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RESEARCH ARTICLE

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Comparative Study of Conventional Concrete with Binary Cement Concrete

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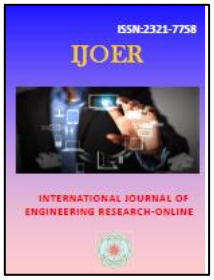

ABSTRACT

The utilization of innovative material becomes mandatory in recent days due to developing population, which is now a great challenge to the society, because of the scarcity of materials. The most important part of concrete is cement. In concrete the price of cement is higher than other raw materials. The population keeps on increasing but raw materials for concrete are limited. The production process of cement produces a lot of CO_2. The enormous emission of CO_2 initiates harmful environmental changes. Nowadays researchers make efforts to minimize industrial emission of CO_2.This major problem can be solved by replacing the material to some extent with advance materials or by making alterations in the property of the conventional concrete. In this project, cement is partially replaced by bentonite, it includes the composition of cement. This paper presents the experimental result carried out to determine workability and compressive strength of concrete at different replacements of PPC. M-25 grade of concrete (1:1.6:2.98) at w/c of 0.48 was designed as per IS-10262-2009. The results show that PPC can be replaced up to 10% by bentonite without hampering the compressive strength of concrete.

KEYWORDS: Bentonite, cement, maximum percentage.

INTRODUCTION

In this research, an attempt has been made to minimize the above problem by the limited use of Bentonite powder in place of Cement. The aim of present work is to explore Bentonite as a material of hope for the twenty first century. In this work, investigational examination has been done to measure the effect of replacement of usual material by a cheaper alternative i.e. Bentonite, on strength of concrete. For this study 60 cubes were cast by replacing cement (PPC) by Bentonite. Compressive strength of Bentonite concrete was observed. To achieve this comparative study, cubes were cast replacing cement by 5%, 10% and 15% with Bentonite. These cubes were put for curing in water and tested after 7, 14, 28 and 56 days. Compressive strength for design mix(1: 1.601 :2.916) and water cement ratio 0.48 were identified. Bentonite is chemically weathered volcanic ash generally used as lubricant in drilling operations. The name Bentonite was given by Wilbur C. Knight in the year 1898 near Rock River, Wyoming. Bentonite is a type of clay consisting mostly of montmorillonite. It is made up of different type of clay which was formed from the volcanic ash. Bentonite belongs to Smectite clay family. Smectites have a good absorbing and adsorbing power as compared to other types of clay. Due to good absorption and adsorption powers, it is called Living Clay. Bentonite also has a high detoxifying ability. Bentonite concrete has appreciable later strength and is enough economical and susceptible than conventional concrete. Bentonite is highly plastic in nature. Availability of Bentonite can be in both powdered and solution

form. The ionic property of Bentonite helps in forming a sticky coating on grains of the sand (fine aggregate). Powdered Bentonite are used in different types of industrial applications for example, pharmaceuticals industry, paper, cement, dyes and ceramics etc, thus changing the rheology and controlling the stability of the material. There are some special and noticeable properties of Bentonite i.e. hydration, swelling, water absorption, viscosity, thixotropy which makes it a precious material for extensive uses and applications. Quarrying results in exploitation of Bentonite deposits. Bentonite is a solid with approximately 30% of moisture content in it. To bring about 15% of moisture content, the material is crushed and activated by adding of soda ash which has chemical formof Na_2Co_3. The final application is done by either granulated form or powdered form. The special way of application is done by the purification of Bentonite by the removal of gangue minerals or by treating it with acids to obtain acid activated Bentonite. Swelling as well as the mineralogy can change considerably by the modifications. Swelling capacity of Bentonite is temperature and pressure dependent. There are basically two types of Bentonite that exists, Sodium Bentonite and Calcium Bentonite which were found by Hosterman and Patterson in the year 1992.The sodium Bentonite has absorbing property and gets swelled up when it comes in contact with water. It is used in drilling mud for oil and gas wells for environmental and geotechnical investigations because of its colloidal property. Sodium Bentonite have good swelling capacity and are useful as sealant. It provides self-sealing, low permeability barrier. It enhances rheological or sealing performance in geo-environmental applications. Calcium Bentonite has just opposite properties that of sodium Bentonite. It acts as an absorbent of fats and oils. It is most diligent element of fuller's earth and suitable industrial purifying agent. It may be converted into sodium Bentonite by ion exchange process.

Review of literature

Akbar et al. (2013) Evaluated that the Effect of Bentonite on Strength and Durability of High Performance Concrete. Cement used in the project was Ordinary Portland Cement meeting the requirements of ASTM C150 Type I cement. Fineness of cement was determined using ASTM C184.The aggregate was purchased locally, naturally available.Mix design was aimed for Ordinary Portland Cement Concrete (PCC) having compressive 28 days strength of 6000psi for control samples. W/c ratio was 0.5. Ultrasonic Pulse Velocity testing was performed. Bentonite resulted in poor early stage and good later stage Compressive strength. Sulphate resistance of concrete increases as the Pozzolana replacement increases. Compressive strength were increased when bentonite replacing cement are increased up to 20%. Bentonite can be used in a place where later stage strength is required. And for durability purposes it gives good results at every stage.

Devrim et al. (2011) carried out investigation on Usability of sand-bentonite-cement mixture in the construction of impermeable layer. Bentonite and cement were chosen as admixtures and sand was chosen as the main material. The chemical components of the P 32.5 cement used. The rate of admixture is 43.62% and the clinker is 56.38%.The dry and washed sieve test results made for determining the category of the sand with 0.92% water content brought from Yenicekent (Denizli) to be used in the experiments. In all samples prepared by adding bentonite and bentonite-cement mixture, permeability decreased significantly compared to sand. When bentonite is mixed with sand the dry density increases significantly. As the mixing ratio of bentonite to sand changes from % 10 to 40%, the maximum dry density of the bentonite – sand mixtures increases and the corresponding optimum moisture content decreases. An optimum10% bentonite /sand mixture satisfies the minimum requirement of hydrolic conductivity 10 to 20% bentonite/sand mixture is recommended for an unpermeable layer. Bentonite can be used in a place where later stage strength is required. Bentonite resulted in poor early stage and good later stage Compressive strength.

Ali Memon et al. (2012) examined Utilization of Pakistani bentonite as partial replacement of cement in concrete. In this research, eight different mixes were prepared. One nominal mixes and Bentonite mixes include 3%, 6%, 9%, 12%, 15%, 18% and 21% of Bentonite in replacement mode by

weight of cement. The mix was designed for compressive strength of 30 Mpa.

.Chamundeswari et al .(2012) Studied on partial replacement of cement by bentonites in paver block. 53 grade cement is used. Compressive Strength 53 MPa, Specific Gravity3.15, Initial Setting Time 30 min, Final Setting time 570 min. Sand consisting of rounded grains with Fineness modulus 3.24, Specific Gravity 2.58, Size Passing through 4.75mm sieve, Water absorption ratio 1%is used.The coarse aggregate used is of the size 10mm. W/C Ratio=0.35M50 grade was used. The replacement of cement by bentonite includes of 10%,20%,30%,40%,50%. It concludes that, by the usage of bentonite powder, we can increases the compressive strength and decrease the cement content in concrete up to 30%. Replacing the amount of cement used by bentonite powder decreases the total expenses of cement by 50% and also eco-friendly.The mixes show higher rate of reactivity at 28 days than at 7 days bentonite provides cost effective, durable, and environmental friendly option to construction industry. Bentonite powder decreases the total expenses of cement by 40- 50% and also eco-friendly.

Fernandez et al. (2012) studied on mineral reaction front developed in 4.5 years test for the study of concrete – bentonite interface. Soluble salts, both migrating through the concrete plugand those already present in the bentonite, concentrate as a function of time towards theheater zone. Cl and Na^+ became more concentrated compared to SO4and other cations.The behaviour of exchangeable cations is affected both by exchange reactions and dissolution/precipitation processes. Calcium and Sodium increased in the bentonite-concreteinterface with time.

.Namdar et al . (2012) discussed about natural minerals mixture for enhancing concrete compressive strength. The kaolin and bentonite have been mixed in equal quantity and treated by heat for 1 hour under 600 ºC, 800 ºC and 1000 ºC to create new minerals under high temperature condition to introduce an acceptable concrete additive for achieving concrete compressive strength in early age.The result is indicated that 6% proportion of unheated kaolin bentonite is improving concrete compressive. if kaolin-bentonite mixture treated by heat under 800 ºC and in quantity of 12 % has been used in concrete mixed design, then the concrete compressive strength of 7 days shows the best result.The proportion of additive before subjected to heat has different effect on concrete compressive strength compare to when additive is modified under high level of heat. The amount of 6% additive not subjected to the heat has shown acceptable result in improving concrete compressive strength.

Sivakumar et al . (2012) reported on "Strength properties of geopolymer mortar containing binary and ternary blends of bentonite". The present study investigates the setting and strength properties of geopolymer mixtures containing binary combinations of bentonite-flyash, bentonite-cement, bentonite-silica-fume and ternary blends of bentonite-flyash-lime.The experimental results showed that the initial and final setting time of binary mixtures containing bentonite and silica fume (5%) with alkali activator (NaOH) showed early setting time of 30 minutes compared to other geopolymer mixtures. It was also noted that compressive strength of ternary mixtures containing 40% bentonite, 30% flyash and 30% lime (M16) attained the maximum strength of 24.74 MPa at 28 days. The highest rate of strength gain was observed at early curing period (7 days) for the ternary mixtures (M14) consisting of 80% bentonite, 10% flyash and 10% lime compared to other mixtures. It can be realized from the experimental study that, geopolymerisation reaction was effective for the specimens cured at 100°C hot air oven.

MATERIALS AND METHODOLOGY

Cement: Cement is an adhesive and cohesive material which is capable to bound solid materials into compact durable mass. It is made up of calcareous and argillious material. Cement of uniform colour (i.e. grey with a light greenish shade) and free from lumps was used in this experimental work. The different types of tests like initial setting time, fineness, specific gravity , final setting time and compressive strength were done as per IS 4031(Part 5,6) -2000.

Physical properties of cement

Characteristics	Values Obtained	Standard value
Fineness (specific surface)	342.0	Min 300 m^2/ kg
Specific gravity	2.72	3.5
Initial setting time	3 hours 30 minutes	Min 30 minutes
Final setting time	5 hours 45 minutes	10 hour

Coarse aggregate: Aggregate retained on 4.75 mm sieve are identified as coarse aggregate. Locally available coarse aggregate with fraction of 20mm was used in the present experimental work. Aggregate was washed to remove dust and dirt. Testing of coarse aggregate was done as per IS: 383-1970.

Fine aggregate: Locally available zone II river sand conforming to IS 383-1970 was used in this experimental work. To remove the impurities and particle greater than 4.75 mm, It was passed by IS Sieve 4.75mm.

Bentonite: Bentonite is chemically weathered volcanic ash generally used as lubricant in drilling operations. The name Bentonite was given by Wilbur C. Knight in the year 1898 near Rock River, Wyoming. It is an absorbent aluminium phyllosilicate, impure clay which has most of Montmorillonite consisting in it. Montmorillonite mineral is a three layered mineral sheet that is one silica (Si) sheet on the top and bottom of gibbsite sheet (Gi). The two connecting units attract water to form a layer of water between them. The bonding is due to water forces and exchangeable ion linkage which further results in expansion and swelling because of this phenomenon Bentonite having high shrinkage and swelling property. Bentonite is highly plastic in nature. Availability of Bentonite can be in both powdered and solution form and hence it can replace cement by 40% when used for concreting. Strong colloidal properties can be observed and volume is increased when it comes in contact with water. The ionic property of Bentonite helps in forming a sticky coating on grains of the sand (fine aggregate). Powdered Bentonite are used in different types of industrial applications for example, pharmaceuticals industry , paper , cement , dyes and ceramics etc, thus changing the rheology and controlling the stability of the material.

There are some special and noticeable properties of Bentonite i.e. hydration, swelling, water absorption, viscosity, thixotropy which makes it a precious material for extensive uses and applications. Quarrying results in exploitation of Bentonitedeposits. Bentonite is a solid with approximately 30% of moisture content in it. To bring about 15% of moisture content, the material is crushed and activated by adding of soda ash which has chemical formNa_2Co_3 .The final application is done by either granulated form or powdered form. The special way of application is done by the purification of Bentonite by the removal of gangue minerals or by treating it with acids to obtain acid activated Bentonite.

Fig. 1 shows the research methodology flow chart as used for this study.

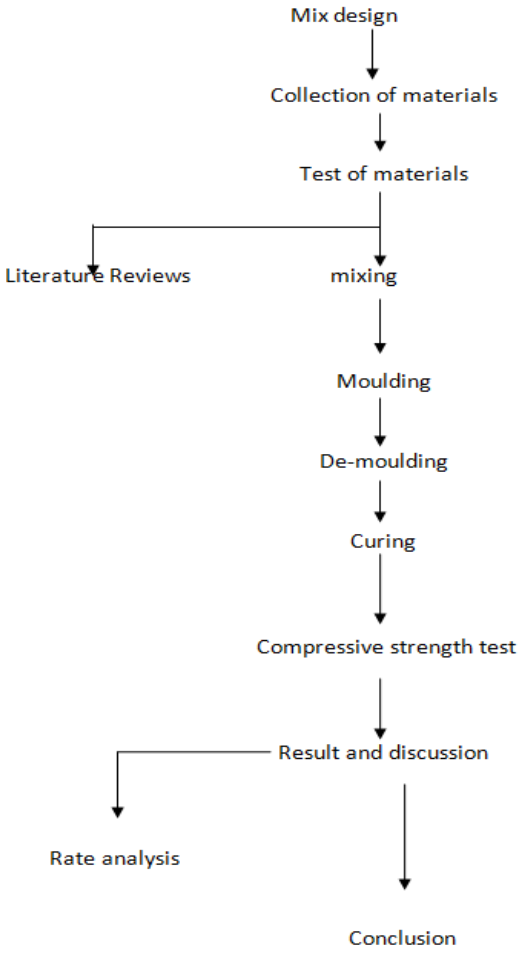

Fig. 1 Research Methodology Flow Chart

RESULT & CONCLUSION

The compressive strength of conventional concrete as well as bentonite concrete at 7, 14, 28 and 56 days are given in table 1. It is evident from the table that strength increases with the addition of bentonite. Strength increases up to 5% - 7.5% bentonite content and after that it decreases. Strength is prominent at 5% - 7.5% replacement level. It was observed that at 7 day curing bentonite concrete gives low strength than conventional concrete and after 28 day curing it achieve better strength than conventional concrete. At 56 days curing it gives best result. Hence it can be said that Bentonite gives bad early strength and good latter strength. It showed that with increase in bentonite content in concrete the rate of strength gain is only up to 5%- 7.5% replacement level.

S.N.	Cube designation	Compressive strength(N/mm^2)				% age of bentonite
		7 days	14 days	28 days	56 days	
1	V1	14.8	18.06	19.8	26.86	0
2	V2	13	14.73	21.73	28.4	5
3	V3	10.8	13.7	20.8	27.7	7.5
4	V4	8.9	12.6	18.7	26.4	10
5	V5	7.6	8.6	12.5	16.6	15

From the above study following conclusions are drawn:-

1. The compressive strength of bentonite concrete up to 5-7.5% replacement level is more than to referral concrete at 56 days.
2. Maximum replacement of 10% is beneficial.(compressive strength is almost same)
3. Bentonite gives better later strength.
4. Cost is decreases by 3.5% per cum as bentonite is available fee free.
5. Setting time is delayed.
6. Replacement up to 5% - 7.5% gives positive result.
7. The dead load of concrete remains the same.
8. Usage of bentonite helps in reducing the degradation of the environment by reducing the usage of cement whose manufacturing process degrades the environment.

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