EVALUATION OF NATURAL ADDITIVES FOR MODIFICATION CONCRETE

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ABSTRACT

Bentonite is a rock composed essentially of a crystalline clay-like mineral formed by devitrification and the accompanying chemical alteration of a glassy igneous material, usually a tuff or volcanic ash; and it often contains variable proportions of accessory crystal grains that were originally phenocrysts in the volcanic glass. This project report presents an investigation carried out on study the compressive strength of concrete with the possibility of using bentonite as natural additives in the concrete mix. By following DoE mix design, the mix material proportion, Ordinary Portland cement (OPC) was made to have target strength of 40N/mm^2. In the same condition, this research also consists of OPC concrete with 0.25% and 0.50 % unheated and heated bentonite was prepared by weight of the mix proportions. The bentonite used in this research is the readymade materials and it will be crushed with Jaw Crusher and then it will be heated in Furnace with the different temperatures which are 200°C-800°C with the increment of 200°C within 1 hour respectively. A total of 55 samples concrete cubes of sizes 150 x 150 x 150 mm^3 with different percentages by weights were cast, and tested within the age of 7, 14 and 28 days curing period. A compressive strength result reveals that the compressive strength containing bentonite is higher than the normal OPC concrete. It can be concluded that it is possible to used bentonite which is a part of clay mineral as natural additives in the concrete to increase the compressive strength of the concrete.

ABSTRAK

Bentonite adalah batu yang terdiri dasarnya mineral seperti tanah liat berhablur dibentuk oleh "devitrification" dan perubahan kimia yang disertakan bahan igneus berkaca, biasanya tuf atau abu gunung berapi; dan ia selalunya mengandungi perkadaran ubah bijian kristal aksesori "phenocrysts" yang asalnya dalam kaca gunung berapi. Laporan projek ini membentangkan suatu penyiasatan yang dijalankan pada kajian kekuatan mampatan konkrit dengan kemungkinan menggunakan bentonit sebagai bahan tambah semula jadi dalam campuran konkrit. Dengan mengikuti DoE reka bentuk campuran, nisbah campuran bahan, simen Portland Biasa (OPC) telah dibuat untuk mempunyai kekuatan sasaran 40N/mm2. Dalam keadaan yang sama, kajian ini juga terdiri daripada konkrit OPC dengan 0.25% dan 0.50% bentonite tidak panas dan dipanaskan telah disediakan oleh berat nisbah campuran. Bentonite yang digunakan dalam kajian ini adalah bahan sedia ada dan ia akan dihancurkan dengan Jaw Crusher dan kemudian ia akan dipanaskan di dalam Furnace dengan suhu yang berbeza yang 200°C-800°C dengan kenaikan sebanyak 200°C dalam masa 1 jam bagi setiap sampel. Sebanyak 55 sampel kiub konkrit saiz 150 x 150 x 150 mm^3 dengan peratusan berbeza mengikut wajaran telah dibuang, dan diuji dalam tempoh pengawetan umur 7, 14 dan 28 hari. Keputusan kekuatan mampatan mendedahkan bahawa bentonite yang mengandungi kekuatan mampatan adalah lebih tinggi daripada konkrit OPC biasa. Dapat disimpulkan bahawa kemungkinan untuk menggunakan bentonite yang merupakan sebahagian daripada mineral tanah liat sebagai tambahan semula jadi di dalam konkrit untuk meningkatkan kekuatan mampatan konkrit.

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LIST OF SYMBOLS

˚C	Degree Celcius
%	Percent
m^3	Volume
µm	Micro meter
kg	Kilogram
lb	Pound
m	Meter
cm	Centimeter
mm	Millimeter
in	Inch
P	Compressive load of concrete
A	Surface area of the sample
N	Newton
Mpa	Mega pascal

LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
AFM	Atomic Force Microscopy
CNMNC	Commission on New Minerals and Mineral Names
FIB	Focused Ion Beam
IA	Image processing and Analysis
IPCC	Intergovernmental Panel on Climate Change
OPC	Ordinary Portland Cement
PCA	Portland Cement Association
SEM	Scanning Electron Microscopy
XRD	X-ray Diffraction
U.S	United State
CO_2	Carbon dioxide
SiO_2	Silica dioxide
Al_2O_3	Aluminium Trioxide
Na2+	Sodium cation
Ca2+	Calcium cation
Al3+	Aluminium cation
H+	Hydrogen cation
CaO	Calcium Oxide
Fe_2O_3	Iron Trioxide
MgO	Magnesium Oxide
Na_2O	Sodium Oxide

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Concrete is a material that commonly used in construction field, consisting of a hard, chemically inert particulate substance, known as an aggregate which usually made from different types of sand and gravel that is bonded together by cement and water. concrete also be able to be used in a wide variety of applications because it can be poured into any shape, reinforced with steel or glass fibers, precast, colored and has a variety of finishes and can even set under water.

Occasionally, concrete consists of combining mixture of cement, aggregate and water. Cement is the most important ingredients of concrete composition. While aggregates can be find in the form such as coarse aggregate made of gravel or crushed rocks such as limestone or granite which it is used for massive structures or sections of cement and fine aggregate such as sand which used in making concrete slabs and smooth surfaces.

Concrete is well-known for a long time ago for construction in many ancient structures. Concrete is used more than any other man-made material in the world. Its be a major components in any building to be build and it should consider many affect and effect to human being, living thing, environment and others that would be a factors to the concrete. Concrete also can increase world economy now and ever which it is continuously material that will be used in the construction. Might be there is any improvement in concrete component and characteristics in the future.

Concrete is a materials that have high compressive strength but low in tensile strength. Beside there are another advantages of concrete such as it's a non combustible material which be able to withstand high temperature. Concrete also durable where it doesn't rot, decay or corrode. Other than that, fresh concrete are easily to handled and molded into any desired shape needed. Concrete will take a minimal maintenance because it has long life and relatively low maintenance that able to save cost and it's also more economic which its ingredients are readily available in the market.

Even thought concrete give an advantages, but it also has some problem associated with its properties such as it can be easily cracks while when overload it can cause creep to its. Besides it can expand and contracts according to the change of temperature thus we have to consider the temperature of places to appropriate with the concrete. In others hand, concrete isn't impervious to moisture and contains soluble salts which it can cause efflorescence. Concrete is also liable to disintegrate by alkali and sulphate attack because of the chemical reaction between them.

In this modern life with new technologies, concrete ingredients will be modified to improve its common properties to be better enough. They have done many investigations and experiment their idea as a proof to what the thought. Some examples of a new works that have been introduced such as added or replaced new material such as palm fiber, marconite and many more in the concrete ingredients.

Thus such of the reasons, nowadays, uses of recycled material to the concrete ingredients wide spread, become popular among the researcher and this will be able increase new development in construction filed where there lots of research doing their research due to the concrete properties.

1.2 PROBLEM STATEMENT

Bentonite is actually being used in civil engineering as sealing shallow boreholes and seismic shot holes, decommissioning wells and also providing an interface between gravel pack and bentonite or cement grout but bentonite materials is not widely applied in civil engineering abroad and there are still lack application of this type of material in Malaysian construction industry. This may be caused by the lack of knowledge and information about bentonite in the construction sector or might there is no appropriate that can used such materials in Malaysia.

There are many researcher works are going on for improving quality and performance of concrete without increasing the cost of construction and maintaining environment pollution using mineral admixtures. In previous, it has well established about the effect of the heat on the bentonite characteristic and also determination of bentonite behavior when submitted to the heat.

But, for bentonite characteristic modification under the heat for 1 hours from 200-800°C in increment 200°C based on mineralogy and morphology analysis with connection of concrete mix design has been never documented.

Therefore, this research is aimed to perform a series of the assessing concrete behavior using natural processed additive with the improving concrete strength characteristics.

1.3 OBJECTIVES

The main objective of this research is to determine and compare the compressive strength of ordinary Portland cement concrete and bentonite concrete subjected with different heated of bentonite temperatures. The related objectives of this study are:

a) To determine best percentage of thermally modified bentonite in concrete mix design.

b) To identify the best degree of heat could modify bentonite in new concrete product mixing proportion on compressive strength.

c) To determine the compressive strength of hardened concrete containing 0.25% and 0.50% of bentonite at age 7, 14 and 28 days.

1.4 SCOPE OF STUDY

This research is prepared to observe the performance of concrete behavior with addition of natural additives on concrete samples. Natural additive s that used is bentonite as part of additional material in concrete proportion by weight. A mix proportion of heated and unheated bentonite concrete was developed as well as producing an ordinary Portland cement concrete that acted as control samples.

Other than that, this study done to investigate factors percentage bentonite used in concrete samples mixed that influence to concrete compressive strength as well as to develop of a new concrete material. Not only have that, this research also focusing on the study the affect of heat of bentonite on concreted mix samples.

Apart from that, each type of samples mix proportion mixed consists three cubes respectively. The concrete samples were design with characteristics strength of 40 N/mm^2. The percentages of bentonite used are 0% as a control, 0.25% and 0.50% by weight of the mix proportion. Then there are heated and unheated bentonite used where the heated bentonite were heated in Furnace with initial 200°C with increment of 200°C. The size of coarse aggregates used is 10-20mm and the sizes of fine aggregates are all passing 600 μm. Then the sizes of cubes samples used are 150mm x 150mm x 150mm for compressive strength test. There are total 55 cubes of concrete samples were prepared.

Furthermore, the hardened concrete samples were cured in water at age of 7, 14 and 28 days for all samples. The strength performance of concrete samples has been investigated through the compressive test conducted and the tests were carried out when the concrete samples reach its ages based on the prepared schedule.

Then, the result of compressive strength test were obtained will recorded in the table and will be discussed in the form of pictures and graphs. Other than that, all the necessary result related in this research also has been discussed.

Overall this research is carried out by specifying, proportioning, mixing, placing and testing of concrete samples are conducted accordance to the existing standard used.

1.5 SIGNIFICANT OF RESEARCH

As the concrete is an important materials and very useful in the construction field and it is widely used around the world. In the meantime, there are many modifications and developments of the concrete to increase its properties. For instance, used of POFA, fiber, and other materials as a substitute or replacement instead of cement and aggregate for concrete proportion.

This research is used natural additives such as bentonite for modification of concrete where the purposed of this study of the entire research exercise would be to reducing construction activities cost and improving concrete quality as well as eliminate chemical additive in construction industry by introducing natural additive for reducing environment pollution due to producing construction materials.

Besides that, this research would provide new information on the performance of bentonite concrete in term of hardened properties based on compressive strength when subjected to different condition of bentonite. Moreover, perhaps, the finding from the research would useful knowledge on the construction industry to produce concrete that will enhanced strength in order to compared with the existing ordinary Portland cement concrete.

CHAPTER 2

LITERATURE REVIEW

2.1 CEMENT

Cement is a material that functions as a binder which it is a substance that sets and hardens independently and can bind with other materials together. Cement is the important material used in construction which is for production of mortar and concrete. Nowadays, cement remains as a key material to fulfill global housing demand and modern infrastructure needs. Production of cement was undergone a tremendous development begins about 2000 years ago. Meanwhile, the use of cement in concrete discovered a long history which is started in the middle of 19^{th} century of the industrial production of cements. (M. Schneider,2011)

Besides that, cement is a fine grey powder that can form a rigid chemical mineral structure which gives concrete high strength when reacted with water. The earliest cements were made from lime and pozzolana (a volcanic ash containing significant quantities of SiO_2 and Al_2O_3) mixed with ground brick and water. This cement was not improved upon until 1758, when Smeaton noticed that using a limestone that was 20 - 25 % clay and heating the mixture resulted in cement that could harden under water. He called this new cement 'hydraulic lime'. When the mixture was heated, a small quantity of it was sintered.

Cement in construction can be characterized as hydraulic and non-hydraulic which hydraulic cement is an inorganic material or a mixture of inorganic materials that sets and develops strength by chemical reaction with water by formation of hydrates and is capable of doing so under water. (ASTM C 125, Portland Cement

Association (PCA). While non-hydraulic cements must be kept dry in order to retain their strength. Hydraulic cement can be classified such as Portland cement while non-hydraulic cement can be classified such as lime and gypsum.

Furthermore, cement is produced in three main grades which are ordinary Portland cement, rapid hardening cement and moderate-heat cement. Rapid-hardening cement is used in precast concrete, pipes and tiles. It is finer ground so that it hydrates more quickly and has more gypsum than other cements. Moderate-heat cement is used for the construction of hydro-electric dams, as the heat produced by ordinary cement creates uneven expansion and hence cracking when such a large volume of concrete is used.

Portland cement is the most widely used in the world while the others being used where concretes with special properties required. Portland cement used as building material in the world with about 1.56 billion tones (1.72 billion tons) produced each year. Annual global production of Portland cement concrete hovers around 3.8 million cubic meters (5 billion cubic yards) per year (Cement Association of Canada, 2001). In the U.S., rigid pavements are the largest single use of Portland cement and Portland cement concrete (ACPA, 2002).

In addition, Portland cement is also a common cement that be used in construction in Malaysia. In addition, Portland cement can be classifies into various type based on the AASHTO M 85 and ASTM C 150, Standard Specification for Portland cement.

Type	**Name**	**Purpose**
I	Normal	General-purpose cement suitable for most purposes.
IA	Normal-Air Entraining	An air-entraining modification of Type I.
II	Moderate Sulfate Resistance	Used as a precaution against moderate sulfate attack. It will usually generate less heat at a slower rate than Type I cement.
IIA	Moderate Sulfate Resistance-Air Entraining	An air-entraining modification of Type II.
III	High Early Strength	Used when high early strength is needed. It is has

		more C_3S than Type I cement and has been ground finer to provide a higher surface-to-volume ratio, both of which speed hydration. Strength gain is double that of Type I cement in the first 24 hours.
IIIA	High Early Strength-Air Entraining	An air-entraining modification of Type III.
IV	Low Heat of Hydration	Used when hydration heat must be minimized in large volume applications such as gravity dams. Contains about half the C_3S and C_3A and double the C_2S of Type I cement.
V	High Sulfate Resistance	Used as a precaution against severe sulfate action - principally where soils or ground waters have a high sulfate content. It gains strength at a slower rate than Type I cement. High sulfate resistance is attributable to low C_3A content.

Table 2.1: ASTM Types of Portland cement

2.2 NATURAL MINERAL

Mineral species can be grouped in a number of different ways, on the basis of chemistry, crystal structure, occurrence, association, genetic history, or resource, for example, depending on the purpose to be served by the classification. However, if the classification is to adequately meet the needs of the CNMNC, it is proposed that the grouping be based on chemical composition and crystal structure, as these are the two essential components in the characterization of a mineral species. Consequently, the simplified definition of a mineral group is

"A mineral group consists of two or more minerals with the same or essentially the same structure, and composed of chemically similar elements".

The term crystalline generally used in mineralogy means atomic ordering on a scale that can produce an "index able" (i.e with Miller indices) diffraction pattern when the substances is traversed by a wave with a suitable wavelength (X-ray, electrons, neutrons, etc). However, some naturally occurring substances are none crystalline. Such substances can be divided into two categories which is amorphous, substances that have never been crystalline and do not diffract X-rays or electron. Some mineralogist are reluctant to accept amorphous substances as mineral because of the difficulty in determining whether the substance is a true chemical compound or a mixture, and the impossibility of characterizing it completely; some prefer to call such substances "mineraloids". However, some amphous substances (e.g georgite, calciouranoite) have been accepted as minerals by Commission on New Minerals and Mineral Names (CNMMN).

Besides that, metamict, those that was crystalline at one time, but whose crystallinity has been destroyed by ionizing radiation. Metamict substances, if formed by geological process, are accepted as minerals if it can be established with reasonablecertainty that the original substances (before metamictization) was a crystalline mineral of the same bulk composition.

2.3 CLAY

A clay material is any fine-grained, natural, earthy, argillaceous material (Grim, 1962). Clay is a rock term and is also used as a particle size term. The term clay has no genetic significance because it is used for residual weathering products, hydrothermally altered products, and sedimentary deposits. As a particle size term, the size fraction comprised of the smallest particles is called the clay fraction. The Wentworth scale defines the clay grade as finer than 4 mm (Wentworth, 1922), which is used by many engineers and soil scientists whereas clay scientists generally consider 2 mm as the upper limit of the clay size grade. Grim (1968) summarized what he termed the clay mineral concept which stated that clays are composed essentially of a small group of extremely small crystalline particles of one or more members of a group of minerals that are commonly known as the clay minerals.

The clay mineral groups are kaolin, smectite, palygorskite–sepiolite, which are sometimes referred to as hormites (Martin-Vivaldi and Robertson, 1971) (the term has not been accepted by the International Nomenclature Committee); illite, chlorite, and mixed-layered clays. The properties of these clays are very different which are related to their structure and composition (Murray, 2000a).

The clay mineral composition refers to the relative abundance and identity of the clay minerals present in a clay material. In some instances, very small amounts of certain clay minerals have a large impact on the physical properties. An example is a kaolin that has a small percentage of smectite present. This may alter the low and high shear viscosity detrimentally. Also, the degree of crystal perfection of the kaolinite present affects the physical properties of the kaolin. A well-ordered kaolinite will have different properties than a poorly ordered kaolinite (Murray and Lyons, 1956). The identity of all the clay minerals present in a clay material must be determined in order to evaluate the physical properties (Murray, 2000a).

The non-clay mineral composition is also important because in many cases the non-clay minerals can significantly affect the properties of a clay material. An example is the presence of a fine particle quartz in a kaolin which seriously affects the abrasiveness of the kaolin (Murray, 2000b).

The texture of a clay material refers to the particle size distribution of the constituents, the particle shape, the orientation of the particles with respect to each other, and the forces which bind the particles together. The particle size distribution and the particle shape are very important properties in kaolins and ball clays (Murray, 2000b). The orientation of the particles and the forces which bind them together can shed a great deal of information about the environment of deposition (Murray, 1976).

The first American geologist to specialize in the study of clays was Prof. Heinrich Ries of Cornell University. He studied the clay resources of many of the eastern states by describing their ceramic properties (Ries, 1908). In the middle and late 1920s, X-ray diffraction began to be used to identify the clay minerals. Several scientists in the United States and Europe published studies of clays using X-ray diffraction to positively identify the clay materials (Hadding, 1923; Rinne, 1924; Hendricks and Fry, 1930; Ross and Kerr, 1930, 1931).

At the present time, much more sophisticated analytical equipment is available to identify and quantify the specific clay minerals present in a sample.

Some of the more important analytical techniques that are used include X-ray diffraction, electron microscopy, infrared spectroscopy, and differential thermal analysis (Brindley and Brown (1980), Moore and Reynolds (1997), Mackenzie (1970, 1972), Van der Marel and Beutelspacher (1976), and Sudo, Shimoda, Yutsumoto, and Aita (1981)).

2.4 BENTONITE

Montmorillonite is an alumino-silicate mineral with a 2:1 unit layer structure. Individual layers (or lamellae) are about 10Å (1nm) thick, but up to several orders of magnitude larger in the other directions (Grim, 1968; Mitchell, 1993). Stable montmorillonite unit particles are stacks of 1 to 16 lamellae (Sposito, 1984), although 2-3 lamellae is typical of sodium montmorillonite (van Olphen, 1991). These unit particles can aggregate together to form clusters which, due to the tendency of the platy unit particles to align, are anisotropic (Pusch, 1999). Pusch (op. cit.) suggests that bentonite clusters can consist of many unit particles (possibly 10^7 to 10^9). Thus, structural elements exist at several scales and can be arranged in the size order:

Unit layers (Lamellae) < Unit particles < Particle clusters

A representative volume of bentonite consists of particles and voids which, arranged in size order, comprise:

Interlayer pores < Interparticle pores (or micropores) < Intercluster pores (macropores)

(after Pusch, 1999; Yong, 1999b)

Bentonite is alumina silicate clay made up of sodium and calcium montmorillonites (Agnello, 2005:1; Klein 2002:531). Bentonite consists of aggregates of flat platelets, has a high specific surface area, high plasticity, and can expand several times its original volume when placed in water (Agnello, 2005:1). The clay's ability to swell is a result of the incorporation of water molecules between the *t-o-t* (tetrahedraloctahedral- tetrahedral) sheets in association with the interlayer cations (Na2+ and Ca2+), which are driven off when the clay is heated in air. The expulsion of water leads to the layers collapsing, causing the clay to have a somewhat unbalanced structure with an overall slightly negative charge. This is balanced by exchangeable cations that are adsorbed around the edges of the fine clay particles. The basic composition of bentonite is summarized in the Tables I and II (Ramebäck *et al.*, 1999:210).

To enhance the adsorptive properties of bentonite clay, it can be acid activated. This involves all the cations present in the bentonite (typically Ca2+, Na2+ and Al3+) being replaced by H+ by the addition of either sulphuric or hydrochloric acid. Acid activation changes the clay's physical and chemical properties, but keeps its layered structure. Initially during activation the outer cations are replaced by H+. As activation continues the individual layers are attacked by the acid and the various ions present, such as aluminium, iron, calcium and magnesium, are released from the lattice. This causes the inner surface of the crystal platelets to increase in size and active acid centres are formed. Physically, the edges of the clay open up, pore diameters increase in size, and the surface area increases. There is, however, a point of maximum activation beyond which the crystal structure disintegrates and silicic acid is formed (Agnello, 2005: 9).

According to Agnello (2005:18) it has been estimated that quality reserves of bentonite in South Africa will be sufficient for up to 67 years at the current production rate of 120 kt/a. The newest bentonite mine and largest deposit ever to be found in South Africa, is the Yellow Star Quarries in the Kroonstad district. According to Waanders (2003:3) it is estimated that this deposit, which contains approximately 750 000 m^3 bentonite, can be mined at 4 000 m^3/month. The bentonite layer is between 6 and 10 m thick. The mine was commissioned in 2007 and has an expected lifetime of over 10 years during which the clay will be mined and the project will be economically feasible.

Typical composition of Bentonite clay (mass %) for constituents with an abundance larger than 1%	
SiO_2	61–64
Al_2O_3	20–21
CaO	1.2–1.4
Fe_2O_3	3.8–3.9
MgO	2.4–3.7
Na_2O	2.1–2.4
*LOI*1	5.2–6.3

Table 2.2: Typical composition of Bentonite Clay

Mineral composition of Bentonite clay (mass %)	
Montmorillonite	75
Quartz	15
Mica	<1
Feldspar	5 – 8
Carbonate	1.4
Coalinites	<1
Pyrite	0.3
Other minerals	2
Organic carbon	0.4

Table 2.3: Mineral composition of Bentonite Clay

2.5 NANOTECHNOLOGY IN CONCRETE MIX DESIGN

2.5.1 Nanotechnology

Nanotechnology is not a new science and it is not a new technology either. It is rather an extension of the sciences and technologies that have already been in development for many years and it is the logical progression of the work that has been done to examine the nature of our world at ever smaller and smaller scale. Nanotechnology is an enabling technology that allows us to develop materials with improved or totally new properties.

The critical factor for nanotechnology is the size of the particles where at the nanoscale which anything from one hundred or more down to a few nanometers or 10^{-9} m material properties are altered from that of larger scales which the exact point at which this occur depends on the material.

Concrete is stronger, more durable, more easily placed and probably unique in construction in that it is the only material exclusive to the business and therefore is the beneficiary of a fair proportion of the research and development money from industry. Applications of nanotechnology in construction that are being developed or are even available today which at the basic science level, much analysis of concrete is being done at the nano-level in order to understand its structure using the various techniques developed for study at that scale such as Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM) and Focused Ion Beam (FIB).

One of the fundamental aspects of nanotechnology is its interdisciplinary nature and there has already been cross over research between the mechanical modeling of bones for medical engineering to that of concrete which has enabled the study of chloride diffusion in concrete (which causes corrosion of reinforcement). Concrete is, after all, a macro-material strongly influenced by its nano-properties and understanding it at this new level is yielding new avenues for improvement of strength, durability and monitoring.

2.5.2 Scanning Electron Microscope (SEM)

Scanning electron microscope (SEM) is one of the most versatile instruments available for the examination and analysis of micro structural characteristics of solid objects. The primary reason for the SEM's usefulness is the high resolution that can be obtained when bulk objects are examined. Scanning electron microscopy was employed to capture images from the cross sections of the concrete specimens.

SEM has been developed for imaging the complex microstructure of concrete and provides images with sub-micrometer definition. The application of SEM enhances ability to characterize cement and concrete microstructure and will aid in evaluating the influence of supplementary cementing materials, evaluation of concrete durability problems and in the prediction of service life.

The SEM scans a focused beam of electrons across the specimen and measures any several signals resulting from the electron beam interaction with the specimen. Images of topography can be used to study particle size, shape, surface, roughness and fracture surface, while polished surfaces are used for determination of phase distribution and chemical composition. The SEM electrons are emitted from a tungsten cathode and are accelerated towards an anode. As the primary electrons strike the surface they are in elastically scattered by atoms in the sample and subsequent emission of electrons are then detected.

X-ray microanalysis provides quantitative spot chemical analysis as well as maps of element distribution. Images are monochrome because they reflect the electron or X-ray flux resulting from the beam/specimen interaction. Backscattered electron and x-ray imaging are the most useful imaging modes for quantitative scanning electron microscopy while computer based image processing and analysis (IA) makes routine quantitative imaging possible.

In addition, there also an ideal uses for SEM method such as high resolution images and also elemental microanalysis and particle characterization. SEM methods have its own strengths such as rapid and high-resolution imaging. While it also can