An-Najah National University
Faculty of Graduate Studies

Utilization of Olive Husk as a Replacement of Fine Aggregate in Portland Cement Concrete Mixes for Non-Structural Uses

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3. Dr. Shakir Al-Bitar(Member)	....

DEDICATION

To the owners of the glowing hearts and burning vigor……………

To those who sacrificed their money, souls and blood for their faith.....

To those who faced the devil of evil and the devil of craving………

To Al-Aqsa Intifada martyrs and all the martyrs of Palestine………

To the spirit of the struggling martyr, my nephew,

To the stubborn heroes and political prisoners………………………

To those who loved Palestine as a home land and peace…………….

To those sharing me the life, spending the nights keep my eyes open to continue this work then offer me all comfort……………………….

To my tender mother, honored father and dear brother and sisters.

To all of them,

I dedicate this work

ACKNOWLEDGMENT

Thank God for the blessing granted to us …………………………

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Abstract

This research aims at partially solving the environmental problem of olive oil wastes (husk & ash) by utilizing this waste in non-structural concrete mixes. On the other hand, this research aims at studying the effects of using olive oil wastes (husk & ash) on the physical properties of Portland cement concrete.

To achieve the purpose of this thesis, the following methodology will emphasize and express the physical characteristics of Portland Cement Concrete (PCC) when olive oil waste (Husk) and Burned Husk (Ash) are used in the production of lightweight concrete, the following tests were done: sieve Analysis and specific gravity for coarse aggregate, fine aggregate, olive husk, olive ash. Different percentage replacements of olive husk or ash were used (0, 25, 50, 75, 100) % for concrete grades (PCC150, PCC200, PCC250, PCC300, PCC450), for each grade four samples for each proportion were done to test slump, density and compressive strength. In addition, three samples were prepared for testing absorption, abrasion, noise insulation, and thermal insulation.

Results for all percentage replacements of olive husk and ash for all grades were ranging from (23-29) mm for slump. For olive husk and ash (density & compressive strength) are decreased as percentage replacement increases. For water absorption, as percentage replacement by olive husk and olive ash decrease, water absorption increases. For abrasion test, losses in weight due to abrasion increase as a percent replacement of olive husk or ash increases.

For noise insulation, sound reduction increases as the percentage replacement of olive husk or ash increases.

For thermal insulation, it increases as percent replacement of olive husk increases; however, it decreases as percent replacement of olive ash increases.

Key words: Portland cement concrete, olive oil waste, husk, burned husk, ash, utilization, non-structural concrete.

Chapter One

Introduction

Chapter One

Introduction

1.1 Background

The world is full of factories that produce and release many types of untreated liquid and solid wastes, which lead to many environmental problems that affect and threaten life on the surface of the earth.

These wastes cause many problems when it is dumped in to the rivers or down streams and in valleys. This condition will make wastes to be mixed with soil and ground water causing direct contamination to the environment. In the Middle East, the amount of wastes is still increasing at an alarming rate due to the lack of waste management techniques as recycling or reuse. Management through recycling will usually add burden on the behalf of the producer of the waste, which will eventually add to the cost of the product.

Some of these wastes are produced from olive trees. More than 750 million olive trees are cultivated worldwide, the greatest number of which being planted in the regions of the Mediterranean (Hytiris 2004). About 3/4 of the global olive oil production come from the European Union, while around 97% of European production comes from Spain, Italy and Greece. The history of olive oil in our country goes back into the centuries and even today, thousands of families are occupied in its production.

1.2 Olive Wastes in Palestine:

In the Palestinian Territories, water is the most precious resource and its relative scarcity and quality is a major constraint on economic development. The random dumping of untreated wastewater into the valleys and watercourses is threatening the groundwater aquifers as the main source of water. The groundwater and surface water pollution by discharging wastewater into the valleys are discussed by several research projects as being among the core problems that should be solved in the Palestinian Territories.

During the past years and as part of the several activities related to the rehabilitation of the infrastructure of the Palestinian Territories, different projects have been implemented aiming at the construction of wastewater treatment plants. The sewerage project Tulkarem-region (DAR, 1999) among other projects has stated that a decisive pre-condition for the achievement of the objectives and protection of the environment is the treatment/pre-treatment of industrial and olive mill wastes. In Palestine many types of wastes are also still dumped in the common regions without any restrictions or limitations due to absence of an environmental law, which leads to resources being exposed to pollution and problems of extinction.

One of these wastes is olive oil waste either solid (Husk or Ash) or liquid (Zebar). This type of waste is available in large quantities in

Palestine due to the high dependency of people on agriculture, especially olive trees planted in many Palestinian cities (districts) and villages.

Palestinian areas are characterized by dense local agricultural and industrial products especially in villages and towns. Since the Palestinian areas and the Middle East, in general, depend on agricultural side on the olive oil products which in-turn generates from these agricultural products. High amount of waste requires relatively high cost in processing for environmental protection. Owners of olive trees will not benefit from these wastes produced from olive oil. This will result in disposing wastes in the common and residential areas which may cause pollution for both human health and the environment. Olive wastes consist of solid wastes (Husk) and olive mill wastewater (Zebar).

The industrialization of agriculture is accompanied by an increase in production of organic wastes. Disposing olive wastes as Husk, oil sludge, and mill wastewater to water drainage networks, causes environmental and healthy problems as pollution, bad odors, spread of diseases to the neighboring regions, etc.

1.3 Problems Produced from Olive Wastes Disposing

The olive mills contribute largely to the core problem of surface and groundwater pollution. The wastewater from the different olive mills located in and around the different villages in the West Bank is being disposed randomly. The Olive Mill Wastewater (OMW) is mixed with flowing untreated municipal wastewater or with rainwater. The high organic polluted wastewater affects the soil, groundwater and watercourses downstream. This occurs mainly during the olive season, generally from early October to late December (Shaheen, 2004).

Wadi Zeimar in Nablus-Tulkarm region is one example, where OMW is discharged to flow with municipal wastewater to the west contributing to the flow of Alexander River, behind the green line (the 1967-cease fire border between Israel and Jordan) towards the Mediterranean. Thus, causing severe environmental problems and causing death to the aquatic life in the river.

The disposal of the untreated OMW into the open areas and/or the water receiving bodies is considered as an urgent ecological problem that deteriorates the environment in the Palestinian Territories. It also delays the construction of wastewater treatment plants. The biological pollution due to the improper disposal of the high organic content OMW into the water bodies destroys the aquatic life and prevents its further development.

One alternative in effective utilization of olive oil wastes (Husk), burned husk (Ash) is the replacement of natural aggregate in concrete mixes or a replacement of light manufactured aggregate to produce foam concrete to be used for non-structural uses. This thesis aims to contribute partially in reducing the environmental problems through utilization of this waste in Portland cement concrete production and at the same time reduce the cost dumping or recycling of this waste material.

1.4 Problem Definition

There is a large amount of wastes produced yearly, but without any utilization (consumption for beneficial purposes), efforts must be employed to find simple and economical methods for utilization as an alternative for disposing these wastes in the traditional ways.

Large amounts of wastes burned in the world either in residential areas or specific locations (dumping sites) creating emissions and pollutants spreading in the atmosphere, causing environmental and health problems for living creatures and human beings. Some of the olive oil wastes are Husk and Ash; this research will contribute to solving this problem by using these materials in Portland Cement Concrete (PCC) mixes to produce lightweight concrete for non-structural uses.

1.5 Goals and Objectives

The objective of this thesis is the utilization of olive oil solid waste (Husk) and Burned Husk (Ash) as a replacement of fine aggregate in (PCC) mixes for non-structural uses. This will provide cleaner environment, reduce spread of insects, germs, and flies which cause many diseases to the public as well as the elimination of the cost for disposing this waste material.

In addition to the above, the research will study the effect of olive husk and burned husk on the physical properties of concrete such as Compressive strength, Workability, Density, Water absorption, Abrasion, Thermal insulation and Noise insulation and some mechanical properties such as Modulus of elasticity, Crushing due to loading by Compressive strength.

1.6 Thesis Structure

In this thesis, the contents of the material will be presented as follows:

- Table of Contents
- List of Tables
- List of Figures
- Acknowledgment
- Abstract
- Chapter One: Introduction, problem statement, goals and objectives, contents of research).

- Chapter Two: Literature Review
- Chapter Three : Methodology
- Chapter Four: Experimental Tests Results
- Chapter Five: Analysis of Results
- Chapter Six: Conclusions and Recommendations
- References
- Appendices

Chapter Two

Literature Review

Chapter Two

Literature Review

2.1 Introduction

Due to the production of large amounts of olive oil in Palestine, and due to the large amounts of olive oil wastes that are not treated properly, spread randomly, and their environmental adverse effects, all of the above can cause bad odors, many diseases, pollution, and cost of disposing. Utilization of these wastes in concrete mixtures will help partially in solving the environmental problem and reducing the negative impacts of these wastes, the effect of using olive oil wastes on the physical characteristics of the PCC will be studied.

This research will investigate a methodology to utilize olive husk and olive ash in the PCC mixes and reduce health and environmental impacts resulted of disposing these wastes in a random way, then study the effect of these wastes on the physical properties of concrete and some of its mechanical properties.

2.2 Characteristics of Olive Wastes and Production Methods:

Olive Mill Wastewater (OMW) generated by the olive oil extraction industry is a great pollutant because of its high organic load and also because of its high content of phytotoxic and antibacterial phenolic substances, which resist biological degradation (Saez et al. 1992). OMW is a major environmental problem in the Mediterranean area. The problems created in managing OMW have been extensively investigated during the last 50 years without finding a solution, which is technically feasible, economically viable, and socially acceptable (Niaounakis and Halvadakis 2004). Up-to-date the emphasis has been on detoxifying OMW prior to disposal to wastewater treatment plants. However, the present trend is towards further utilization of OMW by recovering useful by-products. Therefore a new strategy for olive waste management must be adapted.

The OMW characteristics in terms of both its quantity and quality are highly dependent on the extraction process. Olive oil is extracted mainly according to two methods; traditional (classical pressing) and continuous (centrifuging) methods starting from the pulp of olive fruits obtained by grinding them with stones or knife-edge spinal mills. In the traditional method the ground olives are pressed in bags then the oil is separated from the liquid mixer by resting in a series of tanks or by using a centrifuge. In the continuous method the crushed olive fruits are pumped into a three-phase decanter and then the impure oil is centrifuged. The average values for the typical parameters of OMW samples obtained from nine different classical (traditional) and eight centrifugal mills (continuous) are presented in Table 2.1 (Esra et al. 2001). The BOD_5 values of OMW are typically in the range of 40-200 g/l. The wide concentration range is again mainly due to variations in the extraction process adapted in the olive mill. The traditional methods of extraction, based on press, and the continuous three phase decanting processes generate one stream of olive oil and two streams of wastes, an aqueous waste (OMW) and a wet solid waste (Zebar) (Shaheen 2004).

2.2.1 Physical and Chemical characteristics

Olive Mill Wastewater is described as the liquid waste produced after extraction process of oil. It contains some of chemical items, which have different physical qualities and chemical effects when added to concrete. The chemical constituents of OMW are shown in Table 2.1.

Table 2.1: Physical and chemical characteristics of OMW

Characteristics	Average ± S.D	
	Traditional	Continuous
pH	4.5 ± 0.3	4.8 ± 0.3
Total solids g/l	44.4 ± 13.8	78.2 ± 13.6
Total suspended solids g/l	2.7 ± 1.1	27.6 ± 5.1
Volatile solids g/l	33.6 ± 12.3	62.1 ± 15.8
Volatile suspended solids g/l	2.5 ± 1.1	24.5 ± 5.0
Fixed solids g/l	10.8 ± 3.2	16.1 ± 7.7
Reduction sugar g/l	2.2 ± 1.7	4.7 ± 1.8
Oil-grease g/l	6.3 ± 10.1	12.2 ± 13.3
Polyphenol g/l	2.5 ± 0.7	3.8 ± 1.5
Volatile phenol mg/l	3.0 ± 2.6	3.1 ± 2.1
Nitrogen mg/l	43.7 ± 33.9	78.8 ± 39.6
COD g/l	65.7 ± 27.1	103.4 ± 19.5

Source: Esra et al.2001

2.2.2 Components of olives:

The olive itself consists of pulp (75-85% weight), nut (13-23% weight) and seed (2-3% weight) (Maesrto 1989 and Improlive, 2000). The chemical composition of the olive is shown in Table 2.2 OMW is the characteristic of by-product of olive-oil production. Typically, the weight composition of OMW is 80-96% water, 3.5-15% organics, and 0.5-2% mineral salts (Galili et al. 1996).

Table 2.2: Chemical composition of olives (Improlive, 2000)

Constituents	Pulp	Nut (stone)	Seed
Water	50-60	9.3	30
Oil	15-30	0.7	27.3
Constituents	2-5	3.4	10.2
containing	3-7.5	41	26.6
nitrogen	3-6	38	1.9
Sugar	1-2	4.1	1.5
Cellulose	2-2.25	0.1	0.5-1
Minerals	-	3.4	2.4
Polyphenols			
(aromatic			
substances)			
Others			
Values in percent by weight (%)			

2.2.3 Effects of Olive Products on Environment:

The olive mills contribute largely to the core problem of surface and groundwater pollution. The wastewater from the different olive mills located in and around the different villages in the West Bank is being disposed into the wadies. The Olive Mill Wastewater (OMW) is then mixed with the flowing untreated municipal wastewater or with rainwater.

The high organic polluted wastewater affects the soil, groundwater and water courses downstream. This occurs mainly during the olive season, generally from early October to late December.

The wadi Zeimar in Nablus-Tulkarm region is one example, where OMW is discharged to flow with municipal wastewater to the west contributing to the flow of Alexander River behind the green line (the 1948 cease fire live between Israel and Jordan) towards the Mediterranean. Thus, causing severe environmental problems and causing death to the aquatic life in the river (Shaheen 2004).

The disposal of the untreated OMW into the open wadies and/or the water receiving bodies is considered as an urgent ecological problem that deteriorates the environment in the Palestinian Territories. The biological pollution due to the improper disposal of the high organic content OMW into the water bodies destroys the aquatic life and prevents its further development (Shaheen 2004).

2.3 Utilization of Olive Wastes in Construction, Concrete, Building Materials and Different Admixtures:

Many research studies promote utilization of these wastes. Armesto (2001) investigated the co-combustion of coal and olive industry waste; he made an assessment of the feasibility of co-firing coal and specification biomass waste from the olive oil industry to be used in the combustion process.

2.3.1 Use of OMW as A replacement of Fresh Water in Clay Brick Manufacture:

Olive mill wastewater (OMW) was used to replace fresh water normally used in clay brick manufacture. OMW is recognized as the major agro-food industry pollutant in the Mediterranean/North African olive-growing region. The research involved adding OMW to laboratory-produced clay bricks following the same making procedure used at a collaborating Tunisian brick factory (Mekki 2006).

2.3.2 Investigating the Potential of Using OMW as an Additive for the Development of Construction Materials:

Olive mill wastewater (OMW), a by-product of olive oil processing, is one such waste. It is produced in large quantities in the Mediterranean Region, an area that accounts for 95% of the total olive oil production worldwide. In recent years both physicochemical and biological treatment methods for OMW have been employed. Olive mill sludge (OMS), a by-product of the biological treatment methods, poses a major environmental threat, yet little research has been undertaken in its treatment and recycling. (Hytiris and Kapellakis2004) investigated the potential of using OMS as an additive for the development of construction materials. An attempt was made to solidify (fixate and stabilize) this sludge with cement, mixed with an improver/additive containing a mixture of natural and synthetic zeolites, alkaline elements, and oxides (Kapellakis 2004).

2.3.3 Using Olive Mill Wastewater in PCC:

Hytiris (2004) showed that the potential use of olive sludge continuation is solidification process. This study illustrates the investigation of the potential of using olive mill wastewater as an additive for the development of construction materials. An attempt was made to solidify (fixate and stabilize) this sludge with cement mixed with an improver/additive containing a mixture of natural and synthetic zeolites, alkaline elements, and oxides.

Azbar (2004) made a review of waste management options in olive oil production, this leads to treatment and disposal alternatives of olive oil mill wastes and technical requirements for their management are covered. Waste characteristics, treatment options with regard to the economic feasibility and challenges of existing waste disposal practices in olive growing countries are mentioned.

Shaheen (2004) further investigated treatment of olive-oil industry wastes. In this case the waste products derived from olive oil extraction are an aqueous effluent (vegetation) and a solid residue mainly containing the olive skin and stone (olive husk).

2.3.4 Utilization of OMW (ZEBAR) as an additive to PCC Palestine:

The reuse options have been investigated in the Palestinian Territories. The effect of adding OMW (Zebar) as an admixture on the durability and permeability of concrete and the effect of adding it as water replacement on fresh and hardened concrete have been investigated by Imseeh (1997). Using Zebar taken from an automatic mill has improved the workability of fresh concrete. It has increased the slump by 6% to 400% and the compressive strength at 28 days by 1 to 38% depending on the percentage of water replacement and the contents of concrete mix.

The use of Zebar, along with lime, as an admixture for the stabilization of soils has also been investigated. Test results indicated that the strength characteristics, represented in CBR values, increased considerably. Plasticity was reduced indicating good potential for the use of OMW for stabilization and improvement of road sub-grade characteristics.

2.3.5 Management Options in Olive Oil Production:

Treatment and disposal alternatives of olive oil mill wastes and technical requirements for their management are covered. Waste characteristics, treatment options with regard to the economic feasibility and challenges of existing waste disposal practices in olive growing countries are mentioned (Azbar 2004).

2.4 Using Some of Waste Materials in Concrete and Construction:

2.4.1 Using of Waste Materials in Concrete and as Filler Aggregate:

Waste materials can partly be used, or processed, to produce materials suitable as aggregates or fillers in concrete. These can also be used as clinker raw materials, or processed into cementing systems. New grinding and mixing technology will make the use of these secondary materials simpler. Developments in chemical admixtures: super plasticizers, air entraining agents etc., help in controlling production techniques and in achieving the desired properties in concrete. Use of waste products is not only a partial solution to environmental and ecological problems, it significantly improves the microstructure, and consequently the durability properties of concrete, which are difficult to achieve by the use of pure Portland cement. The aim is not only to make the cements and concrete less expensive, but to provide a blend of tailored properties of waste materials and Portland cements suitable for specified purpose (Shaheen 2004).

2.4.2 The Potential Use of Hay Material as a New Stabilizing Agent for Cohesive Clayey Soils:

The main objective of this work is to study the potential use of hay material as a new stabilizing agent for cohesive clayey soils. For this purpose, three types of clayey soils were mixed with hay material at 2%, 4%, 6%, 8% and 10% percents by dry weight of the soil. The natural physical properties of the soils such as Atterberg Limits, unconfined compressive strength, California bearing ratio, and shear strength parameters were evaluated before and after hay treatment. The experimental results indicated that the increase in the amount of the hay material decreases maximum dry density and increases both the optimum water content and plasticity index of the soil. Additionally, increasing the hay material increases the unconfined compressive strength up to certain percentages of hay content and then the unconfined compressive strength decreases. The cohesion of the clayey soils was increased by increasing the hay percent up to 4%. The California Bearing Ratio for three soils was increased with the increase of hay content up to 6% percent. Further increase in the hay content more than the 4% and 6% will decrease both the cohesion and the California bearing ratio, respectively (Attom 2005).

2.4.3 Use of Bottom Ashes (Wastes in Lower Layers) as a Construction Material:

Four samples of bottom ashes used as an aggregate in lightweight concrete masonry units, as a raw feed material for Portland cement, as an aggregate in cold mix emulsified asphalt mixes, base or sub-base courses, or in shoulder construction. Systematic study of the unburned lignite of bottom ashes is needed for possible re-combustion (Kantiranis 2004).

2.5 Using Fly Ashes , Glass Wastes, Olive Wastes in Cement and Concrete:

2.5.1 Uses in Bricks for Thermal Insulation:

Cost-effective thermal insulating bricks were produced from treated fly ash pastes. The pastes were prepared by mixing dried fly ash ground to particles smaller than 63 μm (derived from a pressurized fluidized-bed combustor, PFBC) with water at different water to solid weight ratios in a 170rpm agitated vessel for 5 min. The paste was cast into a rectangular mold before being placed in a humidity-controlled chamber for curing. The curing conditions were kept at 80°C and 80% relative humidity for 3 days. The effect of the addition of 10, 20, and 30 % by weight of car-window glass fragments to the paste was also investigated. Measurements of the density, thermal conductivity and mechanical properties of the resulting brick were used for the evaluation of its suitability as a thermal insulator. The insulators prepared from water to solid weight ratio (W/S) of 0.5 showed good specifications in terms of low density and thermal conductivity, and high mechanical strengths. The addition of 10% by weight of glass to the ash during slurring enhanced the mechanical properties of the insulating material produced but had no significant effect on its density and thermal conductivity (Trifilio and Calabria’s 2003).

2.5.2 Using of Fly Ash and Olive Wastes in Cement and Concrete Works:

(Taylor and Francis 1987) studied the possibility of using fly ash in cement and concrete works. Investigators such as Gidley (1984) proposed several methods for utilizing some industrial wastes in engineering construction. Hytiris (2004) studied the use of sludge ash in Portland cement concrete works. Other studies examined the possibility of improving soil properties such as increasing shear strength, reducing settlement, and minimizing swelling problems by using solid waste. (Esra et al. 2001) combine industrial waste with lime to stabilize soil. (Mughieda and Al-Widyan 1998) evaluated burned olive waste for use as soil stabilizer, which is considered a partial solution to the problems associated with the increase of olive waste in Jordan.

2.6 Using Industrial Residues to Produce Light Weight Masonry Blocks:

The concretes designs were mainly related to comply with the ASTM requirements about compressive strength, density, and water absorption. Normal curing was used for a polystyrene added concrete (PAC) and high pressure steam curing for a cellular concrete (ACC) prepared by incorporation of wasted aluminum chips and FAC. The best result achieved was 5.0 MPa (709 psi) reported by the PAC when the apparent density was

1450 kg/m^3. The ACC specimens showed a maximum strength of 2.6 MPa (362psi). The water absorption ranged from 1.9 to 30.6 %. The results of this study indicated that tried industrial waste remaining could be suitable to produce lightweight masonry blocks for non-load bearing applications with weather protective coatings (Niaounakis and Halavadakis 2004).

2.7 The Effect of Rice Husk Ash on Compressive Strength for Sandcrete Blocks:

The compressive strength of some commercial sandcrete blocks in Minna, Nigeria was investigated. Rice Husk Ash (RHA) was prepared using Charcoal from burning firewood. Preliminary analysis of the constituent materials of the Ordinary Portland Cement (OPC) / Rice Husk Ash (RHA) hollow sandcrete blocks were conducted to confirm their suitability for block making. Physical test of the freshly prepared mix was also carried out. 150mm×450mm hollow sandcrete blocks were cast cured and crushed for 1, 3, 7, 14, 21, and 28 days at 0, 10, 20, 30, 40 and 50 percent replacement levels. Test results indicate that most commercial sandcrete blocks in Minna town are below standard. The compressive strength of the OPC/RHA sandcrete blocks increases with age at curing and decreases as the percentage of RHA content increases. The study arrived at an optimum replacement level of 20%(Oyetola andAbdullah 1983).

2.7.1 Chemical stabilization of soils using rice husk ash and cement:

The chemical stabilization of soils was studied by using cement and rice husk ash. Three types of soils, residual soils, kaolinite, and bentonite were used in the study. The experimental study included the evaluation of the main index properties of the soil and compaction, along with a characterization of the materials through X-Ray diffraction. Test results show that both cement and rice husk ash reduces the plasticity of soils. In term of compact ability, addition of rice husk ash and cement decreases the maximum dry density and increases the optimum moisture content. From the viewpoint of plasticity, compaction characteristics, and economy, addition of 6 to 8 percent cement and 10 to 15 percent rice husk ash are recommended as an optimum amount (Basha and Hashim 2003).

2.8 Comparison between Previous Researches and This Research:

The previous researches studied the effect of adding different wastes on to the physical properties of concrete mix as a replacement of either aggregate, cement, fine aggregate with different proportions. Nevertheless the previous researches studied the effect of that wastes on limited properties of concrete such as compressive strength, density, water absorption, but they didn't study the effect of wastes on (noise and thermal) insulation, not only that but they also didn't talk about long term effect . In this research physical properties of concrete were investigated basically (compressive strength, density, water absorption, abrasion, thermal and noise insulation), also mechanical properties such as (modulus of elasticity, crushing in compressive strength).

2.9 Summary:

In this chapter, characteristics of olive wastes and production methods were described. Also physical and chemical properties for concrete due to addition olive mill wastewater (OMW) were studied. Components of olives were mentioned. The previous researchers talked about olive wastes production on the environment, next utilization of olive wastes in concrete, construction, building materials. Some researchers studied the effect of different wastes especially the ashes of materials on the physical properties of concrete, such use of rice husk, glass and fly ashes. Some of researchers study the effect of different wastes on the physical properties of concrete by adding these wastes to concrete mixes as a replacement of water, sand, aggregate and cement.

CHAPTER THREE

Methodology

CHAPTER THREE

Methodolog

3.1 Introduction

This thesis aims at utilizing olive oil wastes (Husk & Ash) as a constituent in Portland cement concrete mixes and its products as a partial replacement of natural and artificial aggregate components.

3.2 Work Procedure

The following represents the methodology by which the study on the effect of utilizing husk and ash in Portland cement concrete mixes were done.

3.2.1 Materials

The materials used in this thesis were obtained from Mawasi concrete plant in Nablus city (Nablus industrial area near Beit-Eiba village). The original source of crushed coarse aggregate are Abu Shusheh Crusher Corporation and Daymoona (Naqap desert area) for fine aggregate (sand), and olive oil wastes (husk and ash) were obtained from KANA'AN factory in Nablus city (Alhesba Street). Though, a large amount of olive wastes exists in the West Bank area, no industries yet exist for the availability of these wastes.

The basic ingredients of Portland Cement Concrete (PCC) and its products, used in this research work, are:

1- Normal Portland cement (Cement type 1).

2- Natural Coarse aggregate (sedimentary rock source).

3- Natural Fine aggregate (sand).

4- Water (fresh drinkable water).

5- Olive husk and ash.

3.2.2 Raw Material Tests

The raw materials used in this research work were tested for the purpose of identification of basic physical characteristics using the following tests:

- Sieve analysis. (AASHTO T-27)/ (ASTM)
- Specific gravity and water absorption. (ASTM C-127)
- Abrasion (Lose Angles abrasion test). (ASTM C-88)
- Amount of fines and injurious particles (Sand equivalent) (ASTM D-2419).

Tests results of the raw materials used will be presented in the following chapter of this thesis.

3.2.3 Plain Portland Cement Concrete Mixes:

Standard Portland cement concrete mixes without olive wastes was made with different grades and different water cement ratios. These mixes are used as a reference standard comparison mixes. Such mixes reflect the common design mixes used by the ready mix plants.

Table 3.1 shows the proportions of the raw materials used for each grade for one cubic meter of Portland cement concrete. Table 3.2 shows the mix ingredients for a patch of 0.01 cubic meters.

Table (3.1): Concrete mix design by weight of mix ingredients (kg/m^3 of PCC)

Concrete Grade	PCC-150	PCC-200	PCC-250	PCC-300	PCC-450
Coarse aggregate (size1)	650	650	590	590	590
Coarse aggregate (size2)	220	220	220	220	220
Coarse aggregate size3)	425	425	440	440	440
Sand	500	520	580	580	590
Cement	200	220	260	290	470
Water	180-200	180-200	180-200	180-200	180-200

Source: Mawasi Palestine Company for concrete (2006)

Table (3.2): Mix ingredients (kg/0.01m^3 of PCC)

Concrete Grade	PCC-150	PCC-200	PCC-250	PCC-300	PCC-450
Coarse aggregate	12.95	12.95	12.50	12.50	12.50
Fine aggregate Sand	5.0	5.2	5.8	5.8	5.5
Cement	2.0	2.2	2.6	2.9	4.7
Water	1.9	1.95	1.9	1.8	2.0
W/C	0.95	0.89	0.73	0.62	0.43

3.2.4 Olive (Husk and Ash) Portland Cement Concrete Mixes:

Portland cement concrete mixes utilizing Olive (husk and ash) by volumetric replacement of sand with different proportions of replacements, basically 25, 50, 75, and 100% replacements was made. Tables 3.3 through 3.12, shows the replacement of fine aggregate (sand) in different proportions by the olive husk and ash volumetric.

By dividing the weight of sand to be replaced by olive husk or ash by its specific gravity, the volume of sand was obtained; this volume is to be replaced by volume of olive husk or ash wastes converted to weight using the following physical characteristics:

- Dry Rodded Weight of Sand = 1.431 g/cm3
- Specific Gravity of Sand = 2.644 g/cm3
- Specific Gravity of olive husk = 1.18 g/cm3
- Specific Gravity of olive ash = 0.83 g/cm3

Table (3.3): Values of Replacement Husk with fine aggregate (PCC-150)

Replaced ratio %	Concrete type	Aggregate Kg/0.01m^3	sand Kg/0.01m^3	Husk gm/0.01m^3	Cement Kg/0.01m^3
0	PCC-150	12.95	5.00	0.00	2.00
25	PCC-150	12.95	3.75	558.7	2.00
50	PCC-150	12.95	2.50	1117.4	2.00
75	PCC-150	12.95	1.25	1676.1	2.00
100	PCC-150	12.95	0.00	2234.85	2.00

Table (3.4): Values of Replacement Husk with fine aggregate (PCC-200)

Replaced ratio %	Concrete type	Aggregate Kg/0.01m^3	sand Kg/0.01m^3	Husk gm/0.01m^3	Cement Kg/0.01m^3
0	PCC-200	12.95	5.20	0.00	2.20
25	PCC-200	12.95	3.90	581	2.20
50	PCC-200	12.95	2.60	1162.1	2.20
75	PCC-200	12.95	1.30	1743.2	2.20
100	PCC-200	12.95	0.00	2324.2	2.20

Table (3.5): Values of Replacement Husk with fine aggregate (PCC-250)

Replaced ratio %	Concrete type	Aggregate $Kg/0.01m^3$	sand $Kg/0.01m^3$	Husk $gm/0.01m^3$	Cement $Kg/0.01m^3$
0	PCC-250	12.50	5.80	0.00	2.60
25	PCC-250	12.50	4.35	648.1	2.60
50	PCC-250	12.50	2.90	1296.2	2.60
75	PCC-250	12.50	1.45	1944.3	2.60
100	PCC-250	12.50	0.00	2592.4	2.60

Table (3.6): Values of Replacement Husk with fine aggregate (PCC-300)

Replaced ratio %	Concrete type	Aggregate $Kg/0.01m^3$	sand $Kg/0.01m^3$	Husk $gm/0.01m^3$	Cement $Kg/0.01m^3$
0	PCC-300	12.50	5.80	0.00	2.90
25	PCC-300	12.50	4.35	648.1	2.90
50	PCC-300	12.50	2.90	1296.2	2.90
75	PCC-300	12.50	1.45	1944.3	2.90
100	PCC-300	12.50	0.00	2592.4	2.90

Table (3.7): Values of Replacement Husk with fine aggregate (PCC-450)

Replaced ratio %	Concrete type	Aggregate $Kg/0.01m^3$	sand $Kg/0.01m^3$	Husk $gm/0.01m^3$	Cement $Kg/0.01m^3$
0	PCC-450	12.50	5.80	0.00	4.00
25	PCC-450	12.50	4.72	706.2	4.00
50	PCC-450	12.50	3.15	1408	4.00
75	PCC-450	12.50	1.58	2109.7	4.00
100	PCC-450	12.50	0.00	2815.9	4.00

Tables (3.8): Values of Replacement Ash with fine aggregate (PCC-150)

Replaced Ash ratio %	Concrete type	Aggregate $Kg/0.01m^3$	sand $Kg/0.01m^3$	Ash $gm/0.01m^3$	Cement $Kg/0.01m^3$
0	PCC-150	12.95	5.00	0.00	2.00
25	PCC-150	12.95	3.75	393	2.00
50	PCC-150	12.95	2.50	986	2.00
75	PCC-150	12.95	1.25	1179	2.00
100	PCC-150	12.95	0.00	1572	2.00

Tables (3.9): Values of Replacement Ash with fine aggregate (PCC-200)

Replaced Ash ratio %	Concrete type	Aggregate Kg/0.01m^3	sand Kg/0.01m^3	Ash gm/0.01m^3	Cement Kg/0.01m^3
0	PCC-200	12.95	5.20	0.00	2.20
25	PCC-200	12.95	3.90	408.7	2.20
50	PCC-200	12.95	2.60	817.4	2.20
75	PCC-200	12.95	1.30	1222	2.20
100	PCC-200	12.95	0.00	1634.9	2.20

Tables (3.10): Values of Replacement Ash with fine aggregate (PCC-250)

Replaced Ash ratio %	Concrete type	Aggregate Kg/0.01m^3	sand Kg/0.01m^3	Ash gm/0.01m^3	Cement Kg/0.01m^3
0	PCC-250	12.50	5.80	0.00	2.60
25	PCC-250	12.50	4.35	455.9	2.60
50	PCC-250	12.50	2.90	911.7	2.60
75	PCC-250	12.50	1.45	1367.6	2.60
100	PCC-250	12.50	0.00	1823.5	2.60

Tables (3.11): Values of Replacement Ash with fine aggregate (PCC-300)

Replaced Ash ratio %	Concrete type	Aggregate Kg/0.01m^3	sand Kg/0.01m^3	Ash gm/0.01m^3	Cement Kg/0.01m^3
0	PCC-300	12.50	5.80	0.00	2.90
25	PCC-300	12.50	4.35	455.9	2.90
50	PCC-300	12.50	2.90	911.7	2.90
75	PCC-300	12.50	1.45	1367.6	2.90
100	PCC-300	12.50	0.00	1823.5	2.90

Tables (3.12): Values of Replacement Ash with fine aggregate(PCC-450)

Replaced Ash ratio %	Concrete type	Aggregate Kg/0.01m^3	sand Kg/0.01m^3	Ash gm/0.01m^3	Cement Kg/0.01m^3
0	PCC-450	12.50	5.80	0.00	4.00
25	PCC-450	12.50	4.72	496.7	4.00
50	PCC-450	12.50	3.15	990.3	4.00
75	PCC-450	12.50	1.58	1483.9	4.00
100	PCC-450	12.50	0.00	1980.7	4.00

3.3 Tests on PCC

Slump test was made on fresh concrete to measure the effect of change in ingredients on workability according to the addition of olive husk and ash.

The following tests on hardened concrete were made using four specimens (cubes) from every proportion were made:

- Compressive Strength (PS-55).
- Water absorption (ASTM C-642).
- Abrasion (ASTM C-944).
- Modulus of Elasticity (ASTM C-469).
- Weight before replacement and weight after replacement.

3.4 Thermal and sound insulation testing

For sound and thermal insulation, a concrete wood mold having a dimension of 15x15x5cm was made; three specimens of each proportion were made as shown in Figure (3.1) with 0.0%, 25%, 50%, 75% and 100% olive husk and ash with properties same as that of concrete cubes mixes using.

A wooden box was made in a way that the heat will be directly transferred from one chamber having constant temperature exposed on one of the faces of the specimen for a period of time through the specimen to another chamber. The temperature was measured until the temperature became constant in the two faces of concrete specimen using a laser thermometer. Figures (3.2), shows a schematic diagram of the mechanism of the thermal testing.

The same procedure was made for testing the sound insulation using a constant noise source and a noise measuring device. A figure (3.2) shows a schematic diagram of the mechanism of the noise testing.

Figure (3.1): A concrete wood mold having a dimension of 15x15x5cm was made to produce concrete samples for (abrasion, absorption, noise and thermal insulation tests).

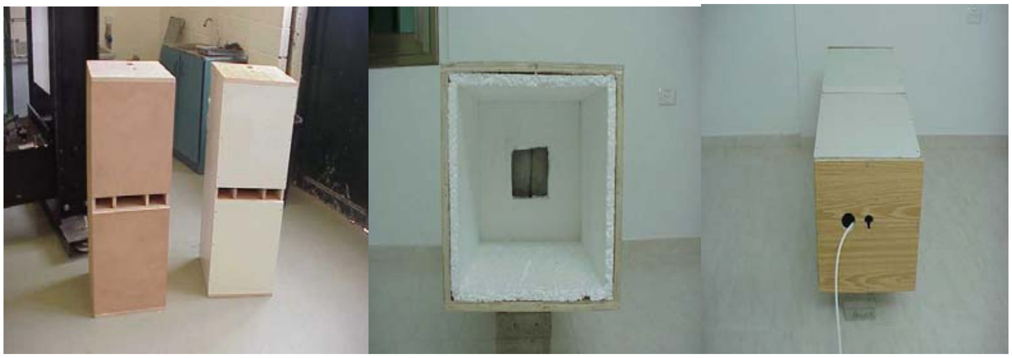


Figure (3.2): A schematic diagram of the mechanism of the thermal and noise testing.

CHAPTER FOUR

Experimental Tests Results

CHAPTER FOUR

Experimental Tests Results

4.1 Introduction

This chapter presents a summary of the results obtained from laboratory tests that have been done on the samples. Tests were done on materials (fine and coarse aggregates), fresh and hardened concrete.

4.2 Materials Testing Results

Figure 4.1 gives the grain size distribution of aggregates used in the mixes relative to specification limits. Table 4.1 summarizes the tests results of the properties of materials used in this thesis. Note that these materials are used locally in West Bank by concrete plants.

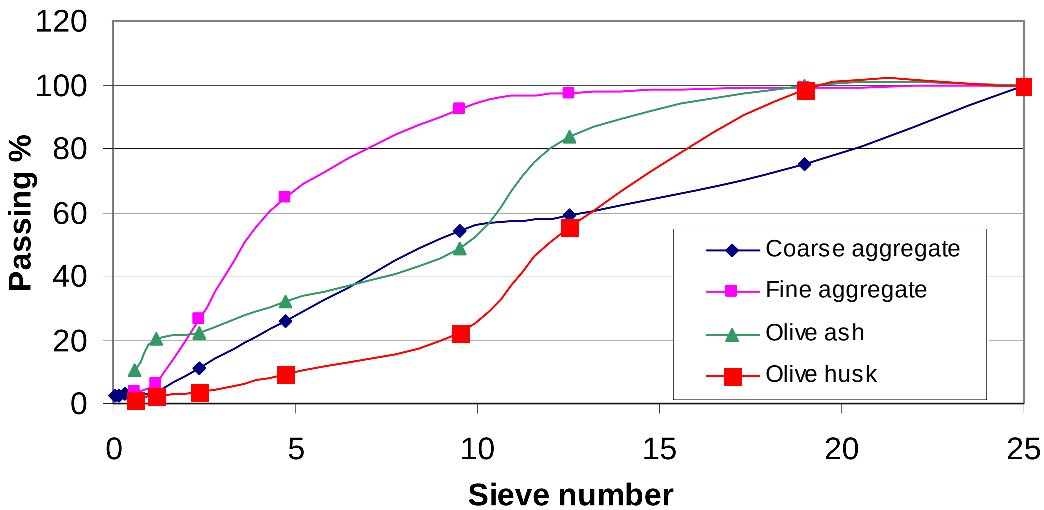


Figure 4.1: Particle size distribution

Figure 4.1 shows the particle size distribution for the components of the concrete mix which are (Coarse aggregate, fine aggregate, olive husk and olive ash), it is clear that coarse aggregate curve has the lowest slope; this means that it has the largest particle size, while fine aggregate curve perform the soft slope that has less inclined which leads to that all particle size of the curve are fine and passing of number 8 sieve. Similarly olive husk, all particles passed of sieve# 8, which means that the curve likes fine aggregate curve due to the high ratio of fine particles contained. Relatively to the olive ash curve it is nearly approaches of olive husk curve due to the high similarity in the particle size.

Table (4.1): Materials tests results

RESULTS OF AGGREGATE TESTING												
1- Gradation (AASHTO T-27)												
Sieve No.		**1"**	**3/4"**	**1/2"**	**3/8"**	**# 4**	**# 8**	**# 16**	**# 30**	**# 50**	**# 100**	**# 200**
Coarse aggregate	**Passing%**	100	75	59	54	26	11	3.9	3.3	2.8	2.5	2.4
Fine aggregate		-	-	100	100	99.0	97.0	92.2	64.6	26.3	6.1	3.9
Olive husk		-	-	100	100	98.2	55.17	22.4	9.1	3.6	2.2	1.4
Olive ash		-	-	100	99.59	99.56	83.8	48.9	32.2	22.28	20.2	10.48

No.	**Type of test**	**Standard**	**Unit**	**Result**			
				Coarse aggregate	**Fine aggregate**	**Olive husk**	**Olive ash**
2.	Bulk specific gravity	ASTM C-127	-	2.560	2.521	1.212	1.056
3.	Specific Gravity (Saturated surface Dry – SSD)		-	2.621	2.640	1.313	1.067
4.	Specific Gravity (Apparent)		-	2.716	2.734	1.424	1.088
5.	Water absorption		%	1.02	0.5	-	-
6.	Los Angeles abrasion	ASTM C-88	%	30.1	-	-	-
7.	Sand equivalent	ASTM D-2419	-	-	66.0	-	-
8.	Clay lumps and friable particles	ASTM-C142	%	1.1	-	-	-

4.3 Concrete Compressive Strength and Slump Tests Results

Tables 4.2 & 4.3 summarize concrete compressive strength and slump tests results for different types of concrete with and without replacement of sand.

4.3.1 Values of Compressive Strength for Concrete Containing Olive Husk.

Due to the nature of olive husk, which behaves as an excessive retarder to the concrete hardening, the compressive strength for concrete specimen didn't overcome more than 25% of the specified compressive strength, as shown in Table 4.2 .

4.3.2 Compressive Strength for Concrete Containing Burned Olive Husk (Ash).

In this section, values of compressive strength for concrete contains olive ash were higher than that of concrete contains olive husk, due to the high carbon content in olive ash which fastens concrete hardening and increases brittleness quality. So concrete samples have the highest compressive strength between 25% and 75% percent replacements, due to high cohesion between particles of concrete specimen in this range of replacements, see Table 4.3 for more data.

Table (4.2): Concrete compressive strength test results for concrete containing olive husk

Concrete Grade	Percent replacement of olive husk (%)	Average compressive strength at 28 days (kg/cm^2)	Slump (mm)
PCC-150	0.0	159.1	23.0
	25	32.0	25.0
	50	4.00	24.0
	75	2.60	26.0
	100	1.60	24.0
PCC-200	0.0	178.2	26.0
	25	51.5	25.0
	50	37.5	26.0
	75	14.2	27.0
	100	5.70	28.0
PCC-250	0.0	290.1	25.0
	25	62.0	30.0
	50	43.2	27.0
	75	13.1	27.0
	100	6.90	27.0
PCC-300	0.0	313.5	29.0
	25	73.3	30.0
	50	53.7	26.0
	75	36.0	28.0
	100	21.0	29.0
PCC-450	0.0	472.6	25.0
	25	108.8	28.0
	50	75.0	26.0
	75	47.4	26.0
	100	29.7	25.0

Table (4.3): Concrete compressive strength test results for concrete containing olive ash

Concrete Grade	Percent replacement Of olive ash (%)	Average compressive strength at 28 days (kg/cm^2)	Slump (mm)
PCC-150	0.0	159.1	23.0
	25	131	25.0
	50	137	27.0
	75	120	27.0
	100	89	29.0
PCC-200	0.0	178.2	22.0
	25	163.3	24.0
	50	133.8	26.0
	75	130.3	26.0
	100	106.8	28.0
PCC-250	0.0	290.1	24.0
	25	161	24.0
	50	176	27.0
	75	155	27.0
	100	95.3	28.0
PCC-300	0.0	313.5	29.0
	25	245	30.0
	50	211	26.0
	75	118	28.0
	100	123.3	29.0
PCC-450	0.0	472.6	23.0
	25	304.3	25.0
	50	304.8	26.0
	75	317.8	27.0
	100	232.8	29.0

4.4 Water Absorption Test Results

Tables 4.4 and 4.5 summarize concrete water absorption test results for different types of concrete with and without replacement by sand.

4.4.1 Percentage Absorption for Concrete Containing Olive Husk

In this section, values of absorption for concrete samples were between (4.0-6.0) percent due to the high content of moisture in burned husk which reduce void's absorption to the water; this will be clearer in Table 4.4:

Table (4.4): Concrete water absorption test results for concrete containing olive husk

Concrete grade -	Percent replacement by olive husk (%)	Saturated surface dry weight (gm)	Oven dry weight(gm)	Water absorption (%)
PCC-150	0.0	2555.0	2414.4	**5.8**
	25.0	2034	1918	6.0
	50.0	1940	1865	5.9
	75.0	1820	1734	5.0
	100	1705	1627	4.8
PCC-200	0.0	2664.0	2519.4	**5.7**
	25.0	1999	1902	5.1
	50.0	1944	1862	4.4
	75.0	1892	1805	4.8
	100	1816	1732	4.8
PCC-250	0.0	2534.0	2392.0	**5.9**
	25.0	1911	1802	6.0
	50.0	1877	1795	4.6
	75.0	1822	1738	4.8
	100.0	1768	1687	4.8
PCC-300	0.0	2484.0	2347.2	**5.8**
	25.0	1859	1778	4.6
	50.0	1823	1745	4.5
	75.0	1798	1717	4.7
	100.0	1712	1639	4.5
PCC-450	0.0	2629.0	2485.1	**5.8**
	25.0	2023	1932	4.7
	50.0	1988	1902	4.5
	75.0	1899	1811	4.9
	100.0	1786	1697	5.2

4.4.2 Percentage Absorption for Concrete Containing Olive Ash

In this section abrasion test was applied on ash samples, Table 4.5 shows values of percentage water absorption which ranges from (6.0 to 15.0) %, these values reflecting high moisture content in the olive husk.

Table (4.5): Concrete water absorption test results for concrete containing olive ash

Concrete grade -	Percent replacement by olive ash (%)	Saturated surface dry weight (gm)	Oven dry weight (gm)	Water absorption (%)
PCC-150	0.0	2555.0	2414.4	**5.8**
	25.0	2108	1914	7.8
	50.0	2073	1897	9.2
	75.0	1955	1776	10
	100	1848	1722	7.3
PCC-200	0.0	2664.0	2519.4	**5.7**
	25.0	2184	1997	9.4
	50.0	2051	1868	9.8
	75.0	1880	1732	8.5
	100	1732	1606	7.8
PCC-250	0.0	2534.0	2392.0	**5.9**
	25.0	2214	2082	6.3
	50.0	2150	2016	6.6
	75.0	1892	1750	8.1
	100.0	1680	1540	9.10
PCC-300	0.0	2484.0	2347.2	**5.8**
	25.0	2114	1988	6.3
	50.0	2010	1860	8.0
	75.0	1881	1728	8.8
	100.0	1762	1601	10.0
PCC-450	0.0	2629.0	2485.1	**5.8**
	25.0	2210	2064	7.1
	50.0	2115	1961	7.8
	75.0	2095	1935	8.3
	100.0	1980	1827	8.4

4.5 Abrasion Test Results

4.5.1 Abrasion Test for Concrete Containing Olive Ash and Olive Husk

Tables 4.6 and 4.7 summarize Abrasion test results. Abrasion test was made on 28 days for all samples, the weight was taken and abrasion was done for four minutes, the difference in weight divided by two perform the actual loss in weight which represent abrasion magnitude for the tested sample.

Values of average loss were ranged from (2.6 to 10.3) for olive husk and (5.25 to 14.15) for olive ash. The cause for the difference in the values range due to the high moisture content in the olive husk which retards concrete hardening which leads to weak cohesion between particles of the concrete sample, then the magnitude of loss will be more due to large voids that is included in the loaded concrete sample.

On the contrary for the burned husk (ash) contains high quantity of carbon which increase concrete hardening in a short period so the sample will endure compressive strength more than olive husk, which means that abrasion will be less than olive husk due to the high resistance when abrasion machine is doing. Table 4.6 and 4.7 show the average losses in both cases.

Table (4.7): Concrete Abrasion Test Results for Concrete Containing Olive Ash

Concrete Grade	Percent replacement of olive ash (%)	Average loss (gm)
PCC-150	0.0	**3.0**
	25	9.5
	50	11.5
	75	12.8
	100	14.15
PCC-200	0.0	**2.6**
	25	9.4
	50	9.6
	75	10.2
	100	12.6
PCC-250	0.0	**2.5**
	25	6.2
	50	6.55
	75	6.05
	100	12.55
PCC-300	0.0	**2.4**
	25	8.2
	50	12.8
	75	11.7
	100	13.5
PCC-450	0.0	**2.2**
	25	8.75
	50	7.55
	75	10.8
	100	9.45

Table (4.6): Concrete Abrasion Test Results for Concrete Containing Olive Husk.

Concrete Grade	Percent replacement of olive husk (%)	Average loss (gm)
PCC-150	0.0	**2.6**
	25	14.55
	50	16.05
	75	18.8
	100	20.8
PCC-200	0.0	**2.5**
	25	11.1
	50	11.95
	75	13.25
	100	13.6
PCC-250	0.0	**2.0**
	25	18.3
	50	21.5
	75	22.05
	100	22.95
PCC-300	0.0	**2.2**
	25	10.05
	50	11.95
	75	13.05
	100	20.05
PCC-450	0.0	**2.3**
	25	14.55
	50	16.05
	75	18.8
	100	20.8

4.6 Noise Insulation Test Results

4.6.1 Noise Insulation Test Results for Concrete Containing Olive Husk

The sound reduction for any material depends on the voids composed between the particles of the specimen. For concrete containing olive husk , as percent replacement of olive husk increases, sound reduction increases, as shown in table 4.8.

Table (4.8): Noise insulation for concrete containing olive husk

Concrete grade	PCC150	PCC200	PCC250	PCC300	PCC450	Replacement %
Reduction %	14.7	14.6	14.5	14.2	13.9	**0**
	15.3	15.1	15	14.7	14.1	**25**
	15.9	15.6	15.4	15.1	14.7	**50**
	16.2	16	15.9	15.7	15.2	**75**
	16.8	16.6	16.3	16.1	15.8	**100**

4.6.2 Noise Insulation Test Results for Concrete Containing Olive Ash

Table 4.9 shows percentage noise insulation values (reduction %) for concrete containing olive Ash.

Table (4.9): Thermal insulation for concrete containing olive ash

Concrete grade	PCC150	PCC200	PCC250	PCC300	PCC450	Replacement %
Reduction %	14.8	14.8	14.6	14.2	14.1	**0**
	16.7	16.6	16.3	15.8	15.8	**25**
	16.9	16.7	16.5	15.9	16	**50**
	17.1	16.8	16.6	16	16.2	**75**
	17.6	17.1	16.9	16.4	16.6	**100**

4.7 Thermal Insulation Test Results

4.7.1 Thermal Insulation Test Results for Concrete Containing Olive Husk

The values of thermal insulation for concrete containing olive husk is shown in table 4.10:

Table (4.10): Thermal insulation (reduction %) for concrete containing olive husk

Concrete grade	PCC150	PCC200	PCC250	PCC300	PCC450	Replacement %
Reduction %	32.2	33.1	33.3	32.8	33.4	**0**
	32.6	33.5	33.7	33.5	33.8	**25**
	33	33.8	34	33.9	34.2	**50**
	33.4	34.2	34.3	34.3	34.7	**75**
	33.9	34.6	34.6	34.9	35.4	**100**

4.7.2 Thermal Insulation Test Results for Concrete Containing Olive Ash

Values of thermal insulation (reduction %) is shown in table 4.11:

Table (4.11): Thermal insulation (reduction %) for concrete containing olive ash

Concrete grade	PCC150	PCC200	PCC250	PCC300	PCC450	Replacement %
Reduction %	32.2	33.1	34.2	35.8	36.2	**0**
	32.1	32.7	33.3	33.9	34.7	**25**
	30.5	31.2	32.8	33.9	33.8	**50**
	32.1	32.6	33.2	35.7	34.9	**75**
	33.9	34.1	34.6	35.7	35.4	**100**

4.8 Modulus of Elasticity Test Results

4.8.1 Modulus of Elasticity Values for Concrete Containing Olive Husk

Modulus of elasticity values are shown in table 4.12, which illustrates modulus of elasticity for concrete grade PCC250.

Table (4.12): Modulus of elasticity for PCC250 with percent replacements of olive husk

Concrete grade PCC250		**Replacement %**
Modulus of elasticity KN/mm	43	0
	6	25
	3	50
	1.6	75
	1.5	100

4.8.2 Modulus of Elasticity Values for Concrete Containing Olive Ash

Modulus of elasticity for concrete grade PCC250 with various replacements of olive ash is shown in table 4.13:

Table (4.13): Modulus of elasticity for PCC250 with percent replacements of olive ash

Concrete grade PCC250		**Replacement %**
Modulus of elasticity KN/mm	43	0
	7	25
	9	50
	26	75
	20	100

4.9 Density Test Results

4.9.1 Values of Density for concrete specimens containing olive husk for various concrete categories

Values of density for concrete containing olive husk are shown in table 4.14:

Table (4.14): Density values for various concrete categories for different replacement of olive husk

Concrete grade	PCC150	PCC200	PCC250	PCC300	PCC450	Replacement %
Density Kg/m^3	2336	2378	2406	2395	2430	0
	2090	2065	2063	2048	2044	25
	2021	1979	1877	1929	1869	50
	1721	1749	1705	1809	1780	75
	1554	1604	1610	1686	1681	100

4.9.2 Values of Density for concrete specimens containing olive husk for various concrete categories

Values of density for concrete containing olive husk are shown in table 4.14:

Table (4.15): Density values for various concrete categories for different replacement of olive ash

Concrete grade	PCC150	PCC200	PCC250	PCC300	PCC450	Replacement %
Density Kg/m^3	2336	2378	2406	2395	2430	0
	2165	2169	2160	2170	2213	25
	2126	2084	2086	2095	2142	50
	1997	1944	1875	1938	2085	75
	1803	1796	1769	1791	1953	100

CHAPTER FIVE

Analysis of Results

CHAPTER FIVE

Analysis of Results

5.1 Introduction

This chapter aims at analyzing the tests results to show how concrete behavior will change as a result of the volumetric replacement of sand with olive husk and olive ash when compared to standard mixes of PCC containing no olive husk or ash.

5.2 Compressive Strength

5.2.1 Effect of Using Olive husk on Compressive Strength.

The relationship between compressive strength and percent replacement for any additive depends on the qualities and specification of material, when olive husk or burned olive husk is added to the concrete mix with different replacement.

Figure 5.1 shows compressive strength for concrete grade B-150 versus percent replacement by olive oil husk, it is clear the decrease in compressive strength as percent replacement of olive husk increases. In Figure 5.2 for concrete grade of B-200, the compressive strength for percent replacement by olive husk is 178.2, 51.5, 37.5, 14.2, 5.7 kg/cm^2 for replacement values of 0, 25, 50, 75, and 100% respectively. The percentage drop reflecting those percentages is 71.1, 78.9, 92, and 96.8% respectively. Comparing between the concrete grades of B-150 and B-200, it can be noticed that differences are 8.9, 18.1, 6.3, and 2.2% for 25, 50, 75, and 100% replacements respectively. The compressive strength decrease as percentage replacement increase due to existence of oil on the external surface for particles of olive husk, that leads to separation between concrete and particles of olive husk, which weaken the bonds in the concrete.

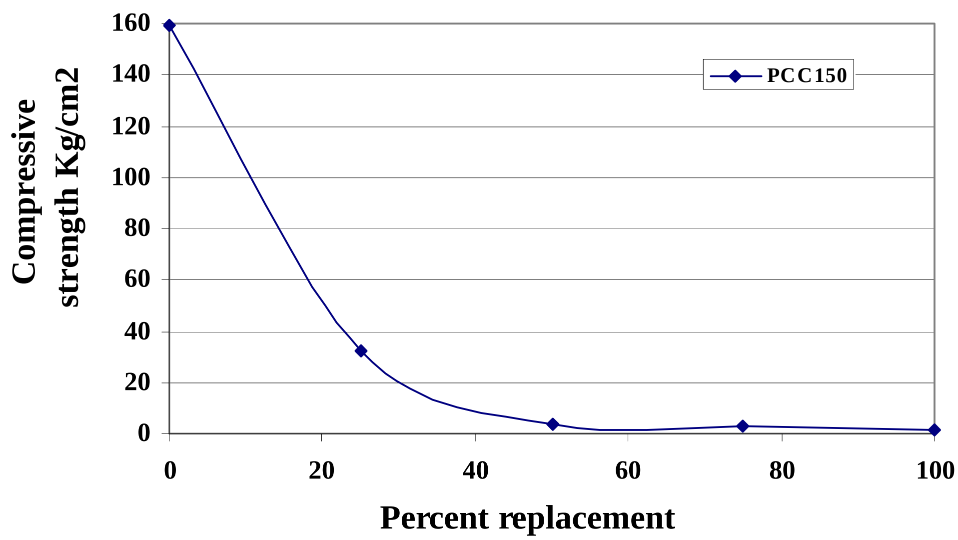


Figure 5.1: Percent replacement by olive husk versus compressive strength for various PCC 150

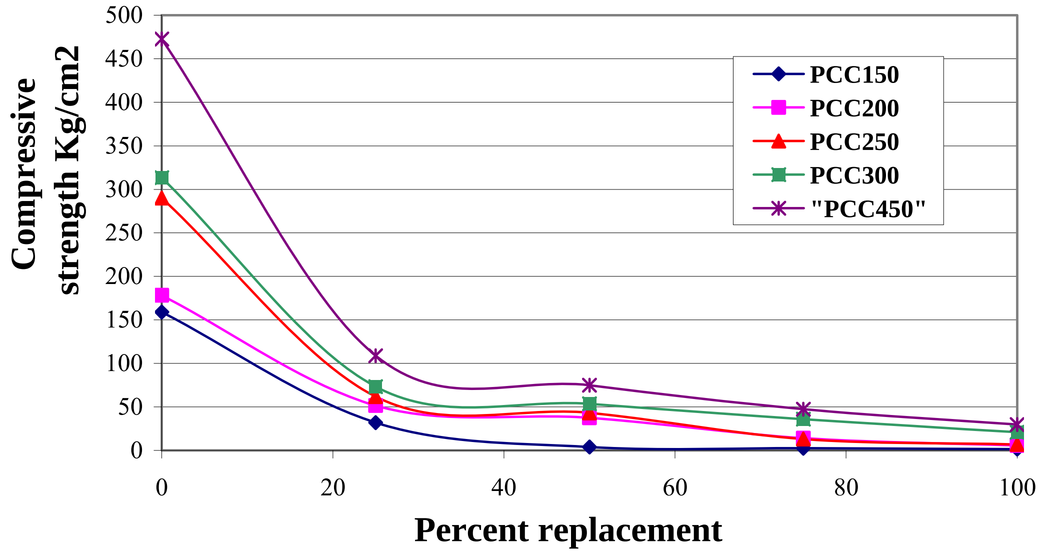


Figure 5.2: Percent replacement by olive husk versus compressive strength for various PCC

From Figure 5.2 for PCC category of PCC-250, the compressive strengths when olive husk are used for replacement are 290.1, 62.0, 43.2, 13.1, and 6.9 kg/cm^2 for 0, 25, 50, 75 and 100% replacement respectively, showing a decreases in compressive strength of 78.6, 85.1, 95.5, and 97.6% respectively from the original reference values. When comparing PCC-250 with PCC-300 it is noticed that at 25, 50, 75, and 100% replacements shows a decrease in compressive strength of 76.7, 82.9, 88.6 and 93.3 % respectively. By comparing PCC250 with PCC300 when olive husk replaced the difference in compressive strength decrease will be 1.9, 2.2, 6.9 and 4.3 respectively for 25, 50, 75, 100% replacements used. This means that as concrete grade increase the difference between two consequence grades will be less , that's the decrease in compressive strength will be also less.

From Figure 5.2 for concrete grade of PCC450, the compressive strength at 0% replacement is 472.6 kg/cm^2, but for 25, 50, 75, and 100% the compressive strength was 108.8, 75, 47.4, and 29.7 kg/cm^2 respectively. This shows a decrease in compressive strength of 77, 84.1, 90, and 93.7% respectively. By comparing PCC450 with PCC300 when olive husk was used the resulted difference in compressive strength is 0.4, 1.1, 1.4, and 0.4% respectively when 25, 50, 75, 100% replacements used.

5.2.2 Effect of Using Olive Ash on Compressive Strength

The relationship between compressive strength and burned olive husk when it is added to the concrete mix is decreased as percent replacement increase. As percent replacement increases concrete becomes more brittle that increases compressive strength in some cases, but increasing olive ash increases brittleness and damages the texture of concrete sample that becomes more weak.

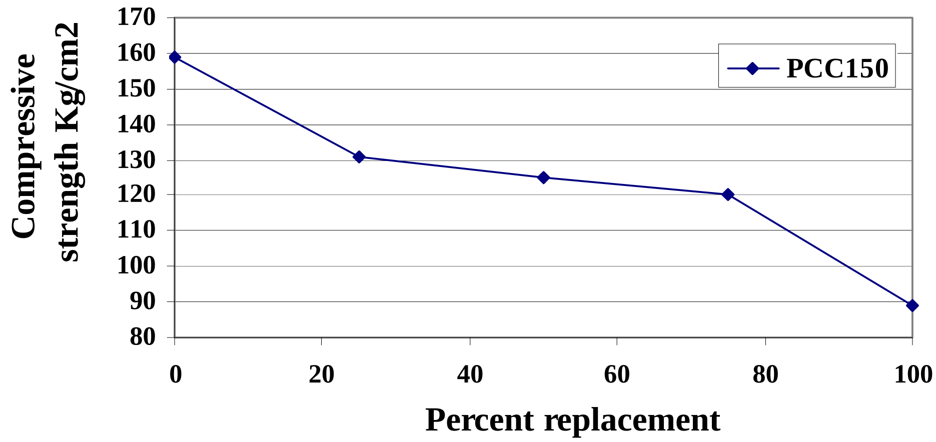


Figure 5.3: Percent replacement by olive ash versus compressive strength for PCC 150

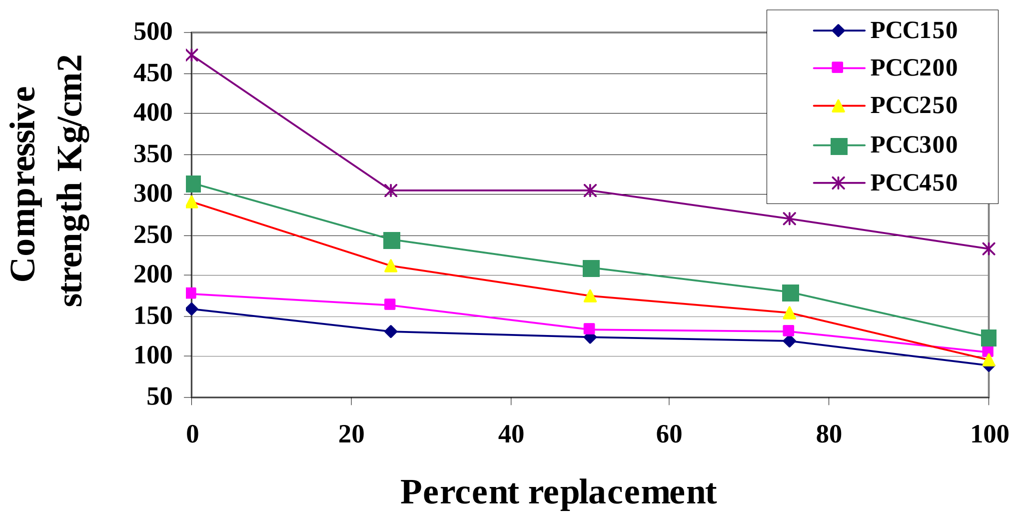


Figure 5.4: Percent replacement by olive ash versus compressive strength for various PCC categories

Figure 5.3 shows percent replacement by olive ash versus compressive strength for concrete grades PCC150. As shown in figure 5.4, for concrete grade PCC200 with zero replacement by olive ash, the compressive strength is 178.2 kg/cm^2. At 25% replacement of olive ash the compressive strength is 163.3 kg/cm^2 that is a decreases of 8.4% from the original value, while for 50, 75, and 100% replacement the compressive strength decreases to 24.9, 26.9, and 40.1% respectively. Comparing PCC200 with PCC150 the difference in compressive decreases to 9.2, 11.1, 2.4 and 2.9% respectively, this difference is not considered a large difference which means that olive ash gives a relatively constant strength when it is added to concrete mix. In comparison with compressive strength difference of olive husk, olive ash for grades PCC200 and PCC150 gives larger compressive strength with a clear difference from olive husk based on concrete grade.

In Figure 5.4, percent replacement by olive ash versus compressive strength is shown, compressive strength for grades PCC150, PCC200, PCC250, PCC300 and PCC450 for 0, 25, 50, 75 and 100% replacements are drawn. For grade of PCC250 the compressive strength was 290.1, 161,176, 155, and 95.3 Kg/cm2 respectively for 0, 25, 50, 75 and 100% replacements respectively. This reflects a decrease in compressive strength of 44.5, 39.3, 48.8, and 67.1% for 25, 50, 75 and 100% respectively. Also compressive strength for PCC of PCC150 it was 313.5 Kg/cm2 at 0% percent replacement and reflected a decrease in compressive strength of 21.8, 32.7, 62.3 and 60.6 % for 25, 50, 75 and 100 % respectively. But for PCC450 compressive strength for 0% replacement was 472.6 kg/cm^2 that reflect percent decrease in compressive strength of 35.6, 35.5, 32.8, 50.7% for 25, 50, 75 and 100% respectively.

5.2.3 Comparison between Compressive Strength for Concrete containing Olive Husk and other Containing Olive Ash for PCC150

For analysis of the laboratory results for compressive strength, Figure 5.5 gives the basic relationship of the percentage replacement by olive husk and olive ash versus compressive strength for concrete category PCC150.

As a result of a volumetric replacement of sand by olive husk and olive ash, compressive strength decreases as percent of olive husk or olive ash increases as shown in Figure 5.5. At zero replacement, compressive strength is 159.0 kg/cm^2, while at 25% replacement by olive husk or olive ash the compressive strength decreases to 32 kg/cm^2 that is a decrease of 80%, and decreases to 131 kg/cm^2 that is a decrease of 17.6%, respectively.

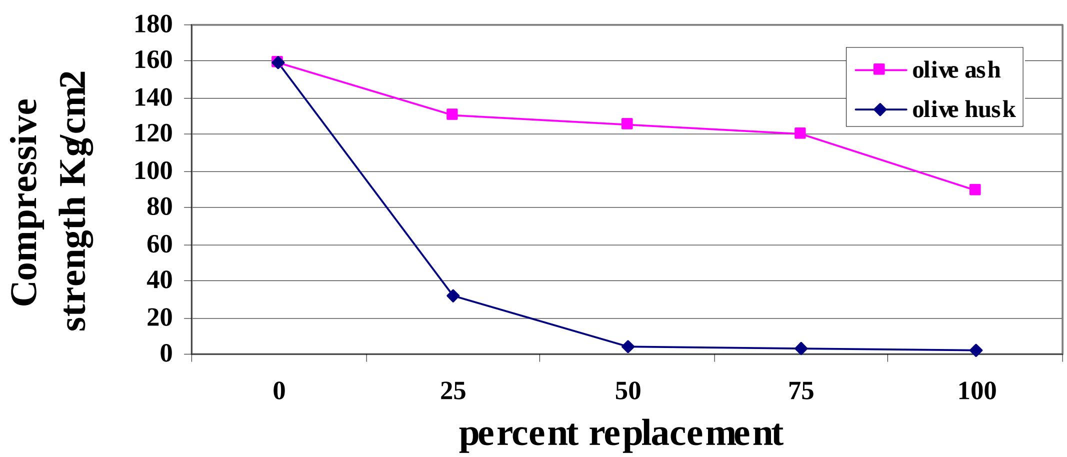


Figure 5. 5: Percent replacement by olive husk and olive ash versus compressive strength for PCC-150

At 50% replacement, compressive strength is 4 kg/cm^2 that is decease of 97% from the original value for olive hush, but compressive strength for olive ash is 125 kg/cm^2 that is a decrease of 16.4%. For 75% and 100% replacements, the compressive strength drops to (98.3, 99) % and (24.5, 44) % respectively from the original reference value. This behavior can be explained as the olive husk increases compressive strength decrease , this due to the high content of moisture and oils which cause with time an excessive retarder to the concrete hardening which leads to weak cohesion between particles of concrete paste. But for olive ash it gives higher compressive strength either at 50% or 75% replacements (Armesto 2001). Due to the high content of carbon contained in burned husk (ash) which increase concrete hardening, that is, it makes the composed samples to be more brittle which leads to more compressive strength value under loading.

5.2.4 Effect of Olive Husk Replacements on Specified Compressive Strength.

The relation between olive husk replacement and compressive strength is dependant on the percentage replacement of olive husk for the concrete grade. Specified Compressive strength is proportion linearly with replacement.

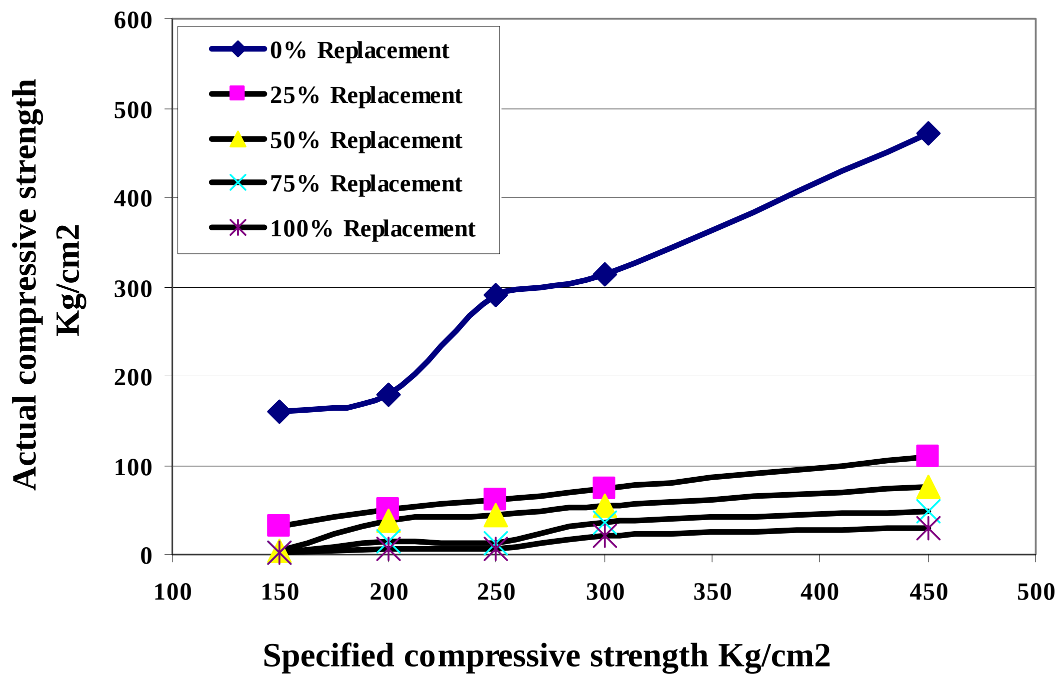


Figure 5.6: Compressive strength of Portland cement concrete for various percentages of replacements of olive husk

Figure 5.6 shows also how compressive strength changed with replacement of sand by olive husk to the specified compressive strength.

Notice actual compressive strength at 0, 25, 50, 75, and 100% replacement for grades PCC-150, 200, 250, 300, and PCC-450. At PCC150&PCC200 specified compressive strength has less difference of the actual compressive strength for replacement 0, 25 50, 75, 100% , these differences in compressive strength increases at concrete grades PCC-250, PCC-300, and PCC-450 versus replacement.

As olive husk proportion increase, the specified compressive strength decrease, then the difference in between compressive strength decrease as olive husk proportion increase as follow: the difference in compressive strength between (25%&50%), (50% & 75%), (75% & 100%) replacements are (28,14,18.8,19.6,33.8)%, (1.4,23.3,30.1,17.7,27.6)%, (1,8.5,6.2,15,15,17.7) for PCC150,PCC200,PCC250,PCC300 and PCC450 respectively.

5.2.5 Effect of Olive Ash Replacements on Specified Compressive Strength.

The relation between actual compressive strength and specified compressive strength according to the percentage replacement is depending on the percentage replacement of olive husk. As concrete grade increase specified compressive strength in the same proportion increases. As shown in Figure 5.7.

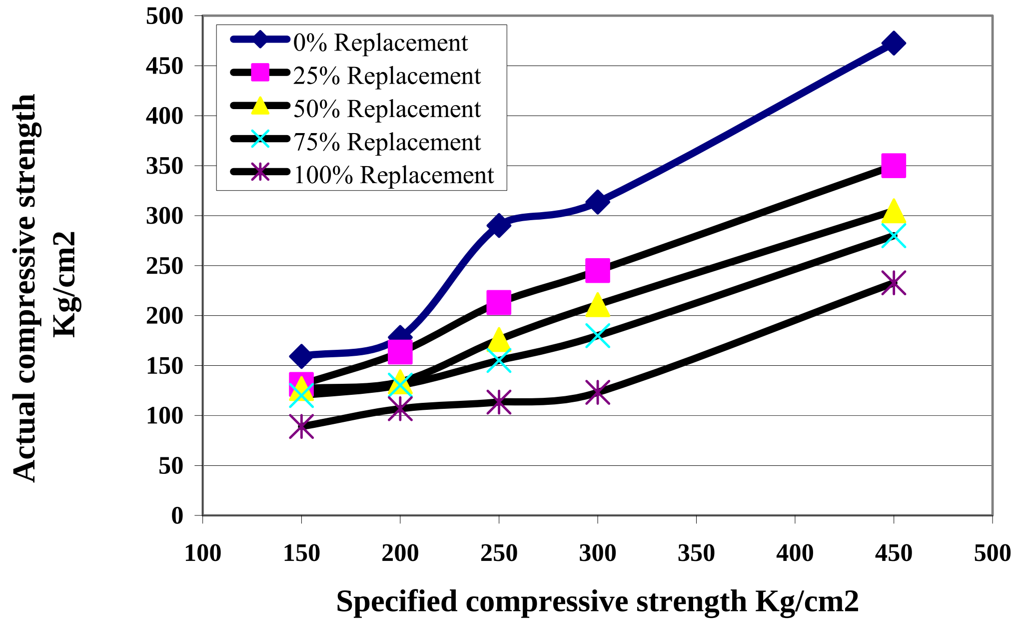


Figure 5.7: Compressive strength of Portland cement concrete for various percentages of replacements of olive ash

Figure (5.7) shows also how actual compressive strength changes with replacement of sand by olive ash to the specified compressive strength. From Figure 5.7 it seems that compressive strength at 0% replacement is 159.1, 178.2, 290, 313.5 and 472.6 kg/cm^2 for grades PCC150, PCC200, PCC250, PCC300 and PCC450 respectively. The difference between the four replacements is (-6,29.5,-15,34,-0.5), (17,3.5,21,93,-13), 31,23.5,59.7,-5.3,85) for (25%,50%), (50%,75%), (75%,100%) respectively. So as concrete grade increase cement ratio will increase, so as percent replacement increase the actual compressive strength will decrease, because shear force occurs in the weak components such as cement and sand, so as percent replacement of olive ash increase actual compressive strength will decrease.

5.3 Density

Relationship between density and percentage replacement of olive husk is depending on the number of olive husk particles that increases with increasing percent replacement, which increase number of voids that leads to smaller density.

5.3.1 Density Analysis for Concrete Containing Olive Husk

In the relation between olive husk and percentage replacement, due to existence of oils on external surface for particles of olive husk, more voids composed, that leads to decrease in density as replacement increase.

Figures 5.8 & 5.9 show how density decreases when olive husk percentage increases for PCC150 and the other concrete categories. The Figures show a homogeneous representation for decreasing density with percent replacement of olive ash for various PCC categories.

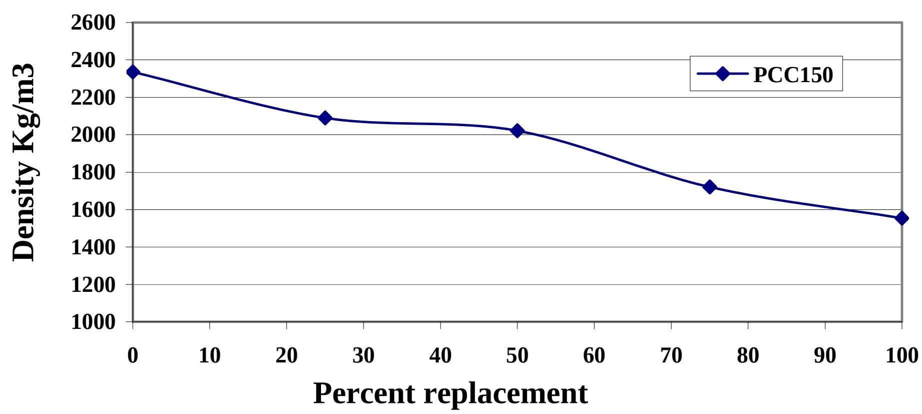


Figure 5. 8: Percent replacement by olive husk versus density for PCC150

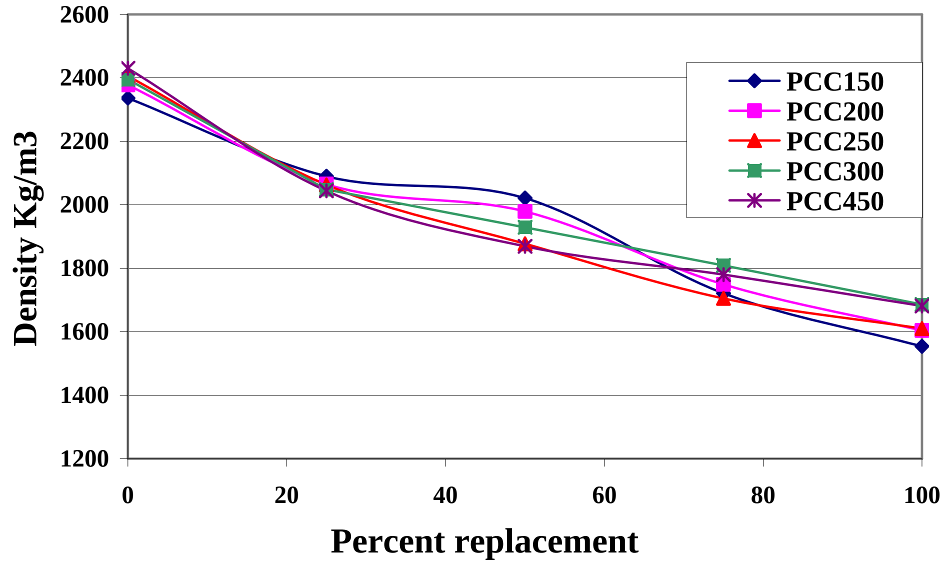


Figure 5. 9: Perecent replacement by olive husk versus density for PCC categories

From Figure 5.8 densities for PCC150 are 2330, 2090, 2021, 1721, and 1554 kg/m^3 for replacements of 0, 25, 50, 75, and 100% respectively. Those replacements show a decrease in density to 10.3, 13.3, 26.1, and 33.3% with reference to zero replacement.

Note that the difference in densities for various PCC versus replacement in Figure 5.9 which shows that, for PCC-200 replacements, the decrease in density to 13.1, 16.8, 26.4 and 32.5% at 0, 25, 50, 75, and 100% respectively with reference to zero replacement. Also for PCC450 replacements show a decrease in density to 15.9, 23.0, 26.7and 30.8% at 0, 25, 50, 75, and 100% respectively with reference to zero replacement. The difference in density decreases between PCC450 & PCC150 to 5.6, 9.8, 0.6 and -2.5% at 25, 50, 75, 100% replacements respectively. This means that as concrete grade increases the difference in density increase.

To compare density with typical light weight concrete, it seems that densities for standard mix are 2336, 2378, 2406, 2395, 2430 Kg/m3 for grades PCC150,PCC200,PCC250,PCC300 and PCC450 respectively. If densities for 100% replacement of olive husk was taken for all grades, the densities will be 1554, 1604, 1610, 1686 and 1681 Kg/m^3.

5.3.2 Density Analysis for Concrete Containing Olive Ash Replacement.

In this relation density according to olive ash replacement is not decreasing to reach the natural weight for light weight concrete , due to oils that existed only in the inner part of particles , no oils on the external surface , that means voids still limited, so weight will not decreased to the natural light weight density.

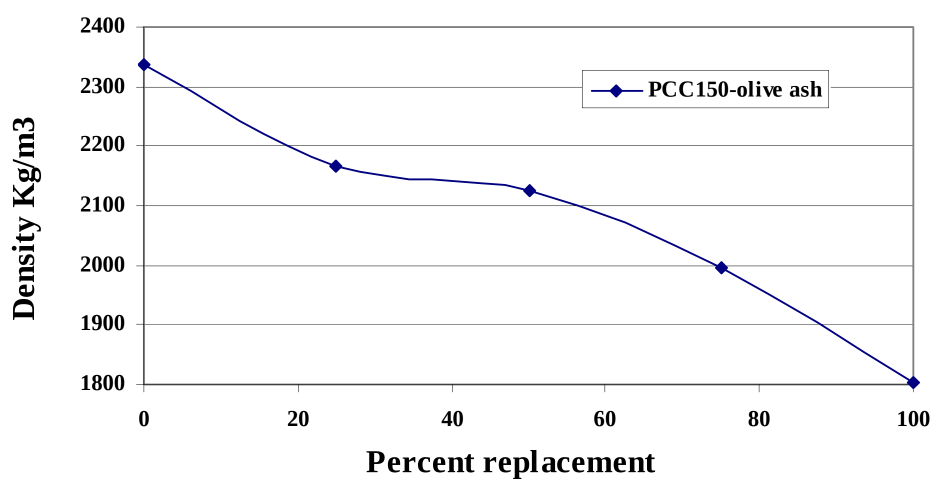


Figure 5.10: Percent replacement by olive ash versus density for PCC150

Figures 5.10 and 5.11 show the decreasing in density according to percent replacement of olive ash, relative to the standard density (0% replacement). Figure 5.10 shows the percent replacement by olive ash versus density for PCC150. It shows that as the percent replacement increases, density decrease, densities were 2336, 2165, 2126, 1997, 1803; the replacements of 25, 50, 75, and 100% were decreased in density to 7.08, 8.8, 14.3, and 22.6% respectively.

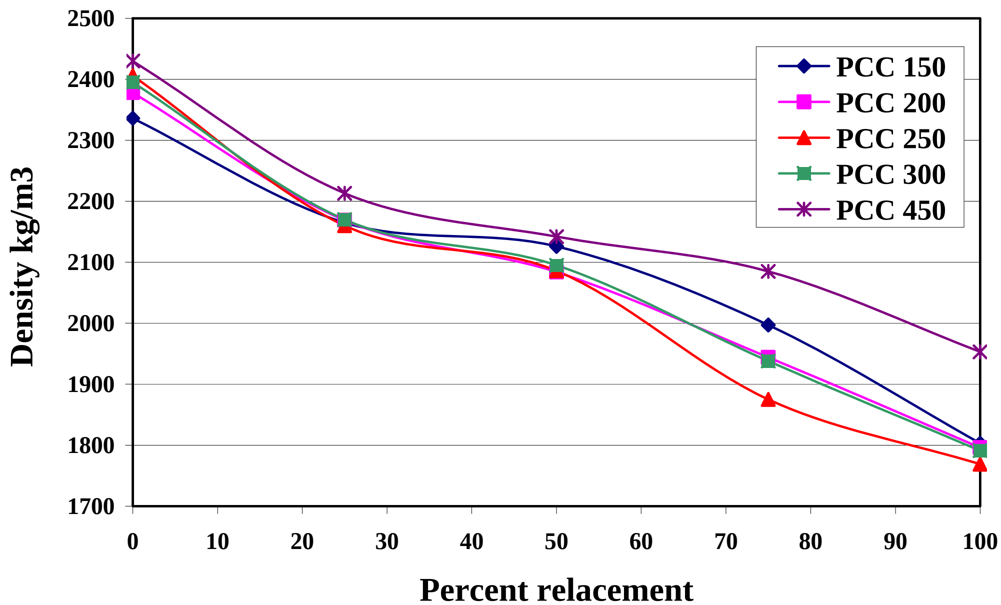


Figure 5.11: Perecent replacement by olive ash versus density for various categories of concrete

This means that as replacement increase the percentage decrease in density increase. Also for Figure 5.11 the decrease in density with replacement is shown for the different PCC categories. For all categories, as olive ash replacement density decrease, for PCC450 the densities were 2430, 2395, 2170, 2095, 1938 Kg/m3 and the decrease in density was 14.5, 11.9, 11.7, 19.6% at 25, 50, 75, and 100% for olive ash replacements respectively. The difference in density decreases between PCC450 & PCC150 is 7.4, 3.1, -2.6, -3.0 this means that as concrete grade increases at 25% & 50% replacement, the decrease in density increases and at 75% & 100% replacement, as concrete grade increases density decreases.

5.3.3 Comparison between Densities for Concrete Containing Olive husk and Other Containing Olive ash.

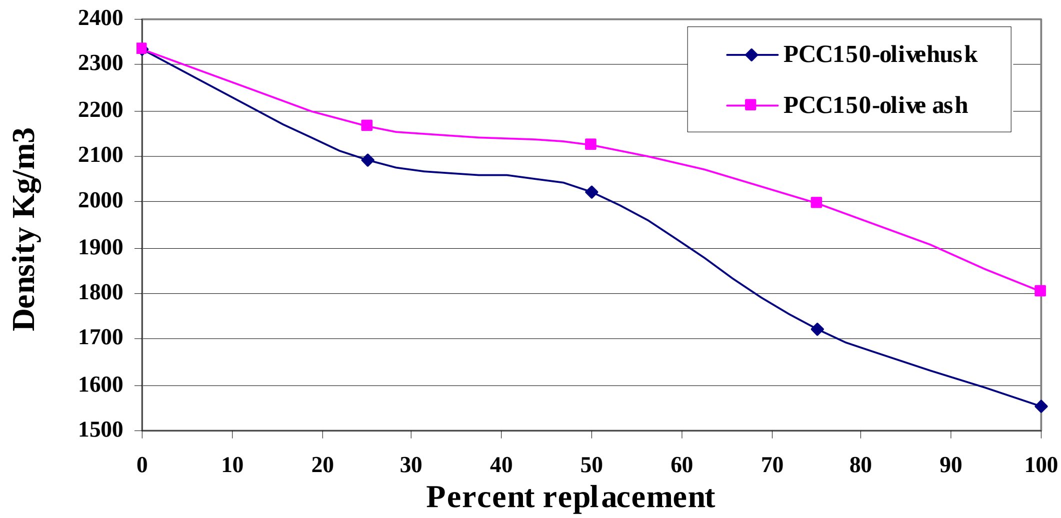


Figure 5.12: Percent replacement by olive husk and ash versus density for PCC150

Olive husk has moisture content and plenty of oils, so concrete containing olive husk didn't absorb much water when it placed in the water to continue curing. However concrete containing olive ash was absorbing water more and more as percent replacement increases, so densities of concrete containing olive ash more than of densities for concrete containing olive husk.

5.4 Water Absorption

5.4.1 Water Absorption for Concrete Containing Olive Husk

To show the form of relationship for olive husk and ash replacements versus percentage absorption, different proportions of olive husk are used to show the relation.

As shown in Figure 5.13 absorption decrease at 25, 50% replacements and increase at 75% then refers to decrease at 100% replacement compared to 0% replacement. Also in Figure 5.14 water absorption for different concrete categories is shown. The differences in water absorption for the different grades are small. For PCC150 percentage absorption was 5.8, 5.4, 4.7, 5, 4.8% and for PCC450 was 5.8, 4.7, 4.5, 4.9, and 5.2% for 0, 25, 50, 75, and 100% replacements respectively. The explanation for these Figures will be as follows: at 25,50% replacement of olive husk absorption decrease, this number of particles carrying oils on there external surfaces contained in that proportions, these particles compose a limited size of voids saturated with oil the didn't allow the water to stay in it , so it passes and flee(water) through. But for 75% replacement number of particles of olive husk in the same sample increase, that means increasing the amount of surrounded oils which increases size of voids, some of passing water stays in the voids due to their size. For 100% replacement the texture of the sample is damaged due to large amount of olive husk added to the concrete mix, so the voids become larger and concrete sample easily to be penetrated by water, so water absorption decrease at this replacement.

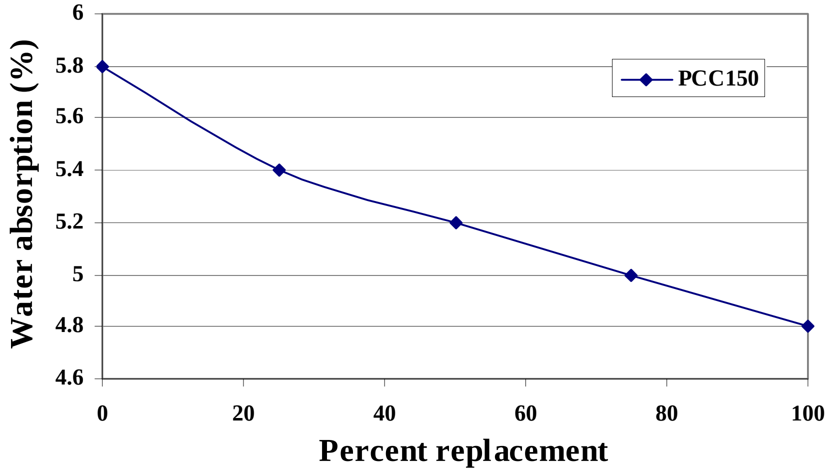


Figure 5.13: percent replacement by olive husk versus water absorption for PCC150

The relation depending on the moisture and oils existed in the added material (olive husk). It seems that the behavior of the material is not linear; this is due to the variation of effect which is related to percent replacement.

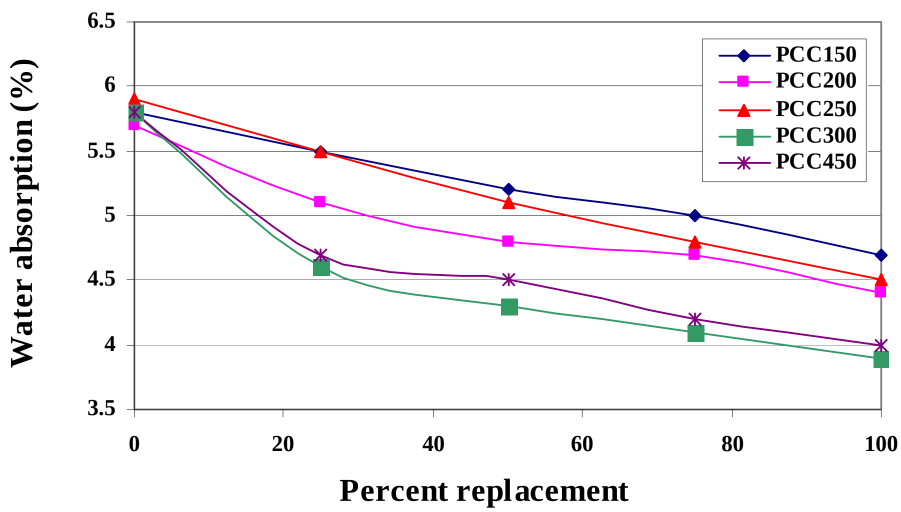


Figure 5.14: Percent replacement by olive husk versus water absorption for different concrete categories

5.4.2 Water Absorption for Concrete Containing Olive Ash

Olive ash is dried of external surface; it means it has no oils on the external surface of particles. When it is added to the concrete mix as a replacement of sand it allows the water to be absorbed because its surface is dry, and allow performing absorbable voids, so as olive ash replacement increase water absorption increase. As shown in Figures 5.15 & 5.16, as olive ash replacement increase percentage absorption increase. For PCC150 percentage absorption is 5.8, 8.1, 9.2, 10, and 10.3% and for PCC450 is 5.8, 7.1, 7.8, 8.3, 8.7% for 0, 25, 50, 75, and 100% replacements respectively. The difference in absorption between PCC150 and PCC450 are due to different amounts cement and sand that reduce void's size as they increased.

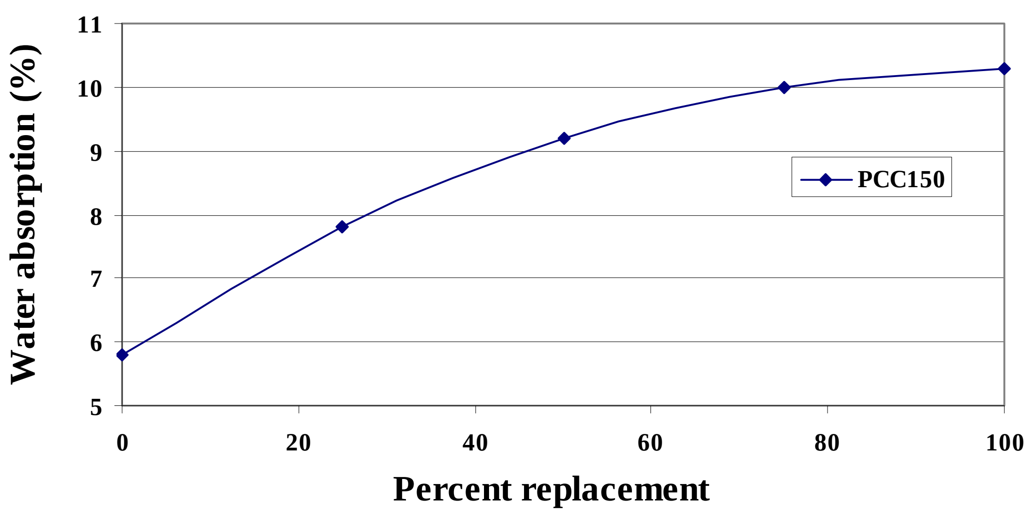


Figure5.15: Percent replacement by olive ash versus water absorption for PCC150

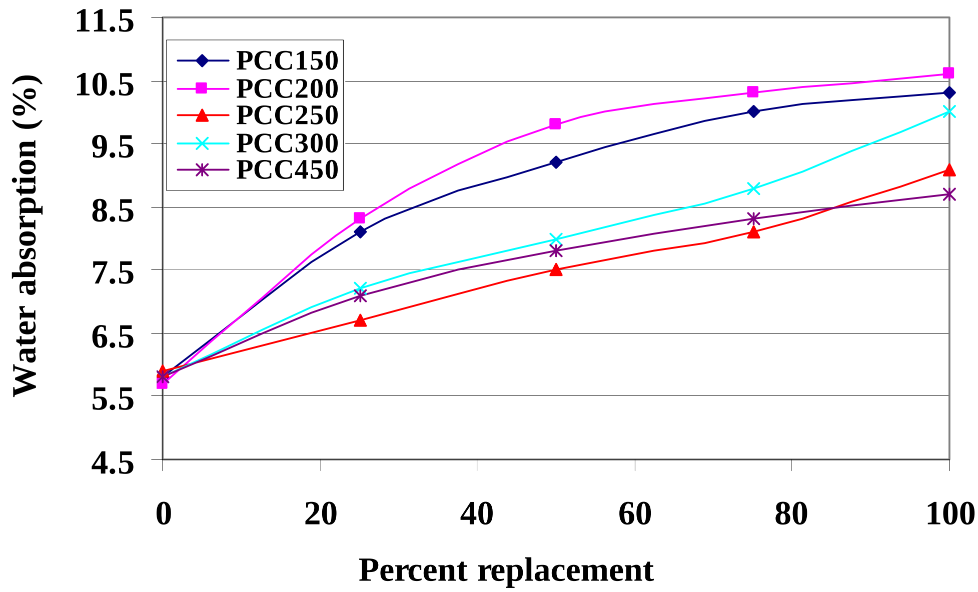


Figure 5.16: Percent replacement by olive ash versus water absorption for various PCC categories

5.4.3 Comparison between Concrete Containing Olive Husk and other Containing Olive Ash under Absorption Test

The comparison between olive husk and olive ash is depending on the amount of oils contained in the particles. For olive husk the variance in water absorption for proportions due to the voids occurred due to existence of oils on particles, but for olive ash linearity in relation between olive ash replacement and water absorption is shown. Figure 5.17 shows the difference in relation between olive husk and ash replacements with water absorption.

Figure 5.17 shows increase in water absorption with increasing olive ash replacement, but for olive husk water absorption decrease at 25, 50% replacements and increase at 75, 100% replacements with respect to the 0% replacement of olive husk.

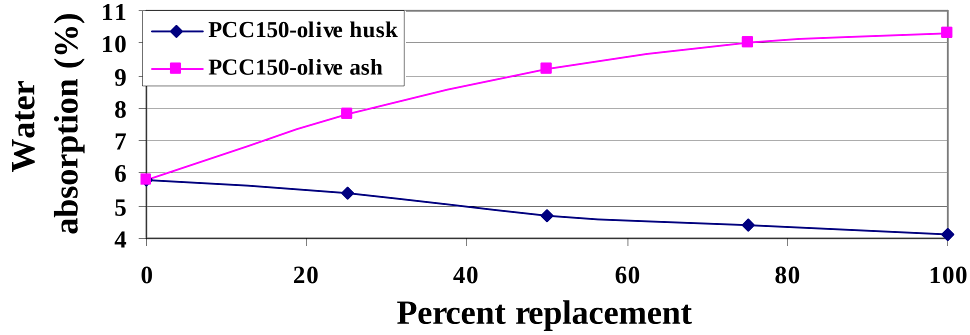


Figure 5.17: percent replacement by olive husk versus water absorption for PCC150

5.5 Abrasion Test Analysis:

5.5.1 Abrasion Test for Concrete Containing Olive Ash

The form of relation depends on the degree of hardness for concrete. As percent replacement of olive ash increase, voids increase by number and size, so losses in weight by abrasion increase as percent replacement of olive ash increase. As shown in figure 5.18, for concrete of PCC150, as percent replacement of olive ash increase losses in weight by abrasion increase. From figure 5.19 percent replacement by olive ash versus losses in weight for various PCC categories, also as percent replacement of olive ash increase losses in weight decrease, because as percent replacement increase voids increase, that give more affected specimens by abrasion.

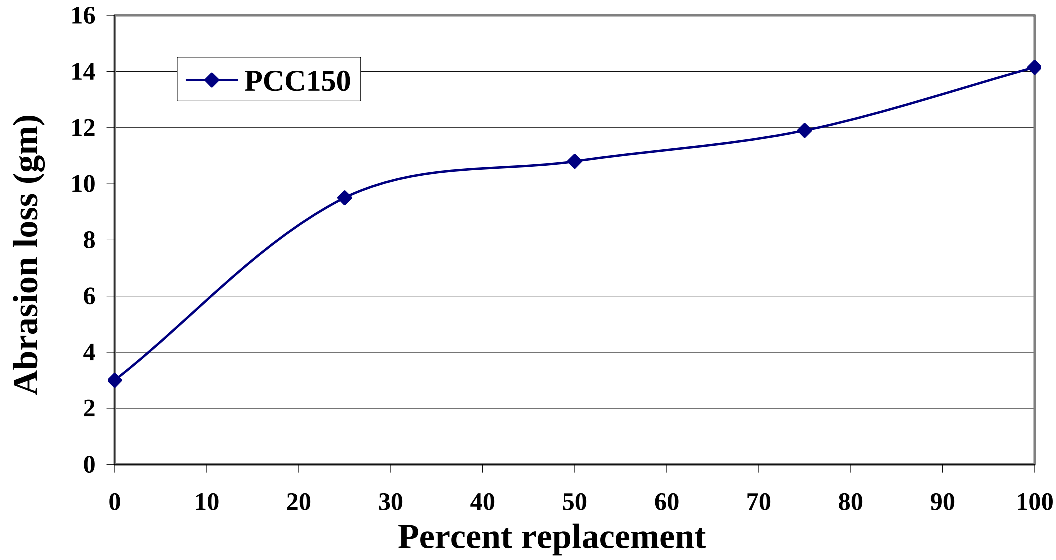


Figure 5.18: Percent replacement by olive ash versus abrasion loss for PCC150

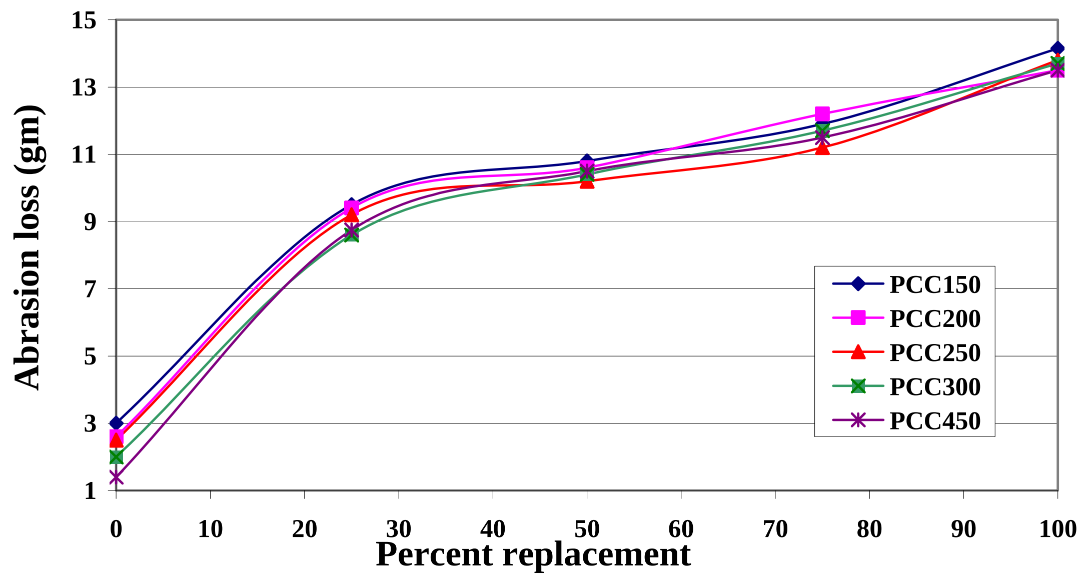


Figure 5.19: Percent replacement by olive ash versus abrasion loss for various concrete categorie

5.5.2 Abrasion Test for Concrete Containing Olive Husk.

The relation between olive husk replacement and loss due to abrasion is depending on the oils contained on olive husk surfaces that weaken bonds due to separation between oils and concrete, so as olive husk replacement losses by abrasion increase.

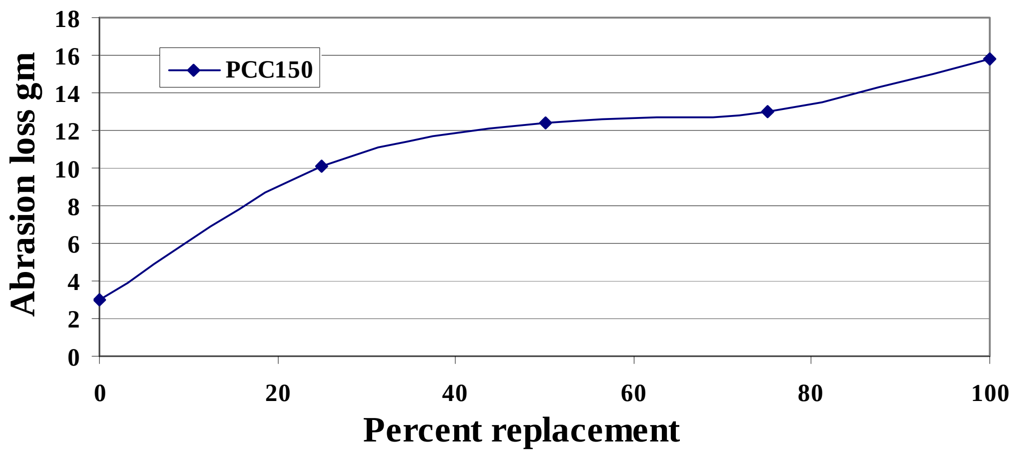


Figure 5.20: Percent replacement by olive husk versus abrasion loss for PCC150

Figure 5.20 shows losses values in weight by abrasion for PCC150 when olive husk is used as a replacement of sand in concrete mixes. It seems from the figure that abrasion loss increases as replacement of olive husk increases. From the figure losses due to abrasion for PCC150 were 3, 10.1, 12.45, 13 and 15.85gm for replacements 0, 25, 50, 75, 100% respectively. In figure 5.21, the differences in abrasion loss for various concrete categories are shown. For PCC450 losses in abrasion were 1.4, 10.05, 11.95, and 13.05, 20.05gm for 0, 25, 50, 75 and 100% replacements respectively. It seems from the differences of abrasion loss that, as olive husk replacement increase abrasion loss increases due to high liquid oil contained in olive husk which make concrete of weak bonding that facilitate process of abrasion**.**

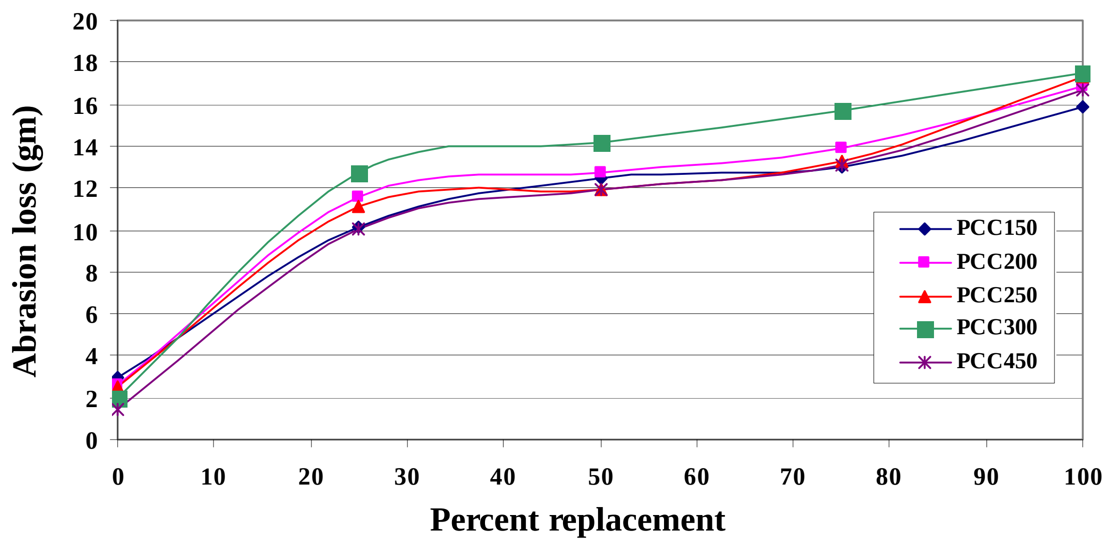


Figure 21: Percent replacement by olive husk versus abrasion loss for various concrete categories

5.5.3 Comparison between Concrete Containing Olive Husk and other Containing Olive Ash under Abrasion Test

The difference in relation between concrete containing olive husk and concrete containing olive ash depends in the behavior of the material it self. Olive husk performing an excessive retarder to the concrete mix, so as replacement increase loss under abrasion increase. Olive ash perform a quick factor for concrete hardening, so as percent replacement increases, voids increases then losses in weight due to abrasion increases. So losses in weight under abrasion for concrete containing olive husk more than that for concrete containing olive ash.

Figure 5.22 shows a percent replacement by olive ash and husk versus losses in weight due to abrasion for PCC150.

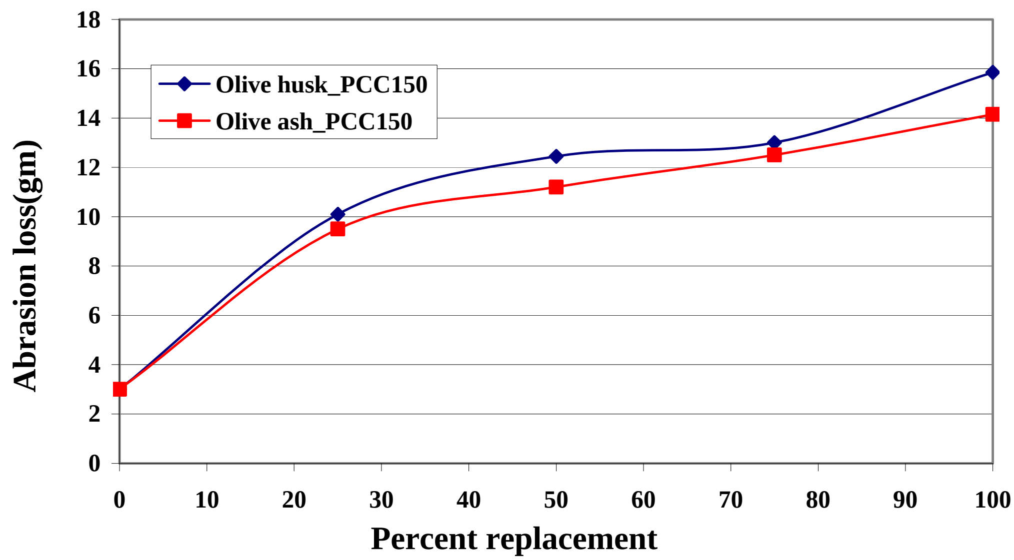


Figure 5.22: Percent replacement by olive husk and ash versus abrasion loss for PCC150

5.6 Slump (Consistency)

Slump test depends on the workability of concrete, but still the behavior of the added material limits the values of slump. Olive husk and olive ash described as material needs for much water to obtain high slump values, so slump values ranges from 23mm to 39mm in all cases and for all categories of concrete used in the test.

5.6.1 Slump for Concrete Containing Olive Husk.

Concrete slump depends on the workability of the concrete mix. the relation between concrete slump and percentage replacement of olive husk depends on the proportion of replacement. Nevertheless when olive husk added to the concrete mix had not affected concretes workability, because adding olive husk to the concrete creates more voids as percent replacement increased, so it needs too much water to give the suitable slump, but adding water more than what is required looses the concrete mix its behavior. so as percent replacement increase slump increase slowly & linearly. As shown in Figures 5.23 & 5.24.

From figure 5.23, it seems that values of slump consistency are ranging from (23mm to 29mm). There are no high values mentioned. This means that workability is not high. From figure 5.24 values of slump for different PCC categories is shown, the values range from (23mm to 39m).

From figure 5.23 slumps for PCC150 were 23, 25, 26, 27.5, 28.5mm for replacements 0, 25, 50, 75, 100% respectively. From Figure 5.24 slumps For PCC450were 25, 26.5, 27.3, 27.8, 28.7% for 0, 25, 50, 75, 100% replacements respectively. The difference in slump between the two grades is 2, 1.5, 1.3, .3, .2 mm for 0, 25, 50, 75, 100% replacements respectively.

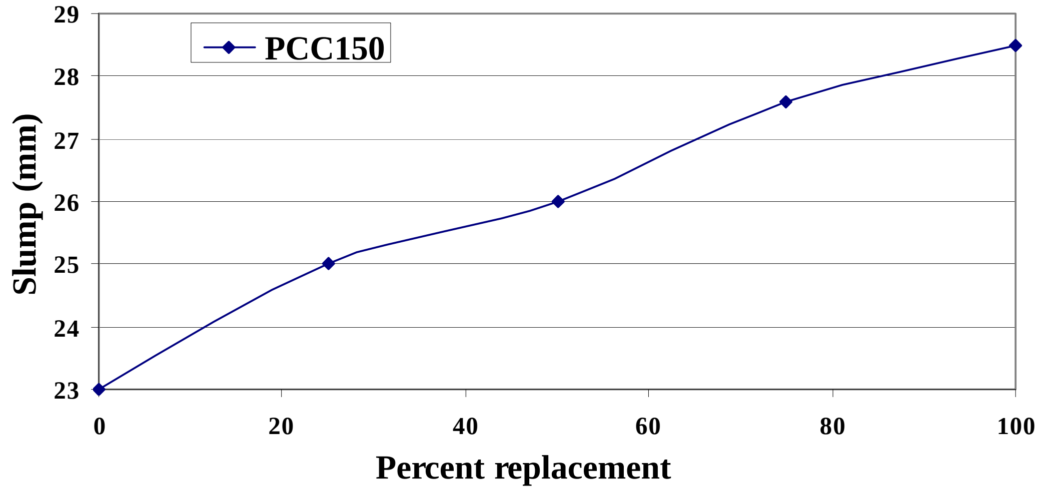


Figure 5.23: Percent replacement by olive husk versus slump for PCC150

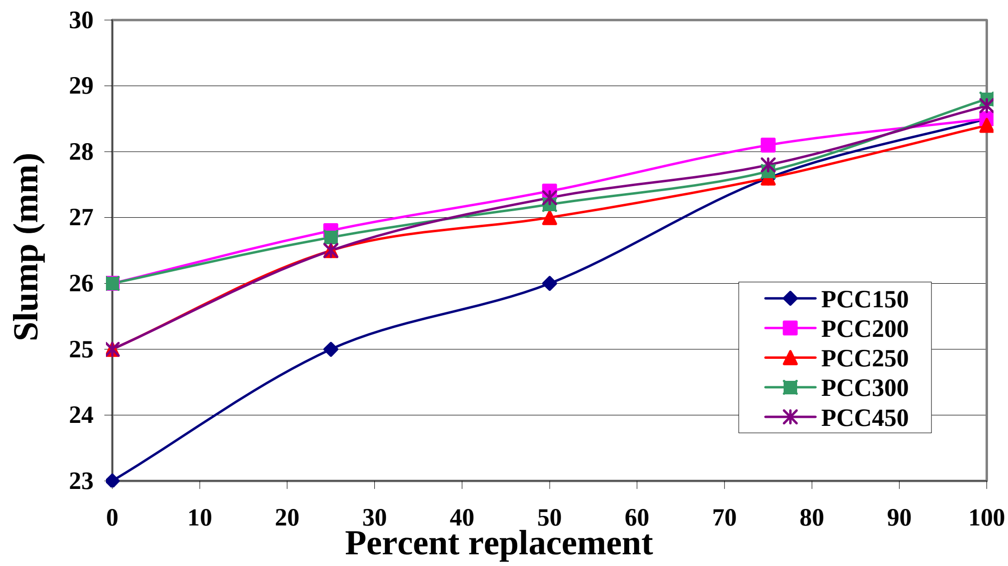


Figure 5.24: Percent replacement by olive husk versus slump for various concrete

5.6.2 Slump for Concrete Containing Olive Ash.

The relation between slumps for concrete containing olive ash and percent replacement of olive ash depends on the amount of added ash. When olive ash is added to the concrete it accelerates concrete hardening due to the amount of carbon contained that reduce slump and make it to increase at 25, 50% replacements, stay the same as 75% replacement and increase slightly at 100% replacement. For 25, 50% replacement voids decrease cohesion and bonding that increase slump, at 75% replacement, the amount of olive ash increase that increase particles which increase voids and loose the concrete its texture, at 100% the separation of particles from other components of concrete that's increase slump.

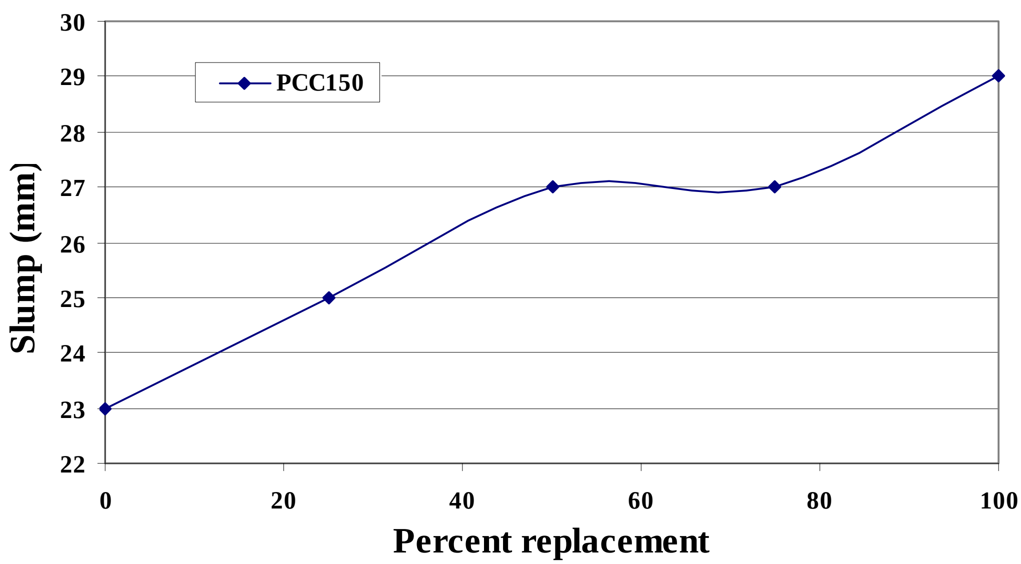


Figure 5.25: Percent replacement by olive ash versus slump for PCC150

From figure 5.26 values of slump increase as replacement of olive ash increases. The values of slump of olive ash replacement for PCC150 are 23, 25, 27, 27, 29mm that ranging from (23mm to 29mm), and from figure 5.26 slumps for PCC450 were 23, 25, 26, 27, 27.5 mm, at 0, 25, 50, 75,100% replacements respectively.

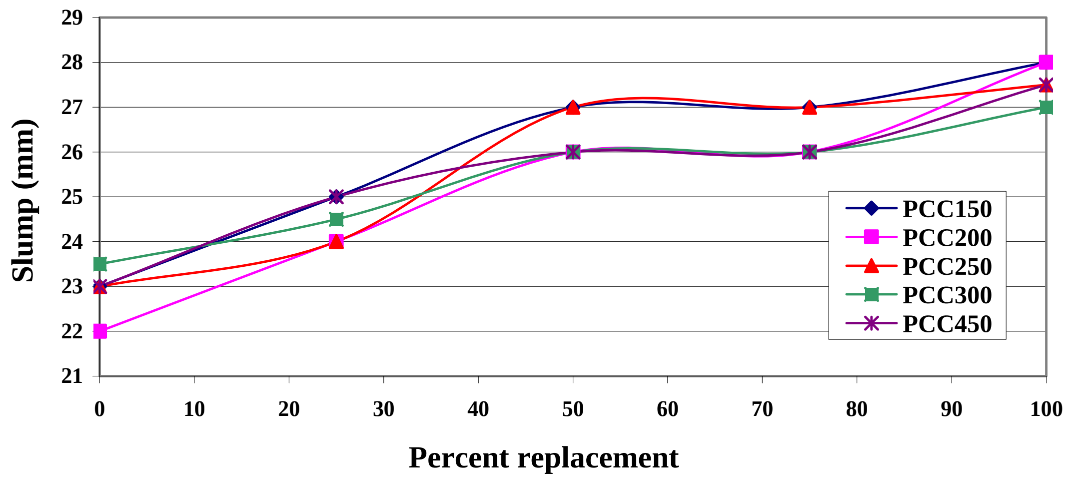


Figure 5.26: Percent replacement by olive ash versus slump for various PCC categories

5.6.3 Comparison between Concrete Containing Olive Husk and Concrete Containing Olive Ash under Slump (Consistency) for PCC150

There is a difference between olive husk and olive ash when they added to the concrete mix under slump test. The difference in relation depends on the composed bonding; due to amount of oils existing on the external surface of the particles. Figure 5.27 shows the difference in relation between olive husk and ash.

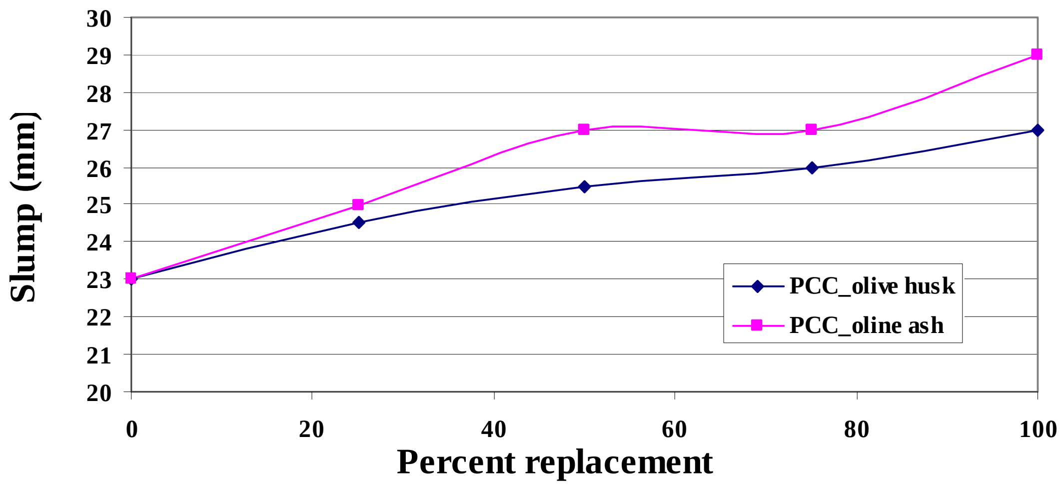


Figure 5.27: Percent replacement by olive husk and olive ash versus slump for PCC150

5.7 Noise Insulation:

5.7.1 Noise Insulation for Concrete Containing Olive Ash.

The relation for concrete containing olive ash depends on the number and size of composed voids due to the behavior of the material. At 25% replacement of olive ash, amount of ash although small, it allows composition of voids that increase sound reduction, at 50%, 75%, 100% replacement concrete become more brittle, that means increase pores and voids which allow more voids composition, the cause for increasing for sound reduction.

Figure 5.28 shows increase in noise insulation at 25%, 50%, 75% and 100% replacement of olive ash respectively.

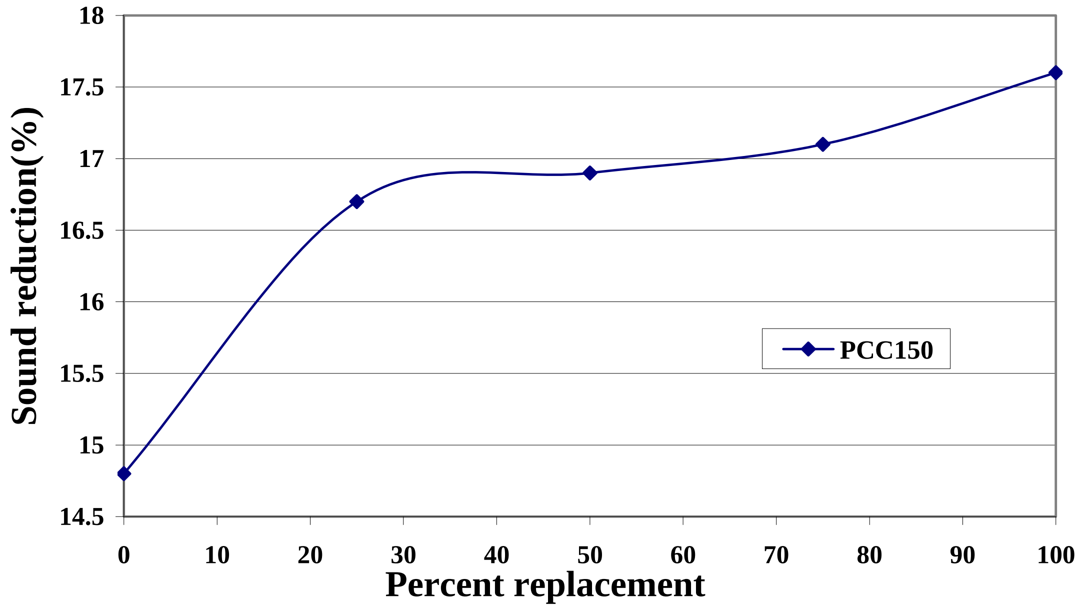


Figure 5.28: Percent replacement by olive ash versus sound reduction for PCC150

Sound reduction for PCC150 were 14.8, 16.7, 16.9, 17.1 and 17.6% for 0, 25 50, 75 100% replacements of olive ash respectively. For figure 5.29 percent replacement by olive ash versus sound reduction for various PCC categories is shown. The differences between all grades are shown. In the figure sound reduction for PCC450 is 14.1, 15.8, 16, 16.2, 16.6% for 0, 25 50, 75 100% replacements of olive ash respectively. It clear from figure 5.29 as percent replacement increases sound reduction increases, for all categories of concrete as concrete grade in crease sound reduction decreases, because as the a mount of cement increases the specimen becomes more brittle and compressive strength increases, so sound reduction decreases.

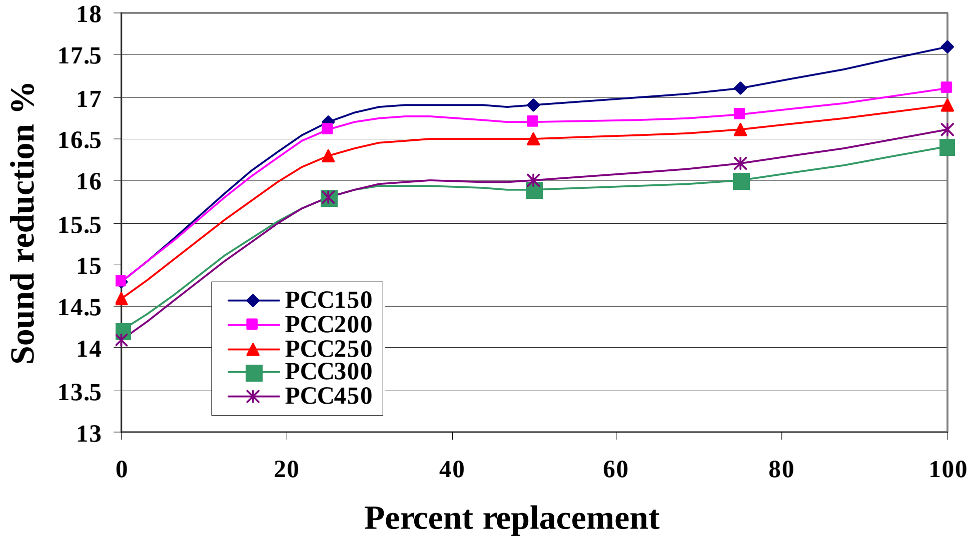
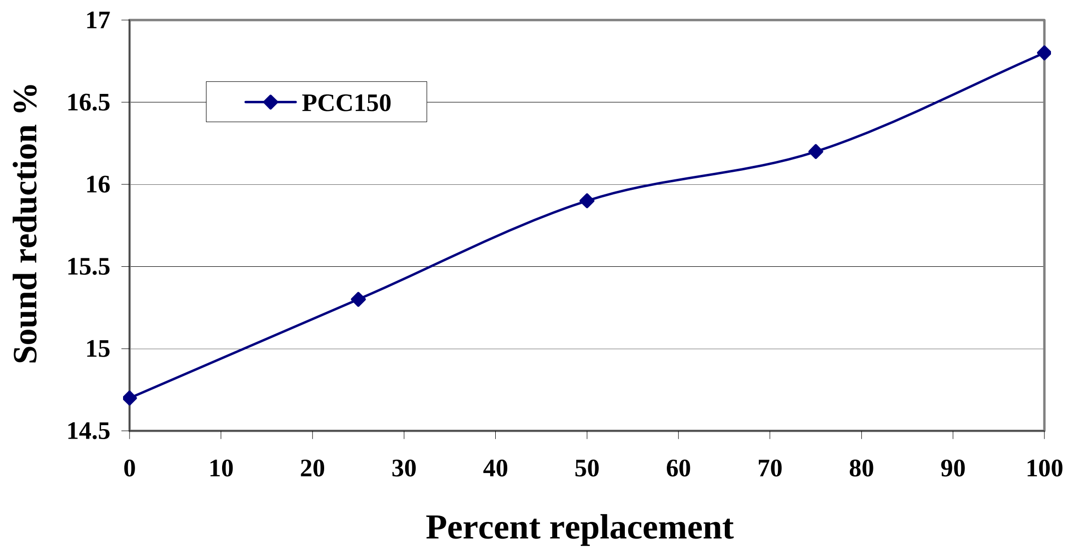


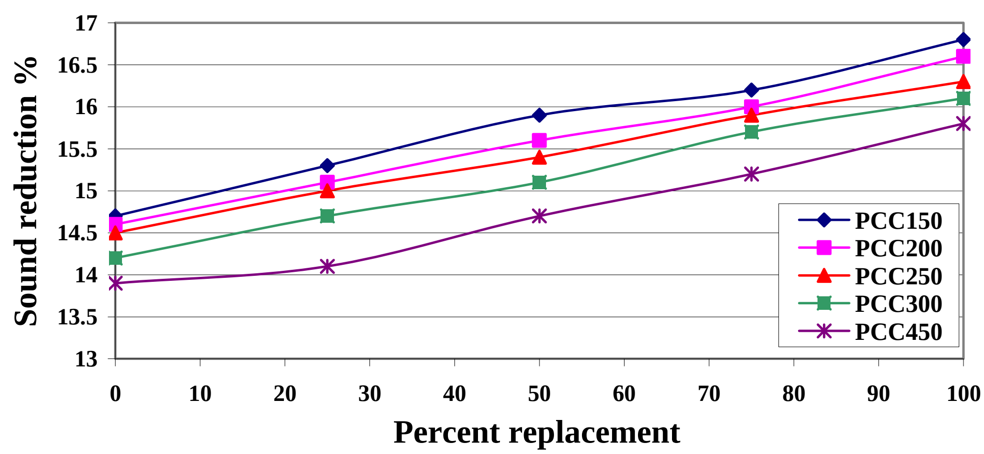
Figure 5.29: Percent replacement by olive ash versus sound reduction for various PCC categories

5.7.2 Noise Insulation for Concrete Containing Olive Husk

For relation of percentage replacement of olive husk with sound reduction, amount of husk very important due to number of particles in each proportion of replacement, because as percent replacement increase oils that establish insulation with other particles increase, then voids increase that allow increments in sound reduction. The same in figure 5.30 noise insulation increases as olive husk replacement increase. In the Figure sound reduction for PCC150 is 14.7, 15.3, 15.9, 16.2, 16.8% for 0, 25, 50, 75, 100% replacements respectively. Figure 5.31 shows sound reduction for different PCC categories. Differences between sound reductions for PCC categories are shown. For PCC450 sound reduction was 13.9, 14.1, 14.7, 15.2, 15.8 for 0, 25, 50, 75, 100% replacements respectively.



Fgure 5.30: Percent replacement by olive husk versus sound reduction for PCC150



Fgure 5.31: Percent replacement by olive husk versus sound reduction for various PCC categories

The difference between PCC150 & PCC450 was 0.8, 1.2, 1.2, 1, 1 for 0, 25, 50, 75, 100% replacements respectively. This means that as olive husk replacement increase sound reduction increase, because when replacement increase compressive strength decrease, so the pores and voids that absorb noise will be more, that makes material to accept more sound reduction. Also as grade increase sound reduction increase according to proportion replacement.

5.7.3 Comparison between Concrete Containing olive husk and Concrete Containing Olive Ash under Noise Insulation

The difference in relation between concrete containing olive husk and concrete containing olive ash depends on the voids composed between material and other component of concrete mix. In all cases olive ash contains voids that absorb noise more than olive husk that contains high amounts of moisture and oils, which mean olive ash, contain closed voids, but olive husk contains voids surrounded with oils and water.

In the Figure shown, difference between sound reduction for olive husk and olive ash is shown. The difference between olive ash and olive husk is 0.0, 1.5, 1.2, 0.8 and 0.7 for 0, 25, 50, 75, 100% replacements respectively. That means, olive ash used totally dried when it mixed with concrete, it creates pores and voids during concrete mix, which makes it more extensive to record higher sound reduction. On the contrary for husk that is used wet, so it leaves less pores and voids due to evaporation process during 28 days for testing, so olive husk record less sound reduction than olive ash. As shown in figure 5.32, as percent replacement increases , the difference in sound reduction between concrete containing olive husk and other containing olive ask decreases.

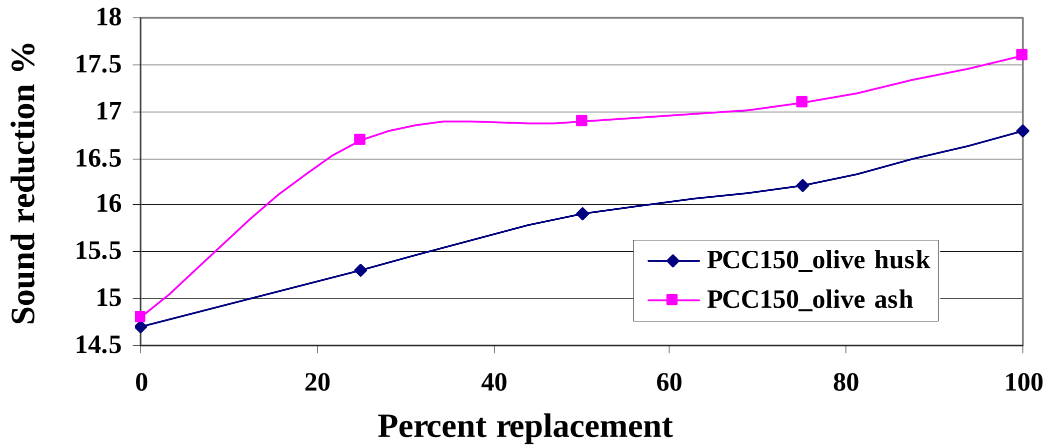


Figure 5.32: Percent replacement by olive husk and olive ash for PCC150

5.8 Thermal Insulation:

Thermal insulation is known how concrete can allow for temperature to pass through it. The degree of Thermal insulation for concrete depends on the additives to the Portland cement concrete in addition to the basic components. Thermal insulation depends on the composing voids of the added material. For concrete containing olive husk, as percent replacement increases, number of voids through specimen increases, next thermal insulation increases. For concrete containing olive ash, as percent replacement increases, number of particles that compose more number of connected voids that allow passing temperature through the specimen, so as percent replacement of olive ash increases, thermal insulation decreases.

5.8.1 Thermal Insulation for Concrete Containing Olive Husk

There are many additives may be add to the concrete mix. Some of these additives are olive husk. It was added to the concrete mix as a replacement of fine aggregate with different percent replacement.

The relation between thermal insulation and different percent replacement of olive husk increasing linearly, as shown in Figures 5.33 & 5.34 .. In figure 5.33 thermal reduction for PCC150 is 32.2, 32.5, 32.8, 33.3 and 33.9% for 0, 25, 50, 75, 100% replacement of olive husk respectively. In Figure 5.34 thermal insulation for different PCC categories is shown. As percent replacement of olive husk increases, thermal insulation increases. The difference in thermal reduction between PCC450 & PCC150 is 1.2, 1.2, 1.2, 1.3 and 1.5%, it means, as PCC grade increase the difference in thermal reduction increase,. Due to the number of particles that increasing with increasing percent replacement, so as percent replacement increases number of voids increases, that increases thermal insulation.

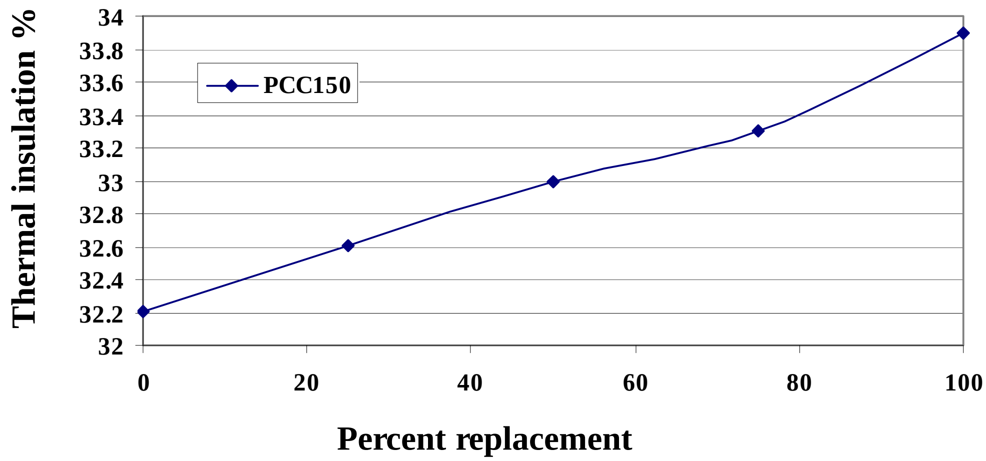


Figure 5.33: Percent replacement by olive husk versus thermal insulation

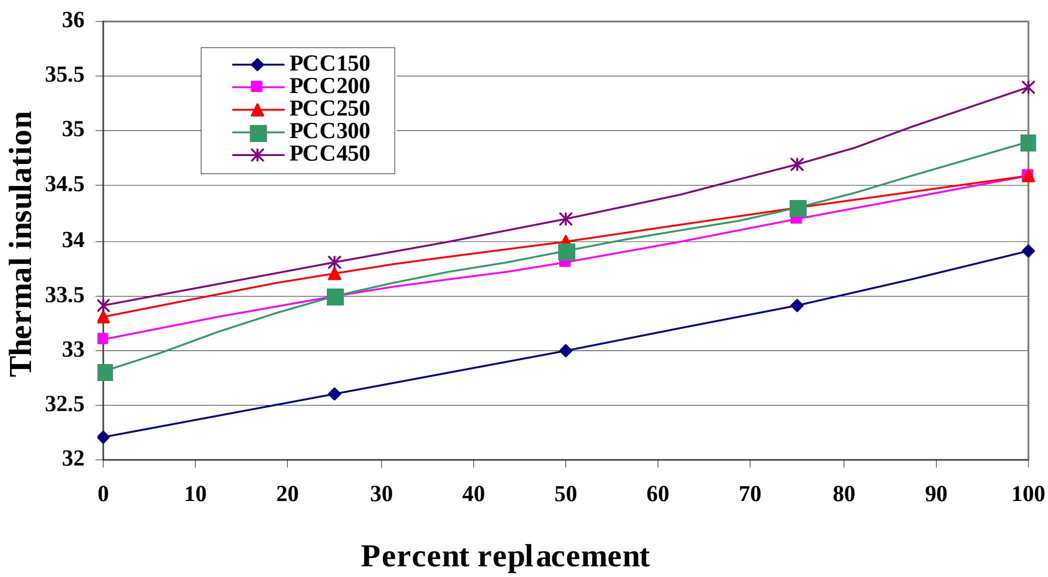


Figure 5.34: Percent replacement by olive husk versus thermal insulation for different PCC categories

5.8.2 Thermal Insulation for Concrete Containing Olive Ash

Some of additives to the concrete mix as a replacement of fine aggregate is burned olive husk (olive ash). it described to have a high content of carbon and less amount of oil , because the external surface didn't contain oils, that's mean the quantity of oils less than that in olive husk, so thermal reduction will be less.

The relation between thermal reduction and concrete containing olive ash is shown in Figures 5.35 & 5.36 For PCC150 containing olive ash as a replacement of fine aggregate thermal insulation is 29, 28.2, 27, 25.3, 24.7% at 0, 25, 50, 75, 100% replacements respectively, as shown in Figure 34. As olive ash replacement is increases thermal reduction decrease. This is a logical result, because as percent replacement increase number of voids increase that means increasing in the points that passing temperature. From Figure 5.35 thermal reduction for PCC450 is 30.1, 28.2, 28.5, 27.9, 27.2% for 0, 25, 50, 75, 100% replacement of olive ash respectively. It seems also, as concrete grade increase thermal reduction increase, because as grade increase compressive strength increase for the same proportion of replacement, due decrease in number of voids contained in the selected sample of concrete.

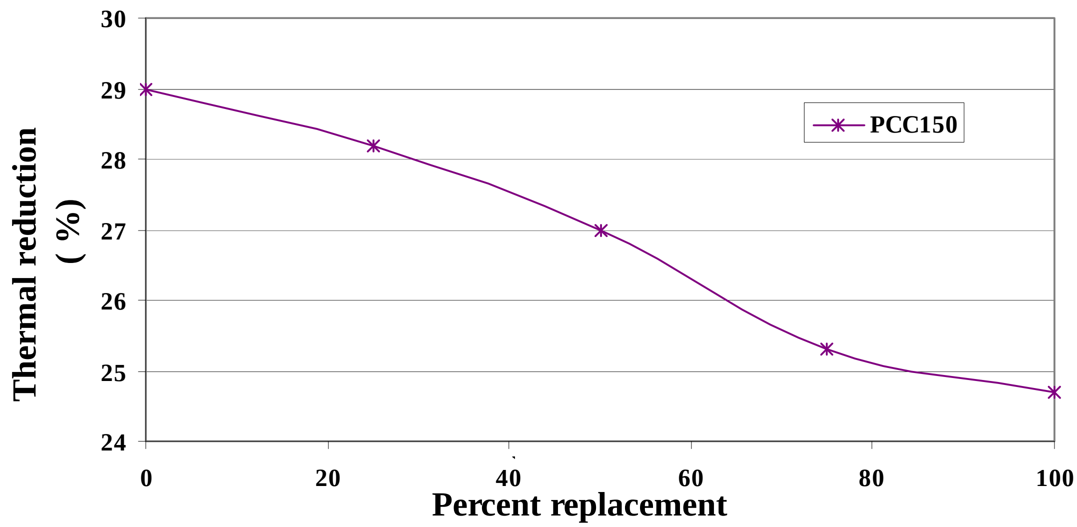


Figure 5.35: Percent replacement by olive ash versus thermal insulation for PCC 150

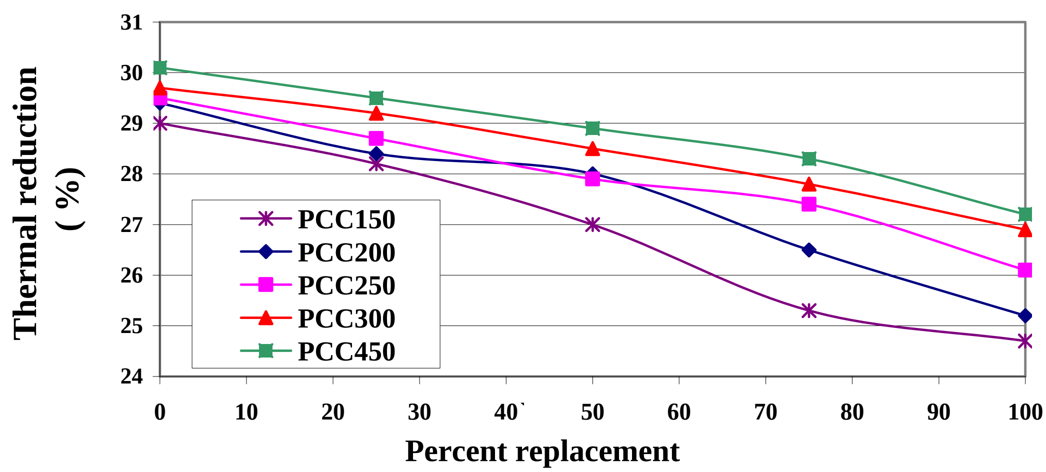


Figure 5.36: Percent replacement by olive ash versus thermal insulation for various PCC categories

5.8.3 Comparison between Thermal Insulation for Concrete Containing Olive Ash and Concrete Containing Olive Husk.

The relation between thermal reduction and additive depends on the qualities and specifications of the added material. For olive husk and olive ash the ratio of moisture and oil perform a basic factor in thermal reduction.

The difference in relation between olive husk and olive ash refers to the amount of oils contained in the one particle. Olive husk contains oils more than olive ash, because oils existed in the inner part of the particles for olive ash, but for olive husk amounts of oils contained in the inner part (2-6) % by Soxhlet Extractor for absorption the inner oils, in addition to the oils on the external surface, because it was used wet without drying. So as shown in figure 5.37, olive husk has thermal reduction more than olive ash. From igure 36 difference in thermal reduction between olive husk and olive ash for PCC150 is 3.2, 3.5, 3.5, 6.8 and 9.2 for 0, 25, 50, 75, 100% replacements respectively.

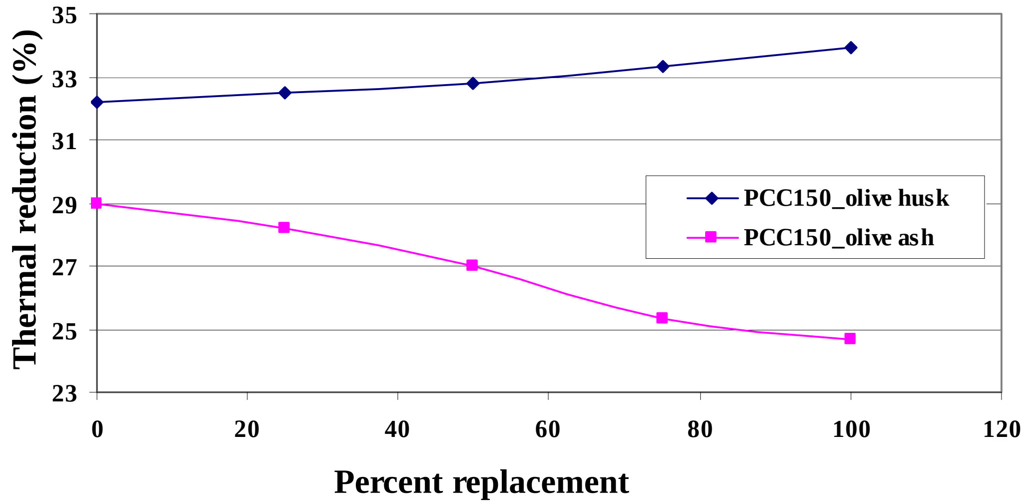


Figure 5.37: Percent by olive husk and olive ash versus thermal reduction for PCC150

5.9 Modulus of Elasticity Results Analysis

Modulus of elasticity represents materials elasticity. If the modulus of elasticity was high, it means that material is brittle or high deformation existed, however when modulus of elasticity is low, it means that material is flexible or low deformation existed.

5.9.1 Modulus of Elasticity for Concrete Containing Olive husk

For concrete containing olive husk, when compressive strength test is done, and from stress - strain curves it is clearly that modulus of elasticity is very low. It is clear from figure 5.38 that at 50%, 75%, 100% replacements no curves for modulus of elasticity appeared, because concrete compressive strength at those replacements is very low. Figure 5.38 represents modulus of elasticity for 0, 25% replacement only.

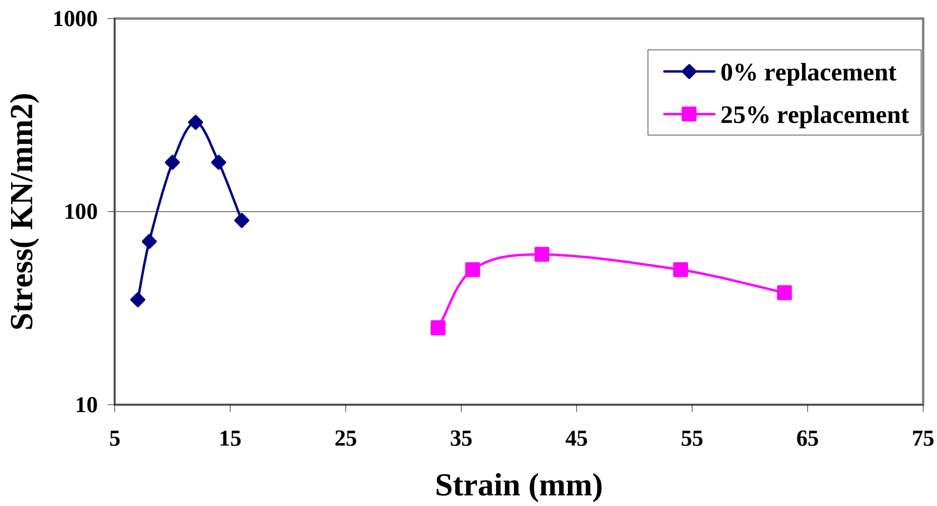


Figure 5.38: Stress versus Strain for PCC250 for percent replacements of olive husk

5.9.2 Modulus of Elasticity for Concrete Containing Olive Ash

For concrete containing olive ash, when compressive strength test is done, the failure of the specimen occurs suddenly, this happened because of high compressive strength the specimens had, which means that the concrete was brittle, so high stress recorded through low strain. Concrete failure occurs through surface specimen once a time, so modulus of elasticity will be high. Figure 5.39 shows modulus of elasticity for concrete containing olive ash.

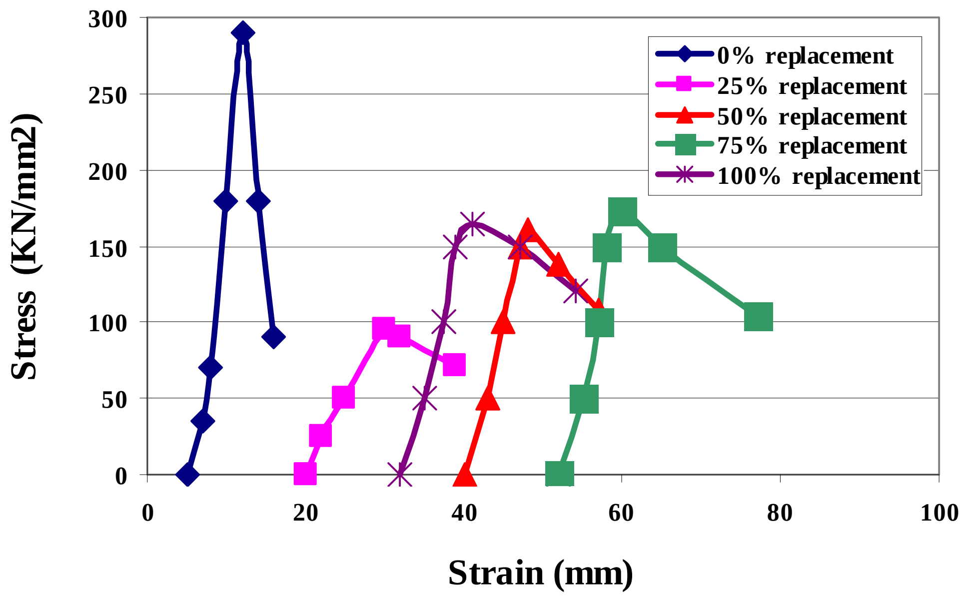


Figure 5.39: Stress-strain relationship for concrete containing olive ash of PCC250

5.9.3 Comparison between Modulus Elasticity for Concrete Containing Olive Husk and Other Containing Olive Ash

Modulus of elasticity depends on the properties of the added material to the concrete mix. So if modulus of elasticity was high this means brittle material existed, however, if modulus of elasticity was low, it means flexible material. In figure 5.40 modulus of elasticity for concrete containing olive more than that for concrete containing olive husk, because olive husk perform excessive retarder to the concrete, so stresses occur on a high strains, while olive ash accelerate concrete hardening, so stress will be high and occurs on a low strain.

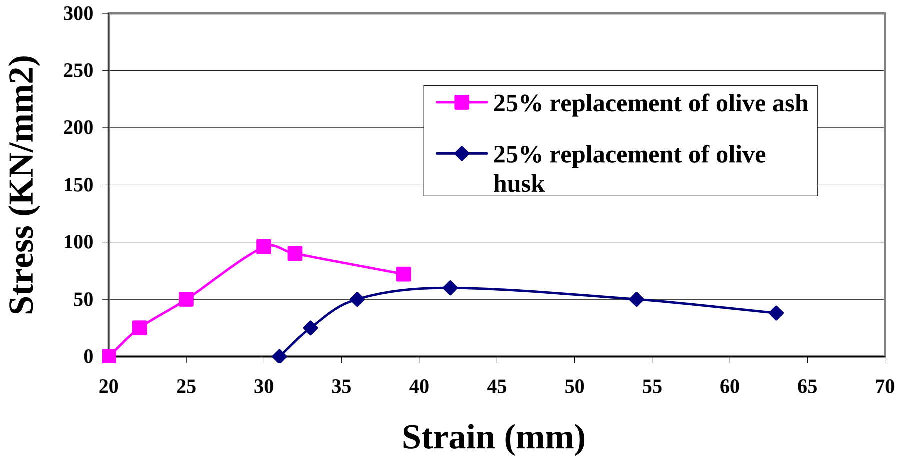


Figure 5.40: Stress-strain relationship for concrete containing olive husk and olive ash of PCC250

Chapter Six
Conclusions & Recommendations

Chapter Six

Conclusions & Recommendations

6.1 Introduction

From the previous results, olive husk and olive ash had two different effects on the physical properties of concrete.

6.2 Conclusions (Olive Husk)

Based on the results achieved and analysis discussed as apart of this research thesis for olive oil husk, the following are concluded:

- When olive husk used in concrete mix it requires a long period for curing (long period needed to be used).
- It is difficult to deal with Portland cement concrete having more than 25% by volume of replacement of olive husk.
- At 75% and 100% replacement by olive husk, Portland cement concrete looses its inherent structure.
- When a high percentage of olive husk are used, non uniformity in the mix was observed.
- The olive husk contains high oil and water content due to the high difference in weight before and after drying.

- No curing for concrete when Replacement of olive husk used, because it has enough moisture.
- Slump value in all cases is about 23-39 mm with no significant change due to replacement by olive husk.
- As percentage replacement of olive husk increases, compressive strength for all concrete categories decreases.
- As percentage replacement of olive husk replacement increases the color of concrete mix alter to the darkage color (dark brown).
- For 75% and 100% replacements of olive husk excessive retarding occurred, in return; compressive strength, abrasion, absorption, thermal and noise insulation are not applicable on that samples that carry the same proportion of replacement, due to weak bonding and cohesion between olive husk and constituents.
- As percent replacement increases, density of PCC specimens decreases.
- As olive husk replacement increases, sound insulation increases.
- For thermal insulation, as percent replacement increases, thermal insulation increases.
- Modulus of elasticity is too low.

6.3 Conclusions (Burned Olive Husk (Ash))

Based on the results achieved and analysis discussed as apart of this research thesis for Burned husk (Ash), the following are concluded:

- When burned olive husk is used as an additive to the concrete mix, hardening process will be faster than concrete mix containing olive husk, because it is totally dried, due to the high carbon content in olive ash.
- As olive ash replacement increases, concrete becomes more brittle.
- Slump value in all cases was about 23-39 mm with no significant change due to replacement by olive husk.
- As the percentage replacement of olive ash increase the color of concrete mix gets darker that (black color).
- As percentage of replaced ash increases it will be more difficult to obtain smooth surfaces due to harsher concrete mix.
- As percentage replacement of olive ash increases more water is required.
- When 100% replacement by olive ash is used in concrete mix, the cohesion property between the particles of the mix becomes weak.
- It is more suitable to test concrete containing ash after two weeks due to quick hardening by effect of ash.

- Density of concrete decreases as percent replacement of olive ash increases by as much as from (90-220)gm.

- For noise insulation, the maximum value was reached at 50% replacement, and the lowest value was reached at 100% replacement.

- For thermal insulation, as percentage replacement increases thermal insulation increase, the highest value was reached at 25% replacement and the lowest was reached at 100% replacement.

* Modulus of elasticity is too high.

6.4 Recommendations:

Based on the out come of thesis, the following can be recommended:

- It is recommended to use 25% replacement of olive husk a long with sand to ensure reasonable concrete behavior.

- It is better to use olive ash as an additive to concrete mix than olive husk, because it keeps concrete behavior.

- These types of concrete can be used for non-structural concrete, for the parts of structure that is not exposing to direct load, such as (blocks in roofs, walls, behind insulating walls, side walk blocks, walls over cantilevers).

- It is possible to use other additives in addition to olive wastes to improve physical properties of concrete.
- It is possible to use olive ash as a filler material, due to its ability in hardening process for concrete.
- It is recommended to use other mixes with different gradation from different concrete plants.
- For next researches on the same work, it is recommended to take into consideration the long term effect of olive husk and ash on the physical properties of concrete.
- It is recommended to use mix sample of olive husk and ash together as a replacement of fine aggregate, then study its effect on the physical properties of concrete.
- For next researches, it is recommended to study the effect of adding olive husk or ash on the mechanical properties of concrete.

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Appendices

Appendix "A"

Test Results

Table A-1: Weights of husk samples for compressive strength test B-150

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
	1	2095	30.0		
25	2	2086	29.3		
	3	2089	32.0	2090	32
	4	2091	35.4		
	1	2010	4.5		
50	2	2026	3.1		
	3	2034	3.8	2021	4
	4	2015	4.2		
	1	1725	2.7		
75	2	1717	2.5		
	3	1730	2.2	1721	2.6
	4	1712	2.8		
	1	1578	1.8		
100	2	1536	1.5		
	3	1560	1.3	1554	1.6
	4	1542	1.7		

Table A-2: Weights of husk samples for compressive strength, grade B 200

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
	1	2068	52.4		
25	2	2068	48.3		
	3	2069	54.6	2065	51.5
	4	2054	50.7		
	1	1970	35.2		
50	2	1978	41.9		
	3	1986	42.2	1979	37.5
	4	1980	30.8		
	1	1740	15.3		
75	2	1757	14.8		
	3	1750	13.9	1749	14.2
	4	1752	12.7		
	1	1611	5.8		
100	2	1580	6.2		
	3	1607	5.3	1604	5.7
	4	1618	5.6		

Table A-3: Weights of husk samples for compressive strength test: B-250

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
25	1	2065	62.3	2063	62
	2	2056	60.5		
	3	2058	61.8		
	4	2072	63.1		
50	1	1884	45.3	1877	43.2
	2	1858	40.8		
	3	1878	42.5		
	4	1886	44.2		
75	1	1767	14.2	1705	13.1
	2	1691	14.6		
	3	1675	11.7		
	4	1685	12.0		
100	1	1632	8.1	1610	6.9
	2	1617	6.2		
	3	1589	5.9		
	4	1603	7.4		

Table A-4: Weights of husk samples for compressive strength test: B-300

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
25	1	2031	72.4	2048	73.3
	2	2035	74.5		
	3	2072	71.8		
	4	2053	74.3		
50	1	1946	55.1	1929	53.7
	2	1936	51.6		
	3	1944	58.4		
	4	1890	49.8		
75	1	1804	38.4	1809	36
	2	1832	35.6		
	3	1810	32.7		
	4	1788	37.3		
100	1	1715	25.4	1686	21
	2	1717	18.2		
	3	1641	20.4		
	4	1671	19.8		

Table A-5: Weights of husk samples for compressive strength test: B-450

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
25	1	2049	100.7	2044	108.8
	2	2050	112.2		
	3	2033	114.6		
	4	2042	107.8		
50	1	1872	78.3	1869	75
	2	1861	75.6		
	3	1868	73.2		
	4	1876	72.7		
75	1	1771	48.7	1780	47.4
	2	1792	44.8		
	3	1771	49.2		
	4	1784	46.7		
100	1	1685	32.2	1681	29.7
	2	1705	30.7		
	3	1672	27.6		
	4	1660	28.4		

Table A-6: Weights of ash samples water saturated (surface dry) and after drying for absorption test:B-150

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2555.0	2414.4	140.6	5.8
25	2108	1914	194	8.1
50	2073	1897	176	9.2
75	1955	1776	179	10
100	1848	1722	126	10.3

Table A-7: Weights of ash samples water saturated (surface dry) and after for absorption test:B-200

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2664.0	2519.4	144.6	5.7
25	2184	1997	187	8.3
50	2051	1868	183	9.8
75	1880	1732	148	10.3
100	1732	1606	126	10.6

Table A-8: Weights of ash samples water saturated (surface dry) and after drying for absorption test: B-250

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2534.0	2392.0	142	5.9
25	2214	2082	132	6.3
50	2150	2016	134	6.6
75	1892	1750	142	8.1
100	1680	1540	140	9.1

Table A-9: Weights of ash samples water saturated (surface dry) and after drying for absorption test: B-300

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2484.0	2347.2	136.8	5.8
25	2114	1988	126	6.3
50	2010	1860	1500	8
75	1881	1728	153	8.8
100	1762	1601	161	10

Table A-10: Weights of ash samples water saturated (surface dry) and after drying for absorption test: B-450

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2629.0	2485.1	143.9	5.8
25	2210	2064	146	7.1
50	2115	1961	154	7.8
75	2095	1935	160	8.3
100	1980	1827	153	8.7

Table A-11: Weights of husk samples water saturated (surface dry) and after drying for absorption test: B-150

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2555.0	2414.4	140.6	5.8
25	2034	1918	116	5.4
50	1940	1865	110	4.7
75	1820	1734	86	5
100	1705	1627	78	4.8

Table A-12: Weights of hush samples water saturated (surface dry) and after drying for absorption test: B-200

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2664.0	2519.4	144.6	5.7
25	1999	1902	97	5.2
50	1944	1862	82	4.4
75	1892	1805	87	4.8
100	1816	1732	84	4.6

Table A-13: Weights of husk samples water saturated (surface dry) and after drying for absorption test: B-250

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2534.0	2392.0	142	5.9
25	1911	1802	109	5.5
50	1877	1795	82	4.6
75	1822	1738	84	4.8
100	1768	1687	81	4.6

Table A-14: Weights of husk samples water saturated (surface dry) and after drying for absorption test: B-300

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2484.0	2347.2	136.8	5.8
25	1859	1778	81	5.2
50	1823	1745	78	4.5
75	1798	1717	81	4.7
100	1712	1639	73	4.5

Table A-15: Weights of husk samples water saturated (surface dry) and after drying for absorption test: B-450

Replacement ash ratio (%)	Weight of sample (gm) Water saturated Surface dry	Weight of sample(gm) Totally dried	Difference gm	%
0.0	2629.0	2485.1	143.9	5.8
25	2023	1932	91	5.3
50	1988	1902	86	4.5
75	1899	1811	88	4.9
100	1786	1697	89	4.4

Table A-16: Weights of ash samples for compressive strength test:B-150

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
25	1	2180	136	2165	131
	2	2209	131		
	3	2161	134		
	4	2111	124		
50	1	1973	115	2126	137
	2	2279	172		
	3	1971	110		
	4	2281	149		
75	1	2004	116	1997	120
	2	2023	118		
	3	1942	113		
	4	2018	132		
100	1	1845	89	1802	89
	2	1826	87		
	3	1769	88		
	4	1766	93		

Table A-17: Weights of ash samples for compressive strength test: B-200

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
25	1	2207	162	2169	163.3
	2	2154	159		
	3	2174	160		
	4	2141	172		
50	1	2137	139	2084	133.8
	2	2078	131		
	3	2083	133		
	4	2038	132		
75	1	1948	112	1943.75	130.3
	2	1954	114		
	3	1960	149		
	4	1913	146		
100	1	1830	111	1796	106.8
	2	1817	101		
	3	1767	106		
	4	1770	109		

Table A-18: Weights of ash samples for compressive strength test: B-250

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
25	1	2180	159	2160	161
	2	2168	159		
	3	2141	164		
	4	2150	161		
50	1	2075	173	2086	176
	2	2121	174		
	3	2071	176		
	4	2078	181		
75	1	1837	161	1875	155
	2	1891	149		
	3	1867	150		
	4	1903	160		
100	1	1780	97	1769	95.3
	2	1779	97		
	3	1779	91		
	4	1737	96		

Table A-19: Weights of ash samples for compressive strength test: B-300

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
	1	2163	231		
25	2	2185	264	2170	245
	3	2186	242		
	4	2147	241		
	1	2100	215		
50	2	2107	216	2095	211
	3	2062	207		
	4	2111	206		
	1	1960	108		
75	2	1931	106	1938	118
	3	1946	125		
	4	1914	131		
	1	1828	122		
100	2	1794	125		
	3	1795	124	1791	123.3
	4	1748	122		

Table A-20: Weights of ash samples for compressive strength test: B-450

Replaced husk %	Sample #	Weight (gm)	Compressive strength Kg/cm2	Avrge. Weight gm	Avrge.comp. Strength Kg/cm2
	1	2069	299		
25	2	2067	314	2213	
	3	2031	303		304.3
	4	2144	301		
	1	2146	316		
50	2	2127	298	2142	
	3	2160	302		304.8
	4	2135	303		
	1	2056	315		
75	2	2090	317	2085	
	3	2108	317		317.8
	4	2089	322		
	1	1992	244		
100	2	1957	242		
	3	1937	218	1953	232.8
	4	1925	227		

Table A-21: Abrasion results for concrete grade B-150 with olive ash

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2388.8	2382.2	6.0	3
25 %	2329.5	2310.5	19	9.5
50 %	2264.5	2236.5	28	14
75 %	2016.8	2001.4	15.4	11.9
100 %	1986.7	1958.4	28.3	14.15

Table A-22: Abrasion results for concrete grade B-200 with olive ash

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2366.4	2361.2	5.2	2.6
25 %	2292.7	2273.9	18.8	11.6
50 %	2269.8	2250.6	19.2	12.7
75 %	2009.4	2998.9	10.5	13.9
100 %	1836.1	1819.7	19.4	16.9

Table A-23: Abrasion results for concrete grade B-250 with olive ash

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2347.3	2342.2	5.0	2.5
25 %	2285.3	2257.7	27.6	9.2
50 %	2110.3	2097.2	13.1	13.6
75 %	2009.5	1997.4	12.1	11.2
100 %	1820.5	1795.4	25.1	13.8

Table A-24: Abrasion results for concrete grade B-300 with olive ash

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2303.6	2297.6	4.0	2
25 %	2262.6	2245	16.4	8.6
50 %	2223.4	2196.6	25.8	12.8
75 %	1952.4	1929	23.4	11.7
100 %	1805.8	1788.8	17	13.7

Table A-25: Abrasion results for concrete grade B-450 with olive ash

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2352.9	2350.1	2.8	1.4
25 %	2232.2	2215.1	17.5	8.75
50 %	2469.2	2454.1	15.1	13.3
75 %	2297.3	2275.7	21.6	10.8
100 %	2067.1	2048.2	18.9	13.5

Table A-26: Abrasion results for concrete grade B-150 with olive husk

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2288.8	2282.2	6.0	3
25 %	2147.6	2125.4	22.2	10.1
50 %	2022.2	1997.3	24.9	12.45
75 %	1888	1862	26	13
100 %	1728	1696.3	31.7	15.85

Table A-27: Abrasion results for concrete grade B-200 with olive husk

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2366.4	2361.2	5.2	2.6
25 %	2245.5	2216.4	29.1	11.6
50 %	2124.2	2092.1	32.1	12.7
75 %	1975.4	1937.8	37.6	13.9
100 %	1855.4	1813.8	41.6	16.9

Table A-28: Abrasion results for concrete grade B-250 with olive husk

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2247.3	2242.2	5.0	2.5
25 %	2124.7	2102.5	22.2	11.1
50 %	2092.3	2068.4	23.9	11.95
75 %	1934.8	1908.3	26.5	13.25
100 %	1702.8	1675.6	27.2	17.3

Table A-29: Abrasion results for concrete grade B-300 with olive husk

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2203.6	2197.6	4.0	2
25 %	1952.4	1913.8	38.6	12.7
50 %	2040.7	1997.7	43.0	14.2
75 %	1215.4	1171.3	44.1	15.7
100 %	1112.5	1066.6	45.9	17.5

Table A-30: Abrasion results for concrete grade B-450 with olive husk

Percentage replacement of olive ash	Actual weight gm	Weight after abrasion gm	Difference in weight (Loss)gm	Average Loss (Abrasion) gm
0 %	2347.5	2344.7	2.8	1.4
25 %	2239.4	2219.3	20.1	10.05
50 %	2035.5	2011.6	23.9	11.95
75 %	1870.7	1844.6	26.1	13.05
100 %	1753.3	1713.2	40.1	16.7

Table A-31: **Thermal insulation for concrete containing olive husk**

Concrete grade	B150	B200	B250	B300	B450	Replacement %
Reduction %	32.2	33.1	34.2	35.8	36.2	0
	32.1	32.7	33.3	33.9	34.7	25
	30.5	31.2	32.8	33.9	33.8	50
	32.1	32.6	33.2	35.7	34.9	75
	33.9	34.1	34.6	35.7	35.4	100

Table A-32: Thermal insulation for concrete containing olive ash

Concrete grade	B150	B200	B250	B300	B450	Replacement %
Reduction %	29	29.4	29.5	29.7	30.1	0
	28.2	28.4	28.7	28.2	28.2	25
	27	28	28.2	28.2	28.5	50
	25.3	26.5	27.4	27.8	27.9	75
	24.7	25.2	26.1	26.9	27.2	100

Table A-33: Noise insulation for concrete containing olive husk

Concrete Grade	B150	B200	B250	B300	B450	Replacement %
Reduction %	14.7	14.6	14.5	14.2	13.9	0
	15.3	15.1	15	14.7	14.1	25
	15.9	15.6	15.4	15.1	14.7	50
	16.2	16	15.9	15.7	15.2	75
	16.8	16.6	16.3	16.1	15.8	100

Table A-34: **Noise insulation for concrete containing olive as**h

Concrete grade	B150	B200	B250	B300	B450	Replacement %
Reduction %	14.8	14.8	14.6	14.2	14.1	0
	16.7	16.6	16.3	15.8	15.8	25
	15.9	15.2	14.9	14.8	14	50
	17.1	16.8	16.6	16	14.3	75
	17.6	17.1	16.9	16.4	14.8	100

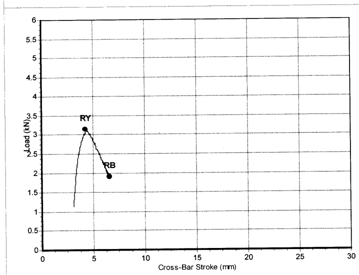
Appendix "B"

Stress-Strain Relationship

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC150-50of 02/04/2007**	**Provetta N.**		**of 02/04/2007**	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	6.55	mm	

PCC150-50-2



Tests results

Fm	3.143	kN
σM	.314	MPa
εM		%
σY	.314	MPa
εY		%
σB	.190	MPa
εB		%

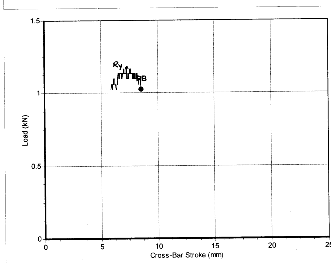
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-150-7!of! 02/04/2007**	**Provetta N.**		**of 02/04/2007**	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	8.54	mm	

PCC150-75-2



Tests results

Fm	1.170	kN
σM	.117	MPa
εM		%
σY		MPa
εY		%
σB	.102	MPa
εB		%

Operator
Eng. Ameed

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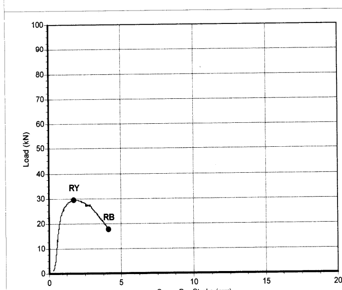
PROVA DI COMPRESSIO
NORMATIVA EN ISO (

Certificato N.	**PCC200-25of 20/03/2007**	**Provetta N.**		**of 20/03/2007**	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	4.12	mm	

PCC200-25-1



Tests results

Fm	29.458	kN
σM	2.946	MPa
εM		%
σY	2.942	MPa
εY		%
σB	1.769	MPa
εB		%

Operator
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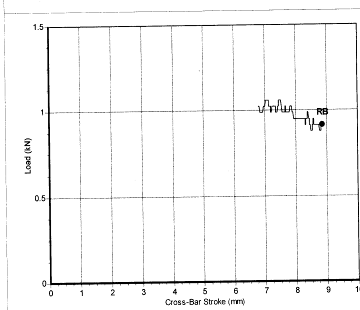
NORMATIVA EN ISO 604

Certificato N.	**PCC-200-1(of-302/04/2007**	**Provetta N.**		**of 02/04/2007**	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	8.86	mm	

PCC200-100-3



Tests results

Fm	1.060	kN
σM	.106	MPa
εM		%
σY		MPa
εY		%
σB	.091	MPa
εB		%

Operator
Eng. Ameed

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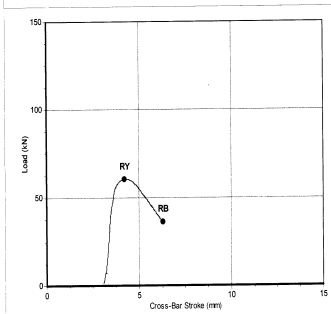
PROVA DI COMPRESSIONE
NORMATIVA EN ISO

Certificato N.	**PCC-250-2lof 02/04/2007**	**Provetta N.**		**of 02/04/2007**	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	6.30	mm	

PCC250-25-2



Tests results

Fm	60.523	kN
σM	6.052	MPa
εM		%
σY	6.052	MPa
εY		%
σB	3.633	MPa
εB		%

Operator
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PROVA DI COMPRESSIONE
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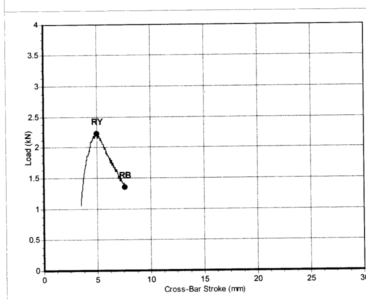
Certificato N.	**PCC-250-5(of**	**Provetta N.**		**of**	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	7.62	mm	

PCC250-50-1



Tests results

Fm	2.229	kN
σM	.223	MPa
εM		%
σY	.223	MPa
εY		%
σB	.135	MPa
εB		%

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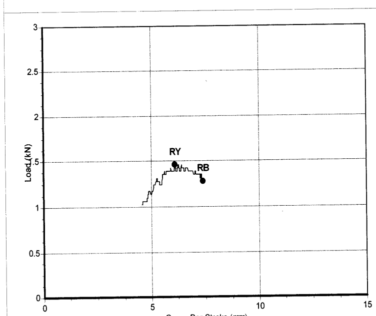
PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-250-7lof 02/04/2007**	**Provetta N.**		**of 02/04/2007**	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	7.38	mm	

PCC250-75-3



Tests results

Fm	1.462	kN
σM	.146	MPa
εM		%
σY	.146	MPa
εY		%
σB	.128	MPa
εB		%

Operator
Eng. Ameed

Manager
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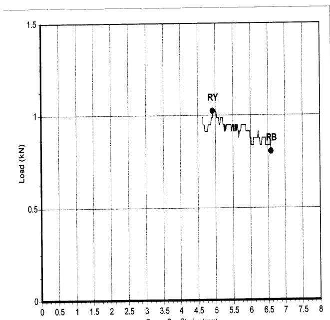
PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-250-1(of-302/04/2007**	**Provetta N.**		**of 02/04/2007**	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	6.60	mm	

PCC250-100-3



Tests results

Fm	1.023	kN
σM	.102	MPa
εM		%
σY	.102	MPa
εY		%
σB	.080	MPa
εB		%

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Manager
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PROVA DI COMPRESSIONE
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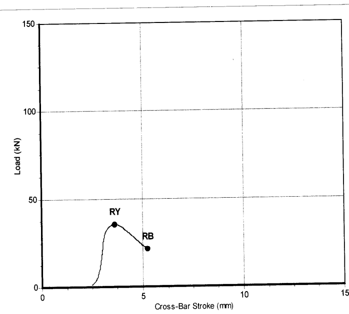
Certificato N.	PCC-300-25of 4/4 07/04/2007	**Provetta N.**		of 07/04/2007	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen	Square	**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	5.25	mm	

PCC300-25-4



Tests results

Fm	35.525	kN
σM	3.552	MPa
εM		%
σY	3.552	MPa
εY		%
σB	2.134	MPa
εB		%

Operator
Eng. Ameed

Manager
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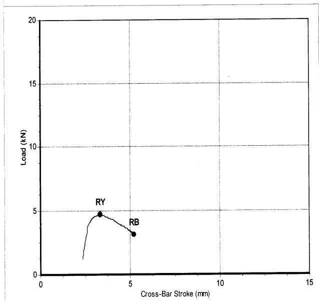
NORMATIVA EN ISO 604

Certificato N.	PCC-300-5(ofl 07/04/2007	**Provetta N.**		of 07/04/2007	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen	Square	**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	5.21	mm	

PCC300-50-4



Tests results

Fm	4.715	kN
σM	.471	MPa
εM		%
σY	.471	MPa
εY		%
σB	.314	MPa
εB		%

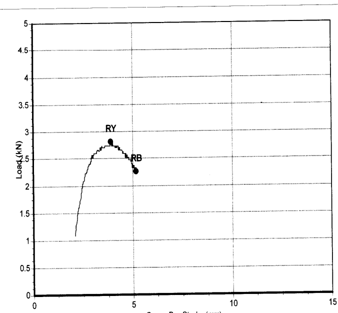
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-300-7!ofl 07/04/2007	**Provetta N.**		of 07/04/2007	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen	Square	**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	5.18	mm	

PCC300-75-1



Tests results

Fm	2.814	kN
σM	.281	MPa
εM		%
σY	.281	MPa
εY		%
σB	.227	MPa
εB		%

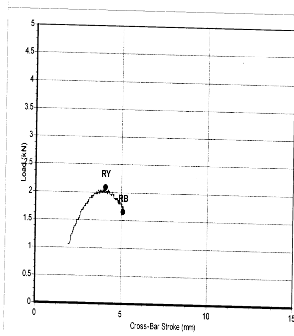
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-300-100/3/07/04/2007	**Provetta N.**		of 07/04/2007	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen	Square	**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	5.12	mm	

PCC300-100-3



Tests results

Fm	2.083	kN
σM	.208	MPa
εM		%
σY	.208	MPa
εY		%
σB	.164	MPa
εB		%

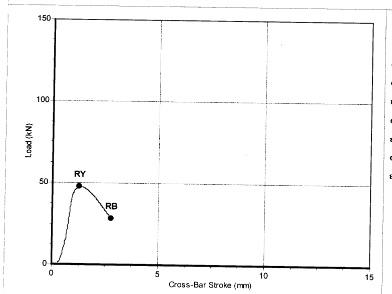
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-450-25/4 07/04/2007	**Provetta N.**		**of**	**07/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	2.78	mm	

PCC450-25-4



Tests results

Fm	47.512	**kN**
σM	4.751	**MPa**
εM		**%**
σY	4.751	**MPa**
εY		**%**
σB	2.851	**MPa**
εB		**%**

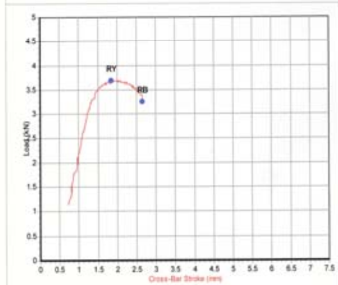
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-450-50/3 07/04/2007	**Provetta N.**		**of**	**07/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	2.65	mm	

PCC450-50-3



Tests results

Fm	3.691	**kN**
σM	.369	**MPa**
εM		**%**
σY	.369	**MPa**
εY		**%**
σB	.325	**MPa**
εB		**%**

Operator
Eng. Ameed

Manager
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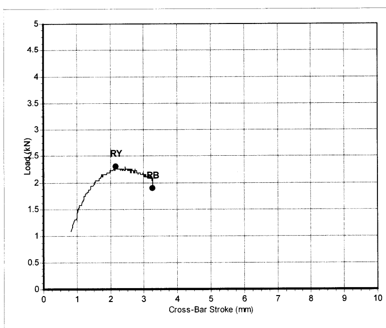
PROVA DI COMPRES
NORMATIVA EN I

Certificato N.	PCC-450-75/4 07/04/2007	**Provetta N.**		**of**	**07/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	3.27	mm	

PCC450-75-4



Tests results

Fm	2.303
σM	.230
εM	
σY	.230
εY	
σB	.190
εB	

Operator
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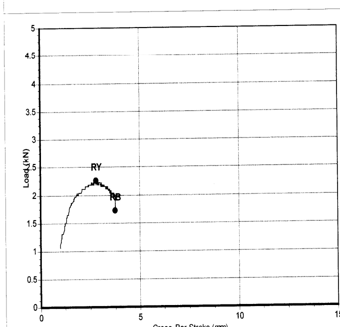
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-450-100/4 07/04/2007	**Provetta N.**		**of**	**07/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	3.76	mm	

PCC450-100-4



Tests results

Fm	2.266	**kN**
σM	.227	**MPa**
εM		**%**
σY	.227	**MPa**
εY		**%**
σB	.172	**MPa**
εB		**%**

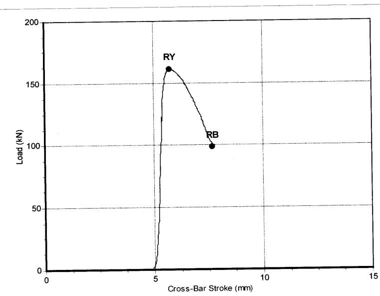
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIO
NORMATIVA EN ISO 6

Certificato N.	**PCC-250-2ofi4 14/04/2007**	**Provetta N.**		**of**	**14/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen	Square	**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	7.68	mm	

PCC250-25a4



Tests results

Fm	160.811	kN
σM	16.081	MPa
εM		%
σY	16.081	MPa
εY		%
σB	9.883	MPa
εB		%

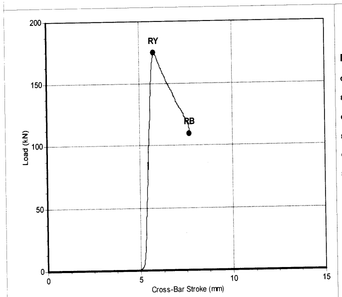
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-250-5ofi2 14/04/2007**	**Provetta N.**		**of**	**14/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen	Square	**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	7.68	mm	

PCC250-50a2



Tests results

Fm	174.114	kN
σM	17.411	MPa
εM		%
σY	17.411	MPa
εY		%
σB	10.968	MPa
εB		%

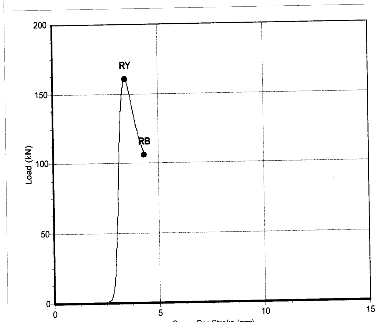
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-250-7ofia14/04/2007**	**Provetta N.**		**of**	**14/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen	Square	**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	4.32	mm	

PCC250-75a4



Tests results

Fm	160.445	kN
σM	16.045	MPa
εM		%
σY	16.045	MPa
εY		%
σB	10.639	MPa
εB		%

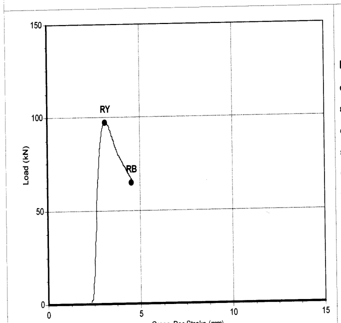
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-250-1ofia14/04/2007**	**Provetta N.**		**of**	**14/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen	Square	**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	4.55	mm	

PCC250-100a2



Tests results

Fm	97.290	kN
σM	9.729	MPa
εM		%
σY	9.729	MPa
εY		%
σB	6.491	MPa
εB		%

Operator
Eng. Ameed

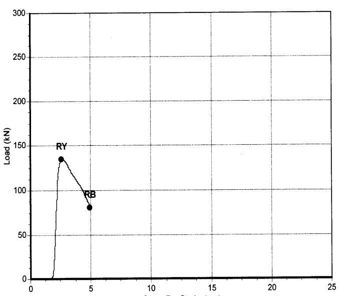
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-150-2ofa308/04/2007	**Provetta N.**		**of**	**08/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	4.95	mm

PCC150-25-a3



Tests results

Fm	134.715	**kN**
σM	13.472	**MPa**
εM		**%**
σY	13.472	**MPa**
εY		**%**
σB	8.084	**MPa**
εB		**%**

Operator
Eng. Ameed

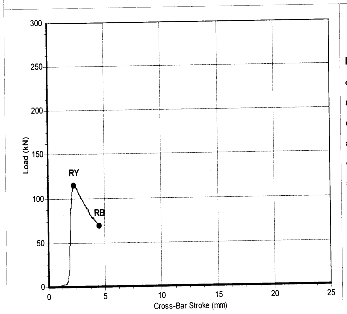
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-150-5ofa108/04/2007	**Provetta N.**		**of**	**08/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	4.51	mm

PCC150-50-a1



Tests results

Fm	114.833	**kN**
σM	11.483	**MPa**
εM		**%**
σY	11.483	**MPa**
εY		**%**
σB	6.893	**MPa**
εB		**%**

Operator
Eng. Ameed

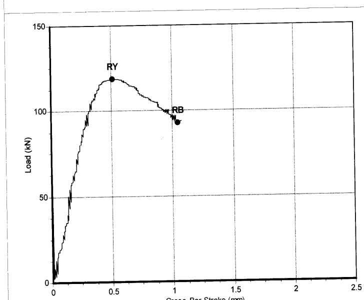
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIO
NORMATIVA EN ISO (

Certificato N.	PCC-150-7ofa208/04/2007	**Provetta N.**		**of**	**08/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	1.04	mm

PCC150-75-a2



Tests results

Fm	118.634	**kN**
σM	11.863	**MPa**
εM		**%**
σY	11.863	**MPa**
εY		**%**
σB	9.269	**MPa**
εB		**%**

Operator
Eng. Ameed

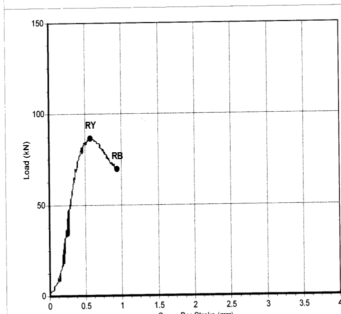
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-150-1of-a08/04/2007	**Provetta N.**		**of**	**08/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	.94	mm

PCC150-100-a2



Tests results

Fm	86.692	**kN**
σM	8.669	**MPa**
εM		**%**
σY	8.669	**MPa**
εY		**%**
σB	6.940	**MPa**
εB		**%**

Operator
Eng. Ameed

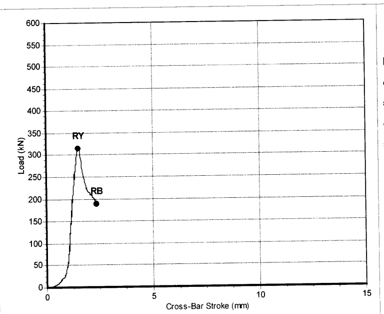
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-450-2ofi2 15/04/2007**	**Provetta N.**		**of**	**15/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	2.37	mm

PCC450-25a2



Tests results

Fm	314.421	**kN**
σM	31.442	**MPa**
εM		**%**
σY	31.442	**MPa**
εY		**%**
σB	18.873	**MPa**
εB		**%**

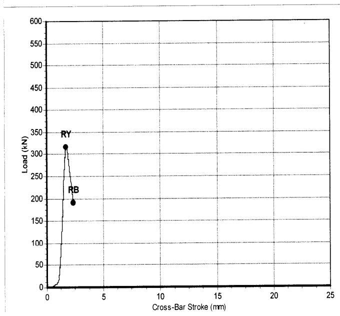
Operator	Manager
Eng. Ameed	Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-450-5ofi1 15/04/2007**	**Provetta N.**		**of**	**15/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	2.35	mm

PCC450-50a1



Tests results

Fm	315.920	**kN**
σM	31.592	**MPa**
εM		**%**
σY	31.592	**MPa**
εY		**%**
σB	19.001	**MPa**
εB		**%**

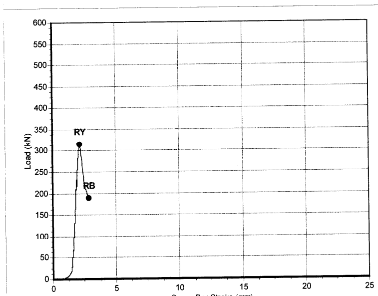
Operator	Manager
Eng. Ameed	Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-450-7ofi1 15/04/2007**	**Provetta N.**		**of**	**15/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	2.90	mm

PCC450-75a1



Tests results

Fm	314.787	**kN**
σM	31.479	**MPa**
εM		**%**
σY	31.479	**MPa**
εY		**%**
σB	18.888	**MPa**
εB		**%**

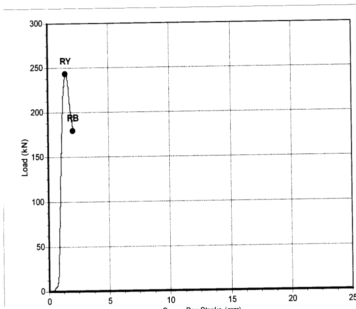
Operator	Manager
Eng. Ameed	Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	**PCC-450-1ofia 15/04/2007**	**Provetta N.**		**of**	**15/04/2007**
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	2.07	mm

PCC450-100a1



Tests results

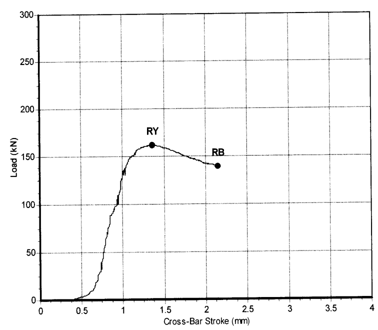
Fm	243.555	**kN**
σM	24.355	**MPa**
εM		**%**
σY	24.355	**MPa**
εY		**%**
σB	17.927	**MPa**
εB		**%**

Operator	Manager
Eng. Ameed	Eng. Abdelnaser

PROVA DI COMPRESSIO
NORMATIVA EN ISO (

Certificato N.	PCC-200-2ofa108/04/2007	**Provetta N.**		**of** 08/04/2007	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	2.15	mm	

PCC200-25-a1



Tests results

Fm	161.944	kN
σM	16.194	MPa
εM		%
σY	16.194	MPa
εY		%
σB	13.870	MPa
εB		%

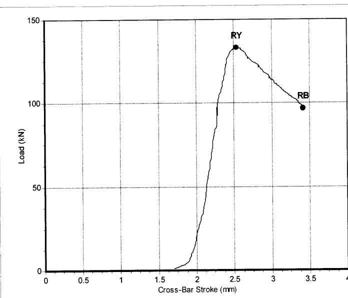
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-200-5ofa408/04/2007	**Provetta N.**		**of** 08/04/2007	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	3.42	mm	

PCC200-50a4



Tests results

Fm	132.888	kN
σM	13.289	MPa
εM		%
σY	13.289	MPa
εY		%
σB	9.663	MPa
εB		%

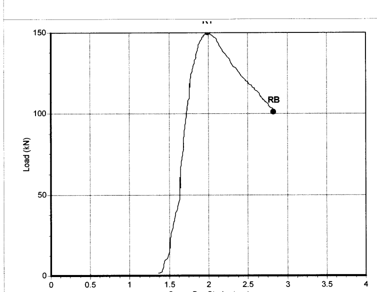
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIO
NORMATIVA EN ISO (

Certificato N.	PCC-200-7ofa308/04/2007	**Provetta N.**		**of** 08/04/2007	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	2.82	mm	

PCC200-75a3



Tests results

Fm	149.883	kN
σM	14.988	MPa
εM		%
σY	14.988	MPa
εY		%
σB	10.105	MPa
εB		%

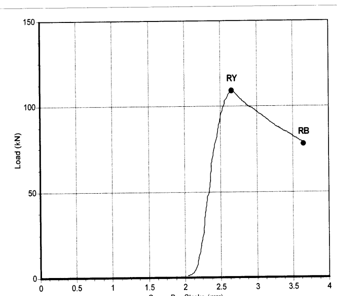
Operator
Eng. Ameed

Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N.	PCC-200-1ofa08/04/2007	**Provetta N.**		**of** 08/04/2007	
Lotto di Consegna					
Natura del Materiale	Dr.Abaza				
Massa Lineica		**Temperatura Amb.**	20		
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical		
Umidità Relativa		**Direzione Prelievo**	Vertical		
Specimen Square		**Speed 1**	1.00	mm/min	
Width	100.00 mm	**Speed 2**	0.50	mm/min	
Thickness	100.00 mm	**Lo**	.00	mm	
		Le	.00	mm	
Preloading time	.00 sec	**Lc**	.00	mm	
So	10000.000 mm²	**Lu**	3.65	mm	

PCC200-100a4



Tests results

Fm	108.876	kN
σM	10.888	MPa
εM		%
σY	10.888	MPa
εY		%
σB	7.788	MPa
εB		%

Operator
Eng. Ameed

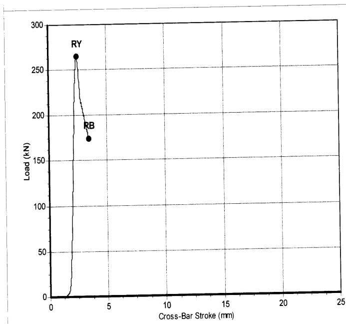
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N. PCC-300-2of12 14/04/2007	**Provetta N.**		**of** 14/04/2007
Lotto di Consegna			
Natura del Materiale Dr.Abaza			
Massa Lineica		**Temperatura Amb.**	20
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical
Umidità Relativa		**Direzione Prelievo**	Vertical

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	3.44	mm

PCC300-25a2



Tests results

Fm	264.131	kN
σM	26.413	MPa
εM		%
σY	26.413	MPa
εY		%
σB	17.371	MPa
εB		%

Operator
Eng. Ameed

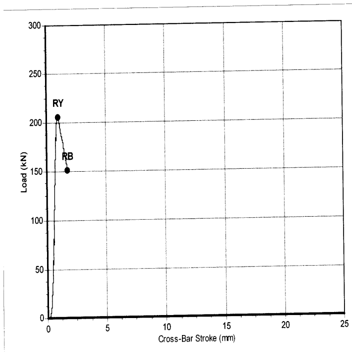
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N. PCC-300-5of4 14/04/2007	**Provetta N.**		**of** 14/04/2007
Lotto di Consegna			
Natura del Materiale Dr.Abaza			
Massa Lineica		**Temperatura Amb.**	20
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical
Umidità Relativa		**Direzione Prelievo**	Vertical

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	1.78	mm

PCC300-50a4



Tests results

Fm	205.911	kN
σM	20.591	MPa
εM		%
σY	20.591	MPa
εY		%
σB	15.098	MPa
εB		%

Operator
Eng. Ameed

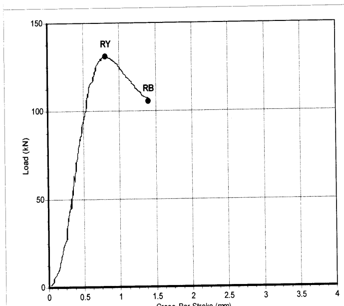
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N. PCC-300-7of4 14/04/2007	**Provetta N.**		**of** 14/04/2007
Lotto di Consegna			
Natura del Materiale Dr.Abaza			
Massa Lineica		**Temperatura Amb.**	20
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical
Umidità Relativa		**Direzione Prelievo**	Vertical

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	1.40	mm

PCC300-75a4



Tests results

Fm	130.878	kN
σM	13.088	MPa
εM		%
σY	13.088	MPa
εY		%
σB	10.529	MPa
εB		%

Operator
Eng. Ameed

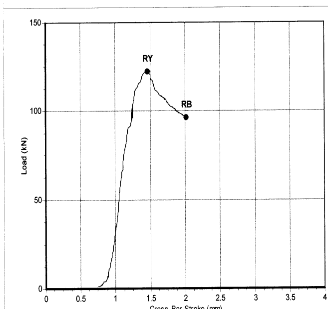
Manager
Eng. Abdelnaser

PROVA DI COMPRESSIONE
NORMATIVA EN ISO 604

Certificato N. PCC-300-10fa14/04/2007	**Provetta N.**		**of** 14/04/2007
Lotto di Consegna			
Natura del Materiale Dr.Abaza			
Massa Lineica		**Temperatura Amb.**	20
Classe (EN 10002/2)		**Posizione Prelievo**	Vertical
Umidità Relativa		**Direzione Prelievo**	Vertical

Specimen Square			**Speed 1**	1.00	mm/min
Width	100.00	mm	**Speed 2**	0.50	mm/min
Thickness	100.00	mm	**Lo**	.00	mm
			Le	.00	mm
Preloading time	.00	sec	**Lc**	.00	mm
So	10000.000	mm²	**Lu**	2.02	mm

PCC300-100a4



Tests results

Fm	122.070	kN
σM	12.207	MPa
εM		%
σY	12.207	MPa
εY		%
σB	9.623	MPa
εB		%

Operator
Eng. Ameed

Manager
Eng. Abdelnaser

جامعة النجاح الوطنية
كلية الدراسات العليا

إستخدام جفت الزيتون بدلا من الرمل في الخلطات الخرسانية لإنتاج باطون وذلك لأغراض غير إنشائية

إعداد
إياد جميل أحمد بني عودة

إشراف
د. أسامة أباظة

قدمت هذه الأطروحة استكمالا لمتطلبات درجة الماجستير في هندسة الطرق والمواصلات بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.
2007

استخدام جفت الزيتون بدلا من الرمل في الخلطات الخرسانية لإنتاج باطون لأغراض غير إنشائية

إعداد

إياد جميل أحمد بني عودة

إشراف

د. أسامة أباظة

الملخص

هذا العمل يهدف إلى حل المشاكل البيئية الناجمة عن جفت الزيتون و جفت الزيتون المحروق وذلك عن طريق استخدامها في الخلطات الخرسانية. من ناحية أخرى يهدف هذا البحث إلى دراسة آثار استخدام مخلفات زيت الزيتون على الخواص الفيزيائية للخلطة الخرسانية.

من أجل تحقيق هدف هذا البحث، آلية العمل الآتية سوف تأكد وتعبر عن الخواص الفيزيائية للخرسانة عندما يستخدم جفت الزيتون والجفت المحروق في إنتاج الباطون الخفاف، الفحوصات الآتية نفذت: التدرج الحبيبي والوزن النوعي للحصمة، الرمل، جفت الزيتون وكذلك الجفت المحروق. النسب المختلفة المستبدلة من الجفت والجفت المحروق بالرمل كانت (0، 25، 50، 75، 100)%لدرجة الباطون (B150، B200، B250، B300، B450) ، لكل نوعية خرسانة تم عمل أربعة عينات من المكعبات الخرسانية من أجل عمل فحوصات التهدل، الكثافة وقوة التحمل، هذا بالإضافة إلى ثلاثة عينات من أجل عمل فحوصات الامتصاص، الأهتراء، العزل الصوتي، العزل الحراري .

النتائج لجميع النسب المئوية المستبدلة ولجميع درجات الخرسانة كانت (23–29)ملم لاختبار التهدل. بالنسبة للجفت و الجفت المحروق كلما زادت النسب المستبدلة تقل الكثافة و قوة التحمل بالنسبة إلى الجفت امتصاص الماء يقل عندما يتم استبداله بنسب 25%، 50% لكنه يزيد عند استخدام نسبة 75% و يقل عند استخدام نسبة 100% من الجفت. بالنسبة للجفت المحروق كلما زادت النسبة المئوية المستبدلة امتصاص الماء يقل. بالنسبة لفحص الأهتراء ، يزيد الفقدان

بالوزن نتيجة الأهتراء كلما زادت النسب المئوية المستبدلة من الجفت و الجفت المحــروق، مــا عدا أنه يقل عند نسبة 50% من الجفت المحروق .

مفتاح الكلمات: الخرسانة الأسمنتية، مخلفات زيت الزيتون، الجفت، الجفت المحــروق، استخدام، باطون لأغراض غير إنشائية.