International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-11, September 2019

Conglasscrete with EPCO KP-200

Mohankumar Namdeorao Bajad

Abstract*: Concrete durability keeps on being a subject of contention among structure proficient, specifiers, Government instrumentalities, manufacturers and designers in spite of the huge changes made in the concrete code. This paper address two perspectives sulphate attack and chloride attack. The key science-related with all of these systems is spread out and isolated. The exploratory examination has been done with a cement substitute by the waste glass powder (WGP) in the arrangement of 5% to 40% in augmentations of 5% by weight of cement and EPCO KP-200 utilized in concrete as a consumption inhibitor with 2%, by weight of cement. Substitute of 20% cement by WGP and expansion of 2% EPCO KP-200 by weight of cement improved strength and durability as well as diminished the unit weight of concrete exposed to chloride or sulphate attack.

Keywords: chloride attack, corrosion inhibitor, durability, strength, sulphate attack, unit weight.

I. INTRODUCTION

Glass is non-biodegradable (stays in our condition) and don't disintegrate effectively without anyone else's input along these lines don't have a noteworthy natural and social effect could bring about a genuine effect after transfer [1]. The weakening of reinforced concrete structures emerges because of corrosion of steel present in concrete which prompts basic failure [2]. The corrosion of reinforcing steel inserted in concrete is considered as a noteworthy overall issue. This issue happens due to the impact of chloride [3]. Therefore, the activity of chloride and sulphates in concrete containing WGP by utilizing consumption inhibitor should be researched.

This examination revolves around considering the effects of substance attacks by using inhibitor on the properties of concrete conveyed by displacing the cement with WGP [Conglasscrete] in various rates.

II. RESEARCH SIGNIFICANCE

The waste glass contains about 72.5%, SiO_2. When it is ground to a fineness of around 600 µm, SiO2 responds with alkalis in cement to frame cementitious item [4]. Such item help adds to the strength advancement and durability. The specific gravity of WGP is lower than the specific gravity of cement hence its aides diminishes the unit weight being a reasonable material sets aside cash by supplanting cement, yet additionally lessens the measure of expendable squanders. The utilization of inhibitors in concrete is an elective choice for avoiding the concrete decay within the sight of chloride particle [5]. Thusly a test assessment in making concrete containing WGP by using utilization inhibitor is noteworthy.

III. METHODOLOGY AND INVESTIGATIONS

The purpose of this investigation was to evaluate the effect of corrosion inhibitor and partial replacement of cement by WGP on the strength and durability of concrete specimens subjected to chemical attack. The reason for this examination was to assess the impact of corrosion inhibitor and halfway substitution of the cement by WGP on strength and durability of concrete specimens exposed to compound attack.

A. Procuring ingredients

Cement:

Common Portland concrete (OPC) 43 affirming to IS [6]. Compound organization of cementitious materials as appeared in figure 1. Figure 2 indicates the particle size distribution of cementitious materials.

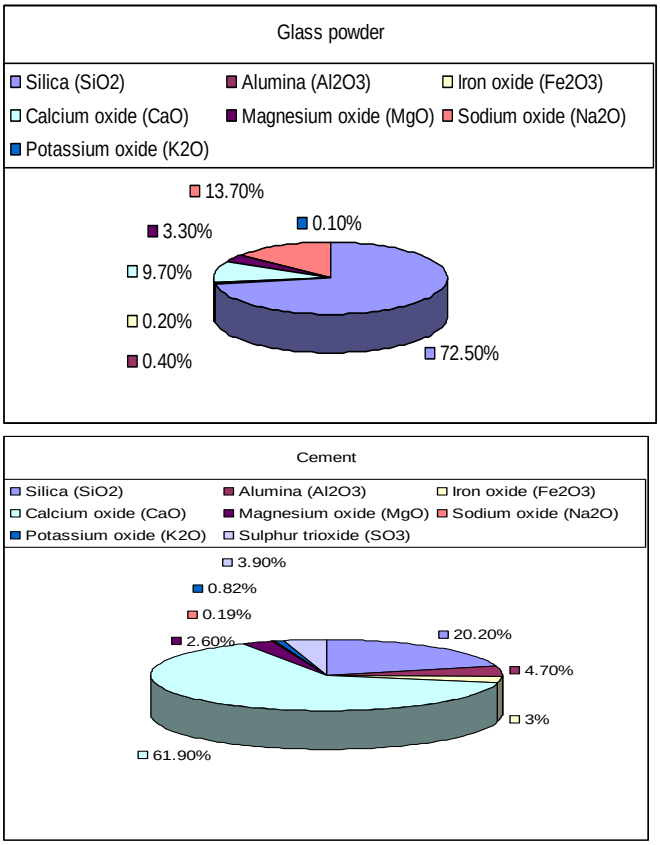

Fig. 1. Chemical composition of cementitious materials

Manuscript published on 30 September 2019.
*Correspondence Author(s)
Mohankumar Namdeorao Bajad, Department of Civil Engineering, Sinhgad College of Engineering, Pune-411041, Maharashtra, India.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC-BY-NC-ND license http://creativecommons.org/licenses/by-nc-nd/4.0/

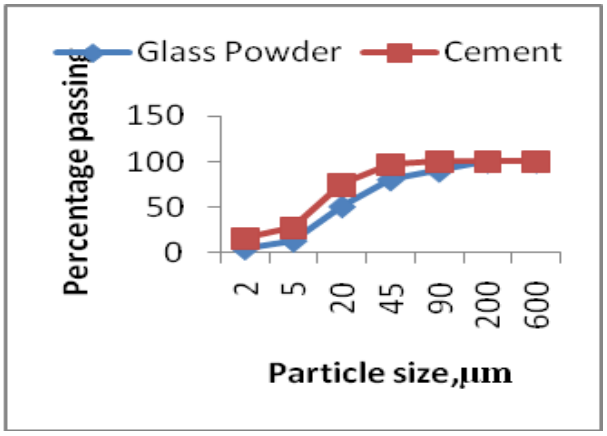

Fig. 2. The particle size distribution of cementitious materials

Aggregate:

The locally accessible sand of zone II had the specific gravity of 2.62. The specific gravity of the locally accessible coarse aggregate was 2.93. The coarse aggregate utilized were around 20 mm and downsize. An aggregate, utilized for trial examination, affirmed to the arrangements of Indian standard detail IS [7].

Admixture:

To allow users to the mix, superplasticiser-Sulphonated Naphthalene Formaldehyde (SNF) was used to the estimation of 2% by weight of concrete.

Water:

Water affirming to IS [8].

Supplementary Materials:

Waste glass

WGP were procured by beating waste glass pieces in a cone smasher production line. The 600 µm passing part was utilized for the analysis.

Corrosion inhibitor

To concede the security of concrete against chlorides, EPCO KP-200 was used to the estimations of 2% by weight of cement.

B. Casting and Mix Design

Blend configuration completed to shape M20 evaluation of cement by utilizing IS [9] yielded a blended extent of 1:2.35:4.47 with a W/C proportion of 0.45.

108 quantities of cube specimens of measurements 150 x 150 x 150 mm and 27 quantities of beam specimens of measurements 150 x 150 x 700 mm were cast by the blend extent and by utilizing corrosion inhibitor with a WGP as a cement substitution in various extent.

C. Curing of specimens

To discover the strength of control concrete, the 27 quantities of a 3D square and beam specimens of each were drenched in a 100% H_2O solution for 7 days, 28 days, and 90 days. By and large ocean water content 3.5% of salt. All together that to discover the impact of chloride attack for most exceedingly terrible condition, 54 quantities of block specimens were submerged in a 5% sodium chloride (NaCl) answer for 7 days, 28 days, and 90 days. To discover the impact of sulphate attack for most exceedingly awful condition, 27 quantities of 3D shape specimens were inundated in a 5% magnesium sulphate (MgSO4) solution for 7 days, 28 days, and 90 days.

D. Testing of strength

To discover the strength, the specimens were tested as per the provisions of the Indian standard specifications IS [10]. Fig. 3 exhibits test set in for estimating the strength of samples and for compound examinations.

Fig. 3. The test set in for measuring the strength of samples and for chemical investigations.

E. Chemical Content

To discover Cl_2, the powder tests were tried utilizing Argentometric technique as per the arrangements of the Indian standard detail IS [11] and to discover SO_4, the powder tests were tried utilizing Gravimetric strategy as per the arrangements of the British standard particular [12].

IV. TEST OUTCOMES AND DISCUSSIONS

Test outcomes are exhibited in unthinkable structures and have been discussed under various classes.

A. Effects of WGP on rheology property

Slump values were acquired as 100,94,91,88,82,76,73,72 and 66 mm for nine distinctive blends, for example, reference, WGP-5, WGP-10, WGP-15, WGP-20, WGP-25, WGP-30 and WGP-40 individually. It indicated 34 % functionality of concrete diminished as the 40% WGP expanded. A diminishing pattern in the functionality of concrete was seen with expanding supplanting of cement with WGP. It is because of the decrease of fineness modulus of cementitious material. Moreover, in control concrete, at given water content, an impressive bringing down of the cement substance will, in general, produce cruel blends. Also, for high total cement proportion, less amount of concrete glue will be accessible for giving greasing up impact per unit surface zone of the total, and thus usefulness diminishes. It is additionally seen that WGP in concrete influences the exhibition of superplasticizer-SNF because of similarity issues with a WGP and cement.

B. Effects of WGP on hardened properties

Density:

Unit weight of concrete at 28 days were acquired as 2408,2396,2379,2369,2354,2335,2315,2303 and 2283 kg/m^3 for nine distinctive blends, for example, reference, WGP-5, WGP-10, WGP-15, WGP-20, WGP-25, WGP-30 and WGP-40 separately. It demonstrated a 5.19 %-unit weight of concrete diminished as the 40% WGP expanded. A diminishing pattern in the density of concrete was seen with expanding supplanting of cement with WGP. It is because of the decrease of specific gravity of cementitious material. It was ascribed to the way that the specific gravity of WGP (2.58) is lower than the specific gravity of cement (3.15).

© Copyright: All rights reserved.

Strength:

Table I exhibits general results of various strength of concrete at different age with cement substitution by WGP.

Flexural strength of concrete with 20% cement substitution by WGP demonstrated a higher incentive by 22%, 20%, and 17% than reference blend for 7 days, 28 days and 90 days separately. Compressive strength of concrete with 20% cement substitution by WGP exhibited a higher motivator by 30%, 24% and 24 % than reference mix for 7 days, 28 days and 90 days separately. A growing example in strength was seen with extending overriding of cement with WGP up to 20%. It is expected to the pozzolanic reaction of WGP. WGP particle tinier than 45 µm atom gauge, SiO_2 reacts artificially with dissolvable bases in cement and structure cementitious things (by making C-S-H gel) with improved limiting limits and substance sufficiency that help add to the strength improvement and durability. Additionally, unreacted WGP particles go about as small-scale totals topping off voids, rendering the pressing impact. This offers to ascend to a unit weight of concrete. As needs are, WGP particles offer restriction against expansive forces realized by engineered substances and passageway of the compound particle into the strong mass. What's more, high SiO_2 content in WGP draws out the setting time and gives more strength. Besides, use of WGP envisions Ca $(OH)_2$ sifting. A pozzolana material, WGP atom reacts with Ca $(OH)_2$ (liberated in the hydration method at ordinary temperature) to casing blends taking care of cementitious properties. A decreasing example in strength was seen with growing replacing of cement with WGP past 20%, in light of the way that the debilitating effect commands and the strength starts to drop. In addition, the decline of the cement substance causes fewer proportions of C-S-H gel and reliably decreasing strength. The strength improvement at early reestablishing ages was moderate as a result of pore filling effect of glass. At first, WGP acts like pore filler material yet following 7-10 days, when the auxiliary pozzolanic response happens, does it begin to hydrate. This response expands the C-S-H gel development. The strength improvement thusly at early ages is moderate when simply pore filling effect exists and improves at later ages when the assistant pozzolanic reaction starts. Following 28 days, strength proceeds uncertainly at a consistent rate in light of the fact that in about a month's time, 85 to 100 % of cement hydrates. The 28 days strength of concrete is expected as full strength.

Table - I: General consequences of different strength (MPa) of concrete at various age with cement substitution by WGP.

Mix	7 days					28 days					90 days				
	fcr	*fc*	*fcc*	*fccci*	*fcs*	*fcr*	*fc*	*fcc*	*fccci*	*fcs*	*fcr*	*fc*	*fcc*	*fccci*	*fcs*
Ref.	2.4	21.0	20.4	23.3	20.6	3.5	27.0	24.7	29.1	25.4	3.6	27.3	22.2	25.8	22.8
WGP-5	2.4	22.2	21.3	25.5	21.8	3.6	28.5	26.9	30.7	27.1	3.6	28.8	23.9	27.9	24.2
WGP-10	2.7	23.2	22.5	25.9	22.5	3.7	29.7	27.8	32.7	28.1	3.8	30.0	25.0	28.9	25.6
WGP-15	2.8	24.8	23.6	27.7	24.3	3.9	31.5	29.3	33.5	30.0	4.0	31.8	26.5	31.0	27.1
WGP-20	3.0	27.3	25.9	29.9	26.7	4.1	33.5	31.1	36.3	31.8	4.2	33.8	28.2	32.4	28.8
WGP-25	2.9	23.7	22.7	26.6	23.0	4.0	30.5	27.4	31.5	29.0	4.0	30.8	25.7	30.1	26.3
WGP-30	2.8	17.6	16.7	19.0	17.0	3.9	24.2	23.1	26.9	23.2	3.9	24.4	20.8	23.9	21.6
WGP-35	2.4	16.0	15.3	17.9	15.7	3.5	22.4	21.0	24.2	21.5	3.6	22.7	18.8	22.1	19.7
WGP-40	2.3	12.9	12.5	14.5	12.6	3.4	19.0	18.1	20.9	18.2	3.4	19.2	16.3	18.6	16.8

Durability:

Effect of exposure conditions-

Table I likewise exhibits by and large consequences of the confraternity of cement exposed to concoction attack at various age with cement substitution by WGP. It was seen that chloride attack brought down the compressive strength of control concrete by 3 % at 7 days, 9 % at 28 days and 19 % at 90 days. Compressive strength of concrete with 20% cement substitution by the WGP in the chloride attack trial demonstrated a higher incentive by 23%, at 7 days, 15% at 28 days and 3% at 90 days than control concrete. Compressive strength of concrete by using 2% EPCO KP-200 presented to chloride ambush with 20% cement substitution by WGP exhibited a higher motivator by 42 % at 7 days, 34 % at 28 days and 19 % at 90 days than control concrete. It was analyzed that sulphate attack brought down the compressive strength of control concrete by 2% at 7 days, 6 % at 28 days and 17% at 90 days. Compressive strength of concrete with 20% cement substitution by the WGP in the sulphate attack test demonstrated a higher incentive by 27%, at 7 days, 18 % at 28 days and 6% at 90 days than control concrete. It is seen that there was a decrease in the strength of concrete delivered by supplanting cement by WGP when such concrete was exposed to concoction attack. This is because of the chloride kept in the pores of the concrete and response of sulphate with the result of hydration. Following 28 days, strength proceeds uncertainly at a diminishing rate when concrete exposed to synthetic attack. Since more time of the attack, rises the proportion of compound particle in strong mass. At the early time of the attack, the expansion of 2% EPCO KP-200 not just remunerated the loss of confraternity (because of the chloride attack) yet additionally expanded the strength colossally because of filling concrete pores and obstructing the porosity of concrete by the development of complex intensifies that is by geometric pore-blocking impacts. While following 28 days' time of the attack, the expansion of 2% EPCO KP-200 just incompletely remunerated the loss of confraternity (because of the chloride attack) on the grounds that following 28 days' time of the attack, strength proceeds inconclusively at a diminishing rate.

Chemical contents:

Table II demonstrates generally speaking aftereffects of compound substance in concrete for various age with cement substitution by WGP.

© Copyright: All rights reserved.

It was seen that Cl_2 in cement exposed to chloride attack with 20% cement substitution by WGP demonstrated a lower an incentive by 71% at 7 days, 70% at 28 days, and 58% at 90 days concerning reference blend. Cl_2 in cement by using 2% EPCO KP-200 presented to chloride ambush with 20% cement substitution by WGP showed a lower a motivator by 77 % at 7 days, 76% at 28 days and 62% at 90 days than concrete presented to chloride attack. SO_4 in cement exposed to sulphate attack with 20 % cement substitution by WGP demonstrated a lower an incentive by 73% at 7 days, 78% at 28 days, and 67% at 90 days as for reference blend. With the expanding level of WGP in concrete, the Cl_2 or SO_4 substance was seen to diminish. It accomplished a base when the cement substitution level was 20%. The control example with no cement substitution had the most elevated Cl_2 or SO_4 content. It is expected to WGP offering a boundary against infiltration of synthetic concoctions by delivering a thick C-S-H gel. The gel finishes off the thin pore space giving impermeability and reliably extending strength. - Moreover, WGP's pozzolanic response obstructs the pores diminishing the porosity of the folio and thwarting the concoction particle transport. Besides, extra C-S-H gel is framed when SiO_2 responds with Ca (OH) $_2$. This development expands protection from the compound particle. Furthermore, the utilization of WGP has been observed to be helpful in opposing the entrance of concoction particles into concrete in view of the miniaturized scale auxiliary densification bestowed by the pozzolanic response or optional hydration of WGP. Too, WGP refines the system of hydrated Portland cement in light of its reaction with free lime molded in the midst of concrete hydration, thusly improving the penetration restriction against commanding administrators, for instance, chloride and sulphate. Likewise using WGP in cement decreases warmth of hydration, refinement of pore structure, vulnerability and augmentation the insurance from compound attack. Henceforth it is reasoned that the concrete created by supplanting 20% of the cement by a WGP was increasingly compelling in hindering the infiltration of Cl_2 or SO_4 particles in the concrete mass. Past 20%, the Cl_2 or SO_4 substance started to augment yet again, in light of the way that in term of oxide association low calcium oxide content (9.7 %) in WGP does not bolster the coupling sway, rather achieves crippling the cement stick. The Cl_2 or SO_4 content at early restoring ages (0 to 7 days) was less after it was more and afterward proceeds uncertainly at an expanding rate. It is an aftereffect of the additional season of attack, lessens the resistance of concrete against passageway in light of the fact that the pace of increment of confraternity a snappier to start and the rate get diminished with age as at later stages the hydration strategy ends up being slower. The EPCO KP-200 decreased the entrance of chloride particle on the grounds that a typical instrument for repressing decay includes the development of a slim defensive covering which forestalls access of chloride.

Table -II: General consequences of chemical contents in concrete at various age with cement substitution by WGP.

Mix	WGP (%)	7 days			28 days			90 days		
		Cl_2 [Mg/lit.]	*Cl_2^1 [Mg/lit.]*	*SO_4 [Mg/lit.]*	*Cl_2 [Mg/lit.]*	*Cl_2^1 [Mg/lit.]*	*SO_4 [Mg/lit.]*	*Cl_2 [Mg/lit.]*	*Cl_2^1 [Mg/lit.]*	*SO_4 [Mg/lit.]*
Reference	0	109.97	90.97	226.35	131.97	109.97	370.40	139.96	115.97	432.14
WGP-5	05	80.98	67.98	185.20	84.98	75.98	205.78	100.97	83.98	288.09
WGP-10	10	44.98	39.99	133.75	56.98	47.98	164.62	81.98	68.98	195.49
WGP-15	15	36.99	30.99	92.60	40.99	33.99	102.89	68.98	54.98	154.33
WGP-20	20	31.99	24.99	61.73	39.99	31.99	82.31	58.98	52.98	144.04
WGP-25	25	69.98	58.98	154.33	86.98	70.98	246.93	108.97	87.98	308.67
WGP-30	30	96.97	78.98	174.91	102.97	87.98	308.67	119.97	101.97	329.24
WGP-35	35	106.97	89.97	185.20	114.97	92.97	339.53	126.97	103.97	390.98
WGP-40	40	101.97	90.97	216.07	124.97	104.97	360.11	128.97	108.97	411.56

C. Optimum WGP content

Most elevated strength and least Cl_2 or SO_4 substance was accomplished with 20 % substitution of cement by WGP. It is because of more beneficial gathering of 20% of WGP and 80% of OPC for delivering perfect measure of hydration items [greatest C-S-H gel and littlest $Ca(OH)_2$] and improving the pressing thickness of the glue in light of the fact that the utilization of mixing pozzolana materials, for example, WGP diminishes the measure of $Ca(OH)_2$ in concrete and to defeat its awful impact by changing over it into a cementitious item is a development in research work. Control concrete contains 30% Ca $(OH)_2$ and 70% C-S-H gel of the volume of concretes in a completely hydrated concrete glue. The nonattendance of confraternity and sturdiness of cement is by uprightness of the closeness of Ca $(OH)_2$. The primary great position is that a Ca $(OH)_2$, being acid neutralizer in nature keeps up pH regard around 13 in the strong which restrict the corrosion of fortification.

Along these lines, it is assumed that 20% was the perfect level for replacing cement with WGP.

V. CONCLUSION

Based on the aftereffects of this test examination, the accompanying ends are drawn

- The workability reduced up to 18% as the 20% WGP expanded.
- Superplasticizer-SNF was not reasonable to remunerate the loss of functionality because of the expansion of WGP.
- Superplasticizer-SNF was not reasonable to remunerate the loss of functionality because of the expansion of WGP.
- Use of appropriate superplasticizer was observed to be important to keep up functionality with limited (W/C) proportion.

© Copyright: All rights reserved.

- Higher-strength progression 17% to 30% was practiced when 20 % of cement was superseded by the WGP in cement.
- Concrete created by supplanting 20% of the cement by WGP indicated more noteworthy strength in the scope of 3% to 23% when cement exposed to chloride attack and 6 % to 27% when cement exposed to sulphate attack.
- Concrete made by overriding 20% of the cement by WGP and EPCO KP-200 admixed at 2% development measurement by weight of concrete showed a most outrageous strength in the extent of 19 % to 42 %.
- Chloride attack brought down the compressive strength ranges between 3 % and 19 %.
- Sulphate attack brought down the compressive strength ranges somewhere in the range of 2% and 17 %.
- Concrete created by supplanting 20 % of concrete by WGP demonstrated less measure of chloride ranges from 58% to 71% and sulphate ranges from 67% to 73%
- Concrete conveyed by replacing 20% of the cement by WGP and EPCO KP-200 admixed at 2% development measurement by weight of concrete showed less proportion of chloride reaches out between 62 % and 77%.
- The expansion of EPCO KP-200 expanded the strength of concrete as well as improved the opposition of cement against infiltration of chloride particle.
- The thickness diminished up to 2% as the 20% WGP expanded

Thus, it is recommended that the utilization of the 20 % WGP in concrete as cement overriding close by 2 % utilization inhibitor is useful.

NOTATION

Cl_2 is chloride content in concrete subjected to chloride attack

Cl_2^1 is chloride content in concrete with EPCO KP-200 subjected to chloride attack

f_c is compressive strength of concrete without subjecting to attack

f_{cc} is compressive strength of concrete subjected to chloride attack

f_{ccci} is compressive strength of concrete with EPCO KP-200 subjected to chloride attack

f_{cr} is flexural strength of concrete

f_{cs} is compressive strength of concrete subjected to sulphate attack

SO_4 is sulphate content

REFERENCES

1. Baxer.S, Jin W and Meyer C, “Glasscrete-concrete with glass aggregate”, ACI Materials Journal, 2000, pp.208-213.
2. Ahmad Shayan and Aimin Xu, “Performance of GP as a pozzolana material in concrete: A field trial on concrete slabs”, Cement and Concrete Research, Vol.36, 2006, pp.547-468.
3. Saraswathy V., Ha-Won Song, “Improving the durability of concrete by using inhibitors ”, Building And Environment, Vol.42, 2007, pp.464-472.
4. Caijun Shi, Yanzhhhong Wu, Chris Riefler and Hugh Wang, “Characteristics and pozzolana reactivity of glass powders (GP)”, Cement and Concrete Research, Vol.35,2005, pp.987-993.
5. Devi M.and Kannan K, “Analysis of strength and corrosion resistance behavior of inhibitors in concrete containing quarry dust as fine aggregate”, ARPN Journal of Engineering and Applied sciences, Vol.l6, 2011, pp.124-134.
6. IS 8112, **“**Specification for 43 grade ordinary Portland cement”, Bureau of Indian Standards, New Delhi, 1989
7. IS 383, **“**Specification for coarse and fine aggregates from natural sources for concrete”, Bureau of Indian Standards, New Delhi, 1970.
8. IS 456, **“**Indian standard code of practice for Plain and Reinforced Concrete”, Bureau of Indian Standards, New Delhi,2000.
9. IS 10262, “Recommended guidelines of concrete mix design”, Bureau of Indian Standards, New Delhi,2009.
10. IS 516, “Methods of tests for strength of concrete” Bureau of Indian Standards, New Delhi, 1959.
11. IS 14959: Part 2, “Determination of water-soluble and acid-soluble chlorides in concretes in concrete and mortar”, Bureau of Indian Standards, New Delhi,2001.
12. BS 1881: Part 124, “Methods for analysis of concrete (Cement content, sulphate content (SO_4) and alkali contents)”, Bureau of British Standards, New Delhi, 1988.

AUHORS PROFILE

Dr. Mohankumar Namdeorao Bajad is a Professor of Department of Civil Engineering at Sinhgad College of Engineering, Pune, Maharashtra (India). He holds DCE from MSBTE Mumbai, Maharashtra (India); BE in Civil Engineering from Amravati University, Maharashtra (India) and ME in Structural Engineering from Pune University, Maharashtra (India) and Ph.D. in Civil Engineering from Sardar Vallabhbhai National Institute of Technology; Surat, Gujarat (India). He is a member of the Indian Concrete Institute, Indian Association for Structural Engineering, Indian Association for Computational Mechanics, Indian Society for Technical Education and International Association of Engineers (IAENG). He has guided many students for their research work. He is the sole author of so many Structural Engineering books. His research interests include advances in science and technology of concrete. He has published several research papers in the reputed national and international journals. He possesses vast experience in the field of teaching and research.

© Copyright: All rights reserved.