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Concrete Microstructure

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Abstract

Conventional cement concrete has a long way in the journey of building materials of about 30 decades has served number of applications. Depending up on the application of concrete, the mix proportion, admixture and mode of transport varies. Let us discuses about various application of concrete in this paper.

Keywords: *Concrete, Cement, Aggregates*

INTRODUCTION

Concrete is considered the most unique and un-replaceable construction material for about 20 decades, due to its engineering property, easy use, comparatively economical made it a predominant construction material. Concrete being a composite material made preliminarily with cement, sand, aggregate, water and admixture with different mix proportion depending upon the strength, and application.

In micro-level concrete is considered to have two material namely a binder matrix and a filler. In the cement concrete the cement past is the binder matrix in which aggregates are filler. The chemical action of cement with water makes the cement paste adhesive nature whereas anhydrous cement does not have adhesive powder. Chemistry of concrete is the action of water with cement as the aggregate should be inert and should not react with any other but added to concrete to fill the space filler volume

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concrete. In this paper let us discuss about the nature of cement in micro level.

CONCRETE AT MICROSCOPIC LEVEL

The complexity of concrete begins when investigated in microscopic level. Both the phases are neither homogeneously distributed with each other nor homogeneous them self.

In microscopic level interfacial transition zone existing as a small layer covering aggregates of range 10 to 50 μm. Acts as a bridge between two phases (i.e. aggregate and cement paste). It is the weaker phase of the two main phases .Thus acts a predominant role in the mechanical behaviour of concrete rather than the size of interfacial transition zone[1].

The interfacial transition zone itself have micro cracks and voids. Which actually subjected to change with time, environmental humidity. This make the concrete more heterogeneous and dynamic nature. This is main reason for the study of the microstructure of concrete which is generally helpful in prediction of the engineering property of concrete.

AGGREGATE PHASE OF CONCRETE

The elastic modulus unit weight and dimensional stability of concrete depends on the aggregate used in concrete. The physical properties of aggregate plays a vital role more than the chemical character. The physical properties which includes porosity, texture, shape of aggregate. It is the strong phase of the three, but doesn't has a direct influence in the strength of concrete.

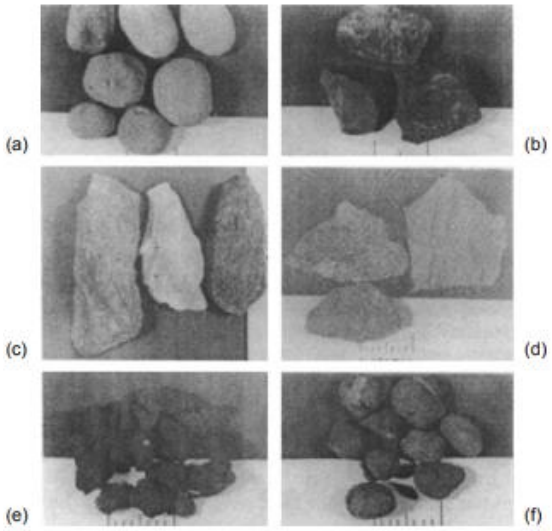


Figure 1 Shape and surface texture of a coarse aggregate particles: (a) gravel, rounded and smooth; (b) crushed rock, equi-dimensional; (c) crushed rock, elongated; (d) crushed rock, flat; (e) lightweight, angular and rough; (f) lightweight, rounded and smooth.

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The shape of size of aggregate plays a vital role in concrete strength. The texture of aggregate plays important role in the bonding between cement paste some of the texture shown in the fig.1. The fig 2 shows elongated and flat particles tend to from a water film around aggregate which weakens the interfacial transition zone, resulting in bleeding.

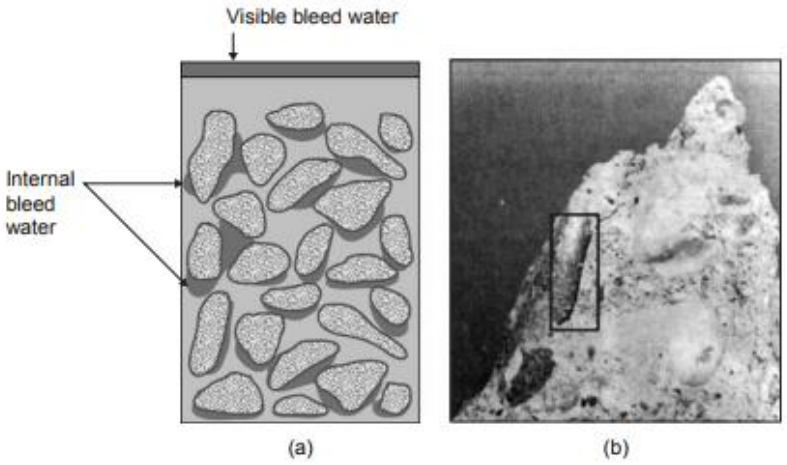


Figure 2-4 (a) Diagrammatic representation of bleeding in freshly deposited concrete; (b) shear-bond failure in a concrete specimen tested in uniaxial compression.

Table 1 Major components of cement

Si. No.	**Name**	**Symbol**	**Commercial name**	**% of content in cement**
1.	Tricalcium silicate	$3caO.SiO_2$	C_3S (alite)	45 – 60
2.	Di calcium silicate	$2CaO. SiO_2$	C_2S(leite)	15 – 30
3.	Tricalcium aluminate	$3\ CaO.Al_2O_3$	C_3A(celite)	6 – 12
4.	Tetra calcium aluminaferrate	$4\ CaO.Al_2O_3\ Fe_2O_3$	C_4AF(Felite)	6 – 8

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Hydrated cement paste phase

As said earlier, anhydrous cement doesn't has a powder of adhesion. Whereas once water added to cement, it gains the adhesive power. To understand the behaviour of this phase, the basic chemical composition of the cement have to be studied. Though cement have various compounds, major 4 compounds are important to be considered is shown in the table.1[5]

Hydration of Cement

As a result of cement compounds reacts with water major 3 compounds formed namely.

i. Calcium tri sulfoaluminate hydrate (ettringite)

ii. Ca (OH)2iii. CSH gel

At first water reacts with C3A forms calcium trisulphoaluminate hydrate also known as ettrinigite forms a needle shaped crystals. After few hours C3S and C2S on hydration results in calcium hydroxide and c-s-h gel forms a fibrous crystals begin to fill the gaps formed by ettrigite.[2]

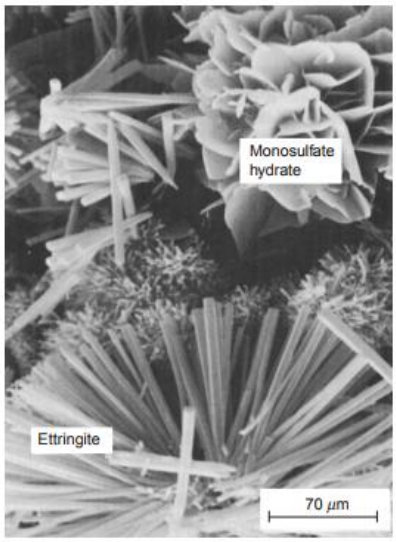


Figure 3 Scanning electron micrograph of typical hexagonal crystals of monosulfate hydrate and needle like crystals of ettringite formed by mixing calcium aluminate and calcium sulfate solutions.

Depends on the alumino-sulphate ratio the ettrigite becomes unstable and decompose to from mono-sulfoaluminate hydrate. Which is a hexagonal plate morphology. This is shown in fig. 3solids formed in the cement paste in shown below[6], **See Table: 2**

Interfacial transition zone phase

The most week and lost in the list interfacial transition zone which is much more important phase in determining the strength and durability of concrete. Which ranges from 10 to 50 around the aggregate surface. The initially freshly formed concrete have

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aggregate covered with water film around them and a week interfacial transition zone. With the increase in age of concrete this zone gain's its strength equal to or even greater than that of cement paste. This increase in strength by time is the result of hydrated product and growth of crystallization of new product in voids and a reaction between cement pastes and aggregate forms a siliceous aggregate.

Table 2 Content of hydrated cement paste

Compound	Percentage of content
Calcium silicate hydrate	50-60%
Calcium hydroxide	20-25%
Calcium sulfoaluminate hydrate	14-20%
Unhydrated cement	5-15%

Interfacial transition zone is generally called "a weakest link of a chain" which is responsible for the strength of concrete. This is because this zone likely to fail first at considerably low stress level[3].

At 50% of ultimate strength, concrete itself shows in elastic nature. Due to the phenomenon that components of concrete remains elastic until fracture in a uniaxial compression.

At 70% of ultimate strength, the crack begins to profligate in the voids inside. Interfacial transition zone.[4] With increased stress level mortar crack begins to join the crack formed by interfacial transition zone. Considerable energy is needed for concrete in compression.

On the other hand tension loading cracks propagates rapidly and at much lower stress level and forms the reason for brittle failure in tension. But is relatively tough in compression. This is also a main reason for concrete has high compression strength and weak in tension.

CONCLUSION

In this paper the following conclusion are made

i) The microstructural study of concrete reacts that the interfacial transition zone has a greater influence in the stiffness and strength of concrete.

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ii) The interfacial transition zone acts as a bridge between the mortar matrix and coarse aggregate

iii) iii)The microstructural study of concrete influence a better understanding and exercising control on their properties.

iv) This paper deeply discuss three phase of concrete namely the aggregate, cement matrix and interfacial zone between cement paste and aggregate.

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