EXPERIMENTAL STUDY ON HIGH STRENGTH SELF COMPACTING CONCRETE WITH USING METAKAOLIN AND MARBLE POWDER

[1]Rinal Patel, [2]Nihil Sorathia

[1]Student (M. Tech), [2]Assistant Professor,
[1]Structural Engineering,
[1]Parul Institute of Engineering and Technology, Vadodara, India

Abstract: Researchers tried almost every conceivable material to be mixed in concrete to alter some of its properties. High strength self-compacting concrete (HSSCC) is one of the concrete innovations that have a high quality standard. This paper reports an experimental study of the influence of metakaolin and marble powder on the mechanical properties of high strength self-compacting concrete (HSSCC). This type of concrete has a high compressive strength and can compact without tools. Parameters that are about to study in this research are fresh properties and mechanical properties of HSSCC. In this research, trying to prepare high strength self-compacting concrete mix design without decreasing its mechanical characteristic, where metakaolin and marble powder replace cement in percentages of 5% ,10%,15% by weight of the control cement content.
In this study used two types of superplasticizers which are conplast sp 430 which is naphthalene based superplasticizer and the other one is pc based superplasticizer. Several samples were prepared to study the effect of the superplasticizer on concrete and the result and noted. Fresh properties of the self-compacting concrete tested such the test that are perform are slump-flow, l-box test, v-funnel and all gave the positive result and for the compressive strength using metakaolin with pc based superplasticizer at all three percentages such as 5%,10%,15% of cement replace with metakaolin gives good result at 7 and 28 days after curing. But for the compressive strength using marble powder with using naptha based plasticizer it didn't give result up to the design expectation at both 7 and 28 days with all 5%,10%,15% replacement of cement. Flexural and tensile strength are also tested.

Index Terms **-Self-compacting concrete, metakolin, marble powder, Super Plasticizer, Mechanical Properties.**

➢ INTRODUCTION

Generally, a high strength concrete has a high durability and low cement water factor ratio compared to conventional concrete that has only a compressive strength of 30 MPa - 40 MPa. To obtain a compressive strength till 60 MPa or equivalent to 650 kg/cm2 can use the type of concrete self-compacting concrete. Self-compacting concrete is a very plastic and easy-flowing fresh concrete because its own weight can fill up throughout the mold. This concrete has the properties to solidify itself without the need for the aid of a vibrator commonly used in concrete compaction. SCC concrete is often called a flowing concrete because it has a very high slump value. Self-compacting concrete must have a homogeneous, cohesive, non-segregated, and no bleeding properties. HSSCC is one of the concrete innovations that have high quality standards. This type of concrete has a high compressive strength and can solidify without the aid of tools. High quality concrete tends to have high viscosity, so the use of super-plasticizer is required to improve workability and maintain SCC parameters. In order to achieve high workability super plasticizer can be used as an added ingredient that is directly mixed into the mortar of concrete. Then to reach high compressive strength concrete, from previous research, adding pozzolan material able to increase the ultimate strength. Added material (admixture) is a powder or liquid material, which is added to the mixture of concrete during stirring in order to alter the nature of the mortar or its concrete. The use of meta- kaolin in normal concrete can make more homogeneous concrete paste because of reaction between meta-kaolin which is pozzolan with calcium hydrate of cement hydration. The more the amount of addition of meta-kaolin in the concrete, the decreased workability caused by the surface area of meta-kaolin is greater than the cement. This can be overcome by the addition of super-plasticizer so that concrete SCC parameters can be maintained. According to Parameters to be studied in this research is compressive strength, self-compacting concrete parameters and durability. Marble powder (MP) which is an inert material obtained as an industrial by-product during sawing, shaping, and polishing of marble has also successfully been used as an addition in SCC and SCM. The purpose of this study was to investigate the usability of waste marble dust as an additive in composite cement production and determine its performance properties as a function of waste marble dust addition.

➢ SELF-COMPACTING CONCRETE AND MATERIALS

Self-consolidating concrete is a highly flow-able type of concrete that spreads into the form without the need for mechanical vibration. Self-compacting concrete is a non- segregating concrete that is placed by means of its own weight. The importance of self-compacting concrete is that maintains all concrete's durability and characteristics, meeting expected performance requirements. In certain instances, the addition of superplasticizers and viscosity modifier are added to the mix, reducing bleeding and segregation. Concrete that segregates loses strength and results in honeycombed areas next to the formwork. A well designed SCC mix does not segregate, has high deformability and excellent stability characteristics. Self-compacting concrete produces resistance to segregation by using mineral fillers or fines and using special admixtures. Self-consolidating concrete is required to flow and fill special forms under its own weight, it shall be flow able enough to pass through highly reinforced areas, and must be able to avoid aggregate segregation. This type of concrete must meet special project requirements in terms of placement and flow. Self-compacting concrete with a similar water cement or cement binder ratio will usually have a slightly higher strength compared with traditional vibrated concrete, due to the lack of vibration giving an improved interface between the aggregate and hardened paste. The concrete mix of SCC must be placed at a relatively higher velocity than that of regular concrete. Self-compacting concrete has been placed at heights taller than 5

meters without aggregate segregation. It can also be used in areas with normal and congested reinforcement, with aggregates as large as 2 inches.

➢ Justification for use of metakaolin and marble powder

Metakaolin is kind of mineral admixture that helps in increasing strength and it can be used in concrete production. The use of metakaolin helps in reducing clinker content in concrete. This way mineral admixture benefits in receiving energy savings, reduce greenhouse gas emissions. It is also manufacture at lower temperature the cement which helps in reducing pollution. Marble powder is waste powder that is generate during cutting and sawing of marble which leads to serious environmental problem, hence utilization of marble dust powder is preferable in concrete. Marble powder contents high oxide calcium which is a cementing property. So marble powder can be used as partial replacement of cement in concrete. By utilizing marble powder strength of concrete improves & reduces environmental problems. And the chemical composition of MDP and MK matches with cement so we can replace cement with both marble powder and metakaolin.

Figure 1 metakaolin powder and marble powder

➢ Marble powder

It has been estimated that several million tons of MDP are produced during quarrying worldwide. Hence utilization of marble powder has become an important alternative material towards the efficient utilization in concrete for improved harden properties of concrete. Marble is a metamorphic rock resulting from the transformation of a pure limestone. Waste marble powder is generating as a by-product during cutting of marble which in range of 20% total marble used. This waste leads to serious environmental and dust pollution. Marble powder contents high oxide calcium which is a cementing property. So marble powder can be used as partial replacement of cement in concrete. By utilizing marble powder strength of concrete improve, & reduces environmental problems. Waste marble dust (WMD) is use as an additive material in concrete production. WMD used consists of basically SiO_2, Al_2O_3, and CaO with minor contents of MgO, Fe_2O_3, K_2O and Na_2O.

➢ Metakaolin powder

Metakaolin is one of the mineral admixtures which is available commercially since mid-1990 and can be used in concrete production. The production of metakaolin can be done at lower temperature than the cement, which leads to lower cost of metakaolin. Metakaolin is a pozzolan, probably the most effective pozzolanic material for use in concrete. It is a product that is manufactured for use rather than a byproduct and is when china clay, the mineral kaolin, is heated to a temperature between 600 and 800°C. Metakaolin is the anhydrous calcined form of the clay mineral kaolinite. Minerals that are rich in kaolinite are known as china clay or kaolin. The particle size of the metakaolin is smaller than cement, but not as fine as silica fume. Its quality controlled during manufacture, resulting in a much less variable material than industrial pozzolan that are by products.

➢ Superplasticizer

Superplasticizer in this work used are Conplast SP430 which naphthalene based and another is pc based superplasticizer, and the naptha based superplasticizer are Particularly suitable other high early strength requirements, significantly improving the workability of site mixed and also major increases in strength at all ages by significantly reducing water demand in a concrete mix. Its Appearance is brown color and which is in liquid form with specific gravity of 1.18@25°C.similarly the pc based is also used to improve workability and the strength.

Compressive strength results

control mix				
Days	Sample 1	Sample 2	Sample 3	average
7	25.91	16.53	23.97	22.13
28	41.96	39.37	40.40	40.57

5% mk				
Days	Sample 1	Sample 2	Sample 3	average
7	42.70	31.83	30.33	34.95
28	45.42	55.05	54.40	51.62

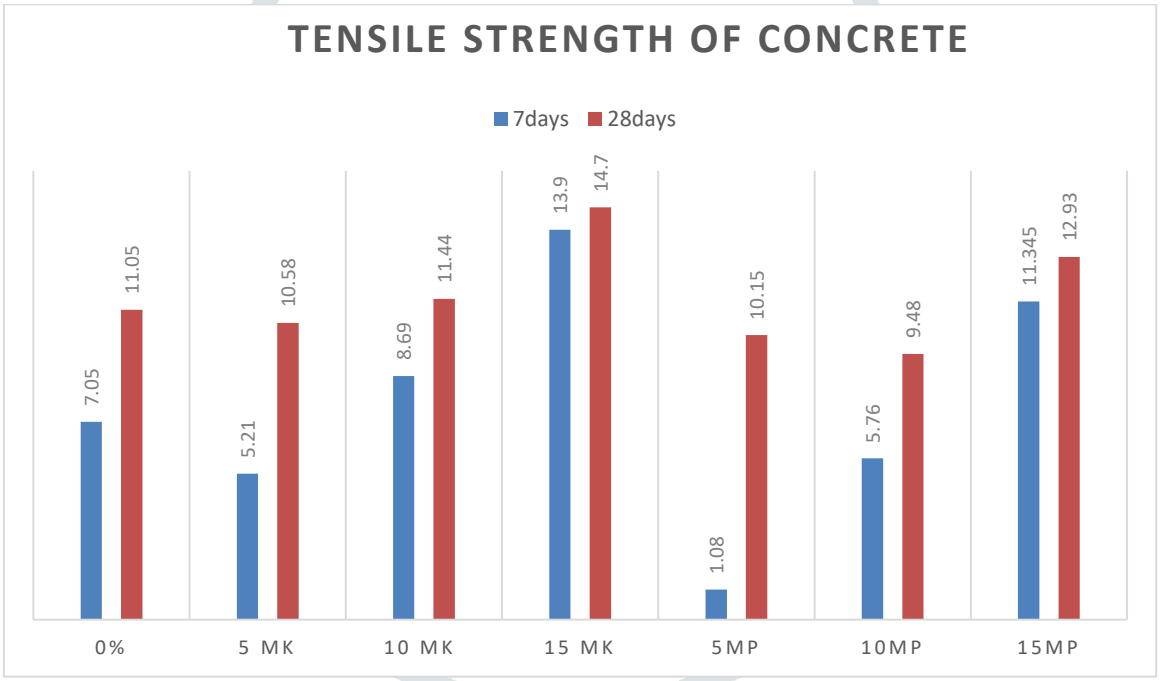
10% mk				
Days	Sample 1	Sample 2	Sample 3	average
7	23.77	24.25	12.5	20.17
28	47.98	50.40	51.34	49.90

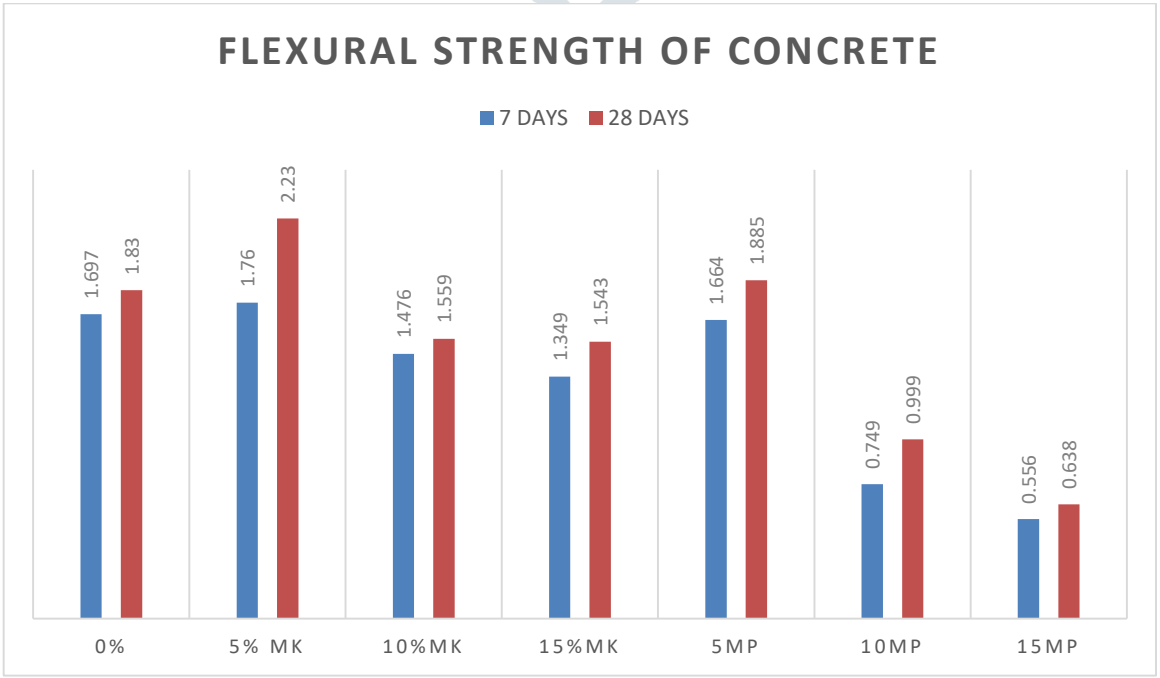
15% mk				
Days	Sample 1	Sample 2	Sample 3	average
7	36.66	47.80	22.31	35.59
28	45.62	33.97	50.98	43.52

5% MP				
Days	Sample 1	Sample 2	Sample 3	average
7	21.07	20.41	19.70	20.39
28	34	30.79	29.87	31.55

10 % MP				
Days	Sample 1	Sample 2	Sample 3	average
7	18.92	11.07	20.46	16.81
28	24.82	33.10	35.20	30.37

15 % MP				
Days	Sample 1	Sample 2	Sample 3	average
7	6.38	10	4.56	6.98
28	22.23	20.91	28.35	23.83





➢ TEST RESULTS

This study focused on the effect of the metakaolin powder and marble dust powder on the self-compacting concrete in terms of strength and on the fresh properties of self-compacting concrete such as filling ability, passing ability test are such as slump flow test, v-funnel; and in terms of sealing capability. Several percentages of metakaolin and marble powder were used to study the effect of the MP and the MK on the targeted concrete property. In this study we use two type of superplasticizer for the cubes containing marble powder naphthalene based superplasticizer has been used and it didn't give the result up to the expectation. And for the beam and cylinder containing marble powder pc based superplasticizer has been used, it gives good workability and with less water cement ratio compare to MP with naphthalene based superplasticizer and it also give the good strength.

The self-compacting concrete containing metakaolin with using pc based superplasticizer give good result with compare to the naphthalene based superplasticizer. From the results above we can say that the pc based superplasticizer work wisely and give positive result with metakaolin containing concrete. Fresh properties of scc containing at all percentages of MK and MP give positive result in the form of passing ability, filling ability, and 5% mk with pc based superplasticizer give positive result in form of mechanical properties.

➢ Conclusion

The superplasticizer has a significant effect on the behaviour of self-compacting concrete in its two stages, fresh concrete and hardened concrete. In this study three different percentages of MK and MP has been replaced with cement. Metakaolin containing polcarboxylic ether based superplasticizer give good result we can see that from the tables and marble powder containing naphthalene based superplasticizer not give satisfied results according to design for the high strength self-compacting concrete. Using of naphthalene based superplasticizer take more than two days to dry and it also didn't suitable with marble powder and the metakolin as it takes too much time to dry and demand more water with compare to pc based superplasticizer. So it's preferable to use the pc based superplasticizer with both MK and MP for high strength self-compacting concrete. And the pc based superplasticizer give good result as it's reduce retention time, good workability and give high strength. There is an optimum value 5%MK to be added to the concrete as an admixture get the maximum compressive strength of concrete. The increase beyond the 5% MK optimum amount will affect the concrete strength negatively.

In tensile test of concrete cylinder and compressive strength of cubes showed that it is minimum at 5% mk gives good strength and for the flexural strength 15% mk gives the maximum strength and for the marble powder increasing the amount of marble powder decrease the strength for compressive and flexural and increasing for tensile.

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