick beyond what many would consider possible (stream limit) of the strong with a most surprising rigid size of 20 mm. The channel is heaped up with around 12 liters of concrete and the time taken for it to experience the mechanical get-together is evaluated . After this the involve should be possible off concrete and left for 5 minutes to settle. If the strong shows withdrawal, by then the stream time will amplify essentially.

Framework

1. Around 12 liters of bond is relied on to play out the test, evaluated for the most part.
2. Set the V-channel on firm ground. Drench inside surfaces of the channel.
3. Keep the catch gateway open to connect any surplus water to drain.
4. Close the catch passage and see a holder underneath.
5. Fill the gadget totally with concrete without compacting or pressing; simply strike off the strong level with the top with the trowel.
6. Open inside 10 sec in the wake of filling the catch door and draw in the strong to stream out under gravity.
7. Start the stopwatch when the catch portal is opened and record the perfect open gateway for the discharge to complete (the stream time).
8. This is taken to be when light is seen from above through the channel .The whole test must be performed inside 5 minutes. .The Procedure for the stream time at T5 minutes

Table - 10: V Funnel Test results

Mix	V Funnel test (sec)
Standard values	6 - 12
Nominal mix	10.3
10% marble powder	9.2
20% marble powder	10.5
30% marble powder	9.1
40% marble powder	8.3
50% marble powder	7.2

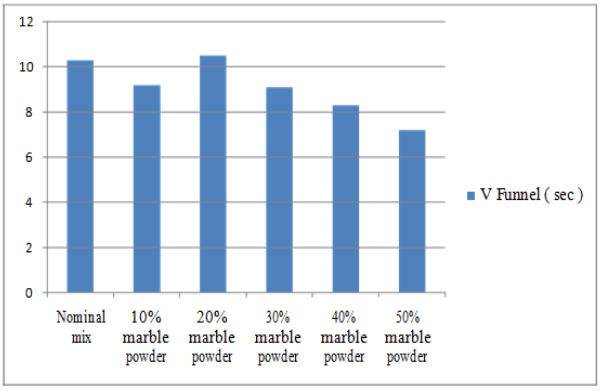

Chart - 4: V Funnel test results

3.4 U-box test

The test was moreover made in Japan .Sometimes the contraption is known as a "compartment surrounded" test .The test is used to check the filling farthest reaches of self-compacting concrete.

The mechanical party fuses a vessel that is pulled back by an inside divider in to two compartments. An opening with a sliding passage is fitted between the two sections.

Framework

1. Around 20 liter of bond is required to play out the test, kept an eye on normally.
2. Set the scoop level on firm ground, ensure that the sliding entryway can open uninhibitedly and starting there close it.
3. Drench inside surface of the contraption, oust any surplus water. Fill the one compartment of the mechanical get-together with the strong model.
4. Leave it to address 1 minute.
5. Lift the sliding gateway and empower the strong to stream in to the going with compartment.
6. After the strong has finished, measure the height of the strong in the compartment that has been filled, in two puts and register the mean (H1).Measure also the stature in other compartment (H2).
7. The whole test must be performed inside 5 minutes.

Table - 11: U Box test results

Mix	U BOX test (mm)
Standard values	6 – 12
Nominal mix	10.3
10% marble powder	9.2
20% marble powder	10.5
30% marble powder	9.1
40% marble powder	8.3
50% marble powder	7.2

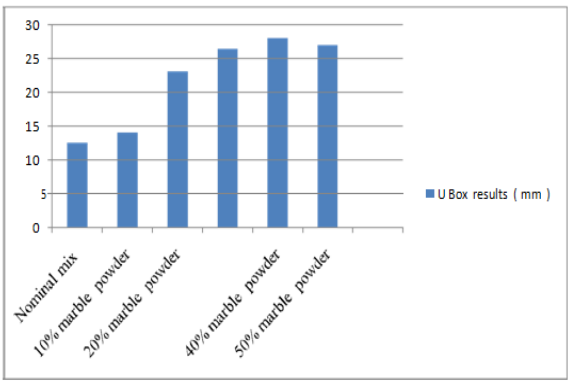

Chart -5: U Box test results

IV. TEST FOR HARDEND CONCRETE & RESULTS

The tests that are to be conducted on the concrete specimens are as follows,

1) Compressive quality test on concrete
2) Split rigidity test
3) Flexure test on Beams

4.1 Compressive Strength Test on Concrete

Compressive nature of security is delineated as the store, which causes the slip-up of a standard model isolated by the zone of cross-zone in uniaxial pressure under a given pace of stacking. The starter of compressive quality ought to be made on 150 mm size 3D shapes. See the shape in the weight testing machine. The green catch is squashed to turn over the electric engine. Irrefutably when the stack is applied amazingly, the chamber is lifted staggeringly near the lower plate and in that limit the model use of the store ought to be 300 kN every moment and can be obliged by weight rate control handle. Extraordinary weight is noted for each model. The discharge valve is worked and the chamber is permitted to go down. The qualities are delineated and estimations are finished.

Table - 12: Compressive strength test

Blend	Compressive quality at 7 days (N/mm^2)	Compressive quality at 28 days (N/mm^2)
Nominal mix	28.5	52.5
10% marble powder	24	51
20% marble powder	29.3	54.2
30% marble powder	32.7	57.6
40% marble powder	33	59.4
50% marble powder	30.5	54

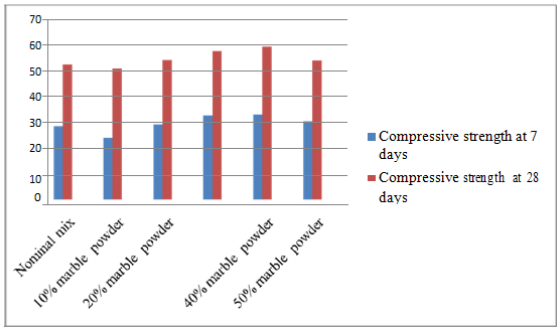

Chart - 6: Compressive strength test results

4.2 Split Tensile Strength Test On Concrete

A strong council of is presented to the movement of the compressive power along two backwards edges, by applying the power all things considered .The chamber is presented to weight near the stacked area and the length of the chamber is presented to uniform versatile stress.

Horizontal tensile stress=2 P/π D L

Where,

P = the compressive weight on the chamber.

L = length of the chamber

D = separation crosswise over of chamber

Table - 13: Splitting tensile strength test

Mix	Splitting tensile strength at 28 days (N/mm^2)
Nominal mix	5.2
10% marble powder	5.5
20% marble powder	5.7
30% marble powder	5.9
40% marble powder	6
50% marble powder	5.3

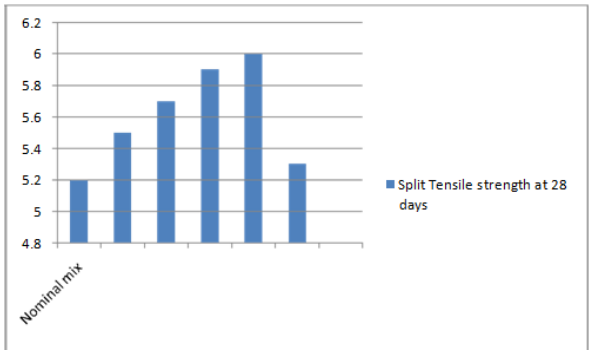

Chart -7: Splitting tensile strength results

4.3 Flexure Test on Beam

Initially the beam is cast as per the dimension requirements and after one week of curing the test is being conducted for better results.

System

1. The pillar will be tried on its side comparative with the situation in which it was thrown.
2. The range ought to be 457.2 mm (multiple times the profundity). The heap ought to be applied to the example at the third focuses (152.4 mm from each help).
3. The example ought not be expelled from the relieving tank until just before testing. Indeed, even a limited quantity of drying can antagonistically influence the outcomes. Two tests will be made on each bar. Along these lines for the principal test position the pillar with one end around 30 mm from the help.
4. The purposes of help and stacking ought to be set apart on the shaft.

5. The test ought to be done at a pace of stacking demonstrated by the teacher.

6. After the heap test, the normal profundity and width of the example at the disappointment segment must be estimated to the closest mm.

Table - 14: Flexural strength test

Mix	Flexural strength at 28 days (N/mm^2)
Nominal mix	4.78
10% marble powder	4.98
20% marble powder	5.43
30% marble powder	6.63
40% marble powder	7.13
50% marble powder	6.84

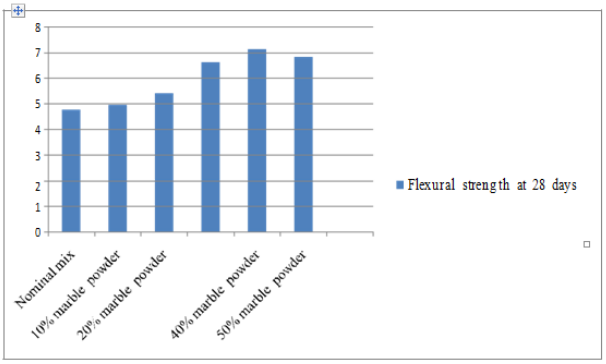

Chart -8: Flexural strength test results

V. CONCLUSION

Self-compacting cement is a non-isolating strong that is set by frameworks for its very own exceptional weight. It has been seen that, on development of waste marble powder, the filling farthest reaches of SCC by Slump cone test, T50cm test and V-Funnel test and saw as loosening up with increase in level of waste marble powder. The passing uttermost scopes of SCC by L-Box test in like manner saw as loosening up with increase in level of waste marble powder. Right when the strong is made with a waste material, it is depended on to improved accommodation, quality and nature of strong properties or if nothing else to be close to these properties concerning reference concrete. The evaluation intends to develop a strong mix in with most remarkable marble content that has quality properties in each down to earth sense misty from that of the non-marble reference concrete, as opposed to working up a marble powder entwining bond with most perceptible compressive quality Using up to 40% marble powder in bond is fitting according to the essentials. In this way, earth neighborly, money related and remarkable security is obtained.

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