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Influence of Tefla Content as Partial Replacement of Fine Aggregate on Performance of Concrete

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Abstract— **Concrete is the most widely used material, Natural aggregate consists of up to 80% of the volume of concrete. Given the increasing depletion of natural aggregate, Fine aggregate is a prime material used for preparation of concrete and which plays a major role in mix design. Tefla is considered alternative material satisfy properties of fine aggregate and available easily, domestically with a great amount in OmAlrozam, a town near the city of Derna, Libya. The tefla were ground to roughly fine aggregate fineness, sieve analysis in ASTM C33 requirement of fine aggregate and tefla. physical tests were conducted and chemical composition of the tefla material was determined using X-Ray Fluorescence (XRF). This study aimed to investigate the suitability of tefla, I think is missing partial fine aggregate replacement on performance of concrete, the yellow tefla utilized in its dry condition (without pre-wetting). Four replacement levels, 2.5%, 5%, 7.5%, and 10%, were compared with the control specimen of w/c ratio 0.50. The mechanical and physical properties tests were performed after 7 and 28 days of curing in water. Results showed that concrete containing tefla as partial replacement of fine aggregate compare favourably well with the control specimen. Consequently, it is suggested that tefla can be used as replacement of fine aggregate in the production of concrete.**

Index Terms: ***Tefla, Compressive strength, split tensile strength, Water absorption, Porosity.***

I. INTRODUCTION

Concrete is a mixture of various materials coarse aggregate, fine aggregate, cement and water, each of them is mixed in various proportions to achieve specific strength [1]. There are huge demands of components of the raw materials for the production of ordinary Portland cement concrete turning into to extensive exploring of natural resources [2].

Aggregates coarse and fine do not have a role to play in the chemical reactions within concrete but they are very useful because they act as economic filler materials with good resistance to volume changes, which occur in concrete after mixing. Another important aspect of aggregates is that they improve the durability of concrete [3].

Fine aggregate and coarse aggregate are used enormously in the construction, the demand for these materials is high in privatization and globalization. To meet this high demand for coarse and fine aggregate the increased extraction from the natural resources is required. Fine aggregate is one of the important constituents in concrete. An alternative material that can satisfy technical properties of fine aggregate and should be available easily economically, domestically with a great amount. Fine aggregate as natural resource is limited in nature, thus tefla can be the best alternative for fine aggregate. The present study presents efforts for the replacement of fine aggregate and to evaluate the utility of tefla as a partial replacement of sand in concrete. Furthermore, the replaced concrete material is compared with the performance of conventional concrete. In addition to that, this work helps in understanding the effectiveness of tefla in strength enhancement.

A. Objectives and scopes:

1. Determine the chemical composition properties of yellow tefla, compared with the fine aggregate.
2. To check out experimentally the results for the fine aggregate which are partially replaced by yellow tefla in different ratio such as 2.5%,5%,7.5%, and 10% which are designated as T1, T2, T3 and T4 respectively.
3. To determine the physical and mechanical properties of the concrete with yellow tefla and compare it with the normal concrete.

II. MATERIALS AND METHODS

A. Materials

The ingredients of concrete consist of cement, fine aggregate, coarse aggregate and water. In this work yellow tefla is used as a partial replacement for fine aggregate.

The experimental program includes first the preliminary investigation on the materials used in the study, i.e., ingredients of concrete. The requirement

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which forms the basis of selection and proportioning of mix ingredients are:

1. CEMENT

The cement used is Ordinary Portland Cement (OPC) obtained from Alfataih Factory (Derna – Libya) complying with ASTM C150 [4], Chemical and physical properties is given in table 1.

Table 1. Physical and chemical properties of cement.

Chemical	Composition %
SIO2	19.88
AL_2O_3	5.37
Fe_2O_3	2.86
CaO	63.09
MgO	1.52
Na_2O	0.01
K_2O	0.95
SO_3	2.59
Physical properties	
Fineness - Blaine (g/cm^2)	3600
Setting Time (minute)	
Initial	118
Final	164
Specific weight	3.15
Compressive Strength (MPa)	
3 days	23
28 days	44

2. Terla

The tefla used in this study was obtained from the eastern part of OmAlrozam, town near the city of Derna, Libya. The area of which tefla are abundant., used to replace Fine aggregate to maintain the homogeneity between the tefla and fine aggregate in the concrete mixture. Sample of raw yellow tefla is shown in figure.1. The chemical composition analysis with X-Ray Fluorescence (XRF) and Physical properties in tefla according to ASTM D4318[5] is given in table 2, its soil classification is unified soil classification system (USCS) according to ASTM D2487[6].

Figure 1. Sample of the yellow tefla used in study.

Table 2. Physical and chemical properties of yellow tefla and fine aggregate.

Chemical	Composition % Yellow tefla	Composition % Fine aggregate
SIO2	4.942	0.110
AL_2O_3	1.471	0.222
Fe_2O_3	2.467	0.159
CaO	43.16	51.85
MgO	3.326	3.136
Na_2O	0	0.105
K_2O	0	0
SO_3	3.163	0.622
CI	1.913	0.046
$CaCO_3$	77.028	92.538
$MgCO_3$	6.957	6.558
Physical properties		
Specific Gravity	2.66	2.57
Fineness Modulus	2.48	2.40
Absorption %	14.63	2.28
Moisture %	-	0.31
Liquid limit %	28.60	-
Plastic Limit %	23.10	-
Plasticity Index %	5.50	-

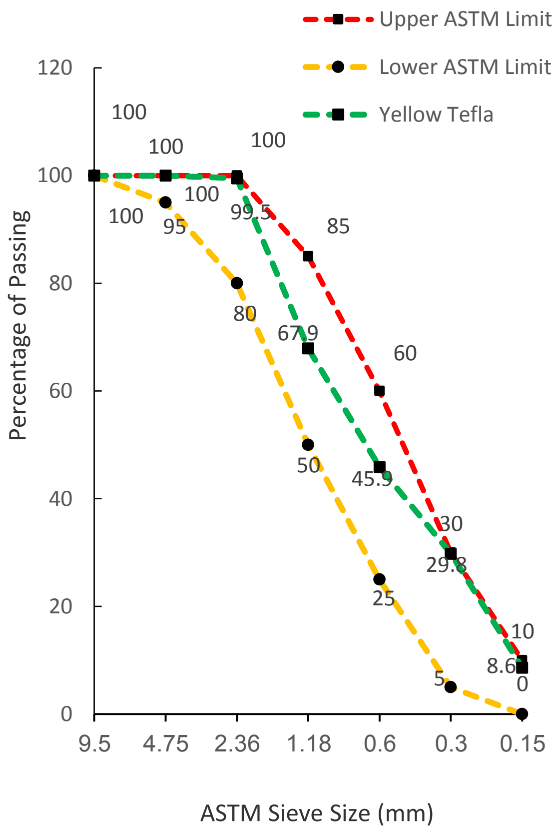

Figure 2. Gradient curve for the yellow tefla.

3. *FINE AGGREGATE*

Fine aggregate from local source was used, figure.3 gives the sieve analysis and ASTM C33[7] requirement of fine aggregate. The basic physical and chemical tests were conducted and results given in table 2 [8, 9].

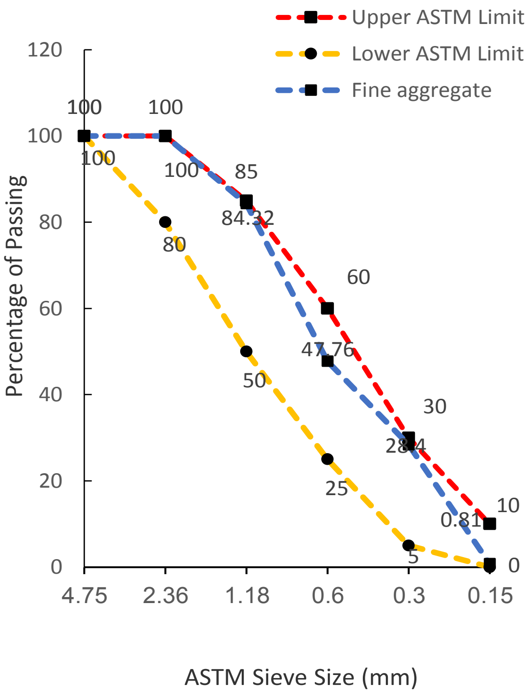

Figure 3. Gradient curve for the fine aggregate with ASTM C33 limits.

4. *COARSE AGGREGATE*

Coarse aggregate was used in this study, figure.4 shows the requirements for aggregates according to ASTM C33[7]. Physical and mechanical is shown in table 3 [10, 11].

Table 3. Physical and mechanical tests of coarse aggregate.

Properties	**Coarse aggregate**
Aggregate impact value	18.66 %
Abrasion resistance of aggregate in los angeles machine	28.53%
Specific Gravity	2.60
Absorption	2.88 %
Moisture	0.30 %

5. *WATER*

Drinking water was used for mixing and curing all concrete samples.in accordance with ASTM C1602 standard [12]. Mixing water is free from impurities that could adversely affect the process of hydration and, consequently, the properties of concrete [3].

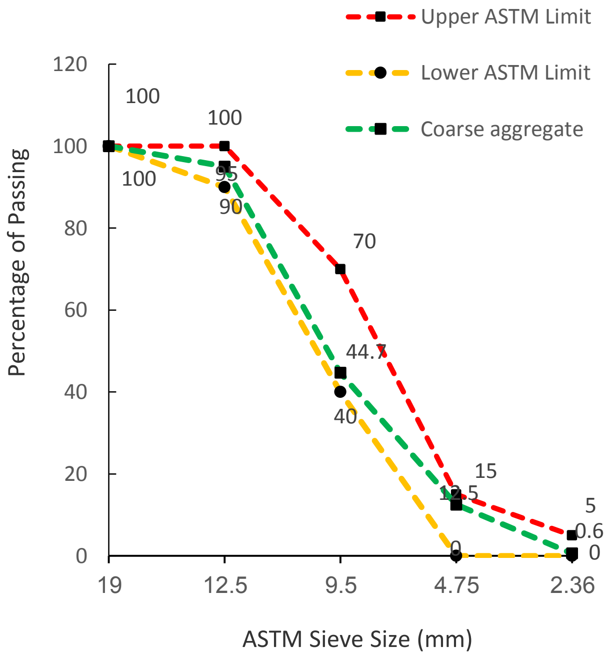

Figure 4. Gradient curve for the coarse aggregate with ASTM C33 limits.

B. *Methods*

The mix design and considered variables was performed by using American method of selection of mix with W/C ratio of 0.50[13]. Weights of concrete constituents for cubic meter is shown in table 4. The effects of replacing percentage of fine aggregate with yellow tefla on the physical and mechanical properties of concrete wase studied. The yellow tefla utilized in its dry condition (without pre-wetting) by (2.5%,5%,7.5% and 10%) which are designated as T1, T2, T3 and T4 respectively of yellow tefla. All concrete specimen were obtained with fair casting, the cubes were covered with plastic 24 hours at room temperature. After 24 hours, they were demolded with care so that no edges were broken and were placed in the curing tank.

III. RESULTS AND DISCUSSION

A. *Workability - slump*

The results of slump according to ASTM C143[14] of all concrete mixes is shown in fig.5.the slump value decreases as the replacement of fine aggregate by yellow tefla increases, the decrease in slump value as a result of increase in fines percentage in concrete can be attributed to the fact that finer particles in yellow tefla have larger surface area from fine aggregate which absorbs more water in concrete mix, hence decrease the water-cement ratio in which, will lead to decrease in the fluidity of the mix resulting in decreasing the workability. In general, the workability reduction caused by addition of yellow tefla in concrete mix.

Table 4. Mix proportions of the concrete mixtures per cubic meter

Materials	Weight (Kg / m^3)				
	0 %	2.5 %	5 %	7.5 %	10 %
Cement	432	432	432	432	432
Water content	216	216	216	216	216
Coarse aggregate	953.93	954.49	955.05	955.61	956.17
Fine aggregate	655.25	638.87	622.49	606.11	589.72
Yellow Tefla	0	16.38	32.76	49.14	65.53

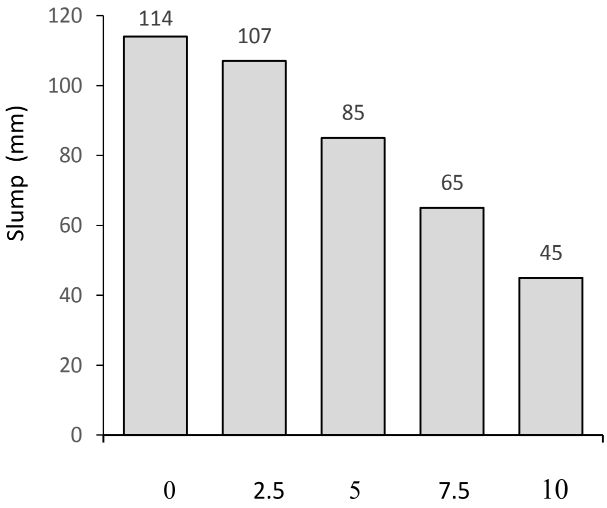

Figure 5. Slump for different concrete mixes.

B. *Compressive Strength Test*

The study was conducted based on 7and 28 days of curing time for the different concrete in order to establish their compressive strength development. This test is performed in accordance to ASTM C39[15], 100 × 100 × 100 mm cube specimens were tested. The influence of replacement of fine aggregate by yellow tefla on compressive strength of concrete mixes at 7 and 28 days of curing is shown in fig 6., it can be seen that the strength of partially replaced concrete samples is higher than the pure concrete samples. It is found that the compressive strength of the control concrete was 35.71 MPa. The compressive strength was found to be maximum at 2.5% (38.46 MPa) replacement of fine aggregate by yellow tefla which was greater than the conventional concrete. The transition zone between cement paste and aggregates is improved, This improvement may be attributed to the good grading of the yellow tefla. The compressive strength reduced beyond 7.5% replacement. Thus, it is evident that fine aggregate can be replaced by the yellow tefla up to 7.5%.

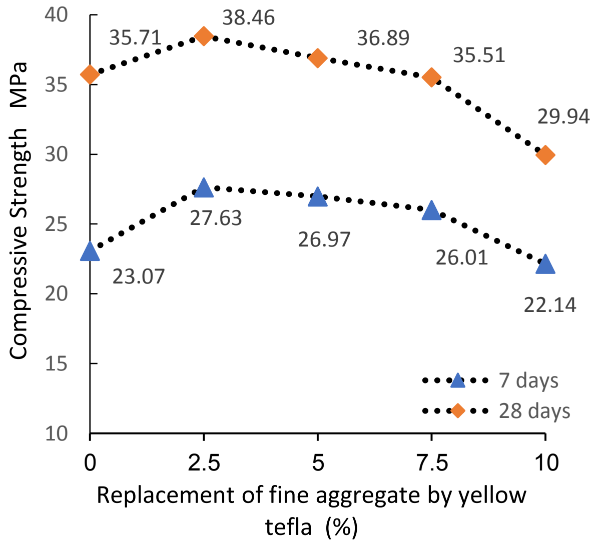

Figure 6. Variation of 7 and 28 days compressive strength replacement of fine aggregate by yellow tefla in concrete.

C. *Spliting tensile strength*

According to ASTM C 496 the splitting tensile strength was done on 100 × 200 mm control and partially replaced fine aggregate concrete cylinders [16]. The test results are shown in fig.7. It is found that the split tensile strength after 28 days of the control concrete was 2.79 MPa. The split tensile strength was found to be maximum at 2.5% (2.84 MPa) replacement of fine aggregate by yellow tefla than the conventional concrete, this effectiveness of the yellow tefla is better than the fine aggregate in concrete. The split tensile strength reduced beyond 7.5% replacement. Thus, it is evident that fine aggregate can be replaced by yellow tefla up to 7.5%.

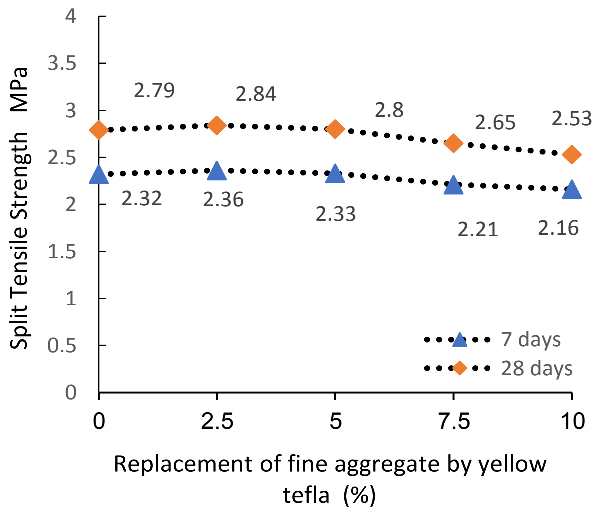

Figure 7. Variation of 7 and 28 days split tensile strength of fine aggregate by yellow tefla in concrete.

D. *Water absorption and total porosity*

The water absorption and total porosity were evaluated according to ASTM C 642[17]. A set of three cylinders of 100 x 200 mm size were tested for each mix. The water absorption and total porosity of different mixes at 28 days are presented in figure.8.

The replacement of fine aggregate by yellow tefla at 2.5% displayed the lowest water absorption 7.52% and porosity of 12.89% as compared to other mixes. The replacement of fine aggregate by yellow tefla at 10% mix exhibited the highest water absorption 9.95% with corresponding porosity of 15.66%. It shows that the porosity affects the water absorption. When the porosity decreased, the water absorbed also decreased. The porosity of concrete, is an important characteristic, which determines to a large extent their mechanical properties. High porosity is strongly detrimental to the strength of a concrete.

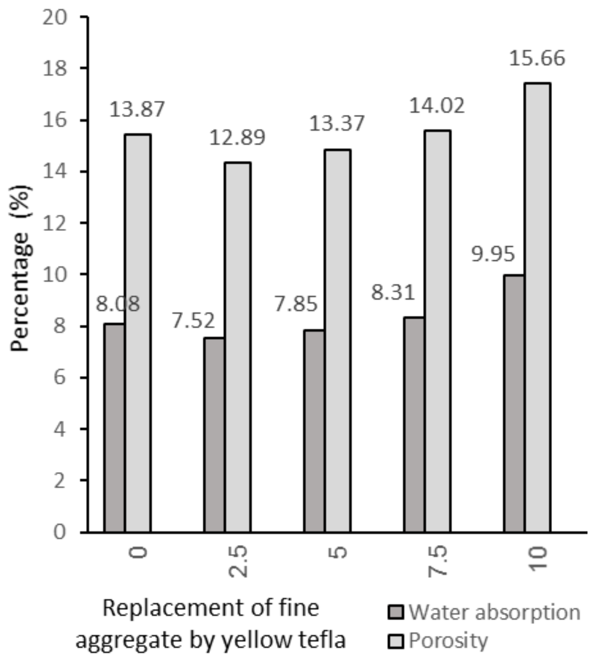

Figure 8. Water absorption and total porosity of concrete mixes.

E. Water permeability test

In this investigation, the water penetration depth of concrete samples is measured in accordance with BS EN 12390-8[18]. A set of three cubes of 150 x 150 x 150 mm size were tested for each mix. The water penetration depth of different mixes at 28 days are presented in figure.9. The results given in this paper are maximum depth of penetration obtained from three specimens per mix, expressed in mm.

Both porosity and water absorption in figure.8 of replacement of fine aggregate by yellow tefla concrete were found to be 7.5% to 10% higher making it much more pervious than of concrete control. Porosity and water absorptions are indication of pores or voids in concrete through which water permeates. Therefore, increase in these parameters results in corresponding increase in water permeability [19].

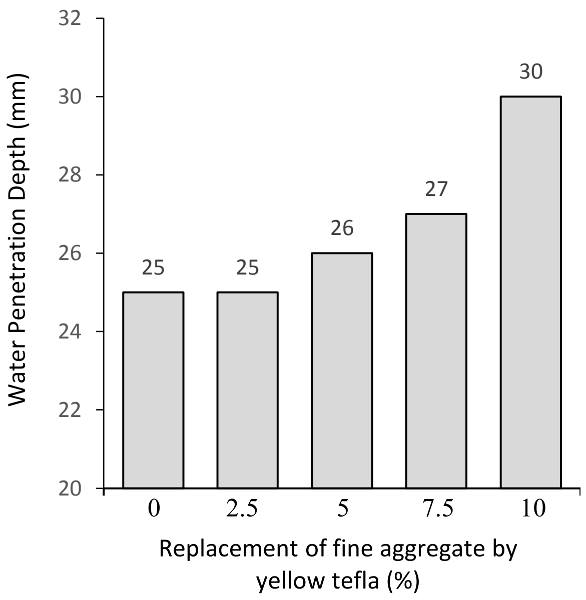

Figure 9. Water penetration depth of concrete mixes.

IV. CONCLUSION

Based on the experimental results of this investigation on, the replacement of fine aggregate with yellow tefla in concrete, lead to the following conclusions which are limited to the materials used in the study.

1. The chemical properties of yellow tefla indicate that the sum of SiO2 (4.942%), Al_2O_3 (1.471%), and Fe_2O_3 (2.467%) constituting 8.88% of the material, higher than of fine aggregate which constitutes 0.491%.
2. A reduction in slump value was observed by replacement of fine aggregate with yellow tefla. Absorption of more water by yellow tefla in concrete mix, cause a reduction in slump.
3. The compressive strength and split tensile strength of concrete was significantly improved with 2.5% replacement of yellow tefla after 28 days compared with that of normal concrete when utilized as fine aggregate.
4. Porosity and water absorptions are indication of pores or voids in concrete, rises in porosity and water absorption in concrete with yellow tefla result in a corresponding increased water penetration depth.
5. This study clearly indicates that yellow tefla can be adopted as a concrete component and a construction material.

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