A Review on Strength and Durability Properties of Quarry Dust Powder and Metakaolin in concrete

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***Abstract*: Concrete is the most commonly used material for construction. The worldwide production of cement has greatly increased since 1990. Production of cement results in a lot of environmental pollution as it involves the emission of Co2 gas. Quarry dust powder is the waste generated from manufactured sand (M Sand) units and constitutes to 30-40% of the total quarry dust produced. When dry, it turns into fine dust that causes severe health issues to people and also causes serious threats to environment by polluting soil and water. Transportation and proper disposal of this waste is a tedious task because of its adhesive nature and high water absorption character. Metakaolin material was made of kaolin clay calcined at a temperature of 1000 °C and at a final temperature for 1h in a laboratory-type electric arc furnace. Quarry dust powder and Metakaolin was used as the row material in the preparation of concrete. Quarry dust powder and Metakaolin was used as a substitution material in different ratio. The present study reports the suitability of quarry dust powder and Metakaolin in the development of concrete cube by evaluating its strength, durability, acoustic and thermal properties. Cement was replaced with Quarry dust powder and Metakaolin in the test specimens at varying percentage of 0%, 5%, 10%, 15% and 20%. The results of the study have thus proved the effective use of quarry dust powder and metakaolin in development of concrete cube in an economic, effective, sustainable way and improved compressive strength.**

***Keywords*: Metakaolin, strength properties, Durability, Quarry dust powder, Concrete.**

1. INTRODUCTION

In construction Industry, consumption of cement is increasing day by day as well as cost is also increasing so to reduce the consumption of cement, partial replacement with Metakaolin and Quarry dust powder was done in this study. The demand for Portland cement is increasing dramatically in developing countries. Portland cement production is one of the major reasons for CO2 emissions into atmosphere. It is due to the use of fossil fuels, including the fuels required to generate electricity during cement manufacturing process. The use of pozzolanas for making concrete is considered efficient, as it allows the reduction of the cement consumption while improving the strength and durability properties of the concrete. Metakaolin is a calcinied clay and easily available in Gujarat, Maharashtra & Bombay etc. It is a Dehydroxylated form of the clay mineral Kaolinite. Stone having higher percentage of Kaolinite are known as china clay or kaolin. The particle size of Metakaolin is smaller than cement particles. Metakaolin is obtained by thermal activation of kaolin clay. Metakaolin is used in oil well cementing to improve the compressive and flexural strength of the hardened cement. Metakaolin also reduces the hardened cement permeability to liquids and gases. Hence by partially replacing Portland cement with Metakaolin not only reduces carbon dioxide emissions but also increases the service life of building. Quarry dust is a by product of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates.

In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and the construction material would be saved and the natural resources can be used properly. . Quarry dust has been used for different activities in the construction industry, such as building materials, road development materials, aggregates, bricks, and tiles. The present research work mainly deals with the influence of different replacement proportion of cement with quarry dust on the properties of concrete. The present study is planned to study the effects of quarry dust addition in normal concrete and to assess the rate of compressive strength development.

2. LITERATURE REVIEW

2.1 Pandyala chanakya, Diptikar behra. Metakaolin is a highly pozzolanic material.The present study investigates the effects of metakaolin and super plasticizer on strength properties of M-35 grade concrete.The replacement levels of cement by metakaolin are selected as 4%, 8%, 12%, 16%, and 20%. For constant w/c material ratio of 0.43. In this study show that 12 % replacement of cement by metakaolin gives higher strength.

2.2 Gokhan Goohan, Ridvan Aslaner. In this paper fly ash was used as the raw material in the preparation of geopolymer paste and metakaolin was used as a substitution material in different ratio. Metakaolin material was made of kaolin clay calcined at a temperature of 1000 °C and at a final temperature for 1h in a laboratory type electric arc furnace. The fly ash in the prepared mixture was substituted by metakaolin ranging from 10-40%.

As a result, ideal curing temperature and curing time were decided to be 60 °C and 2h for the production of the geopolymer paste. It was also determined that the compressive strength valve of sample subjected to curing reached up to 25.10 Mpa and that a 40%. Metakaolin substitute provided a better geopolymerization and improved compressive strength valves.

2.3 Vikas srivastava. Investigated the suitability of silica fume and metakaolin combination in production of concrete.The optimum combined does of silica fume and metakaolin were found out as 6%, and 15% (by wt.) respectively. The 28th day compressive strength of concrete generally increased with the metakaolin content for at all the silica fume content.

2.4 P.Usha, L.Chris, Dr. N.S.Elangovan , In this paper deals with study the applicability,performance,availability, complexity, and the effect of using local calcined kaolin and metakaolin obtained commercially as pozzolana on the development of high strength and permeability/ durability characteristics of concrete designed for a very low w/c ratio of 0.4. The optimum replacement with respect to strength and durability were determined by varying the amount of metakaolin as partial cement and fine aggregate replacement. Thus to make concrete sustainable in the Indian content a multiprong strategy should be adopted. It show that optimal performance is achieved by replacing 7% to15% of the cement with metakaolin. while it is possible to use less, the benefits are not fully realized until at least 10% metakaolin is used. Metakaolin have positive impact on concrete.

2.5 Nikhil saboo, shekhar shivhare. In this paper Effect of fly ash and metakaolin on pervious concrete properties. Study, fly ash and metakaolin were used as partial replacement for OPC with curing condition as another variable. Basic tests such as porosity, density, compressive strength, and permeability were conducted to determine the effect of test variables. The curing conditions were found to be insignificant in affecting the properties of pervious concrete unlike fly ash and metakaolin. A 2% addition of metakaolin decreased porosity by 10%, while the optimum range of fly ash replacement in pervious concrete was found to be between 5 and 15%. Statistical tests indicated that fly ash content dominated the effect on influencing permeability and compressive strength. the study was to investigate the effect of fly ash, metakaolin, and curing condition on the properties of pervious concrete. The interaction plots showed that addition of 2% of metakaolin reduced the porosity and increased the density significantly. These results clearly indicate that instead of increasing cement content to produce higher strength pervious concrete, cement can be partial replaced by SCMs, which not only increases the workability but as well aid in achieving higher strength with lesser cement contents rendering optimal solution for usage of industrial by-products.

2.6 Abdullah Anwar. In this paper the author represented that quarry dust powder has replaced the (OPC and PPC) cement of 0%, 5%, 10%, 15%, by wt. And M20 grade concrete was used. Concrete is M30 mixtures were developed, tested and compared in terms of compressive strength to the conventional concrete. The purpose of the investigation is to analyse the behaviour of concrete while replacing the quarry dust powder with different properties in concrete. The result obtained for 28 day compressive strength confirms that the optimal percentage for replacement of cement with quarry dust powder is about 10%. For
(ppc) and (opc). This will post less on the production of carbon dioxide and solving the environmental pollution by cement production there by enhance the surrounds.

2.7 Joseph. O. Ukpata , was identified that properties of tensile and flexural strength compared with conventional concrete. Hence, the proportion of concrete with lateritic sand and quarry dust is below 50% for construction purpose. Both flexural and tensile strength are increase with increase in lateritic content.

2.8 Burak Felekoglu, identified that the integration of quarry waste and the equal amount of cement content generally reduced the super plasticizer requirement and improved the 28 days compressive strength of SCC. Normally the strength mixture of SCC contains nearly 300 to 310 kg of cement by inducing the quarry dust it can be increased a lot per cubic meter.

2.9 K. Shyam prakash. In this paper The replacement of natural fine aggregate by using quarry dust leads to consumption of generated quarry dust, the requirement of land fill area can be reduced and solves the natural sand scarcity problem. The chemical analysis, specific gravity, sieve analysis and compressive strength is identified for various percentage and grades of concrete by replacement of sand with quarry dust. From the experimental study it is concluded that the quarry dust can be used as a substitute for sand. It is identified that 40% replacement of sand by quarry dust give good result in strength than normal concrete for M20 and M30 grade. The results possess that 40% replacement of sand by the quarry dust induced higher compressive strength and the workability of concrete decreases as replacement increases. Thus the environmental effects and waste can be significantly reduced.

2.10 G.Kattukappalli febin, A.Abhirami. In this paper the suitability of quarry dust powder in the development of concrete building blocks by evaluating its strength, durability, acoustic and thermal properties. mix. M Sand was replaced with quarry dust powder in the test specimens at varying percentages of 0, 15, 30, 45 and 60 and tests were conducted to study these properties after finalizing the optimum mix. On comparing the results, it was found that compressive and split tensile strength increased and impact strength decreased on replacing M Sand with quarry dust powder. Abrasion resistance, acoustic absorption and sorptivity properties were found to improve at 30% replacement whereas thermal conductivity was found to increase with increasing percentages of M Sand replacement. From the observed results, it can be concluded that 30% replacement of quarry dust powder was found to be the optimum level of replacement for making concrete building blocks. An increase in M Sand replacement beyond 30% showed negative strength results. This can be attributed to the filler effect, due to which there is an increase in strength up to 30%, beyond which the strength decreases. The low strength can be due to the low workability and lower compaction of the mortar having high percentage of quarry dust powder. Rate of water absorption reduced for 15 and 30% M Sand replaced mixes because of its reduced porosity. Increase i absorption after 30% replacement could be attributed to an increased water absorption, which could be due to an increased mean surface area of quarry dust powder. Various mechanical and durability properties and strength increased by varying the percentages of the quarry dust powder.

3. MATERIALS

As per studying and review of many research papers, here will explain some important materials used in this study.

3.1 Cement

Cement is manufactured through a closely controlled chemical combination of calcium, silicon, aluminium, iron and other ingredients. Use OPC 43 grade cement.

3.2 Fineaggregate

Locally available natural river sand passing through 4.75mm sieve was used for all of the mixes of concrete. The fine aggregate was free from organic impurities.

3.3 Coarse Aggregate

Cursed stone was used as a coarse aggregate passing through 20 mm and retaining on 4.75mm was used for all of the mixes of concrete.

3.4 Water

Water used was fresh, colourless, odourless and tasteless, convenient water that was free from cause early-age cracking organic matter of any type.

3.5Metakaolin

The metakaolin used in obtained from Gujarat India. Metakaolin is produced from high purity Kaolin clay by calcinations at moderate temperature (650- 800°C). Metakaolin is a dehydroxylated aluminium silicate.

3.6 Quarry Dust Powder

Quarry dust powder used in the study was obtained from a quarry in Jabalpur district of the M.P state. Quarry dust is a by product of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution.

4. CONCLUSION

Based on literature review, It was found that cement can be replaced effectively with Supplementary Cementitious Materials (SCM's) like Metakaolin. In the case of strength and durability, the SCM's shows better results than normal mixes. With regard to workability and setting time, Metakaolin generally required more super plasticizer and it reduces the setting time of pastes as compared to control mixtures. When compared with cement, the use of Metakaolin may be uneconomical due to its high cost whereas it is economical in the aspects of durability and strength. And The quarry dust can be used as a substitute for sand. It is identified that 40% replacement of sand by quarry dust give good result in strength than normal concrete for M30 grade. The results possess that 40% replacement of sand by the quarry dust induced higher compressive strength and the workability of concrete decreases as replacement increases. Thus the environmental effects and waste can be significantly.

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