International Journal of Recent Research and Review, Vol. XVII, Issue 2, June 2024
ISSN 2277 – 8322

USE OF WOLLASTONITE AND GRANITE SLURRY IN GREEN CONCRETE

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Abstract: Rapid growth in construction industries leads to consumed large amount of cement and sand, for save environment and natural resources of sand we need alternate of these materials. In study design concrete M35 grade mix ratio of (1:1.5:3)with combination of 10% wollastonite powder as cement replacement and partially replaced the natural river sand by granite fines in range of 0 to 50% in steps of 10% study their physical, mechanical and durability's characteristic of mix,find that the workability is decrease for each mix, attained to required workability need a SP (ECMAS-HP-888) dosage, maximum strength in flexural and compression are observed at 7, 28daysfor 20% replacement GP in mix (W10G20) and further increase amount of replacement decrease in strength is observed. Maximum UPV observed at 20% granite fines replacement for 28 days is 4500m/sec. Depth of carbonation is observed minimum at 20% replacement for mix (W10G20) at 7, 28 days is 2.2mm and 4mm, maximum depth found for 50% replacement of GP by sand in mix (W10G50) is 4.9mm and 6.9mm for 7, 28 days.

Keywords: -wollastonite powder, granite powder, flexural, compression strength, UPV test, carbonation depth.

1. INTRODUCTION

Intense growth in infrastructure are basic need of society development and urbanization to achieve economic growth of a country. Infrastructure development consume the natural resources and generate waste products.Large quantity of stone dust produced annually by mining and stone processing these wastes are non-biodegradable, it's dumped in open lands which create a lot of environmental issues for surrounds. The continue generating of waste in every year creating the hazardous problem for environment.Best used of granite slurry as fine sand in construction sector,it's could be economically and environmentally beneficial. Rapid growth in cement production industriescreate environmental problems and effect the health of human being.Studies have shown cement industries releases 0.9 tons of CO_2 in environment by p/t manufacturing of cement.CO_2emissionincrease carbon footprints and greenhouse effect generate in atmosphere. Increasing demand of cement in construction industriesleads to rising the prices of cement. So, we need to alternate of cement as binder for combat to issues and save the environment. Many research uses the alternate of cement and possible replacement of sand by waste of stone processing residue in production of mortars and concrete.

2. LITERATURE REVIEW

2.1 Wollastonite Powder as cement replacement in concrete

Workability

(Abhishek Jindal et al.,2020)observed that the self-compacted concrete achieved desire workability at w/c ratio of 0.60 need to a super plasticizer's dosage of 3.0% by weight of cement. V-funnel flow decrease when part of wollastonite fiber by sand replacement is increases. **(Ajay Kumar Mandrawalia,2020)**observed that theused w/c ratio is 0.35 reduce the workability when combine used of wollastonite and waste granite powder. Due to fine morphology of wollastonite and waste granite powder, a super plasticizer needs to mister glenium sky87777 attained to required workability for compaction factor value 0.90 observed.

Compressive Strength

(Ajay Kumar Mandrawalia,2020)observed that when partially substitute of cement and sand with combination of (wollastonite fiber and granite fines), each combination improves the strength of concrete mix, at highest level of substituting (10% WF and 30% of WGF) increase the compressive strength is 5.7%, and increase 10.2% by 30% WGF at constant w/c ratio 0.35 is observed.**(Kandula Mohan Krishna Reddy et al.,2016)**increasing compressive strength of mix up to 10% partially cement replace by wollastonite fiber and further increasing the level of substitution reduced the strength, and maximum strength is achieved 52.44N/mm^2 ismore than 16.06% to control mix at 10% replacement of cement by wollastonite. Combine replacement (10% W +15% fly ash) attained strength is 56.35N/mm^2 is 22.3% increases to control mix.

Flexural Strength

(Supriya Xavier Lopes et al.,2020) concrete grade of M30 at constant water cement ratio is 0.44, flexural strength increases at 10-16% wollastonite fiber replacement, maximum flexural strength is 16% wollastonite fiber replacement is 3.83MPa is 2% more than the control mix and 18% wollastonite fiber contain replacement decreasing the flexural strength.(**Kalla et al.,2013)** observed that lower w/c ratio at maximum curing days is increase the flexural strength addition of wollastonite fiber is maximum at 5% wollastonite fiber replacement is 4.16N/mm, minimum at 25% wollastonite content and replacement of cement by combine of wollastonite fly ash is more beneficial compare to mix only fly ash replacement.

Carbonation

(**Kallaet al.,2013)** investigated on 100 mm cube prepare as per CPC-18 RILEM at 28 days periods, indicator uses as (5% phenolphthalein in 70% ethyl alcohol) observed reducing the carbonation depth up to 45% cement replace by (W-FA) depth is more in high w/c ratio 0.55 and lower depth in w/c 0.45, 5% and 10% wollastonite reduction in depth of carbonation.

2.2 Granite waste fines as sand in concrete

Workability

(Kanmalai Williams et al.,2008) study on the high-performance concrete in the fine aggregate replacement by granite powder at level of (0% ,25%, 50%, 75% ,100%) shows that the slump value of concrete mixer is decreases when percentage level of granite powder is increases. Due to more fineness and roughly surface of granite particles it increasing the water demand causes reduce the workability.

(M. Vijayalakshmi et al.,2013)investigated the slump value with time in addition 30- and

60-min intervals, that workability decreases with increasing the replacement rate of granite waste and poor workability is observed in term loss in slump for mix of 20% and 25% granite waste replacement, due to rough and irregular texture of granite fines.

Compressive Strength

(M.Vijayalakshmi et al.,2013) observed that the addition of granite powder up to 15% increases the compressive strength according to ages of curing and further increment level reduces the strength and observed lower strength at 20% and 25% replacement level due to high demand of water and specific area lead to voids in structure.

(Danish Shaikh et al.,2021) found that the replace the percentage of granite fines as sand for M20 mix proportion tested on 28 days end of curing period, results show that 40% replacement to granite powder gives higher strength compared to control mix, increment in compressive strength is 1.06% and with admixture the cast of 35% replacement of sand with granite fines increment in compressive strength is 1.03% compare control mix.

Flexural Strength

(Divakar. Y et al.,2012)flexural strength of concrete beam size of 10*10*50 cm with no reinforcement in M20 grade, result shows that 5% replacement of granite powder by sand increasing the flexural strength up to 5.41% and decreasing 5% with replacement of 15, 25, 35% and 6% decreases at 50% replacement, beam with reinforcement (15*15*70cm) increasing the flexural strength 2% with replacement level of granite fines is 25% replacement.

(K. Chiranjeevi Reddy et al.,2015)observed that the 7.5% granite powder replacement with cement in concrete the tensile strength in flexural a beam (100*100*500mm), tested on 2-point loading result shows increases the flexural strength is 6.34 N/mm^2 compare to control mix.

Ultra-Pulse Velocity

(M. Vijayalakshmi et al.,2013) result shows that UPV value for 5, 10, 15% replacement of natural sand by waste granite powder is relatively equal to control mix and concrete classified good the UPV value is greater than 3500m/sec. And further increases the granite powder, 20% and 25% decreases the UPV value, due to porosity of concrete is increased.

(ShivamShivhare et al.,2021) Result shows that UPV value of 28 days is increases up to 15% replacement of granite powder with cement is obtain4.45m/sec. Further increases the replacements level of cement with granite powder results showing decrement in UPV values due to porosity specimen is increased.

Carbonation Depth

(M. Vijayalakshmi et al.,2013) replacement of granite waste powder with sand level of 9-15%, carbonation depth is close to control mix and beyond increases the replacement level affect the depth of carbonation due to lower workability and poor compactness, the carbonation depth is observed at 20% replacement is 8.9mm and 10.2mm at 25% replacement level. **(Singh Nagar et.,2016)** found in study that when granite powder substitute with sand in concrete 10-70% in steps of 15% with water cement ratio of 0.30 and 0.40 result shows that depth of carbonation is decreased up to 25% substitution level. Further increase replacement level up to 70% seen increment in depth of carbonation.

3.MATERIALS AND METHODOLOGY

3.1 Ordinary Portland cement

the (OPC)43grades of cement, utilized shall be conforming to specifications set by IS:8112-1989 and design strength of 28 days. physical properties of OPC are tested as per IS 1489-1(1991). Specific gravity 3.15, initial setting time is 49min, final setting time is 253min. and compressive strength for 28 days is 43Mpa.

3.2Natural River sand

Sand obtains locallyareavailable to nearest, conforming to as per IS: 383:2016 sand for concrete, it's used to as inert fine aggregate in concrete size of less than 4.75mm. Test perform as per IS 2386 -1963 on sand. Fines modulus of sand is 2.6, specific gravity 2.72 and water absorption is 1.1.

3.3Coarse aggregate

Coarse aggregate size of 20mm is used for perfect mix of concrete as per IS: 383:2016, specific gravity coarse aggregate 2.64 and fineness modulus is 7.1.

3.4 Granite waste powder

Granite sand produce large amount in every year in Rajasthan, by stone processing units was procured from nearby stone processing industry, Material passing through 4.75mm was acquired and its specific gravity is 2.58, 1.6 water absorption and FM is 1.78. of GP are tested carried out.

3.5 Wollastonite Powder

Wollastonite powder supply by (SVN BHARAT MINCHEM PRIVATE LIMITED), JAIPUR RAJASTHAN Wollastonite powder used to partially replace the cement. Wollastonite is the natural occurring acicularcalcium metasilicate mineral ($Casio_3$), white mineral with needle like crystals, the range of particles less than 25micron is knows as wollastonite powder, specific gravity 2.6 and density is 2.8, pH is 9.9.

3.6 Admixture

Produce satisfied slump of mix by using high range water reducer admixture (super plasticizers) ECMAS HP 890 as per IS-9103:1999,

3.7 Research Methodology

this study on concrete mix grade M35 prepare as per IS 10262:2009with combination of (wollastonite powder + granite slurry) concrete mix. Partially replacement of wollastonite powder with cement optimum value of replacement is 10% kept constant, then fine river sand partially substitutes with granite slurry (GS) in range of 0% to 50% in steps of 10%, prepare 6 mix quantity given below table. Evaluate their result on 7 and 28 days curing after, test performed on mix workability, compressive strength, flexural strength, UPV and other durability properties test and compare their result with reference mix without granite sand.

3.8 Preparation of Specimen

Concrete mix designgrade of M35 ratio of (1:1.5:3) as per IS 10262: 2009.Water cement ratio and minimum cement content is taken as per IS 456: 2000. Minimum size of aggregates is 20 mm. Mix prepares in kg/m^3, required water cement ratio 0.40 to produce satisfied slump using byhigh range water reducer admixture ECMAS HP 890 as per IS-9103:1999,casting and curing of specimens done as per IS 10262:2009, cube of 150mm and beam size of 150*150*700mm Cube of 150mm size is used testing on compressive strength, UPV test and carbonation test and beam size of 150*150*700mm beam specimen are used total cubes is 72 and 36 beams are casted.

Mix	W/C Ratio	OPC	WP	GP	FA	CA	WATER	SP (%)	SLUMP (MM)
W10G0	0.40	355.5	39.5	0	600	1220	158	1.4	75
W10G10	0.40	355.5	39.5	60	540	1220	158	1.6	75
W10G20	0.40	355.5	39.5	120	480	1220	158	1.8	75
W10G30	0.40	355.5	39.5	180	420	1220	158	2.0	74
W10G40	0.40	355.5	39.5	240	360	1220	158	2.2	74
W10G50	0.40	355.5	39.5	300	300	1220	158	2.4	73

Table 3.1Quantity of material for each mix

3.9 Experimental methodology

Following test are to be discuss with procedure of conducting in this study. Test are to be conducting are mention below table, and evaluate their physical, mechanical and durability properties of concrete mix.

S. No	Test	Specification
1	Workability (slump)	IS 456 (2000)
2	Compressive strength	IS 516 (1959)
3	Flexural strength	IS 516 (1959) ASTM-C293
4	Ultra-pulse velocity	IS 13311 (1992) ASTM-C597
5	Carbonation test	RILEM CPC 18 (1988)

Table 3.2 Detail of test to be performed

4. EXPERIMENTAL TESTS AND RESULTS

Wollastonite powder 10% keep constant for all mixes by partially cement replacement andgranite sand partially substitutes by natural river sand at range of 0 to 50% in steps of 10% mix of W10G0, W10G10, W10G20, W10G30, W10G40, W10G50, are study there physical, mechanical and durability's properties and evaluate their 7, 28 days results and compare with reference mix without granite fines.

4.1 Workability

when granite slurry adds in concrete mix place of natural sand observed that workability is decreased with increasing amount of granite sand, due to granite powder required more water compare to sand and having high specific surface area, rough and angular texture of granite powder. That reason increases the water demand and decreases the workability of mix, attained to required slump of 75mm add a Super plasticizers ECMAS HP 890 as per IS-9103:1999.

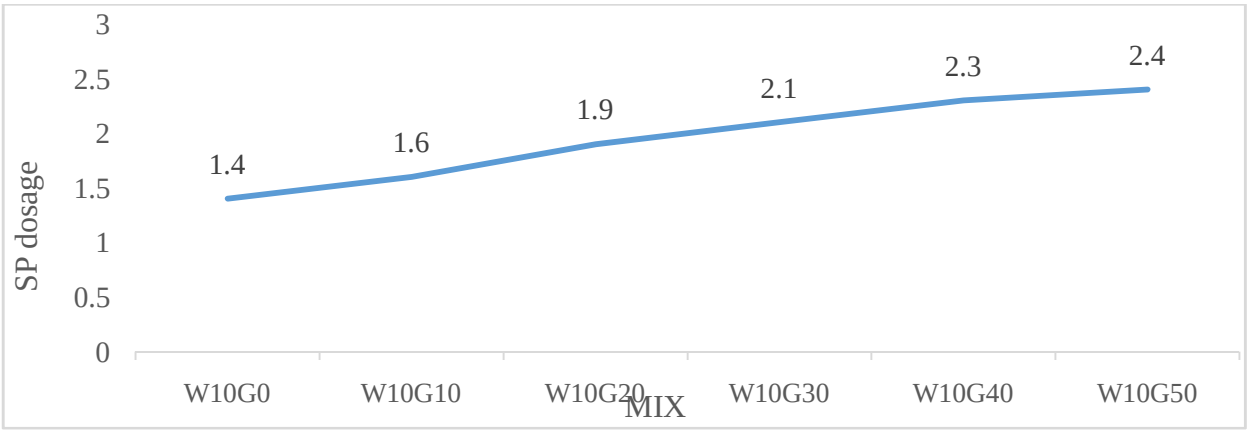

Figure 4.1 W/C ratio variation with granite slurry

4.2 Compressive Strength

Observedincrease the compressive strength at 7 and 28 days of curing up to 20% replacement of granite sand by river sand, decrease in strength is observed when further replacement up to 50% of granite sand. Maximum compressive strength is observed at 7, 28 days for mix (W10G20) is34N/mm^2 and 28 days is 47/mm^2 is 21% and 23% more than the reference mix (W10G0) without granite sand, Increases the strength is due to more fineness of granite powder compare to river sand for better filling and rough and angular texture of granite sand particles is provided better packing properties of mix and mix has less voids for more compact, minimum at 50% substitution for 7 and 28 days is 27N/mm^2, 37N/mm^2.

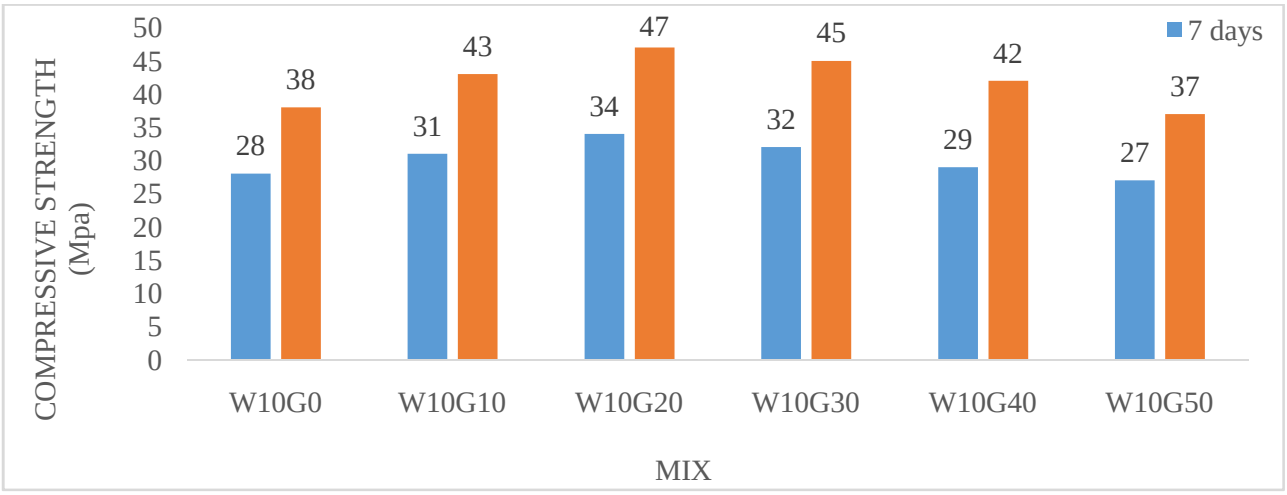

Figure 4.2 compressive strength 7 and 28 days

4.3 Flexural Strength

Increment of flexural strength of mix till 20% granite replacement, further increment shows reduction in strength. The maximum flexural strength for 20% granite replacement mix (G10W20) at 7, 28 days of curing is 4.2Mpa and 5.1Mpa, is 10% and 18% more than compare to reference mix (W10G0) without granite slurry, this increment due to better packing of granite fines and good bonding of angular and rough particles of GP, minimum strength is obtained at 50% granite fines mix (W10G50) at 7 and 28 days is 3.6Mpa and 3.9Mpa, due more percentage of granite fines increase surface area so increase the water demand and voids in mix.

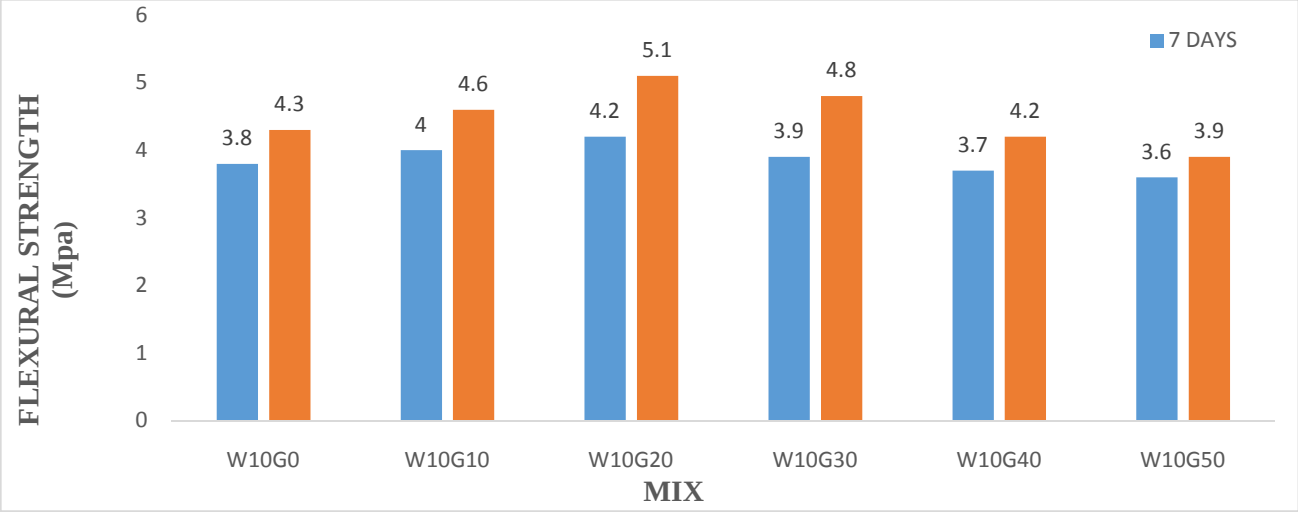

Figure 4.3 flexural strength variation at 7 and 28 days

4.4 Ultra Pulse Velocity Test

Observed maximum UPV value obtained 28 days for mix (W10G20) at 20% granite fines is 4500m/sec for 28 days of curing that is 21% more than compare to reference mix(W10G0). This increment due to improvement of packing and denseness of mix, further increment granite powder after 20% its shows the reduction in UPV values till 50% replacement, is due to increase of granite fines leads to voidsporous. Minimum UPV value observed at 50% granite fines is 3500m/sec is 6% lower than reference mix.

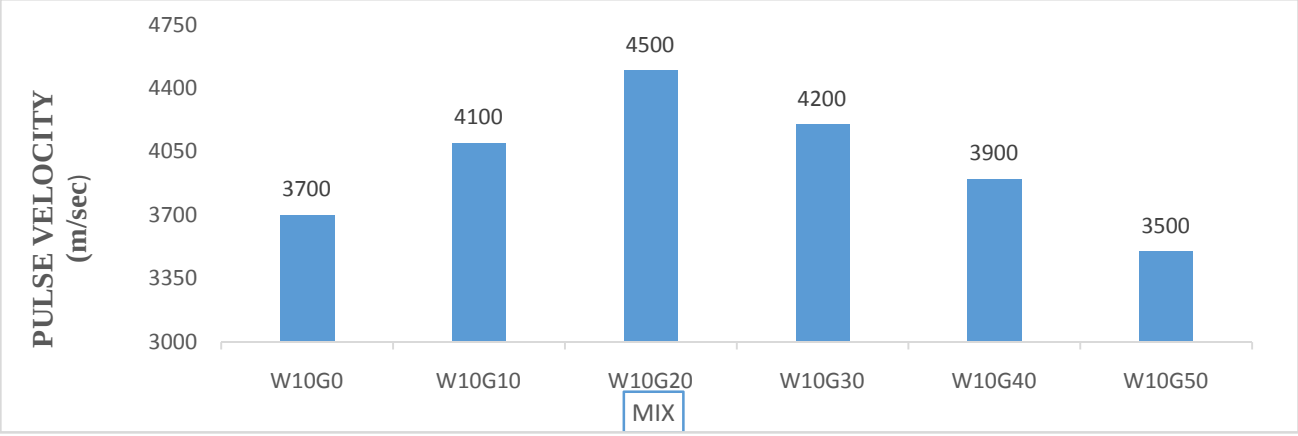

Figure 4.4Ultra pulse velocity at 28 days

4.6 Carbonation depth

Test perform on150mm cube specimens put in carbonationchamber inside presence of 5% CO_2 concentration and 50% relative humidity, after 7- and 28-days sample are test. Split the cube specimens longitudinally and spray an indicator solution of phenolphthaleineach exposure period 7 and 28 days. Maximum reduction in depth of carbonation for(W10G20) at 7 and 28 days is 2.2mm, 4mm is 42%, 28% lower than to reference mix. Further increase the concentration of granite fines depth of carbonation is increased, due to presence of voids and lessdensified of mix. Maximum depth obtained at 50% concentration of GP for mix (W10G50) is 4.9mm, 6.9mm for 7 and 28 days is 29% and 23% more than reference mix (W10G0).

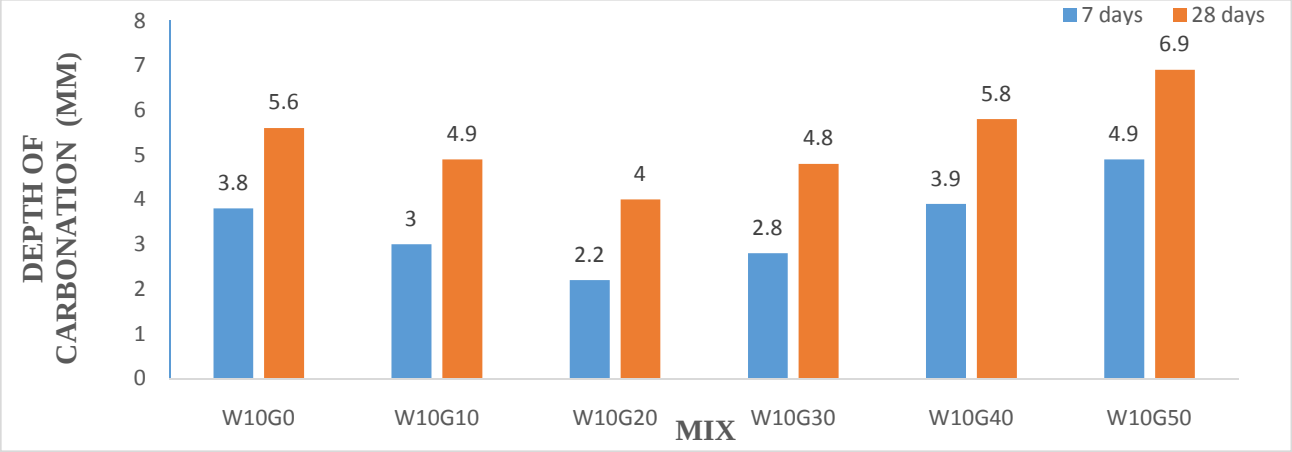

Figure 4.5Depth of carbonation variation at 7 and 28 days

5. CONCLUSION

1.Workability of mix is reduced with addition of granite sand due to more fineness and angular texture of granite fines that required more water, attained to required slump need a high range water reducing admixture.

2. Compressive strength increase up to 20% replacement of granite sand, Maximum compressive strength is observed at 7, 28 days for mix (W10G20) at 7 days is34N/mm^2 and 28 days is 47/mm^2 is 21% and 23% more than the reference mix (W10G0). Minimumstrength at 50% substitution for 7 and 28 days is 27N/mm^2, 37N/mm^2. Reduction in strength duetovoids increase the porosity of mix.

3.The maximum flexural strength for 20% granite replacement mix (G10W20) at 7, 28 days of curing is 4.2Mpa and 5.1Mpa, is 10% and 18% more than compare to reference mix (W10G0). Minimum strength is obtained at 50% granite fines mix (W10G50) at 7 and 28 days is 3.6Mpa and 3.9Mpa.

4. Maximum UPV value obtained 28 days for mix (W10G20) at 20% granite fines is 4500m/sec for 28 days that is 21% more than to reference mix without granite fines. This increment due to improvement of packing and denseness of mix. Further increment granite powder reduction in UPV value. Minimum UPV value observed at 50% granite fines is 3500m/sec is 6% lower than reference mix.

5.Carbonation depth result observed minimum depth at 20% replacement for 7 and 28 days is 2.2mm, 4mm is 42%, 28% lower than to reference mix. Maximum depth obtained at 50% concentration of GP for mix (W10G50) is 4.9mm, 6.9mm for 7 and 28 days is 29% and 23% more than reference mix (W10G0). Its shows up to 20% granite replacement its better resist Co_2 exposure.

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