AN EVALUATION OF STRENGTH PARAMETERS OF HIGH STRENGTH CONCRETE CONTAINING METAKAOLIN AND GROUND PUMICES

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Abstract - *Concrete is the most commonly used material made from cement, water, fine aggregate and coarse aggregate. Worldwide production of cement has greatly increased from last many years. Amongst which about 60% to 80% volume is occupied by Aggregates. For many of structure high strength concrete is used for to increases the load carrying capacity of structure. High strength of concrete is achieved by using different types of super plasticizer. Super plasticizer are used in content of about of 0.5% to 3%. Here in this problem we used SMF sulphonated melamine formaldehyde based super plastisizer in content of 2%.*

The aim of the study is partial replacement of cement with metakaolin and fine aggregate with ground pumices.in this study we replacing the cement 10% of metakaolin with ground pumices of 10 to 40% by weight of fine aggregate. We performed the different experimental study on strength, durability of concrete. The different experiments are performed like compressive strength test, split tensile, flexural strength and slump test of concrete containing metakaolin and ground pumices compared with normal concrete at the age of 7 days , 14 days and 28 days. Here in pilot study results are compared with normal concrete at the age of 3 days and 7 days. from this results we decided the various combination. From the recent work we can say that the metakaolin and ground pumices can be used for achieving the high strength concrete.

Key Words: **HIGH STRENGTH CONCRETE, GROUND PUMICES, METAKAOLIN**

1. INTRODUCTION

Concrete is the most widely used construction material with the ever increasing industrialization and urbanization huge amount of natural resources are required to make concrete. It is the mixture of the cement, sand, water and aggregate. The hardening of concrete is caused by chemical action between the water and cement and continues for long time period. It is the quality that makes the concrete different from other binding materials High strength of concrete has the characteristics strength is about 50 to 100 N/mm^2.high strength of concrete also having higher resistance capacity against chloride and abrasion of concrete. With development of new and efficient admixtures for concrete for example like metakaoline and high quality additives like high range of water reducer are used for the production of high strength of concrete. The introduction into general use of high performance materials, such as High Strength Concrete, is of great importance as the move towards sustainable design certainly requires that materials be utilized to their full potential, in order for this to happen a proper understanding of the behaviour of these materials is required.

Metakaolin is the most recent supplementary cementitoius materials to be commercially introduced to the concrete construction industry. Unlike other supplementary cementitious materials, metakaoline is not an industrial by product; it is produced by calcining High purity kaolin clay at temperatures of 700 to 800 C. It has been shown that the inclusion of metakaolin could improve the properties and durability performance of concrete. Metakaoline is the very reactive calcined clay and it has focused on many of investigations. High reactivity metakaoline is recently developed material for achieving the high strength of concrete.it simply converts the material to MK phase, which is an amorphous aluminosilicate. Metakaoline has been refined carefully such that to remove its impurities, its particle size controlled and lightened color like the other industrial product like Silica fume, blast furnace slag and Fly ash.. The particle size of metakaolin is generally smaller than the size of cement particles and it is less than 2 µm. Metakaoline is an efficient pozzolona and react with the calcium hydroxide which comes from the cement hydration by pozzolanic reaction which produce the calcium aluminosilicate hydrates and calcium silicate hydrates. This two products reacts with $Ca\ (OH)_2$ which is by-products of hydration reaction of cement produced C-S-H gel which has been increase the strength of concrete.in this chapter we summarised the detailed study on turnery material and various test conducted for that. The aim of study is to identifying the strength parameters of high strength concrete by using metakaoiline and ground pumices. The particle size of metakaoline is finer size so we can replace that materials by cement. The is replace by weight of cement about 10% and ground pumices is replaced by 10 to 40% by weight of fine sand. We find the replacement for this materials for to achieving the high strength and to compare the result.

2. EXPERIMENTAL INVESTIGATION

A. Materials

1 cement:

The most widely recognized cement at present utilized as a part of development is OPC 53 grade. This sort of cement is regularly utilized as a part of development and is promptly accessible from an assortment of sources. The Blaine fineness is utilized to measure the surface zone of cement. The surface territory gives an immediate sign of the cement fineness. The commonplace fineness of cement reaches from 350 to 500 m^2/kg for OPC 53 grade cement. Determination of the kind of cement will rely on upon the general necessities for the concrete, for example, strength, toughness and so on.C_3A content higher than 10% may bring about issues of poor workability maintenance. The regular substance of cement is 350-450 Kg/m^3.More than 500 Kg/m^3 cement can be dangerous and increase the shrinkage cracks. Less than 350 Kg/m^3 may only be suitable with the inclusion of other fine filler, such as fly ash, pozzolona, etc. Cement has higher content of lime CaO about 62% and silica about 22%. Cement is obtained by burning of calcareous materials at very high temperature about 1400 ºc alkali oxides Na_2O, K_2O, MgO are harmful for cement.

2 Fine aggregate:

All type of sands are suitable for concrete. Either crushed or rounded sands can be used. Siliceous or calcareous sands can be used. Sand is generally considered to have a lower size limit of about 0.07 mm. material between 0.06 and 0.002 is classified as silt.

A minimum amount of fines (arising from the binders and the sand) must be achieved to avoid segregation. There are different types of sand is natural sand , crushed gravel sand , crushed stone sand etc.it is depending upon the particle size distribution according to IS: 383-1970 has divided the fine aggregate in to four grading zone.

3 coarse aggregate:

All types of aggregates are suitable for concrete. The normal maximum size is generally 16 – 20 mm. Consistency of grading is of vital importance. Regarding the Characteristics of different types of aggregate, crushed aggregates tend to improve the strength because of the interlocking of the angular particles, whilst rounded aggregates improve the flow because of lower internal friction. Gap graded aggregates are frequently better than those continuously graded, which might experience greater internal friction and give reduced flow.

4 Metakaolin:

High-reactivity metakaolin (HRM) is a highly processed reactive aluminosilicate pozzolan, a finely-divided material that reacts with slaked lime at ordinary temperature and in the presence of moisture to form a strong slow-hardening cement. It is formed by calcining purified kaolinite, generally between 650–700 °C in an externally fired rotary kiln. It is also reported that HRM is responsible for acceleration in the hydration of ordinary Portland cement (OPC), and its major impact is seen within 24 hours. It also reduces the deterioration of concrete by Alkali Silica Reaction (ASR), particularly useful when using recycled crushed glass or glass fines as aggregate.

5 Ground pumices

Ground Pumice called pumicite in its powdered or dust form, is a volcanicrock that consists of highly vesicular rough textured volcanic glass, which may or may not contain crystals. It is typically light colored. Scoria is another vesicular volcanic rock that differs from pumice in having larger vesicles, thicker vesicle walls and being dark colored and denser. Pumice is created when super-heated, highly pressurized rock is violently ejected from a volcano. The unusual foamy configuration of pumice happens because of simultaneous rapid cooling and rapid depressurization. The depressurization creates bubbles by lowering the solubility of gases including water and CO_2. that are dissolved in the lava.

B. Mix Proportions

M60 grade of Concrete is used to present the investigation. mix design was done based on IS: 10262-1982. Quantity of 1 M^3 of concrete containing 450 kg cement,1121 kg coarse aggregate, 701 kg fine aggregate and 138 litters of water.

C. Experimental Procedure

The specimen of standard cube of 150x150x150 mm, standard cylinder of 300x150 mm and standard beam of 700x150x150 mm were used to determine the compressive strength , split tensile strength and flexural strength specimens are tested for 7,14 and 28 days with each proportion of combination of metakaolin with replacement of ground pumices. Total 72 cubes , 54 cylinders and 54 beams were cast for strength parameters. w/c ratio is constant for all mix is 0.35 . the constituents are weighted and materials were mixed by mixture. The concrete was filled in different layers by compaction. The specimen were Demoulded after 24 hours , cured in water for 7, 14 and 28 days and then it is tested for its compressive strength, split tensile strength and flexural strength.

3. TEST RESULT AND DISCUSSIONS

Result of fresh concrete with partial replacement of metakaolin and ground pumices is to be investigated and result is compare with normal concrete. workability of concrete is carried out by slump test. from slump test result we can say that the slump value is very less for high strength concrete and for its combinations.

A) SLUMP TEST

Slump test result for M60 grade concrete with metakaolin and ground pumices is shown as below:

SR NO	CONCRETE MIX	SLUMP VALUE(mm)
1	NORMAL	10
2	20% GP	09
3	22% GP	09
4	24% GP	08
5	26% GP	08
6	28% GP	08
7	30% GP	07

Table 1 slump test result

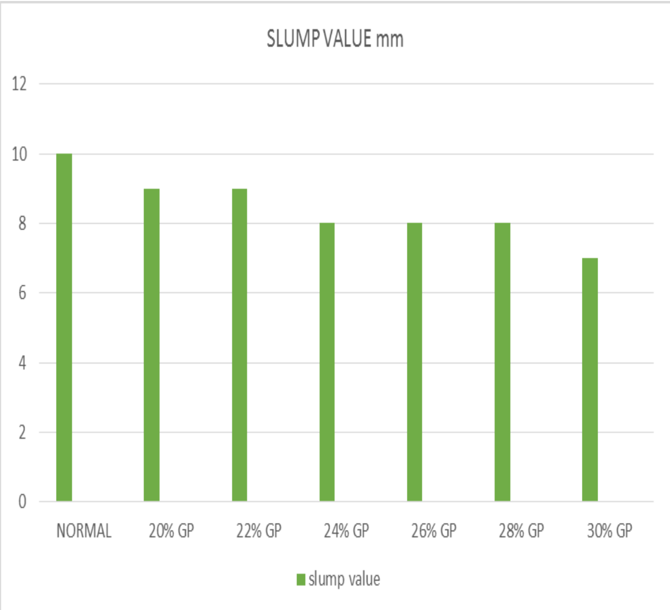

Fig -1: Slump test result

B) HARDENED CONCRETE TEST

1) Compressive strength test:

The compressive strength of cube specimen is checked after 7, 14 & 28 days in compressive testing machine. The specimens containing MK and GP with varying percentage are tested during this project. The results of compressive strength are as shown In Table. we also tested the result after 28 days.

SR NO	MK%	GP%	COMP STRENGTH Mpa		
			7 days	14 days	28 days
1	10%	20%	56.10	66.5	74.87
2	10%	22%	57.52	67.18	76.80
3	10%	24%	58.68	68.93	79.19
4	10%	26%	54.94	64.72	74.22
5	10%	28%	51.57	60.17	71.24
6	10%	30%	47.33	56.67	66.07

Table 1. Compressive strength test result

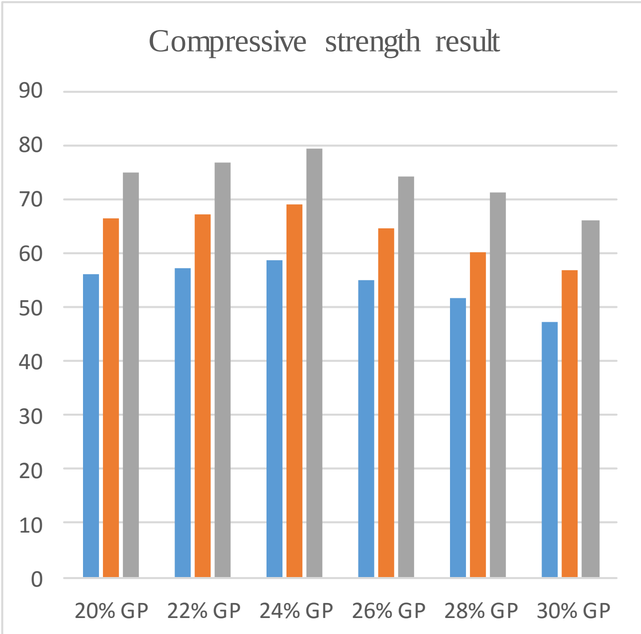

Fig 2 Compressive strength test result

2) Split tensile strength test:

Table shows that split tensile strength of cylinder is increased for 20%,22% and 24% of GP and it will be reduced for 26%,28% and 30% of GP. Concrete is very lower in tension so split tensile strength of concrete is very less. split tensile test is measured for the capacity of tension.

SR NO	MK%	GP%	SPLIT TENSILE STRENGTH Mpa		
			7 days	14 days	28 days
1	10%	20%	5.66	6.1	6.64
2	10%	22%	6.08	6.36	7.21
3	10%	24%	6.40	6.78	7.63
4	10%	26%	5.65	6.22	7.35
5	10%	28%	5.20	5.79	6.78
6	10%	30%	5.51	5.51	6.5

Table 2. Split tensile strength test result

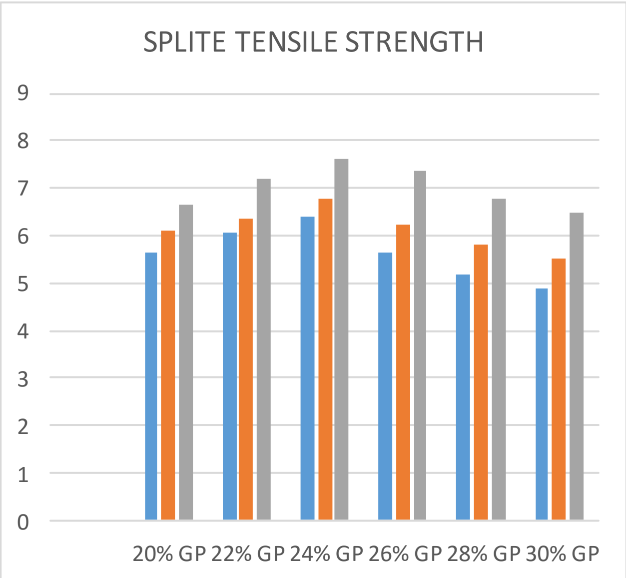

Fig 3: Split tensile strength test result

3) Flexural strength test:

Concrete has very smaller flexural strength. the above fig shows the flexural strength of concrete is increased up to 24% of GP and it will reduced for further replacement up to 30%.

Flexural strength test is performed on the bean of different size. Standard size of beam is 700x150x150 mm.

SR NO	MK%	GP%	FLEXURAL STRENGTH Mpa		
			7 days	14 days	28 days
1	10%	20%	5.24	5.7	5.97
2	10%	22%	5.31	5.80	6.13
3	10%	24%	5.4	5.92	6.42
4	10%	26%	5.18	5.61	6.03
5	10%	28%	5.02	5.48	5.84
6	10%	30%	4.80	5.26	5.73

Table 3 Flexural strength test result

4. COST COMPARISION:

Cost comparison is required for to compare the price of two or more different products. In our experimental work comparison of cost between different combinations with normal concrete mix.

In this process the Quantity of material required for to made concrete and the rate of material is required. Here we compare the cost of $1m^3$ of 20%, 22%, 24%, 26%, 28%, and 30% replacement of GP with normal concrete mix is compare.

From the cost comparison we can say that the cost of normal concrete is less compare than 20% replacement of GP. Cost of that concrete is about 1.6 times higher than the normal concrete. for 22% replacement of GP. Cost of that concrete is about 1.65 times higher than the normal concrete. for 24% , 26% , 28% and 30% cost of concrete is higher about 1.71 , 1.773 , 1.832. , 1.9 times higher than normal concrete.

5. CONCLUSION:

1. From the above study we conclude that the compressive strength , split tensile strength , and flexural strength gradually increases up by addition of 10% of metakaolin and 10% ground pumices.

2. With increses in replacement of ground pumices by 20% the strength is also increases and for 30% ground pumices the compressive strength , split tensile strength , and flexural strength were decreasing .
3. So from pilot study results we decided the combination by replacement of 20% , 22% , 24% , 26%, 28% , 30% replacement of ground pumices.
4. For 20% , 22% , and 24% of ground pumices the compressive strength , split tensile strength , and flexural strength will be increased and for 26% , 28% , and 30% of ground pumices strength will be decreased.
5. For 20% and 30% of pumices the compressive strength will be 14% increased and 3% decreased respectively for 28 days.

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