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RESEARCH ARTICLE

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INVESTIGATION OF CONCRETE RESISTANCE IN VARIOUS AGGRESSIVE SOLUTIONS WITH FLY ASH REPLACEMENT

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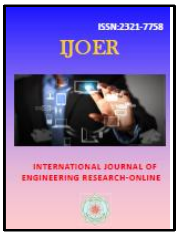

ABSTRACT

Concrete is the most frequently used material worldwide in construction industry. Conventional concrete (CC) casting relies on compaction to ensure adequate strength and durability. Inadequate compaction affects the quality and durability of concrete structures. Utilization of fly ash as a supplementary cementitious material adds sustainability to concrete by reducing the CO2 emission of cement production. The positive effects of fly ash as a partial replacement of cement on the durability of concrete are recognized through numerous researches; however, the extent of improvement depends on the properties of fly ash. Fly ash is used in concrete as an admixture as well as in cement. The effect of these fly ash on durability of concrete is discussed in this article. The use of concrete in aggressive and potentially aggressive environmental condition has been increased substantially. Concrete structures are employed to support machineries, staffs, and products of oil and gas exploration and productions. Concrete structures used to keep nuclear reactor and need to contain gases and vapors that released at high temperatures and pressure in emergency situations. In all aforementioned conditions, fly ash utilization like cementitious materials play significant role.

So, studying and understanding the influence of fly ash on concrete durability is extremely important. In this article the effect of fly ash on the concrete durability will be explored. And also The inclusion of fly ash as a component of concrete either as an admixture to the cement or as partial replacement of cement imparts significant enhancement to the basic characteristics of the resulting concrete, both in its fresh and hardened state. In this study the concrete cube specimens are prepared for different % of fly ash as a replacement viz. 0%, 10%, 20% & 30% and tested for compressive strength of concrete in various curing conditions i.e. in water, in the solution of 10% Na_2SO_4, 2%H_2SO_4, in the solution of 10% H_2SO_4, 2%Na_2SO_4 and in the solution of NH_4NO_3 with M20, M25 and M30 grades of concrete and results were tabulated and the conclusions are made.

I INTRODUCTION

Homogeneous mixture of Cement, fine aggregate, Coarse aggregate and water is called concrete. Success of its based on in its versatility which has been designed to withstand cruel environments which needs to take as most inspirational. Further capable like Engineers and scientists are trying to increase its limits to get full understanding of the span of structure by using the avant-grade chemical admixtures and various supplementary cementicious nonspirituals SCNs.

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Early SCNs ash which is obtained from volcans consists of natural and available in everywhere readily. The aqueducts, Coliseum are the famous marvels which are constructed by skills of Romans and Greeks.. Nowadays, most of the SCMs are concrete admixtures because these are out growth materials attained from the industries. The increasing care is paid to find the deterioration over a long period on concrete structures. When they exposed to the chemicals which are aggressive in nature. It important to know the span of the structures. Three factors meet the contact to play an important role at concrete to acid warding off. the permeability, determining the reach of which acids can ingresses into concrete. the alkalinity and the composition of the chemicals, cement paste. On addition of fly ash in Past studies have shown the positive influence, fume of silica and slag of blast-furnace because of the lower CH content, reduced Ca-to- Si ratio in calcium silicate hydrates the clarifies pore structure they yields in concrete. Chemical degradation of concrete is the reactions of consequence between the constituents of cement stone, i.e., calcium reacts with nitrates and dilutes the cementeceous material, tc. The most important invading agents are: SO_4^{2-}, Mg_{2+}, NH_{4+}, Cl-, H_+, and HCO_{3-}. Primarily the degradation of the Sulphate consists the impact on cement stone due to sulphate ions and nitrates. The major cause for the corrosion is nitrate ion which causes tumours and humps, because it causes the occurrence of un suppressed compounds, such as ettringite, $C_3A·3CaSO_4·32H_2O$, which come to pass in the shape of prismatic crystals. Damages to the concrete are the consequences and destruction at inferior. Deterioration of the concrete by sulphates, and ammonium nitrate for example, covers the most destructive corrosion Protective gel takes place On concrete and neither by balancing nor creating . In this case by the expansion of the cement matrix and by mollifying the cement matrix concrete is damaged. By Affixing of fly ash to Portland cement this cement become more safeguarding to the sulphate destructive environment but concrete can't resist nitrate attack. Between sulphates and hydrated cement components the chemical reactions yield the following reaction secondary gypsum ($CaSO_4·2H_2O$), secondary ettringite ($3CaO·Al_2O_3·3CaSO_4·32H_2O$), thaumasite ($CaSiO_3·CaSO_4·CaCO_3·15H_2O$), brucite ($Mg(OH)_2$), M–S–H ($3MgO·2SiO_2·2H_2O$) and gel of silica ($SiO_2·xH_2O$). Expansion and exploding will maked up by Secondary ettringite. Whether gypsum embodiment results in maturation is thrashing out in the literature. Ettringite, gypsum have an streching and devastated character which was indicated by Several researchers, while others claimas compared to the ettringite domination gypsum contribution is limited. Mekedup of thaumasite leads to resistance against the fracture loss due to the putrescenes of the strength-forming hydration products (C–S–H). As we all known, ammonium nitrate solutions are very sarcastic to cementations materials, which guides to dissolution of cement-based nonspirituals according to the following reaction:

$$2NH_4NO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2NH_3 + 2H_2O.$$

Between nitrates and ammonia, there happens the reaction both of which are easily fluidities in water. Furthermore, as compared to the water, in the ammonium nitrate solution the defrosting of calcium hydroxide is higher. Due to evacuation of calcium hydroxide It is clear from the above-mentioned chemical reception that, the ammonium nitrate decalcifies the hardened cement paste. If it happens Reduction of the pH- value takes place because of bending and terminating of other products of the hardened cement paste. Consequently, at an enhancing rate of corrosion in steel reinforcement may occur. Under the attack of erosive solutions superimposed with a mechanical load when the material suffers Cement based decadence and marring must be intensities and stimulated.

Based on the ascertaining of the abasement of the material This test is conducted in properties such as loss in mechanism, especially the strength of the compression, which is perceptible to the degree of abasement than the strength of compression. To obtain results and To advancing the processes in a short period of time, the test uses small specimens that are immersed in solutions where aggressive in nature. Aggressiveness of the solution As compared to the concentration of the natural environment must be higher. Based on comparison of the behaviour of similar specimens inundating in the

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medium of unfriendly and in distilled water The decadence of the results obtained.

II LITERATURE REVIEW

Georgescu, D.; Apostu, A.; Gavrilescu, R [1] when the percentage of steel in the concrete is Primarily exposed to the marine or aggressive circumstances. Due to reinforcement The structural vitiation of concrete structures corrosion is major stubbornness of fractures all over globe. An attempt had been made in forewarning the overhauling life of RC structures In the work. Liu, Z. [10] Here we are going to study about under low-temperature sulfate environment at low water-binder ratio the strength developed and the arrangement of engaging of cement-based material made of limestone powder. El-Hachem, R.; Roziere, E.; Grondin, F.; Loukili, [12] cementitious material, if we diminish the water-binder ratio, after the material is souses in the magnesium sulfate solution at low temperature at the age of 90 d the loss of compressive strength has evenly abates. Schmidt Lotenbach and RomerNeuenschwander[14] By established test methods the consequences of attack on external sulfate and nitrate were examined, i.e. change of length and mass, as well as by a newly developed, surface sensitive ultrasonic method, using Leaky Rayleigh waves (1 MHz). De Belie De Coster and Van Nieuwenburg[3] Feed and manure acquired from animal houses are affaired to disputatious substances of Concrete.By acids of feed, lactic and acetic acids, and abrasion Chemical attack happens caused by animals and cleaning were limitated which were studied using rapid corrosion tests. M. Sacaand Voicu, G.[2]Corrosive environment is important for the long wearing of the concretes when limestone filler exhibtis to it made with the materials which shows the blended possessions such as blinders. The paper gives information about the compartment of some blended cements carrying Portland cement which reacts with 5% solution of $MgCl_2$ and cement contains 10-40% limestone filler.Miletic and lic Ranogajec Marinovic-Neducin[8]considers Portland cements are corroded by sulphate (C_3A content in clinker 6.60% and 13.31%) and nitrates the same Portland cements where the 30% of Portland cement clinker was replaced with coal ash. MacíasGoñi and Madrid[19] By means of the Köch-Steinegger test The durability of OPC and GGBS pastes in buffered acetic/acetate medium (pH 4.5) was studied. Results show that measurement ofcompressive strength is not a good parameter to estimate the degradation degree of paste of cement in acid medium because two effects take place with opposite consequences on compressive strength as a result of acid attack: a degradation of the external surface with loss of resistance occurs because of densification of the paste of the cement in the specimen core. Santhanamand M. Cohen [13] , By Portland cement (PC) mortars, concrete cubes the Sodium sulfate and nitrate assault was studied on C_3S mortars in an attempt to autonomously appraise the effect of formation of gypsum on the performance. Bertronand Escadeillas[6] Aim of this research is to analyze the s cement-based materials deterioration mechanism stored in aggressive solutions and organic acids. To specify the composition parameters of binders that impacts durability This results are used.Pavllk, V.[16] Solutions of nitric, hydrochloric, sulphuric, acetic and formic acids were compared to test the rate of corrosion of hardened cement paste . Corrosion in solutions of acetic and nitric acids with different concentrations and PH was studied in more detail. Bertron, Duchesne and Escadeillas, [6]Manure like effluents of ensilage and manure of liquid contains organic acids toward the concrete that represent a rigorous chemical combination to structures. Reason behind this study is to search out the chemical composition of parameters to urge the sturdiness by dissecting the behaviour of the cement paste that exhibit chemical paste(, Fe and Mg ,Ca, Si, Al) in organic acid and erosive solutions and to analysing the force of the chemical assault by the varied acids like sulphates and nitrates. Cement paste is employed to hold this check that made of four binders (ordinary cement, dross cement, OPC blending with silicon dioxide fume and OPC blending with fly ash).

III MATERIALS AND METHODS

A. Ordinary Portland cement.

Portland cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco, and most non-specialty grout. It developed from other types of hydraulic lime in England in the mid-19th century and usually originates from limestone. It is a fine powder produced by heating materials in a kiln to form what is called clinker, grinding the clinker, and adding small amounts of other materials. Several types of Portland cement are available with the most common being called ordinary Portland cement (OPC) which is grey in color, but white Portland cement is also available.

B. Sand.

Fine aggregate / natural sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles, but is distinct from clays which contain organic materials. Sands that have been sorted out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains. Usually commercial sand is obtained from river beds or from sand dunes originally formed by the action of winds.

C. Coarse aggregate

Coarse aggregate of size less than 10 mm i.e., passed through 10mm sieve and retained on 6.3mm sieve are taken. Because, if we add aggregate of larger size, then the crack width of concrete specimen increases and it cannot heal the cracks in presence of moisture.Two single sized crushed stone aggregates ranging from 12.5mm to 2.36 mm and 20 mm to 4.75 mm (10mm and 20mmsizes) were used in respective proportions in concrete mixes.

D. Flyash

Fly ash, that is that the higher substitute for cement and for the most part created from oxide and quicklime, will be used as a, or as a supplement thereto. The conjure ash pozzolanic materials that, that means that they'll be wont to bridle cement materials along. Pozzolanic materials, as well as ash cement, add sturdiness and strength to concrete.in the combustion of coal, ash is one among the residues generated. ash is usually astrict from the chimneys of coal-fired power plants, and that they area unit classified as 2 types; the opposite, bottom ash, is far away from all-time low of coal furnaces. relying upon the supply and makeup of the coal being burned, the elements of ash vary significantly, however all ash includes substantial amounts of oxide (SiO2) (both amorphous and crystalline) and fluxing lime (CaO). ash is classed as category F and sophistication C varieties.

The Experimental programme was passed out in the fallowing manner.

Designed the mix for various grades of concrete (M20, M25& M30) which are given bellow. This investigational search was agreed not in for three unlike proportions of fly ash replacement with Portland cement. Then finest percentage substitute was found for fly ash substitution. Then casted the concrete cubes for curing in 10% Na_2SO_4 solution and 2% H_2SO_4 solution, 2% Na_2SO_4 and 10% H_2SO_4 solution and water, ammonium nitrate and tested the specimens after 7 and 28 and 90 days of curing.

For M20 grade:1:1.13:2.49:0.43

For M20 grade:1:1.69:3.25:0.47

For M25 grade:1:1.55:2.55:0.45

IV RESULTS

The results are represented in the graphical form for this Experimental work.

A. Variation of compressive strength for M30 grade concrete

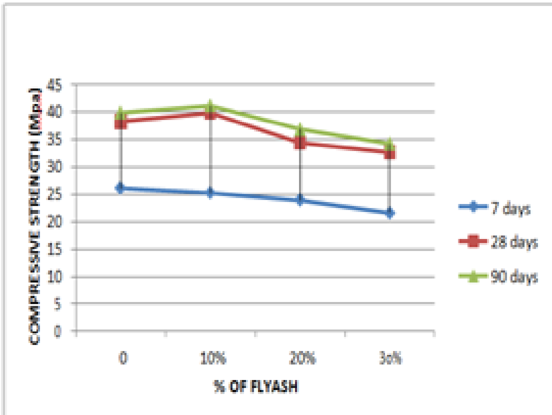

Figure 1.variation of compressive strength when cured in water

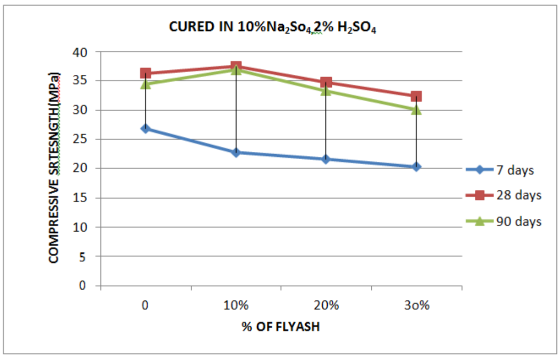

Figure 2.variation of compressive strength When cured in cured in 10% NA_2SO_4 and 2% H_2SO_4

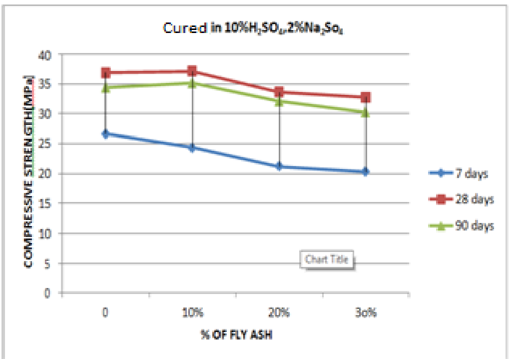

Figure 3.variation of compressive strength When cured in 2% NA_2SO_4 and 10%H_2SO_4

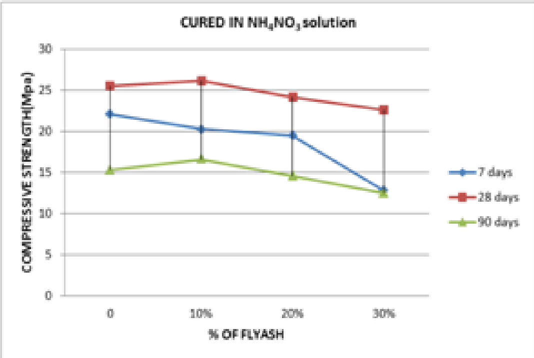

Figure 4.variation of compressive strength When cured in NH_4NO_3 solution

B. Variation of compressive strength for M25 grade concrete

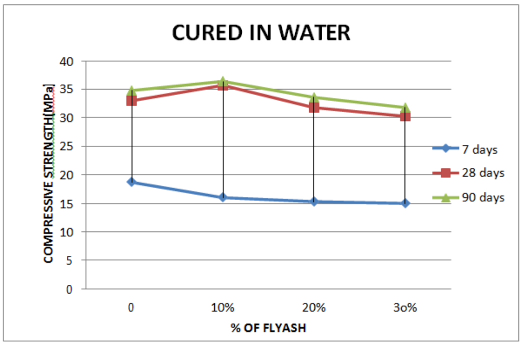

Figure 5. Variation of compressive strength When cured in water

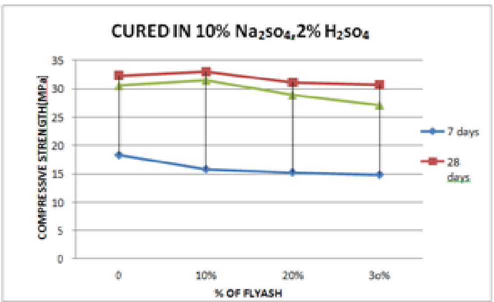

Figure 6.variation of compressive strength When cured in cured in 10% NA_2SO_4 and 2% H_2SO_4

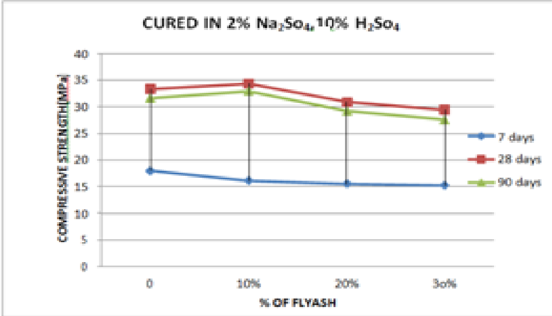

Figure 7.variation of compressive strength When cured in 2% NA_2SO_4 and 10%H_2SO_4

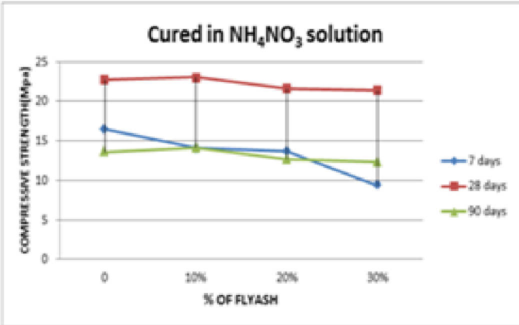

Figure 8.variation of compressive strength When cured in NH_4NO_3 solution

C. Variation of compressive strength for M20 grade concrete

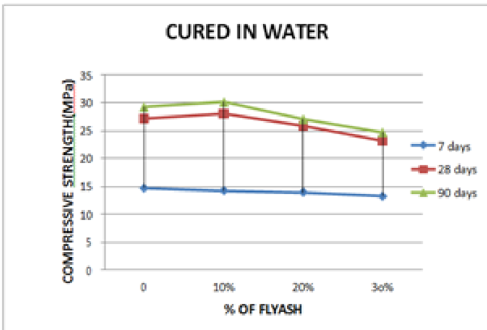

Figure 9.variation of compressive strength when cured in water

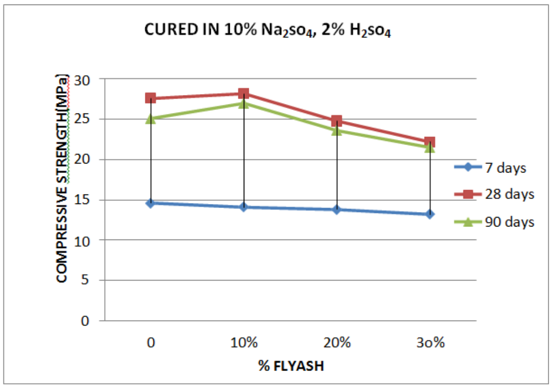

Figure 10.variation of compressive strength When cured in cured in 10% NA_2SO_4 and 2% H_2SO_4

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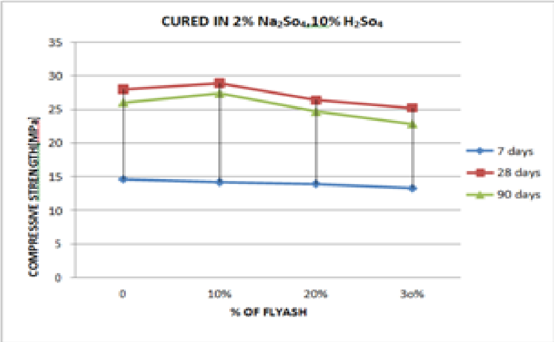

Figure 11.variation of compressive strength When cured in 2% NA_2SO_4 and 10%H_2SO_4

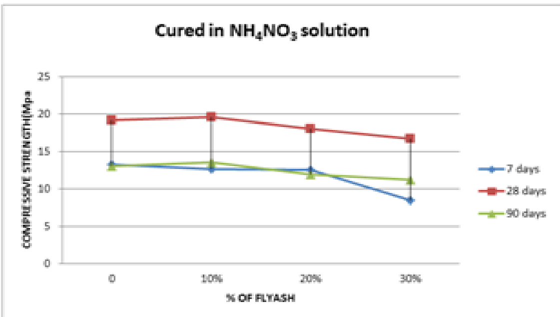

Figure 12.variation of compressive strength When cured in NH_4NO_3 solution

V DISCUSSIONS

- The compressive strength of M30 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 3.33%, 8.61% and 17.35 respectively when Cured in normal water for 7 days, increased by 4.10% decreased by 10.12% and 14.67% respectively for 28 days and is increased by 4.14%, decreased by 7.40% and 14.18% respectively for 90 days when Cured in normal water.
- The compressive strength of M30 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 15.06%, 19.32% and 24.28% respectively and is increased by 3.41% decreased by 4.61% and 10.69% respectively for 28 days and is increased by 7.07%, decreased by 3.48% and 12.67% respectively for 90 days when Cured in 10% Na_2SO_4, 2%H_2SO_4 solution.
- The compressive strength of M30 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 8.51%, 20.59% and 23.85% respectively for 7days, is increased by 1.59%, decreased by 8.91% and 11.16% respectively for 28 days and is increased by 2.20%, decreased 6.68% and 12.03% respectively for 90 days when Cured in 2% Na_2SO_4, 10%H_2SO_4 solution.
- The compressive strength of M30 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 8.06%, 11.82% and 40.77% respectively for 7 days, is increased by 2.33%, decreased by 5.39% and 11.57% respectively for 28 days and is increased by 8.28%, decreased 4.5% and 18.5% respectively for 90 days when Cured in NH_4NO_3solution.
- The compressive strength of M25 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 14.43%, 18.18% and 19.78% respectively for 7 days, is increased by 8.18%, decreased by 3.63% and 8.18% respectively for 28 days and is increased by 4.59%, decreased by 3.44% and 8.62% respectively for 90 days when Cured in normal water.
- The compressive strength of M25 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 13.63%, 16.90% and 19.12% respectively for 7 days, is increased by 2.16%, decreased by 3.71% and 4.95% respectively for 28 days and is increased by 2.94%, decreased by 5.55% and 11.43% respectively for 90 days when Cured in 10% Na_2SO_4, 2%H_2SO_4 solution.
- The compressive strength of M25 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 10.55%, 13.88% and 15.55% respectively for 7 days, is increased by 3.0%, decreased by 7.20% and 11.71% respectively for 28 days and is increased by 4.11%, decreased by 7.59% and 12.65% respectively solution for 90 days when Cured in 10%H_2SO_4, 2% Na_2SO_4.
- The compressive strength of M25 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 14.3%, 16.73% and 42.97% respectively for 7 days, is increased by 1.4%, decreased by 4.7% and 5.63% respectively for 28 days and is increased by 4.04%, decreased 6.53% and 9.70% respectively for 90 days when Cured in NH_4NO_3solution.
- The compressive strength of M20 grade concrete when Replaced fly ash with 10%, 20%

and 30% is decreased by 3.40%, 18.18.44% and 9.52% respectively when for 7 days, is increased by 3.30%, decreased by 4.77% and 14.70% respectively for 28 days and is increased by 3.07%, decreased by 7.50% and 15.69% respectively for 90 days when Cured in normal water.

- The compressive strength of M20 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 3.42%, 5.47% and 9.58% respectively for 7days, is increased by 2.17% decreased by 10.14% and 19.56% respectively for 28 days and is increased by 7.56%, decreased 5.97% and 14.34% respectively for 90 days when Cured in 10% Na_2SO_4, 2%H_2SO_4 solution.
- The compressive strength of M20 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 2.70%, 4.79% and 8.90% respectively for 7 days, is increased by 3.21%, decreased by 5.71% and 10.0% respectively when Cured in for 28 days and is increased by 5.38%, decreased by 5.0% and 11.23% respectively for 90 days when Cured in 10%H_2SO_4, 2% Na_2SO_4solution.
- The compressive strength of M20 grade concrete when Replaced fly ash with 10%, 20% and 30% is decreased by 4.5%, 5.22% and 36.21% respectively for 7 days, is increased by 3.86%, decreased by 5.99% and 12.98% respectively for 28 days and is increased by 11.89%, decreased 8.44% and 14.12% respectively for 90 days when Cured in NH_4NO_3solution.

VI CONCLUSIONS

For M30 grade of concrete the specimens with 10% replacement of flyash cured in solution 1(10% Na_2SO_4, 2% H_2SO_4) got optimum increment i.e 7.07% compared to NH_4NO_3 solution of 6.28%. For M25 grade of concrete the specimens with 10% replacement of flyash cured in water got optimum increment i.e 4.59% at solution (10% Na_2SO_4, 2% H_2SO_4) as compared to NH_4NO_3 solution of 4.04%. For M20 grade of concrete the specimens with 10% replacement of flyash cured in solution 1(10% Na_2SO_4, 2%H_2SO_4) got optimum increment i.e 13.30% as compared to NH_4NO_3 solution of 11.89 %.

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