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**Research Paper**

# Study of the Properties of Aggregates from Various Sources and Its Impact on the Compressive Stregth 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 charges in coarse aggregate con 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 ostentation.There is strong evidence that aggregate type is a factor in the strength of concrete.*
*This research descry des word that is aimed at improving the understanding of the role that coarse aggregate plays in the compressive and fracture behaviours of concrete.*

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## 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 concreter 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 METHODSANDMATERIALS:**

**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 (wk) = (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 20~25C°. 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 (1and 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 | - | |
| $Al_2O_3$ Aluminum oxide | 5. 61 | - | |
| $Fe_2O_3$ Ferric oxide | 4. 08 | - | |
| $Na_2O$ Sodium oxide | 0.29 | - | |
| Alkaline Content | 20. 17 | - | |
| $K_2O$ Potassium oxide | 0.91 | - | |
| $C_3S$ | 48. 73 | - | |
| $C_2S$ | 23. 33 | - | |
| $C_3A$ | 13. 84 | - | |
| $C_4AF$ | 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 (nearly200 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(Awatta region quarry)**

| No. | Test | Result | Specification limits | Remarks |
|---|---|---|---|---|
| 1 | Specific gravity | 2.65 | 2.6-2.7with 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)**

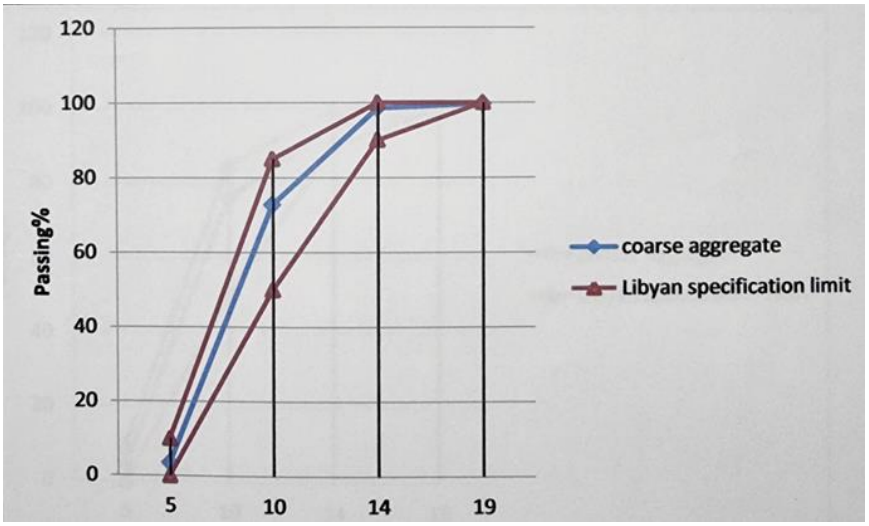
| No. | Test | Results | Specification limits | Remarks |
|---|---|---|---|---|
| 1 | Specific gravity | 2.6 | 2.6-2.7 with in natural range | (✓) |
| 2 | Unit weight | 1512.5 Kg/$m^3$ | (1400-1800)Kg/$m^3$ | (✓) |
| 3 | Water absorption | 2.7% | 3% max. allowable | (✓) |
| 4 | Crushing value | 13.67%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

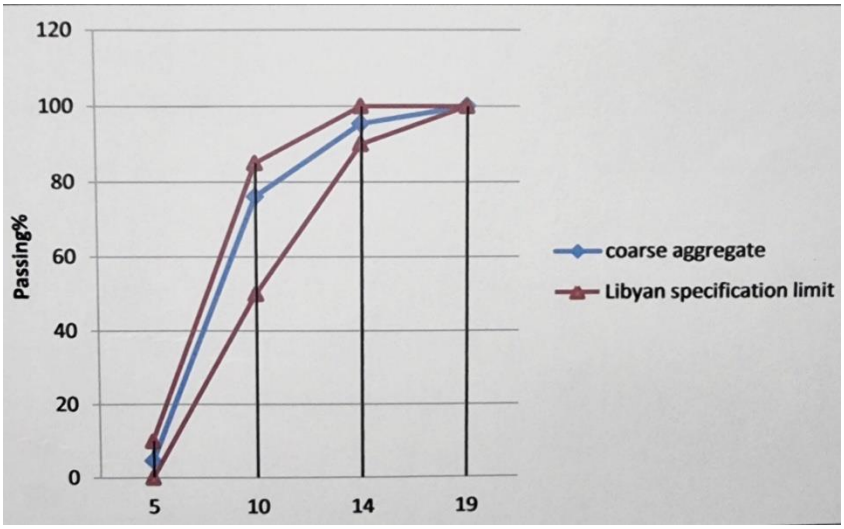
| Sieve Size (mm) | Passing % | Specification limit |
|---|---|---|
| **19** | 99.712 | 100 |
| **14** | 98.54 | 90-100 |
| **10** | 72.75 | 50-85 |
| **5** | 3.54 | 0-10 |
| **Plate** | - | - |




**Coarse Aggregate Sieve Analysis (Awatta region quarry)**

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

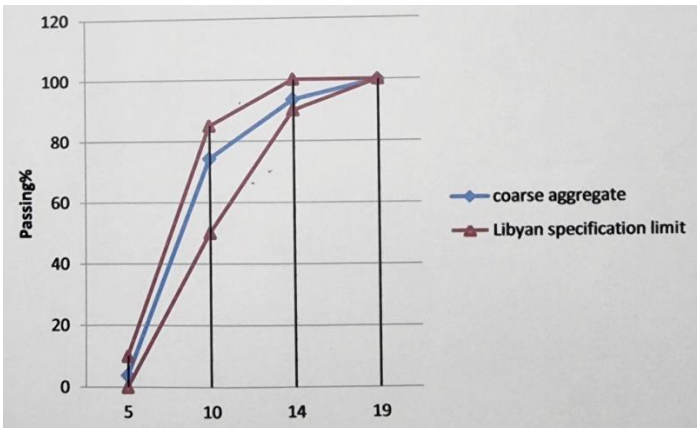
| Sieve Size (mm) | Passing % | Specification limit |
|---|---|---|
| **19** | 100 | 100 |
| **14** | 95. 4 | 90-100 |
| **10** | 76.09 | 50-85 |
| **5** | 4.62 | 0-10 |
| **Plate** | - | - |




**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

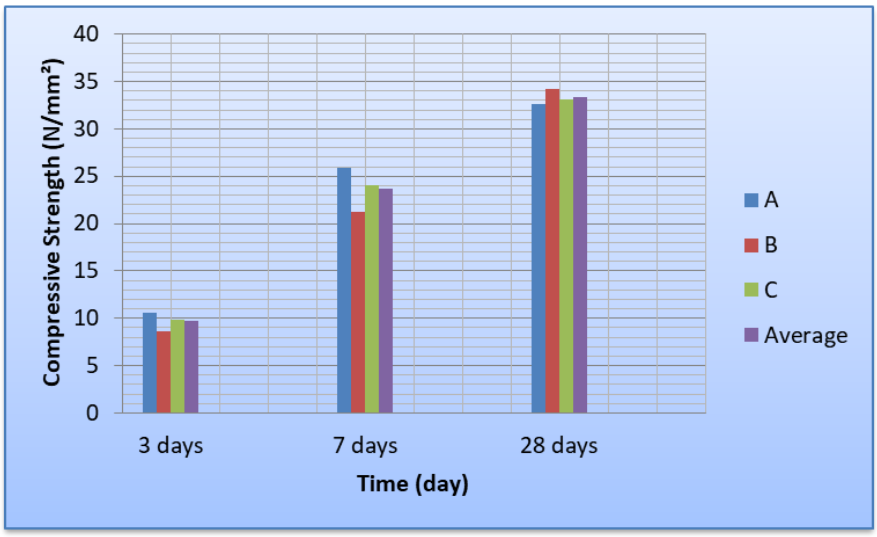
**METHODOFTESTING:**
- **Compressive and tensile strength of concrete:**

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**

Theresults 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/mm² | Load (KN) | Stress N/mm² | Load (KN) | Stress N/mm² |
| A<br>B<br>C | 238.2<br>193.7<br>220.4 | 10.6<br>8.6<br>9.8 | 582.1<br>477.5<br>539.8 | 25.9<br>21.2<br>24 | 734.3<br>769.8<br>744.2 | 32.6<br>34.2<br>33.1 |
| Average | | **9.7** | | **23.7** | | **33.3** |

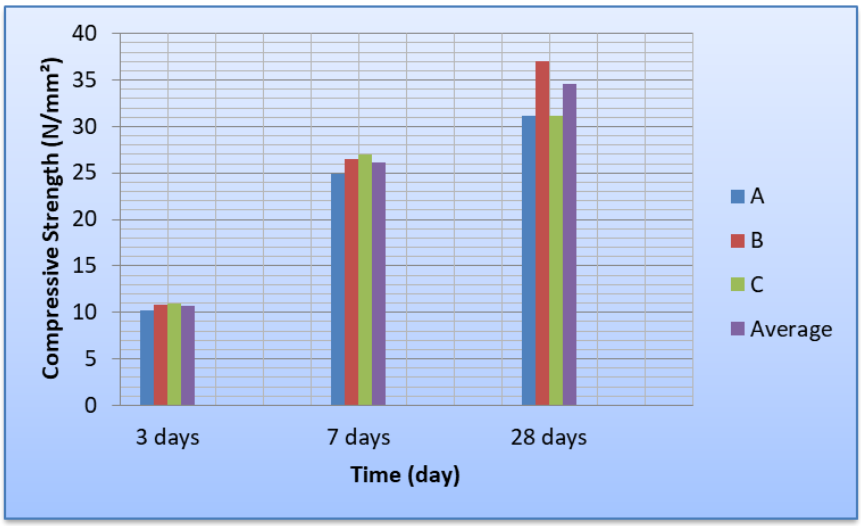



**Compressive strength results of Awatta region quarry**

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

| Sample | 3 days | | 7 days | | 28 days | |
|---|---|---|---|---|---|---|
| | Load (KN) | Stress N/mm² | Load (KN) | Stress N/mm² | Load (KN) | Stress N/mm² |

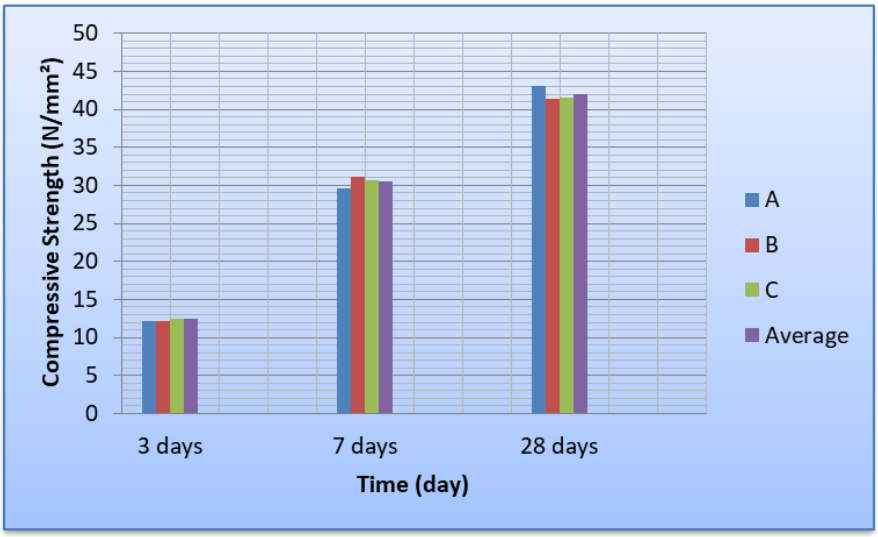
| | | | | | | |
|---|---|---|---|---|---|---|
| **A**<br>**B**<br>**C** | 229.0<br>243.2<br>247.1 | 10.2<br>10.8<br>11.0 | 559.1<br>596.8<br>606.5 | 24.9<br>26.5<br>27 | 700.4<br>833.6<br>802.4 | 31.1<br>37<br>35.7 |
| **Average** | | **10.7** | | **26.1** | | **34.6** |




**Compressive strength results of Alheera region quarry**

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

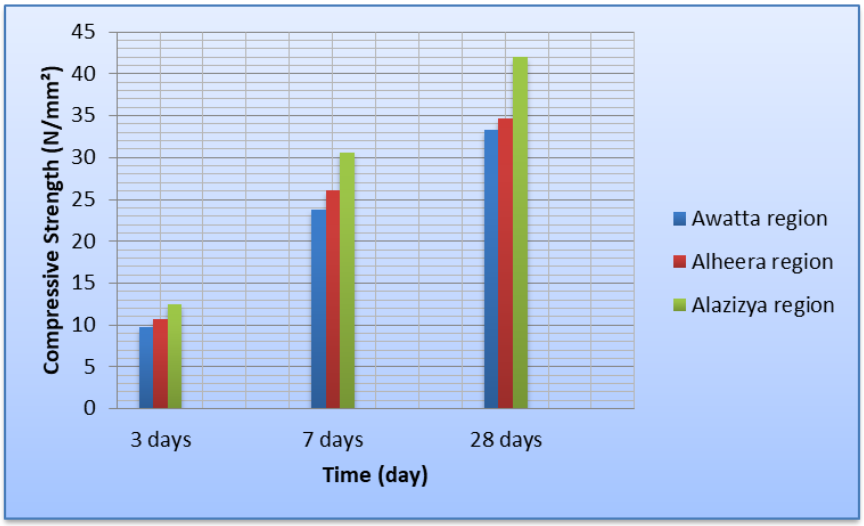
| Sample | 3 days | | 7 days | | 28 days | |
|---|---|---|---|---|---|---|
| | **Load (KN)** | **Stress N/mm²** | **Load (KN)** | **Stress N/mm²** | **Load (KN)** | **Stress N/mm²** |
| **A** | 272.04 | 12.18 | 666.6 | 29.6 | 967.9 | 43.0 |
| **B** | 285.7 | 12.19 | 700.2 | 31.1 | 932.2 | 41.4 |
| **C** | 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.

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