

Study of the Properties of Aggregates from Various Sources and Its Impact on the Compressive Strength of Concrete

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ABSTRACT

It is well recognized that coarse aggregate plays an important role in concrete. Coarse aggregate typically occupies over one third of the volume of concrete, and research indicates that changes in coarse aggregate can change and fracture properties of concrete. To predict the behaviour of concrete under general loading requires an understanding of the effects of aggregate type (from different sources).

This understanding can only be gained through extensive testing and observation. There is strong evidence that aggregate type is a factor in the strength of concrete.

This research describes the work that is aimed at improving the understanding of the role that coarse aggregate plays in the compressive and fracture behaviours of concrete.

I. INTRODUCTION

Aggregates are mixtures of various sizes of stone or rock particles in contact with each other. They are typically combinations of gravel and crushed materials, such as limestone, basalt and granite, but may also include blast furnace slag or recycled concrete greater than 3/16 in or 5 mm (retained on the No. 4 sieve) are usually classified as coarse aggregate. In a Portland cement concrete mix coarse and fine aggregate typically make up 60 to 70% of the total volume. For this reason, aggregate characteristics such as size, shape and

surface texture influence greatly the properties of a concrete mix.^[1]

EXPERIMENTAL

METHODS AND MATERIALS:

Laboratory works program:

Detailed investigation of the material properties was executed; chemical, physical and mechanical tests were undertaken for these materials, where tables (1-10) show all results of the executed tests with reference to the relevant standards.

On the other hand, cylinder samples of (150X300) mm were used. Three mixes were prepared according to the variables for water: cement ratios (w/c) = (0.38, 0.55 and 0.80), cement: sand ratio (c/s) = (0.5, 1 and 1.5). Compressive and tensile strength tests were scheduled to be tested at 3, 7 and 28 days.

MATERIALS:

- Cement:

The cement used throughout the experiments was ordinary Portland cement (Type I). The material was stored in original packaging sacks which were put on the wooden platform in temperature 20~25°C. For testing the compressive strength and in compliance with the (70.7*70.7) mm.

Nine samples of the mortar were made and performed for the tests after (3, 7 and 28 days) of curing. The measuring tests (physical and chemical properties) are shown in tables (1 and 2).

Table (1): Physical and mechanical properties of cement

No.	Test	Result	Specification Limits(34)	Remarks
1	Standard Consistency	24.2%	(-)	

2	Fineness		3497 cm ² /g	Min. 2500 cm ² /g	(✓)
3	Initial Setting Time		2:05hr	Min. 45 minutes	(✓)
4	Final Setting Time		4:10hr	Max. 10 hours	(✓)
5	Soundness		1.5 mm	Max. 10 mm	(✓)
6	Compressive strength	3 days	23 N/mm ²	Min. 21 N/mm ²	(✓)
		7 days	33.5 N/mm ²	(-)	
		28 days	42.0 N/mm ²	Min. 39 N/mm ²	(✓)

(-): Unconditional.

(+): Specification accepts results up to 2.5 N/mm² below this limit.

(✓): Conforming to Specification.

Note: Specific gravity of this cement = 3.1 according to manufacturer certificate.

Table (2): Chemical properties of cement

Components	The results (percentage of weight)	Specification Limits (percentage of Weight)	Remarks
L.O.I. Loss of ignition	0.93	Max. 3.0	(✓)
I.R Insoluble Residue	0.72	Max. 1.5	(✓)
SO ₃ Sulfur trioxide	2.35	Max. 3.0	(✓)
MgO Magnesium oxide	2.42	Max. 5.0	(✓)
Cl Chloride	0.05	Max. 0.1	(✓)
SiO ₂ Silicon dioxide	20.20	-	
CaO Calcium oxide	60.12	-	
Al ₂ O ₃ Aluminum oxide	5.61	-	
Fe ₂ O ₃ Ferric oxide	4.08	-	
Na ₂ O Sodium oxide	0.29	-	
Alkaline Content	20.17	-	
K ₂ O Potassium oxide	0.91	-	

C ₃ S	48.73	-	
C ₂ S	23.33	-	
C ₃ A	13.84	-	
C ₄ AF	6.69	-	
L.S.F.	0.89	-	
S.M.	2.08	-	
A.M.	1.37	-	

(✓): Conforming to specification.
(-): Unconditional.

- Fine Aggregate (Sand):

The fine aggregate used in the manufacturer of grout was a natural beach sand from Zliten quarry (nearly 200 Km east of Tripoli city) with specific gravity 2.63 and the maximum greatest size 1.18 mm according to specification.

Table (3): physical properties of fine sand:

No.	Test	Result	Specification Limits	Remarks
1	Fines content	0.46%	4% max. allowable	(✓)
2	Specific Gravity	2.62	2.6~2.7 as a Natural Range	(✓)
3	Chloride content	0.0012%	0.05% max. chloride content	(✓)
4	Sulphate content	0.213%	0.5% max. allowable (35)	(✓)
5	Moisture Content	0.5%	(-)	(✓)

(✓): Conforming to specification.
(-): Unconditional.

- Coarse Aggregate:-

The coarse aggregate used in these experiments 3 types from different sources, the sources of the stone aggregate is obtained from Awatata quarry, Alherra quarry and Alazizya quarry physical tests of coarse aggregate are shown in tables below.

Table (4): Coarse aggregate test results (Awatata region quarry)

No.	Test	Result	Specification limits	Remarks
1	Specific gravity	2.65	2.6-2.7 with in natural range	(✓)
2	Unit weight	1498.3 Kg/m ³	(1400-1800)Kg/m ³	(✓)
3	Water absorption	2.8%	3% max. allowable	(✓)

4	Crushing value	14.2%	30% max. allowable	(✓)
5	Impact value	7.05%	30% max. allowable	(✓)

Table (5): coarse aggregate test results(Alheera region quarry)

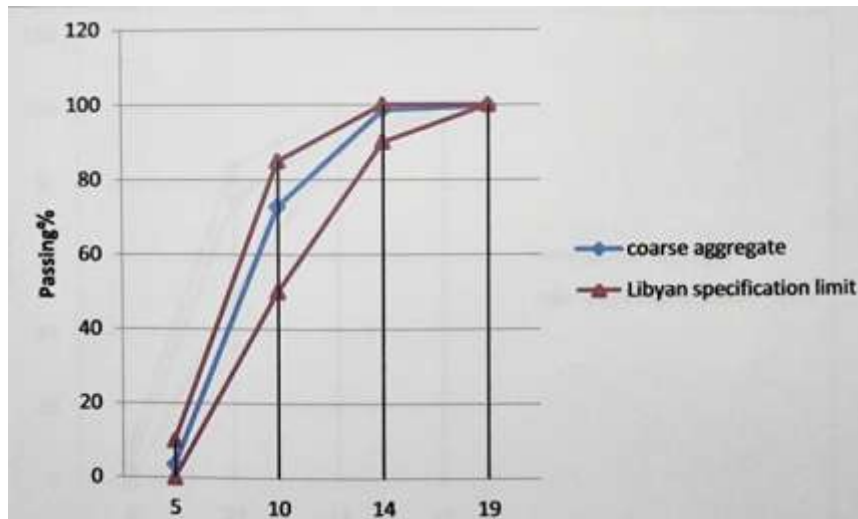
No.	Test	Results	Specification limits	Remarks
1	Specific gravity	2.6	2.6-2.7 with in natural range	(✓)
2	Unit weight	1512.5 Kg/m ³	(1400-1800)Kg/m ³	(✓)
3	Water absorption	2.7%	3% max. allowable	(✓)
4	Crushing value	13.67%	30% max. allowable	(✓)
5	Impact value	7.01%	30% max. allowable	(✓)

Table (6): coarse aggregate test results(Alazizya region quarry)

No.	Test	Result	Specific limits	Remarks
1	Specific gravity	2.68	2.6-2.7 with in natural range	(✓)
2	Unit weight	1587.2Kg/m ³	(1400-1800)Kg/m ³	(✓)
3	Water absorption	2.8%	3% max. allowable	(✓)
4	Crushing value	13.035%	30% max. allowable	(✓)
5	Impact value	6.78%	30% max. allowable	(✓)

Table (7): sieve analysis test results for coarse aggregate (Awatta region quarry)

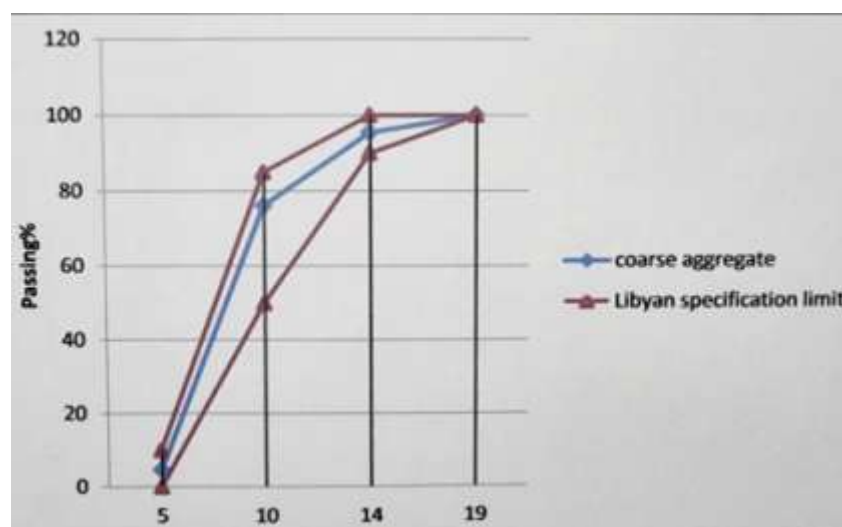
Sieve Size (mm)	Passing %	Specification limit
19	99.712	100
14	98.54	90-100
10	72.75	50-85
5	3.54	0-10
Plate	-	-



Coarse Aggregate Sieve Analysis (Awatta region quarry)

Table (8): sieve analysis test results for coarse aggregate (Alheera region quarry)

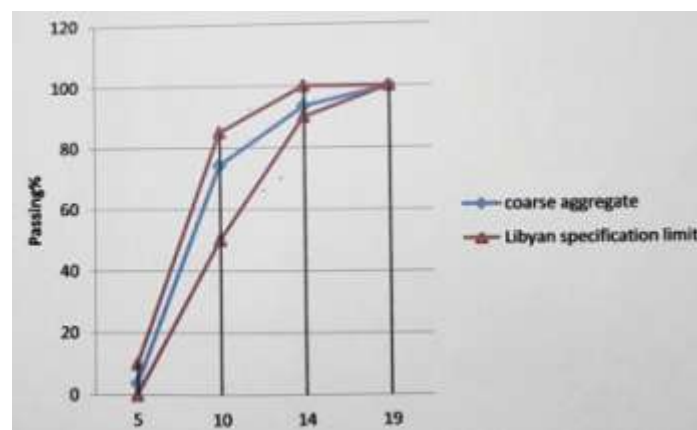
Sieve Size (mm)	Passing %	Specification limit
19	100	100
14	95.4	90-100
10	76.09	50-85
5	4.62	0-10
Plate	-	-



Coarse Aggregate Sieve Analysis (Alheera region quarry)

Table (9): sieve analysis test results for coarse aggregate (Alazizya region quarry)

Sieve Size (mm)	Passing %	Specification limit
19	99.89	100
14	93.4	90-100
10	74.23	50-85
5	3.8	0-10
Plate	-	-



Coarse Aggregate Sieve Analysis (Alazizya region quarry)

- Water:

The water from municipal water pipe network was used for preparing the binder mixture. The application of drinking water guarantees both its chemical and biological purity. Thus, it can be

assumed that water for mixing the grout corresponds to the specified requirements. For further indication sample of the water was analyzed as followed:

Table (10): water test result

No.	Test	Results	Specification limits	Remarks
1	T.D.S	465 mg	2000 mg max. allowable	(✓)
2	PH value	7.5	6-8 ranges	(✓)
3	Chloride content	110 mg	500 mg max	(✓)
4	Sulphate content	46.0 mg	1000 mg max	(✓)

- Apparatus:

Set of different apparatus and equipment were used:

- Balance weight
- Mixing machine
- Different sieve sizes
- Compression machine

- Cylinder molds for concrete

METHOD OF TESTING:

- **Compressive and tensile strength of concrete:**

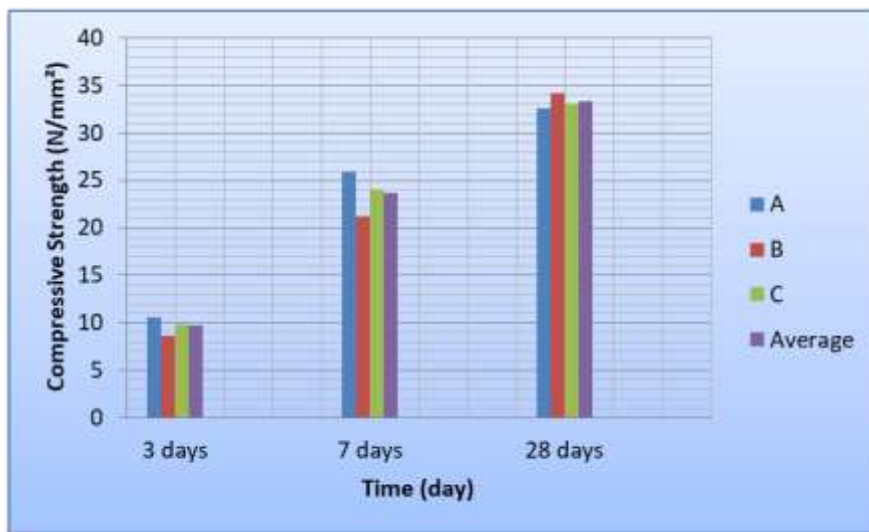
At the ages of (3, 7 and 28) days, the concrete cylinder samples were be subjected to compression and split test until failure by

compression machine where during the test type of failure and cracks has been observed for each set of samples.

- **Results of tests**
 The results of compressive strength of concrete test at (3, 7 and 28 days)

Table (11): Compressive strength results of Awatta region quarry

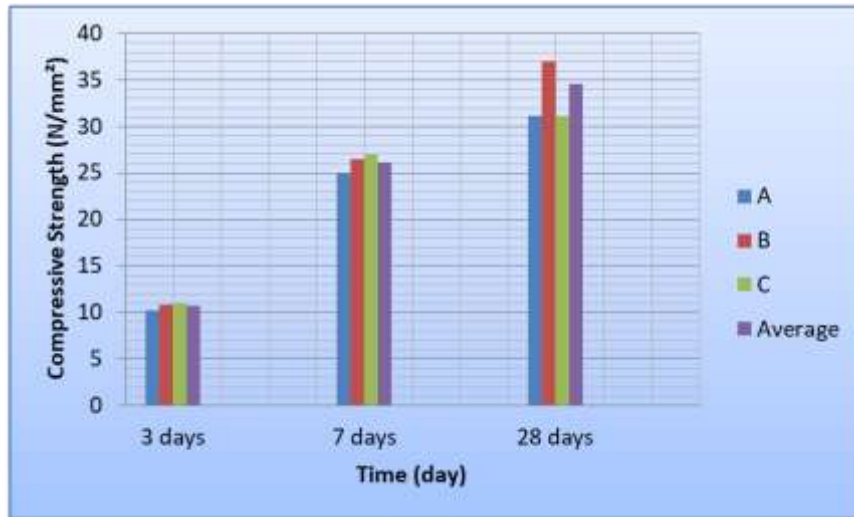
Sample	3 days		7 days		28 days	
	Load (KN)	Stress N/mm ²	Load (KN)	Stress N/mm ²	Load (KN)	Stress N/mm ²
A	238.2	10.6	582.1	25.9	734.3	32.6
B	193.7	8.6	477.5	21.2	769.8	34.2
C	220.4	9.8	539.8	24	744.2	33.1
Average		9.7		23.7		33.3



Compressive strength results of Awatta region quarry

Table (12): compressive strength results of Alheera region quarry

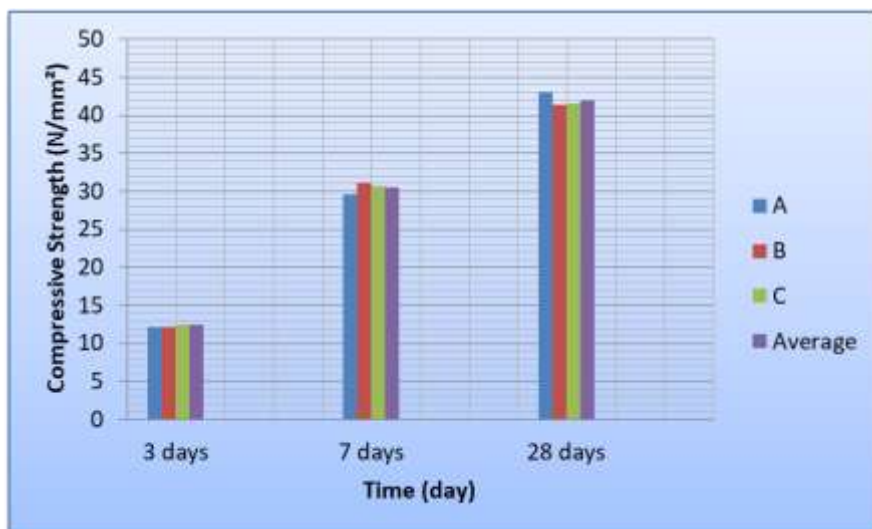
Sample	3 days		7 days		28 days	
	Load (KN)	Stress N/mm ²	Load (KN)	Stress N/mm ²	Load (KN)	Stress N/mm ²
A	229.0	10.2	559.1	24.9	700.4	31.1
B	243.2	10.8	596.8	26.5	833.6	37
C	247.1	11.0	606.5	27	802.4	35.7
Average		10.7		26.1		34.6



Compressive strength results of Alheera region quarry

Table (13): Compressive strength results of Alazizya region quarry

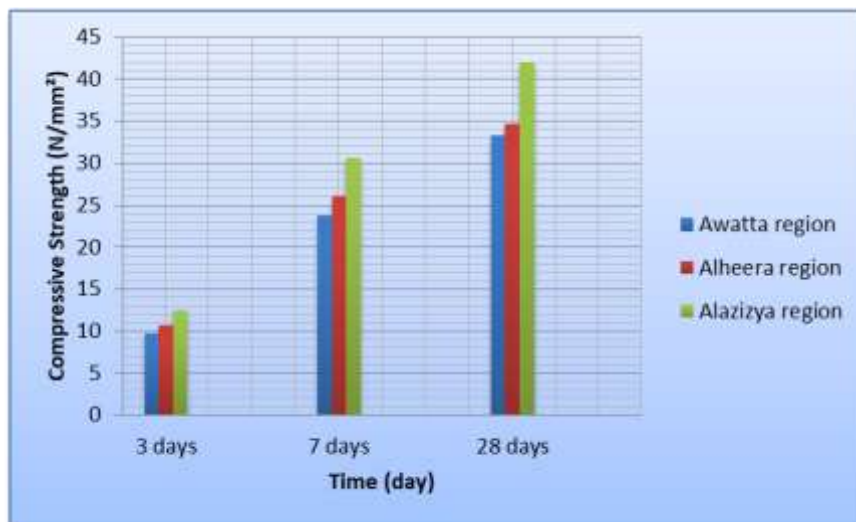
Sample	3 days		7 days		28 days	
	Load (KN)	Stress N/mm ²	Load (KN)	Stress N/mm ²	Load (KN)	Stress N/mm ²
A	272.04	12.18	666.6	29.6	967.9	43.0
B	285.7	12.19	700.2	31.1	932.2	41.4
C	281.66	12.5	690.1	30.7	934.6	41.5
Average		12.4		30.5		42.0



Compressive strength results of Alazizya region quarry

Table (14):Compressive strength results

Quarries	Compressive strength (Mpa)		
	3days	7 days	28 days
Awatta region	9.7	23.7	33.3
Alheera region	10.7	26.1	34.6
Alazizya region	12.4	30.5	42.0



Compressive strength results

Table (15): All tests results of aggregates

Quarries	Specific gravity	Unit wieght	Water Absorption	Crushing value	Impact value	Compressive strength (Mpa)
Awatta region	2.6	26.65	2.7%	13.67%	7.01%	34.6
Alheera region	2.65	25.65	2.8%	14.2%	7.05%	33.3
Alazizya region	2.68	26.7	2.8%	13.035%	6.78%	42

II. CONCLUSION:-

By comparing the results of tests carried out on the aggregate obtained from three different quarries as well as the results of the compressive strength of concrete mixing we found that the results close to all quarries while the best results was in azizya quarries and gave the highest resistance from the rest of quarries.

REFERENCES

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