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To Study the Variation in Compressive and Split Tensile Strength of Concrete by Using Various Binders

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Abstract: This paper accentuates the effect of bentonite, sugarcane molasses, jaggery and polyvinyl acetate on strength properties of concrete. The experimentation has been carried out to assess the strength properties of concrete using these materials in concrete composition. Based on the literature, the main reason of usage of these materials is due to the binding property possessed by them. Three different percentages of polyvinyl acetate were chosen in the experimentation as 0.1%, 0.2% and 0.3% respectively and keeping proportion of bentonite, sugarcane molasses and jaggery constant at 30%, 0.1% and 0.1% respectively by weight of cement. Cement was only replaced bentonite. Sugarcane molasses, jaggery and polyvinyl acetate were only added without replacing cement. However, the values of strength observed were at lower side initially, later gain in strength was observed. At 0.2% PVA composite proportion maximum strength was observed. The test results show some marginal strength variation at all proportions.
Keywords: Binders, Compressive strength, Tensile strength, Workability.

I. INTRODUCTION

Concrete plays a crucial and undeniable role in construction industry because of its superior characteristics like strength and durability. Cement is an inevitable material in concrete as it plays a vital responsibility of holding all the ingredients together. Apart from its advantages, it is responsible in emission of carbon dioxide and greenhouse gases. Manufacturing process of cement is a significant contributor to release of greenhouse gases into the environment. The worldwide production of cement accounts for almost 7% of the total world carbon dioxide production. So, formulating cement properties using a low proportion of calcinated material, thereby reducing the carbon dioxide emissions per unit of product. Another way of reducing the amount of cement in concrete without compromising the strength properties is substitution of cement by other materials possessing similar properties .In due course of time natural pozzolona was proved to impart beneficial properties to concrete in terms such as low heat of hydration, high ultimate strength, high impermeability and high corrosion resistance.

According to the literature referred, some other materials can be substituted in concrete without hampering the strength and durability of the concrete. Bentonite was found to be useful because of its blending ability and having some properties similar to cement. In addition to this, bentonite is a naturally occurring material recovered from the precipitates of volcanic eruptions so it does not emit any greenhouse gases and is environment friendly. On the other hand sugarcane molasses and jaggery tend to make significant variation in the strength of concrete even in very small percentages. Polyvinyl acetate isn't a naturally occurring adhesive and no records of its usage in concrete have been found so the effect of addition of polyvinyl acetate in concrete is to be observed.

II. MATERIALS

A. Bentonite

Bentonite possesses an ability to absorb moisture when it is wet and expands as much as several times its dry mass. This property of expanding makes it useful as a sealant and as low permeability barriers. The ionic surface of bentonite has a useful property in making a sticky coating resulting in strong binding. Cement contains constituent ingredients like lime, silica, alumina, iron oxide, magnesia, silica and alkali. Out of which, lime imparts binding property, silica imparts strength and alumina imparts setting property. Bentonite is pozzolanic in nature and it also contains lime, silica and alumina in significant amounts. Apart from its construction uses, bentonite is also useful in purification of wastewater and in manufacture of some pharmaceutical drugs.

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Figure 1.Bentonite

B. Jaggery

The jaggery contains approximately 60-85% sucrose, 5-15% glucose and fructose.Along with 0.4% of protein, 0.1 g of fatand 0.6 to 1.0g of minerals (8 mg of calcium, 4 mg of phosphorus and 11.4 mg of iron). It is also found to contain traces of vitamins and aminoacids. Hydrolysis breaks the glycosidic bond converting sucrose into glucose and fructose. This conversion imparts adhesion i.e. interlocking capability which is predominantly dependent on the viscosity and ion exchange property. According to literature, jaggery was used as a building material in addition with cement for joining bricks. Jaggery, which is predominantly contains sucrose, upon reacting with calcium carbonate in lime and silica in clay, forms strong bonds and became very hard on drying. Some examples of such buildings can still be seen in West Bengal and in other parts of India if they are still standing. In fact, jaggery doesn't contribute at all in emission of greenhouse gases.

Figure 2.Jaggery

C. Sugarcane Molasses

Molasses is a by-product obtained from the sugar refining process. Molasses can also be obtained from the paper industries. India and Brazil are the largest sugarcane cultivating countries. Molasses is thick syrup with around 40-50% of total reducing sugar, rich in minerals like potassium, calcium, iron etc. There is about 4% yield of molasses for every ton of sugarcane processed. In construction industry, molasses can be used as a minor component of mortar for brickwork and as a binder. Out of all its constituent elements lime, ash and gum impart binding property to sugarcane molasses.

Figure 3.Sugarcane Molasses

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D. Polyvinyl acetate

Polyvinyl acetate (PVA) is a synthetic glue. It is made by polymerisation of vinyl acetate monomer. It is used in binding due to its strong flexible bond and alkaline nature. Its alkalinity makes it suitable for usage in concrete as it won't corrode the reinforcement. Mainly it is used as an emulsifier and as a primer for dry walls.

Figure 4.Polyvinyl Acetate

III. METHODOLOGY

Mix design of M20 grade concrete was carried out according to IS: 456-2000. Total 60 specimens concrete were casted consisting 30 cubes and 30 cylinders. 6 cubes and 6 cylinders of each proportion were casted. Conventional, Base, 0.1%PVA, 0.2%PVA and 0.3%PVA were the 5 set of proportions. Conventional concrete contained water, cement and aggregates without any admixtures. Base concrete contained water, cement, aggregates, bentonite replacing 30% cement, 0.1% of jaggery and sugarcane molasses without replacing cement. 0.1% PVA concrete contained base concrete plus 0.1% PVA by weight of cement without any replacement and same for 0.2%PVA and 0.3%PVA composite concrete.

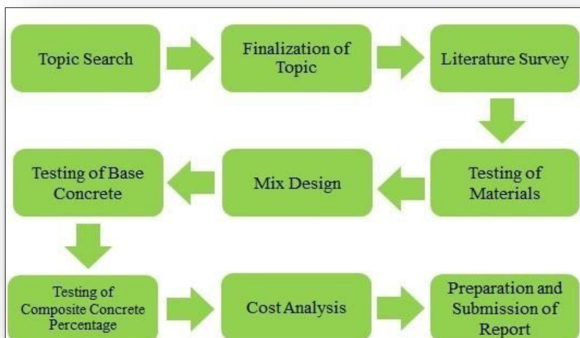

Figure 5. Methodology

IV. TESTING OF SPECIMENS AND RESULTS

Specimens were demoulded after 24 hours and kept in the curing pond at a temperature of 27±2°C for 28 days. 3 cubes and 3 cylinders of each proportion were tested at 7 days and 28 days. Specimens were dried before mounting them on CTM. Load was applied gradually and ultimate load was recorded.

Figure 6.Casting of Specimens

Figure 7. Testing of Specimens

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Table 1 Compressive Strength

Type of Concrete	Compressive Strength (MPa)	
	7 days	28 days
Base[30%Be(Replacement)+0.1%J+0.1%SM]	12.26	20.30
Conventional (M20)	15.18	24.65
0.1%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.1%PVA]	11.59	18.89
0.2%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.2%PVA]	12.31	21.49
0.3%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.3%PVA]	11.02	18.89

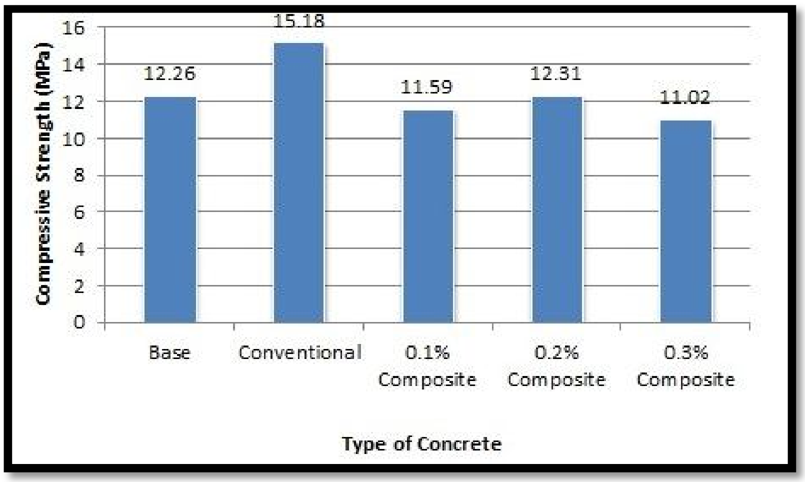

Figure 8. Variation in compressive strength (7 days)

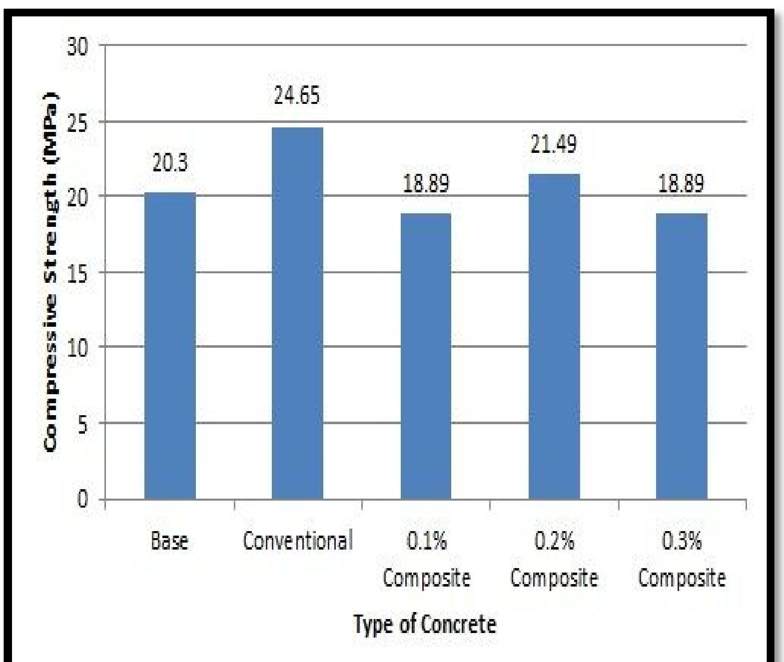

Figure 9. Variation in compressive strength (28 days)

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Table 2 Split Tensile Strength

Type of Concrete	Split Tensile Strength (MPa)	
	7 days	28 days
Base[30%Be(Replacement)+0.1%J+0.1%SM]	1.34	1.60
Conventional (M20)	1.53	2.48
0.1%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.1%PVA]	1.26	1.29
0.2%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.2%PVA]	1.03	1.33
0.3%Composite[30%Be(Replacement)+0.1%J+0.1%SM+0.3%PVA]	1.00	1.10

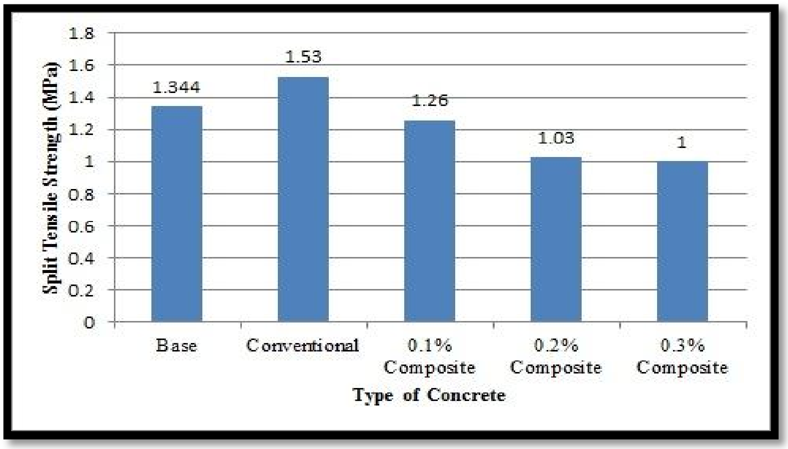

Figure 10. Split Tensile Strength (7 days)

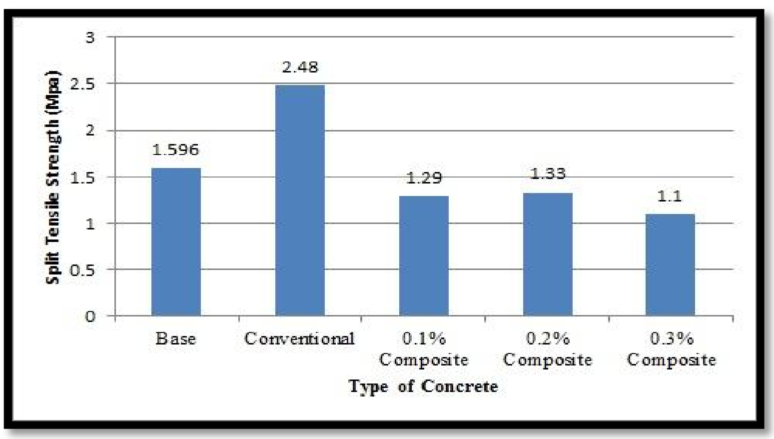

Figure 11. Split Tensile Strength (28 days)

V. CONCLUSION

A. Workability of composite concrete was less than conventional concrete.
B. 0.2% PVA composite concrete shows highest strength values out of all combinations.
C. Maximum 30% cement can be replaced by bentonite.
D. Setting time of composite concrete was more than conventional concrete.

E. This type of composite mixture can be useful in reducing early setting of cement in hot weather concreting.

F. Segregation and bleeding of composite concrete was very less due to admixtures.

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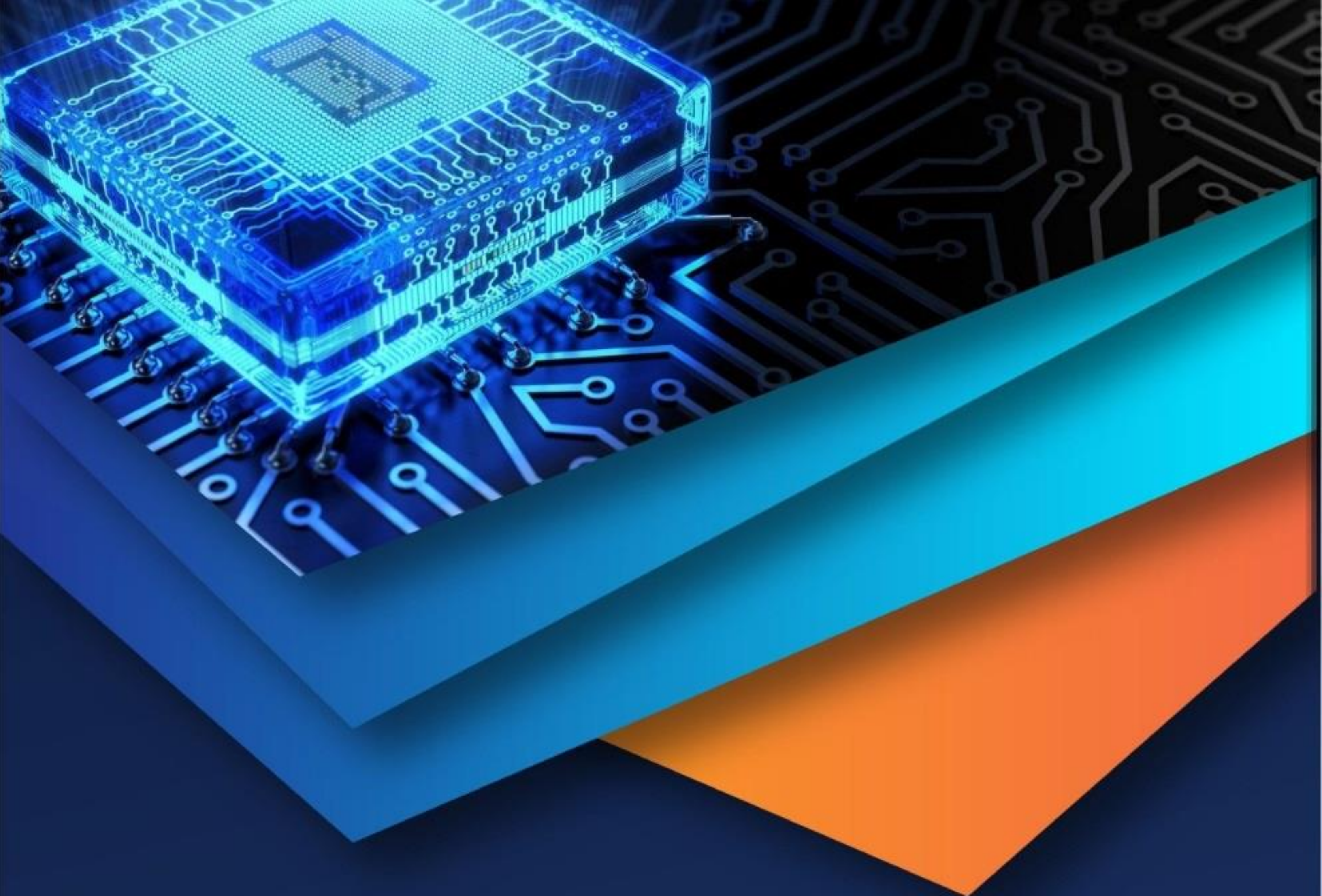

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