"Substitute For Sand In The Concrete Content"

By:

Roba AM Darawish

Supervisor:

Dr. Nafeth Nasereddin

Submitted to the College of Engineering

In partial fulfilment of the requirements for the degree of

Bachelor degree in Civil Engineering

Palestine Polytechnic University

May 2019

"Substitute For Sand In The Concrete Content "

By:

Roba AM Darawish

According to the system of the College of Engineering, the supervision of our supervisor and the approval of the members of the examination committee, this project was submitted to the Department of Civil and Architectural Engineering in order to finish the requirements of a bachelor's degree in building engineering.

Supervisor signature

……………………………

Examination committee signature

…………………………… ……………………………

College head signature

……………………………..

May 2019

Dedication

To mom and dad for the endless support

To my family for the huge love

To my best friend who’s always there when needed

To those who watered my flame for the challenges they put me in

To my roses for the hope they give me every morning

To every one who stays up all night working hard

To every one who tried to put me down and didn’t believe in me

To me for standing strong all along this rough road

Thanks and appreciation

The first thank is to Allah , who gave me the ability to start work and the faith to complete this task even when it's hard to keep going . My thanks to my university Palestine Polytechnic University .

My big thanks to my supervisor Dr.Nafez Nasereddin, who directed and supported me every time I needed , in addition to his knowledge, time, encouragement, supervision and guidance , without him the success of this project wouldn’t be possible .

I would like to thank the staff of the materials and soil lab Eng. Jebreel shwaike and Eng. Afnan Alkaraki for their guidance and help during the experimental phase of this project .

Finally, my deep sense and sincere thanks to my parents, brothers and sisters for their patience and their endless support. In addition to everyone who tried to help me during my work and gave me strength to keep going , and every one who didn’t have faith in my abilities and doubts my work for they made me have more motivation and more courage to complete this task .

Project abstract

Due to the large demand on sand and the lack of sources in our geographical area , we had to make a move and search for alternatives .

This project will study the possibilty to replace the sand in the concrete mixture , along with the effects of this procces on the properities of concrete .

An expiremental approach will take a place in this study , it will contain the requierd test to check the concret strength , cohesion and durability then compare the results with the code requirments . Different materials may be used if the results didn't fullfilled as desired

.

Available literature studies will be taken in consideration .

The results are hard to be expected but there is a huge chance that we will reach the wanted results .

ملخص المشروع

بسبب الطلب الكبير على الرمال و اعتماه بشكل أساسي في عملية البناء ونقص المصادر الطبيعية في منطقتنا الجغرافية بشكل خاص ، كان علينا أن نتحرك و أن نبحث عن بدائل .

سيقوم هذا المشروع بدراسة إمكانية استبدال الرمل في الخليط الخرساني ، إلى جانب آثار هذا التغيير على خصائص الخرسانة.

سيأخذ النهج العملي مكانًا في هذه الدراسة ، وسيتضمن الاختبارات المطلوبة للتحقق من قوة الخرسانة ، والتماسك والمتانة ، ثم مقارنة النتائج مع القيم القياسية من الممكن يمكن استخدام مواد مختلفة إذا لم يتم الحصول على النتائج بالشكل المطلوب.

سوف تؤخذ الدراسات الأدبية المتاحة في الاعتبار و يبقى من الصعب توقع النتائج ولكن هناك فرصة كبيرة بأن نصل إلى النتائج المطلوبة.

Table OF Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

1.1.1 Concrete History

Concrete is a commonly used construction composite generally made from varying types of dry, chemically inert, fine particles of sand, gravel, ash, shale, stone, and/or clay (also known as aggregate). The materials that compose concrete bond together by another fluid material called cement. Cement comes in different forms, but it is commonly a mixture of lime, calcium silicate, and water. Therefore, cement is an essential component of making concrete.

Although crude, naturally occurring cement compounds developed because of limestone and oil shale deposits that combined over 12 million years ago. The word “concrete” is derived from the Latin word “concretus,” which translates to compact or condensed. “Concrescere” is the Latin participle of concretus. The “con-” means together, and “crescere” means to grow. These Latin words are useful to understand because as concrete solidifies from a liquid to a solid form over time, the chemical hydration process causes the aggregate materials to grow together or bind.

1.1.1.1 **Concrete in Ancient Times**

The earliest form of concrete that resembles the concrete we know today is from the Egyptian pyramids (between 3000 and 2500 B.C.). Egyptians made cement from lime and gypsum to bind their aggregate materials: mud and straw. These aggregate materials bound together resulted in the bricks that Egyptians used for building their pyramids.

1.1.1.2 **Evolution of Concrete**

By 193 B.C. the Romans erected the first true concrete structure made from materials essentially the same as those used in modern cement. This structure was called the Porticuss Aemeilia.

By 200 A.D. the Roman Colosseum and Pantheon provided examples of how quickly this technique became commonplace. The Romans became famous for their vast and elaborate concrete architecture and sculpture. Contemporary excavations of Roman ruins showed approximately 95% of Roman concrete and mortar was produced using a simple lime cement that cured by way of carbon dioxide precipitation

However, the Dark Ages and the fall of the Roman Empire stagnated scientific progress. Previously-used techniques were forgotten.

Over 1000 years would pass before a new type of industrial concrete was discovered.

1.1.1.3 **Industrial Concrete**

In 1765, John Smeaton rediscovered hydraulic lime, which made cement that can harden underwater and is used to make water resistant concrete.

Joseph Aspdin, an English inventor, created Portland cement in 1824. Named after the high-quality stone excavated from quarries in Portland, England, Portland cement became the chosen type of cement for contractors because it was the strongest available due to the refinement process used to remove carbon dioxide.

The next big step of concrete evolution took place during the industrial revolution when Joseph Monier invented reinforced concrete, concrete with iron rods inside, in 1849. He came up with this idea because he made gardening vessels reinforced with iron mesh. For commercial and industrial applications, however, the imbedded metal is generally steel. Today, reinforced concrete is also known as ferroconcrete, and it is used in many applications including but not limited to highways, bridges, tunnels, skyscrapers, hydraulic dams (retaining walls), and railway ties.

Concrete, in some shape or form, has been used by humans nearly since the dawn of civilization. It allowed us to create vessels for storage, roads to travel on, and weather resistant structure for protection.

Every year human understanding of methods and materials evolves, and so does cement technology.

1.1.2 Sand

Sand is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass.

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or $SiO2$), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example, aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish.

For example, it is the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years like the Caribbean.

Only some sands are suitable for the construction industry, for example , for making concrete. Because of the growth of population and of cities and the consequent construction activity there is a huge demand for these special kinds of sand, and natural sources are running low. In 2012 French director Denis Delestrac made a documentary called "Sand Wars" about the impact of the lack of construction sand. It shows the ecological and economic effects of both legal and illegal trade in construction sand.

Sand's many uses require a significant dredging industry, raising environmental concerns over fish depletion, landslides, and flooding. Countries such as China, Indonesia, Malaysia and Cambodia ban sand exports, citing these issues as a major factor. It is estimated that the annual consumption of sand and gravel is 40 billion tons and sand is a US$70 billion global industry.

1.2 Reasons to choose this project

1.2.1 General Reason

Everyone seems to be getting something constructed (directly or indirectly) nowadays. Irrespective of location, scale or type, concrete is the base of all the construction activity in the nation. In fact, concrete is the second most consumed material after water, with nearly three tonnes used annually for each person on the planet. but do we have enough sand to make concrete?

And it’s known that sand is a non-renewable resource over human timescales, and sand suitable for making concrete is in high demand .

So due to this large demand on sand and the lack of sources in our geographical area in specific , we had to make a move and search for alternatives .

1.2.2 Personal Reason

I've always wanted to make a difference and do something creative , so I decided for my graduation project to be a research project instead of the ordinary structural design project .

This way , we may be able to find a solution for an important existing problem and serve the community .At the same time I'll be trying something different.

Moreover, I would like to submit this project to the architectural and civil engineering department in the Engineering College of Palestine Polytechnic University for completing graduation conditions and gaining a bachelor's degree in building engineering major.

1.3 Project objectives

1. To study the possibility to replace the sand in the concrete mixture along with the effects of this process on the properties of concrete .
2. To make a concrete mixture that apply to the code requirements and the market needs.

1.4 Research problem

The problem of this project is finding a substitute for sand in the concrete admixture that gives an admixture with the required properties , by using sandy soil at the beginning then adding different possible material to strengthen the concrete .

1.5 Methodology

1.5.1 Theoretical part

1. Study the concrete admixture and its content .
2. Collecting data and information about the topic and its related aspects .
3. Reviewing available literature studies and researches .

1.5.2 Experimental part

An experimental approach will take a place in this study , it will contain the following:

1. The required test to check the concrete properties (strength , cohesion and durability , …).
2. Compare the results with the code requirements .
3. Different materials may be used if the results didn’t full filled as desired .

1.6 Scope of the Project

Project contains several chapters as follows:

1. Chapter One: General Introduction To The Project.
2. Chapter Two: Literature Reviews.
3. Chapter Three: Materials And Experimental Works.
4. Chapter Four: Results And Discussion.
5. Chapter Five: Recommendations.

1.7 Time schedule

The expected time table of the first semester of the year 2018\2019.

Mission/week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Research selection	■	■	■											
Data Collection				■	■	■	■							
Previous studies							■	■	■	■				
experimental work											■	■		
Data analysis													■	
Due date														■

The expected time table of the second semester of the year 2018\2019.

Mission / week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data collection	■	■													
Experimental Works			■	■	■	■	■	■	■	■	■	■			
Data Analysis										■	■	■	■	■	
Due Date															■

2 Literature reviews

A previous study were used in this project “ Use of furnace slag and welding slag as replacement for sand in concrete “ by Rajan Gandhimathi , Puthiya Veetil Nidheesh , Shanmugam Rajakumar and Subramani Prateepkumar from the Department of Civil Engineering ,National Institute of Technology Tiruchirappalli India .

2.1 Background

Since the large demand has been placed on building material industry especially in the last decade, owing to the increasing population which causes a chronic shortage of building materials, the civil engineers have been challenged to convert the industrial wastes to useful building and construction materials. The challenge for the government is to reduce the waste’s harmful impacts to both health and the environment .

Concrete industry is particularly important as it is not only responsible for consuming natural resources and energy but also for its capacity of absorbing other industrial wastes and by-products. It is known that about 8 to 10 tons of fresh concrete waste can be produced every day from a concrete-batching plant with a daily output of 1,000 m3 of concrete. The choice of aggregates is important, and their quality plays a great role; they can not only limit the strength of concrete, but owing to their characteristics, they affect the durability and performance of concrete .

The worldwide consumption of sand as fine aggregate (FA) in concrete production is very high, and several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years . So, there is large demand for alternative materials for fine aggregates in construction industry. To overcome the stress and demand for river sand, researchers have identified some alternatives for sand, namely scale and steel chips , waste iron , crushed granite fine , etc.

Environmental management in developing countries is a complex issue because environmental problems are linked with social and economic aspects, which must be considered in the development of any environmental program or regulation . The problem of waste accumulation exists worldwide, specifically in the densely populated areas . Scale, granulated slag, and steel chips are industrial wastes in the iron and steel industry and cause a nuisance both to the health and environment when not properly disposed . Reuse of industrial solid waste as a partial replacement of aggregate in construction activities not only saves landfill space but also reduces the demand for extraction of natural raw materials . Recent studies showed that slag can also replace with sand in concrete .

2.2 Conclusions

The furnace and welding slags have been utilized in the work by using it in the building materials as addition to concrete. WS and FS concretes showed better performance towards compressive strength. The compressive strength on seventh day of concrete cubes increases from 10% to 15% replacement of sand by WS than the reference materials. Similarly 10% of FS shows an optimum strength of 21.1 N/mm2.

The compressive strength on 28th day of concrete cubes increases from 5% to 15% of replacement of sand by WS than the reference materials. The optimum compressive strength of slag concretes has been found to be 41 N/mm2 for 5% WS and 39.7 N/mm2 for 10% FS. The results show that 5% of WS and 10% FS replacement with sand is very effective for practical purpose.

In addition to this article , several graduation projects have been studied from the university library .

3 Materials

3.1 Concrete

Concrete is basically a mixture of two components: aggregates and paste. The paste, comprised of portland cement and water, binds the aggregates (usually sand and gravel or crushed stone) into a rocklike mass as the paste hardens because of the chemical reaction of the cement and water. Supplementary cementitious materials and chemical admixtures may also be included in the paste.

The paste is composed of cementitious materials, water, and entrapped air or purposely entrained air. The paste constitutes about 25% to 40% of the total volume of concrete. The absolute volume of cement is usually between 7% and 15% and the water between 14% and 21%. Air content in air - entrained concrete ranges from about 4% to 8% of the volume. Since aggregates make up about 60% to 75% of the total volume of concrete, their selection is important.

Aggregates should consist of particles with adequate strength and resistance to exposure conditions and should not contain materials that will cause deterioration of the concrete.

The quality of the concrete depends upon the quality of the paste and aggregate, and the bond between the two. In properly made concrete, each and every particle of aggregate is completely coated with paste and all of the spaces between aggregate particles are completely filled with paste.

For any particular set of materials and conditions of curing, the quality of hardened concrete is strongly influenced by the amount of water used in relation to the amount of cement. Unnecessarily high water contents dilute the cement paste (the glue of concrete).

Following are some advantages of reducing water content:

- Increased compressive and flexural strength.
- Lower permeability, thus lower absorption and increased water tightness.
- Increased resistance to weathering.
- Better bond between concrete and reinforcement.
- Reduced drying shrinkage and cracking.
- Less volume change from wetting and drying.

The less water used, the better the quality of the concrete—provided the mixture can be consolidated properly. Smaller amounts of mixing water result in stiffer mixtures; but with vibration, stiffer mixtures can be easily placed.

Thus, consolidation by vibration permits improvement in the quality of concrete. The freshly mixed (plastic) and hardened properties of concrete may be changed by adding chemical admixtures to the concrete, usually in liquid form, during batching.

Chemical admixtures are commonly used to:

(1) adjust setting time or hardening,

(2) reduce water demand,

(3) increase workability,

(4) intentionally entrain air, and

(5) adjust other fresh or hardened concrete properties.

After completion of proper proportioning, batching, mixing, placing, consolidating, finishing, and curing, concrete hardens into a strong, non combustible, durable, abrasion - resistant, and watertight building material that requires little or no maintenance. Furthermore, concrete is an excellent building material because it can be formed into a wide variety of shapes, colors, and textures for use in an unlimited number of applications.

3.1.1 Concrete Mix Design

The proportioning of concrete mixtures is the process of arriving at the right combination of cement, aggregates, water, and admixtures for making concrete according to given specifications. The ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavy Weight, and Mass Concrete is described, with a sample computation to illustrate the procedures.

A properly proportioned concrete mix should possess these qualities:

1. Acceptable workability of the freshly mixed concrete,
2. Durability, strength, and uniform appearance of the hardened concrete,
3. Economy

Understanding the basic principles of mixture design is as important as the actual calculations used to establish mix proportions. Only with proper selection of materials and mixture characteristics can the above qualities be obtained in concrete construction.

Before a concrete mixture can be proportioned, mixture characteristics are selected based on the intended use of the concrete, the exposure conditions, the size and shape of building elements, and the physical properties of the concrete (such as frost resistance and strength) required for the structure. The characteristics should reflect the needs of the structure; for example, resistance to chloride ions should be verifiable and the appropriate test methods specified.

3.1.2 ACI Method of Mix Design

There are a number of different methods of mix design available. They do give approximately the same relative proportions of materials, and all are capable of yielding suitable concrete mixes. The most common method used is that established by ACI Recommended Practice 211.1. It must be remembered, however, that any mix design method will provide only a first approximation of proportions.

These must be checked by trial batches in the laboratory or in the field and can then be adjusted as necessary to produce the desired concrete characteristics. With any given set of materials, it may be found that considerable deviations from the ACI recommended practice may be necessary. Once sufficient experience with local materials is acquired, the ACI method should be modified to take their properties into account.

The job specifications may dictate certain mix requirements, such as minimum cement contents and w/c ratios, slump, air content, maximum aggregate size, strength, the use of admixtures, or other special requirements. But regardless of the specification requirements, the establishment of the batch weights can best be accomplished by following the sequence of steps laid out below. This will ensure that the characteristics of the available materials are properly considered in combining them into a suitable concrete mixture. In summary, the mix design process consists of:

1. determining the job parameters - aggregate properties, maximum aggregate size, slump, w/c ratio, admixtures;

2. calculation of batch weights; and

3. adjustments to the batch weights based on a trial mix made according to these calculations.

3.1.3 Mix Design Procedures

1. Required material information. Before starting the mix design process, the following raw material properties should be determined: sieve analyses of both the fine and coarse aggregates, unit weight of the coarse aggregate, bulk specific gravities, and absorption capacities of the aggregates.

2. Choice of slump. Usually, slump will be specified for a particular job, to take into account the anticipated methods of handling and placing the concrete. However, where the slump has not been specified, appropriate values can be chosen from a specific table , which applies when the concrete is to be consolidated by vibration. As a general rule, the lowest slump that will permit adequate placement should be selected.

3. Maximum aggregate size. Generally, the largest maximum size of aggregate available with the limitations for dimensions of reinforced members should be used, as this will minimize the required cement content.

3.2 Materials

The materials that will be used in the concrete admixture in this project are :

3.2.1 Aggregate

3.2.1.1 General review

Aggregates are generally thought of as inert filler within a concrete mix. But a closer look reveals the major role and influence aggregate plays in the properties of both fresh and hardened concrete. Changes in gradation, maximum size, unit weight, and moisture content can all alter the character and performance of your concrete mix.

Economy is another reason for thoughtful aggregate selection. You can often save money by selecting the maximum allowable aggregate size. Using larger coarse aggregate typically lowers the cost of a concrete mix by reducing cement requirements, the most costly ingredient. Less cement (within reasonable limits for durability) will mean less water if the water-cement (w/c) ratio is kept constant. A lower water content will reduce the potential for shrinkage and for cracking associated with restrained volume change.

Particle Shape

The particle shape is important in that it affects the workability of the plastic concrete. The more rounded an aggregate the lower the inter particle friction, the smaller the surface/unit volume and therefore less water is required for a given workability. Therefore, a potentially higher strength is possible. Crushed aggregates can be used to produce higher strength concrete (greater than about 80 N/mm2 - MPa) as a greater bond strength can be achieved between the aggregate and the paste due to the rough angular texture of the aggregate surface.

Rounded, Irregular and Angular particles are more suitable for concrete mixes.

Surface Texture

Smother particles tend to produce a more workable concrete. The bond strength is, however likely to be higher with rough textured materials. The particles can be Glassy, smooth, granular, rough, crystalline or honeycombed.

Aggregates must conform to certain standards for optimum engineering use:

they must be clean, hard, strong, durable particles free of absorbed chemicals, coatings of clay, and other fine materials in amounts that could affect hydration and bond of the cement paste. Aggregate particles that are friable or capable of being split are undesirable.

Aggregates containing any appreciable amounts of shale or other shaly rocks, soft and porous materials, should be avoided; certain types of chert should be especially avoided since they have low resistance to weathering and can cause surface defects such as popouts.

Identification of the constituents of an aggregate cannot alone provide a basis for predicting the behaviour of aggregates in service. Visual inspection will often disclose weaknesses in coarse aggregates.

Service records are invaluable in evaluating aggregates. In the absence of a performance record, the aggregates should be tested before they are used in concrete. For adequate consolidation of concrete, the desirable amount of air, water, cement, and fine aggregate (that is, the mortar fraction) should be about 50% to 65% by absolute volume (45% to 60% by mass). Rounded aggregate, such as gravel, requires slightly lower values, while crushed aggregate requires slightly higher values. Fine aggregate content is usually 35% to 45% by mass or volume of the total aggregate content.

Grading

The grading and grading limits are usually expressed as the percentage of material passing each sieve.

There are several reasons for specifying grading limits and nominal maximum aggregate size; they affect relative aggregate proportions as well as cement and water requirements, workability, pumpability, economy, porosity, shrinkage, and durability of concrete. Variations in grading can seriously affect the uniformity of concrete from batch to batch. Very fine sands are often uneconomical; very coarse sands and coarse aggregate can produce harsh, unworkable mixtures. In general, aggregates that do not have a large deficiency or excess of any size and give a smooth grading curve will produce the most satisfactory results.

Fine - Aggregate Grading

Requirements of ASTM C 33 or AASHTO M 6/M 43 permit a relatively wide range in fine - aggregate gradation, but specifications by other organizations are sometimes more restrictive. The most desirable fine - aggregate grading depends on the type of work, the richness of the mixture, and the maximum size of coarse aggregate. In leaner mixtures, or when small - size coarse aggregates are used, a grading that approaches the maximum recommended percentage passing each sieve is desirable for workability.

In general, if the water - cement ratio is kept constant and the ratio of fine - to - coarse aggregate is chosen correctly, a wide range in grading can be used without measurable effect on strength. However, the best economy will sometimes be achieved by adjusting the concrete mixture to suit the gradation of the local aggregates.

Fine - aggregate grading within the limits of ASTMC 33 (AASHTOM6) is generally satisfactory for most concretes .

The amounts of fine aggregate passing the 300 µm (No. 50) and 150, µm (No. 100) sieves affect workability, surface texture, air content, and bleeding of concrete. Most specifications allow 5% to 30% to pass the 300 µm (No. 50) sieve. The lower limit may be sufficient for easy placing conditions or where concrete is mechanically finished, such a s in pavements. However, for hand - finished concrete floors, or where a smooth surface texture is desired, fine aggregate with at least 15% pas sing the 300 µm (No. 50) sieve and 3 or more passing the 150 µm (No. 100) sieve should be used.

Coarse - Aggregate Grading

The coarse aggregate grading requirements of ASTMC 33 (AASHTOM 80) permit a wide range in grading and a variety of grading sizes . The grading for a given maximum - size coarse aggregate can be varied over a moderate range without appreciable effect on cement and water requirement of a mixture if the proportion of fine aggregate to total aggregate produces concrete of good workability.

Mixture proportions should be changed to produce workable concrete if wide variations occur in the coarse - aggregate grading. Since variations are difficult to anticipate, it is often more economical to maintain uniformity in manufacturing and handling coarse aggregate than to reduce variations in gradation.

3.2.1.2 Sand and its substitute

Function of Sand

Sand for concrete can be classified as soft or sharp sand. Soft sand has a smooth surface on the individual granules. It is natural sand formed by erosion factors such as water movement on a beach. Sharp sand granules have a rough surface. This sand is the result of manufacturing by crushing larger forms of aggregate. The most important factor concerning sand used in concrete is that it must be clean sand. Impurities in the sand such as silt or organic matter will weaken the final hardened concrete .The aggregate--including the sand--used in large commercial or government projects such as road building must meet rigid standards for size and cleanliness. The strongest concrete comes from aggregate labelled as well-graded. This means the sand and coarse aggregate mixture is composed of granules and gravel of different sizes so the concrete mixture has uniform voids between the aggregate particles. The voids fill with cement to give the concrete a uniform structure.

By nature, sand is an inert material and doesn't react with the cement or even with the aggregates.It offers its surface to the cement film .

The sand particles coated with the cement film reach the crevices between the stones and then the cohesive mass known as the concrete is created . So from this we can conclude that the sand can be substituted easily if a material with similar properties or a material that can play this role of filling and coating the cement is available , since there’s no chemical reactions for the sand .

3.2.1.3 **The Importance of Gravel and Sand in Concrete**

Sand and gravel in concrete serve several purposes. Because they act as a filler, they also add more volume to the concrete. More volume means less air and a stronger product. The size of the gravel also helps to determine the concrete's strength. Though larger pieces of gravel produce more friction and make it harder to mix, they also make a stronger concrete.

Water also plays a part in how much sand and gravel to use. The more water you add, the weaker the mixture becomes. Adding aggregate to the mix reduces the amount of water. With less water, the concrete is stronger and less likely to shrink and crack.

3.2.1.4 **Alternatives**

Gravel isn't the only drainage material that works for building a septic tank bed. Sand and crushed materials -- including recycled tires, concrete chunks of the correct size and broken glass -- all work in some situations . As long as the material won't break down in water , it will work.

In this project we will substitute the sand for a sandy soil at the beginning ,that has some properties in common with the sand .

3.2.2 Cement

3.2.2.1 Background

A cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete.

Cements used in construction are usually inorganic, often lime or calcium silicate based, and can be characterized as either hydraulic or non-hydraulic, depending on the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).

Non-hydraulic cement does not set in wet conditions or under water. Rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting.

Hydraulic cements (e.g., Portland cement) set and become adhesive due to a chemical reaction between the dry ingredients and water. The chemical reaction results in mineral hydrates that are not very water-soluble and so are quite durable in water and safe from chemical attack. This allows setting in wet conditions or under water and further protects the hardened material from chemical attack. The chemical process for hydraulic cement found by ancient Romans used volcanic ash (pozzolana) with added lime (calcium oxide).

The word "cement" can be traced back to the Roman term opus caementicium, used to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick supplements that were added to the burnt lime, to obtain a hydraulic binder, were later referred to as cementum, cimentum, cäment, and cement. In modern times, organic polymers are sometimes used as cements in concrete.

Non-hydraulic cement, such as slaked lime (calcium oxide mixed with water), hardens by carbonation in the presence of carbon dioxide, which is naturally present in the air. First calcium oxide (lime) is produced from calcium carbonate (limestone or chalk) by calcination at temperatures above 825 °C (1,517 °F) for about 10 hours at atmospheric pressure:

$CaCO_3 \rightarrow CaO + CO_2$

The calcium oxide is then spent (slaked) mixing it with water to make slaked lime (calcium hydroxide):

$CaO + H_2O \rightarrow Ca(OH)_2$

Once the excess water is completely evaporated (this process is technically called setting), the carbonation starts:

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

This reaction takes time, because the partial pressure of carbon dioxide in the air is low. The carbonation reaction requires that the dry cement be exposed to air, so the slaked lime is a non-hydraulic cement and cannot be used under water. This process is called the lime cycle.

Conversely, hydraulic cement hardens by hydration when water is added. Hydraulic cements (such as Portland cement) are made of a mixture of silicates and oxides, the four main components being:

1. Belite ($2CaO \cdot SiO_2$);
2. Alite ($3CaO \cdot SiO_2$);
3. Tricalcium aluminate ($3CaO \cdot Al_2O_3$) (historically, and still occasionally, called 'celite');
4. Brownmillerite ($4CaO \cdot Al_2O_3 \cdot Fe_2O_3$).

The silicates are responsible for the cement's mechanical properties—the tricalcium aluminate and brownmillerite are essential for formation of the liquid phase during the kiln sintering (firing). The chemistry of these reactions is not completely clear and is still the object of research .

In the concrete admixture for this project , we'll be using hydraulic cements , Portland cement to be specific .

3.2.2.2 Physical and Mechanical Properties of Cement

Specifications for cement place limits on both its physical properties and often chemical composition. An understanding of the significance of some of the physical properties is helpful in interpreting results of cement tests. Tests of the physical properties of the cements should be used to evaluate the properties of the cement, rather than the concrete. Cement specifications limit the properties with respect to the type of cement. Cement should be sampled in accordance with ASTM C 183 (AASHTO T 127). During manufacture, cement is continuously monitored for its chemistry and the following properties:

Particle Size and Fineness

Portland cement consists of individual angular particles with a range of sizes, the result of pulverizing clinker in the grinding mill. Approximately 95% of

Construction materials technology Dr. Nasr Abboushi

cement particles are smaller than 45 micrometers, with the average particle around 15 micrometers. The overall particle size distribution of cement is called "fineness."

The fineness of cement affects heat released and the rate of hydration. Greater cement fineness (smaller particle size) increases the rate at which cement hydrates and thus accelerates strength development. The effects of greater fineness on paste strength are manifested principally during the first seven days.

In the early 1900s, cement fineness was expressed as the mass of cement per fractional size (percent weight retained on specific sieve sizes). Today, fineness is usually measured by the Blaine air - permeability test (ASTM C 204 or AASHTO T 153) that indirectly measures the surface area of the cement particles per unit mass. Cements with finer particles have more surface area in square meters per kilogram of cement.

Soundness

Soundness refers to the ability of a hardened paste to retain its volume. Lack of soundness or delayed destructive expansion can be caused by excessive amounts of hard burned free lime or magnesia. Most specifications for Portland cement limit the magnesia content and the maximum expansion as measured by the autoclave - expansion test.

Consistency

Consistency refers to the relative mobility of a freshly mixed cement paste or mortar or to its ability to flow. During cement testing, pastes are mixed to normal consistency as defined by a penetration of 10 ± 1 mm of the Vicat plunger. (see ASTM C 187 or AASHTO T 129).

Setting Time

The object of the setting time test is to determine (1) the time that elapses from the moment water is added until the paste ceases to be fluid and plastic (called initial set) and (2) the time required for the paste to acquire a certain degree of hardness (called final set). To determine if a cement sets according to the time limits specified in cement specifications, tests are performed using either the Vicat apparatus (ASTM C 191 or AASHTO T 131) or the Gillmore needle (ASTM C 266 or AASHTO T 154).

The Vicat test governs if no test method is specified by the purchaser. Initial set of cement paste must not occur too early and final set must not occur too late.

The setting times indicate that a paste is or is not undergoing normal hydration.

Compressive Strength

Compressive strength as specified by ASTM cement standards is that obtained from tests of 50 - mm mortar cubes tested in accordance with ASTMC 109 (AASHTOT 106). These cubes are made and cured in a prescribed manner using a standards and. Compressive strength is influenced by the cement type, or more precisely, the compound composition and fineness of the cement.

Density and Relative Density (Specific Gravity)

The density of cement is define d as the mass of a unit volume of the solids or particles, excluding air between particles. It is reported as mega grams per cubic meter or grams per cubic centimeter (the numeric value is the same for both units). The particle density of Portland cement ranges from 3.1 0 to 3.25, aver aging 3.1 5 Mg/m 3. A relative density of 3.1 5 is assumed for portland cement in volumetric computations of concrete mix proportioning.

3.2.3 Water

Water is mixed with the cement powder to form a paste which holds the aggregates together like glue. Almost any natural water that is drinkable and has no pronounced taste or odor can be used as mixing water for making concrete.

However, some waters that are not fit for drinking may be suitable for use in concrete. Water of questionable suitability can be used for making concrete if mortar cubes (ASTMC 109 or AASHTO T 106) made with it have 7 - day strengths equal to at least 90% of companion specimens made with drinkable or distilled water. In addition, ASTM C 191 (AASHTO T 131) tests should be made to ensure that impurities in the mixing water do not adversely shorten or extend the setting time of the cement. Acceptable criteria for water to be used in concrete are given in ASTM C 94 (AASHTO M 157) and AASHTOT 26.

Excessive impurities in mixing water not only may affect setting time and concrete strength, but also may cause efflorescence, staining, corrosion of reinforcement, volume instability, and reduced durability. Therefore, certain optional limits may be set on chlorides, sulfates, alkalies, and solids in the mixing water or appropriate tests can be performed to determine the effect the impurity has on various properties.

Some impurities may have little effect on strength and setting time, yet they can adversely affect durability and other properties. Water containing less than 2000 parts per million (ppm) of total dissolved solids can generally be used satisfactorily for making concrete. Water containing more than 2000 ppm of dissolved solids should be tested for its effect on strength and time of set.

4 Experimental work

4.1 Experiments

In order to effectively analyze and study the possibility to replace the normal sand with this soil a number of test should be made . And for that we had to make a concrete mixture with a certain ratios that are explained below . We chose a B250 concrete mixture with a water cement ration of 80% .

Design of a B250 concrete with normal sand

We mixed a 0.01 m^2 for our experiment with the following quantities :

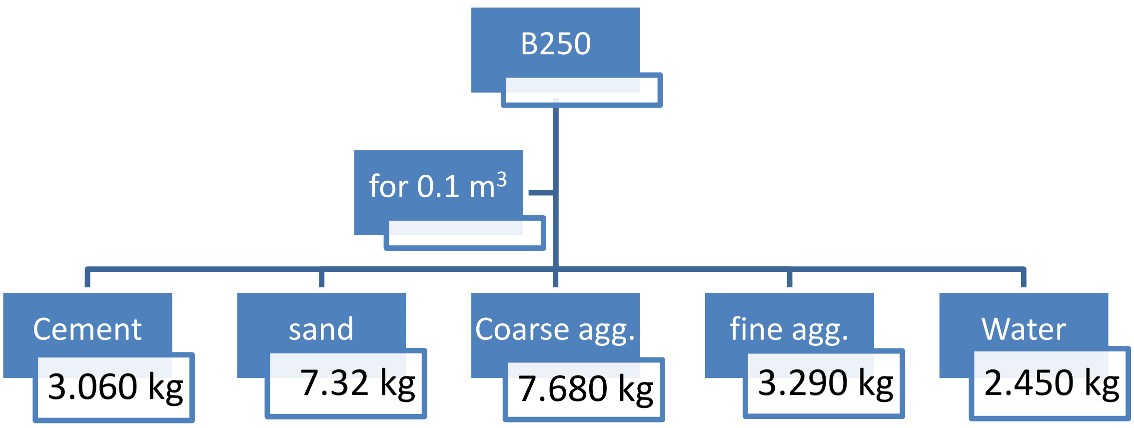


Table 1 design of B250 with ordinary sand

Design of a B250 concrete with

The same mixture was made with the same ratios and quantities but with the sandy soil as a 100% replacement of sand .

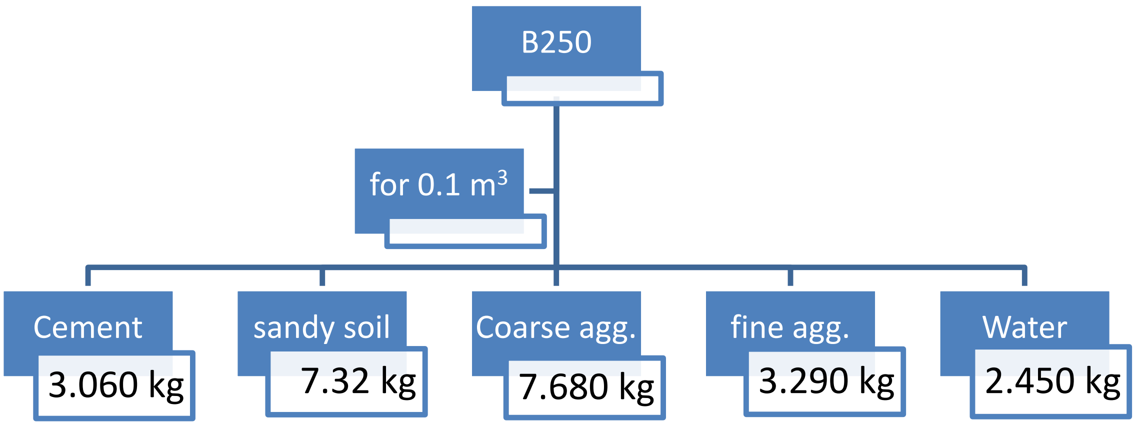


Table 2 design of B250 with sandy soil

Design of a B250 concrete

with 75% replacement of sand

The same mixture was made with the same ratios and quantities but with the sandy soil as a 75% replacement of sand and 25% normal sand . And the quantities were as follow in the figure :

Material	Quantities kg
cement	3.060
Sandy soil	5.490
sand	1.830
Coarse aggregate	7.680
Fine aggregate	3.290
water	2.450

Table 3 Quantities 75% replacement of sand

Design of a B250 concrete

with 50% replacement of sand

The same mixture was made with the same ratios and quantities but with the sandy soil as a 50% replacement of sand and 50% normal sand . And the quantities were as follow in the figure :

Material	Quantities kg
cement	3.060
Sandy soil	3.66
sand	3.66
Coarse aggregate	7.680
Fine aggregate	3.290
water	2.450

Table 4 Quantities of 50% replacement of sand

Design of a B250 concrete

with 25% replacement of sand and W/C =80%

The same mixture was made with the same ratios and quantities but with the sandy soil as a 25% replacement of sand and 75% normal sand . And the quantities were as follow in the figure :

Material	Quantities kg
cement	3.060
Sandy soil	1.830
sand	5.490
Coarse aggregate	7.680
Fine aggregate	3.290
water	2.450

Table 5 Quantities of 25% replacement ,w/c 80%

Design of a B250 concrete

with 25% replacement of sand and W/C =70%

The same mixture was made with the same ratios and quantities but with the sandy soil as a 25% replacement of sand and 75% normal sand . And the quantities were as follow in the figure :

Material	Quantities kg
cement	3.060
Sandy soil	1.830
sand	5.490
Coarse aggregate	7.680
Fine aggregate	3.290
water	2.140

Table 6 Quantities of 25% replacement ,w/c 70%

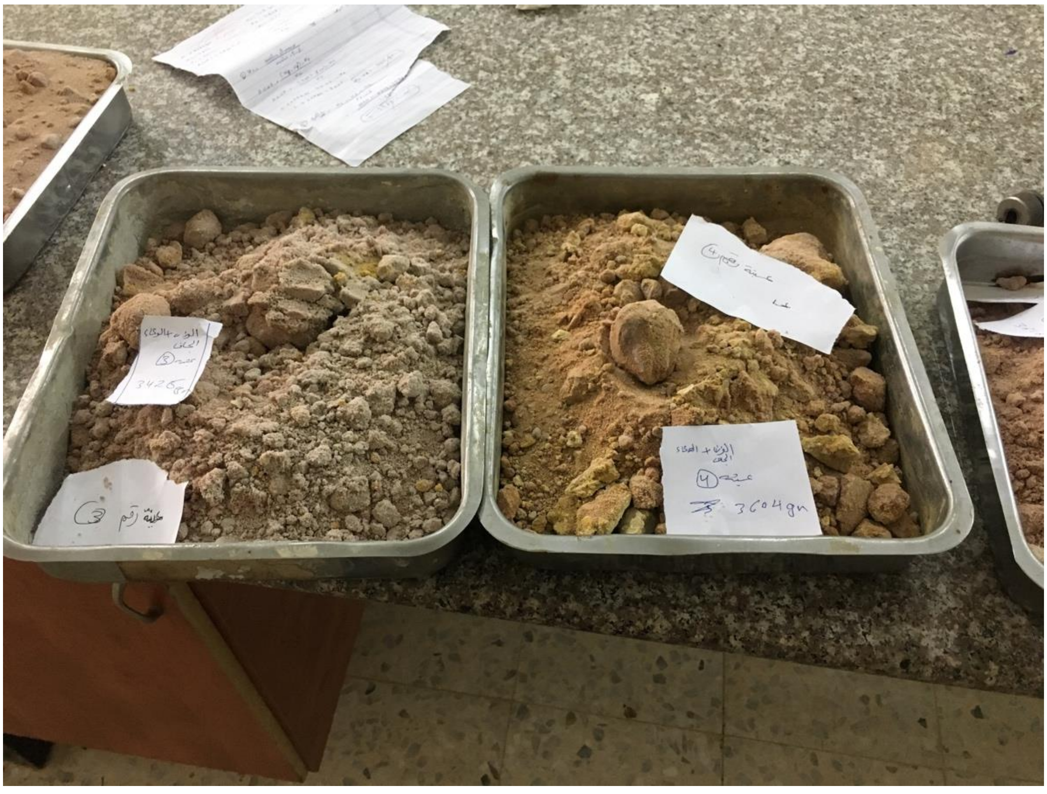
4.2 Procedures

4.2.1 Soil Water content

1. Determine the weight of the empty tray after recording its number .
2. Put a sample of the representative moist soil in the tray ..
3. Then determine the weight again ,this time the weight of the tray and wet soil .
4. Place the tray in the oven to dry the wet soil to a constant weight , for around 24 hours and temperatures $105^o – 110^o$.
5. Now , determine the dry weight of the soil sample and the tray.
6. Calculate the water content using the following relation .

W.C = {(wet weight +empty tray) – (dry weight +empty tray)}/dry weight

Table 7 soil sample preperation



4.2.2 Concerte Slump test

1. Clean the internal surface of the mould and apply oil.
2. Place the mould on a smooth horizontal non- porous base plate.
3. Fill the mould with the prepared concrete mix in 4 approximately equal layers.
4. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.
5. Remove the excess concrete and level the surface with a trowel.
6. Clean away the mortar or water leaked out between the mould and the base plate.
7. Raise the mould from the concrete immediately and slowly in vertical direction.
8. Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

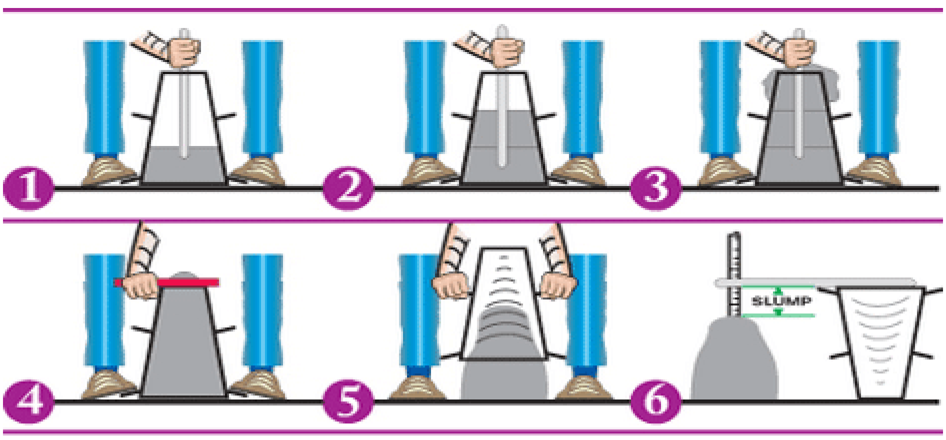


Table 8 Slump test procedures

4.2.3 Compression strength tests

Mixing of Concrete for Cube Test

Mix the concrete either by hand or in a laboratory batch mixer

Hand Mixing

1. Mix the cement and fine aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform color .
2. Add the coarse aggregate and mix with cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch .
3. Add water and mix it until the concrete appears to be homogeneous and of the desired consistency .

Sampling of Cubes for Test

1. Clean the mounds and apply oil .
2. Fill the concrete in the molds in layers approximately 5 cm thick.
3. Compact each layer with not less than 35 strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bullet pointed at lower end).
4. Level the top surface and smoothen it with a trowel .

Curing of Cubes

The test specimens are stored in moist air for 24 hours and after this period the specimens are marked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.

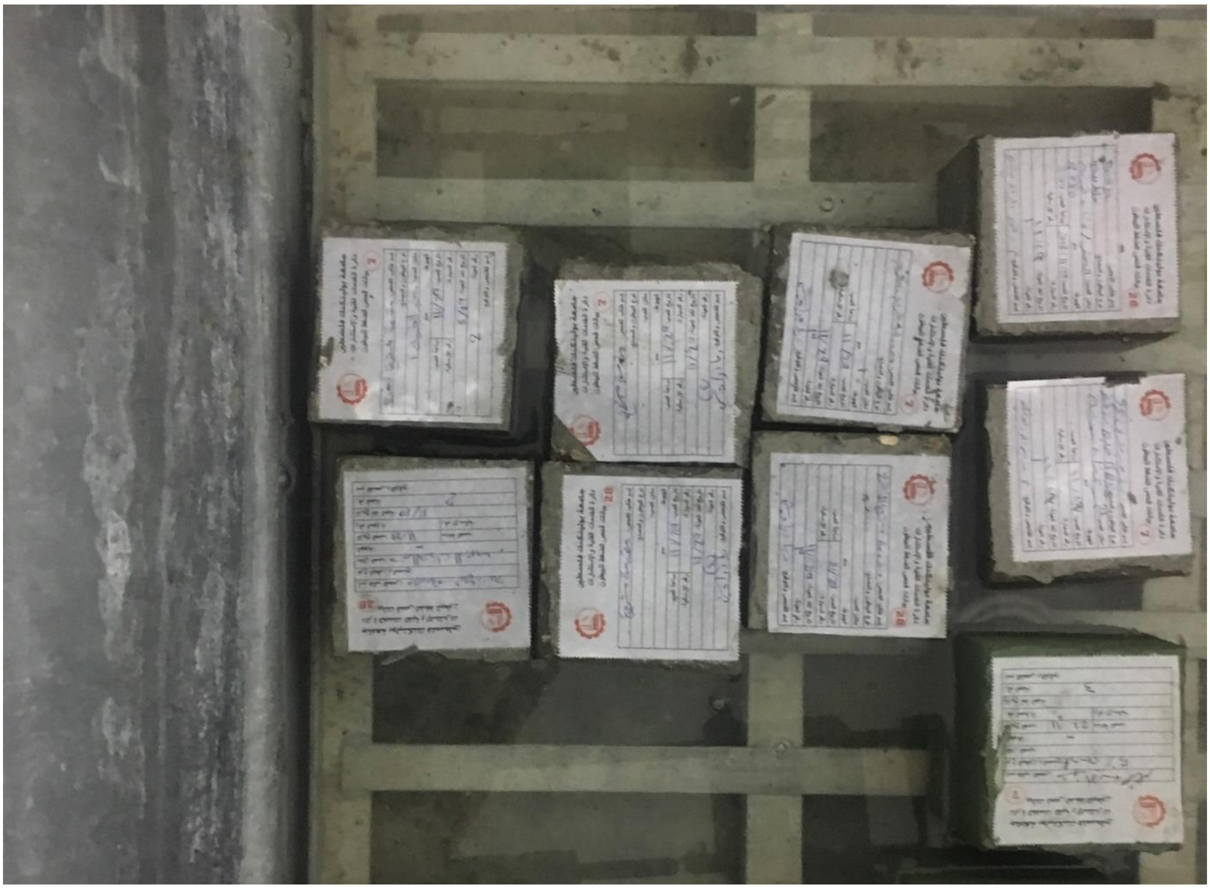


Table 9 Curing of the cubes

Precautions for Tests

The water for curing should be tested every 7 days and the temperature of water must be at 27+-2oC.

Procedure for Concrete Cube Test

1. Remove the specimen from water after specified curing time and wipe out excess water from the surface.
2. Clean the bearing surface of the testing machine .
3. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
4. Align the specimen centrally on the base plate of the machine.

5. Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
6. Apply the load gradually without shock and continuously at the rate of 140 kg/cm2/minute till the specimen fails .
7. Record the maximum load and note any unusual features in the type of failure.

Table 10 testing the cube

Note:

Minimum three specimens should be tested at each selected age. If strength of any specimen varies by more than 15 percent of average strength, results of such specimen should be rejected. Average of three specimens gives the crushing strength of concrete.

Table 11 Failiure of the cube

5 Results and discussion

5.1 Laboratory results

5.1.1 Water content of the soil

The data and the results were as follow :

Table 12 : lab results for water content of the soil

Sample(#)	Empty Tray (gm)	Wet weight +Empty Tray (gm)	Dry weight +Empty Tray (gm)	Dry weight (gm)	W.C(%)
1	**486**	**3230**	**3616**	**2630**	4.33
2	**492**	**3836**	**3778**	**3286**	1.776
3	**544**	**3542**	**3426**	**2882**	4.02
4	**496**	**3778**	**3604**	**3105**	5.60
					Avg = 3.93

The water content of this soil is a little high comparing it with the sand water content , so for this reason we can say that this soil needs more water than the normal sand .

This made us use a water cement ratio of 80% in our concrete admixture .

5.1.2 Modulus of fineness (FM)

The required procedures to determine the modulus of fineness were done at the lab for both the normal sand and the substitute .

5.1.2.1 Modulus of fineness (FM) experiment of sand results were as follow :

SIEZE NO.	Remained Weight(gm)	Corrected Weight(gm)	Remained Weight ratio%	Cumulative ratio%
4	145.05	145.05	14.5	14.5
8	136.10	136.10	13.61	28.11
16	37.05	37.05	3.705	31.815
30	127.56	127.56	12.76	44.545
50	6.12	6.12	0.612	45.157
100	51.623	516.23	51.623	96.78
pan	31.32	31.89	3.19	99.97
Sum.	999.73	1000	100	

Table 13 finnes modulous data for sand

$$\text{F.M} = \frac{0+0+0+14.5+28.11+31.815+44.545+45.157+96.78}{100}$$

F.M = 2.6

5.1.2.2 Modulus of fineness (FM) experiment of soil results were as follow

SIEZE NO.	Remained Weight(gm)	Corrected weight	Correction ratio%	Cumulative ratio%
4	136.78	136.78	13.678	13.678
8	163.24	163.24	16.324	30.00
16	19.76	19.76	1.976	31.98
30	12.95	12.95	1.295	33.28
50	395.21	395.21	39.521	72.78
100	241.46	241.46	24.146	96.93
pan	30.33	30.6	3.06	99.99
Sum.	999.73	1000	100	

Table 14 finnes modulous data for soil

$$\mathbf{F.M} = \frac{\mathbf{0+0+0+13.68+30+31.98+33.28+72.78+96.93}}{\mathbf{100}}$$

F.M = 2.78

5.1.3 Specific Gravity of soil

It is the ratio of the density of a substance to the density of a reference substance; equivalently, it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume .

Table 15 specific gravity test

The test was done at the lab and after collecting the required data the specific gravity value for the soil was determined .

Symbol	Definition	Weight
W_1	Weight of flask full of water	**360.00 gm**
W_2	Weight of flask full of water and soil	**395.46 gm**
W_3	Weight of soil	**60 gm**

Table 16 Specific Gravity lab data

At temperature T = 30 ˚:

$$Gs_{30} = \frac{W3}{(W1+W3)-W2}$$

Gs_{30} =2.4498

$K_{30} = -6*10^{-6}$ (T2) + $5*10^{-5}$ (T) +1.0014

K_{30} =0.9975

$Gs_{20} = K_{30} * Gs_{30}$

$Gs_{20} = 2.44368$

5.1.4 Compression strength test

The compression test were made for several samples of a concrete mixture with 100% with the ordinary sand and other samples of mixtures with different ratio of sand substituting.

Table 17 sample after the test

5.1.4.1 **100% normal sand**

The results of this tests for the B250 admixture with the content of 100 % sand after 7 days are in this table :

The following table shows the lab results for the compression test "B250 with 100% sand"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
7	2348	80	143.6	14.36	146.472
8	2354	80	147.9	14.79	150.858
9	2304	80	146.4	14.64	149.328

Table 18 results of B250 with 100% sand

The results of this tests for the B250 mixture with the content of 100 % sand after 28 days are in this table :

The following table shows the lab results for the compression test "B250 with 100% sand"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
7	2254	80	246.2	24.62	251.124
8	2266	80	244.268	24.43	249.153
9	2226	80	243.3	24.33	248.166

Table 19 results of B250 with 100% sand

5.1.4.2 **100 % of substitute**

The results of this tests for the B250 concrete mixture with sandy soil as a 100 % replacement of sand after 7 days are in this table :

The following table shows the lab results for the compression test "B250 with 100 % soil "

Sample Number	Weight	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
1	2324.5	80	74.07	7.407	76
2	2167.5	80	63.80	6.380	65
3	2293.5	80	74.293	7.4293	76

Table 20 results of B250 with 100 % soil

The results of this tests for the B250 concrete mixture with sandy soil as a 100 % replacement of sand after 28 days are in this table :

The following table shows the lab results for the compression test "B250 with 100 % soil "

Sample Number	Weight	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
1	2324.5	80	110.55	11.055	112.761
2	2167.5	80	96.67	9.667	98.6
3	2293.5	80	112.3	11.23	114.55

Table 21 results of B250 with 100 % soil

5.1.4.3 **75% of substitute**

The results of this tests for the B250 mixture with the content of 75% soil after 7 days are in this table :

The following table shows the lab results for the compression test "B250 with 75% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
1	2320	80	167.5	16.75	170.9
2	2272	80	169.2	16.92	172.6
3	2278	80	167.9	16.79	171.3

Table 22 results of B250 with 75% soil

The results of this tests for the B250 mixture with the content of 75% soil after 28 days are in this table :

The following table shows the lab results for the compression test "B250 with 75% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
1	2239	80	258.33	25.833	263.5
2	2232	80	258.883	25.8883	264.1
3	2238	80	258.28	25.828	263.4

Table 23 results of B250 with 75% soil

5.1.4.4 **50% of substitute**

The results of this tests for the B250 mixture with the content of 50 % soil after 7 days are in this table :

The following table shows the lab results for the compression test "B250 with 50% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
4	**2332**	**80**	**194.4**	**19.44**	**198.3**
5	**2320**	**80**	**194.1**	**19.41**	**198**
6	**2350**	**80**	**183.9**	**18.39**	**187.6**

Table 24 results of B250 with 50% soil

The results of this tests for the B250 mixture with the content of 50 % soil after 28 days are in this table :

The following table shows lab results for the compression test "B250 with 50% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
4	**2276**	**80**	**270.44**	**27.044**	**275.849**
5	**2278**	**80**	**274.588**	**27.459**	**280.08**
6	**2284**	**80**	**282.713**	**28.271**	**288.367**

Table 25 results of B250 with 50% soil

5.1.4.5 **25% of substitute with w/c 80% first trial**

The results of this tests for the B250 mixture with the content of 25 % soil after 7 days are in this table :

The following table shows lab results for the compression test "B250 with 25% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
7	2352	80	175.3	17.53	178.8
8	2350	80	161.0	16.10	164.2
9	2416	80	170.4	17.04	173.8

Table 26 results of B250 with 25% soil

The results of this tests for the B250 mixture with the content of 25 % soil after 28 days are in this table :

The following table shows lab results for the compression test "B250 with 25% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
7	2319	80	278.45	27.845	284.019
8	2328	80	276.17	27.617	281.69
9	2314	80	280.78	28.078	286.396

Table 27 results of B250 with 25% soil

5.1.4.6 **25% of substitute with w/c 80% second trial**

The results of this tests for the B250 mixture with the content of 25% soil after 7 days are in this table :

The following table shows the lab results for the compression test "B250 with 25% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
1	2348	80	202.5	20.25	206.55
2	2358	80	225.1	22.51	229.602
3	2348	80	225	22.5	229.5

Table 28 results of B250 with 25% soil

The results of this tests for the B250 mixture with the content of 25% soil after 28 days are in this table :

The following table shows the lab results for the compression test "B250 with 25% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
1	2314	80	317	31.7	323.34
2	2322	80	330.3	33.03	336.906
3	2346	80	352.4	35.24	359.448

Table 29 results of B250 with 25% soil

5.1.4.7 **25% of substitute with w/c 70%**

The results of this tests for the B250 mixture with the content of 25 % soil after 7 days are in this table :

The following table shows the lab results for the compression test "B250 with 25% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
4	**2360**	**70**	**218.8**	**21.88**	**223.176**
5	**2300**	**70**	**235.6**	**23.56**	**240.312**
6	**2376**	**70**	**215.7**	**21.57**	**220.014**

Table 30 results of B250 with 25% soil ,70% w/c

The results of this tests for the B250 mixture with the content of 25 % soil after 28 days are in this table :

The following table shows the lab results for the compression test "B250 with 25% soil"

Sample Number	Weight gm	Water cement ratio %	Failure load KN	Failure load Mpa	Strength Kg/cm2
4	**2304**	**70**	**338.79**	**33.879**	**345.56**
5	**2290**	**70**	**348.45**	**34.845**	**355.419**
6	**2304**	**70**	**366.7**	**36.67**	**374.034**

Table 31 results of B250 with 25% soil ,70% w/c

5.1.5 Heat affection

The results of the compression tests for the B250 cubes with different ratio after 24 hours in the oven and with the affection of heat after 28 days are in this table :

The following table shows the lab results for the compression test for"B250 with heat affection"

Sample Number	Soil ratio %	Weight of heated sample gm	Failure load of heated sample KN	Average Weight of normal sample gm	Average Failure load of normal sample KN
1	75	2208	186.33	2236	258.5
4	50	2236	214.048	2279	275.91
7	25	2276	284.035	2320	358.34

Table 32 results of B250 with heat affection

5.1.6 Slump Test

Slump test were made for the different mixtures and the results were the following :

The following table shows the lab results of concrete slump test of different samples all have the w/c ration of 80% :

B250 admixture	Ratio %	Height difference «slump » mm
ordinary sand	100	100
sandy soil	100	20
sandy soil	75	50
sandy soil	50	60
sandy soil	25	80

Table 33 slump test results

5.1.7 Absorption Test

Absorption test were done for three cubes with a different ratio of the substitute and the results were as follow ;

Sample Number	Ratio of the substitute %	Dry weight gm	Wet weight gm	Absorption ratio %
1	**75**	**2193**	**2314**	**5.5**
2	**50**	**2123**	**2326**	**9.6**
3	**25**	**2152**	**2366**	**9.9**

Table 34 absorption test result

$$\text{Absorption ratio} = \frac{\text{Wet weight} - \text{dry weight}}{\text{dry weight}}\ \%$$

5.2 Discussion

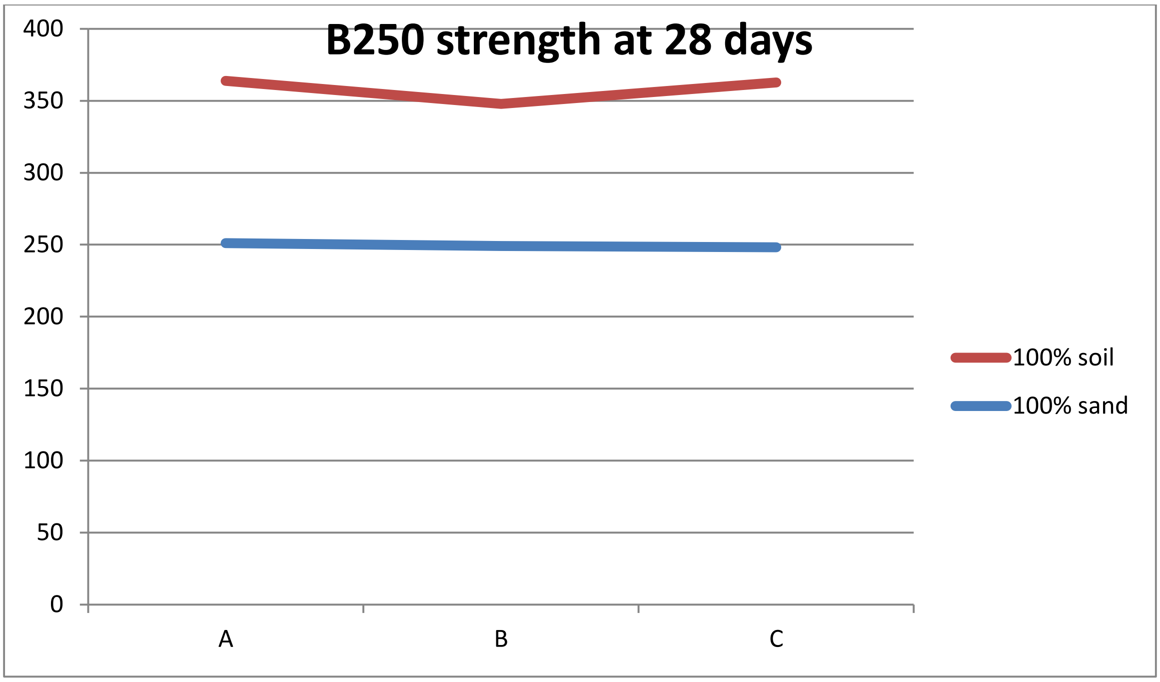
1. Before any concrete tests we had to see first if this soil has the standard properties of the normal sand so we have made several tests to check the properties , first the fineness modulus which was in the range of the standard value ($2 < 2.78 < 3$), same goes for the spesific gravity test .

2. The water content of the soil indicated that this soil need more water than the normal sand which made us use a 80% water cement ratio instead of 60% or 70% .

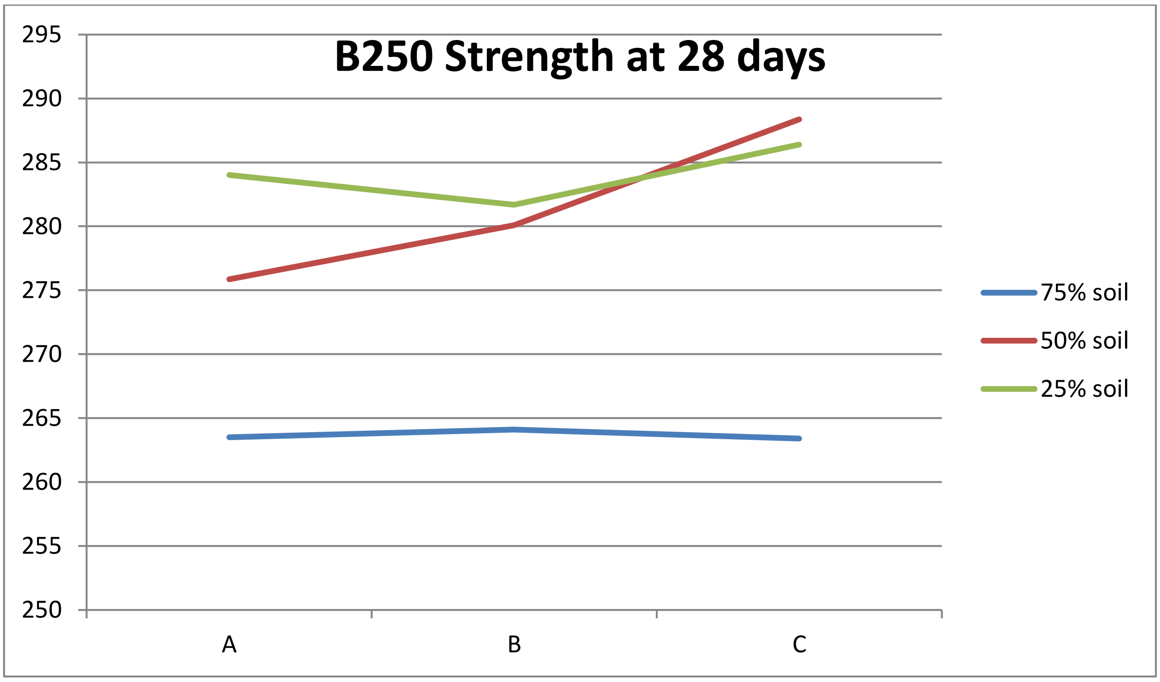
3. The reason that this soil needed more water than the normal sand is the nature of its surface , the surface is smoother than the sand so it needs more water .

4. The slump test results for the 100% substitution indicated the consistency of the mixture which is dry , for this reason the workability is not good for this mixture and it brings us back to the first point that this soil needs more water.

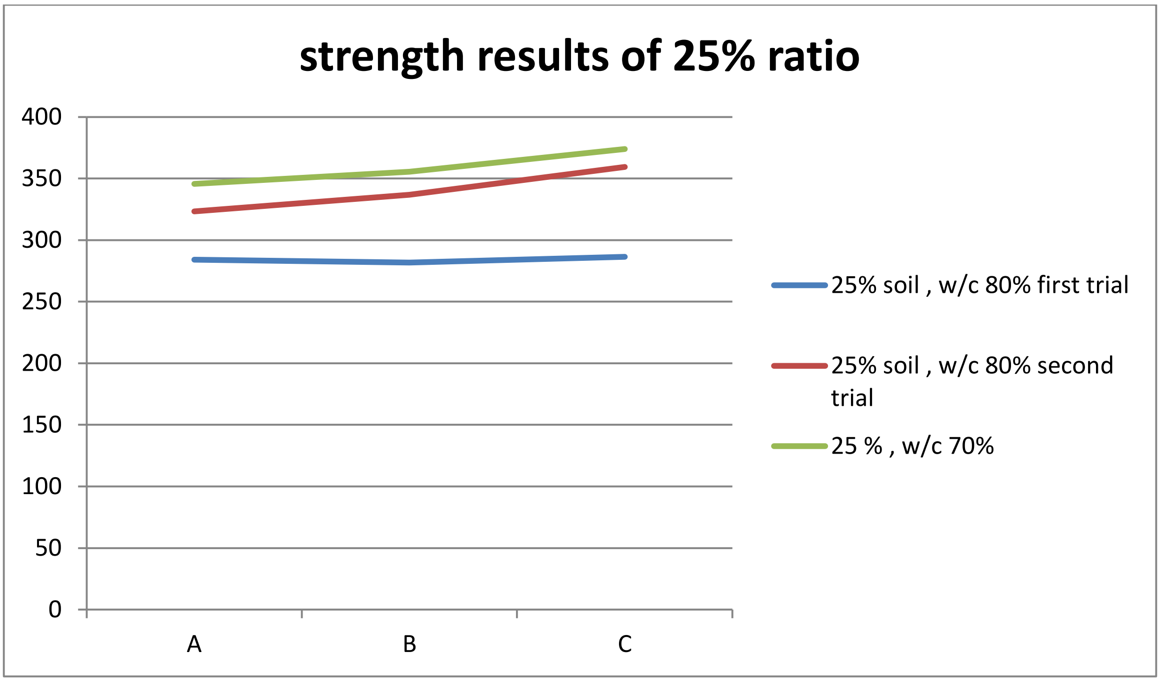
5. The strength of the admixture with 100% sandy soil is less than 50% of the strength of the same admixture but with ordinary sand ,which is unacceptable. The figure below shows the difference:



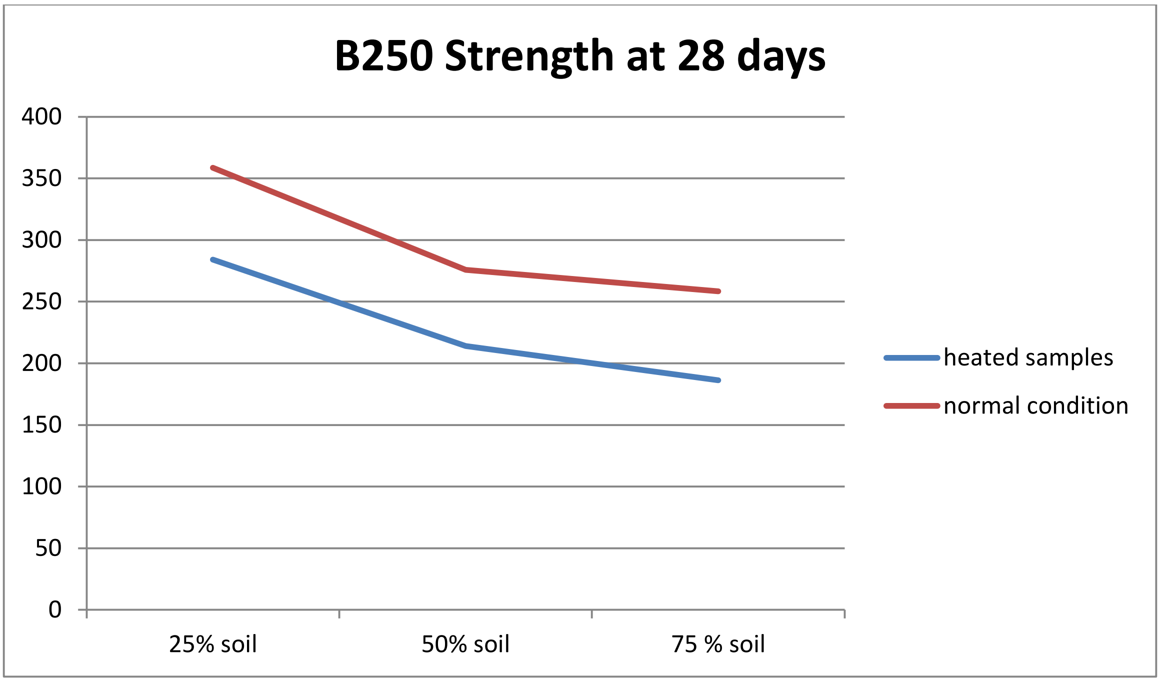
6. After the failure of the first percentage we had to try different ratio , and as the results came out it was clear that the strength is acceptable and full fil the required value , and as expected the relation between the ratio of the substitute in the mixture and the strength is directly proportional as the following chart shows :



7. The strength of the mixture with 25% soil at seven days didn't achieve the expected strength , but at the 28 days test it was as expected so we had to make more different mixture with the same ratio to know the reason and make sure that it is acceptable . the following chart shows the strength results of the three mixture of 25% ratio :



8. we tried to study the affection of heat on the samples with different ratio by using the oven at temperature of 105 c and wait till the day 28 and test the strength and the . results were as expected , the following chart shows the strength results of the three samples with different ratio and comparing it with the samples with normal condition :


B250 Strength at 28 days
400
350
300
250
200
150
100
50
0
25% soil
50% soil
75 % soil
heated samples
normal condition

6 Conclusion and recommendation

1. According to the laboratory work and results of the properties of this soil , it full fill the standards and so can be used in the concrete content as a replacement of the sand .

2. The 100 % ratio mixture may be acceptable for the unimportant uses that doesn't require much strength .

3. The strength results of the mixture with 100 % of sates that this soil can't be a replacement of the ordinary sand in the concrete admixture with a 100% ratio .

4. The results of the other ratios were all acceptable and can be used as a replacement of sand .

5. The mixture with 25 % soil better be used with a water cement ratio less than 80% .

6. And with some different materials with specific ratios along with this soil the mixture may reach the desired results without using sand .

7 References

1. Concrete: A Seven-Thousand-Year History Hardcover – October 4, 2010 Reese Palley .
2. Composition And Properties Of Concrete -McGRAW Hill -Civil engineering series,2nd edition, New York ,1968 .
3. Construction Materials Technology, dept.of civil and arch. ,Palestine polytechnic university, Nasr Abboushi , 2013 .
4. Use of furnace slag and welding slag as replacement for sand in concrete , Ramesh,. et al. Springer Berlin Heidelberg Int J Energy Environ Eng (2013) 4: 3.
5. Almeida N, Branco F, Santos JR: Recycling of stone slurry in industrial activities: application to concrete mixtures. Build Environ 2007, 42: 810–819. 1
6. https://doi.org/10.1186/2251-6832-4-3.
7. https://en.m.wikipedia.org/wiki/Sand
8. https://en.m.wikipedia.org/wiki/Cement.