Mansoura University
Faculty of Engineering
Mansoura Engineering Journal

Burned Shale As Coarse Aggregate in High Performance, Self Compacting Concrete

حريق الطين الصفحى (الطفله) كركام كبير فى الخرسانة عالية الأداء , ذاتية الدمك

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KEYWORDS:
Self-Compacting Concrete; Burned Shale; High Performance concrete; concrete mix design; X-ray Diffraction

الملخص العربي:-**الركام يمثل أكثر من 60% من حجم الخرسانه , يلعب دور رئيسيا فى التأثير على خواصها الطازجه وكذلك خواصها المتصلده .الهدف الرئيسى من هذا البحث هو انتاج خرسانه ذاتية الدمك بأستخدام نوع جديد من الركام الكبير (حريق الطفله) ومواد متاحه فى منطقتنا مثل الرمل ومسحوق الحجر الجيري وسليكافيوم . تم تصميم برنامج تجريبي لتوصيف خصائص الطازجة والمتصلدة لخرسانه ذاتية الدمك وأدائها تحت تأثير محلول كبريتات الصوديوم . تم اختيار اثنين من محتوى الاسمنت 450 كجم / م3 و 550 كجم / م3 في هذا البحث. كما استخدم غبار السيليكا 10٪ و 15٪ من الاسمنت كأضافه .مسحوق الحجر الجيري = 10٪ من الاسمنت كأضافه . تم استخدام الملدنات الفائقة (فيسكوكريت) 3٪ من الأسمنت . وتراوحت نسبة المياه الي المواد الأسمنتية (0.25، 0.35). يوجد طرق اختبار مختلفه لتحديد اداء وخواص الخرسانه ذاتية الدمك فى الحاله الطازجه مثل Slump-flow, V-funnel , L- Box , U box , Fill box .اختبارات الخواص المتصلده تقتصر على مقاومة الضغط بعد 7,28,90 يوم .بإستخدام جهاز موجات فوق صوتيه ومطرقه شميدت لأستدلال على مقاومة الضغط للمكعب . تم إجراء اختبار على 28 يوما**

Abstract—**Aggregates occupy more than 60% of the volume of concrete, play a main role in affecting its fresh properties as well hardened properties. The main objective of this research is to produce Self Compacting Concrete (SCC) by using a new type of coarse aggregate (Burned shale) and locally available materials in our region such as sand, limestone powder and silica fume. Experimental programme was designed to characterize the properties of fresh and hardened SCC and the performance of SCC under influence of a solution of sodium sulphate. Two cement content 450 kg/m3 and 550 kg/m3 were chosen in this research. Also silica fume was used addition with 10% and 15% of cement. Limestone Powder =10% of cement. Super plasticizer (viscocrete) was used addition with 3 % of the cement. Water cementatious ratio ranged from (0.25, 0.35). There different test methods to characteristics performance and properties of scc in the fresh state like Slump-flow test , V-funnel , L- Box , U box , Fill box .All the cube specimens of concrete mixes were removed from the curing tank before testing age about 2 hours to dry in laboratory. The Hardened Concrete properties tests limited to compressive strength test after 7,28,90 days , using pulsive velocity apparatus and shemidet hammer inference cube compressive strength, test was performed at 28 days.**

Received: (8 May, 2016) - accepted: (20 July, 2016)

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I. INTRODUCTION

CONCRETE is the most commonly used construction material for buildings worldwide and stands out as the largest consumer of natural resources such as cement, fine aggregates, coarse aggregates and water (1).

Nearly all countries in the world are facing an acute decline in the availability of skilled labor in the construction manufacture, and hence the need of special concretes becomes very fundamental in this world. The word "Special Concrete" refers to the concrete which meets the special performance and requirements which may not be possible in conventional concrete.

SCC is one of the types of a special concrete which can placed and compacted inside every corner of a formwork under its own weight without any vibration effort. thereby eliminates the problems of placing concrete in difficult conditions and also reduces the time in placing large sections, eliminate some of the potential for human error, improve health and safety on and around the construction site and at the same time giving high strength and better durability characteristics as compared to the Normal Concrete (2,3).

Since the early development of SCC in Japan 1980 (4), this new class of high-performance concrete has been employed in several countries in cast- in- place and precast applications. SCC can be considered high-performance concrete in the plastic state. Fresh properties of SCC have lot higher degree of workability and self-consolidation than any conventional concrete. The workability of SCC is characterized with the following properties: filling ability, passing ability, and stability (segregation resistance) (4).

SCC in researches (5, 6, 7) was called high-performance concrete. However, the term “high performance” should refer only to hardened concrete in some European and Canadian researchers and that the concrete with high fluidity proposed in Japan should be excluded from high- performance concrete and it was then called SCC for which RILEM organized a new committee (6).

SCC is very sensitive to changes in aggregate characteristics (shape, texture, maximum size, grading and morphology), so the aggregate should be chosen carefully. The optimum coarse aggregate for SCC depends on two parameters. The first parameter is the maximum size, where lower values of maximum size lead to increased coarse aggregate content. The second parameter is the shape of the coarse aggregate, whether it's crushed or rounded, where a higher content of rounded shape leads to increasedcoarse aggregate content. increased in maximum size leads to decreased passing ability(8).

The shape and gradation of aggregates play an important role in producing SCC. Much research has been conducted to produce SCC by using locally available aggregates. Rounded aggregates are much preferred as they play an important role to achieve workability with lower cement content as compared to angular aggregates (9).

The success to production of high quality Lightweight self-consolidating concrete (LWSCC) lies in the use of Coarse aggregates. Expanded shale (ESH) is a ceramic material produced by expanding and vitrifying select shale’s. The operation produces a high quality ceramic aggregate that is non-toxic, dimensionally stable, structurally strong, durable, environmentally inert and light in weight. The use of expanded shale aggregate with other quality supplementary cementing materials like silica fume, provide highly workable LWSCC. ESH and other lightweight aggregates such as: clayey diatomite and pumice have been successfully used in the production of lightweight concretes (LWC) over the decades (10).

The application of clays as a main raw material for many traditional clay-based ceramic products is determined by their chemical, mineral and particle size composition. There ara classified the clays applied in the manufacture of ceramic products according to their composition and properties (11).

Nowadays, manufacturing of the different types of solid and perforated building bricks; namely, clay (or shale), cement and sand-lime bricks is considered one of the important building material industries in Egypt. Therefore, there is increasing demand for production of huge amounts of the different types of building bricks, especially shale bricks with accepted physical properties according to the national and international standards for loading and unloading walls. The shale building bricks generally show better physical properties than the other types of bricks. Concerning chemical composition of the brick clays has reported that clays of group C with low $Al2O_3/SiO_2$ ratio and high iron oxides content are satisfactory for brick-making. In addition to iron oxides, the alkali oxides; namely, K_2O and Na_2O as well as the oxides of calcium and magnesium must be present as fluxing agents. Type and amount of the fluxing oxides are the main factors controlling vitrification of building bricks on firing up to ~1000 ^{o}c.

Types of clayey deposits occur in Egypt around the Nile Valley and Delta in the Eastern and Western Deserts as well as around Suez Gulf. Some of these deposits were quarried and exploited for application in many ceramic industries; namely, refractories, white-wares, heavy-clay products and Portland cement.

After reviewing composition and properties of most of the Egyptian clays, it is concluded that most of the clays exposed in the Eastern and Western Deserts are montmorillonite- or smectite- rich and of low grade and none of these montmorillonite clays or shales was found tobelong to the bentonitic type. In order to make these clays or shales to attain the rhyologic properties of bentonite e.g. swelling andthixotropy, it should be activated by different methods e.g. Soda ash or acids to be suitable for different uses of bentonites. Some of these clays are currently used for manufacturing solid and perforated building-bricks by adding suitable amount of quartz sand grains (-2 mm) to control their drying and firing shrinkage on firing up to ~1000 ^{o}c. In addition, these clays are already used all over the country for producing different types of Portland cement after mixing with the calculated amounts of limestone (11).

Some of these clays were also assessed in manufacturing lightweight clay aggregate due to their bloating behaviour on firing up to 1300 ^{o}c. The lightweight clay aggregate is applied all over the world in production of lightweight building units for thermal insulation of buildings and furnaces from ambient temperature up to ~1100 ^{o}c (11).

The lightweight clay aggregate is usually processed by firing pelletized clay-powder in a suitable rotary kiln up to the bloating temperature range (900 ^{o}c -1300 ^{o}c). Bloating is mainly occurred due to their low alumina/silica weight ratio (0.20 - 0.40) as well as high total content (10 - 25%) of iron oxides (FeO and Fe_2O_3), as well as other fluxing oxides; namely, CaO, MgO, Na_2O and K_2O. When the chemical composition of these clays is plotted by means of SiO_2, Al_2O_3 and total fluxing oxides, its composition points should be existed within the area defined for bloated clays (11).

1.1 X-ray powder diffraction

The usual method for characterization of clay minerals is X-ray powder diffraction (XRD). It is a non-destructive rapid analytical technique primarily used for phase identification of a crystalline material. It can be determind of unknown solids is critical to studies in geology, environmental science, material science, engineering and biology. Identification of fine-grained minerals such as clays and mixed layer clays that are difficult to determine optically. The mineralogy of the clay-size fraction was determined by X-ray diffraction methods as shown in figure (1) and (2) and the chemical analysis of the used shale is given in table (1).XRD in centrallab Tanta University

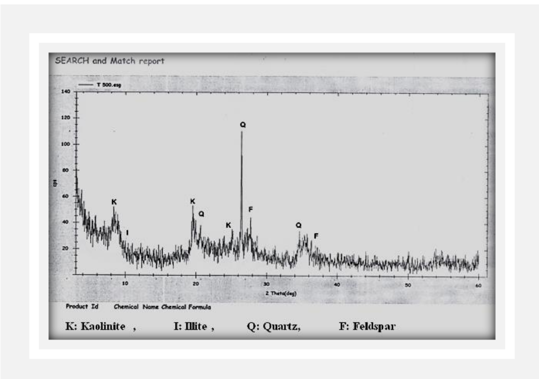

Figure (1): XRD for burned shale (furnace in concrete laboratory temp 500 ^{0}c)

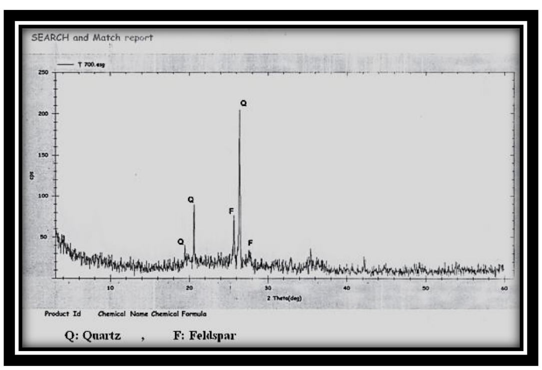

Figure (2): XRD for burned shale (furnace in concrete laboratory temp 700 ^{0}c)

TABLE (1)
CHEMICAL ANALYSIS OF USED SHALE

Chemical properties	Perecent by Weight (%)
SiO2	47.48
Al2O3	20.37
Fe2O3	8.26
TiO2	1.27
MgO	2.90
CaO	0.94
Na2O	1.09
K2O	1.02
P2O5	0.16
SO3	0.99
LOI	15.51

1.2 Sulphates Attacking

Most of deep reinforcement concrete foundations in egypt is attacking by sulphates. The degree of sulphates concentration considerably among various soil locations.

Computation of Sulphates Content

The data of sulphates distribution in egypt were extensive analyzed and the degree of sulphates content was chosen to be 20 gm/L (20000 PPM.), Which equivalent to the maximum value of the underground sulphates, that lies in the lacks near the Swiss canal. This value is equivalent to 5 times maximum value in Cairo area (12).

The steps of computing of sulphates concentration, each 142 gm of sodium sulphate (Na_2So_4) contains 96 gm of sulphates. 29.6 gm sodium sulphate into 1 liters of fresh water given concentration of sulphates =20000 PPM.

Study on sulphate resistance of (SCC). For this purpose, more than 300 cubes (10×10×10 cm) of concrete were subjected to a solution with sodium sulphate.

II. EXPERIMENTAL STUDY

To achieve the objectives of this research fourty-one concrete mixes were designed to study the effect of burned shale on mechanical properties of SCC.

2.1 Materials Properties

The following materials were utilized for producing 41 mixes and casting cubes

2.1.1 Cement

Ordinary Portland cement (CEM I 52.5 N) produced by Sinai cement factory was used in this study, specific gravity of the cement is 3.15. The initial and final setting time of cement were determined using Vicat apparatus , initial setting time = 70 min and final setting time = 200 min . The different laboratory tests were conducted on cement conforms to Egyptian Standards (ES 4756-1/2009).

2.1.2Fine Aggregates

Locally available sand from natural sources was used as a fine aggregate. The specific gravity 2.65 and bulk density 1700 kg/m^3.

2.1.3Coarse Aggregates

Burned Shale (B.S),Burned Shale + sand (B.S.S) and Break Bricks (B.B) were used to produce the concrete in this research .The maximum nominal size of all Coarse Aggregates is (12-20)mm. Bulk Density = 1170 kg/m^3.

The average values of specific gravity for coarse aggregates

B.S in Furnace in Concrete laboratory at T 500 ^{o} c = 2.26

B.S.S in Furnace in Concrete laboratory at T 500 = 2.3

B.S in Furnace in Concrete laboratory at T 700 ^{o} c = 2.2

B.S.S in Furnace in Concrete laboratory at T 700 ^{o} c = 2.24

B.S in brick factory =2.1 , B.S.S in brick factory = 2.2

Manufacture of Coarse Aggregates

Shale shaping spherical pellets with water (12-20)mm or Shale mix with sand (5:1)and shaping spherical pellets with water (12-20)mm, drying up to 60ºC and gradual firing up to (500 or 700 or 1000)ºC.

(500 and 700) ºC in furnace electric in Concrete laboratory, Faculty of Engineering, Mansoura University as shown in figure (4), 1000 ºC in Brick Factory in Nawsa village- Mansoura –Egypt as shown in figure (3).

Figure (3): Firing up to 1000 oC in brick factory in Nawsa village- Mansoura –Egypt

Figure (4): Firing up to (500 and 700) o C in furnace electric in concrete laboratory, faculty of engineering, Mansoura University

2.1.4 Lime Stone Powder

Fine lime stone powder (particle size smaller than 0.125 mm) was used at percentages of the cement weight . The specific gravity of the lime stone powder is 2.5.

2.1.5 Silica Fume

In this study, the used Silica fume was brought from (sika) in Egypt. It mainly consists of spherical particles of amorphous silicon dioxide and is highly pozzolanic. The high level of fineness and practically spherical shape of silica fume results in good cohesion. Silica fume imparts very good improvement to, resistance to segregation, mechanical and chemical properties. The specific gravity of Silica fume is 2.2.

2.1.6 Water

Ordinary water (drinking water) from public net.

2.1.7 Super plasticizer

The essential component of scc is high range water reducer admixture (HRWRA), which is also known as Super plasticizer. Table 2 show Properties of the Super plasticizer. (Sika Viscocrete- 3425) meets the requirements for superplasticisers according to ASTM-C- 494 Types G and F and BS EN 934 part 2: 2001 (16).

TABLE 2
PROPERTIES OF THE SUPER PLASTICIZER

Items	Testing results	Standards quality
Density	1.08 kg/lt	0.938 - 1.146
pH Value	4	5.4 - 7.4
Colour	Clear liquid	-

By the manufacture data sheet

2.2 Plain Concrete Mixes

There is no standard method for SCC mix design and many academic institutions, admixture, ready-mixed, pre cast and contracting companies have developed their own mix proportioning methods. Okamura's method, based on EFNARC specifications, was adopted for mixed design. Different mixes were prepared by varying the amount of coarse aggregate, fine aggregate, water powder ratio, super plasticisers (13). After several trials Table 3 presents the mix proportions of all fourty-one concrete mixes (41 mixes) used throughout this research. For all SCC mixes, the cement content was (450 or 550) kg/m3, the fine to coarse aggregate ratio was one (by weight) and the superplasticizer content was fixed as 3% of the cement content. The water cementatious ratio was (0.25, 0.35). . The silica fume content (10 or 15% of the cement) and the lime stone powder content (10% of the cement).

The experimental variables were the type of the coarse aggregate and methoed of burn shale.

five conventional concrete (VC) mix was prepared using the same type material .the cement content was 550 kg/m3 , the fine to coarse aggregate ratio was 1:1.5 (by weight) and The water cementatious ratio was 0.4 .

The absolute volume method of concrete mix design was employed to design all the concrete mixes taking into consideration the previous reported ranges of the proportions in references (3, 14, and 15) and the Egyptian

Technical Specifications for SCC.

18 cubes (10×10×10 cm) were cast from every concrete mix. All concrete specimens were cured in fresh water (9 cubes) or attacking media (9 cubes) till the tests of hardened concrete would be carried out tested under static loading.

TABLE 3
MIX PROPORTIONS FOR CONCRETE MIXES.

Mix No	Coarse Aggregates			C	Sand	Water		S. P	S. F	L.s. P
	Type	Temp	Content Kg/m3			Content Kg/m3	W/CM	Content Kg/m3		
M 1	B.S	T 700	857	550	572	220	0.4	—	—	—
M 2	B.S.S		867	550	578	220	0.4	—	—	—
M 3	B.S	T 500	804	450	804	173	0.35	4.95	45	—
M 4	B.S	T 700	750	450	750	184	0.34	12.15	45	45
M 5	B.S.S	T 500	727	450	727	216	0.4	13.5	45	45
M 6	B.S	T 500	760	450	760	184	0.34	13.5	45	45
M 7	B.S.S		767	450	767	184	0.34	13.5	45	45
M 8	B.S		708	550	708	171	0.25	16.5	82.5	55
M 9	B.S.S		715	550	715	171	0.25	16.5	82.5	55
M 10	B.S	T 700	748	450	748	184	0.34	13.5	45	45
M 11	B.S.S		756	450	756	184	0.34	13.5	45	45
M 12	B.S		698	550	698	171	0.25	16.5	82.5	55
M 13	B.S.S		704	550	704	171	0.25	16.5	82.5	55
M 14	B.S	Burn in Brick Factory ~ T 800	832	550	555	220	0.4	—	—	—
M 15	B.S		773	450	773	173	0.35	4.95	45	—
M 16	B.S		731	450	731	184	0.34	12.15	45	45
M 17	B.S		730	450	730	184	0.34	13.5	45	45
M 18	B.S		680	550	680	171	0.25	16.5	82.5	55
M 19	B.S.S		857	550	572	220	0.4	—	—	—
M 20	B.S.S		710	450	710	216	0.4	13.5	45	45
M 21	B.S.S		748	450	748	184	0.34	13.5	45	45
M 22	B.S.S		698	550	698	171	0.25	16.5	82.5	55
M 23	B.B		857	550	572	220	0.4	—	—	—
M 24	B.B		729	450	729	200	0.37	13.5	45	45
M 25	B.B		680	550	680	186	0.27	16.5	82.5	55
M 26	B.B		710	450	710	216	0.4	13.5	45	45
M 27	B.B		655	550	655	655	0.3	16.5	82.5	55
M 28	B.S + B.S.S 1 : 1		B.S = 369 B.S.S = 369	450	738	184	0.34	13.5	45	45
M 29	B.S + B.S.S 1 : 1		B.S = 344 B.S.S = 344	550	688	171	0.25	16.5	82.5	55
M 30	B.S + B.S.S 1 : 2		B.S = 247 B.S.S = 494	450	741	184	0.34	13.5	45	45

CONTINUED TABLE 3
MIX PROPORTIONS FOR CONCRETE MIXES

Mix No	Coarse Aggregates			C	Sand	Water		S. P	S. F	L.s. P
	Type	Temp	Content Kg/m3			Content Kg/m3	W/CM	Content Kg/m3		
M 31	B.S + B.S.S 1 : 2	Burn in Brick Factory ~ T 800	B.S = 230 B.S.S = 460	550	690	171	0.25	16.5	82.5	55
M 32	B.S + B.S.S 2 : 1		B.S = 490 B.S.S = 245	450	735	184	0.34	13.5	45	45
M 33	B.S + B.S.S 2 : 1		B.S = 458 B.S.S = 229	550	687	171	0.25	16.5	82.5	55
M 34	B.S + B.B 1 : 1		B.S = 366 B.B = 366	450	732	189	0.35	13.5	45	45
M 35	B.S + B.B 1 : 1		B.S = 336 B.B = 336	550	672	185	0.27	16.5	82.5	55
M 36	B.S.S + B.B 1 : 1		B.S.S = 371 B.B = 371	450	742	189	0.35	13.5	45	45
M 37	B.S.S + B.B 1 : 1		B.S.S = 340 B.B = 340	550	680	185	0.27	16.5	82.5	55
M 38	B.S+B.S.S+B.B 1 : 1 : 1		B.S = 245 B.S.S = 245 B.B = 245	450	735	189	0.35	13.5	45	45
M 39	B.S+B.S.S+B.B 1 : 1 : 1		B.S = 225 B.S.S = 225 B.B = 225	550	675	185	0.27	16.5	82.5	55
M 40	B.S+B.S.S+B.B 1 : 1 : 2		B.S = 185 B.S.S = 185 B.B = 370	450	740	189	0.35	13.5	45	45
M 41	B.S+B.S.S+B.B 1 : 1 : 2		B.S = 169 B.S.S = 169 B.B = 338	550	676	185	0.27	16.5	82.5	55

B.S = Burned Shale
B.S.S = (Burned Shale + sand) , B.B = Break Bricks
5 : 1
C = Cement
S. F = Silica Fuume
L.s.P = Limestone Powder
S. P = Super Plasticizer

Methoed of burn Shale

1- Aggregate in Mixes (1-13) burn in furnace in concrete laboratory, Faculty of Engineering, Mansoura University

2- Aggregate in Mixes (14-41) burn in brick factory in Nawsa village- Mansoura –Egypt.

Mixture in coarse aggregate Mixes (28-41)

III. LABORATORY TESTS

3.1 Tests of fresh concrete

The self-compacting concrete in its fresh state is characterized by its filling ability, Passing ability, Segregation resistanc and flowability , to check the properties of the fresh self-compacting concrete.

Slump-flow and T500 time

V-funnel test

- *L-box test*

- *U box test*

- *Fill box test*

3.2 Tests of Hardened Concrete

IV. Test Results

4.1 Some Properties of Fresh Concrete

Mixes (6-7-10-11-17-21), cement = 450 kg/m3, the fine to coarse aggregate ratio =1, water cementatious ratio =0.34, superplasticizer = 3% cement

, silica fume =10% cement, lime stone powder =10% cement).

The only change is type of aggregate.

Fig (1-6)

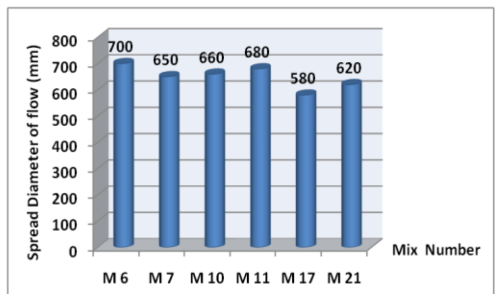

Fig.1 Spread Diameter of Flow

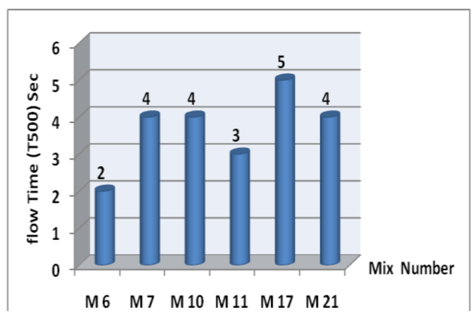

Fig.2 spread flow time (T500)

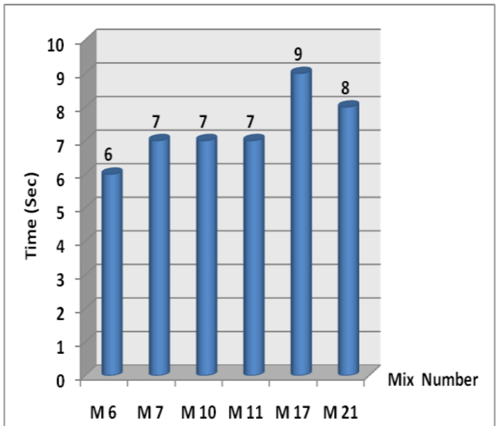

Fig.3 V-Funnel

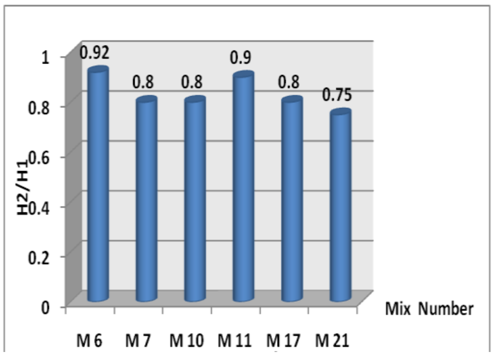

Fig.4 L-Box H2/H1

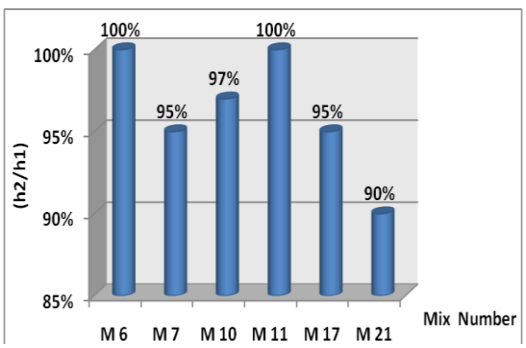

Fig.5 Fill-Box (h2/h1)

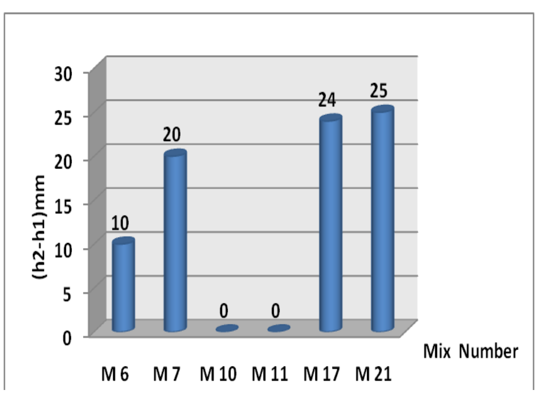

Fig.6 U-BOX (h2-h1)

Mixes (8-9-12-13-18-22), cement = 550 kg/m3, the fine to coarse aggregate ratio =1, water cementatious ratio =0.25, superplasticizer = 3% cement , silica fume =15% cement, lime stone powder =10% cement).

The only change is type of aggregate.

Fig (7-12)

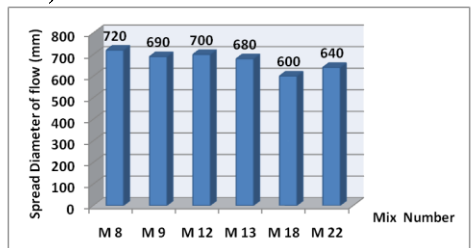

Fig.7 Spread Diameter of flow

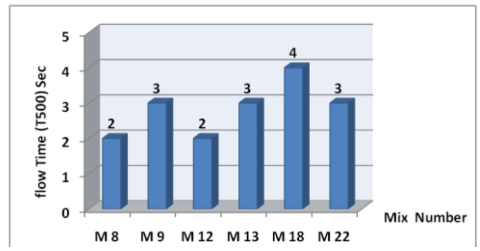

Fig.8 spread flow time (T500)

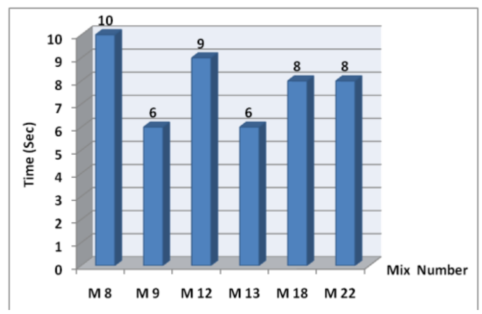

Fig.9 V-Funnel

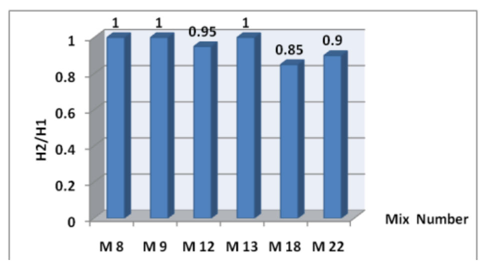

Fig.10 L-Box H2/H1

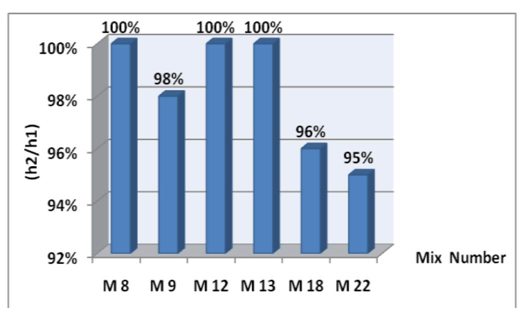

Fig.11 Fill-Box (h2/h1)

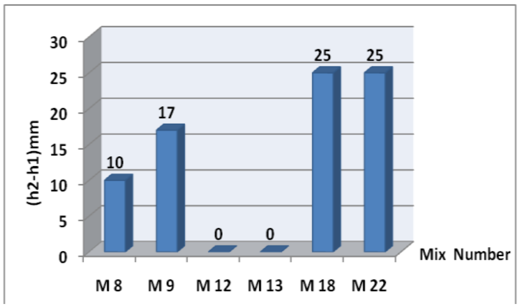

Fig.12 U-BOX (h2-h1)

Mixes (34-36-38-40), cement = 450 kg/m3, the fine to coarse aggregate ratio =1, water cementatious ratio =0.35, superplasticizer = 3% cement, silica fume =10% cement, lime stone powder =10% cement).

The only change is type of aggregate.

(Mixture in coarse aggregate).

Fig (13-16)

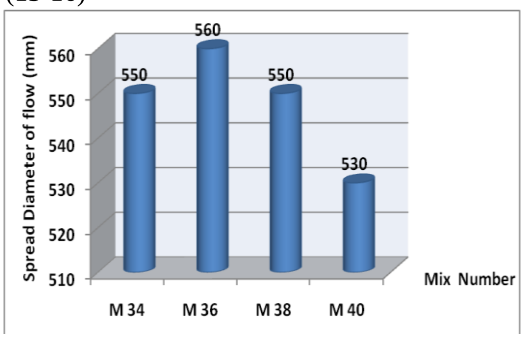

Fig.13 Spread Diameter of flow

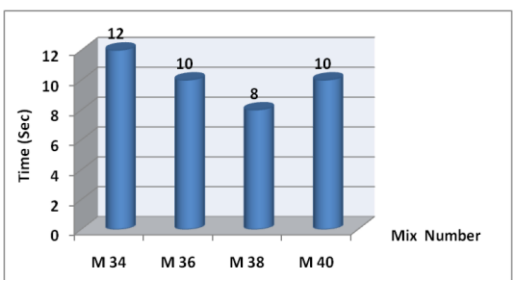

Fig.14 V-Funnel

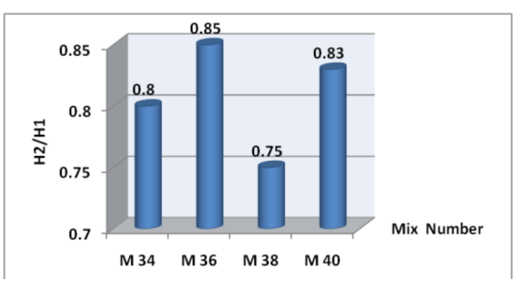

Fig.15 L-Box H2/H1

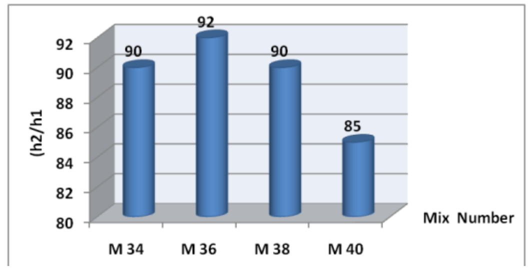

Fig.16 Fill-Box (h2/h1)

Mixes (35-37-39-41), cement = 550 kg/m3, the fine to coarse aggregate ratio =1, water cementatious ratio =0.27, superplasticizer = 3% cement, silica fume =15% cement, lime stone powder =10% cement).

The only change is type of aggregate.

(Mixture in coarse aggregate).

Fig (17-20)

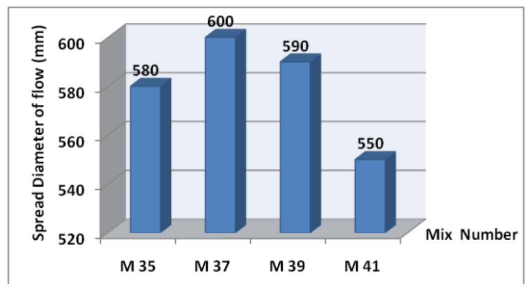

Fig.17 Spread Diameter of flow

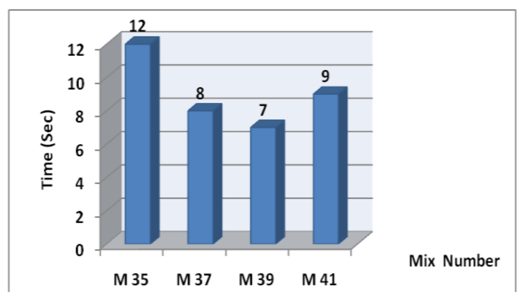

Fig.18 V-Funnel

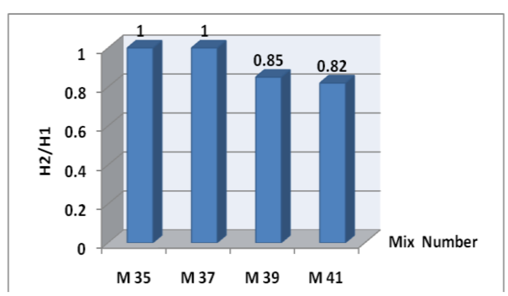

Fig.19 L-Box H2/H1

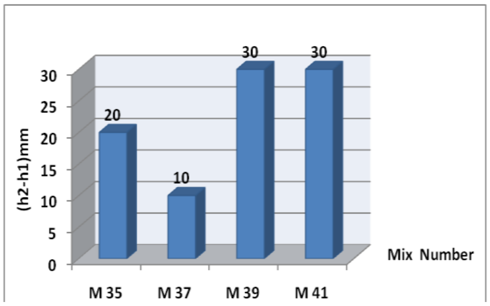

Fig.20 U-BOX (h2-h1)

4.2 Some Properties of Hardened Concrete

Mixes (6-7-10-11-17-21), cement = 450 kg/m3, the fine to coarse aggregate ratio =1, water cementatious ratio =0.3, superplasticizer = 3% cement, silica fume =10% cement, lime stone powder =10% cement). The only change is type of aggregate.

Cured in fresh water

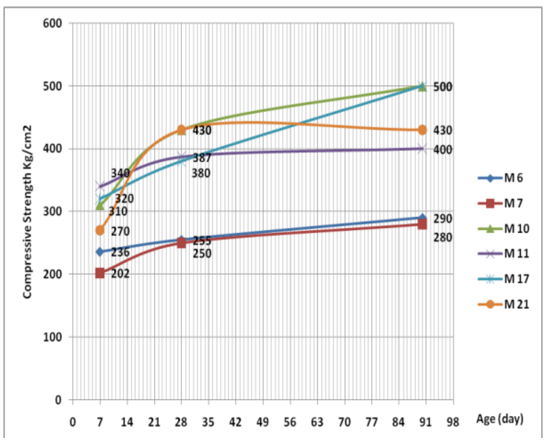

Fig. 21 Relationship between the compressive strength and the age

Fig.22 Mixes (8-9-12-13-18-22) ,cement = 550 kg/m3, the fine to coarse aggregate ratio =1 , water cementatious ratio =0.25 , superplasticizer = 3% cement, silica fume =15% cement, lime stone powder =10% cement).

The only change is type of aggregate.

Cured in a fresh water.

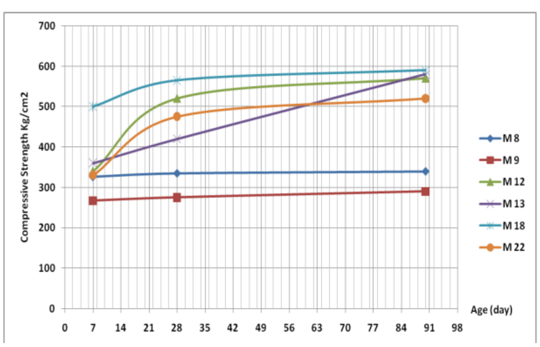

Fig. 22 Relationship between the compressive strength and the age

Mixes (6-7-10-11-17-21), but cured in solution of sodium sulphate.

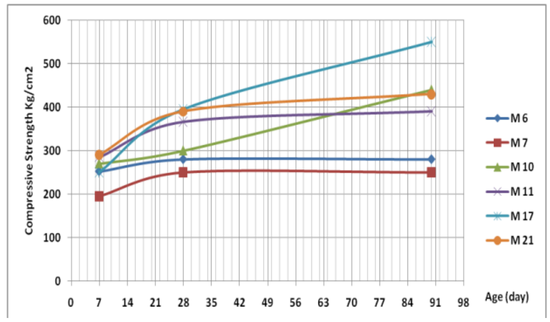

Fig. 23 Relationship between the compressive strength and the age

Mixes (8-9-12-13-18-22), but cured in solution of sodium sulphate.

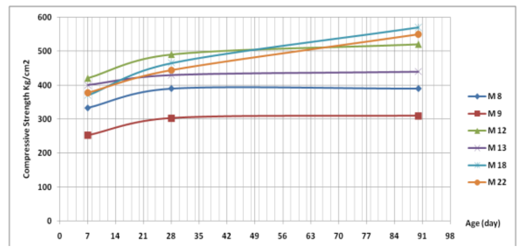

Fig. 24 Relationship between the compressive strength and the age

Fig.25, Mixes (6-7-10-11-17-21), Relationship the Compressive Strength after 28 days, cured in fresh water and cured in solution of sodium sulphate.

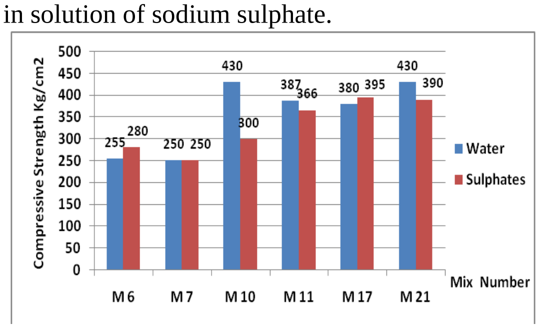

Fig. 25 Relationship between the compressive strength, cured in solution of sodium sulphate and cured in a fresh water after 28 days

Fig.26, Mixes (34-36-38-40), Relationship between the Compressive Strength and Age 7, 28, 90 days

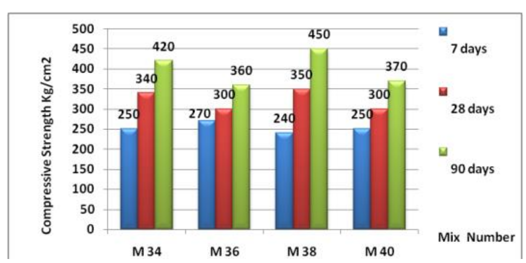

Fig.26 the compressive strength for 7,28,90 days

Fig.27, Mixes (35-37-39-41), Relationship between the Compressive Strength and Age 7, 28, 90 days

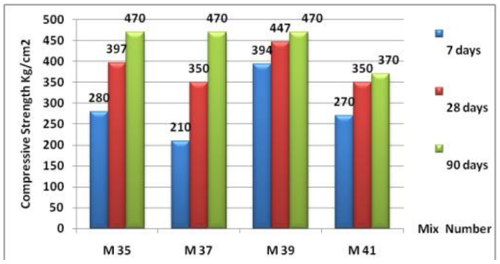

Fig.27 the compressive strength for 7,28,90 days

Fig.28, five conventional concrete mix (1, 2, 14, 19, 23)

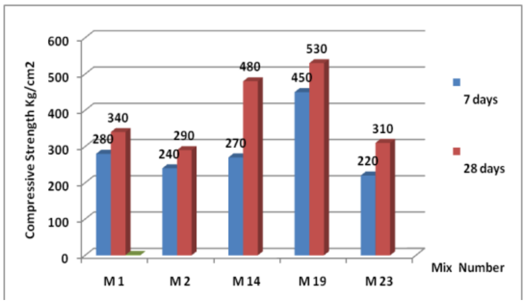

Fig. 28 Relationship between the compressive strength and the age after 7,28 days

TABLE 2
CALCULATE DENSITY OF SOME MIXES

Mix No	Density Kg/m3			
	Water		Sulphates	
	Wet	Dry	Wet	Dry
M 6	2362	2322	2350	2320
M 7	2430	2383	2382	2363
M 8	2395	2300	2397	2300
M 9	2306	2312	2397	2312
M 10	2418	2340	2408	2315
M 11	2316	2238	2266	2238
M 12	2325	2316	2302	2290
M 13	2320	2315	2315	2303

V. CONCLUSION

Some Notes:

- Self-compacting concrete can be easily produced from the locally available materials in Egypt like (Burned Shale) .It is worthy to add that, the production of SCC is promising and could be economic simply because the use of Burned Shale, silica fume and superplasticizer involves no marked increase in the cost as long as they significantly improve and enhance the mechanical performance of SCC.
- Increased burn of Shale increased the Compressive Strength about 10%.
- -Increased the cement content increased the Compressive Strength with Burned Shale.
- Burned Shale given Compressive Strength more than Burned Shale + sand (5:1) and Break Bricks.
- The fresh concrete properties in form of slump-flow and H2/H1 ratios are in a good correlation with those reported in the literature and specifications. This gives an indication about the excellent filling and passing ability as well as the segregation resistance of SCC mixes.
- Mixture in Coarse Aggregate given good results.
- When cured in a solution with sodium sulphate, the results show larger loss of mass of SCC than that of VC probably due to the limestone powder content in SCC
- The limestone particles are then much more sensitive to sulphate attack than when the particles are mixed with cement and covered by the cement gel.
- If the content of sulphates in the groundwater is not known, it is not suitable to use SCC with large amounts of limestone powder together.
- The error at schemidet hummer results about (40 to 50) % different from the compressive strength machine results (cement content = 550 kg/m^3.

APPENDIX

Appendixes, if needed, appear before the acknowledgment.

ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in American English is without an “e” after the “g.” Use the singular heading even if you have many acknowledgments. Avoid expressions such as “One of us (S.B.A.) would like to thank ....” Instead, write “F. A. Author thanks ... .” In most cases, sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page, not here.

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