Palestine Polytechnic University

College of Engineering and Technology

Reuse of stone slurry waste water in production of ready mix concrete

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أهداء

الى من جرع الكأس فارغا ليسقيني قطرة حب

الى من كلَّت انامله لنا لحظة سعادة

الى من حصد الاشواك عن دربي ليمهد لي طريق العلم

الى القلب الكبير ....(والدي العزيز)

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الى من يحملون في عيونهم ذكريات طفولتي وشبابي ....أخوتي وأخواتي

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الى من ضحوا بحريتهم من اجل حرية غيرهم........الاسرى والمعتقلين

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شكر وتقدير

(قل اعملوا فسيرى الله عملكم ورسوله والمؤمنون)

صدق الله العظيم

ألهي لا يطيب الليل الا بشكرك ولا يطيب النهار الا بطاعتك ..ولا تطيب اللحظات الا بذكرك..

ولا تطيب الاخرة الا بعفوك. ولا تطيب الجنة الا برؤيتك

الله جل جلاله......

لا بد لنا ونحن نخطو خطواتنا الاخيرة في الحياة الجامعية من وقفة نعود الى اعوام قضيناها في رحاب الجامعة مع أساتذتنا الكرام الذين قدموا لنا الكثير باذلين بذلك جهودا كبيرة في بناء جيل الغد لتبعث الامة من جديد....

وقبل ان نمضي نقدم أسمى أيات الشكر والامتنان والتقدير والمحبة الى الذين حملوا اقدس رسالة في الحياة.......

الى الذين مهدوا لنا طريق العلم والمعرفة ....

الى جميع أساتذتنا الأفاضل.....

"كن عالما ... فان لم تستطع فكن متعلما , فان لم تستطع فأحب العلماء, فان لم تستطع فلا تبغضهم"

ونخص بالتقدير والشكر الأب الروحي لتخصص الهندسة المدنية والذي علمنا التفاؤل والمضي الى الامام,الى من رعانا وحافظ علينا, الى من وقف الى جانبنا عندما ضللنا الطريق....

أ . الدكتور نبيل الجولاني.....

الذي نقول له بشراك قول رسول الله صلى الله عليه وسلم:

"ان الحوت في البحر, والطير في السماء, ليصلون على معلم الناس الخير"

Abstract

This research investigates the effect of using wastewater from stone slurry waste on concrete properties. The variables of the research are, type of water (tab, stone slurry water, a-with flocculant, b- without flocculant), w/c ratio (0.5, 0.6 , 0.7) , type of tests (slump, compressive , flexural tensile, and absorption), curing time (7,14,28 days) and percent of wastewater replacement as substitute of tab water (30% and 100%).

27 concrete batches were prepared (over 240 samples were prepared). From each concrete batch the following samples were casted: 6 cubes for compressive test, 2 cubes for absorption test after 28 days, one beam (10 cm x 10 cm x 50 cm) for flexural tensile test after 28 days cuing. The experimental data were recorded as the average of two sample tests after each curing age.

The test results revealed a decrease in slump of fresh concrete (workability) by using wastewater in substitute of tab water.

The results showed that at w/c=0.7 the compressive strength of concrete after 28 day curing didn't affected significantly at replacement ratio of 30% and 100%. However, at w/c of 0.5 and 0.6 a varying reduction of compressive strength were observed, at different ages and replacement ratios of stone slurry wastewater were observed.

Analysis of the tests results showed that, at 20% replacement of tab water with stone slurry wastewater, the range of reduction in compressive strength is within the acceptable range of the ACI code for nontraditional mixing water.

For reinforced concrete stone slurry wastewater may be used at w/c =0.7and replacement ratio(30% and 100%) for production of self-compacted concert , low grade concrete or plane concrete .

ملخص

تبحث هذه الدراسة في تأثير استخدام المياه المستخلصة من مادة ربو قص الحجر على خصائص الخرسانة الطازجه والمتصلبة. وتهدف هذه الدراسة بالدرجة الأولى الى توفير كميات من المياه العذبه المستخدمة في صناعة الخرسانة الجاهز عن طريق استبدالها بالمياه المستخلصة من ربو المحاجر.

أهم متغيرات هذه الدراسة هي 3 انواع من المياه وهي المياه العذبه الطبيعية ونوعين من مياه الربو 1- مياه من الربو المضاف الية مادة الترسيب الكيميائية 2- مياه الربو بدون المادة المرسبة , وكذلك 3 نسب من مياه الخلط الى الأسمنت وهي (w/c = 0.5 , 0.6, 0.7) , ومجموعة من الأختبارات المعملية وهي (الهبوط للخرسانة الطازجه , مقاومة الضغط ,مقاومة الشد , والامتصاص الطبيعي بعد 28 يوم معالجة) , والمتغير الأخير هو فترة المعالجة وهي 7 و 14 و 28 يوم. وكذلك تم العمل على نسبتين للاستبدال لمياه ربو قص الحجر بالمياه العذبة وهي (30% و 100%).

تم تحضير 27 خلطة خرسانة بمجموعة عينات يزيد عن 240 عينة كالتالي:

كل خلطة خرسانة رطبة تم فحصها لقابلية التشغيل (slump)

6 عينات مكعبة (10 x 10 x 10) سم ، يتم فحص عينتين بعد كل عمر معالجة

2 عينة مكعبة بنفس المقياس السابق يتم فحص الأمتصاص بعد 28 يوم معالجة.

جسر واحد ابعاده (50*10* 10 سم) لفحص مقاومة الشد.

أظهرت نتائج فحص قابلية التشغيل (Slump) هبوط كبير قابلية التشغيل وخاصة عن نسبة خلط w/c=0.5 . كما بينت النتائج ان استخدام نسبة خلط w//c=0.7 لم يؤثر على مقاومة الضغط للخرسانة بعد 28 يوم معالجة واستبدال مياه 30% ,100% ، من جهة اخرى اظهرت النتائج ان استخدام نسب خلط (w/c= 0.6 , 0.5) تسبب في هبوط متفاوت في مقاومة الضغط وعند نسب الأستبدال 30% و 100%. وكذلك اظهرت النتائج ان قيمة الأمتصاص لم تتغير كثيرا عند نسب خلط (w/c= 0.6 , 0.7) ، على عكس التغير الذي حصل عند استخدام w/c=0.5 حيث كان الهبوط الأمتصاص كبيرا.

من خلال رسم علاقات لجميع نسب الأستبدال من مياه ربو قص الحجر ، يمكن الأستنتاج انه يمكن استخدام نسبة استبدال عن 20% كبديل عن مياه الشرب المستخدمة في صناعة الخرسانة لانه عند هذه النسبة لن يكون هناك تاثير كبير على مقاومة الضغط للخرسانة. وكذلك يمكن استخدام نسبة مياه ربو قص الحجر كبديل عن مياه الشرب في الخلطات الخرسانية بنسب استبدال 30% او 100% عندما تكون نسبة الماء الى الأسمينت w/c=0.7 والتي يمكن ان تستخدم لانواع محدده من الخرسانة التي لا تتطلب مقاومة ضغط عالية.

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Terminologies

Symbol	Meaning
W/C	Water cement ratio
LLW	limestone liquid Wastes
PWA	Palestinian Water Authority
MC	Meter Cube
TSP	Tensile Strength Properties
BDL	Below Detectable Limit
ASTM	American Society of Testing and Materials
TSS	Total Suspended Solid
TDS	Total Dissolved Solid
EC	Electrical Conductivity
GDP	Gross Domestic Product
OPC	Ordinary Portland Cement
sw	Stone slurry wastewater

Chapter One

Introduction

1.1 General Background

Concrete is a substance used for building which is made by together cement, sand, aggregates, and water [1]. Concrete is the second most consumed substance in the world after water, concrete is required approximately for 80% of the construction [2].

With increasing the human need for tap water and water scarcity in the Middle East general and in the West Bank and Gaza Strip in particular due to the occupation policy and restrictions, and based on access to statistics and studies, it was found that the water need for municipal use in 2015 is about 218 MCM and this value is expected to increase further to 268 MCM in 2020 [3].

The quality of the water plays an important role in the preparation of concrete. Impurities in water may interfere with the setting of the cement and may adversely affect the strength and durability of the concrete also. The chemical constituents present in water may actively participate in the chemical reactions and thus affect the setting, hardening and strength development of concrete.
The suitability of water can be identified from past service records or tested to performance limits such as setting times and compressive strength and durability test .Limits are specified for mixing water with their constituents such as total alkalis, chloride sulfate etc. Biological treatment and pathogen reductions are also ensure safety in handling of reclaimed water and saline water [4].

1.2 Statement problem

This project will try to answer the following question: what is the effect of using wastewater from stone slurry waste on properties of fresh and hardened concrete?

The following sub-problems will be answered

1. What is the effect of using stone slurry water on concrete compressive strength, slump, durability, absorption and tensile strength?
2. What is the economic feasibility of using stone slurry water in the production of concrete?

1.3 Importance and objectives of the research

It is important to discuss the percentage of tab water used in the concrete mix and replace it with waste water separated from stone slurry waste. This idea reduces the economic cost of the concrete mix and will also contribute to reducing the environmental problem which caused by disposal of stone slurry waste, in sewer work and open areas.

- **Main objective:**

To investigate the properties and behavior of concrete as aresult of replacement of tab water with stone slurry water.

- **Sub-objective:**

To contribute in mitigation of the environmental pollution which caused by stone slurry waste water.

1.4 Research Variables

- Three types of water used (tab water), and stone slurry waste water (with and without flocculant)
- Replacement ratios (30%, 100%)
- (w/c) ratio (0.5, 0.6, 0.7).
- Curing time of concrete7, 14, 28 days.

The distinguishing concrete tests are: slump test, compression test, tensile strength and absorption.

1.5 Research Hypotheses

The researcher assume that any type of contaminated water can be used in the concrete mix and obtain a concrete resistance of not less than 90% of the resistance of the concrete made of clean water.

- The researcher assumes that the waste water of the stone slurry will not adversely affect the properties of the concrete.
- The researcher assumes that the stone slurry waste water will achieve positive results because it contains fine filler material.

1.6 Research Tools

In this research the two tools were used.

a- Special questionnaire was designed to collect data from stone cutting and concrete factories. The questionnaire contain information about each factory and the monthly consumption of tab water and generation of stone slurry wastewater.

b-The experiment: a series of laboratory experiments were conducted to investigate the effect of stone slurry wastewater on concrete properties.

1.7 Method of conducting research

In order to achieve the objective of the project, the following steps will be followed:

1. Prepare concrete constituent material and test for their properties.
2. Mix the concrete constituent and prepare sufficient sample (cubes 10*10*10cm).
3. Make slump test for each mix.
4. Cast the concrete in molds and compact it in layers (25 blows / layer)
5. Curing of concrete samples in water.
6. Test all the sample (compressive strength, tensile strength, absorption) after specific time (7,14,28 days).

1.8 Research structure

The research will contain several chapters:

- Chapter one: Introduction.
- Chapter two: Literature review.
- Chapter three: Experimental work.
- Chapter four: Experimental test results.
- Chapter five: Comparison of results and discussion.

1.9 Work plan

The work plan, of the research is shown in tables (1.1 and 1.2)

Table (1.1): Work plane of second semester 2017/2018

Month / Task	January	February	March	April
Identifying project idea				
Formation of project problem				
Obtaining production formulas				
Sourcing raw materials and preparing it				
Preparing research proposal and concept				
Literature review				
Performing preliminary experiments				
preliminary experiments results analysis				
Documentation and presentation of research proposal				

Table (1.2): Work plan for first semester 2018

Month / Task	September	October	November	December
Investigate the effect of using stone slurry waste water in concrete mixture	■			
Testing different mixes of concrete mixture with different variable	■	■	■	
Data analysis preparation of chart and tables		■	■	
Documentation and presentation of project			■	■

1.10 Expected difficulty

1- The stone cutting owners usually didn’t give accurate information for privacy.

2- Most of the stone cutting plants and concrete plants are located in zone (c), where there is limited access to the area because of Israeli.

Chapter Two

Literature Review

2.1 Introduction

Methods of industrial liquid waste reduction, liquid waste reuse and recycling are the preferred options when managing industrial liquid waste. There are many environmental benefits that can be derived from the use of these liquid waste. The reduction of industrial liquid waste will reduce or prevent greenhouse gas emissions, reduce the release of pollutants, conserve resources, save energy and reduce the demand for liquid waste treatment technology. Therefore it is advisable that these methods be adopted and incorporated as part of the liquid waste management plan [5].

2.2 Study area

The industrial area is located south of Hebron city, it contains 170 factories, the most important industries are marble, shoes industry and the glass industry, The number of stone and marble factories in the region is about 200, the factory produces about 12% of the Palestinian GDP the marble and stone industry specially produce about 5% of the Palestinian GDP according to united Palestinian industry figure (2.1) show the study area in Hebron city.

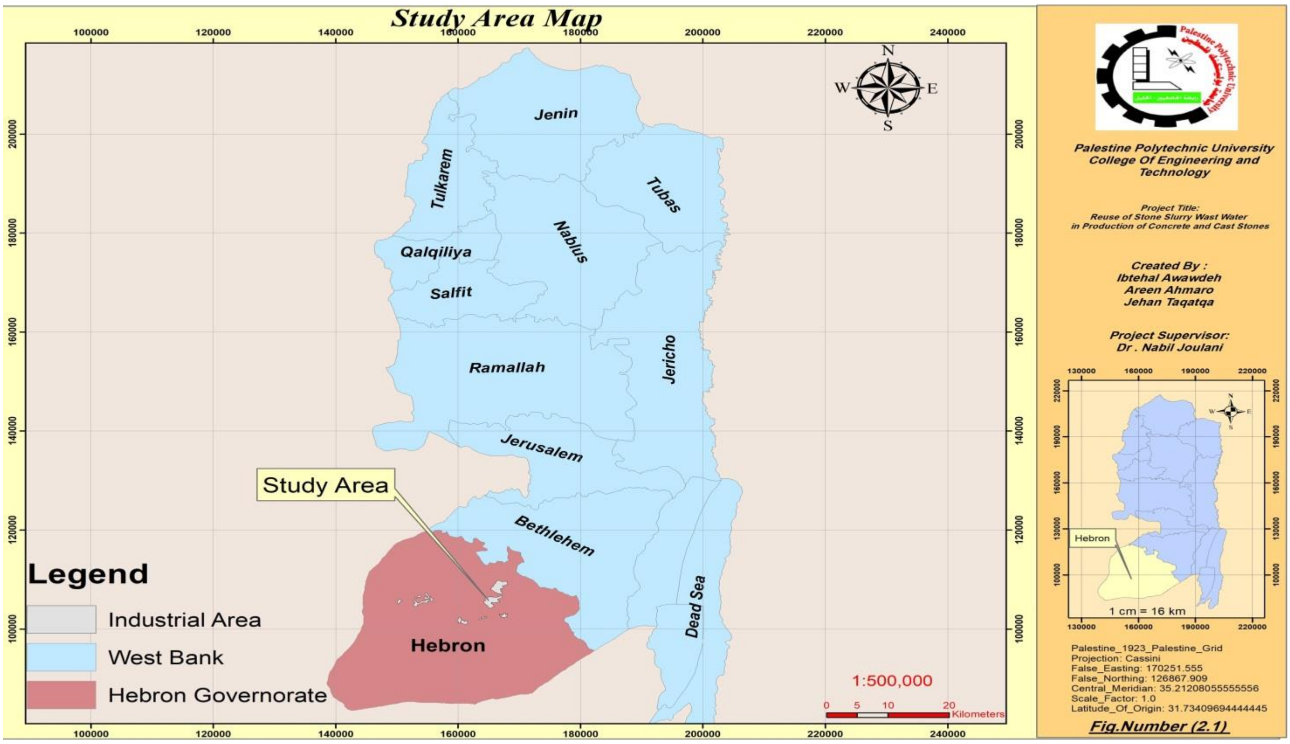

Figure (2.1): Study area map

2.3 Local Industrial liquid Wastes/by products

2.3.1 Stone Cutting Industry

Most of limestone liquid wastes (LLW) are cumulated, which cause environmental impacts and health effects[6] .In Palestine, quarrying and stone cutting industry generates a huge amount of stone slurry waste, which is disposed in open areas and sewage network. It causes serious environmental impact to water, air, soil, landscape, biodiversity and human communities. The stone cutting liquid wastes could be used in artificial stones production closely to natural stones specifications [7].The removed quarry dust from the aggregates by washing is referred as limestone dust. The most important uses of limestone dust are: in agricultural as liming material, in plastics and paper industry as filler, and in many other industries.

For the purpose of this study a questionnaire was designed to collect information about the monthly amount of fresh water consumed by the stone cutting industry and concrete industry, and the monthly amount of wastewater generated from the stone cutting industry. The survey covered 31 stone cutting factory. The results of the survey revealed that the total monthly consumption of fresh water in 31 stone cutting factory is about 2409 m^3, and about 3100 m^3 for two ready concrete plant. The information collected about the stone cutting factories and ready mix concrete plants are presented in Appendix A and the questionnaire in Appendix B.

2.3.2 Concrete and water

Water and concrete have many common relationships. As an analogy, if water consumed more than any other natural resource, concrete is used more than any other man made material on the planet. Water is the key ingredient of concrete which, when mixed with cement, forms a paste that binds the aggregate together. Water causes the hardening of concrete through a process called hydration. In the USA as of 2005, over six billion tons of concrete are made each year, amounting to the equivalent of one ton for every person on the earth [8]. The concrete industry uses over one trillion gallons of water each year worldwide, not including washing and curing water [9]. Due to the current water shortage in the world, there is a need of, as well as opportunities to look for, new non-conventional water resources for use in concrete production. Studies indicated that 65 % of slurry generating from the stone cutting process is water while the solid particles represent only 35 %, so it could be considered as a source of water and can be recycled in concrete mixes [8].

At present, stone cutting factories generate high quantities of stone slurry, which are expected to increase due to the increase in using stone, marble, and granite. The equipment used in stone cutting processes requires the use of large amounts of water, for cooling, lubrication, and cleaning. In general, it is estimated that about 20 % of the total weight of the stone block is converted into slurry. PWA estimate the present demand of municipal water demand is 101.3 MCM/year and the water industry demand is 8.3 MCM/ year, it represent 8% of municipal water demand [3].According to ministry of industry in Palestine 13,131 MC/year industries distribution in Gaza strip and west bank [9].

Quarrying and mining present 1.7% of industries. Figure (2.2) show the percentage of the Palestine industries activities [3].

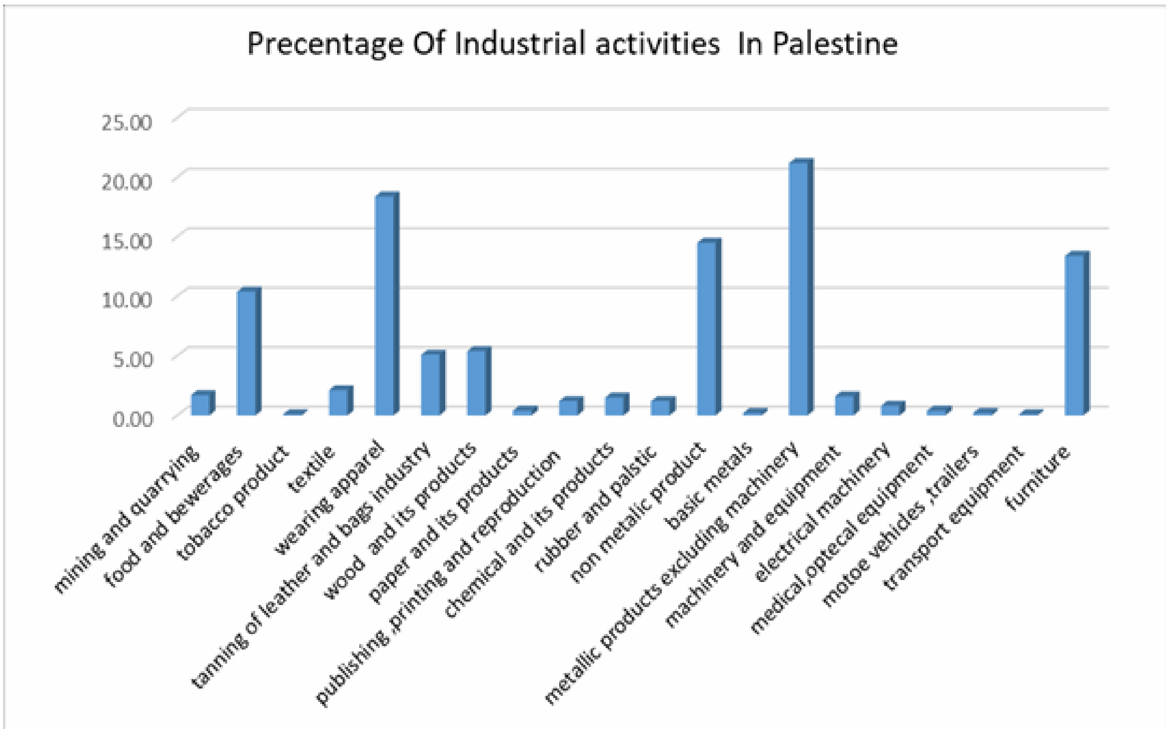

Figure (2.2): Percentage of industrial activities in Palestine [3].

2.4 Conclusion of literature Review

The following tables (2.1, 2.2, and 2.3) present summary of the literature researches about using the stone slurry waste in concrete, bricks and artificial stones (cast stones).

Table (2.1): Concrete from stone slurry waste.

Ref. no	year	Type of stone waste	Sample size	Curing of test (day)	Tests	Results
[10]	2015	Stone slurry water	Cubes 5x5x5 cm cylinder 15 cm x 30 cm	7 days 14 days 28 days	Compressive strength, Splitting tensile strength, natural water absorption	The result showed the used of stone slurry water in concrete mixture improved the work ability , compressive strength , splitting and natural absorption , therefore it recommended to used slurry stone water in production non-structural concrete (in backfill) .
[11]	2013	Stone slurry	Cylinders 30x20cm 30x10cm	7, 14, 21, 28 day	workability, compression strength, tensile strength And flexural strength.	The obtained results indicated that the slump values decreased as the ratio of slurry water increased,The compressive strength of concrete showed a gradual increase as slurry percentage increased up to a substitution percentage of 50 % Direct tensile strength Increased in concrete tensile strength relative to the control sample were approximately -8.2, -9.9, 4.3, and 3.9 % flexural strength of the hydraulic mortars increased in concrete flexural strength ranged from 5.5 % - 18.4%
[12]	2015	Stone slurry powder	Standard cubes (150X 150 X 150) mm (70.6 X 70,6X 70.6) mm standard cylinders (150mm dia X 30mm height)	7 days 14 days 28 days	slump cone test, Workability compressive strength , flexural strength and splitting tensile strength	When 12% TSP was used in Concrete, the compressive strength and the split tensile strength of concrete have been increased. Cement compressive strength has been increased When 12% TSP was used. Concrete compressive strength and the split tensile strength have been decreased linearly when 16%, 24% and 28% TSP was used.
[13]	2006	Slurry water	Cubes (150 X150 X150 mm)	7 days 28days	Compressive Strength, Indirect single tensile	Result showed compressive strength increased about 20-40% according to standard sample , and tensile increased about 25 % according to standard sample .

Table (2.2): Bricks from stone slurry waste .

Ref no	Year	Type of stone waste	Sample size	Curing of test (day)	Tests	Results
[5]	2013	Slurry stone	230x115x75 mm	7 days 14 days 21 days	Compressive Strength	When we used slurry stone strength increase Maximum compressive strength was obtained at an additional 30% slurry sludge in bricks mixture
[14]	2016	Slurry stone	Cubes (10 x10 x 10cm)	7 days 14 days 21 days	Compressive strength, Tensile strength, Flexural strength	The result was showed When use slurry kota stone in bricks mixture it improved compressive strength , tensile strength and flexural strength

Table (2.3): Artificial stone from stone slurry waste.

Ref .no	Year	Type of stone waste	Module size	Duration	Tests	results
[7]	2014	Slurry Powder	5x 8cm	7 days 14 days 28 days	Compressive strength, Absorption Compressive pressure Flexural strength	increase absorption of stone
[15]	2017	Slurry stone	5 x5 cm	7 days 14 days 28 days	Compressive strength Compressive pressure Flexural strength Abrasion Temperature Density resistance absorption	the results showed increased all properties when used slurry stone in artificial stone

The chemical composition of different stone slurry waste from different countries is shown in table (2.4)

Table (2.4): Chemical analysis of stone slurry waste water (Mass/Mass) %.

	[16] Jordan	**[17] Portugal**	**[18] Jordan**	**[19] India**	**[7] Palestine**	**[6] Technical University of Lisbon**	**[11] Jordan**
SiO_2	0.83	0.91	0.26	29.27	1.21	17.50	0.79
Cao	54.22	54.29	56.19	36.40	-	64.20	54.13
Al_2O_3	0.21	3.72	0.25	0.80	2.12	2.15	1.32
Fe_2O_3	0.11	0.40	0.3	0.89	0.3	0.20	0.34
Mgo	0.91	0.30	0	0.693	3.12	0.80	0.3
K_2O	4.43	-	-	0.70	-	0.24	BDL
Cl	0	0.03	-	-	-	-	BDL
SO3	0.11	0.09	-	-	0.2	2.50	0.09

Chapter Three

Experiment work

3.1 Concrete Mix

Concrete: A heterogeneous mixture of aggregates, cement and water with some blanks, and some other additives can be added to obtain certain properties. The proportions of these materials are selected in concrete mix according to the type of work required and materials available was used according to the properties listed in the table below (3.1) [20] .

Table (3.1): Mix proportions of concrete (kg /m^3).

MIX	00Portland cement type 1 kg/m^3	Water (kg/m3)	Sludge water (kg/$m^{3)}$	River sand (kg/$m^{3)}$	Crushed limestone rock (kg/m^3)
OPC(0.5)	347	174	0	896	956
OPC(0.6)	309	185	0	896	956
OPC(0.7)	279	195	0	896	956
SW10(0.5)	347	156	17	896	956
SW10(0.6)	309	167	18	896	956
SW10(0.7)	279	176	19	896	956
SW20(0.5)	347	138	35	896	956
SW20(0.6)	309	148	37	896	956
SW20(0.7)	279	156	39	896	956
SW30(0.5)	347	121	52	896	956
SW30(0.6)	309	130	55	896	956
SW30(0.7)	279	137	58	896	956
SW40(0.5)	347	104	69	910	966
SW40(0.6)	309	111	74	910	966
SW40(0.7)	279	117	78	910	966
SW60(0.5)	347	69	104	910	966
SW60(0.6)	309	74	111	910	966
SW60(0.7)	279	78	117	910	966
SW80(0.5)	347	35	139	910	966
SW80(0.6)	309	37	148	910	966
SW80(0.7)	279	39	156	910	966
SW100(0.5)	347	0	173	910	966
SW100(0.6)	309	0	185	910	966
SW100(0.7)	279	0	195	910	966

Where is:

SW(X): Sludge Water.

(X): Sludge Water Percentage in Mixture.

OPC: Ordinary Portland cement

3.1.1 Components of concrete mixture

A.Cement

It is that soft, dark-colored substance that possesses the properties of the cohesion attached to the presence of the water, making it capable of connecting the concrete components together and its cohesion with the arming iron, the cement consists of three basic raw materials: calcium carbonate in limestone, and silica in clay Sand, alumina (aluminum oxide), and iron oxides.
Four types of cement take their name from their purpose and need to be used, but remain basic: Ordinary Portland cement, fast solidification Portland cement, low-temperature Portland cement, cement-resistant sulphate, alumina cement, and in this research Portland cement will be used [21].

B.Mixing water

The important of water in concrete mixture [25]

1. Water is necessary for the maturation of concrete during hardening.

2.It is an essential element in the chemical reaction with the cement material, which is necessary in manufacture.

3. The concrete mixture, consisting of coarse, fine aggregate and cement, gives an appropriate degree of flexibility to help it operate and form.

4.The water represent about (15-20%) of concrete volume.

Three types of water is used in this research as follows:

1. Tab water

The appropriate water for mixing is potable water, and the specifications (ASTM C94) usually stipulate that the water must be free of chloride, sulfate and salts and is free also harmful substances such as oils, grease, acids, alkalis, organic matter, cork and other substances that have a reverse effect on concrete in terms of resistance to fracture and durability [22].

2. Stone slurry waste water

The stone slurry wastewater is the water produced from the manufacturing process and specifically the cutting of the stone and the process , disposing and reuse of these waters is environmental and economic problem , where the stone cutting companies discharge water with TSS(total suspended solid) about 12000 mg/l ; leading to high maintenance cost of sewage network , and it low pH lead to harmful of agricultural land , furthermore , the discharge areas of slurry stone wastewater in Palestine are locates in the recharge areas of principle aquifers used for drinking water supply , the eastern and western aquifers [23].In this research two types of stone slurry wastewater were used in concrete mixtures :

A-Wastewater with flocculant.

B-Wastewater without flocculant.

Flocculant is a chemical composition material used to accelerate settlement of suspended fine particles from the stone slurry wastewater in order to reuse it in the cutting process.

Properties of stone of stone slurry wastewater used in this research are shown in tables (3.2, 3.3).

Table (3.2): properties of stone slurry wastewater used without flocculant

Test	**unit**	**result**
Cao	mg/l	72.75
Al2O3	mg/l	0.823
Fe2O3	mg/l	0.831
Mgo	mg/l	52.36
Cl	mg/l	75
SO3	mg/l	20.5

Table (3.3): Properties of stone slurry wastewater used with flocculant

Test	**unit**	**result**
Cao	mg/l	2.88
Al2O3	mg/l	<0.001
Fe2O3	mg/l	0.003
Mgo	mg/l	0.106
Cl	mg/l	0.011
SO3	mg/l	0.003

Water Cement Ratio (w/c)

water-cement ratio is a ratio between the weight of the water allocated to the reaction (except the water absorbed by the gravel) to the weight of the cement in the mixture, high-quality concrete must contain the lowest ratio of water to cement without affecting the workability of fresh concrete. The ratio of water to cement ranges from 35% to 60% and depends on the following factories:

1.The required degree of operation for fresh concrete that requires a specific purpose (dry, wet).

2. Type of engineering work – concrete paving of roads requires less water mixing than armed concrete.

3. The amount of cement used with concrete mixture, that is, the extent to which the concrete mixture is rich in cement.

4.The method of concrete compact, using mechanical shakers, requires a lower amount of water than handled compaction.

5.The type of debris, the extent of its granular gradient and the amount of its surface area and its maximum size.

Increasing the mixing water from the required threshold is harmful to concrete in the following ways [24]:

1.The occurrence of a granular separation of fresh concrete.

2.Concrete with voids.

3.The difficulty of connecting the old concrete with the newly-casting concrete.

4.The difficulty of pouring concrete into a very cold atmosphere.

5.The presence of a soily layer on the surface of the concrete slab.

C. Aggregates

The aggregates is a basic ingredient in concrete as it is 60-70% of the size of the concrete and the aggregates consists in a general of rocky granules in size including small grains such as sand and other big grains like gravel. The quality and characteristics of the aggregates have a significant impact on the properties and quality of the concrete and as constituting the bulk of the concrete structure, which supports stability, constancy and its resistance to the influence of external forces and the various weather factors of heat, humidity and freezing, its presence in this proportion in the mixture reduces volumetric changes resulting from solidification and hardening of cement.

from the above, it is clear that the strength of the concrete, its cohesion and resistance to water penetration increase over time as long as the conditions are dependent on the chemical reaction between water and cement, and other concrete properties such as resistance to heat and cold and volatile weather factors.

The improvement in concrete properties is rapid in its first time of concrete but slowly continues for an unknown time. Concrete can reach 90% of its resistance within 28 days. Therefore, early, effective and continuous treatment in the early stages of concrete life is necessary to form strength, durability, non-permeability. The basic conditions that must be met for the reaction to continue are the suitable temperature and humidity. Soft concrete contains too much water to complete the chemical reaction of cement.

In most cases, however, a large part of this water evaporates due to heat, so water must be constantly added to the concrete to compensate for evaporating water , Thus, the aggregates is strong and must be unaffected by the various weather factors, such as heat and cold, which lead to fragmentation of the aggregates as the harmful interaction between aggregates and cement compounds must not occur.

In addition it must be free of clay and non-purified materials, and it must be strong, shock-resistant and appropriate in terms of absorption (low absorption) of a suitable shape and texture [25] .

Requirements for aggregates to be used in concrete according to ASTM (American Society of Testing and Materials) C 125 & D 8 are as follows [25]:

1. Granules should be semi-spherical and non-flat.

2. The absorption rate should not exceed 5%.

3. The specific weight should not be less than 2.35.

4. The aggregate must be washed before use to ensure that it is free of organic matter and salts.

The type of aggregates used in this research as following: sand, coarse aggregate, fine aggregate.

1-Sand

Sand: A natural of well graded particles. The size of its particles varies between gravel and silt. Figure (3.1) shows the sand used. The ability of sand to absorb water is virtually non-existent and therefore does not affect the proportion of water in the mixture and the purpose of using sand in the concrete mixture is filling of the blanks in the mixture, and therefore, the inter- granules are achieved and have the ability to move loads from one grain to another.

Figure (3.1): Commercial sand used.

2-Fine aggregate

Fine crushed stone, it can pass through 4.75 mm sieve in sieve analysis test, mean that the size of particle less than 4.75 mm (show in figure (3.2)).

Figure (3.2): Fine aggregate used.

3- Coarse aggregate

Big crushed stone , size of this particles bigger than 4.75 mm. show it in figure (3.3) [26].

Figure (3.3): Coarse aggregates used .

Table (3.4) shows gradation of aggregate used and figure (3.4) shows the gradation curves.

Table (3.4): Sieve analysis of concrete aggregate. [27].

Sieve size		**WT Ret (gm)**	**Ret %**	**Accum Ret %**	**Pass % Foul**	**Pass % Addas**	**Pass % simsim**	**Passs % sand**
Nominical True (in)	**Aperture mm**	**gm**	**%**	**%**	**%**	**%**	**%**	**%**
2 1/2 "	63	0	0	0	100	100	100	100
2"	50	0	0	0	100	100	100	100
1.5"	37.5	0	0	0	100	100	100	100
1"	25	0	0	0	100	100	100	100
3/4"	19	222	15.7	15.7	84.3	100	100	100
5/9"	14	990	70.1	85.8	14.2	94.3	100	100
3/8"	9.5	178	12.6	98.4	1.6	30.1	100	100
#4	4.75	6	0.4	98.8	1.2	1.4	98.5	99.9
#8	2.36	2	0.1	98.9	1.1	1.4	35.3	98.9
#16	1.18	0	0	98.9	1.1	1.4	3	95.1
#30	0.6	0	0	98.9	1.1	1.4	1.4	73.7
#50	0.3	0	0	98.9	1.1	1.4	1.4	27.6
#100	0.15	0	0	98.9	1.1	1.4	1.4	5.9
#200	0.075	0	0	98.9	1.1	1.3	1.2	2.2
Pan	Pan	15	1.1	100	0	0	0	0
	modulus of fineness 8.9							

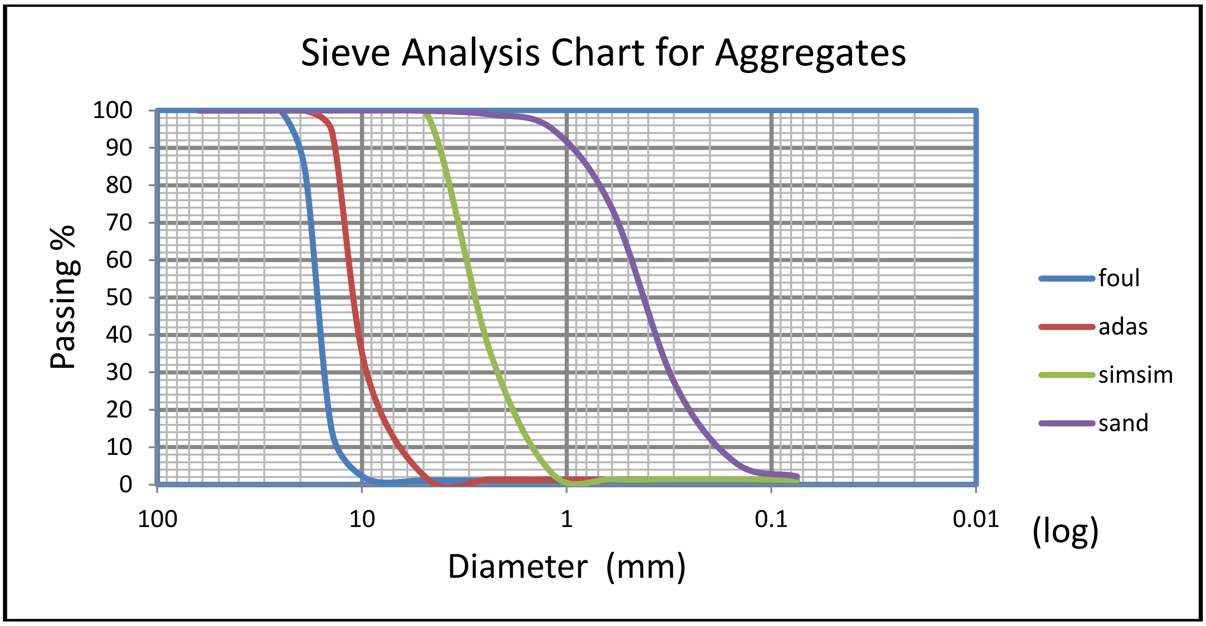

Figure (3.4): Sieve analysis for aggregate used

Table (3.5) shows the abrasion resistance of aggregate used in this research from Los Angles Test.

Table (3.5): Los Angeles Test (ASTMC 131-06) For Addas, Foul, Simsim [27].

	Foul	Addas	Simsim
Sample total weight (gm)	5000	5000	5000
Sample weight after 100 revolutions (gm)	4666	4740	4762
Sample weight after 500 revolution (gm)	3816	3680	3790
Abrasion after 100 revolution %	6.68	5.2	4.76
Abrasion after 500 revolution %	23.68	26.40	24.2

Table (3.6) shows the unit weight of different type of aggregate used in the research.

Table (3.6): Unit weight of aggregate [27].

	Foul	addas	Simsim
unit weight g/cm^3	1.507	1.503	1.509

Table (3.7) shows the sand equivalent of the fine sand used in the research.

The sand equivalent test quantifies the relative abundance of sand versus clay in soil. It is measured by standardized test methods such as ASTM D2419, AASHTO T176, and EN933-8 The test is used to qualify aggregates for applications where sand is desirable but fines and dust are not. A higher sand equivalent value indicates that there is less clay-like material in a sample [28].

Table (3.7): Sand equivalent value [27].

Test no.	1	2	3
A. Sand reading	102	100	100
B. Clay reading	150	155	195
Sand equivalent ((A/B)*100)	68.0	66.0	52.0
Average sand equivalent	62		

Table (3.8) shows the specific gravity and absorption of aggregate.

Table (3.8): Test Specific Gravity & Absorption for Aggregate [27].

Sample No.	Sample Type	Dry weight (gm)	SSD (gm)	Wt, in Water (gm)	Dry S.G (gm/cm^3)	Bulk Density (gm/cm^3)	Apparent S.G	Absorption %
		A	B	C	=A/(B-C)	=B/(B-C)	=A/(A-C)	=100*(B-A)/A
1	**Foul**	1479	1500	930	2.595	2.632	2.694	1.420
2	**Addas**	1029.2	1052	650	2.560	2.617	2.714	2.215
3	**Simsim**	532.3	536	332	2.565	2.627	2.735	2.427
4	**Sand**	***	***	***	***	***	***	***

3.2Curing of concrete

Curing: It is one of the ways in which concrete helps in obtaining the required resistance and also helps the concrete to resist the weather. It has been shown that the use of good materials and the right proportions is not enough to get concrete with good properties if we neglect the curing stage. Complete curing will increase concrete resistance as well as improving the resistance of the permeability of liquids. The water used in the concrete mix is distributed as follows: (Part of it is absorbed by aggregates - a part to improve the degree of operation - the important part is the completion of cement saturation from water) picture (3.5) shows that the Concrete curing stage [29].

Figure (3.5): Concrete in curing stage.

3.3 Methodology

In this research we used 3% of the quantities shown in table (3.1) to prepare concrete mixture.

1- Concrete mixtures we prepared by using 3 w/c ratios (more than 27 concrete batch).
2- Slump test is performed for each concrete mixture.
3- From each concrete mixes 8 cubes of 10x10x10 cm were prepared for compressive test, and one beam 10x10x50cm were casted for flexural test.
4- Compressive test if performed on 2 cubes after 7 days, 14 days and 28 days curing.
5- The stress and vertical deformation were recorded during compression test and the stress-strain relationship is plotted as an average of two cubes.
6- Absorption test carried out on two cubes after 28 days curing for each concrete mixture.
7- Test results from all concrete mixtures, with different w/c ratios and with different wastewater replacement ratios were compared with concrete made with tab water.

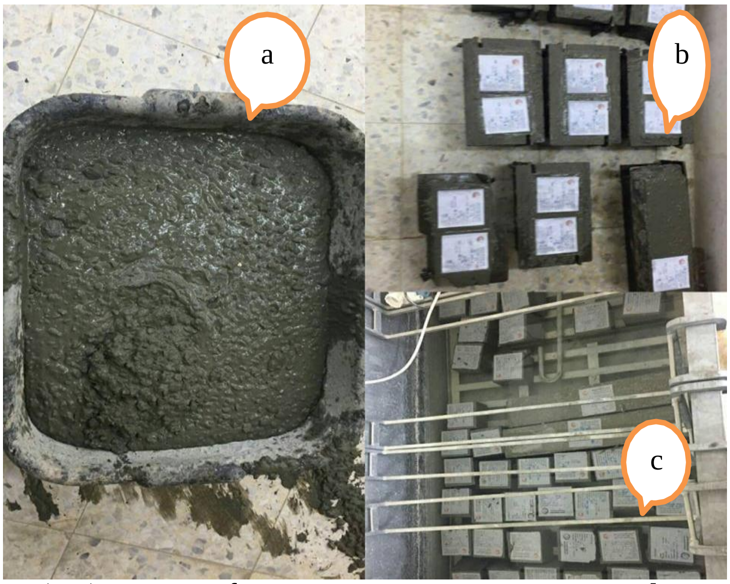

Figure (3.6): Stages of preparing concrete mixtures and sample.

3.4Concrete tests

3.4.1Slump test

This test is used to check the workability of concrete: it is the ability to form and pour concrete, if the concrete needs effort to be poured in site or to be molded into mold, it means that their workability is difficult and the mixture is rigid and vice versa, the easy formation means soft concrete. rigid concrete mix has many advantages, it is less expensive in terms of materials, stronger, does not crack during dryness if treated well, does not get the separation of granular, and it is less frozen. One must save a balance between the advantages and the disadvantages so choose the mix of workability that fits the nature of the work.

Procedure:

- The inspection mold shall be in the form of an incomplete cone made of galvanized steel sheets (thickness 1.6 mm) or more. Its interior surface shall be smooth and supplied from the outside with special hands and feet for lifting and fixing.
- Its dimensions and details shall conform to the standard specifications.
- The steel rod is made of steel with a circular section of diameter 16 mm long and 600 mm wide, its bottom edge is hemispherical.
- The mold shall be placed on a flat, smooth and non-waterproof surface. It is preferable to use a flat plate of galvanized steel for this purpose. The surface shall be fixed horizontally at a location away from any source of vibrations or concussions.
- Fill the mold with fresh concrete on successive layers so that the thickness of each layer is equal

to quarter of the height of the mold. Each layer is properly stamped with a hammer rod and a 25-stroke spread evenly over the entire surface of the layer. remove the excess concrete and level the surface with trowel.

• Rise the mold vertically to the top slowly and carefully to ensure that the concrete is not moved.

•The mold is placed vertically next to the concrete block that has been removed. The concrete drop is measured by measuring the difference in height between the mold and the highest point of the concrete block

•The test should be repeated if a horizontal collapse of the fresh concrete occurs when lifting the mold, Figure (3.7) shows the slump measurement [30].

Figure (3.7): The slump measurement

3.4.2 Compressive strength test

Compressive strength is one of the most important properties of concrete. It expresses the quality and strength of concrete. Most properties and other resistors such as tensile, bending, cutting and bonding with reinforcing steel are improved and increased by increasing Compressive strength . Compressive strength is conducted to control the quality of concrete production at the project site.This test is also used for structural design purposes.

Stress (σ): Calculated by dividing the load on the area of the primary section (MPa)

Strain (ε): Calculated by dividing the difference in length on the initial length of the sample (%)

$$\sigma = Pv/A \text{ ....(1)}$$

$$\epsilon = \Delta L/L \text{ .... (2)}$$

$$E = \sigma/\epsilon \text{ ....(3)}$$

Whereas:

Pv: Vertical Pressure (KN) A: sample section area (m^2)

ΔL: Change in length (mm).

L: Original length (mm).

E: Modules of Elasticity (MPa).

The compressive strength test also determines the validity of the aggregate and the mixing water to identify the effect of impurities on the compressive strength of the concrete. The compressive strength of concrete structures ranges from 250-350 kg / cm^2. The samples were examined after a week, 14days and after 28 days to calculate the compressive strength and determine the effect of different water types on that strength [31] .

Figure (3.8) shows a concrete cube before testing, and Figure (3.9) shows the compressive strength testing device used.

Figure (3.8): Concrete cube.

Figure (3.9): Set up of compressive test .

3.4.3 Absorption test

Absorption: It is the ability of concrete to pull water into its cavities. It is known that the continued absorption of concrete for water reduces the life of concrete because the arrival of moisture to the reinforcing steel leads to rust and the entry of acids and salts damage the concrete. This test is done by taking the weight of the sample dry after placing it in the oven for 24 hours and then taking a wet weight after placing it in water for 24 hours. The water weight in the sample is divided by the dry sample weight. The absorption ratio should not exceed 5% and the specific weight of 2.35[32] .

Absorption rate is calculated from the following relationship:

$$\frac{Ww}{Ws} * 100\% \quad \ldots\ldots\ldots\ldots\ldots(4)$$

$$Ww = Wt - Ws \quad \ldots\ldots\ldots\ldots(5)$$

Ws: Oven dried Concrete Weight.

Wt: The weight of the wet concrete.

Ww: Water weight in concrete.

3.4.4 Flexural test of concrete

Is one of the most important mechanical tests performed on various materials. Flexural tensile strength is approximately (10% - 15%) of the value of compressive strength. As the hardened concrete is a brittleness substance therefore it is weak in direct or indirect tensile.

There are two ways to define tensile strength:

- Direct tensile testing (difficult to perform) for the difficulty of processing samples and axle loads.
- Flexural Tensile Test. This test is done on a beam of (10, 10,50cm) after 28 days curing.

Figure (3.10): Set up of flexural tensile test .

3.5Water Tests

In this project make many tests for water samples (tab water , slurry wastewater with coagulant , slurry waste water with coagulant) as a following :

3.5.1 Total Dissolved Solid "TDS" (mg/l):

The concentration of impurities measured by ppm unit , according to ASTM C94, which is don't access than 5000 ppm, because the use of contaminated water in the mixture will not only affect the time of the hardening of the concrete, concrete strength in concrete containers, but it can lead to the appearance of the rust of reinforcing steel and permanent change In the size of concrete and reduce the durability of concrete[33] .

3.5.2 Electrical conductivity (μs/cm):

An electrical current results from the motion of electrically charged particles in response to forces that act on them from an applied electric field. Within most solid materials a current arise from the flow of electrons, which is called electronic conduction. In all conductors, semiconductors, and many insulated materials only electronic conduction exists, and the electrical conductivity is strongly dependent on the number of electrons available to participate to the conduction process.

Most metals are extremely good conductors of electricity, because of the large number of free electrons that can be excited in an empty and available energy state. In water and ionic materials or fluids a net motion of charged ions can occur. This phenomenon produce an electric current and is called ionic conduction [1].

3.5.3pH:

PH is the important parameter in studying the properties of concrete. Low and high pH both creates problem in concrete in terms of corrosion and spalling. For this ASTM has recommended 0.6% alkalinity of cement or mineral admixtures (if alkaline) for use in concrete.

High pH of the cement is due to presence of portlandite ($CaOH_2$) and after adding in concrete mix the pH of the concrete decreases after setting due to utilization of portlandite in the formation of hydration products like CSH, ettringite and others. This formation of CSH and other hydration products den the matrix and reduces the permeability of the chloride or reduces the carbonated dissolved in reduced corrosion.

Several studies have been reported on the use of mineral admixtures (like SCMs etc.) that reduce the high alkalinity of cement-concrete, fills the voids and hardens the matrix leads to reduction in porosity and / or permeability. The addition of SCMs decreed the pH or alkalinity up to certain limit that is necessary for hydration reaction and additional supply of Al, Si from the admixtures enhance the formation of additional hydration products.

The reduction in pH of the concrete mix before casting and molding affects the early hydration and strength but improves the later age concrete properties [2].

Figure (3.11) shows water samples tested.

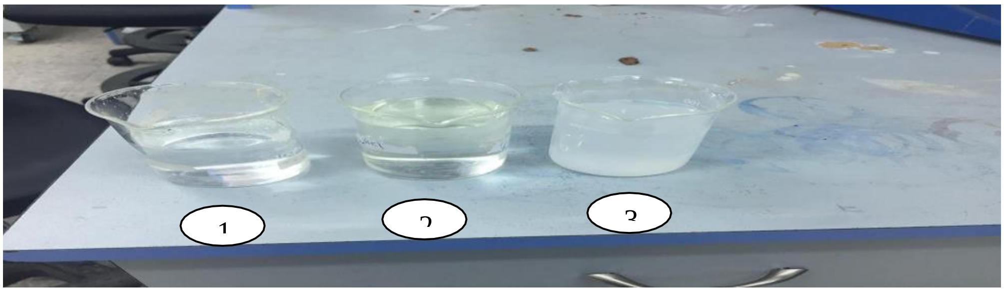

Figure (3.11): Water samples that have been tested for pH.

1. water.
2. Slurry waste water with flocculent.
3. Slurry waste water without flocculant

Chapter Four

Experiment test results

4.1 Test Results of water Samples Used :

Table (4.1) shows test results of different water to be used in this research.

Table (4.1): Properties of each water type used.

Test Water Type	EC (µs/ cm)	TDS (mg/l)	PH
Tab Water	317	519	7.33
Slurry Water With Coagulant	340	568	6.77
Slurry Water Without Coagulant	519	697	7.43
DRINKING WATER STANDARD According to EPA	>= 335 µs/ cm [34].	>= 500mg/l [35].	6.5-8.5 [36].

4.2 Results of concrete made with tab water as mixing water .

4.2.1 Slump results

After processing the concrete mixture in the laboratory and before casting it in the molds, the slump rate was examined at all mixing ratios for fresh concrete. The slump rate was found to be as in table (4.2).

Table(4.2): The slump results

w/c %	Slump(mm)
0.5	20
0.6	100
0.7	220

The following figure (4.1) shows the variation in the slump at different w/c ratios (0.5, 0.6, 0.7)

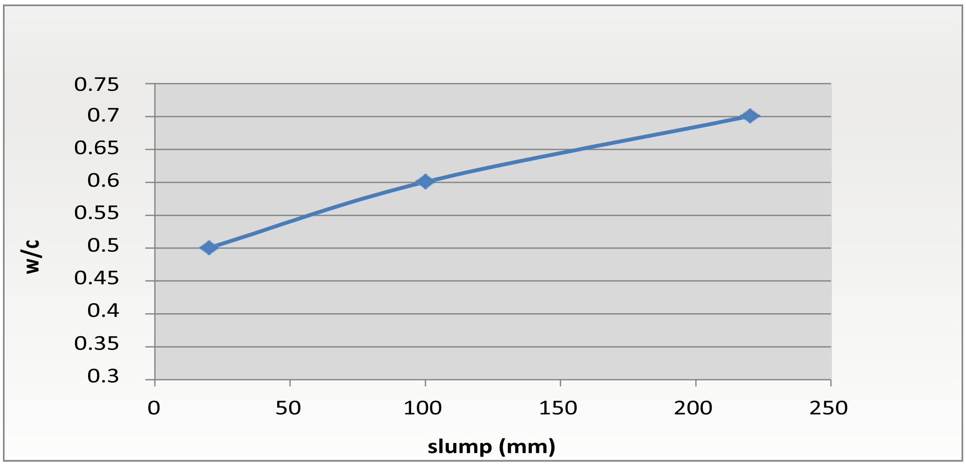

Figure (4.1): Slump for different w/c %.

4.2.2 The Result of Compressive Strength test

Table (4.3) summarizes all tests results of compressive stress for different w/c ratio

Table (4.3): Average stress – strain for sample in different ages and w/c ratios.

w/c %	0.5			0.6			0.7		
E	7 days	14 days	28 days	7 days	14 days	28 days	7 days	14 days	28 days
	avg stress	avg stress	avg stress	avg stress	avg stress	avg stress	avg stress	avg stress	avg stress
0	0	0	0	0	0	0	0	0	0
0.002	1	5.7	2.95	5.8125	1.35	4.7	4.35	3.1067	5.45
0.004	9.1	16.6	17.85	18.875	14.6	12	11.2	12.067	13.45
0.006	31.4	32.9	39.9	27	30.9	23.3	16.325	22.13	24.55
0.008	35.3	38.6	43.2	27.27	34.6	32	16.9	21.867	26.05
0.01	36.1	42.3	39.1	26.6	32.1	34.3	16.55	20.2	25.35
0.012	33	35.2		24.525	27.8	33	15.8	19.65	23.15

Figures (4.2 to 4.4) present the stress -strain relationships at different w/c ratio using tab water .

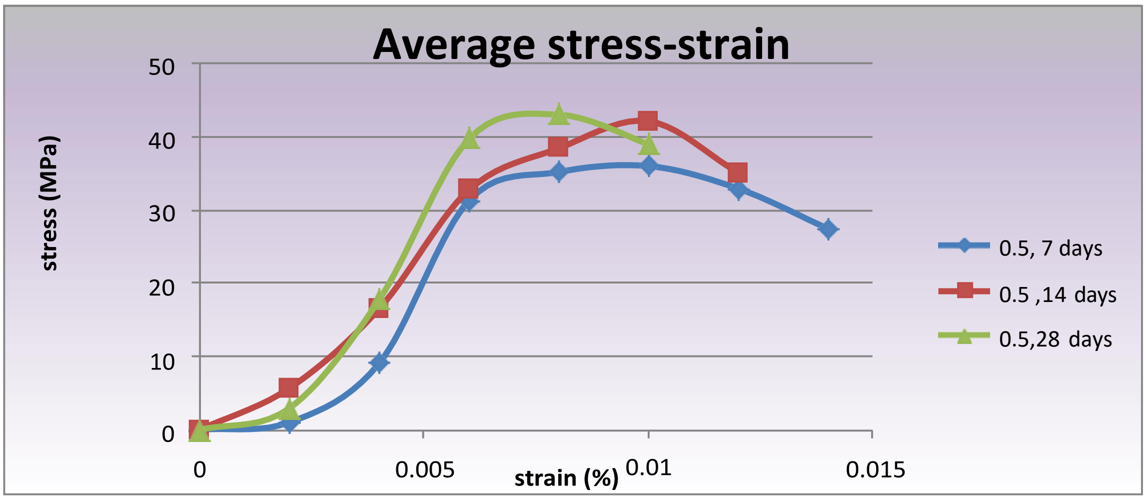

Figure (4.2) : Average stress-strain relationship for sample with w/c = 0.5 in different ages.

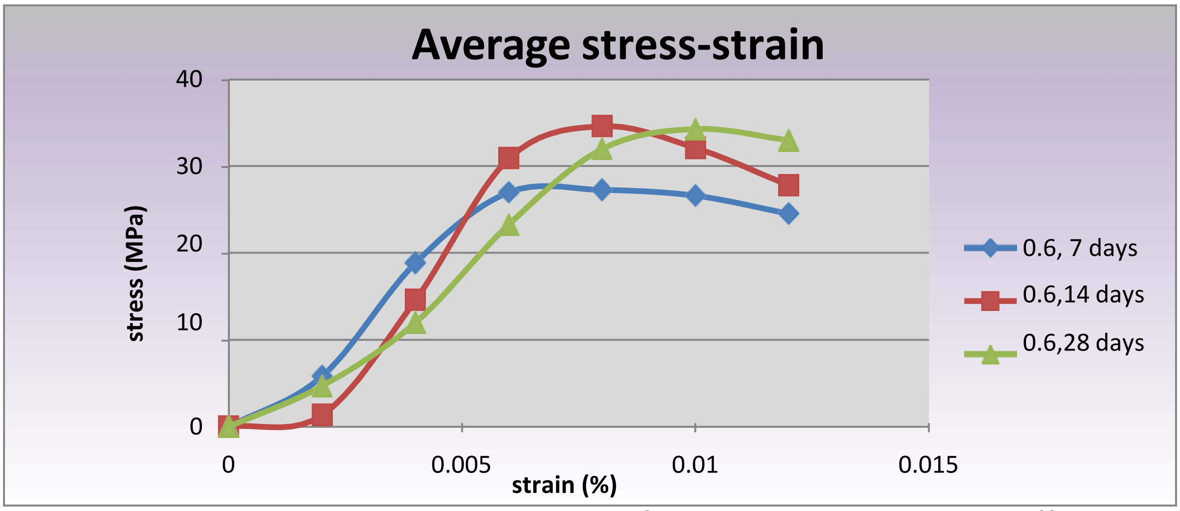

Figure (4.3): Average stress-strain relationship for sample with w/c = 0.6 in different ages.

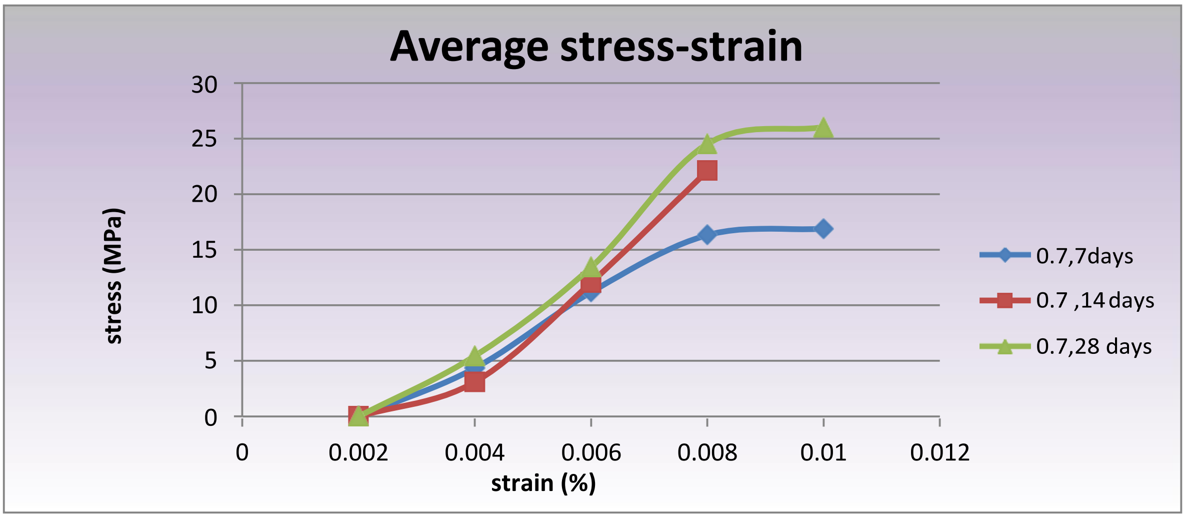

Figure (4.4): Average stress-strain relationship for sample with w/c = 0.7 in different ages.

Table (4.4) show the max stress values from stress-strain data at different ages and w/c ratios .

Table (4.4) : Maximum stress for sample, with different age and w/c

w/c %	0.5	0.6	0.7
days	Stress (MPa)	Stress (MPa)	Stress (MPa)
7	36.1	27.8	16.9
14	42.3	34.6	22.13
28	43.2	34.3	26.05

Figures (4.5 and 4.6) show the variation of max stress with w/c and curing time respectively using tab water.

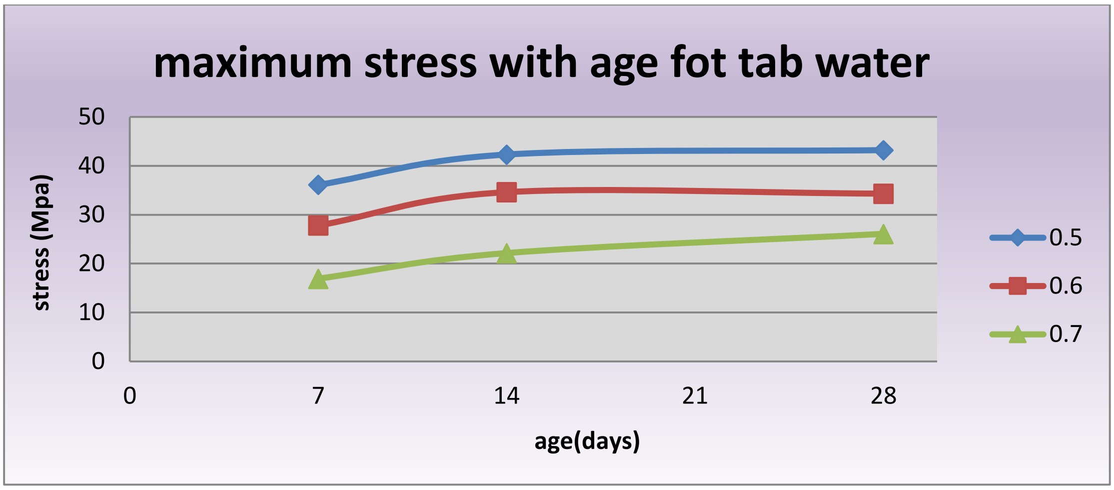

Figure (4.5): Maximum compressive stress at different age for samples in different w/c.

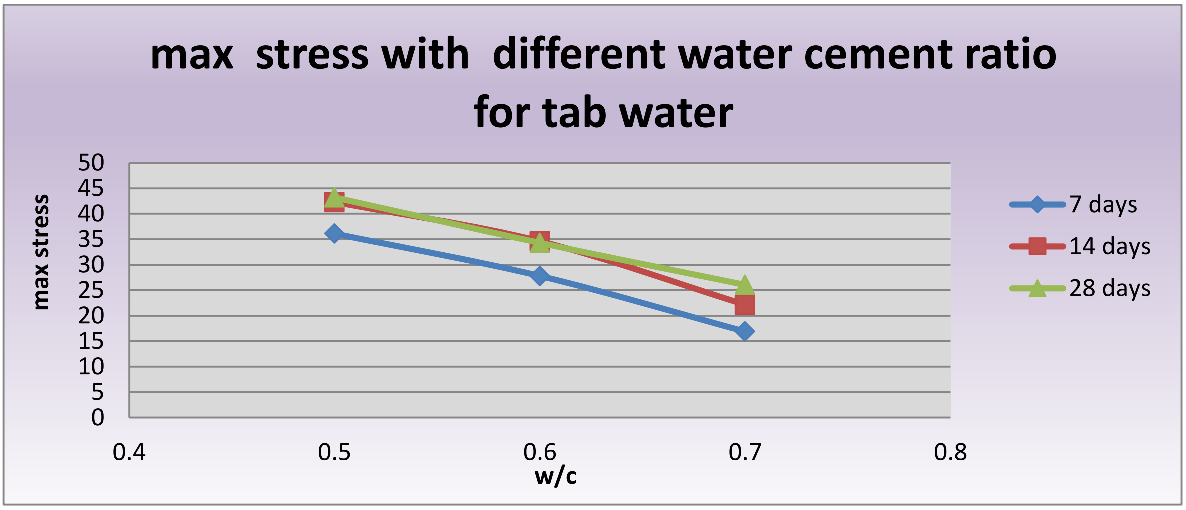

Figure (4.6): Maximum stress at different w/c ratio for tab water.

Table (4.5) shows the modulus of elasticity calculated by used the stress-strain relationship at strain =0.005.

Modulus of elasticity = $\frac{\Delta\ avg\ stress}{\Delta strain}$

Table (4.5): Modulus of elasticity results.

w/c %	0.5	0.6	0.7
Days	Elasticity (MPa)	Elasticity (MPa)	Elasticity (MPa)
7	40	32	14
14	58	48	16
28	60	50	18

Figure (4.7) shows the variation of modulus of elasticity of concrete made with tab water with w/c ratios and ages.

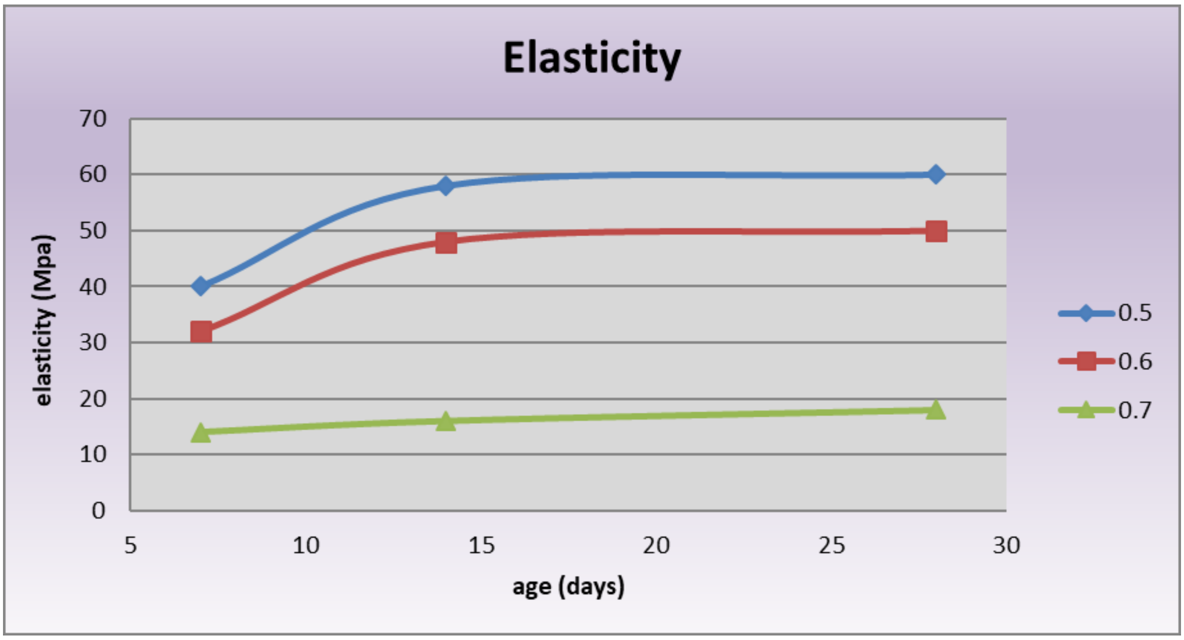

Figure (4.7): modulus of elasticity relationship for different w/c ratio and ages.

4.2.3 Results of flexural tensile strength

Results of flexural tensile stress for 28 days for different water cement ratios are shown in the following table (4.6). The modulus of rapture is calculated as follow:

$$\sigma = 3FL/2bd^2 \text{..........(6)}$$

Where:

F: is the load (force) at the fracture point (N).

L: is the length of the support span b: is width

d: is thickness(depth).

Table (4.6): Tensile strength (tab Water).

w/c %	Tensile strength after 28 days (KPa)	Modules of rapture (MPa)
0.5	10.5	4.7
0.6	17	7.5
0.7	14.5	6.6

Figure (4.8) shows sketch for flexural tensile test.

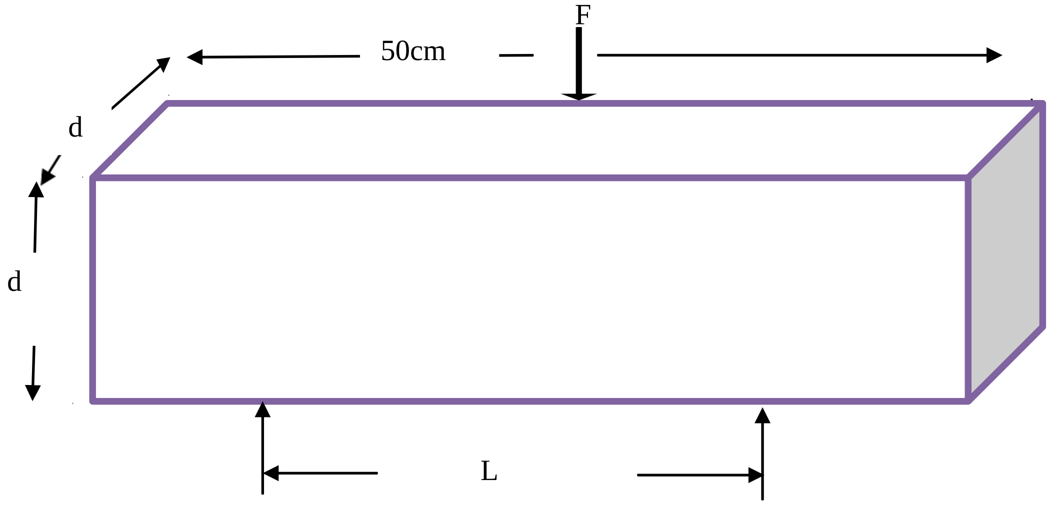

Figure (4.8): Sketch of flexural tensile test of concrete.

4.2.4 Absorption results

Table (4.7) shows the results of the absorption test on samples made with tab water after 28 days curing for different water cement ratio

Table (4.7): Absorption results

w/c %	Absorption rate after 28 days (%)
0.5	5.84
0.6	2.4
0.7	2.01

4.2.5 Summary of test result of concrete made with tab water.

w/c %	Compressive Strength (28 days)	Flexural Tensile (28days)	Modules of elasticity (MPa)	Modules of rapture (MPa)	Absorption (28days)	Slump (mm)
0.5	43.2	10.5	4.7	60	5.84	20
0.6	34.3	17	7.5	50	2.4	100
0.7	26.05	14.5	6.6	18	2.01	220

Chapter Five

Comparison of results and Discussion

5.1 Result of stone slurry wastewater (with flocculant)

5.1.1 Comparison of slump test results

Table (5.1): Comparison of slump test result for stone slurry wastewater with flocculant

type of water	sw %	w/c%	Slump (mm)
tab water	**0**	**0.5**	20
	0	**0.6**	100
	0	**0.7**	**220**
Stone wastewater with flocculant	**30%**	**0.5**	17
	30%	**0.6**	25
	30%	**0.7**	30
	100%	**0.5**	10
	100%	**0.6**	18
	100%	**0.7**	23

It is noticed that replacement of 30 % of mixing water with stone slurry wastewater reduces slump by (15-89%), on other hand replacement of mixing water by 100% of stone slurry wastewater reduces the slump by (50-90%), this reduction may be attributed the fine particle in stone slurry wastewater because fine particles high specific surface and absorb more water of mixing water.

5.1.2 Comparison of compressive stress

It should be noticed that the result presented here are the average of two sample tested at each curing time.

Table (5.2): maximum stress of samples at w/c =0.5 , 7 days curing and replacement of 30%,100% of wastewater.

Sludge wastewater % in sample	Maximum stress(MPa)
0	36.1
30	25.4
100	27.7

Figure (5.1) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater at 7 days.

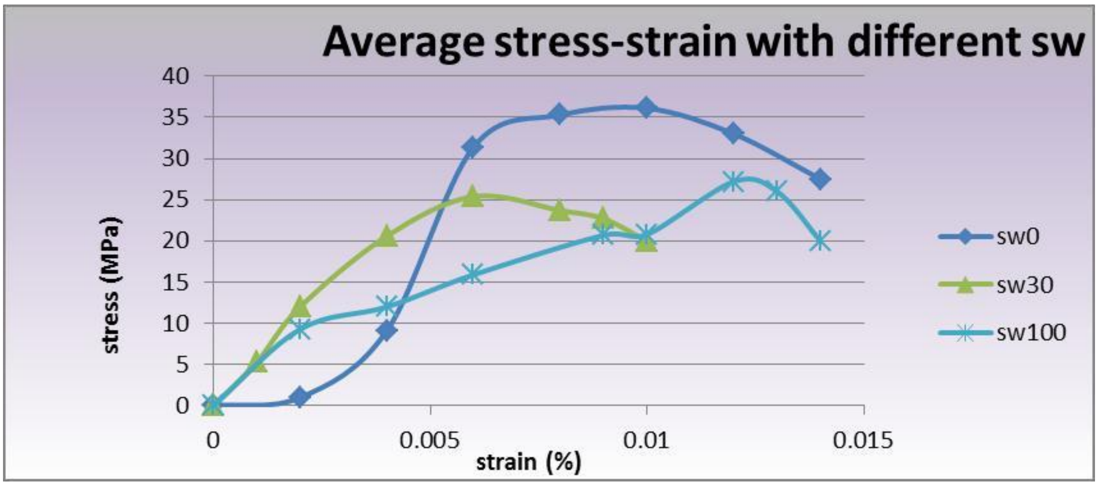

Figure (5.1) : compressive stress at w/c=0.5 and 7 days curing for tab water and wastewater .

It is noticed that replacement of 30 % tab water with stone slurry wastewater reduces maximum stress by (30%) , on the other hand at replacement of 100% tab water with slurry wastewater reduced maximum stress by (28%) .

Table (5.3) : Maximum stress of samples at w/c =0.5 , 14 days curing and replacement of 30%,100% of wastewater .

Sludge waste water % in sample	Maximum stress (MPa)
0	42.3
30	27.6
100	21.5

Figure (5.2) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater at 14 days.

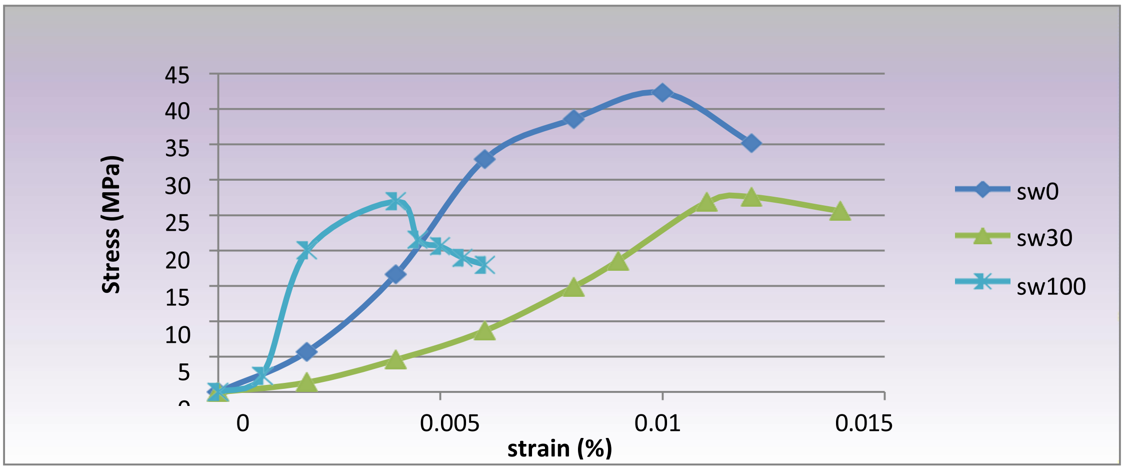

Figure (5.2) : compressive stress at w/c=0.5 and 14 days curing for tab water and wastewater

It is noticed that replacement of 30 % tab water with stone slurry wastewater reduced maximum stress by (35%), on other hand replacement of 100% tab water with stone slurry wastewater reduced the stress by (49%).

Table (5.4): Maximum stress of samples at w/c =0.5 , 28 days curing and replacement of 30%,100% of wastewater.

Sludge wastewater % in sample	Maximum stress(MPa)
0	43.2
30	31.6
100	18.1

Figure (5.3) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater at 28 days.

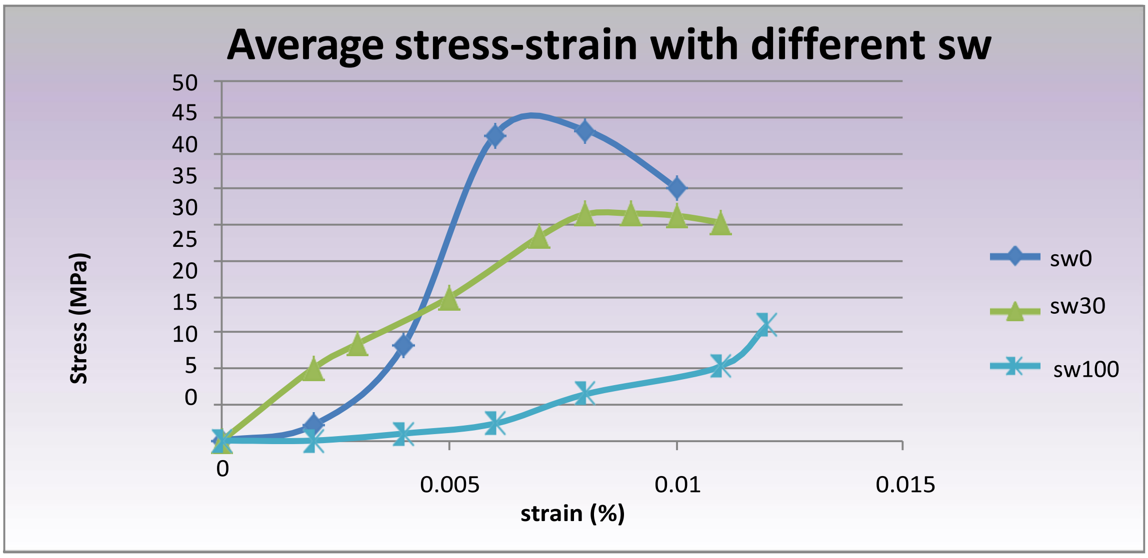

Figure (5.3): compressive stress at w/c=0.5 and 28 days curing for tab water and wastewater.

It is noticed that replacement of 30 % tab water with stone slurry wastewater reduced maximum stress by (25%), on the other hand replacement of 100% of tab water by stone slurry wastewater reduced the maximum stress (58%).

Table (5.5) : Maximum stress of samples at w/c =0.6 , 7 days curing and Replacement of 30%, 100% of wastewater.

Sludge waste water % in sample	Maximum stress(MPa)
0	27.27
30	28.3
100	25.9

Figure (5.4) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater (w/c=0.6) after 7 days curing.

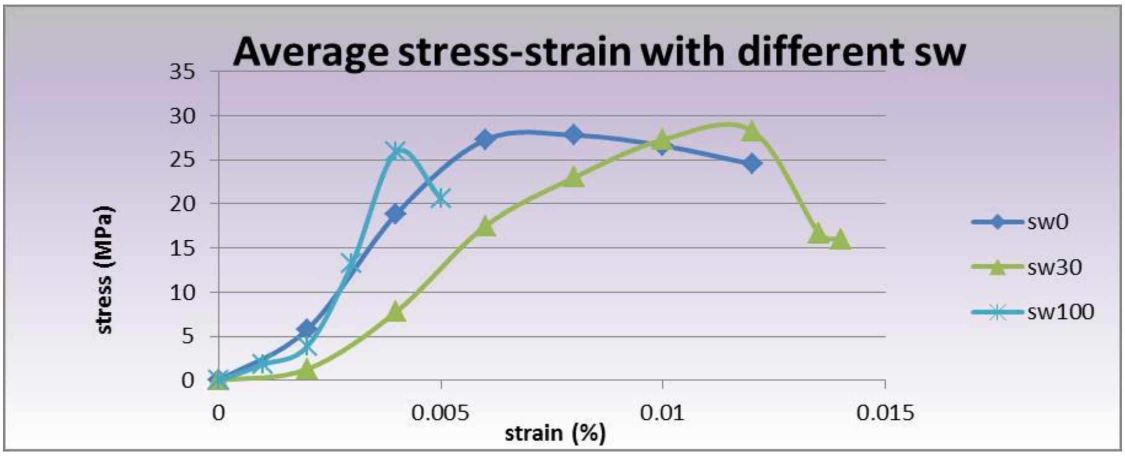

Figure (5.4) : compressive stress at w/c=0.6 and 7 days curing for tab water and wastewater.

It is noticed that replacement of 30 % tab water with stone slurry wastewater increased maximum stress by (4%), on other hand replacement of 100% tab water with stone slurry wastewater reduced the stress by (5%).

Table (5.6) : . Maximum stress of samples at w/c =0.6, 14 days curing and replacement of 30%, 100% of wastewater

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Sludge wastewater % in sample	Maximum stress(MPa)
0	34.6
30	31.5
100	18.3

Figure (5.5) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater (w/c=0.6) after 14 days curing.

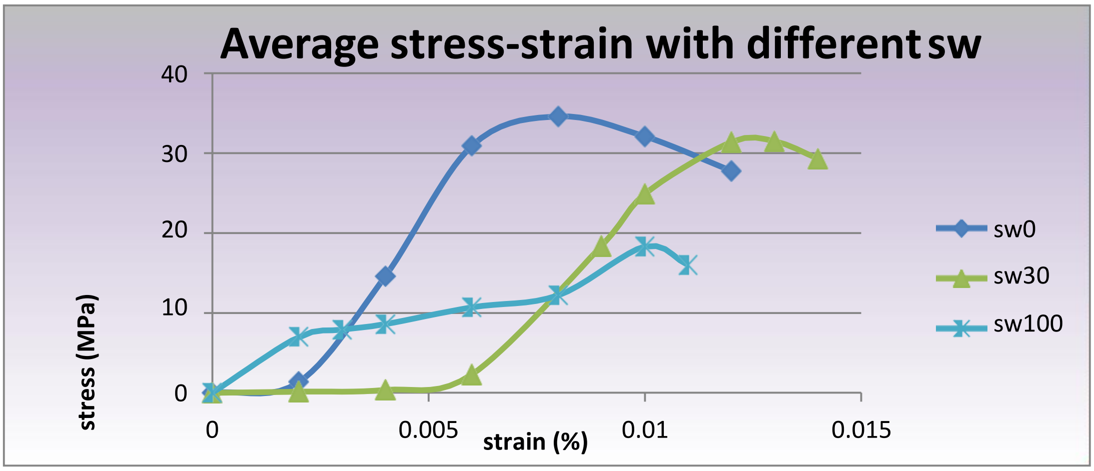

Figure (5.5) : compressive stress at w/c=0.6 and 14 days curing for tab water and wastewater.

It is noticed that replacement of 30 % tab water with stone slurry wastewater reduced maximum stress by (9%), on other hand replacement of 100% tab water with stone slurry wastewater reduced the stress by (47%).

Table (5.7) : Maximum stress of samples at w/c =0.6, 28 days curing and replacement of 30%, 100% of wastewater.

Sludge wastewater % in sample	Maximum stress(MPa)
0	34.3
30	38
100	18.3

Figure (5.6) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater at 28 days.

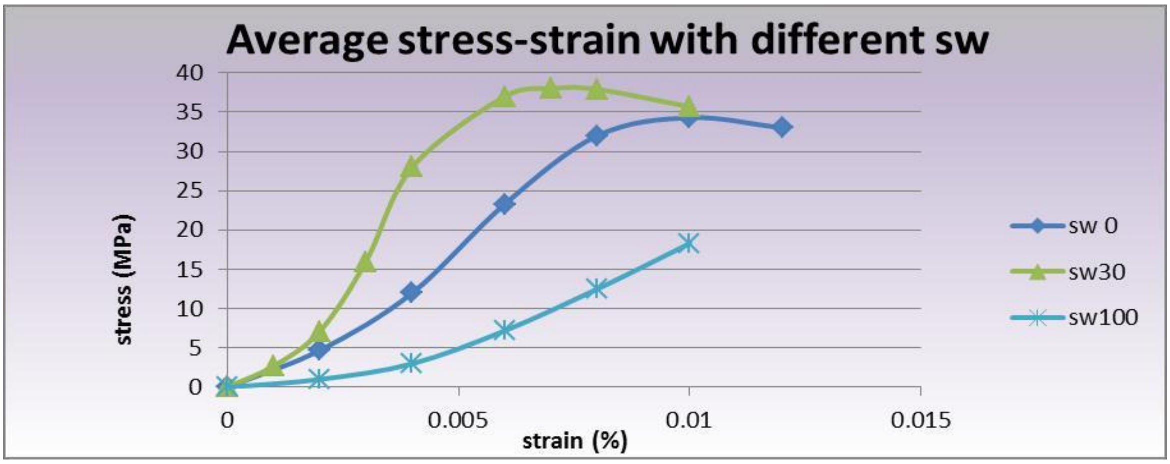

Figure (5.6): Compressive stress at w/c=0.6 and 28 days curing for tab water and wastewater.

Replacement of 30 % tab water with stone slurry wastewater increased maximum stress by (11%), on other hand replacement of 100% tab water with stone slurry wastewater reduced the stress by (64%).

Table (5.8): Maximum stress of samples at w/c =0.7, 7 days curing and replacement of 30%, 100% of wastewater.

Sludge wastewater % in sample	Maximum stress(MPa)
0	16.9
30	27.7
100	24.6

Figure (5.7) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater at 7 days.

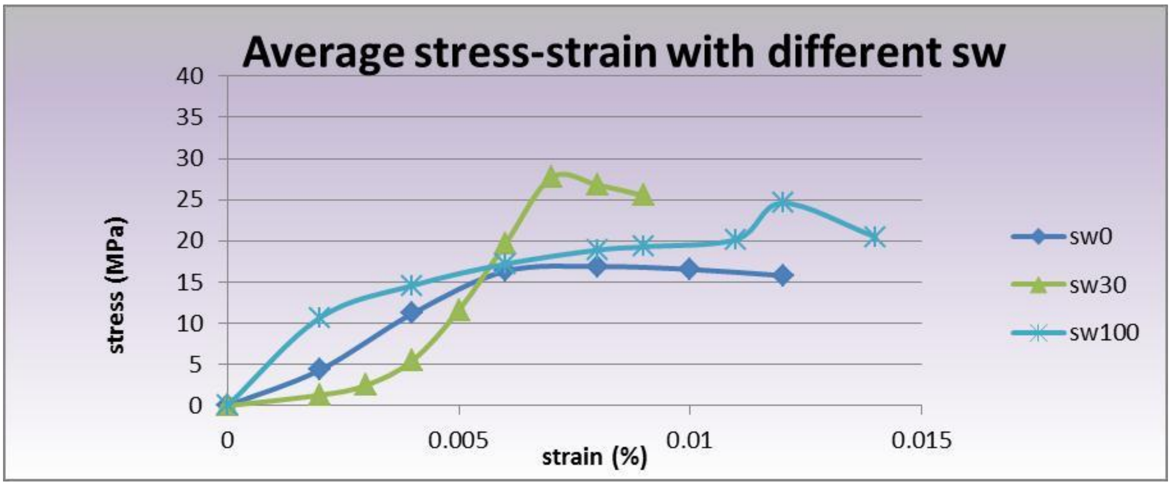

Figure (5.7) : compressive stress at w/c=0.7 and 7 days curing for tab water and wastewater.

It is noticed that replacement of 30 % tab water with stone slurry wastewater increased maximum stress by (64%), on other hand replacement of 100% tab water with stone slurry wastewater increased maximum stress by (46%).

Table (5.9) : Maximum stress of samples at w/c =0.7, 14 days curing and replacement of 30%, 100% of wastewater.

Sludge wastewater % in sample	Maximum stress(MPa)
0	23
30	17.8
100	25.3

Figure (5.8) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater (w/c=0.7) and 14 days curing.

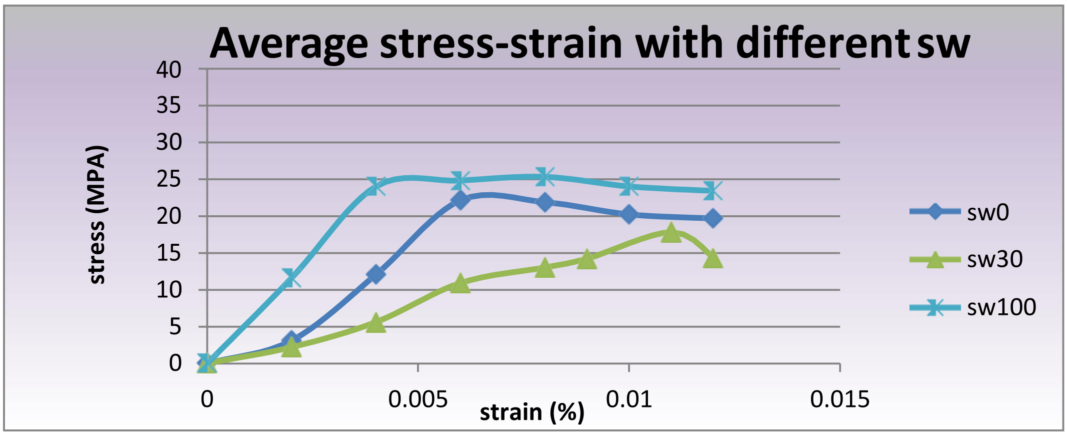

Figure (5.8) : compressive stress at w/c=0.7 and 14 days curing for tab water and wastewater.

It is noticed that replacement of 30 % tab water with stone slurry wastewater reduced the maximum stress by (23%), on other hand replacement of 100% tab water with stone slurry wastewater increased the maximum stress by (10%).

Table (5.10) : Maximum stress of samples at w/c =0.7, 28 days curing and replacement of 30%, 100% of wastewater.

Sludge wastewater % in sample	Maximum stress(MPa)
0	26.05
30	14.57
100	33.1

Figure (5.9) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater at 28 days.

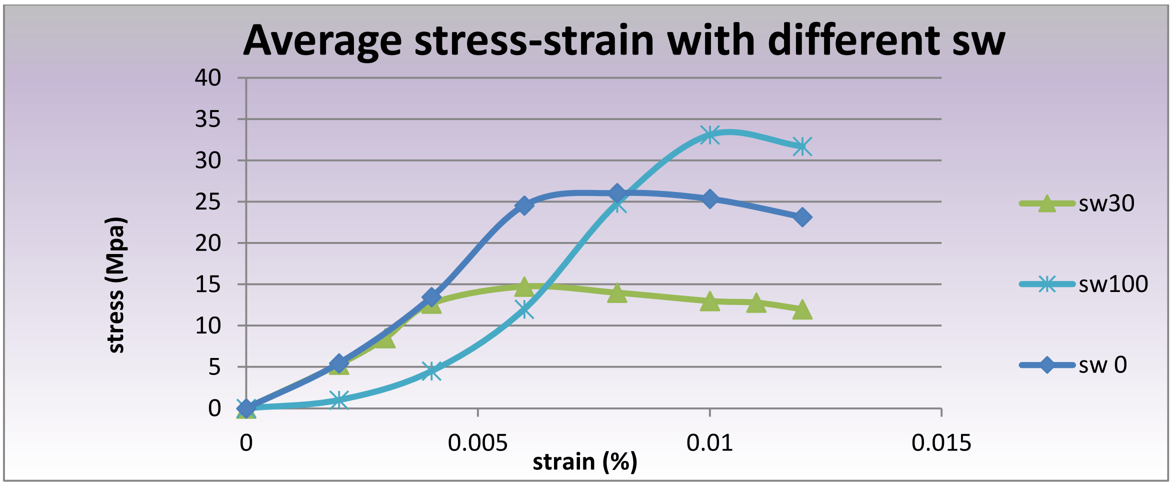

Figure (5.9): compressive stress at w/c=0.7 and 28 days curing for tab water and wastewater.

Replacement of 30 % tab water with stone slurry wastewater reduced maximum stress by (44%), on other hand replacement of 100% tab water with stone slurry wastewater increased the maximum stress by (27%).

Table (5.11) shows the Comparison of water absorption of concrete after 28 days curing.

Table (5.11) : Comparison of water absorption test result of tab water and wastewater from stone slurry with flocculant.

water type/ sw %	w/c %	Absorption rate after 28 days
tab water (sw 0)	0.5	5.84
	0.6	2.4
	0.7	2.01
Stone wastewater with flocculant (sw 30%)	0.5	2.41
	0.6	2.4
	0.7	2.21
Stone wastewater with flocculant (sw100%)	0.5	2.88
	0.6	2.8
	0.7	2.74

It is noticed that concrete absorption did not affected significantly at w/c of 0.6 and 0.7 at all replacement ratio. However, at w/c=0.5 absorption reduced between 51-59%. Table (5.12) shows Comparison of flexural Tensile strength of concrete.

Table (5.12): Comparison of flexural Tensile strength of tab water and Wastewater from stone slurry with flocculant.

type of water	sw %	w/c %	Tensile strength after 28 days (Kpa)	modules of rapture (MPa)
tab water	0	0.5	17	7.5
	0	0.6	14.5	6.6
	0	0.7	10.5	4.7
Stone wastewater with flocculent	30%	0.5	19	8.5
	30%	0.6	12.5	5.6
	30%	0.7	10	4.6
	100%	0.5	11	4.8
	100%	0.6	10.1	4.8
	100%	0.7	10.2	4.9

Table (5.13) shows Comparison of maximum stress of tab water and wastewater with flocculant compared with tab water.

Table (5.13): Comparison of maximum stress of tab water with wastewater From stone slurry with flocculant.

w/c %	Age (days)	% Replacement water 0%	30%	100%	Replacement water 30%	100%
		maximum stress (MPa)			% (change in max. stress) increase or reduction	
0.5	7	36.1	25.4	27.7	-30%	-28%
	14	42.3	27.6	21.5	-35%	-49%
	28	43.2	31.6	18.1	-27%	-58%
0.6	7	27.27	28.3	25.9	+4%	-5%
	14	34.6	31.5	18.3	-9%	-47%
	28	34.3	38	12.3	+11%	-64%
0.7	7	16.9	27.7	24.6	+39%	+46%
	14	23	17.8	25.3	-23%	+10%
	28	26.05	14.57	33.1	-44%	+27%

It is noticed that the maximum stress increased at w/c= 0.6 after 7 and 28 days at 30% replacement of tab water with stone slurry wastewater. Similarly the stress increased at w/c = 0.7 after 7 and more than 45% at replacement ratios of 30% and 100%. Table (5.14) shows Comparison of modulus of elasticity at strain =0.005 for wastewater from stone slurry with flocculant.

Table (5.14): Comparison of elasticity at strain=0.005 for wastewater from stone Slurry with flocculant

w/c %	Age (days)	Elasticity (at strain 0.005) (MPa)		
		sw%		
		0%	30%	100%
0.5	7	40	14	10
	14	58	39.8	28
	28	60	48	54.4
0.6	7	32	0.8	10
	14	48	26	20
	28	50	70	41.2
0.7	7	14	18	18
	14	16	23.3	32
	28	18	28	48

5.2 Result of stone slurry wastewater (without flocculant)

5.2.1 Comparison of slump test result

Table (5.15): Comparison of slump test result for wastewater from stone slurry without flocculant.

type of water	sw %	w/c %	Slump (mm)
tab water	0	0.5	20
	0	0.6	100
	0	0.7	220
stone wastewater without flocculant	30%	0.5	10
	30%	0.6	10
	30%	0.7	25
	100%	0.5	20
	100%	0.6	35
	100%	0.7	55

It is noticed that replacement of 30 % and 100% of tab water with stone slurry wastewater in concrete mixtures reduced slump significantly. This reduction may be attributed the fine particle in stone slurry wastewater with high specific area which absorb the mixing water. Workability can be increased by using additives.

5.2.2 Comparison of compressive stress

It should be noticed that the result of testing are average of two sample tested at each curing time.

Table (5.16) : Maximum stress of samples at w/c =0.5, 7 days curing and replacement of 30%, 100% of waste water without flocculant.

Sludge wastewater % in sample	Maximum stress(MPa)
0	36.1
30	21.4
100	28.7

Figure (5.10) shows comparison of the stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater without flocculant 7 days.

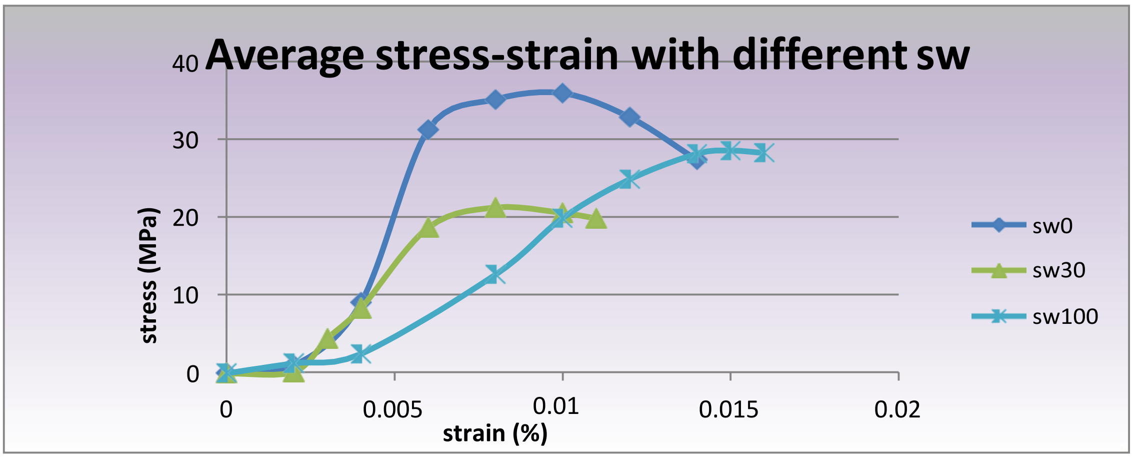

Figure (5.10): compressive stress at w/c=0.5 and 7 days curing for tab water and wastewater without flocculant .

Replacement 30% of tab water with stone slurry wastewater reduced max stress by (41%), on other hand replacement of tab water with100% of slurry wastewater reduced the stress by (20%). Table (5.17) shows the maximum stress of concrete with w/c=0.5 after 14 days curing.

Table (5.17) : Maximum stress of samples at w/c =0.5, 14 days curing and replacement of 30%, 100% of wastewater without flocculant.

Sludge wastewater % in sample	Maximum stress(MPa)
0	42.3
30	21.9
100	26

Figure (5.11) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater without flocculant 14 day.

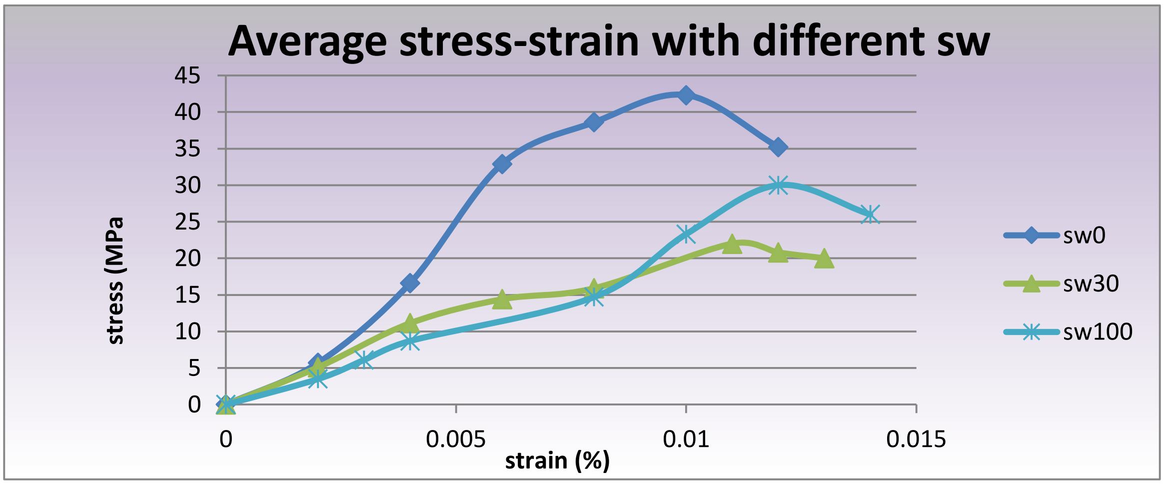

Figure (5.11): compressive stress at w/c=0.5 and 14 days curing for tab water and wastewater Without flocculant.

Replacement 30% of tab water with stone slurry wastewater reduced max stress by (48%), on other hand replacement of tab water with100% of slurry wastewater reduced the stress by (29%). Table (5.18) shows the maximum stress of concrete with w/c=0.5 after 28 days curing.

Table (5.18) : Maximum stress of samples at w/c =0.5, 28 days curing and replacement of 30% 100% of wastewater without flocculant.

Sludge wastewater % in sample	Maximum stress(MPa)
0	43.2
30	24
100	31.3

Figure (5.12) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater (w/c=0.5), without flocculant after 28 days curing.

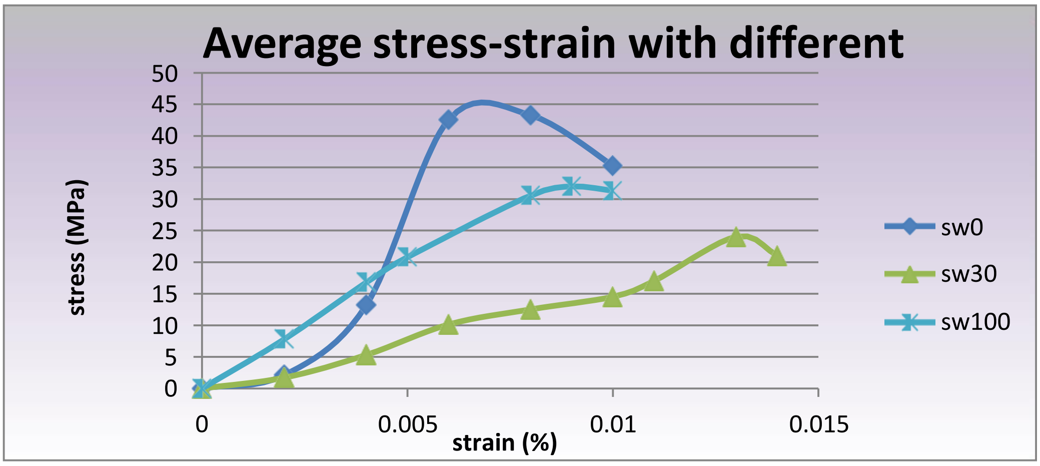

Figure (5.12) : compressive stress at w/c=0.5 and 28 days curing for tab water and Wastewater without flocculant.

Replacement of 30 % tab water with stone slurry wastewater reduced the maximum stress by (44%), on the other hand replacement of tab water by 100% of slurry wastewater reduced the maximum stress by (27%).

Table (5.19): Maximum stress of samples at w/c =0.6, 7 days curing and replacement of 30%, 100% of wastewater without flocculant.

Sludge wastewater % in sample	Maximum stress(MPa)
0	27.7
30	26.2
100	18.9

Figure (5.13) shows comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater (w/c=0.6) without flocculant after 7 days curing.

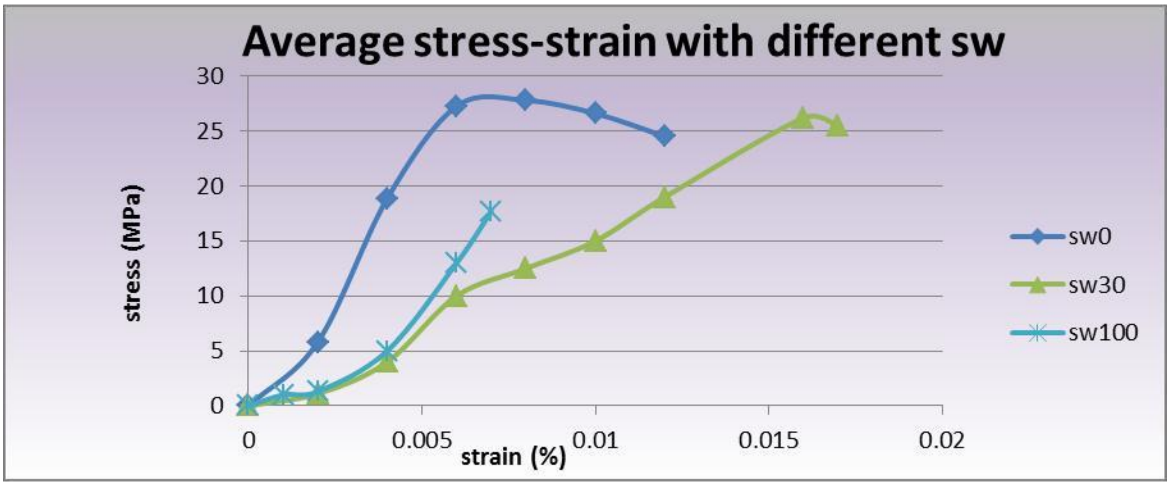

Figure (5.13): compressive stress at w/c=0.6 and 7 days curing for tab water and Wastewater without flocculant..

It is noticed that replacement of 30 % tab water with stone slurry wastewater reduced stress by (5%), on other hand replacement of tab water by 100% of slurry wastewater reduced the stress by (32%).

Table (5.20): Maximum stress of samples at w/c =0.6, 14 days curing and replacement of 30%, 100% of wastewater without flocculant.

Sludge wastewater % in sample	Maximum stress(MPa)
0	34.6
30	27
100	19.1

Figure (5.14) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater without flocculant after 14 days curing.

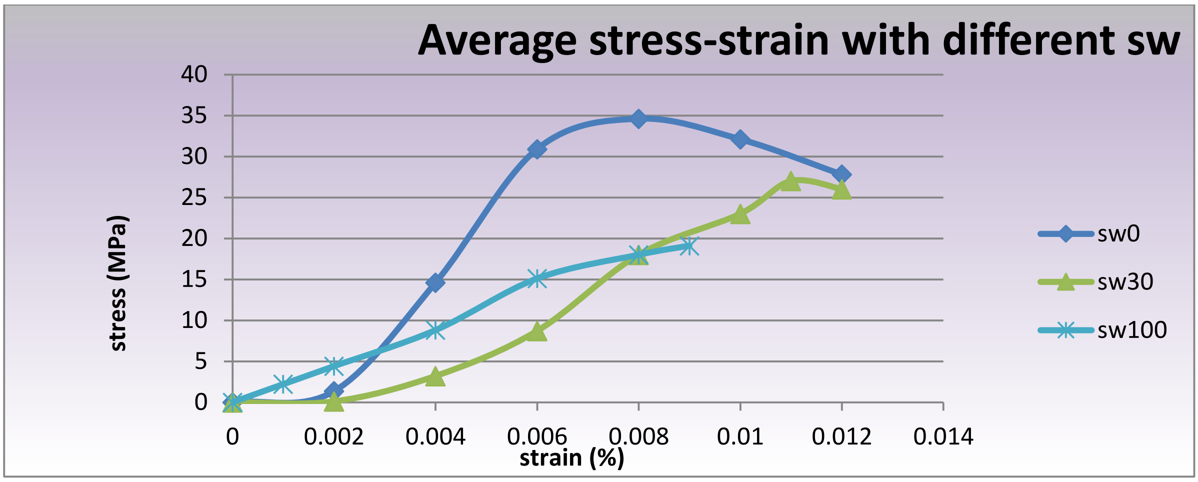

Figure (5.14): compressive stress at w/c=0.6 and 14 days curing for tab water and wastewater without flocculant.

It is noticed that replacement of 30 % tab water with stone slurry wastewater reduced stress by (21%) on the other hand replacement of tab water by 100% of slurry wastewater reduced the stress by (43%) .

Table (5.21): Maximum stress of samples at w/c =0.6, 28 days curing and replacement of 30%, 100% of wastewater without flocculant

Sludge wastewater % in sample	Maximum Stress (MPa)
0	34.3
30	28
100	20

Figure (5.15) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater without flocculant 28 days.

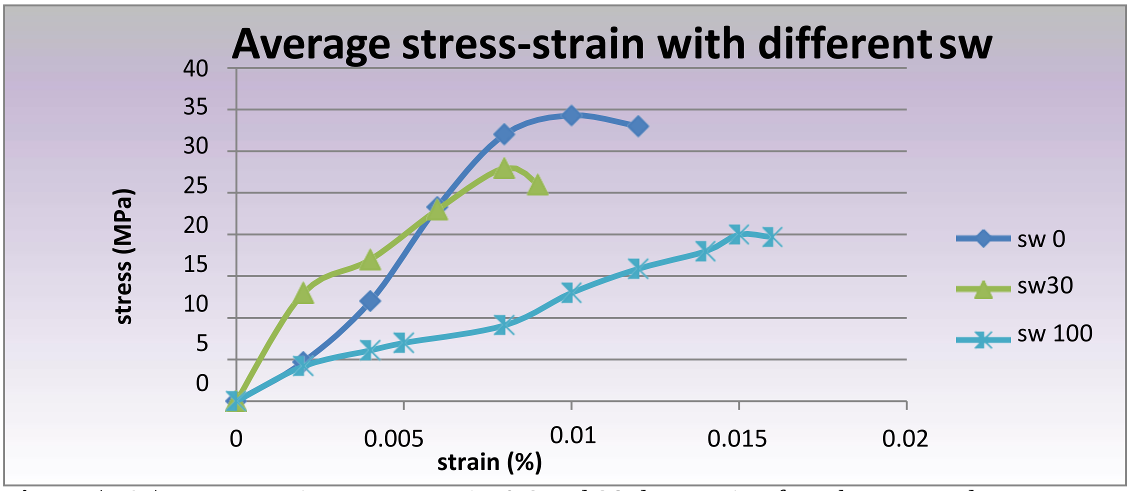

Figure (5.15) : compressive stress at w/c=0.6 and 28 days curing for tab water and wastewater without flocculant.

Replacement of 30 % tab water with stone slurry wastewater reduced stress by (18%), on the other hand replacement of tab water by 100% of slurry wastewater reduced the maximum stress by (42%).

Table (5.22) : Maximum stress of samples at w/c =0.7, 7 days curing and replacement of 30%, 100% of wastewater without flocculant.

Sludge waste water % in sample	Maximum stress(MPa)
0	16.9
30	17.8
100	8.8

Figure (5.16) shows comparison of stress-strain relationship of concrete made with tab water and replacement of 30% and 100% of stone slurry wastewater (w/c=0.7) without flocculant 7 days curing.

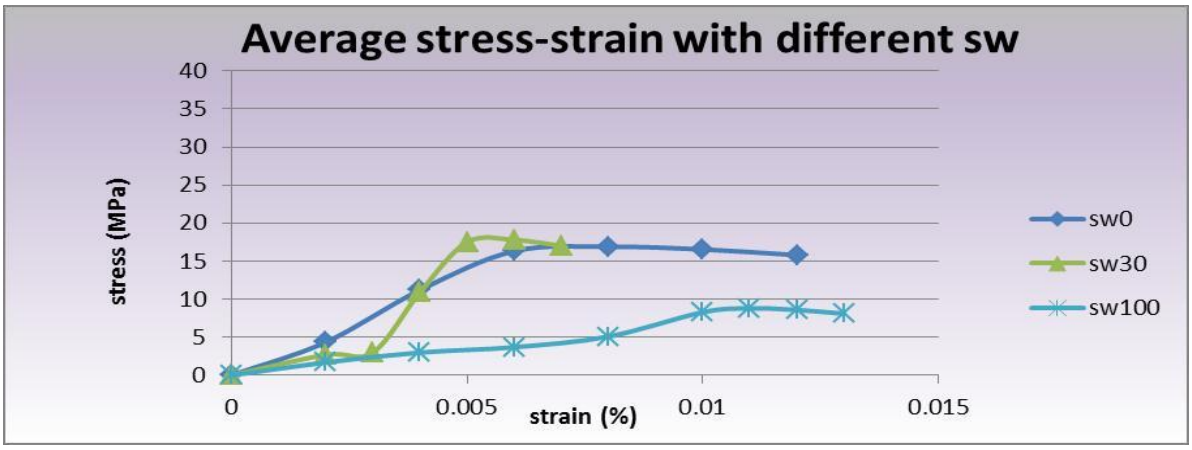

Figure (5.16) : Compressive stress at w/c=0.7 and 7 days curing for tab water and wastewater without flocculant.

Replacement 30 % of tab water with stone slurry wastewater increased stress by (5%), on other hand replacement of tab water with 100% of wastewater reduced the stress by (48%).

Table (5.23): Maximum stress of samples at w/c =0.7, 14 days curing and replacement of 30%, 100% of wastewater without flocculant.

Sludge wastewater % in sample	Maximum stress(MPa)
0	23
30	21.8
100	15.4

Figure (5.17) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater without flocculant 14 day

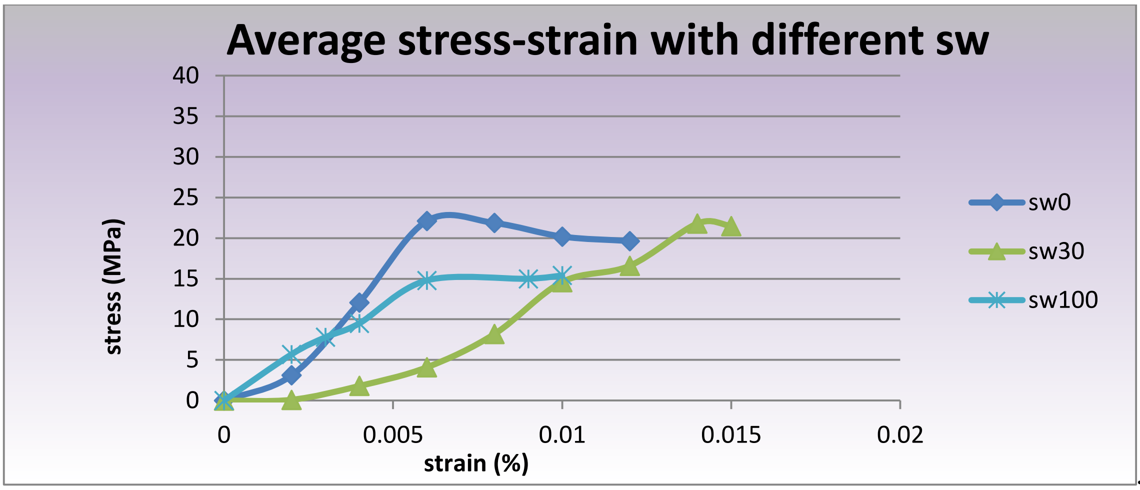

Figure (5.17): compressive stress at w/c=0.7 and 14 days curing for tab water and wastewater Without flocculant.

Replacement 30% of tab water with stone slurry wastewater reduced stress by (5%), on the other hand replacement of tab water with 100% of slurry wastewater reduced the stress by (33%).

Table (5.24) : Maximum stress of samples at w/c =0.7, 28 days curing and replacement of 30%, 100% of wastewater without flocculant.

sludgewastewater in sample %	Maximum stress(MPa)
0	26.05
30	22
100	21.8

Figure (5.18) shows the comparison of stress-strain relationship of concrete made with tab water and 30%, 100% stone slurry wastewater without flocculant 28 days.

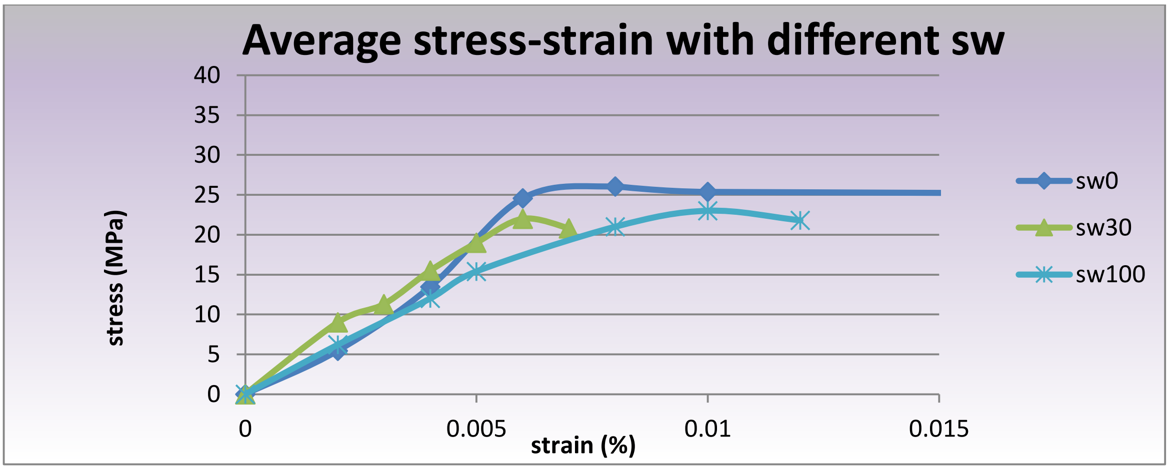

Figure (5.18): Compressive stress at w/c=0.7 and 28 days curing for tab water and wastewater Without flocculant.

Replacement of 30 % tab water with stone slurry wastewater reduced stress by (15%), on the other hand replacement of tab water by 100% of slurry wastewater reduce the stress by (16%). Table (5.25) shows the absorption of concrete samples made with tab water and stone slurry wastewater without flocculant, at different w/c ratios and 28 days curing.

Table (5.25): Comparison of water absorption result of tab water and wastewater from stone slurry without flocculant.

water type/ sw %	w/c (%)	Absorption rate after 28 days
Tab water	0.5	5.84
	0.6	2.4
	0.7	2.01
stone wastewater without flocculant sw30%	0.5	4.5
	0.6	2.6
	0.7	2.26
Stone wastewater without flocculant sw(100%)	0.5	2.9
	0.6	2.28
	0.7	1.84

It is noticed that concrete absorption did not affected significantly at w/c of 0.6 and 0.7 at all replacement ratios. However, at w/c=0.5 absorption reduced between 22-50%. Table (5.26) shows comparison of maximum stress of tab water and wastewater without flocculant.

Table (5.26): Comparison of maximum stress of tab water and wastewater from stone slurry without flocculant

w/c%	Age (days)	% Replacement water			% Replacement water	
					30%	100%
		0%	30%	100%	% reduction in max stress	
		maximum stress				
0.5	7	36.1	21.4	28.7	-41%	-20%
	14	42.3	22	30	-48%	-29%
	28	43.2	24	31.3	-44%	-27%
0.6	7	27.27	26.2	18.9	-5%	-31%
	14	34.6	27	19.1	-51%	-43%
	28	34.3	28	20	-18%	-42%
0.7	7	16.9	17.8	8.8	+5%	-48%
	14	23	21.8	15.4	-5%	-33%
	28	26.05	22	21.8	-15%	-16%

Table (5.27) shows comparison of flexural tensile strength

Table (5.27): Comparison of flexural Tensile strength for wastewater from stone slurry without flocculant.

type of water	sw %	w/c %	Tensile strength after 28 days (KPa)	modules of rapture(MPa)
tab water	0	0.5	17	7.5
	0	0.6	14.5	6.6
	0	0.7	10.5	4.7
Stone wastewater without flocculent	30%	0.5	17	7.5
	30%	0.6	12	5
	30%	0.7	11.5	4
	100%	0.5	15	6.8
	100%	0.6	12.5	5.9
	100%	0.7	11.5	5.5

Table (5.28) shows Comparison of modulus of elasticity at strain =0.005 for wastewater from stone slurry without flocculant.

Table (5.28) : Comparison of elasticity at strain=0.005 for wastewater from stone slurry without flocculant.

w/c %	Age (days)	Elasticity, (at strain 0.005) (MPa)				
		sw%				
		0%	10%	30%	60%	100%
0.5	7	40	10	16	20	10
	14	58	10	24	32	20
	28	60	44	30	43	41.6
0.6	7	32	5	10	10	14
	14	48	10	14	14	20
	28	50	18	16	20	24
0.7	7	14	30	6	18	7
	14	16	35.2	35	22	24
	28	18	40	38	36	30.8

Table (5.29) shows comparison of tests result of water absorption for concrete after 28 days curing for all types of water used.

Table (5.29): Comparison of absorption test results of using all types of water.

w/c %	% Replacement water			% Replacement water		
	0%	30%	100%	0%	30%	100%
	w/c %			w/c %		
	wastewater with flocculant			wastewater without flocculant		
0.5	5.84	2.41	2.88	5.84	4.5	2.9
0.6	2.4	2.4	2.8	2.4	2.6	2.28
0.7	2.01	2.21	2.74	2.01	2.26	1.84

Figures 5.19- 5.24 shows the variation trend of max compressive stress for concrete samples with different replacement ratios at different ages for stone slurry wastewater with and without flocculant.

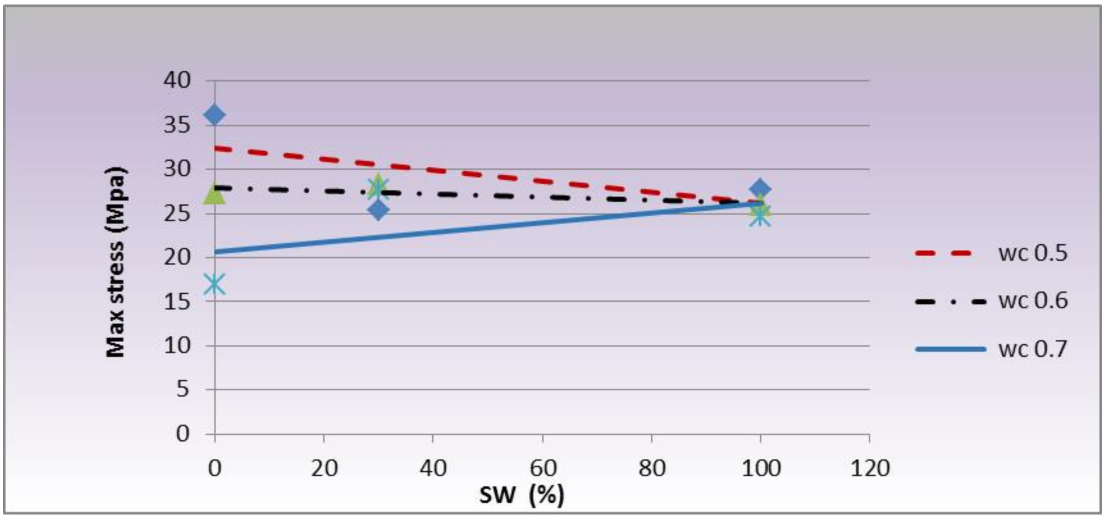

Figure (5.19): Variation of max stress with different replacement of stone slurry Wastewater with flocculant after 7 days curing

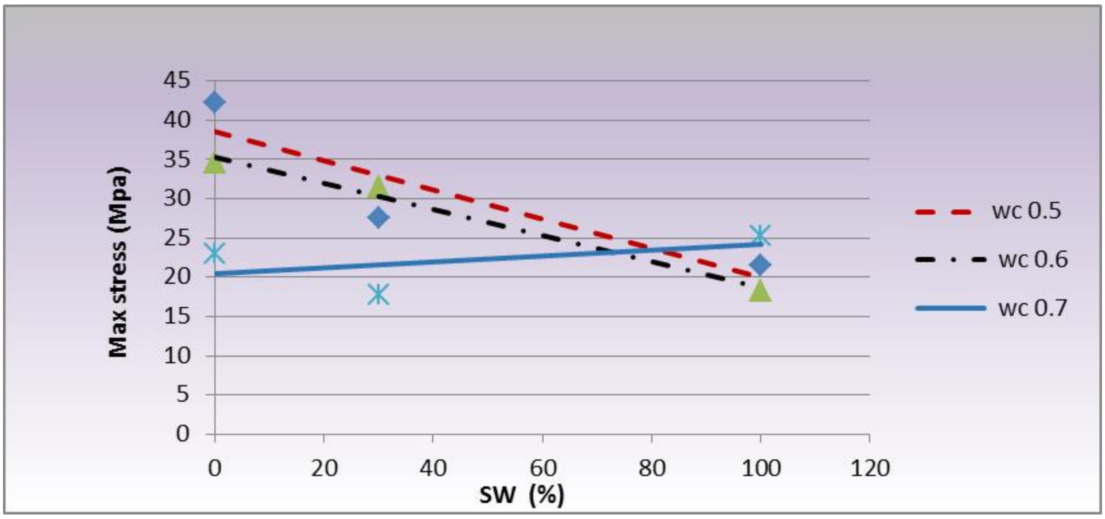

Figure (5.20): Variation of max stress with different replacement of stone slurry Wastewater with flocculant after 14 days curing

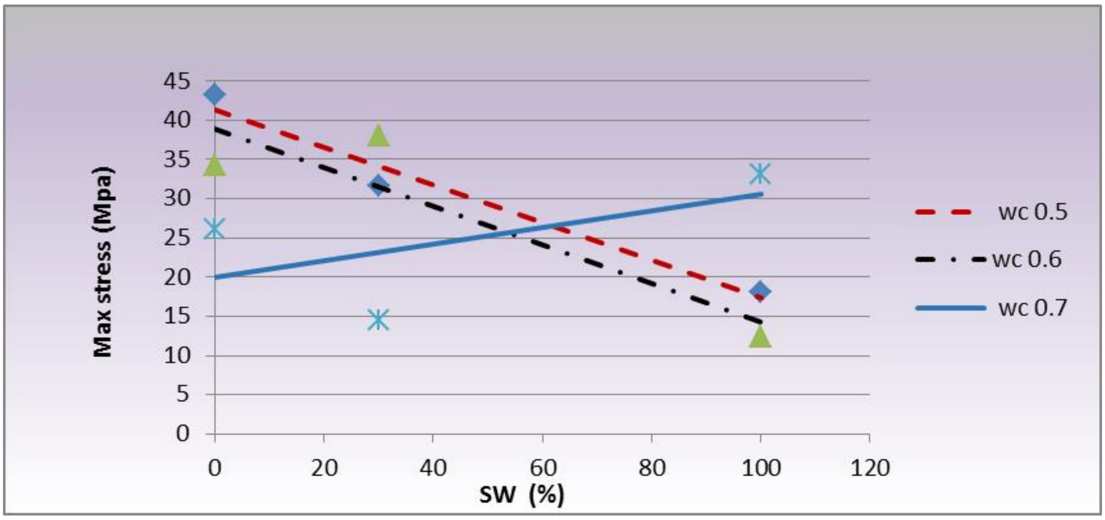

Figure (5.21): Variation of max stress with different replacement of stone slurry wastewater with flocculant after 28 days curing

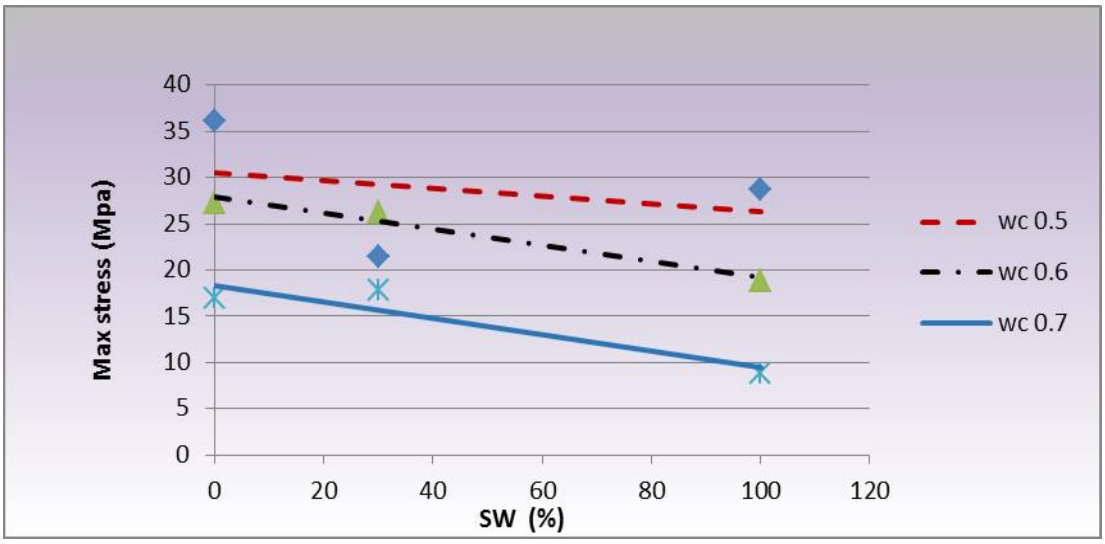

Figure (5.22) : Variation of max stress with different replacement of stone slurry Wastewater without flocculant after 7 days curing.

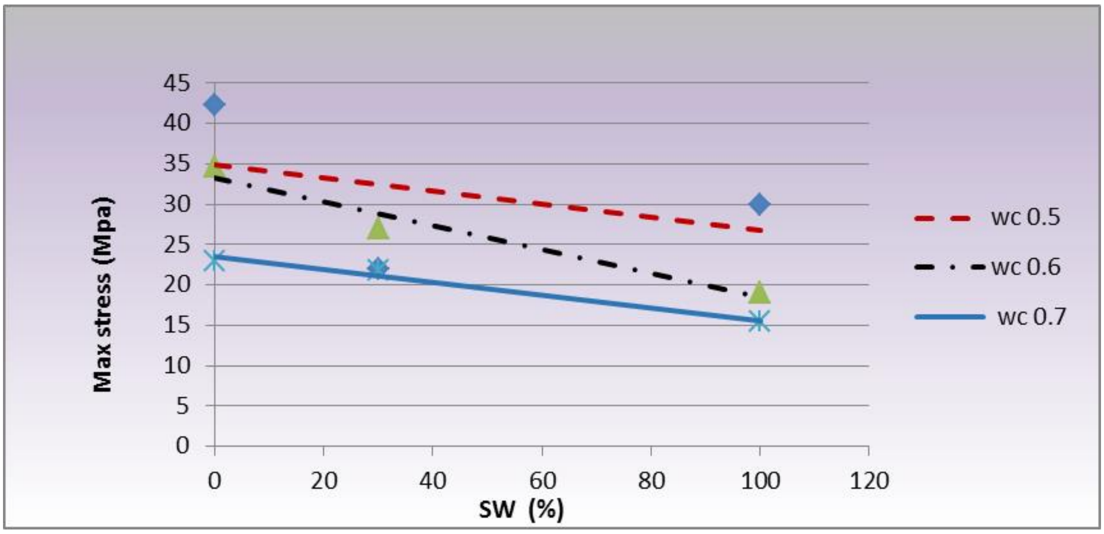

Figure (5.23): Variation of max stress with different replacement of stone slurry Wastewater without flocculent after 14 days curing

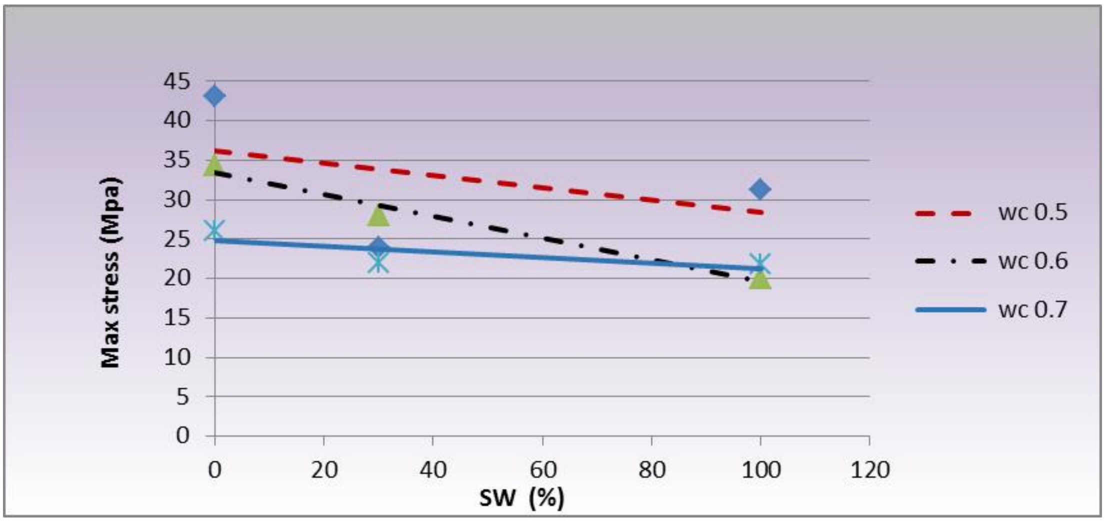

Figure (5.24): Variation of max stress with different replacement of stone slurry Wastewater without flocculent after 28 days curing.

Table (5.30) present the results of compressive stress at 20% replacement of stone slurry wastewater as substitute of tab water in concrete mixtures. It is noticed that most stresses are reduced less than 20%. Therefore it is possible to use the stone slurry wastewater at 20% in concrete mixtures.

Table (5.30): Results of compressive stress at 20% replacement of tab water With stone slurry waste water from figures 5.19 to 5.24

Age(days)	**tab water**			**slurry wastewater with flocculant**			**change in max stress %**		
	0.5	0.6	0.7	0.5	0.6	0.7	0.5	0.6	0.7
	max stress(MPa)			max stress(MPa)					
7	36.1	27.27	17	33	26	20	-8%	-4%	18%
14	42.3	34.6	23	35	33	21	-17%	-4%	-9%
28	43.2	34.4	26	37	34	25	-14%	-1%	-12%
Age(days)	**tab water**			**slurry wastewater without flocculant**			**change in max stress %**		
	0.5	**0.6**	**0.7**	**0.5**	**0.6**	**0.7**	**0.5**	**0.6**	**0.7**
	max stress(MPa)			**max stress(MPa)**					
7	36.1	27.27	17	30	25.1	16.8	-17%	-4%	0.50%
14	42.3	34.6	23	34	30	23	-19%	-13%	-13%
28	43.2	34.4	26	35	30	25	-18%	-13%	-4%

5.3 Conclusion and recommendation

1- Result showed that at w/c=0.7 the stone slurry wastewater did not affect compressive strength significantly after 28 day curing, on the other hand at w/c of 0.5 and 0.6 caused varying reduction of compressive strength at different ages.

2- The result showed that replacement of tab water with stone slurry wastewater (with flocculent and without flocculent) in each percent caused slump reduce between 15%-90%, on other hand slump did not affected at w/c = 0.5 and replacement of 100% .

3- The result showed varying reduction of max stress by replacement of tab water with stone slurry wastewater (with flocculent and without flocculant) at w/c =0.5 and 0.6 after 28 days curing.

4- The result showed that the replacement tab water with stone slurry wastewater (with flocculent and without flocculent) in each percent increase the water absorption on w/c =0.6 and 0.7 by (8%- 27%) and it decrease at w/c = 0.5 between 5-59% .

5- The modules of elasticity decreased by using stone slurry wastewater (with flocculent and without flocculent)

6- The reduction of max stress, slump, water absorption, and elasticity when using stone slurry wastewater with flocculant may be of attributed to the fine particle and chemical solvent on slurry stone wastewater.

7- Stone slurry wastewater may be used at 20% replacement only of the tab water, according to figures (5.19 -5.24) and this result is in compatible with some research in the literature [37]. This result will be the most feasible and economical ratio of replacement and which will produce concrete with acceptable properties.

8- It is recommended to use the slurry wastewater at w/c =0.7 in replacement of tab water for production of self-compacted concrete, and low grade concrete or plane concrete .

9- It is recommended that more researches to be conducted about the reuse of wastewater from stone slurry waste, in order to arrive at the best standards and ratios of replacement which will give the best concrete properties.

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Appendix (A): Survey Results

Survey of stone cutting factories and concrete factories in the study area.

استهلاك المياه، بلدية		استهلاك المياه، تنكات		وحدة المعالجة			استخدام	المخلفات السائلة (الربو)			بودرة	بقايا حجر	بلوكات حجر	عدد العمال
كوب	شيكل	كوب	شيكل	عصارة	سيلوهات	برك ترسيب	الفوكلانت	الكمية، كوب	تكلفة التخلص، شيكل/شهر	كمية المياه،كوب	كوب/شهر	كوب/شهر	كوب/شهر	
150	1050	0	0	√	√		نعم	100	1000	0	90	150	250	30
120	840	0	0	√		√	نعم	100	1000	0	75	150	270	20
15	105	0	0	√	√	√	نعم	300	3000	0	75	375	750	8
84	588	0	0	√		√	نعم	150	1500	0	105	225	400	26
71	497	0	0			√	لا	220	2200	0	90	75	180	8
100	700	0	0	√		√	لا	300	3000	0	120	210	255	8
150	1050	0	0			√	لا	300	3000	0	75	900	900	15
0	0	120	1440		√		نعم	84	2100	0		250	450	10
17	140	0	0		√		نعم	45	700	0	225	450	900	60
20	140	0	0		√		لا	120	1200	0	150	80	200	12
0	0	70	480		√		لا	90	2100	0	150	300	150	5
30	210	0	0			√	نعم	120	2100	0	60	150	150	6
15	105	0	0		√		نعم	200	2100	0	90	450	900	16
30	210	0	0			√	لا	300	3000	0	450	150	1000	10
25	175	0	0			√	لا	300	3000	0	70	225	300	15
15	105	0	0			√	لا	350	3500	0	75	225	450	10
17	119	0	0			√	نعم	125	1250	0	60	100	150	6
40	240	0	0			√	نعم	200	2000	0	75	50	150	12

40	240	0	0			√	لا	90	900	0	100	120	350	12
20	140	0	0			√	لا	100	1000	0	45	225	240	7
100	700	0	0	√		√	نعم	160	830	0	150	150	200	20
70	490	0	0			√	نعم	175	2100	0	225	195	300	20
71	497	0	0			√	لا	150	1500	0	75	80	200	5
42	504	0	0			√	لا	250	2500	0	75	225	200	12
200	1400	0	0			√	لا	300	3000	0	75	150	200	4
200	1400	0	0			√	نعم	150	1500	0	180	240	270	16
50	420	0	0			√	لا	210	3000	0	150	180	900	9
300	2100	0	0	√	√		نعم	160	2500	0	390	450	750	80
142	1000	0	0		√		نعم	130	1500	0	195	450	900	12
0	0	35	600				لا	30	3000	0	45	225	400	4
50	350	0	0	√	√		نعم	50	5600	0	90	180	225	13
SUM 2184		**SUM 225**												

Summary of quantities of water consumption in two concrete factories

استهلاك المياه، بلدية	استهلاك المياه، تنكات	مياه ابار	الإنتاج الشهري
كوب	كوب	كوب	كوب باطون
-	-	1000	16000
100	500	2000	25000
Sum 100		Sum 3000	

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جامعة بوليتكنك فلسطين

Appendix (B): The Questionnaire

Reuse of Wastewater from the Stone Industry in Production of Ready-Mix Concrete and Cast Stone

استبانة إعادة استخدام المياه المستخلصة من ربو مصانع الحجر في إنتاج الخرسانة الجاهزة والحجر الصناعي

The aim of this questionnaire is to study potential of reuse of wastewater (slurry) generated from stone industry as byproduct materials in the production of ready mix concrete and cast stones. The reuse of wastewater from stone slurry in concrete and cast stone production will lead to substantial saving in fresh water for domestic use, and will reduce the production cost and reduce the environmental pollution.

ملاحظة: تهدف هذه الاستمارة لدراسة إمكانية إعادة استخدام المياه المستخلصة من ربو مصانع الحجر (الناتج عن صناعة قص وتشكيل الحجر) كبديل عن المياه العذبة (من خط البلدية أو التي يتم شراؤها عن طريق التنكات أو من الآبارالخاصة) والمستخدمة في إنتاج الخرسانة الجاهزة والحجر الصناعي بهدف توفير كميات من المياه العذبة لاستخدام السكان ومحاولة تقليل من تكلفة الإنتاج ، والحد من التلوث البيئي جراء القاء ربو المحاجر في المناطق المفتوحة وشبكات الصرف الصحي.

General Information معلومات عامة

- **Name of Factory:-- :اسم المنشأة**
- **Name of Contact Person:--: اسم الشخص المفوض**
- **Governorate:-- :المحافظة**
- **Area:--- :المنطقة**
- **Mobile:---: رقم الهاتف**
- **--Fax:-- : فاكس**
- **No. of employees: -- :عدد العمالة**

Water: المياه

مصدر الحصول على المياه:***Sources of Water***

wells آبار (   )   ***Tanks*** تنكات (   )   ***Municipality***   بلدية (   )

- كمية الاستهلاك للمياه من خط البلدية ------------------ كوب / الشهر

Water consumption from municipality lines: -------------------m^3/month

- تكلفة المياه المستهلكة من خط البلدية ------------------ شيكل / شهر

Cost of water from municipality: ---------------------------------NIS/month

- كمية الاستهلاك للمياه من التنكات -------------------- كوب / الشهر

Water consumption from tanks: ------------------------------------m^3/month

- تكلفة المياه المستهلكة من التنكات -------------------- شيكل / شهر

Cost of water from tanks: --------------------------------------NIS/month

- كمية المياه المستخدمة في غسيل خلاطات الباطون بعد تفريغ الباطون ---------- كوب/شهر

Water consumption in washing concrete mixers: ------------- m^3/month

- تكلفة المياه المستخدمة في غسيل خلاطات الباطون بعد تفريغ الباطون --------- شيكل/شهر

Cost of water used in washing concrete mixers:---------------NIS/month

Solid and Liquid wastesالمخلفات السائلة والصلبة

Treatment of Liquid waste -: معالجة المخلفات السائلة (الربو) يتم عن طريق:
Silos سيلو (   )   **Sedimentation poo*ls*** برك ترسيب   **(slurry)**

Sedimentation pools & filter pressعصارة مع برك ترسيب (   )

Silos and filter pressعصارة مع سيلوهات (   )

كمية المخلفات السائلة (الربو):- --------------تنك/شهر وتعادل ------------ كوب/ شهر.

Quantity of liquid waste (slurry):--------tank/month = ---------m^3/moth

هل يتم استخدام مادة مخثرة (فوكلانت):- نعم (   )   لا (   )

Do you use flocculation agent (flocculant): Yes (   )   No (   )

<u>التخلص من المخلفات السائلة (الربو) يتم عن طريق تحويلها إلى: -</u>

(   )   محجر قديم   (   ) كسارة   (   ) مناطق مفتوحة

Disposal of liquid waste (slurry) is carried out by:

(   ) old quarry   (   ) Crusher   (   ) open areas

تكلفة التخلص من المخلفات السائلة (الربو) --------- شيكل/تنك وتعادل -------- شيكل/كوب

Cost of Disposal of liquid waste (slurry) :-------- NIS/tank= --------NIS/m^3

كميات المخلفات من البودرة الجافة وبقايا الحجر والحجر الكسر (الدبش):

Quantity of solid waste (scraped stone) and dry powder:

البودرة الجافة (من العصارات) ----- حاوية أو قلاب/شهر   وتساوي تقريبا ------كوب/شهر

Stone powder from filter press: ------------ truck/month = ----------m3/month

البودرة الجافة من برك الترسيب ---- حاوية أو قلاب/شهر   وتساوي تقريبا ----- كوب/شهر

Dry powder form sedimentation pools:--------truck/month= --------m^3/month

التخلص من البودرة الجافة يتم عن طريق تحويلها إلى: Disposal of dry powder by transfer it t*o*

(   )   محجر قديم   (   ) كسارة   (   ) مناطق مفتوحة

(   ) old quarry   (   ) Crusher   (   ) open areas

بقايا حجر أو حجر الكسر أو الدبش ------- حاوية أو قلاب   وتساوي تقريبا -------- كوب/شهر

Quantity of Scraped stone -----------truck/month = ------------ m3/month

<u>التخلص من بقايا الحجر أو الحجر الكسر يتم عن طريق تحويله إلى:</u>

Disposal of scraped stone by transfer it to

(   ) مناطق مفتوحة   (   ) كسارة   (   )   محجر قديم

(   ) open areas   (   ) Crusher   (   ) old quarry

كميات الخامة المستهلكة والتي يتم قصها على القواطر او المناجل ------------ كوب / شهر

Quantity of stone blocks consumed by cutting it by gang saw or block cutting machines --------------------m3/month.

كمية الحصمة *coarse aggregate* المستخدمة في صناعة الباطون الجاهز -----------------طن /شهر

Amount of coarse aggregate used in manufacturing of ready mixed concrete ------------ton/month

تكلفة الحصمة *coarse aggregate* المستخدمة في صناعة الباطون الجاهز --------------شيكل /شهر

Cost of coarse aggregate used in manufacturing of ready mixed concrete ------------NIS/month

كمية السمسمية*semsame* المستخدمة في صناعة الباطون الجاهز ------------------------طن/شهر

Amount of semsem used in manufacturing of ready mixed concrete ------------ton/month

تكلفة السمسمية*semsame* المستخدمة في صناعة الباطون الجاهز ------------------------طن/شهر

Cost of semsem used in manufacturing of ready mixed concrete -----------NIS/month

كمية الرمل *Sand* المستخدم في صناعة الباطون الجاهز -------------------------طن/شهر

Amount of sand used in manufacturing of ready mixed concrete -----------ton/month

تكلفة الرمل *Sand* المستخدم في صناعة الباطون الجاهز ------------------------طن/شهر

Cost of sand used in manufacturing of ready mixed concrete -----------NIS/month

كمية الباطون الجاهز التي يتم إنتاجها من كل الأنواع ------------------------- كوب/شهر

Amount of ready mixed concrete produced --------------------------m^3/month.

الكمية المتوقعة من التوفير في ثمن المياه في حال استخدام 100% من مياه المناشير (الربو) بدلا من مياه البلدية او التي يتم شراؤها بالتنكات ----------------------شيكل/شهر

What is the expected amount of saving in the production of ready mixed concrete in the case of using of 100% wastewater (slurry) instead of fresh water? (--------- NIS/month)

الكمية المتوقعة من التوفير في ثمن المياه في حال استخدام مياه مخلوطة بنسبة 50% مياه نقية و 50% مياه مناشير ---------------------- شيكل/شهر

What is the expected amount of saving in the production of ready mixed concrete in the case of using of 50% wastewater (slurry) and 50% fresh water? (--------- NIS/month)

- **هل تعتقد أنه يمكن إعادة استخدام المياه العادمة (الربو) الناتجة عن مصانع الحجر في تصنيع الباطون الجاهز أو الحجر الصناعي وكيف ترى وتقيم هذه الفكرة؟**

Do you think we can use a mixture of fresh water and wastewater from stone slurry in production of concrete and cast stone and how you see this idea?

- **هل فكرت مسبقا باستخدام المياه العادمة من مصانع الحجر في صناعة الباطون الجاهز أوالحجر الصناعي؟ وهل حاولت بالموضوع سابقا؟**

Do you think to use a mixture of fresh water and wastewater in production of concrete and cast stone and do try this idea before?

- **إذا كنت تؤيد فكرة استخدام المخلفات السائلة (الربو) في تصنيع الباطون، هل هنالك من تحفظ معين بالخصوص؟**

If you agree and support the idea, is there any concern you think about it?

- **هل تعتقد أن الزبائن سوف لا تعارض شراء باطون جاهز أو حجر صناعي يدخل في تصنيعه المياه العادمة (الربو) الناتجة من مصانع الحجر؟**

Do you think the customer will buy the concrete if he knew that it makes with wastewater from stone slurry?

- **كيف يمكن تشجيع الزبائن لتقبل شراء باطون جاهز تم تصنيعه من مياه مصانع الحجر (الربو)؟**

How we can encourage the customer to accept buying ready mix concrete and cast stones made with wastewater from stone slurry?

- **ما هي الفرص التي قد تساعد في النجاح في إعادة استخدام مياه مصانع الحجر (الربو) في صناعة الباطون الجاهز او الحجر الصناعي؟**

What are the opportunities that assist in succeeding the reuse of wastewater from stone slurry in Palestine in ready mix concrete and cast stones?

- **ما هي المحددات التي قد تواجه إعادة استخدام مياه مصانع الحجر (الربو) في صناعة الباطون الجاهز او الحجر الصناعي؟**

What are the constraints that the reuse of wastewater from stone slurry in Palestine in ready mix concrete cast stones?

- **هل تعتقد أن السياسات والقوانين والتشريعات مناسبة لفكرة إعادة استخدام مياه مصانع الحجر (الربو) في صناعة الباطون الجاهز او الحجر الصناعي؟**

Do you think that the policies and laws are suitable and appropriate for the reuse of wastewater from stone slurry in Palestine in ready mix concrete and cast stones?

- كيف يمكن لفكرة إعادة استخدام مياه مصانع الحجر (الربو) في صناعة الباطون الجاهز او الحجر الصناعي أن تساعد في ثبات الاقتصاد وتطوير البيئة؟

How the reuse of wastewater from stone slurry in concrete and cast stones will help toward sustainable economic and environmental development in Palestine

- كيف ترى فكرة إعادة استخدام مياه مصانع الحجر (الربو) في صناعة الباطون الجاهز او الحجر الصناعي بعد 10 سنوات؟

How do you see the reuse of wastewater from stone slurry in Palestine in ready mix concrete and cast stones after 10 years?

Thank you