STUDY ON THE EFFECT OF SUCROSE AS THE ALTERNATIVE ADMIXTURE IN ORDINARY PORTLAND CEMENT (OPC) BINDER

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ABSTRACT

This research aims to investigate the effect of sucrose as the alternative admixture in Ordinary Portland Cement (OPC) binder. Chemical admixtures like sucrose are the ingredients that will be used in concrete other than Portland cement, water, and aggregate that is added to the mix directly before or during mixing. The admixtures primarily used to cut the cost of concrete construction, modify the properties of hardened concrete and also ensure the quality of concrete during mixing, transporting, placing, and curing. Furthermore, Ordinary Portland Cement binder by cube 50mm × 50mm × 50mm in size will be prepared. An about 65 samples will be tested during the study where the test that carried out to measure the workability test, compressive strength test and porosity test at 1 day, 7 days and 28 days. In addition, the effects of sucrose at concentrations of 0.50, 0.75, 1.00, 1.25 and 1.50 milimole/liter will be used as the alternative admixture in Portland cement paste. Based on Vicat setting time result, sucrose tends to increase the setting time of Portland cement paste. Furthermore, sucrose causes higher retardation when added a few minutes after the mixing of water and cement. Compressive strength of sucrose shows that as the curing time increase, the compressive strength of paste develops. Based on t – test analysis, 1.25 milimole/l of sucrose are the optimum percentages of admixtures that show higher compressive strength when compared to the control specimen. However, by the inclusion of sucrose was provided a unique correlation between porosity and compressive strength. It is because in sucrose-added system, the increasing compressive strength is followed by the increasing porosity of Ordinary Portland cement paste.

Keywords | Ordinary Portland cement paste, sucrose, workability, compressive strength, porosity

ABSTRAK

Kajian ini dijalankan untuk mengkaji kesan sukrosa sebagai bahan tambah alternatif di dalam simen Portland biasa (OPC). Bahan tambah kimia seperti sukrosa adalah salah satu bahan kimia yang akan digunakan di dalam konkrit selain daripada simen Portland, air, agregat. Sukrosa akan ditambah ke dalam campuran samada sebelum atau semasa proses pencampuran. Bahan tambah yang digunakan bertujuan untuk mengurangkan kos pembinaan konkrit, mengubah suai sifat konkrit mengeras dan juga memastikan kualiti konkrit semasa proses campuran, mengangkut, meletak, dan pematangan. Tambahan itu, simen Portland biasa yg bersaiz 50mm × 50mm × 50mm akan disediakan. Sebanyak 65 sampel kiub akan diuji sepanjang ujikaji di mana ujian yang dilakukan bertujuan untuk menguji kebolehkerjaan, kekuatan mampatan dan keliangan kiub simen pada hari pertama, hari ke – 7 dan hari ke – 28. Di samping itu, kesan-kesan sukrosa pada kepekatan 0.50, 0.75, 1.00, 1.25 dan 1.50 milimole / liter akan digunakan sebagai bahan tambah alternatif di dalam Portland simen. Berdasarkan keputusan ujian Vicat, sukrosa cenderung untuk meningkatkan masa penetapan Portland simen. Selain itu, sukrosa juga menyebabkan simen lambat mengeras selepas beberapa minit simen dan air ditambah ke dalam bancuhan. Kekuatan mampatan simen juga membuktikan bahawa semakin bertambah masa pematangan semakin bertamabah kekuatan mampatan pes simen. Berdasarkan kepada analisis t – test, didapati bahawa 1.25 milimole/liter sukrosa adalah peratus yang paling optimum bagi bahan tambah kimia di mana kekuatan mampatannya lebih tinggi berbanding dengan sampel kontrol. Walau bagaimanapun, dengan kemasukan sukrosa ke dalam simen telah mewujudkan satu hubungan yang unik diantara kekuatan mampatan dan keliangan. Hal ini kerana di dalam sistem penambahan sukrosa, kekuatan mampatan meningkat diikuti dengan peningkatan keliangan di dalam pes simen.

Kata kunci | Simen Portland biasa, sukrosa, kebolehkerjaan, kekuatan mampatan, keliangan

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Modernization has leads to a world with lot of construction. Based on the researched done by McCaffrey, the human activities such as construction works can contribute to the global warming by the release of greenhouse gases, such as CO2, CO to the atmosphere. Among the greenhouse gases, CO2 contributes about 65% of global warming. Therefore, about 7% of the cement industry is responsible towards the emission of all CO2; it is because one ton of Portland cement is able to produce emits roughly one tone of CO2 into the atmosphere (Davidovits, McCaffrey).

Often, construction is related to concrete, which is one of the most important materials in making a project successfully. In addition, the concrete technology is important in generating a higher quality of concrete which tends to beneficial in a more durable, strong and structure result. The main goal of the present study is to investigate the effect of sucrose ($C_{12}H_{22}O_{11}$) as the alternative admixture in Ordinary Portland Cement (OPC) binder. Ordinary Portland Cement (OPC) is the most common cement used in general concrete construction especially when there is no exposure to sulphates in the soil or groundwater. The main chemical components of ordinary Portland cement such as Calcium, Silica, Alumina and Iron.

When cement mixes with water, the different cement compounds start to react with some part of mixing water. So the cement starts to hydrate and that part of water becomes cement and the original cement content. Based on the Power and Brown yard, the maximum amount of chemically bound water requires to the system is about one quarter of the weight of cement. Nowadays, chemical admixtures are used to modify of the concrete properties. The most important admixtures are accelerators and retarders, compounds that accelerate or retard setting or hardening, to decrease the water quantity needed to obtain a given degree of workability, or to entrain in order to increase the resistance of the concrete from freezing.

Sucrose is one of the chemical admixture that often been used in the Portland cement for many years by the researchers. It is because sucrose acts as a type of active retarder that can hold up setting and hardening. Furthermore, retarding effects of a retarder depends on a number of factors including dosage of the admixture, time of addition to the mix and curing conditions. Some admixtures act as retarders when used in small amounts but perform as accelerators when used in large amounts.

1.2 PROBLEM STATEMENT

To know about the chemical composition of this can easily be used as an additive. At the current price of commercial supplements are higher than other concrete component. Among the types of additives at this time should be reviewed to identify the factors that contribute to the strength of concrete with previous studies. At the present time the price of commercial supplements is higher than other concrete component. Among the types of additives at this time should be reviewed to identify the factors that contribute to the strength of concrete with previous studies. Furthermore, sucrose is the one of the alternative admixtures that will be used in order to increase strength of cement binder. It is because sucrose acts as a type of active retarder. In addition, retarder is removed from the solution by the C_3A reaction, so less is available to retard C_3S hydration. Less retarder is removed if its addition to fresh concrete is delayed. Sucrose as retarder admixture extends setting times, a side effect is loss of workability. Even though Set-retarding admixtures have been reported to increase ultimate compressive strengths.

1.3 OBJECTIVES

The objectives of this research are:

1. To determine the effect of Sucrose on the workability of fresh concrete.
2. To determine the effect of Sucrose on the compressive strength and porosity of hardened cement paste.
3. To determine the optimum amount of sucrose that contributes to the performance of Ordinary Portland Cement (OPC) binder.

1.4 SCOPE OF STUDY

This scope of study was focus on type of cement, sucrose concentration, number of test and types of test. The Type 1 of Ordinary Portland Cement (OPC) had been used during this project. Besides, the chemical admixtures that had been used in this project are Sucrose ($C_{12}H_{22}O_{11}$). Furthermore, it is also involve difference sucrose concentration which is start from 0.50, 0.75, 1.00, 1.25 and 1.50 milimole/litre. In addition, about 65 samples had been tested during this study where the performance of these admixtures had been based on workability test, compressive strength test and also porosity test. Compressive strength test had been conducted on 1, 7 and 28 days while porosity test had been conducted on 1 and 28 days of specimen. This study was performed to observe the effect and characteristic of sucrose in OPC.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Nowadays, concrete has been used as a main material in the construction industry since it introduced to the construction world. Basically, water, aggregate (rock, sand or gravel) and Portland cement is a basic three components to make up a concrete. Cement, usually in powder form, acts as a binding agent when mixed with water and aggregates. However, this section of writing will focus on the effect of sucrose as the alternative admixture in Ordinary Portland Cement (OPC) binder.

2.2 ORDINARY PORTLAND CEMENT (OPC)

Ordinary concrete refers to the ordinary Portland cement as a cementing material with sand, gravel, water and admixtures which sometimes is added to a certain proportions according to the strength required and the function to be fulfilled. During concrete mixing, the Portland cement paste and water will coats the surface of the fine and coarse aggregates.

The ordinary concrete is also adaptable to varying structural needs and is available practically anywhere as it is fire resistant and can be used by semiskilled workers. Choo (2003) has stated that there are many advantages of concrete such as built-in-fire resistance, high compressive strength and low maintenance. It has been widely used because of its rich resources of raw materials, simple production process, good performance, low price, high strength and durability and also can be combined with the reinforcement to produce a strong reinforced concrete structure.

However, since global warning has emerged as the most serious environmental and sustainability issue, the next development in the concrete industry will not be the new type of concrete manufactured with expensive materials and special methods but low cost and highly durable concrete mixtures containing largest possible amounts of industrial and urban by-product that are suitable for partial replacement of Portland cement, virgin aggregate and drinking water (Mehta, 2004). The production of Portland cement can be illustrated as flowchart below.

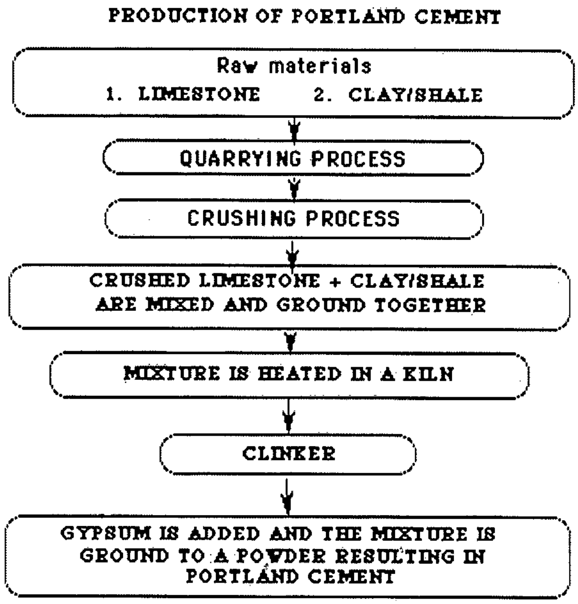

Figure 2.1: A flow diagram of Portland cement production.

2.2.1 Characteristics of Ordinary Portland cement

Properties of cement include fineness, setting time, soundness, specific gravity and compressive strength (Krishnaswamy, K. T., Kamasundara, R., and Khandekar, A. A). The fineness of cement is a measure of the particle size of cement. Finer the cement, the rate of chemical reaction or rate of hydration is faster since more surface area is available for chemical reaction. The strength development is also faster for fine cements. When Portland cement is mixed with water to make paste, it becomes gradually less plastic and finally becomes a hard mass. When it loses plasticity, it is sufficiently rigid to withstand a definite amount of pressure.

Setting is the term used to describe the stiffening of cement paste. The setting time is divided into two parts, initial setting time and final setting time. The time at which the cement paste loses its plasticity after the addition of water is known as initial setting time. The time corresponding to the paste becoming a hard mass is known as final setting time. It is essential that the initial setting time should not be too less to allow time for mixing, transporting and placing of concrete. Within this time, the cement paste, mortar or concrete should be in plastic condition. (Lovely K M and Anniamma Chacko)

Based on this research, Ordinary Portland cement (OPC) Type 1 will be used for the whole project. Type I Portland cement is known as common or general purpose cement. It is generally assumed unless another type is specified. It is commonly used for general construction especially when making precast and precast-prestressed concrete that is not to be in contact with soils or ground water. The typical compound compositions of this type are 55% (C_3S), 19% (C_2S), 10% (C_3A), 7% (C_4AF), 2.8% MgO, 2.9% (SO_3), 1.0% Ignition loss, and 1.0% free CaO. However, a limitation on the composition is that the (C_3A) shall not exceed fifteen percent (Wikipedia). Portland cement consists of five major compounds and a few minor compounds. The composition of a typical Portland cement is listed by weight percentage in Table 2.1.

Table 2.1: Composition of Portland cement with chemical composition and weight percent. (Scientific Principles)

Cement Compound	Weight Percentage	Chemical Formula
Tricalcium silicate	50 %	Ca_3SiO_5 or $3CaO{\cdot}SiO_2$
Dicalcium silicate	25 %	Ca_2SiO_4 or $2CaO{\cdot}SiO_2$
Tricalcium aluminate	10 %	$Ca_3Al_2O_6$ or $3CaO{\cdot}Al_2O_3$
Tetracalcium aluminoferrite	10 %	$Ca_4Al_2Fe_2O_{10}$ or $4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$
Gypsum	5 %	$CaSO_4{\cdot}2H_2O$

2.2.2 Chemistry of Ordinary Portland cement

During calcinations of raw material in the cement plant, the volume of material contracts and during hydration of cement it swells. Two possible reactions take place (Bye G).

Calcinations: $CaCO_3$ (s) $\rightarrow$ CaO(s) + CO_2 (g)
Hydration: CaO (s) + H_2O (l) $\rightarrow$ $Ca(OH)_2$ (s)

The raw materials used for the manufacture of Portland cement consist mainly of lime, silica, alumina and iron oxide. These compounds interact with each other in the kiln to form a series of more complex products, and apart from a small residue of uncombined lime, which has not had sufficient time to react; a state of chemical equilibrium is reached. Chemical components in Portland cement are combined to from different potential compounds. The amounts of these potential compounds are responsible for various physical properties of Portland cement. (Noor-ul-Amin and Khurshid Ali)

2.3 CHEMICAL ADMIXTURE

Chemical admixtures are the ingredients in concrete other than Portland cement, water, and aggregate that is added to the mix directly before or during mixing. The used of admixtures mostly to reduce the cost of concrete construction, to change the properties of hardened concrete, to ensure the quality of concrete during mixing, transporting, placing, and curing and also to solve certain difficulties during concrete operations. Successful use of admixtures depends on the use of appropriate methods of batching and concreting. Most admixtures are supplied in ready-to-use liquid form and are added to the concrete at the plant or at the jobsite. Certain admixtures, such as pigments, expansive agents, and pumping aids are used only in extremely small amounts and are usually batched by hand from premeasured containers.

The efficiency of an admixture depends on several factors such as type and amount of cement, water content, mixing time and temperatures of the concrete and air. Sometimes, effects similar to those achieved through the addition of admixtures can be achieved by altering the concrete mixture-reducing the water-cement ratio, adding additional cement, using a different type of cement, or changing the aggregate and aggregate gradation. The major reasons for using admixtures are:

i) To reduce the cost of concrete construction
ii) To achieve certain properties in concrete more effectively than by other means
iii) To maintain the quality of concrete during the stages of mixing, transporting, placing, and curing in adverse weather conditions
iv) To overcome certain emergencies during concreting operations

Admixtures being considered for use in concrete should meet applicable specifications as presented in Table 2.1. Trial mixtures should be made with the admixture and the job materials at temperatures and humidities anticipated on the job. The amount of admixture recommended by the manufacturer or the optimum amount determined by laboratory tests should be used.

2.3.1 Retarding admixtures

Retarders are used in concrete to offset the accelerating effects of high temperatures which are decrease setting times, or to avoid problems when unavoidable delays between mixing and placing occur. (Bazid Khan and Muhammad Ullah). A delay in the setting of cement paste can be achieved by adding a retarder to the concrete mix. Retarders generally slow down the hardening of the cement paste by stopping the rapid set shown by tricalcium aluminate but do not alter the composition of hydration products (Neville 2006; Lea 1988). The delay in setting of the cement paste can be exploited to produce architectural finish of exposed coarse aggregate (Neville 2006). Sugar, carbohydrate derivatives and some salts exhibit retarding action (Neville 2006; Lea 1988; Ramachandran et al. 1993).

The effective of the retarder depends on the amount of C_3A in the concrete. Retarder is removed from the solution by the C_3A reaction, so less is available to retard C_3S hydration. Less retarder is removed if its addition to fresh concrete is delayed. Even though this admixture extends setting times, a side effect is loss of workability. Set-retarding admixtures have been reported to increase ultimate compressive strengths. Dry shrinkage and creep rate are increased, but ultimate values are unaffected. (Charles Camp)

Table 2.2: Concrete Admixtures by Classification

Type of admixture	Desired effect	Material
Accelerators (ASTM C 494 and AASHTO M 194, Type C)	Accelerate setting and early-strength development	Calcium chloride (ASTM D 98 and AASHTO M 144) Triethanolamine, sodium thiocyanate, calcium formate, calcium nitrite, calcium nitrate
Air detrainers	Decrease air content	Tributyl phosphate, dibutyl phthalate, octyl alcohol, waterinsoluble esters of carbonic and boric acid, silicones
Air-entraining admixtures (ASTM C 260 and AASHTO M 154)	Improve durability in freeze-thaw, deicer, sulfate, and alkali-reactive environments and Improve workability	Salts of wood resins (Vinsol resin), some synthetic detergents, salts of sulfonated lignin, salts of petroleum acids, salts of proteinaceous material, fatty and resinous acids and their salts, alkylbenzene sulfonates, salts of sulfonated hydrocarbons
Alkali-aggregate reactivity inhibitors	Reduce alkali-aggregate reactivity expansion	Barium salts, lithium nitrate, lithium carbonate, lithium hydroxide
Antiwashout admixtures	Cohesive concrete for underwater placements	Cellulose, acrylic polymer
Bonding admixtures	Increase bond strength	Polyvinyl chloride, polyvinyl acetate, acrylics, butadiene-styrene copolymers
Coloring admixtures (ASTM C 979)	Colored concrete	Modified carbon black, iron oxide, phthalocyanine, umber, chromium oxide, titanium oxide, cobalt blue

Table 2.2: Continued

Type of admixture	Desired effect	Material
Dampproofing admixtures	Retard moisture penetration into dry concrete	Soaps of calcium or ammonium stearate or oleate Butyl stearate Petroleum products
Foaming agents	Produce lightweight, foamed concrete with low density	Cationic and anionic surfactants Hydrolized protein
Fungicides, germicides, and insecticides	Inhibit or control bacterial and fungal growth	Polyhalogenated phenols Dieldrin emulsions Copper compounds
Gas formers	Cause expansion before setting	Aluminum powder
Grouting admixtures	Adjust grout properties for specific applications	See Air-entraining admixtures, Accelerators, Retarders, and Water reducers
Hydration control admixtures	Suspend and reactivate cement hydration with stabilizer and activator	Carboxylic acids Phosphorus-containing organic acid salts
Permeability reducers	Decrease permeability	Latex Calcium stearate

Table 2.2: Continued

Type of admixture	Desired effect	Material
Pumping aids	Improve pumpability	Organic and synthetic polymers Organic flocculents Organic emulsions of paraffin, coal tar, asphalt, acrylics Bentonite and pyrogenic silicas Hydrated lime (ASTM C 141)
Retarders (ASTM C 494 and AASHTO M 194, Type B)	Retard setting time	Lignin, Borax, Sugars, Tartaric acid and salts
Shrinkage reducers	Reduce drying shrinkage	Polyoxyalkylene alkyl ether Propylene glycol
Superplasticizers* (ASTM C 1017, Type 1)	Increase flowability of concrete Reduce water-cement ratio	Sulfonated melamine formaldehyde condensates Sulfonated naphthalene formaldehyde condensates Lignosulfonates Polycarboxylates
Superplasticizer* and retarder (ASTM C 1017, Type 2)	Increase flowability with retarded set Reduce water–cement ratio	See superplasticizers and also water reducers
Water reducer (ASTM C 494 and AASHTO M 194, Type A)	Reduce water content at least 5%	Lignosulfonates Hydroxylated carboxylic acids Carbohydrates

Table 2.2: Continued

Type of admixture	Desired effect	Material
		(Also tend to retard set so accelerator is often added)
Water reducer and accelerator (ASTMC 494 and AASHTO M 194, Type E)	Reduce water content (minimum 5%) and accelerate set	See water reducer, Type A (accelerator is added)
Water reducer and retarder (ASTMC 494 and AASHTO M 194, Type D)	Reduce water content (minimum 5%) and retard set	See water reducer, Type A (retarder is added)
Water reducer—high range (ASTMC 494 and AASHTO M 194, Type F)	Reduce water content (minimum 12%)	See superplasticizers
Water reducer—high range—and retarder (ASTMC 494 and AASHTO M 194, Type G)	Reduce water content (minimum 12%) and retard set	See superplasticizers and also water reducers
Water reducer—mid range	Reduce water content (between 6 and 12%) without retarding	Lignosulfonates Polycarboxylates

*Superplasticizers are also referred to as high-range water reducers or plasticizers. These admixtures often meet both ASTMC 494 (AASHTO M 194) and ASTM C 1017 specifications.

Retarding admixture causes cement set retardation by one or more of following mechanisms:

i. Adsorption of the retarding compound on the surface of cement particles, forming a protective skin which slows down hydration.
ii. Adsorption of the retarding compound on to nuclei of calcium hydroxide, poisoning their growth, which is essential for continued hydration of cement after the end of induction period.
iii. Formation of complexes with calcium ions in solution, increasing their solubility and discouraging the formation of the nuclei of calcium hydroxide referred to in (ii) above and
iv. Precipitation around cement particles of insoluble derivatives of the retarding compounds formed by reaction with the highly alkaline aqueous solution, forming a protective skin.

2.3.2 Accelerating admixtures

Accelerators reduce the initial set time of concrete. Liquid accelerators are added to the concrete at the plant. Accelerators are recommended in cold weather to get high-early strength. Accelerators do not act as antifreeze; rather, they speed up the strength gain and make the concrete stronger to resist damage from freezing. Accelerators are sometimes used to allow finishing operations to begin early. Calcium chloride is the most commonly used accelerator, although non-chloride (non-corrosive) accelerators are available. Calcium chloride is specified at not more than 2% by the weight of the cement. Pre-stressed concrete and concrete with embedded aluminum or galvanized metal should not contain any calcium chloride because of the potential for corrosion.

2.3.2.1 Function of Accelerators

Accelerating admixtures can be used either to increase the rate of stiffening or setting of the concrete or to increase the rate of hardening and early strength gain to allow earlier remolding and handling. Most accelerators primarily achieve one rather than both of these functions. (John Dransfield 2012). Accelerators are also used to reduce the risk of damage by freezing when concreting in cold weather and to allow the earlier removal of formwork but it should be noted that they are not an anti – freeze.

However, at normal temperatures, a technically better way of enhancing early strength is to use a high range water reducer/ superplasticiser. Significant reductions (greater than 15 %) in the water cement ratio can more than double compressive strength at ages less than 24 hours. Accelerators can be used in conjunction with superplasticisers (<0.35 w/c ratio) where very early age strength is required, especially at lower temperatures.

2.4 SUCROSE

The performance of sucrose in cement hydration, including both the early structure formation and further development of cement paste under different curing temperatures, was studied by measures of setting time, heat evolution, resistivity evolution, compressive strength, and porosity. The results showed that there was a critical dosage of sucrose. When the dosage was less than, the retarding effect was enhanced by increasing the dosage.

Based on the previous studies, the addition of sucrose in concrete in small amounts delays the hydration reaction of cement (Neville A.M). The concretes made with sugar addition show strength reduction at early ages but their later age strengths might be higher. For example, sucrose, which has five members ring, is classified as non – reducing sugar and may retard the initial setting from 1400 to 15000min (Thomas N L & Birchall J D, Bruere G M). Although there is divergence of opinion among researchers as to what cause the retardation effect, the most commonly accepted opinion is its calcium binding and complexing ability (Gambhir M L, Joisel A). Sucrose is produced from agricultural plants of reed and beet. Hawort formulation of the sucrose (α-D-glukopiranozido-β-Dfruktofuralozid) is given in Figure 2.2 (Berg J M, Tymoczko J L & Stryer L)

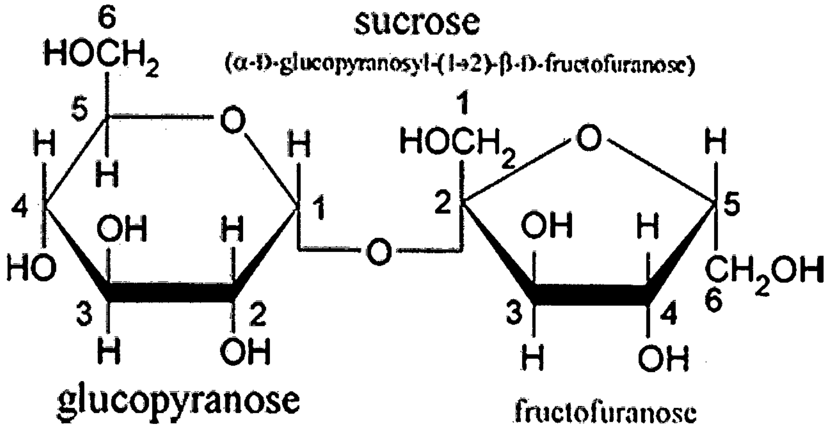

Figure 2.2: Hawort formulation of the sucrose

2.5 COMPRESSIVE STRENGTH

Compressive strength of concrete is one of the most important and useful properties. As a construction material, concrete is employed to resist compressive stresses. While, at locations where tensile strength or shear strength is of primary importance, the compressive strength is used to estimate the required property. Common trend in concrete technology is to use compressive strength as a quantitative measure for other properties of hardened concrete (M.S. Shetty). Cement based materials develop strength with continued hydration. The rate of gain of strength is faster at start and the rate gets reduced with age (M.S. Shetty). In spite of considering the 28-day compressive strength for design purposes, actually concrete develops strength beyond 28 days as well. Most codes of practice do not consider the increase of strength beyond 28 days for design purposes (ACI and ECP).

Many a time it may be necessary to estimate the strength of concrete not only at an early age but also at later ages (M.S. Shetty). Most of the research workers have attempted to estimate the strength of concrete at 1, 3 or 7 days and correlate to 28-day strength. Numerous research works have provided certain relationships. For instance, In Germany, the relation between 28-day strength fc_{28} and the 7-day strength, fc_7 is taken to lie between (M.S. Shetty)

$f_{c28} = 1.4f_{c7} + 150$ and $f_{c28} = 1.7f_{c7} + 850$ (f_c) is being expressed in psi (Eqn. 1)

Early age strength prediction in concrete is very useful in reducing construction cost and ensuring safety. Furthermore, early age strength prediction has several practical applications. It can be used to determine safe stripping time, prestressing application or post – tensioning time, to monitor strength development, particularly when concreting in cold weather, to check serviceability conditions or compliance criteria, to ensure construction safety and, generally to estimate the quality of construction and potential durability (ASTM C 1074–93).

2.6 WORKABILITY

Workability is often referred to as the ease with which a concrete can be transported, placed and consolidated without excessive bleeding or segregation. In addition, the internal work had done required to overcome the frictional forces between concrete ingredients for full compaction. It is obvious that no single test can evaluate all these factors. In fact, most of these cannot be easily assessed even though some standard tests have been established to evaluate them under specific conditions. In the case of concrete, consistence is sometimes taken to mean the degree of wetness; within limits, wet concretes are more workable than dry concrete, but concrete of same consistence may vary in workability.

Because the strength of concrete is adversely and significantly affected by the presence of voids in the compacted mass, it is vital to achieve a maximum possible density. This requires sufficient workability for virtually full compaction to be possible using a reasonable amount of work under the given conditions. Presence of voids in concrete reduces the density and greatly reduces the strength: 5% of voids can lower the strength by as much as 30%. Slump Test and Flow table test can be used to find out the workability of concrete. Workable concrete is the one which exhibits very little internal friction between particle and particle or which overcomes the frictional resistance offered by the formwork surface or reinforcement contained in the concrete with just the amount of compacting efforts forthcoming. Factors affecting workability are as follow (Dr.N.Suresh):