Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Testing The Use Of Phosphate Materials And Glass Fines In Concrete Production

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The research focuses on the testing production of concrete through comparison with control concrete mix for phosphate materials from two sources (Al Shedyah and Abiad mining plants) and glass fines that were used in replacement with fine sand in concrete mix on specific mixing ratios (15%, 30%, 45%, and 60%). The program of concrete testing included fresh concrete properties (slump), and hardened concrete properties (unit weight, compressive, tensile, and flexure strengths). The results were sorted through calculating of averages, standard deviations, and analysis using ANOVA and box plot to test the difference in samples averages. Results showed slump of concrete increases with the increase of phosphate or glass fines ratios. Generally, unit weight is stable using phosphate materials, and decreasing using glass fines materials. The initial analysis of compressive strength showed stability, similar talk can be withdrawn on flexure strength, but tensile strength decreases with increase of material ratio in concrete mix. Similar indication can be withdrawn on unit weight of concrete. But for slump value, it increases with the increase of materials ratios in concrete mix. All properties were tested and reported at 28-day period in current research. Also, a box plot was presented for all properties studied in current research to show the range of properties versus the ratios of phosphates and glass fines materials. Also ANOVA analysis was conducted for the properties of fresh and hardened concrete. ANOVA analysis showed that slump values are significant different and null hypothesis is rejected, but for unit weight null hypothesis is accepted that the unit weight is not significant different. Also, results of ANOVA analysis showed that for compressive, tensile and flexure strengths are significantly different and null hypothesis is rejected accept for 60% mixing ratio of phosphate and glass fines, the results are equal and the null hypothesis is accepted. The results of current research presented a different procedure to document, test, and interpret results to be used in future extend of research.

Keywords— Concrete mix, Control mix, Phosphate, Glass fines, Anova, box plot

I.INTRODUCTION

Structural and industrial concrete that produced in plants and factories need control on quality design (quality control, QC) and quality of testing (quality assurance, QA) in order to control design process to have homogeneous and unified quality in concrete production, and to assure the compliance of concrete production with the specification and target of concrete production process (Alam et al., 2016). In addition, it is essential to employ a statistical tools to test and compare the behavior of concrete mixes through testing the properties of concrete mix in such using ANOVA analysis for this purpose (Kaboosi and Emami, 2019). So, current research concentrate on defining a testing program for the concrete properties when using different components of Phosphates (Al Shedyah and Abiad) and glass fines in replacement with sand portion on ratios of 15%, 30%, 45%, and 60% in trial to use local natural materials and recycled waste of glass.

SUSTAINABILITY THROUGH USING LOCAL MATERIALS

The quality control of concrete is the most crucial issue in achieving its required strength parameters to achieve durability of concrete structure and sustainability of resources. Sarireh (2020-b) addressed the use of local materials in pavement construction and soil layers for paving of roads through the use of volcanic tuff in base and subbase construction for the purpose of developing new construction process and materials that improve sustainability and reducing the cost of soil-pavement layer construction.- using of local materials is preferable for their properties or contribution in waste management and recycling, conservation of scarce natural resources, conservation and reduction of energy use, and in the reduction of greenhouse gas emission. It is required for good environmental practice to use local natural materials in construction industry in the form of rocks, aggregate, and water (Abdulrasool et al., 2021).

CONCRETE MIX DEVELOPMENT: EXPERIMENTAL WORK

Concrete mix development program is in an importance for the parties of construction including contractors, engineers, and researchers to increase the privileges of concrete mix and improve the properties of concrete or change the usage of concrete mix though. Sarireh (2015), tested the use of local materials considering the use of crushed limestone and rounded valley aggregates in Karak and Tafila areas. The study recommended the use of these local aggregate in order to achieve sustainability and employing of local resources in construction.

Sarireh (2017), tested the development of high strength concrete using basalt aggregate in concrete mix to improve the compressive strength of concret ethrough the use of local material such as basalt aggregate to avoid the increase in some expensive materials such as cement. Also, Sarireh (2015-b) had been testing the concrete compressive strength and development of the optimum percentage of volcanic tuff in concrete production to improve the properties of fresh and hardened concrete as lightweight concrete. In addition to Al Dwairi et al. (2018) in studying the characterization of Jordanian volcanic tuff and its potential use as lightweight aggregate to improve the properties of concrete mix also.

Sarireh and Al-Baijat (2019-a) studied the use of local aggregate for the production of the concrete mix in Jordan. Also, Al-Baijat and Sarireh (2019) studied the use of fine blast furnace slag in the improvement of properties of concrete. In addition to, Sarireh and Al-Baijat (2019-b) studied the use Cement-Tripoli Admixture in replacement in concrete mix. And Al-Baijat and Sarireh (2019-b) studied the concrete properties using Tripoli as fine materials in concrete mix. Also, Sarireh (2020-a) studied and examined the suitability of tripoli as admixture in cement paste to increase the setting time of cement and to avoid the addition of free water for remixing.

Sarireh et al. (2023) in development of fine precast concrete mix using local materials that included and implied the use of fine phosphate materials from two sources of phosphate (Abiad mining site and Shedyah mining site), in addition to the use of glass fines in fine concrete mix (maximum size of aggregate is 10mm which known as addaseyah in local construction industry and mining).

The study includes the design, and testing of fresh and hardened properties of precast fine concrete mix through the use of (phosphate Abiad and Shedyah and glass fines in replacement with the fine sand in the concrete mix at percentages of 15, 30, 45, and 60%. It is an effective and innovative procedure to use different materials to improve the properties of fresh and hardened concrete. For the fine concrete mix design, the mix contains only Addaseyah as the maximum size of aggregate (12-6mm) size, Semsemeyah (6-2 mm) size, and fine sand (2-0.6 mm) size. The new mixed materials of phosphate of Abiad, phosphate of Shedyah, and fine ground glass were replaced with the sand portion in the concrete mix. Physical and chemical analyses of proposed materials were conducted, and specific volumes of proposed materials were prepared for the concrete mix at the designed ratios of materials. Also, the w/c ratio is considered constant at 0.4 for all concrete mixes (Sarireh et al., 2023).

Samples of concrete cubes (around 112) were prepared to test the density (unit weight) and compressive strength of concrete on 7-day and 28-day periods. In addition, 96 cylinder samples for tensile strength tests conducted at 7-day and 28-day periods. Also, 96 beam samples were prepared for flexural strength test at 7-day and 28-day periods. Samples were prepared for the control and other phosphate mixes and fine ground glass materials with 15, 30, 45, and 60% ratios. Also, the slump of each fresh concrete mix was tested three times, and the average slump values were calculated for all concrete mixes. Samples were kept in a distilled water tank for curing at 18 °C temperature until testing times at 7-day and 28-day periods.

II. MATERIALS

Cement

Ordinary Portland cement (OPC) Type I was used in concrete mixes according to BS EN 197-1-2011 standards with 3.15 specific gravity. Table 1 shows the chemical and physical properties of the OPC used.

TABLE 1 THE PHYSICAL AND CHEMICAL PROPERTIES OF OPC

Chemical and physical properties	**Percentages (%)**
Silicon Oxide (SiO_2)	20.41
Aluminum Oxide (Al_2O_3)	4.51
Ferric Oxide (Fe_2O_3)	3.43
Calcium Oxide (CaO)	64.74
Magnesium Oxide (MgO)	1.99
Sulfur Trioxide (SO_3)	2.9
Potassium Oxide (K_2O)	0.52
Sodium Oxide (Na_2O)	0.32
Tricalcium Aluminate (C_3A, $3CaO \cdot Al_2O_3$)	7.5
Chloride (Cl)	0.03
Loss On Ignition (L.O.I)	1.15

Specific Service Area	3550 cm^2/g
Initial Setting Time	155 min.

Aggregate and Sand

As aggregates composes 75-80% of concrete volume, it is necessary to test its physical properties, including size, shape, texture, porosity, absorption, moisture content, and bulking of fine components. Aggregate properties influence concrete strength and durability, as well as water/cement ratio (w/c) also influences concrete quality. According to the ASTM C33/C33M-16 standard, aggregate was chosen based on the original rocks, specific gravity, and particle size. The aggregate types used in the experiment were as follows:

Limestone is the source of medium aggregate, and it was used in this study with a maximum size of 9.5 mm (3/8 in.) and passing sieve No. 4 (4.75 mm). The medium aggregate is known as Adaseyah and has a Sp.Gr. (dry) of 2.57, Sp.Gr. (SSD) of 2.55, Sp.Gr. (Apparent) of (2.65), Bulk density of 1500 kg/m3, absorption of 2.5%, and abrasion of 29%. Table 2 shows the specific gravity of used materials in the concrete mix.

TABLE 2 SPECIFIC GRAVITY AND ABSORPTION OF MIXING MATERIALS

Material	**Sp. Gr. (Dry)**	**Sp. Gr. (SSD)**	**Sp. Gr. (App)**	**Bulk Density (kg/m3)**	**Absorption**	**Abrasion**
Medium Aggregate	2.566	2.546	2.649	1500	0.025	0.29
Sand	2.616	2.629	2.65	1577	0.005	-----
Glass	2.67	2.58	2.69	1680	0.004	----

Figure 1 Presents the mixing materials used in fine concrete mixing design in the current project. Ordinary and original materials include Addasseyah medium aggregate, Semsemeyah fine aggregate, and fine sand. Moreover, the new mixing materials include phosphate material from the Abiad mining site that is close to the Al-Hasa area in Tafila, and the Shedyah from Shedyah mining site in Ma'an, in addition to the fine ground glass by collecting waste glass bottles, cleaned and ground to sand gradation size.

FIGURE 1 MATERIALS OF FINE CONCRETE MIX DESIGN

For the quantities of mixed materials in the concrete mix, Table 3 shows the quantity of concrete design for preparing mix 1m3 of concrete, in addition to the volume of cement and w/c ratio of the mix.

TABLE 3 QUANTITIES OF MIXING MATERIALS OF FINE CONCRETE DESIGN

Material	Gradation (mm)	Quantity kg/m3
Addaseyah	4-9.5	1,000
Semsemeyah	2-4	501
Sand	0.06-2	501
Cement	---	391
Water	---	190
*w/c ratio is 0.48		

The admixtures of phosphate (Shedeyah and Abiad) and glass fine were mixed separately at ratios 15, 30, 45, and 60% in replacement with sand materials in the mix are presented in Table 4.

TABLE 4 RATIOS AND QUANTITIES OF ADMIXTURES IN FINE CONCRETE MIX DESIGN

Material	Quantity kg/m3	Admixture Ratio			
		15%	30%	45%	60%
Sand or Fines	501	75.15	150.3	225.45	300.6

Chemical Composition of Fine Ground Glass

A quantity of 15kg of glass was collected and ground to get the size gradation relevant to fine sand to be mixed at 15, 30, 45, and 60% ratios in the concrete mix. Table 5 shows the chemical composition of glass fines used in the concrete mix.

TABLE 5 CHEMICAL COMPOSITION8 OF GLASS

Oxides	SiO_2	Al_2O_3	Fe_2O_3	MgO	Na_2O	K_2O
%	70.4	1.9	1.2	10.3	14	0.4

Chemical Composition of Jordanian Phosphate

The chemical analysis of constituents in phosphate materials and their percentage is essential as the materials will be used to substitute of fine sand. The required quantities are prepared from Jordanian phosphate from Shedyah and Abiad mining sites in the south Jordan. Table 6 presents the chemical composition of Jordanian Phosphate in Abiad and Shedyah in Jordan.

TABLE 6

CHEMICAL COMPOSITION OF JORDANIAN PHOSPHATE

Phosphate Source	**Na2O**	**Al2O3**	**SiO2**	**P2O5**	**K2O**	**CaO**	**TiO2**	**MnO**	**Fe2O3**
Abiad	0.00	1.23	0.56	29.17	0.09	54.00	0.02	0.02	0.30
Shedyah	0.00	1.17	0.48	29.54	0.10	52.70	0.04	0.03	0.29

III.METHODOLOGY

Mixing and Sampling

The required wooden fair-face moulds were prepared to cast the concrete mix properly. The moulds were prepared in specific dimensions for each test. Moulds for concrete compressive test and density were prepared in (150 x 150 x 150 mm) cubes, where cylindrical metal moulds were considered for splitting tensile strength of concrete, and wooden fair-face moulds were prepared for flexural strength of concrete. Figure 2 shows the moulds of sampling in the current project.

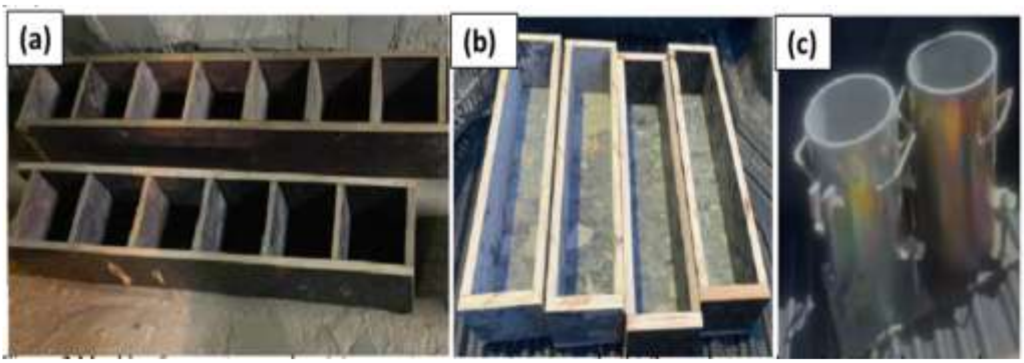

FIGURE 2 MOLDS OF CONCRETE SAMPLES: A)COMPRESSIVE STRENGTH B) FLEXURE STRENGTH C) TENSILE STRENGTH

Hand site mixing was conducted for control and tested mixes that contains Abiad and Shedyah phosphates and fine glass materials. A 6 samples of concrete were prepared to be tested at 7-day and 28-day periods. Figure 3 shows the mixing stage and quantity of concrete prepared each time.

FIGURE 3 MICXING OPERATION AND PREPARING OF SAMPLES

Testing of Fresh Concrete Mix

One of the critical tests for fresh concrete is the slump test, which can evaluate workability and the presence of humidity and its required levels considering construction type and application after mixing concrete ingredients. Concrete ingredients, including aggregate, sand, cement, and water, are mixed for control mix design and other mixes for added materials. Concrete was poured into the frustum cone on three layers. Each layer is compacted with 25 strokes to evaluate the workability and consistency (humidity) of the concrete; the slump was measured to the nearest mm for concrete. Figure 4 presents the mechanism of conducting slump tests on concrete.

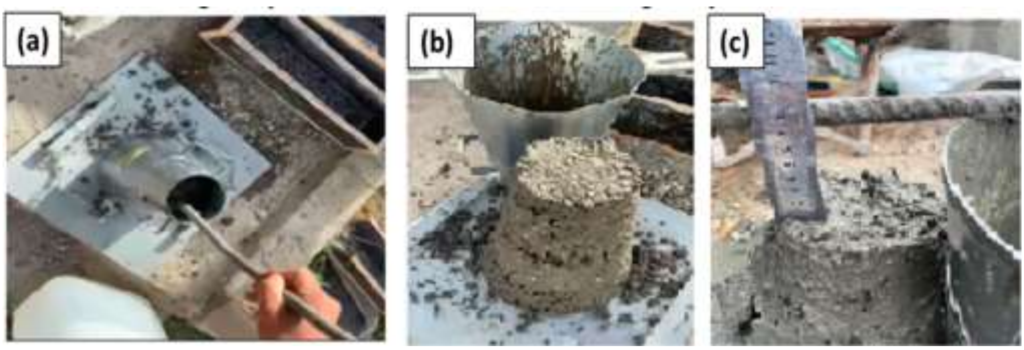

FIGURE 4 SLUMP TEST FOR FRESH CONCRETE MIX; (A) POURING AND COMPACTION (B) FLIPPING OF SLUMP (C) MEASURING OF SLUMP VALUE

A 12 Cubic, cylinders, and beams were taken to represent the test of compressive, tensile, and flexural strengths of control concrete mix and other mixes using Abiad phosphate and Shedyah phosphate and fine glass materials. 6 samples were tested for density, compressive, tensile and flexural strengths on 7-day, and the other 6 samples of each test were tested on 28-day period. Samples of concrete were prepared according to ASTM C31/C31M-22, the Standard Practice for Making and Curing Concrete Test Specimens in the Field. Figure 5 shows the preparation of samples of concrete mix.

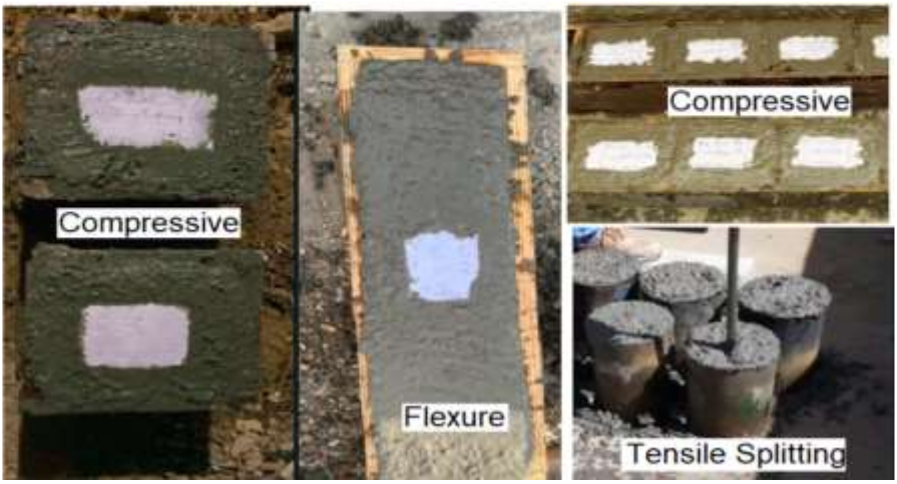

FIGURE 5 SAMPLES OF CONCRETE MIX FOR COMPRESSIVE, FLEXURAL, AND TENSILE STRENGTHS TESTS

Curing and Testing of Concrete Samples

All of concrete samples when prepared, were kept for 24 hours in molds to ensure the drying process, then they were dismantled and kept in distilled water for curing for up to 7-day and 28-day periods until testing. Figure 6 presents the curing of concrete samples for 7-day and 28-day periods until testing samples.

FIGURE 6 CURING OF CONCRETE SAMPLES FOR UP TO 7-DAY AND 28-DAY PERIODS

Samples were tested on 7-day and 28-day for control and other concrete mixes for density, compressive, tensile, and flexure strengths. Also, it was noticed that the shape of failure or fracture of cube, cylinder, and beam were ideal. Figure 7 presents testing process.

FIGURE 7 TESTING OF CONCRETE SPECIMENS FOR A) COMPRESSIVE TEST B)TENSILE TEST C) FLEXURE TEST

IV.CONCRETE MIX DEVELOPMENT: STATISTICAL WORK

ANOVA considers the F-test as a statistical tool and a typical method in an inferential statistics to test if a significant difference exists between two or more means of one or two groups (populations) or more, which may have certain features (treatment levels). It is mostly used when the data sets would follow a normal distribution and may have unknown variances. The test is used as a hypothesis testing mean, which allows testing of an assumption applicable to a population. F-test looks at the F-statistic, the F-distribution values, and the degrees of freedom to determine the statistical significance. To conduct a test with three or more means, one must use an analysis of variance. Mathematically, F-test takes a sample from each of two sets and establishes the statement of the null hypothesis that two means are equal. Based on the applicable formulas, certain values are calculated and compared against the standard values, and the assumed null hypothesis is accepted or rejected accordingly (Investopedia 2020).

The theory of F-test is based on the assumption of null hypothesis that rejects the significance of difference (means are equal) and the alternative hypothesis that accept the significance of difference between means (means are not equal) of samples considering the means, standard deviations, and numbers of members in each sample and the levels of treatment. A t-test is used in a multiple comparison method. This can be done using the analysis of variance (ANOVA), Tukey-Kramer pairwise comparison, Dunnett's comparison to a control, and analysis of means (known as ANOM).

The testing of means actually starts with considering two hypotheses. These are called the null hypothesis and the alternative hypothesis. Ho is the null hypothesis and states that there is no difference between samples' means or populations or that the differences in means equal 0. H1 is the alternative hypothesis and is contradictory to Ho and is concluded when we reject Ho (Killen, 2005). The null hypothesis: Ho: $\mu A = \mu B$ against the alternative hypothesis: H1: $\mu A \neq \mu B$ considering that variance of A sample is SA and denoting for σA and variance of B sample is SB and denoting for σB (Walpole et al. 2007). For example, the null hypothesis: Ho: $\mu A = \mu B$ states that the means of productivity of two areas or regions are equal or the difference between means equals 0. While, the alternative hypothesis: H1: $\mu A \neq \mu B$ states that the two means of productivity are not equal or there is a difference between means of productivity.

Current research selected the testing of means of groups of concrete mixes using phosphate materials and glass fines through a quantitative approach after gathering required data and conducting the required experimental work on concrete mix. This approach is well known for researchers in most of sciences and applications to come to the required conclusions depending on this statistics Difference Which cannot be accepted as normal difference or that should be reacted differently is considered significant difference. It means any intolerable difference is known as significant difference (Shukla, 2017).

The level of treatment that is considered here as the addition of phosphate materials and glass fines in concrete mixes in comparison with control concrete sample. For example, the properties of concrete made using phosphate materials and glass fines are compared to the properties of control concrete mix.

The development of t-test can be conducteed through the ANOVA analysis that can be applied in studding different factors related to any specific levels of treatments to test the significant difference between different properties or factors (Sarireh et al., 2012-a and Sarireh et al., 2012-b) , and through improving of statistics and probablistic distributions in studying construction projects (Sarireh, 2013).

Research Results and Discussion

Current research results showed the testing of difference between averages of concrete properties that included fresh and hardened concrete properties. The results also showed the treatment levels of concrete mix using phosphate materials (Abiad mining source and Al Shedyah mining source), glass fines in addition to the control mix that was considered as the basis for comparison between averages of groups. So, the results of concrete properties were presented depending on using materials (phosphates, and glass fines) on mixing ratios 15%, 30%, 45%, and 60%.

Fresh Concrete Properties

Slump Test Value

The slump value test is important in determining the required workability of concrete mix and the grade of concrete that represented using compressive, tensile, and flexure strengths of concrete in current research. Figure 8 presents box plot for slump values of control and other mixes depending mixing ratios of (Phosphate and glass fines) materials. Also, through testing the difference between means, the results showed that null hypothesis can be rejected that there is a significant difference between averages of concrete mix groups. The F-test statistics = 3,173.294 which is greater than F-critical value = 3.13 for (denominator = N-K = 24-4 = 20 and nominator = K-1 = 4-1 = 3, and the P-value is (0) for 15% mixing ratios with control mix. Table 7 shows the statistical results of F-test for the 15%, 30%, 45%, and 60% mixing ratios in comparison with control mix.

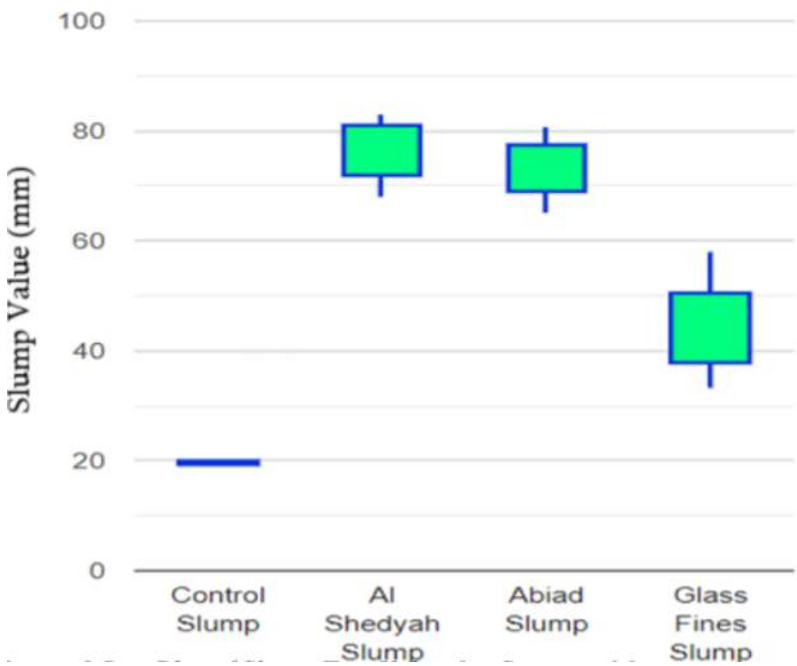

FIGURE 8 BOX PLOT OF SLUMP TEST VALUE FOR CONCRETE MIXES

TABLE 7 STATISTICAL AND CRITICAL TEST VALUES FOR SLUMP TEST IN CONCRET MIXES

Mixing Ratio	**F – test Statistics**	**F – Critical Value**	**P-value**	**Degree of Freedom (N-K, K-1)**
15%	3,173.29	3.13	0	(20, 3)
30%	788.861		0	
45%	2,274.53		0	
60%	666.03		0	

Hardened Concrete Properties

Unit Weight of Concrete

Self-weight of concrete in structure is an important in determining the self-dead load of structure and design considerations of structures. Figure 9 presents the box plot for unit weight of concrete mixes considering mixing ratios of phosphates and glass fines materials. It is shown that the data of unit weight values for control sample, Abiad phosphate, and glass fines are included in the range of Shedyah phosphate range of data. Also, Table 8 presents the statistical parameters of concrete unit weight at 28-day in calculating F-test statistics compared to F- test critical in ANOVA analysis. It is shown that the F-test statistics is less than the F- critical, and the p-value is about 0.05 for 15%, 30%, and 45%, and for 60% the p-value is 0.369 which means that null hypothesis is accepted and that the averages of all groups are not significantly different.

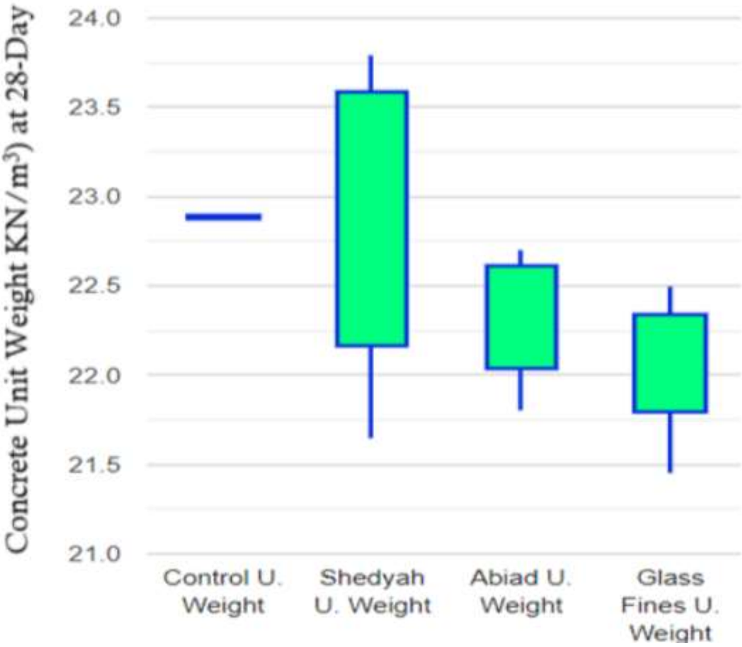

FIGURE 9 BOX PLOT OF CONCRETE UNIT WEIGHT KN/M3) AT 28-DAY

TABLE 8 STATISTICAL AND CRITICAL F-TEST CALCULATIONS FOR CONCRETE UNIT WEIGHT

Mixing Ratio	F – test Statistics	F – Critical Value	P-value	Degree of Freedom (N-K, K-1)
15%	2.96	3.13	0.043	(20, 3)
30%	2.858		0.047	
45%	1.175		0.332	
60%	1.082		0.369	

Compressive Strength of Concrete

Current project had evaluated the effect of addition of Phosphate and glass fines materials on compressive strength of concrete to test the future use of sustainable materials from the local environment. Figure 10 presents the box plot of compressive strength (28 day) of control mix and concrete mixes using phosphate and glass fines on the specified ratios (15, 30, 45, and 60%) of materials. It is shown that the averages of compressive strength for all mixes are far from being concise accept for 60% concrete mixes that their averages are relatively concise and equal. Also, Table 9 presents the statistical parameters of compressive strength (28 day) in comparison of control mix. The averages of compressive strength of 15%, 30%, and 45% are significantly different and null hypothesis can be rejected. While, the null hypothesis is accepted so the averages are not significantly different as the F-test statistics is less than the F-critical and p-value is 0.362 as shown in the analysis.

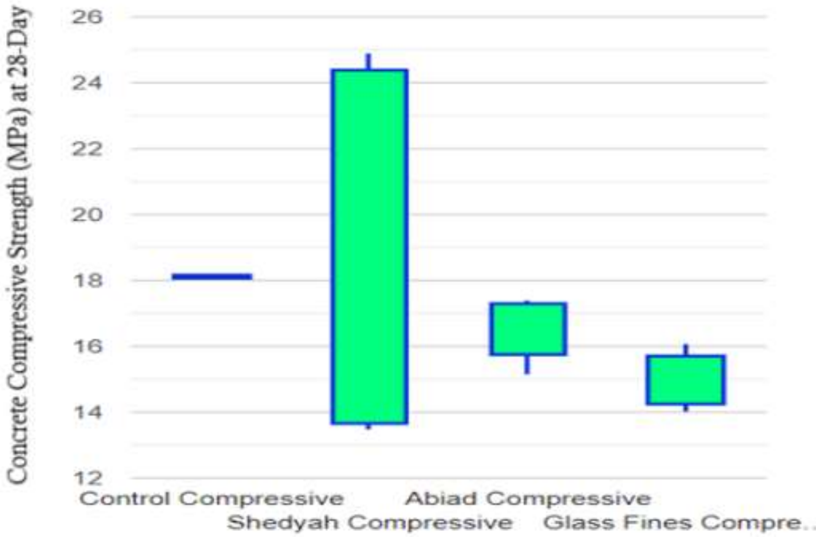

FIGURE 10 BOX PLOT OF CONCRETE COMPRESSIVE STRENGTH (MPA) AT 28-DAY

TABLE 9 STATISTICAL AND CRITICAL TEST VALUES FOR COMPRESSIVE STRENGTH OF CONCRETE

Mixing Ratio	**F – test Statistics**	**F – Critical Value**	**P-value**	**Degree of Freedom (N-K, K-1)**
15%	24.737	3.13	0	(20, 3)
30%	24.586		0	
45%	66.464		0	
60%	1.107		0.362	

Tensile Strength of Concrete

Tensile strength is an important property of concrete that helps in resisting shear and tension cracks. Figure 11 presents the box plot of concrete tensile strength for all groups of mixing ratios. It is shown that the averages of all groups are far from being concise. Also, table 10 presents the ANOVA analysis for the averages of concrete tensile strength for all groups of mixing ratios. Its shown that the F-test statistics is greater than the F-critical and p=value is (0). So, null hypothesis is rejected and the averages of concrete tensile strength are significantly different.

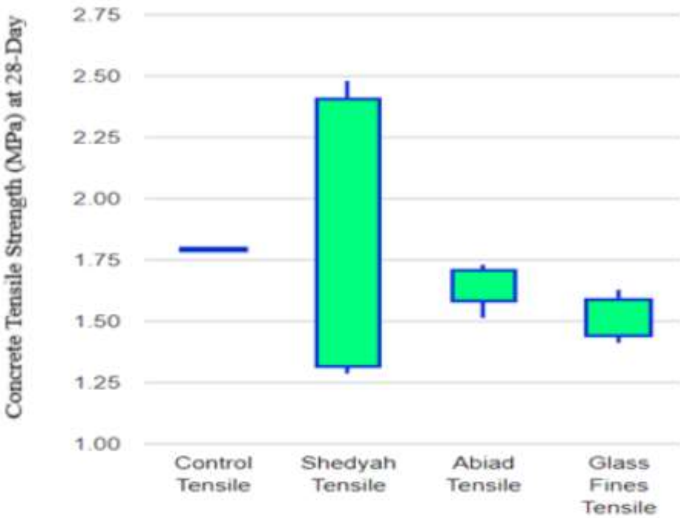

FIGURE 11 BOX PLOT OF CONCRETE TENSILE STRENGTH (MPA) AT 28-DAY

TABLE 10 STATISTICAL AND CRITICAL TEST VALUES FOR TENSILE STRENGTH OF CONCRETE

Mixing Ratio	**F – test Statistics**	**F – Critical Value**	**P-value**	**Degree of Freedom (N-K, K-1)**
15%	127.649	3.13	0	(20, 3)
30%	160.646		0	
45%	61.457		0	
60%	64.861		0	

Flexure Strength

Concrete flexure strength is vital or crucial for the beam strength in treating and bearing flexural load in concrete structures. Figure 12 presents the box plot of concrete flexure strength for all groups of mixing ratios for phosphate and glass fines materials. It is remarkable that the averages of flexure strength are far from being concise or equal. Also, table 11 presents ANOVA analysis for data of flexure strength in control and mixed groups using phosphate and glass fines. Its shown that the F-test statistics is greater than the F-critical and the p-value is (0) for all levels of ratios or treatment. So, the null hypothesis is rejected so the averages of flexure strength are significantly different.

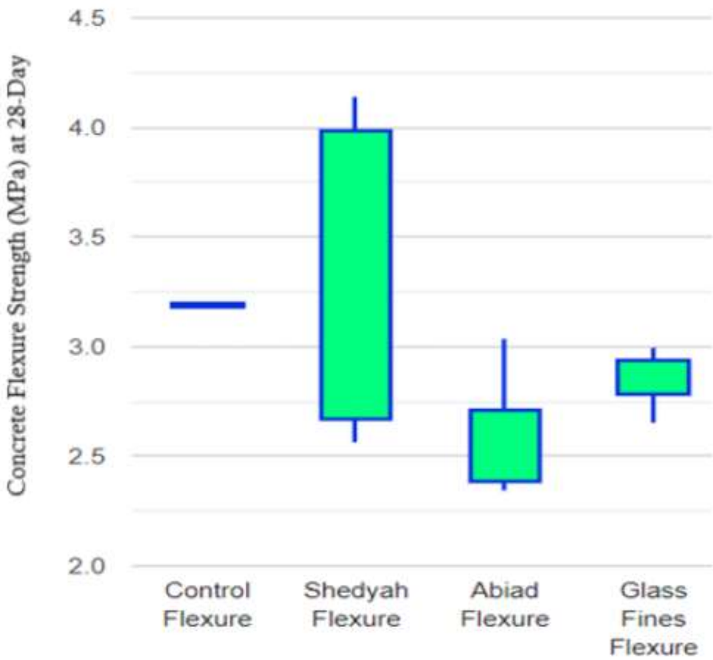

FIGURE 12 BOX PLOT OF CONCRETE FLEXURE STRENGTH (MPA) AT 28-DAY

TABLE 11 STATISTICAL AND CRITICAL TEST VALUES FOR FLEXURE STRENGTH OF CONCRETE

Mixing Ratio	**F – test Statistics**	**F – Critical Value**	**P-value**	**Degree of Freedom (N-K, K-1)**
15%	20.791	3.13	0	(20, 3)
30%	30.811		0	
45%	12.351		0	
60%	11.016		0	

V.CONCLUSIONS

The use of local natural resources (such as phosphate materials from Al Shedyah and Abiad mining sites or the use of recycled waste such as of glass fines will give pioneer solutions for the scarcity of resources and variate the dependency on specific resources for construction industry. Through the testing program of concrete mixes using phosphate and glass fines on 15%, 30^, 45%, and 60% proves that the use of these material is helpful in the case of scarcity of resources. Also, the employment of ANOVA analysis in testing the differences of averages of concrete properties such as fresh properties (slump value), and hardened properties (unit weight, compressive strength, tensile strength, and flexure strength) encourages the use of local natural resources (phosphate from Al Shedyah and Abiad) and environmental friendly recycled material (glass fines) to enhance the production operations of concrete for construction industry.

ACKNOWLEDGEMENT

The author would like to thank the presidency office of Tafila Technical University for the support, and also his colleagues in the department of civil engineering and faculty of engineering. Also, would like to thank hid family for their time and support..

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