CHAPTER-II

LITERATURE REVIEW

2.1 GENERAL:

Concrete means a mixture of a binding material, aggregates as filler materials and water. The cement concrete is a mixture of cement, sand, pebbles or crushed rocks and water. The cement concrete has attained the status of a major building material in the modern construction. Although Portland cement demands are decreasing in industrial nations, it is increasing dramatically in developing countries.

Supplementary cementitious materials (SCM) are finely ground solid materials that are used to replace a portion of the cement in a concrete mixture. The supplementary cementitious materials may be naturally occurring or man-made waste. Various types of pozzolanic materials that improve cement properties have been used in cement industry for a long time such as Metakaolin and fly ash. Metakaolin possesses a high reactivity with calcium hydroxide having the ability to accelerate cement hydration. Since current concrete structures present higher permeability levels that allow aggressive elements to enter, leading corrosion problems, using pozzolanic admixtures not only reduce carbon dioxide emissions but also allow structures with longer service life, thus lowering their environmental impact.

A new revolution took place in the construction industry when cement was invented in the 19th century. Concrete manufacturing is one of the technique related to building and construction industry have been developed after the invention of cement. Marble industry was one of the pristine industry related to building and construction.

'Marble' is a building stone that, because of its aesthetic values, wants to put everyone in their houses from poor to rich. Even so, many splendid buildings all over the world are made of marble stones. From the perspective of the Indians, the houses made of marble are considered as proof of grandeur. Many researchers have looked for the possibility to re-use waste marble in the building and construction industry for making bricks, concrete and tiles.

2.2 LITERATURE REVIEW:

2.2.1 LITERATURE REVIEWS ON METAKAOLIN AS REPLACEMENT TO CEMENT:

Barbhuiya S et al. (2015) in the paper “Microstructure, hydration and nanomechanical properties of concrete containing metakaolin” presents the results of an experimental investigation carried out to evaluate the properties of concrete containing metakaolin. The properties of concrete containing metakaolin at 0%, 5%, 10% and 15% by mass of cement were studied for their compressive strength, sorptivity and carbonation resistance at two different water–binder ratios. It was found that 10% of the Portland cement could be beneficially replaced with the metakaolin to improve the sorptivity and carbonation resistance of concrete. To better understanding the properties various analytical techniques such as XRD, MIP and nanoindentation studies were carried on cement paste samples (with and without 10% MK). Test results showed that the incorporation of metakaolin modifies the cement paste in four different ways. Firstly, by transforming portlandite into C–S–H gel by means of pozzolanic reaction, secondly by reducing the porosity, thirdly by creating nucleation sites for hydration and finally, by modifying the relative proportions various phases of C–S–H gel.

Bhaskara Teja Chavali et al. (2016) in his paper "Effect of varying quantities of Metakaolin and fly ash on strength characteristics of concrete" studies the effect of adding Metakaolin along with fly ash in the concrete on its performance. The replacement was done in a pattern of 0% of Metakaolin and fly ash replacement, 15% of Metakaolin to cement and 30% of fly ash to cement separately and afterwards the combined effect of 15% Metakaolin and 30% of fly ash to cement were calculated. Concrete mix of M40 grade was used for the experimental investigation. The cubes, cylinders and prisms were tested for compressive strength, split tensile strength and flexural strength respectively. The tests are performed after 7 days and 28 days curing of the specimens. The experimental study shows that 15% of Metakaolin to cement gives more strength than the combined percentage of the cementitious materials. The replacement of fly ash of 30% and the combined percentage of 15% of Metakaolin and 30% of fly ash gives strength slightly less than that of the control specimen.

Guneyisi E et al. (2014) in the paper "Combined effect of steel fiber and metakaolin incorporation on mechanical properties of concrete" reports the results of an experimental study on mechanical properties of plain and metakaolin (MK) concretes with and without steel fiber. To develop the metakaolin included steel fiber reinforced concrete mixtures, Portland cement was partially replaced with metakaolin as 10% by weight of the total binder content. Two types of hook ended steel fibers with length/aspect ratios of 60/80 and 30/40 were utilized to produce fiber reinforced concretes. Two series of concrete groups were designed with water to binder ratios (w/b) of 0.35 and 0.50. The effectiveness of MK and different types of steel reinforcement on the compressive, flexural, splitting, and bonding strength of the concretes were investigated. All tests were conducted at the end of 28 days of curing period. Analyses of variance on the experimental results were carried out and the levels of the significance of the variables on the mechanical characteristics of the concretes were determined. Moreover, correlation between the measured parameters was carried out to better understand the interaction between mechanical properties of the concretes. The results revealed that incorporation of MK and utilization of different types of steel fibers significantly affected the mechanical properties of the concretes, irrespective of w/b ratio.

Hossam S et al. (2016) in the paper "Time-dependence of chloride diffusion for concrete containing metakaolin" investigated chloride diffusion and permeability in concrete containing metakaolin. Fifty-three concrete mixtures were tested based on a refined statistical analysis. Enhanced response surface method (RSM) was used to present the most significant factors affecting the chloride diffusion at different ages. The tested mixtures contained various water-to-binder (W/B) (ratios 0.3–0.5), metakaolin (MK) replacement (0–25%), and total binder content (350–600kg/m3).

Bulk diffusion test was adopted for two years to determine the time-dependent coefficient m of chloride diffusion for all mixtures based on the error function solution to Fick's law. This coefficient was calculated based on two different bulk diffusion test methods: total and average methods. Design charts were developed to facilitate the optimization of mixture proportions for designers/engineers. The investigation also included some experimental relationships between the rapid chloride permeability test, chloride diffusion coefficient, and compressive strength results. The results showed that the values of the chloride diffusion indicated a general reduction from 28 days to 760 days of testing. As the percentage of MK or binder content increased or as the W/B ratio decrease, the chloride diffusion reduction coefficients, m total and m avr, were found to increase. Based on the analysis of variance (ANOVA) from the statistical model, MK was found to be the most significant factor affecting the chloride diffusion at late ages, while the W/B ratio was the most significant factor affecting early ages of chloride diffusion(28 and 90 days). And the developed models and design charts in this paper are of special interest for aiding the prediction of service life of concrete containing MK.

Mermerdas K et al. (2012) in the paper “Strength development of concretes incorporated with metakaolin and different types of calcinedkaolins” investigated the effects of metakaolin and calcinedkaolins on the concrete. For this, non purified ground kaolins obtained from different sources were thermally treated at specified conditions. Commercially available metakaolin from Czech Republic was used for comparison. Replacement levels (5%, 10%, 15%, and 20%) of calcined kaolins and metakaolin were assigned for concrete production. One plain mix without admixture was produced as reference. Compressive strength development of the concretes was carried out at 3, 7, 28, and 90 days. The strength development of concretes was evaluated by statistical technique named GLM-ANOVA. From gene expression programming a prediction model was derived to evaluate the parameters affecting the strength. SiO2, Al2O3, kaolinite, and alunite contents, fineness of mineral admixture, age of concrete, and replacement level were the parameters investigated. The experimental investigations showed that type of thermally treated kaolin, the replacement level, and age are very effective on the strength development of the concretes. The seven parameters in the prediction model was compared with the experimental results and proved to be a handful tool for estimating compressive strength of concrete incorporated with commercial metakaolin and calcinedkaolins.

Mirmoghtadaei R et al. (2015) in the paper “The impact of surface preparation on the bond strength of repaired concrete by metakaolin containing concrete” studies the influence of various types of surface preparation on bond strength of repaired concrete is evaluated. Six different surface textures are studied: as-cast; wire brushed; acid etched; grooved; grooved-wire brushed; grooved-acid etched. According to ASTM C882, 144 half-specimens as substrate concrete are cast. To form full-specimens, metakaolin containing repair concrete is poured on half-specimens. The bond strength of all specimens is measured through the slant shear method at the ages of 7, 28, and 90 days and compared with one another. According to the results, grooved-acid etched led to the highest bond strength in comparison to other types of surface preparation. For all surface preparation methods, replacement of metakaolin with 10% of cement instead of 0% or 15% in repair materials leads to have better bond strength.

Nova John (2013) in her paper “Strength Properties of Metakaolin Admixed Concrete” studies the effect of Metakaolin as mineral admixture in the concrete on its performance. The replacement was done in a pattern of 0, 5, 10, 15 and 20% to cement by Metakaolin. Concrete mix of M30 grade was used for the experimental investigation. The cubes, cylinders and prisms were tested for compressive strength, split tensile strength and flexural strength respectively. The tests are performed after 7 days and 28 days curing of the specimens. The results indicate that the use of Metakaolin in concrete has improved the strength characteristics of concrete. From the results of considered parameters, it is observed that 15% replacement of cement with Metakaolin showed better performance in case of strength parameters such as compressive, flexural and split tensile strength.

Ogale R A et al. (2016) conducted a study on “Effect of Metakaolin and fly ash on strength of concrete”. The paper investigates the effect of fly ash and Metakaolin by partially replacing cement. Metakaolin and fly ash are taken as the supplementary cementitious materials which show good pozzolanic activity and production of high strength concrete. The cement was replaced by 0, 5, 10, 15, and 20 percentages of Metakaolin and fly ash. Concrete mix of M20 grade was used for the experimental study with varying percentages of cementitious materials. The specimens, cubes and cylinders were tested for compressive strength and split tensile strength with 7 days and 28 days of curing. The experimental data shows that there was a reduction in the strength beyond 10% of the cementitious materials.

Ramezanianpour A.A et al. (2012) in his paper “Influence of metakaolin as supplementary cementing material on strength and durability of concretes ” investigates the performance of concrete mixtures containing local metakaolin in terms of compressive strength, water penetration, sorptivity, salt ponding, Rapid Chloride Permeability Test (RCPT) and electrical resistivity at 7, 28, 90 and 180 days. The microstructure of the cement pastes incorporating metakaolin was studied by XRD and SEM tests. The percentages of metakaolin that replace PC in this research are 0%, 10%, 12.5% and 15% by mass. The water/binder (w/b) ratios are 0.35, 0.4 and 0.5 having a constant total binder content of 400 kg/m3. Results show that concrete incorporating metakaolin had higher compressive strength and metakaolin enhanced the durability of concretes and reduced the chloride diffusion. There exhibit an exponential relationship between chloride permeability and compressive strength of concrete. A significant linear relationship was found between Rapid Chloride Permeability Test and salt ponding test results.

Rashad A. M et al. (2013) in his paper “Metakaolin as cementitious material: History, scours, production and composition –A comprehensive overview” deals with an overview of the previous works carried out on kaolin. Kaolin can satisfy the world demand for filler, paper and ceramic industries. Kaolin converts to a pozzolanic material named metakaolin after suitable thermal treatment. From the investigations it has proved that it can be used in mortar and concrete to enhance their properties.

2.2.2 LITERATURE REVIEWS ON MARBLE DUST AS REPLACEMENT TO FINE AGGREGATE:

Binici et al (2007), while studying his tests on concrete, replace fine aggregate with 0%, 5%, 10% and 15% by volume with marble dust. He revealed from his study that if the fine aggregate is replaced with 15% of the marble dust, a 24% increase in the compressive strength of concrete after comparing with the Control mix. They have been also reported that due to the sulphate attack, the reduction in the compressive strength of concrete is, at least when 15% replacement of marble dust. Along with this, the maximum abrasion resistance of the concrete, and minimum depth of penetration of water into concrete is obtained at the 15% replacement of marble dust with fine aggregates.

M Shahul Hameed et al (2009) tried to perform their experiments something different from other researchers and acquired the positive results. It is known to all that the quarry rock dust is also harmful to the environment, just like marble dust. Thus, recognizing the importance of the environment, they prepared the sample of concrete cubes with introducing the 50% of the quarry rock dust and 50% of marble dust in place of 100% sand. They published that the compressive strength and split tensile strength of concrete increases approximately 10% and 8% respectively when compare with control mix. They also indicated that the durability properties, i.e. resistance to sulphate attack, permeability of concrete etc. was increased.

Kursat Esat et al (2015) in his experiments on concrete, replaces the fine aggregates from marble dust at 0%, 10%, 20%, 30%, 40%, 50% and 90% by volume. The experiments manifested, that the maximum increase in compressive strength observed in a cube of concrete in which fine aggregate is replaced by 20% of marble dust and after that compressive strength of concrete, again decreases. They have been also explained that the splitting tensile strength and friction resistance of concrete, similarly behaves like the compressive strength of concrete, i.e. increasing as the percentage of marble dust increases in the concrete. But if talks about the water absorption of concrete, then results revealed that the 20% and 30% replacement of marble dust with fine aggregate gives lower values of water absorption of concrete.

M Vijaya Sekhar Reddy et al (2015) performed the experiments on concrete for utilization of waste marble dust in concrete to defend the environment. The experiments unfold that the if the marble dust uses up to 50% instead of fine aggregate in the concrete, then the compressive strength of concrete increases. Identical results trend also shown by G V Vigneshpandian et al (2017), which studied that 28% increase in compressive strength of concrete when marble dust replaces 50% of fine aggregates.

Raj. P. Singh et al (2015) found in his studies that up to 30% of marble dust replaces fine aggregate the compressive strength is above the control mix, whereas the maximum value of compression strength was got at 15% replacement of marble dust with fine aggregates. Similar results have also been incorporated by Siva Kishore et al (2015), that the compressive strength of concrete is increased up to 15% of replacement of Marble dust with fine aggregates and further increase in marble dust content shows the decreasing pattern of compressive strength of concrete.

Baboo Rai et al (2011), on the basis of the tests, said that if the marble dust is added to 10% instead of fine aggregates, the compression strength of the concrete increases and if more than 10% of the marble dust is added at the concrete it slightly reduces the compressive strength of concrete. S Suresh et al (2013) also shows the similar results from their experiments that the concrete blended with marble dust in place of fine aggregates improves the hardened properties of concrete.

A.A. Aliabdo et al. (2014) during the tests was replaced the fine aggregates by marble dust with a ratio of 0%, 5%, 7.5%, 10% and 15% and they also suggested that when maintaining the same marble dust and the sand replacement ratio, reduction in the proportion of water and cement improves the compressive strength of the concrete. Based on their tests, they proved that the tensile strength of concrete and bond strength between steel-concrete increases and optimum value of both properties are obtained when up to 10% of marble dust is used in concrete. The results regarding Porosity of concrete and ultrasonic pulse velocity resemble with results Bahar Demirel experiments on concrete.

Bahar Demirel (2010) differently exercised and took a two fractions of fine aggregates in the experiments, one fraction was 0 - 0.25mm and other fraction was 0.25mm - 4mm.BaharDemirel only replaces the 0-0.25mm portion of fine aggregates from 0% to 100% of marble dust and investigated that the compressive strength of concrete is increased as curing age and percentage of marble dust in place of fine aggregate increases. It also had said that mixing marble in the place of sand in concrete has a profound effect on concrete porosity and concrete porosity decreases with increasing the amount of marble dust and increase its ultrasonic pulse velocity.

Alok D Sakalkale et. al. (2014) examined the behavior of concrete when one of the ingredients of concrete (fine aggregate) was replaced by marble dust in proportions of 0%, 25%, 50% and 100%. From their study, they found optimum compressive strength of concrete by adding up to 50% of the waste marble dust to the concrete in place of fine aggregate, the compressive strength and flexural strength of the concrete shows increasing pattern on the graph. But they also declared that the split tensile strength of concrete cubes shows a decreasing pattern of the curve on the graph from 0% to 100% use of marble dust in place of fine aggregates.

Raman Kumar and Ankit (2016) have shown that the compression strength and splitting tensile strength of concrete increases with replacement of 10% to 15% of the amount of marble dust in place of fine aggregates. According to the two attributes of concrete mentioned above, the flexural strength of the concrete also shows the same trends of results when sand replaced by the marble powder.

Ms. Monica C. Dhoka (2013) also created an extraordinary experimental program in which she prepared three types of concrete mixes. The first was the conventional concrete mix, in the second mix, they replaced completely the fine aggregates with 50% marble powder and 50% of the dust and in the final mix was provided by 10% of paper pulp in place of cement. The results described that the compressive strength and the split tensile strength of second mix was increased about 8% and 25% respectively as compared to conventional mix.