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Review Paper on Use of Robo Sand and Metakaolin as Partial Substitutes for Fine Aggregate and Cement in Concrete

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ABTRACT

The rapid depletion of natural resources and increasing environmental concerns have led to the exploration of alternative materials in the construction industry. This review paper focuses on the incorporation of Robo Sand (manufactured sand) and Metakaolin as partial substitutes for cement and fine aggregates in concrete. It explores the properties, advantages, challenges, and effects of these materials on the mechanical and durability properties of concrete. The paper concludes that the combined use of Robo Sand and Metakaolin can offer a sustainable and cost-effective solution while improving concrete performance

Keyword- ROBO sand, compressive strength, split tensile strength and flexural strength, , Ground Granulated Blast Furnace Slag, , Fly ash, Bottom Ash, Pozzolanic

1. Introduction

The construction industry is a major contributor to environmental degradation, primarily due to the extensive use of natural sand and cement. Natural sand extraction has led to environmental issues such as riverbed erosion, habitat destruction, and the depletion of non-renewable resources. Similarly, cement production is one of the largest sources of carbon emissions globally. Therefore, the incorporation of alternative materials such as Robo Sand and Metakaolin into concrete has emerged as a potential solution to mitigate these environmental concerns.

Robo Sand, also known as manufactured sand, is produced by crushing rocks, and it serves as an alternative to natural river sand in concrete production. On the other hand, **Metakaolin**, a highly reactive pozzolanic material obtained by calcining kaolin clay at high temperatures, can replace a portion of cement. The synergistic use of both materials can enhance the sustainability of concrete while improving its performance.

2. Literature survey & background

[Dhakulkar P. S., Malkhede S. D. (2022)] chemical characteristics differ with species of quarry but chiefly contain silica. Incorporation of as partial replacement of cement adversely decreases the slump of concrete. Due to decrease in slump it indicates increase in water absorption. There was marginal decrease in strength with increasing , percentage in concrete , at replacement percentage up to 15% of the weight of binder can be successfully used as additive in place of cement. Compressive strength of , concrete is found to be optimum at 15%(26.16 N/MM2) Tensile strength of , concrete is found to be optimum at 15%(1.89 N/mm2) Flexural strength is also found to be optimum at percentage of 15%(13 N/mm2)

[Saini K., Chaudhary V., Bisnohi A., Agarwal H.,(2017)] Effect on strength properties of concrete by using waste quarry powder as partial replacement of cement."InternationalJournal of Civil Engineering 3:172-176

Investigated the influence of using waste quarry powder as a partial replacement for cement on the quality characteristics of concrete. The primary objective of this study is the utilization of waste materials (quarry powder) as fine aggregates, which are combined (both as an addition and as a partial substitution) with Ordinary Portland Cement (OPC) to investigate the effects of these waste materials on various properties of concrete grade M30. The quarry dust is replaced in varying proportions of sand (0%, 5%, 10%, 15%, 20%). The substitution of fine aggregates with quarry powder in concrete is determined to significantly enhance the ultimate strength of the concrete. The accompanying focus areas include the following: - The compressive strength, flexural strength, and split tensile strength were observed to decrease when the quarry dust content exceeded 25%.

The substitution of 10% quarryen powder for sand results in approximately a 10% reduction in weight and a 3% decrease in production costs.

Arularasi, V. (2017). Effect of fly ash and quarry dust as a partial replacement of cement and fine aggregate in concrete. International Journal of Latest Research in Engineering and Technology, 2(08), 15-33. ISSN 2454-5031.

Evaluates the effects of quarry dust and fly ash as partial substitutes for cement and fine aggregate in concrete. The concrete organization may also be suitable for complete replacement, up to 60%. Fly ash and quarry shake dust can be utilized as a 20% substitute for cement and fine aggregate in concrete. It was concentrated on preventing natural degradation caused by industrial waste from cement processing plants. The results demonstrated that concrete meeting the specified compressive strength can be produced. It is assumed that an alternative development material can be made available with minimal effort.

Therefore, we obtain The study clearly demonstrates that a 40% substitution of cement and fine aggregate with fly ash and quarry shake dust enhances the compressive properties beyond those of standard concrete.

Consequently, a 40% replacement is recommended, which may prove to be feasible. The replacement exceeding 40% necessitates reserve funds amounting to 30% of the total cost in M30 concrete.

[Aginam C. Nwakaire, Onah, B. (2020)] this experimental investigation on the possible replacement of coarse aggregate with Quarry Dust in Concrete, it could be concluded that the workability of concrete decreases with increasingly percentage of Quarry Dust in the mix and workability test being a pointer to the consistency of the mix does not imply the final strength characteristics of the same.

[Dr. suji D., Narayanan M., Kumar. M, Perarasan M. (2016)] Experimental Study on Partial Replacement of Fine Aggregate with Quarry Dust and Saw Dust, International Journals of Advancement In Engineineering Technology, Management Applied Science, ISSN NO. 2349- 3224

Sawdust and quarry dust are partially utilized as substitutes in the production of fine aggregate for concrete. Quarry dust proportions of 0%, 10%, 20%, 30%, and 40% were employed in this investigation to assess the effects of sawdust and quarry dust. Furthermore, the fine aggregate was observed to have been developed and formed, as evidenced by the particulate concentrations of 0%, 5%, 10%, 15%, and 20%. The result comprises the following:

The maximal compressive strength of 36.26 N/mm² and the split tensile strength of 3.8 N/mm² were obtained with a mixture of 30% quarry dust and 15% sawdust after a 28-day curing period, respectively.

The investigation suggests that the physical and mechanical properties of the material can be unaffected by the addition of sawdust in volumes of up to 15%.

A weight reduction of up to 20 is observed in conjunction with a decrease in the total value of the concrete mix as a result of an increase in the quantity of debris.

Kavibala N. (2016) conducted an experimental investigation on the partial substitution of cement with marble powder and fine aggregate, integrating polypropylene fiber and quarry dust. International Conference on Current Research in Engineering Science and Technology, E-ISSN: 2348-8352, pp. 39-42.

The evaluation involves assessing the fractional substitution of fine aggregate using quarry dust and cement with marble powder, in addition to the integration of polypropylene fiber. The experimental setup incorporates light-emitting diodes to assess the effects of 5%, 10%, and 15% cement replacement with marble powder on compressive strength and split elasticity. This study will involve a comparison with standard concrete, with the objective of determining the ideal substitution level of marble powder, specifically within the range of 10% to 145%. The substitution of quarry dust and marble powder is executed as a replacement for fine aggregate at ratios of 10%, 20%, and 30%. The resulting mixtures are subsequently assessed for compressive strength and split rigidity. The incorporation of polypropylene fiber aims to improve quality results.

The analysis of the outcomes presented above leads to the following conclusion:

The incorporation of marble powder enhances the compressive strength of cubes, achieving peak performance at a 12% substitution of cement by weight.

The optimal substitution rate for cement with marble powder and a fine mixture of quarry dust is established at 12%, with a processing duration of 30 minutes. The compressive strength exhibits an increase of approximately 8.5%, and the elastic modulus demonstrates an increase of about 8.57% when compared to conventional concrete.The workability diminishes with an increase in the replacement level; consequently, a superplasticizer is utilized.

The compressive strength of concrete increased by approximately 13.87%, while the split elasticity showed an increase of about 15.08% with the addition of 0.5% polypropylene fiber relative to the cement load in the concrete mix.

Gourley, Z. (2012) Met kaolin is favored by niche polymer product developers due to its high solubility in the actant solution, ease of manipulation regarding the Si/Al ratio, and its white color. However, for producing concrete in large quantities manufacturing nation, met kaolin is very high priced. Low calcium (ASTM Class F) fly ash is favored as a source material than high calcium (ASTM Class C) flyash. The presence of calcium in high quantity might also intrude with the polymerisation process and modify the microstructure.

[Chauhan L., Bondre A. (2015)] Partial Replacement of Sand by Quarry Dust in Concrete. International Journal of Scientific and Research Publications, ISSN 2250-3153

Has clarified about the incomplete substitution of sand by quarry dust in concrete. This paper describe the exploratory examination which researched the 50% substitution of sand with quarry dust. At first cement concrete block was contemplated with different extents of cement concrete + quarry dust (M 20 and M25). The test comes about determine that the expansion of quarry dust as fine aggregate proportion of percentage is 30, 40 & half was organized to upgrade the compressive properties. In view of the outcomes and discourse specified over, the accompanying conclusions are gotten:

Mix proportion of 1:1.5:3 (cement: aggregate: sand+ quarry dust) give the ideal quality in this investigation. As the proportion of quarry dust gradually increases, the compressive properties of concrete will also improve, provided that the percentage of quarry dust does not exceed fifty percent.

The compressive properties of packed concrete increase with the duration of curing time. The quality assessment for a duration of 28 days exceeds that of a duration of 7 days.

According to the calculation of compressive properties gathered, the esteem is high and it demonstrates the quarry dust reasonable to use as sand replacement. All the calculation of compressive properties outperforms the base estimation of compressive quality for ordinary concrete that is 7 N/mm^2. Along these lines quarry dust can apply as sand substitution in concrete blend for development industry.

[LakshmideviK.,&RaoN.(2015)]EffectofFlyAshandQuarryDustonPropertiesofConcrete. International Journal of Innovative Research in Science, Engineering and technology, pISSN: 2347-6710, 4(9),8343-8350

The effect of quarry dust & fly ash on characteristics of concrete. In the existing work an effort is made to ponder the effect of concrete when cement is supplanted by fly ash at 0,

The M20 concrete blend incorporates 10%, 20%, and 30% by weight of cement and sand replaced with quarry dust at proportions of 20%, 30%, and 40%. Exploratory examinations are performed to assess the properties of concrete, specifically focusing on the compressive strength at curing intervals of 7, 14, 28, 56, and 90 days. The tests evaluate the compressive properties of chambers, split tensile strength, modulus of elasticity, and ultrasonic pulse velocity of concrete after a curing period of 28 days. Concrete blends were formulated, evaluated, and analyzed in comparison to conventional concrete.

Fly ash necessitates a higher volume of water to attain the specified consistency and workability.

The addition of fly ash to cement improves the initial setting time and decreases the final setting time.

All blends surpass the target quality when assessed in comparison to the controlled concrete, regardless of the curing duration.

All blends exhibit uniform quality irrespective of the duration of the curing process.

The compressive properties of various mixes of barrel-shaped samples exhibit a slight reduction compared to those of cube-shaped samples.

The concrete mixture consisting of 20% fly ash and 30% quarry dust is deemed optimal when evaluated for compressive properties, rigidity, modulus of elasticity, and overall quality assessment.

The incorporation of quarry dust as a partial substitute for sand and the use of fly ash in place of cement in concrete formulations improves the material properties of the concrete and simultaneously lowers production costs. This approach also reduces environmental pollution and minimizes the risks linked to the land disposal of these waste materials.

Subramaniam P. and colleagues (2015) Subramaniam, P., Subasinghe, K., & Fonseka, W. K. (2015). This material functions as a suitable raw material for the production of concrete blocks. International Journal of Research in Engineering and Technology, electronic ISSN: 2319-1163, print ISSN: 2321-7308, Volume 4, Issue 2, 2319-1163.

Acquired knowledge regarding an effective raw material for concrete blocks.This investigation concentrated on the implementation of a partial substitution for cement material in the production of sand-cement blocks. The concrete blends were formulated with 10%, 15%, 20%, and 25% as partial replacements for cement using sand. These blends were subsequently evaluated for their compressive properties, water retention capabilities, and heat discharge characteristics.

The specimens with 15% substitution material demonstrated improved compressive strength.

All specimens, with the exception of 25%, demonstrated a substitution that led to a reduction in watering. The most significant result was observed at a content level of 15%.

Specimens with 15% and 20% substitution demonstrated a reduced warm discharge rate following a curing duration of 21 days.

The implementation of a 15% increase during the assembly of concrete squares has resulted in components that conform to the specified breaking points.

Kumar T. and colleagues (2015) conducted an examination on the substitution of cement in concrete through the use of dairy animal manure ash. Evaluate the effects of cow waste ash on the characteristics of mortar and concrete. The consistency cutoff points and compound organization of standard Ordinary Portland cement (OPC), dairy animal excrement ash, and OPC blended with cow manure ash were established. The compressive properties of the concrete and mortar samples were assessed at 7, 14, and 28 days separately. The test results indicated that the consistency limits increased to an optimal level and subsequently decreased with a rise in the percentage of CDA present.

The compressive properties exhibit an increase when 5% of CDA is utilized as a replacement for cement. Conversely, an increase in the content of dairy animal fertilizer ash leads to a reduction in these properties.

The assumption is made that the 5% cement content can be substituted with CDA in the mortar formulation.

3. Conclusion

The incorporation of Robo Sand and Metakaolin as partial substitutes for cement and fine aggregates in concrete presents a promising solution for sustainable construction. Robo Sand helps reduce environmental damage caused by the extraction of natural sand, while Metakaolin enhances the strength and durability of concrete while reducing its carbon footprint. The combined use of these materials offers a viable option for producing high-performance concrete while promoting sustainability. However, further research is required to optimize the mix design and establish standardized guidelines for their use.

REFERENCES

[1] Terrence Ramlochan, Michael Thomas, Karen A. Gruber, "The effect of metakaolin on alkali-silica reaction in concrete". Cement and concrete research, 2000, Vol 30, pp: 339-344

[2] G. Batis, P. Pantazopoulou, S. Tsivilis, E. Badogiannis, "The effect of metakaolin on the corrosion behaviour of cement mortar", Cement and concrete composites, 2005, Vol 27, pp: 125-130.

[3] Nabil, M & AlAkras 2006, 'Durability of Metakaolin Concrete to Sulphate Attack', *Cement and Concrete Research - Elsevier*, vol. 36, no. 1, pp. 1727 - 1734

[4] Erhan Guneyisi, Mehmet Gesoglu, Kasim Mermerdas, "Improving strength, drying shrinkage and pore structure of concrete using Metakaolin", Materials and structures, 2007, Vol 12, pp: 10-26.

[5] Jibing Bai & Albinas Gailius 2010, 'Consistency of Flyash and Metakaolin Concrete', *Journal of Civil Engineering and Management*, vol. 15, no. 2, pp. 131 – 135

[6] P. Dinakar, "High reactive metakaolin for high strength and high performance concrete", The Indian Concrete Journal, 2011, pp: 28-34.

[7] Muthupriya, P, Subramanian, K & Vishnuram, BG 2011, 'Investigation on Behaviour of High Performance Reinforced Concrete Columns with Metakaolin and Flyash as Admixture', *International Journal of Advanced Engineering Technology*, vol. 2, no. 2, pp. 190 – 202

[8] Vaishali & Ghorpade, G 2011, 'Chloride ion Permealiability Studies of Metakaolin based High Performance Concrete', *International Journal of Engineering Science and Technology*, vol. 3, no. 2, pp. 1617 – 1623

[9] Vikas Srivastava, Rakesh Kumar & Agarwal, VC 2012, 'Effect of Silica Fume and Metakaolin Combination on Concrete', *International Journal of Civil and Structural Engineering*, vol. 2, no. 3, pp. 893 – 900

[10] Si-Ahmed, M, Belakrouf, A & Kenai, S 2012, 'Influence of Metakaolin on the Performance of Mortars and Concretes', *International Journal of Civil and Structural and Construction Engineering*, vol. 6, no. 11, pp. 100 – 103