A Comparative Study of Mechanical Properties of M20 Grade Self-curing Concrete with Conventional Concrete

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Abstract – Nowadays concrete is most commonly used building material because it gives good strength results. As per survey the usage of cement rapidly increases from 1.5 2.2 billion tons from 1995 to 2010 (Malhotra, 1999). The durability and strength characteristics of concrete is depends on curing, optimum strength is reached by proper curing. Moisture content, humidity and temperature conditions are influence the curing. The minimum curing time of concrete is 28 days; it gives good hydrations and good strength results. So water/cement ratio place important role in curing. We need proper water/cement ratio to hydrate cement particles of cement and for good bonding in between particles. The water/cement ratio will also be effect the strength of concrete structures. The water/cement ratio of range 0.35-0.45 is give better results.

The aim to this investigation is to study the strength and durability properties of concrete using water-soluble polyethylene glycol, polyvinyl acetate and polyvinyl alcohol as self-curing agents. The function of self-curing agent is reduces water evaporation and increase water retention capacity of concrete compared to the nominal concrete. The use of self-curing compounds is saving water, it is necessity everyday (for each cubic meter of concrete requires 3m3 of water in a construction, most of which is used for curing). In this study, compressive strength and split tensile strength of concrete containing self-curing agent is investigated and compared with those of nominal concrete.

In this project we study the self-curing compound i.e. polyethylene glycol (PEG-600), polyvinyl acetate and polyvinyl alcohol. It is also known as shrinkage reducing admixture. The polyethylene glycol helps in curing, the concrete with mix water only. Generally the weight of self-curing compound is taken as 0.3% weight of cement. In this we study the PEG, polyvinyl acetate polyvinyl alcohol at different proportions of 0.5%, 1%, 2%, 3% and 4% for M20 mix grade. Also study the compressive strength and spilt tensile strength at varying percentages of PEG, polyvinyl acetate, polyvinyl alcohol and compared to nominal concrete.

Index Terms – Self-curing compounds; Water retention; Hydration; Water permeability; Durability; polyethylene glycol-600; polyvinyl acetate; polyvinyl alcohol.

1. INTRODUCTION

Nowadays many techniques are introduced and rapid improvement in the concrete technology. As per survey the usage of cement rapidly increases from 1.5 2.2 billion tons from 1995 to 2010 (Malhotra, 1999). The durability and strength characteristics of concrete is depends on curing, optimum strength is reached by proper curing. Moisture content, humidity and temperature conditions are influence the curing. The minimum curing time of concrete is 28 days; it gives good hydrations and good strength results. So water/cement ratio place important role in curing. We need proper water/cement ratio to hydrate cement particles of cement and for good bonding in between particles. The water/cement ratio will also be effect the life of concrete structures. When the moisture content of concrete is exposed to the Environment evaporation of water takes place and loss of moisture content of the concrete and hence lowering the quality of the concrete. Various factors Such as wind velocity, relative humidity, atmospheric temperature, water Cement ratio of the mix and type of the cement used in the mix. Evaporation In the initial stage leads to drying shrinkage cracking. Curing temperature one of the major factors that affect the strength development rate. At elevated temperature ordinary concrete losses its asset due to the formation of the cracks between two thermally in compatible ingredients, cement paste and aggregates. When concrete is cured at high temperature normally develops higher early strength that concrete produced and cured at lower temperature, but strength id generally lowered at 28 days and later stage. A durable concrete is one that performs satisfactorily under the anticipated exposure condition during is designed service life.

Many researches are conducted to identify effective self-curing agent therefore, several researches are attracted towards finding the self-curing agent. Polyethylene-glycol which decreases the surface tension of the water and minimize the

water evaporation from concrete and hence increases the water retention capacity of the concrete. It has been found water-soluble polymers (polyethylene-Glycol, PVAC and PVA) can be used as self-curing agents in concrete. In the new millennium, concrete incorporating self-curing agents will represent a new development in the concrete construction.

2. METHODS OF SELF-CURING

Self-curing concrete is special type of technique; in this self-curing technique we required different methods. Currently, there are two major systems available for internal-curing of concrete. They are

I) Light weight aggregate (L W A)

ii) Shrinkage reducing admixtures (polyethylene-glycol-600, poly vinyl acetate and poly vinyl alcohol)

I) Light weight aggregate (L W A):

In this method we are using soaked porous light weight aggregate (L WA) in order to supply an internal bases of water, which can substitute the water consumed by chemical shrinkage during cement hydration, so it reduce water content. Natural, synthetic and expanded shale are used as light weight aggregate material.

ii) Shrinkage reducing admixtures (SRA):

In this method we are using shrinkage reducing admixtures (SRA). Propylene glycol i.e. poly-ethylene glycol (PEG-600), poly vinyl acetate or poly vinyl alcohol are the SRA materials. In this poly-ethylene glycol or poly vinyl alcohol is used shrinkage admixture, which reduce the evaporation of water from the surface of concrete and also helps water retention. It holds the water internally in concrete structures; due to this we can control the water evaporation from the concrete structures. In this project we use poly-ethylene glycol-600 is used as shrinkage reducing admixture.

SIGNIFICANCE OF SELF CURING

The self-curing technique is major use in water lacked areas or low water resource areas. It is mainly used to reduce areas. It is mainly used to reduce the water evaporation from concrete structures and also retaining the water internally in concrete structures. When the mineral admixtures are react externally or internally. The water can be much greater than that in a conventional ordinary Portland cement concrete. When this water is not readily available in working areas, significant autogenously deformation and cracking (early-age) may result. So it is very useful in when water is readily not available. Due to control the water evaporation we use light weight aggregate and polyethylene glycol etc. in this self- curing technique we get a good result with significant chemical mix, if chemical mix proportion was not properly mixed early- age cracking and shrinkage may occurs.

MECHANISAM OF INTERNAL CURING

The mechanism of internal curing is holding the preserved water content of concrete structures within it. So concrete structures are not required any additional water for curing purpose. Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials (free energy) between the vapors' and liquid phases. The polymers added in the mix mainly from hydrogen bonds with water molecules and reduce the chemical potential of the molecules which in turn reduces the vapors' pressures, thus reducing the rate of evaporation from the surface. The shrinkage admixtures like polyethylene glycol, polyvinyl acetate and polyvinyl alcohol are used to retention of water content internally.

3. POTENTIAL MATERIALS FOR INTERNEL CURING (IC)

Self-curing is also referred as internal-curing. Self-curing concrete is one of the special concretes in reducing in sufficient curing due to human negligence and also due to scarcity of water in arid areas, inaccessibility of structures in difficult terrains and in areas were the presence of fluorides in water will badly effect the characteristics of concrete. Some of this special type of materials used in internal curing process. They are as fallows

a) Light weight aggregate (natural and synthetic, expended shell)

b) L W S sand (water absorption = 17%)

c) Light weight aggregate size 19mm coarse (water absorption=20%)

d) Super-absorbent polymers (SAP) (60-300 mm)

e) SRA (shrinkage reducing admixture)

(propylene glycol type i.e. polyethylene-glycol, poly vinyl acetate, polyvinyl alcohol)

These are the materials used as self-curing materials for the internal curing. The materials improves the water retention capacity of concrete structures internally and does not required externally curing like immersion curing and sprinkle curing.

ADVANTAGES OF INTERNAL CURING:

The self-curing or internal curing prose's as fallowing advantages they are

- Internal curing (IC) is a method to provide the water to hydrate all the cement, accomplishing what the mixing water alone cannot do.
- Provides water to keep the relative humidity (RH) high, keeping self-desiccation from occurring.
- It eliminates the autogenously shrinkage.

- Maintains the strength of mortar/concrete at the early age (12to22 hrs.)Above the level where internally & externally induced strains can cause cracking.
- Can make up for some of the deficiencies of external curing, both human related (critical period when curing is required in the first 12 to 72 hours)
- It reduce the early age of cracking due to scarcity of water.
- It is very use full where water readily not available and reduce the curing cost.
- Increase/maintain the strength of concrete if the optimum dosage self-curing admixture is used.
- Protects by reflecting the sun rays to keep the concrete surface cooler and prevent excessive heat buildup, which can cause thermal cracking.
- Furnished as a ready-to-use, true water-based compound. Produces hard dense concrete, minimize hair cracking, thermal cracking, dusting and other defects.
- Offers a compressive strength significantly greater then improperly or cured concrete.

POLYETYLENE GLOYCOL:

In this project we are using polyethylene glycol as self-curing agent polyethylene-glycol is a liquid state polymers ethylene oxide and water, having general formula H (OCH2CH2)nOH. Main feature of polyethylene glycol is water-soluble nature. Polyethylene glycol is non-volatile and non-irritating and also used in different pharmaceuticals. It is easily react with the water and less handling difficulty. In this project used as polyethylene glycol-600, here 600 represent the molecular weight of PEG.

POLYVINYL ACETATE:

Polyvinyl acetate produced commercially rom polyvinyl alcohol, usually by a continuous process the acetate groups are hydrolyzed by ester interchange with methanol in the presence anhydrous sodium methyl ate or aqueous sodium hydroxide.

POLYVINYL ALCOHOL:

Polyvinyl alcohol produced commercially rom polyvinyl acetate, usually by a continuous process the acetate groups are hydrolyzed by ester interchange with methanol in the presence anhydrous sodium methylate or aqueous sodium hydroxide.

OBJECTIVES OF THE STUDY

Some specific water-soluble chemicals such as poly-ethylene glycol is added during the mixing can decrease water evaporation from and within the fixed concrete, making it self-curing. The chemicals should have abilities to decrease evaporation from solution and to improve water retention in ordinary port land cement matrix. Therefore the mix does not required extra water concrete, so external curing like immersion curing and sprinkle curing are not required the mix is cured by mixing water alone. The compressive strength and tensile strength of self-curing concrete for 7, 28 and 60 days is found out and compared conventional concrete of similar mix design.

- The scope of the paper is to study the result polyethylene glycol (PEG-600, PVAC and PVAH) on strength characteristics of self-curing concrete.
- The objective is to study the mechanical characteristics of concrete i.e., compressive strength and tensile strength by varying the percentage of PEG, polyvinyl acetate and polyvinyl alcohol at 1% by weight of cement for both Medium strength and High strength concretes.
- The dosage of PEG is taken as 0.3% of total weight of cement used in mix.
- The dosage of polyvinyl acetate is taken as 0.3% of total weight of cement used in mix.
- The dosage of polyvinyl alcohol is taken as 0.3% of total weight of cement used in mix.
- To study the test results of self-curing concrete and compared to the conventional concrete test results.

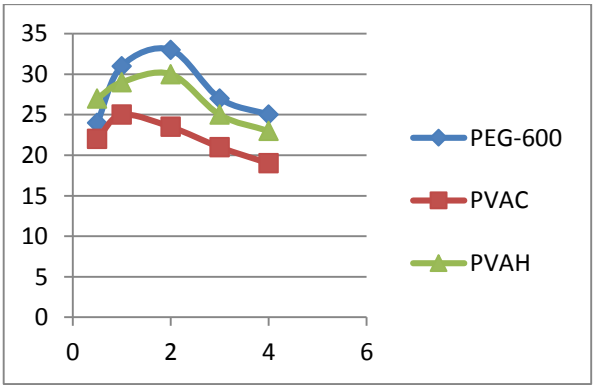
CONCRETE MIX DESIGN

Table. Mix proportions for M20 grade concrete

Water	Cement	Fine agg.	Coarse agg.
191.6 lit	400kg	500kg	1204kg
0.45	1	1.25	3.01

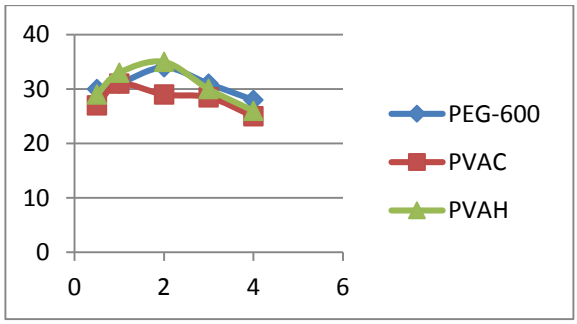
Hence the mix is 1:1.25:3.01
(Designed for M20)

4. EXPERIMENTAL RESULTS



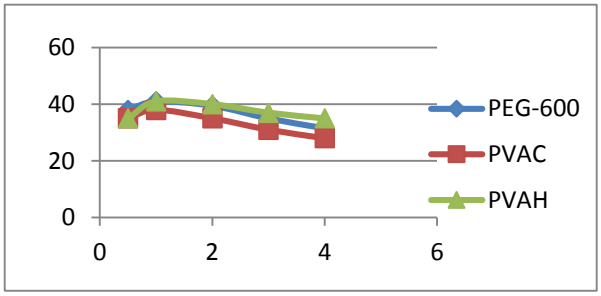
Dosage

Graph for 7 days compressive strength



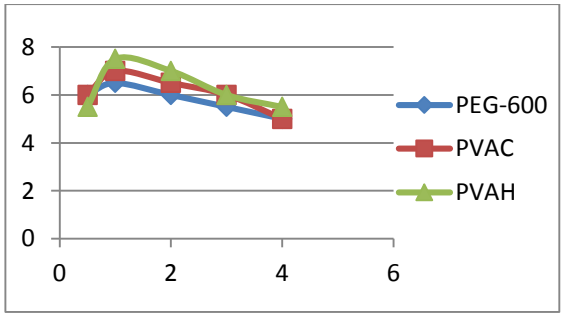
Dosage

Graph for 28 days compressive strength



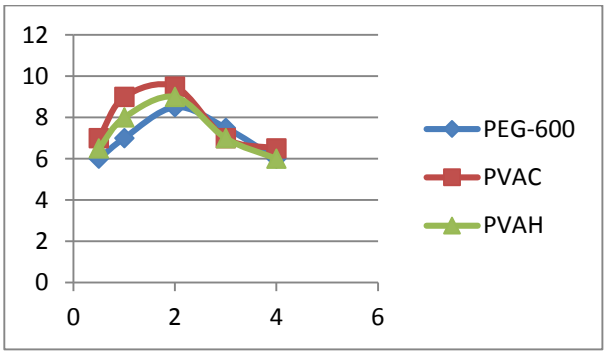
Dosage

Graph for 60 days compressive strength



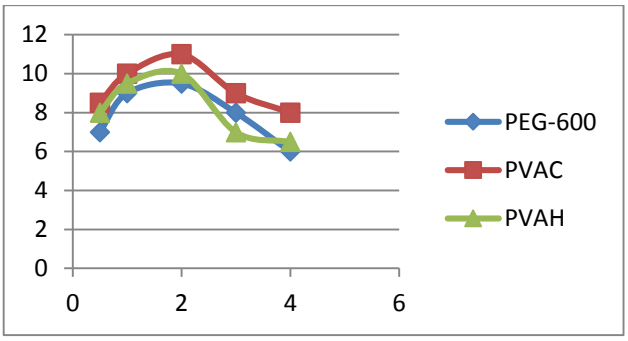
Dosage

Graph for 7 days split tensile strength



Dosage

Graph for 28 days split tensile strength



Dosage

Graph for 60 days split tensile strength

5. CONCLUSION

1. At 2% dosage of PEG-600 for M20 grade concrete the compressive strength is increased by 24% when compared to conventional concrete of same grade
2. At 1% dosage of PVAC for M20 grade concrete the compressive strength is increased by 23.5% when compared to conventional concrete of same grade.
3. At 1% dosage of PVAH for M20 grade concrete the compressive strength is increased by 22% when compared to conventional concrete of same grade.
4. At 2% dosage of PEG-600 for M20 grade concrete the split tensile strength is increased by 32.5% when compared to conventional concrete of same grade.
5. At 1% dosage of PVAC for M20 grade concrete the split tensile strength is increased by 27.5% when compared to conventional concrete of same grade.
6. At 1% dosage of PVAH for M20 grade concrete the split tensile strength is increased by 30.4% when compared to conventional concrete of same grade.

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