International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 05 | May 2022 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON METAKAOLIN CEMENT CONCRETE WITH ROCK SAND

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Abstract

Concrete with pores may perform less when challenged to significant shrinkage and settlement rates. The goal of this research was to employ metakaolin and rock sand to improve performance by decreasing voids in concrete. Metalaolin was proven to be suitable addition to cement concrete as a supplementary cementanious agent.

The properties of concrete with metakaolin are the most often used additives in concrete. Metakaolin used in cement concrete may provide economic advantages due to its fast accessibility in our nation. By weigth of cement, a substitution % of metakaolin 5%,10%, 15%, 20% and 25% was to employed. Cubes and cylinder are cast to determine the durability and strength of concrete. It was seen that ann increase in compressive strength of 47.66%, 27.80% and 47.53% were observed in 15% MK based concrete during 7,28,90 days respectively. Experimentally it was seen that an increase in split tensile strength of 41.03% ,54.90% and 58.16% in compression with control specimen was observed in 20% MK based concrete at 7,28 and 90 days period respectively.

Key Words: Metakaolin, Rock sand, compressive ,split tensile strength.

Introduction

concrete is the most extensively utilized building material on the earth with roughly six billion tons of concrete generated in each year, it is just second to water as the most widely utilised material. this is because to the number of raw materials used in cement production, as well as the relatively low value if cement and the plasticity, flexibility of concrete in producing structural components shapes. ecological impacts, both as regards harm as consequence of co_2 emissions and material extraction during cement production, have pushed against the use of supplemental materials to minimize the requirement of cement. these resources could be by products, industrial waste and materials that take less energy to produce. other factors that contribute to these pressures include an increase in the number of occurrences involving serious degradation of concrete buildings. combinations of protland cement and pozzolans are widely utilized in structural concrete to resolve these issues as well as othe environmental concerns related to the discharge of garbage industrial effluents, as well as for economic problems.

Literature Review

M. R. Chitlange et al. (2010) demonstrated the use of concrete mixer with artificial sand as a replacement for natural sand have considerably higher strength than concrete mixes with real sand. The fine boundaries of synthetic sand particles adhere comparably improving with cement than the curved particles of real sand which results in greater strength. The use of artificial sand instead of natural sand in concrete reduces excessive concrete bleeding.

Hemant Chauhan et al. (2011) attempted to utilise industrial effluents such as activated Fly ash, Iron Oxide, and Metakaolin as supplemental cement-like constituents to replace cement. These mineral admixtures are used in OPC cement, the compressive strength of concrete cubes were find on the five different types of prepared concrete mixtures at 3,7,14,28 and 56 days. When 42% metakaolin was used in place of OPC, At different W/C ratios (0.40 and 0.55), it gives strength upto 40.67 N/mm, and at the 56th day, it gives strength up to 25.47 N/mm. They found that replacing 42 percentage of the cement with varying amounts of mineral mixtures such as metakaolin (10%), fly ash (30%)and iron oxide (10%) made the concrete more cost-effective (2 percentage).

B.B. Patil and P.D. Kumar et al (2012) experimented the durability and strength of High Performance Concrete with High Reactive Metakaolin. The High-performance concrete is a relatively new development in the concrete industry. The current study examines the attributes of M30 grade High Performance concrete with varied amount of

Metakaolin substitution, including workability, compressive strength, and durability. As a consequence, introducing reactive Metakaolin up to 7.5 percentage of the cement weight increased the strength of High-Performance Concrete mixes.

Mukesh and Charkha (2012) evaluated the effect of the tensile and flexural strength on concrete with use of 40% natural sand substituted by crushed stone dust and cement by fly ash from 0% to 40% (0%, 10%, 20%, 30%, 40%). PPC was used to conduct flexure and split tensile testing on the M20 mix. With 0% fly ash and 40% sand substitution, the maximum flexure and split tensile strength was achieved, based on the results of the tests When cement was replaced with fly ash, flexure and split tensile strength were lowered. As a result, for PPC cement, the optimal fly ash content was 0%. Crushed stone dust was shown to be a viable alternative to natural sand as a fine aggregate in concrete when combined with river sand.

Vinayak R. Supekar, Popat D. Kumbhar;s et al. (2012) studied the use of 60% artificial sand in place of natural sand resulted in concrete with acceptable workability and strength attributes. This research will also help to reduce the area of concrete surface cracks, resulting in more durable concrete. However, replacing natural sand with artificial sand by more than 60% decreases the compressive strength of concrete mixtures and increases the crack area. Natural sand replacement will aid in the preservation of sand's natural resources and the maintenance of nature's ecological balance.

L. Vyshnavi Sai, T.Yeswanth, M.Sambasiva Rao and Murthy et al (2015) experimentally showed in a study that the effect of metakaolin with replacement of cement in partial form were conducted for M30 grade concrete. Additional cement-like materials are finely ground solid elements that are utilised in concrete mixes to substitute cement. Metakaolin is an aluminium silicate that has been dehydroxylated. Metakaolin appears to be a very efficient Pozzolanic material that boosts the strength qualities, according to recent scientific work. As a result, the compressive strength of metakaolin was steadily raised up to 10% replacement of cement, whereas the strength of metakaolin was gradually decreased for 20%, 30%, 40%, and 70% replacement of cement.

Material used

Cement

Cement could be identified as the sticky stuff effective of merging fragments or masses of dense matter to a lumped whole Lea et al. (1970). Multiple categories of cement can be utilized in the concrete origination. It have got to be brand-new, release from external circumstances as well as in regard to homogeneous regularity. Generally Ordinary Portland cement is used in standard conditions. Ordinary Portland cement was originated in 1824 by an English builder; The invention of modern Ordinary Portland Cement is credited to Joseph Aspdin of England. He designated his cement Portland, after a rock quarry that manufactured extremely strong stone. That one designated his merchandise Portland cement because it executes a concrete that was of the identical colour as native stone on the bank of Portland in the Britiish Conduit. Raw materials for fabrication of the cement contain of essentially calcareous, siliceous and argillaceous material. The combination is burned to an elevated climate during a revolving furnace to generate a tricky variety of chemicals, mutually known as " Cement Clinker & quot; Neville (1987). Cement is diverse from the earliest cement.

Metakolin

Metakaolin, commonly referred " calcined clay" is a responsive aluminosilicatepozzolana

generated via broiling kaolinite at a precise climatevregime. Kaolinite counts tothe clay mineral that one generates the plasticity of the raw material and modifyin the course of releasing to create constant matter. Kaolinite chemical configuration is Al 2 O 3 .2SiO 2 .2H 2 O whats up aoutcome of heat processingin the scope of 450-750° C, the liquid is impelled back to frame an amorphous aluminasilicate reckoned Metakaolin (Al 2 0 3 .2Si0 2). Metakaolin is

manipulated as a fragmentary exchange in favour of Portland cement in the concrete industry. The concrete execution depends mainly on environmental circumstances, the micro structure, and the chemistry of the concrete. These two later factors are strongly affected by concrete components. It is obvious that Metakaolinoperation affects the concrete performance. Metakaolin thermally activated allumino-silicate material aboutelevated pozzolanic enterprise corresponding to eithersurpassed the enterprise of silica flume. Metakaolin is very useful in enhancing concrete quality, such as enhancing strength, contraction in setting time, reducing autogenous shrinkage, ruling alkali aggregate reaction, overcome thehazardabout chloride- caused corroding of inplanted steel, predominanthydride modification of high alumina cement, as well as enhancing the durability of concrete.

Fine Aggregates

Stream sand has been the most often utilised fine aggregate in concrete for past decades. Cement concrete and mortar, two of the most commonly used construction materials, both require river sand. The sand should be free of organic contaminants and harmful elements, and it should be clean, tough, and substantial. It should be able to produce a suitably workable mix with the least amount of water and cement. Traditionally river sand which is formed by natural climating of rocks for a no. of years is used as the fine aggregate. Natural sand is seasoned and worn out particles of rocks and of many size or grades based on the accounting of wearing. River sand is a natural and inexpensive supply of sand. Because dams are being built on every river, river sand resources are rapidly depleting. Because good sand is no longer easily available, it must be carried from far. Those resources are also quickly depleting. As a result, there is a pressing need to develop many alternatives to natural river sand. Common river sand is very costly due to the expensive cost of the transportation from the natural sources. Also higher-scale depletion of the sources of natural river sand creates huge environmental problems. Because environmental, transportation, and other constraints make river sand less appealing, a substitute, replacement, or partial replacement product for the building sector must be developed.

Coarse Aggregates

Aggregates are created by the natural designation of rocks or by the artificial crushing of rocks or gravel. Chemical and mineral composition, spectrographic description, specific gravity, hardness, strength, physical and chemical stability, pore structure, and colour are all characteristics of coarse aggregate Other aggregate qualities not seen in parent rocks include particle size and form, surface roughness, and absorption, among others. All of these characteristics may have a significant impact on the quality of concrete in both its fresh and hardened states.

Rock sand

Rock sand is an environmentally friendly and cost-effective alternative to ‘River' sand and also ‘constructed’ sand from crushed rock. Based on ‘Rock-on-Rock Technology’, Rock sand is used to lend strength, solidity, and stability to a wide range of structures, including residential neighbor hoods, business complexes, bridges, flyovers, and factories, as well as Metros. Rock sand is manufactured lifting state-of-the-art infrastructure and imported machinery. The rock sand constructed thus conforms to IS:383-1970 norms, Zone II grading ensuring utmost quality and endurance.

Water

Clean, fresh, and potable water should be used for mixing. Water should be devoid of contaminants such as clay, loam, and soluble salts, which cause concrete characteristics to deteriorate. Concrete can be mixed and cured with potable water.

Results and discussion

Compressive Strength

The influence of Metakaolin and Rock sand utilized in this researchupon compressive strength of concrete for M20class of concrete with changing dosages as 0%, 5%, 10%, 15%,20% and 25% of Metakaolin replacing cement by weight and organic sand with 50% Rock sand at 7 days, 28 days and 90 days has been demonstrated in table.

S.NO	Replacement	Compressive Strength(Mpa)		
		7 days	28 days	90 days
1	Control mix	14.29	22.77	26.87
2	MK 5%	19.01	26.93	41.67
3	MK 10%	19.04	32.68	39.13
4	MK 15%	21.10	29.10	39.64
5	MK 20%	18.58	26.45	41.72
6	MK 25%	16.75	28.11	32.27

Split Tensile Strength

The effect of Metakaolin and Rock sand utilized in the current research on Split Tensile strength of concrete for M25 class of concrete with fluctuating dosages (0%, 5%, 10%, 15%,20% and 25%) of Metakaolin replacing cement by weight and organic sand with 50% Rock sand at 7, 28 as well as 90 days has been shown in table.

S.NO	Replacement	Split Tensile Strength(MPa)		
		7 days	28 days	90 days
1	Control mix	1.15	2.86	2.94
2	MK 5%	2.18	2.95	3.08
3	MK 10%	2.37	3.83	3.91
4	MK 15%	2.33	3.84	3.93
5	MK 20%	2.25	4.43	4.65
6	MK 25%	2.04	4.15	4.20

Conclusion

By the current experimental study the following conclusions can be drawn...

1)Use of metakaolin in concrete reduces the porosity of the concrete. Hence, the compressive strength obtained from metakaolin based concrete is greater than convention concrete. Metakaolin is able to increase the strength of calcium silicate hydrate (C-S-H) bond which is responsible for higher compressive strength. If we further increase amount the Metakaolin, the inert material in concrete will increase which will reduce the compressive and split tensile strength.

2)Among all percentage replacement, 15% MK replacement exhibit higher compressive strength during 28 days while it was larger for 20% MK replacement during 90 days.

3)Partial replacement of rock sand with river sand causes an increment in compressive strength and split tensile strength.

4)20% MK concrete demonstrate superior split tensile strength at 28 days. However, it was somewhat near to 25% MK concrete's strength during 90 day curing period.

5) An enhance in compressive strength of 47.55%, 27.88%, and 47.52% were observed in 15% MK based concrete during 7, 28, and 90 days respectively while, it was 41.03, 54.90%, and 58.16% increase in split tensile strength for 20% MK based concrete at 7 days , 28 days and 90 days period respectively.

Scope of future study

1.The influence of Metakaolin probably interrogated on the superior grades of concrete.

2. The consequence of Metakaolin could be considered on the durability, shortening efflorescence and chemical attack expressions as concern concrete.

3. This research have permission to conveyed utilizing recycled coarse aggregates in replacement of coarse aggregates.

4. This research have permission to conveyed utilizing several additional cementitious ingredients prefer Rice husk, GGBS, Fly-ash etc. through switching cement in place of Metakaolin and genuine sand with rock sand.

5. This research has been limited to M20 grade of concrete. It can further extant to higher grade of concrete.

6. The percentage replacement of Metakaolin with cement can be increased for further research analysis.

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