SVU-International Journal of Engineering Sciences and Applications (2022) 3(2): 93-105
Print ISSN 2785-9967 | Online ISSN 2735-4571
DOI 10.21608/svusrc.2022.150500.1059

A review on the development of mechanical properties of polyester /epoxy resins reinforced with different powders /fibers materials

Suha Hashim Ahmed[1,], Zenaa Moyaser Abid Gader[1]

Abstract The main objective of the research is to investigate the organic additives if they are from animal or vegetable source and inorganic, mineral or non-metallic additives for two different types of resin matrix, which are epoxy and polyester and presenting different studies in finding the mechanical properties of the composite materials produced as a result of mixing these materials with different additives and proportions after conducting Several mechanical tests such as tensile strength, bending strength, impact resistance, and hardness resistance, and then conclude and extract what many researchers did.

Keywords:. Epoxy resin, polyester resin, natural and synthetic materials, various powders, and fibers.

1 Introduction

When the Babylonians used sawdust mixed with clay to reinforce it to build their dwellings, the process of creating composite materials was known in its most basic form several centuries ago. This combination leads to producing a novel material with technical and physical qualities that differ from the properties of the materials in its composition. The general use of the composite material depends largely on the mechanical and physical properties of these materials, so studying these properties under the influence of forces and loads in different conditions acquires great importance to know the appropriateness These properties of the workplace of these materials. Nature contains numerous instances of composite materials, such as wood and cellulose fibers. In industry, the reinforcement of resins with synthetic fibers is the most widespread. [1-3].

Received: 16 July 2022/ Accepted: 27 July 2022
Corresponding Author: Suha Hashim Ahmed
suabaumu@uomosul.edu.iq
1. Mechanical Engineering department, College of Engineering, University of Mosul, Mosul, Iraq.

the basic substance (Matrix Material).The basis materials can be ceramic materials, which are characterized by their light weight and strong resilience to high temperatures but low resistance to impact forces, or metallic materials, which are composed of metals and their alloys and are heavy and highly durable. Also, the basis material is polymeric materials and is the most extensively used Epoxy resin, phenol, and polyester are a few examples of polymeric materials. It is distinguished by its good mechanical and thermal qualities. In powders (Particulate), which has a diameter more than (1 μm), the reinforcement is also done by dispersion and in different forms, including needle, spherical and dispersed, and the diameter of the particle is less than (0.1 μm). [38] Fibers made of resin come in a variety of forms and shapes, some of which are continuous, segmented, or braided. [5-2].

2 NATURAL REINFORCES (POWDER, FIBERS)

Hisham Shaloub emphasized in his research the main reason for verifying the effect of natural enhancers of animal and vegetable sources, short fibers, and molecules. On mechanical properties, wood powder, palm fronds fibers, with epoxy. Polymeric compounds reinforced with natural fibers have gained wide popularity due to their biodegradability, light weight, environmentally friendly material, low cost, easy processing, and high-quality coefficients. Cow bones and sheep wool were added as natural reinforces varying the weight ratios such as (5%, 15%, 25%) to the epoxy matrix to form composite materials manufactured by hand lay -up technique. It can be made bigger or smaller according to the type of reinforcement materials, as well as according to the weight ratios used. On composite composites made of natural materials, three mechanical tests were conducted. Materials of animal and vegetable origin in the form of fibers and short granules and mixed with epoxy, and from the results of the three tests, the tensile strength of the composite material consisting of wood powder with epoxy was the best value at 15 percent of the weight ratios, and the best tensile strength of the composite material consisting of reinforced cow bone with Epoxy at 5 percent and palm frond fibers with epoxy at 15 percent by weight. As for sheep’s wool with epoxy at 15 percent by weight, and to verify the hardness, the optimum value of hardness was for wood powder with epoxy at 5 percent , and for cow bone powder with epoxy, the best value for hardness was at 25% %, and for palm fronds with epoxy it was better for the value of hardness at 15%, while for sheep's wool, which is considered as fiber reinforced with epoxy, the best value was at 25%.[3].

Fouly et al., study the mechanical and tribological performance of PMMA dental base material reinforced by natural materials. Two natural powders were used, corn cobs and miswak particles, with loading content of 2.0, 4.0, 6.0, 8.0, and 10 wt.%. The results indicated that PMMA samples filled with 8.0 % corn cobs and 6.0 % miswak recorded a good enhancement. [4]

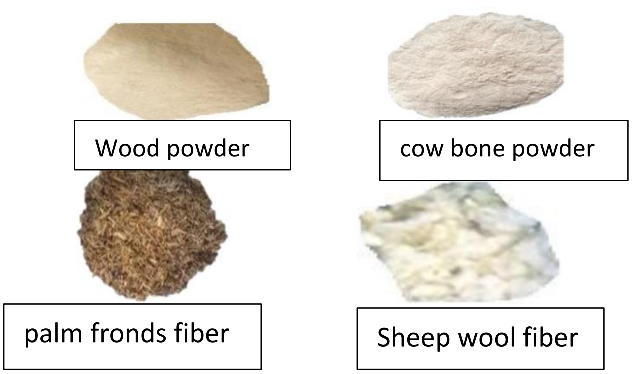

Fig. 1 natural materials (powders and fibers)

DARAMOLA To increase the mechanical capabilities, silica powder with 0.5 m particle size was extracted from rice husk using sol-gel technology, and polymeric compounds were created combining these compounds with inorganic reinforcements less than a micron in size. Weights 0.5, 1, 2, 3, and 4 of silica were combined. After performing mechanical tests like tensile, flexural, and hardness tests, the epoxy resin was mixed with 6 weight percent to determine its mechanical properties. It is effective as an epoxy resin reinforcing filler, although a trade-off needs to be made. It is achieved by figuring out how much silica should be present in the bending resistance. Tensile, hardness, and flexural characteristics of epoxy matrix's mechanical qualities Research has been done on silica enhanced with rice husk particles (RHS). The following conclusions were reached based on the test results: Silica particles collected from rice husks were employed to manufacture the epoxy/SiO_2 compound by hand lay-up Technique, several mechanical parameters such as tensile strength and bending strength were shown to deteriorate at high quantities of silica [5]. Values for bending strength are attained, though, when they are higher than their tensile counterparts. Additionally, silica particles made up of 2% of a composite's weight have improved qualities like hardness, elasticity, and bending modulus. This suggests that silica at low concentrations is advantageous for enhancing mechanical characteristics. In essence, rice husk silica particles provide excellent reinforcing fillers for epoxy resin. To determine the silica concentration of rice husk, nevertheless, a compromise must be made. They are integrated to preserve as much of their tensile and flexural strength as possible [36-40-43]. Esraa A. et al. look at the solid particle erosion of an epoxy-reinforced coating layer consisting of SiO2 nanoparticles. Using a solid impact erosion tester, erosion wear was measured using sand particles of various sizes ranging from 150 to 300 m, impact distances of 15 and 20 cm, and impingement angles of 30°, 60°, and 90°. The findings demonstrate that Epoxy/SiO2 nano-coatings have superior anti-wear performance to neat epoxy. With the addition of SiO2 nano filler, the abrasion resistance and hardness value of epoxy coatings increased by, respectively, 70% and 24% [41].

Cervical fusion implants can treat cervical spine degeneration, one of the flaws that cause neck and neurological issues. However, using a typical implant could result in certain issues. Due to its biocompatibility, high-density polyethylene (HDPE) is now used in this field. This came close examines how well HDPE composites with carbon and Kevlar fiber reinforcement hold up to biomechanical challenges including tension and fatigue pressures brought on by neck movement. It was discovered that the introduction of fibers in HDPE significantly improved the tested composites' ultimate stress and elastic modulus. HDPE composites have improved in fatigue, especially when using KF [12].

3 SYNTHETIC REINFORCES (POWDER, FIBERS)

Mahboob Hassan and Shohel Rana studied the effects of aluminum (Al) and silicon carbide (SiC) hybridization on mechanical characteristics and were investigated. properties and morphology of hybrid epoxy composites reinforced with Al and SiC particles. Hand lay-up technique was used to prepare the composite materials. A microscopic investigation was carried out using scanning electron microscopy and optical microscopy at five levels of reinforcement of silicon carbide and aluminum powder in proportions (10, 20, 30, 40, and 50 wt percent) to investigate the adhesion between the matrix and strengthen. Tensile, flexural, shock, and Tests of hardness were performed. for mechanical characterization, and the findings revealed that the amount of reinforcement increased the tensile forces, elastic modulus, bending modulus, and stiffness. It was 50% of the composite's weight when reinforced with aluminum and silicon carbide particles. The finest collection of mechanical properties among all the produced compounds. Successfully using hand lay-up technology to manufacture affordable hybrid epoxy-Al-SiC compounds. The homogeneous distribution of the reinforcement from aluminum and silicon carbide with epoxy, aluminum and ceramic particles with strong adhesion, and optical microscopic analysis revealed that there are no voids and big air cavities, not even interaction products, in the created compounds. With an increase in the reinforcement content of Al and SiC, reinforcement increases from 10 to 50 percent by weight along with Young's modulus, bending modulus, hardness, and impact strength. Particles are reinforced by 50% by weight across all produced compounds. The hybrid compound combines mechanical qualities most effectively. The synthesized chemicals can be employed in sports, defense, and the automotive and electronic industries in addition to the chemical and aerospace industries [2].

Aleksandra Jeli Researchers looked examined nanofillers made of silicate. Wollastonite, calcium silicate, magnesium silicate, and calcium silicate. By using the aforementioned components as reinforcement and adding epoxy resin in four distinct methods, a composite material was created. to enhance the resin's mechanical attributes. utilizing scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), Fourier transform infrared (FTIR), the synthetic nano composites were characterized (TEM). Analysis of recently produced composite materials supported by silicate nanoparticles is the goal of this study. utilizing a full-field 3D digital image correlation (DIC) approach without contact and a tensile test. Deformation and displacement field analysis ensures reliable testing results. Testing results are reliable thanks to analyze displacement and deformation fields. Results of tests the structural integrity of epoxy composite material enhanced with various silicates nanofillers was evaluated with excellent reliability. It was determined that increasing the tensile strength by 3% by adding wollastonite, magnesium silicate, tricalcium silicate, and dicalcium silicate The strength is up to 31.5%, 29.0%, 27.5% and 23.5% compared correspondingly, neat epoxy. Dicalcium silicate, magnesium silicate, and tricalcium silicates are among the four fillers, and lastonites, have been used to test the tensile strength of composite materials. To overcome the limitations of conventional experimental techniques, complete field displacement detection, and torsion, non-contact whole-field 3D DIC is presented. Following the addition of 1 percent, 2 percent, and finally 3 percent of the filler, a direct rise in the tensile strength of the resultant compounds is seen. Add 3 percent dicalcium to regular epoxy. Increased tensile strength is found in silicates, magnesium silicate, tri-calcium silicate, and wollastonite, at respective rates of 31.51 percent, 29.01 percent, 27.49 percent, and 23.47 percent. Low filler content in the substance According to the results of all samples analyzed, cause a distinct stress concentration to appear at or in the middle of the scale Length. The effectiveness of extra Nano fillers was influenced by the interaction between reinforcements and an epoxy primer: alkyl groups Mg_2SiO_4 and Ca_2SiO_4's presence in the chemical structure encouraged the placement of fillers and strengthened the bonds between these Nano fillers and the epoxy matrix and the resultant composites' tensile characteristics were similarly impacted. via aggregation and dispersing grain size. Due to its minimal particle size and minimal degree of agglomeration, calcium di silicate-reinforced epoxy resins have the maximum tensile strength when reinforced. However, Poor performance of Wollastonite Nano fillers (lack of hydroxyl groups) and distribution of undesirable grain size resulted in the least increase in the tensile properties of reinforced materials. interaction between the fillers and the polymer substrate at the intermolecular level.

The rise in Tg of the immobility led to the composites of the epoxy molecular chains close to the filler surface, according to dynamic mechanical analysis (DMA). Researchers looked at how micro filters affected the viscosity of a liquid epoxy substrate. The function of Nano fillers and the formation of agglomerates in an epoxy resin have been impacted, even though Nano fillers significantly affect the viscosity of epoxy resin. based on the prepared material's viscosity [2].

M.K. GUPTA emphasized that glass fiber reinforced polymeric compounds play a vital role in everyday life. Polymeric compounds based on epoxy resin and polyester reinforced with glass fibers were prepared, with the addition of another filler in the form of gum tree charcoal powder. The glass fibers have been tested for tensile strength, bending resistance, impact resistance, and hardness resistance [25].

Table 1 Mechanical properties of composite material

Designation of composites	Mechanical properties					
	Tensile Strength (Mpa)	Tensile modulus (Gpa)	Flexural strength (Mpa)	Impact strength (Joule)	Hardness	ILSS (Mpa)
Ce1	119.5	3.7	214	9	86.5	7
Ce2	90.4	2.1	166.5	7	80	7.4
Ce3	96.3	2.1	186.7	8	83	6.3
Ce0	221.4	6.4	216.1	8	80.5	7.9
Cp1	176.3	1.7	388.3	12	86.5	7.3
Cp2	142.8	3.1	412.7	10	81	8.2
Cp3	143.2	4.0	585.1	10	83	11.7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Aseel Mahmoud Abdullah has created a polymer-based composite material (polyester) that has been reinforced with glass fibers of the kind (E-glass), and additional models of the material have been created with a polymer basis reinforced with fiber and glass, at a 3 percent weight ratio. When samples are subjected to mechanical testing, such as assessing shock absorption, hardness, and bending, the results reveal that the mechanical qualities get better as the weight fraction increases. In comparison to samples reinforced with glass fibers alone with the same weight fractions, samples reinforced with glass fibers and alumina particles produced the best results in terms of the absorbed energy of the fracture. 1. The mechanical properties of the polymeric material, such as shock, hardness, and bending, were improved by adding glass fibers separately and glass fibers with alumina particles. 2- The polymeric material reinforced with glass fibers and alumina particles for the weight fractions (3, 5, 7 percent wt) increased in hardness with increasing weight fractions, and it produced better results than the glass fibers in a different form. 3- Samples reinforced with glass fibers and alumina particles by weight fractions (3, 5, 7 percent wt) produced the greatest results in terms of the absorbent energy of the fracture. [7].

In his research, Ali Muhammad Ali placed special emphasis on examining the effects of first adding fillers (sodium silicate, talc) to unsaturated polyester (UPR) and then glass fiber reinforced with unsaturated polyester (20%). Second, the mechanical evaluations performed are (strength tensile, bending). In the initial stage of the research, the effects of adding sodium silicate, talc, and sodium alumina silicate (SAS) and a mixture of non-reinforced polyester and glass fibers were examined. The results showed that the best results were obtained when adding a mixture of ((SAS) and Talc) at a percentage of (10 percent SAS, 5 percent Talc), where the tensile strength increased from (31.2 MPa) to (33 MPa) and the value of the of the bending strength increased from (0.057). gigapascal) to (0.0729 gigapascal). The effect of adding fillers (sodium silicate, talc, and a mixture of sodium silicate and talc) to fiberglass-reinforced polyester (20%) was studied in the second stage of the research, and the results showed that the best values were obtained when adding a mixture of ((SAS) and Talc) increased by (5% SAS, 5% Talc), as the tensile strength value increased from (101.7 MPa) to (108.8 MPa), and the value of the elastic modulus was also raised from (5616 MPa) to (6367.9 MPa), and it increased The value of bending strength is from (0.1203 GPa) to (0.1597 GPa) [8].

Abdullah Diaa Asi created a composite material using titanium and alumina particles in varying weight ratios. For unsaturated polyester reinforced with titanium or alumina powder, with weight ratios, several mechanical tests were conducted, including abrasion, shock, compressive strength, and Brinell hardness test (0 percent, 5 percent). For polyester reinforced with alumina and titanium, the wear rate reduced from 28 to 8 g/cm and from 28 to 5 g/cm, respectively, as the weight ratio of the reinforcement material increased. The locations with the highest shock resistance values were for the models reinforced with titanium and alumina, the ratio of 14 and was 10 percent, and it was 14 and 122KJ/m. Also, the compressive strength recorded its highest values at the weight ratio of 10% and it was 229 and MPa 180 for the alumina and titanium, respectively. As for the hardness, it was found that its value increases with the increase in the weight ratio for reinforcing particles, the highest value was at 15% reinforcing ratio, 15 and HBN12 for each of the models reinforced with titanium and alumina particles, respectively. The unsaturated polyester reinforced with alumina particles showed higher resistance to wear and compression, while the polyester reinforced with titanium particles gave higher shock resistance and hardness than those given by the models reinforced with alumina particles [9].

A composite material made of glass fiber and unsaturated polyester 20 percent (V/V) was created by Huda A. Albakry. Random mechanical properties such Brinell hardness (BH), Young's modulus (E), its effect strength (I.S), and compressive strength (CS) were examined and tested at room temperature. Random glass fiber reinforced polyester's mechanical characteristics and stress resistance are improved. Acidic solutions such (HCl, HNO3, and H2SO4) and their effects at various concentrations the findings of a study on the physical characteristics of the Police before and after strengthening revealed a noticeable improvement in those characteristics [11].

In his research, Amer Karnoub examined the mechanical properties by looking at bending, tensile, and impact at three places. To improve the value of boat hulls in the maritime sector and to repair boat hulls, three samples of fiberglass, non-woven polyester slides, and woven resins were created. Through contact casting, three different types of laminates are created. These various wafer samples for mechanical resistance tests are made of woven, non-woven, and mixed (woven and non-woven glass fibers). Bending The test results for these three were examined. One sample stands out and provides a stronger mechanical performance than the other two, according to plate kinds. The study was committed to studying the mechanical properties of the transformed composite materials from glass fibers and polyester resins results in the following findings: a) the use of tests (tensile and bending 3-point) makes it. It is possible to highlight the effect of the nature of the fiberglass on the fracture properties from plate Glass / polyester. The outcomes demonstrated that the sheets are strengthened with woven kind. In comparison to sheets reinforced with non-woven fibers, glass fiber offers superior mechanical characteristics in tensile and bending at three places. b) Composite rupture does not occur instantly; instead, it develops over time [6-7-9]. The findings demonstrated that the type of the fibers has a significant impact on the damage to the glass/polyester sheets. The three samples were subjected to Charpy impact screening procedures to simulate the pressures experienced by real composite materials used in ships. The findings demonstrate that nonwoven glass fiber reinforced sheets are more impact resistant than woven fiber reinforced slats, which are less impact resistant, Consequently, non-woven fiberglass is the material of choice for marine structures. research of how the coastal environment affects the characteristics of glass and polyester A compound to investigate the impact of seawater temperature on the physical, chemical, and mechanical characteristics of composite materials. [13].

Mariana Domnica Stanciu in fact, fiberglass reinforced composites Mats and fabrics with polyester resins have a wide range of uses, including those in the automobile, aerospace, building of wind turbine blades, sanitary ware, furniture, etc. Structures composed of composite materials have a complicated geometry, can at the same time it is impacted by to tensile, shear, bending and torsional stress. In this study, the mechanical characteristics of a composite polyester material reinforced with glass fibers (GFRP) were investigated. Two types of samples were created from this material: the first has four layers of regular fabric (GFRP-RT500), and the second has three layers of chopped mat (GFRPMAT450). The samples were loaded in three different ways: tensile, compressive, and tensile-cyclic tensile. The samples were loaded in three different ways: tensile, compressive, and tensile-cyclic tensile. In terms of initial modulus of elasticity, post-yield stiffness, and viscoelastic behavior under cyclic loading, the results highlight the differences between the two types of GFRP. As a result, it was discovered that the final tensile stress and modulus of elasticity are roughly twice as high in the case of GFRP-RT500 than in the GFRPMAT450 short fiber reinforced compound. In contrast to the tissue-reinforced material, which ruptured after 15 compression cycles, the cyclic tensile-tensile test reveals that the short glass fiber reinforced composite fractured after the first stress cycle. The GFRP-modulus RT500's of elasticity decreased by 13% in response to the applied stress. at a rate of 1 mm/min and 15% for a loading speed of 20 mm/min. At the conclusion of the paper, experimental results from its examination of two different glass fiber reinforced polymers are presented (one is RT500, and Another type is cut glass fiber reinforced MAT450 and MAT225). mechanical characteristics Tensile, compressive, and tensile behaviors are displayed by GFRP. Testing is offered frequently. It can be concluded that:

(1) When compared to composites reinforced with short fibers (GFRP-MAT450, with E = 10,238 MPa), GFRP-RT500 samples have a length modulus of elasticity that is two times higher (E = 21337 MPa). (2) In addition, GFRP-RT500 compound's percentage stress is 1.2 times greater than GFRP-MAT450 compounds. The GFRP-MAT450 strand mat has a tear strength that is roughly 52% lower than the GFRP-RT500. Pressure loading exhibits similar behavior. (3) Normal tissue GFRP-RT500 had a Young's modulus that was 1.82 times greater than that of fiber-reinforced materials (GFRP-MAT450). (4) Evaluation of the mechanical characteristics of the same compound under various It can be noticed that the GFRP-RT500 detected a significant volume during loading (tensile vs. compression). Modulus of elasticity (7.29 times higher in the case of tensile testing) and rip strength (38 percent higher in the case of tensile load than compression) differences in mechanical properties in tensile testing and compression testing. (5) The distinctions between mechanical tension and compression in the case of GFRP-MAT500 The characteristics were lower (2.83 percent between tensile and compressive rupture strength). (6) The two kinds of reinforcing were crucial in the development of viscoelastic plastic. responsive to various pressures and loads. GFRP-MAT450 has been demonstrated to have fewer desirable characteristics than GFRP RT500, although. It has been demonstrated that GFRP-MAT450 has worse properties than GFRP RT500, however it is also known that many composite structures have shorter properties. and layers of scattered fiberglass, which aid in the distribution of efforts in all directions and ensure that the compound in the plate design is semi-isotropic. [14].

The mechanical and corrosion characteristics of polymers containing inorganic particles was investigated by Sunny Bhatia. A mechanical spinning procedure was used to create epoxy matrix packed with different ratios of solid glass microspheres (SGM). ratio of weight percentage effects of SGM particles on the bending strength, compressive strength, and compressive modulus of composite materials were assessed. The SGM ranged from 0 to 30, with a step size of 5% wt. Compared to the steel disc En-32, the composite material had superior abrasion resistance. Using a pin-on-disc tester, they were assessed in terms of mass loss for various SGM ratios. Next to compound densities are also discovered. characteristics of corrosion and mechanics. By including the right amount of reinforce, composite materials can be improved. a rise in density It rises when the proportion of SGM particles in the compounds rises. Mechanical stirring was used to create SGM-reinforced epoxy matrix composites. mechanical characteristics like compressive strength, bending strength, and compressive strength. For reinforced epoxy composites with varied weight ratios (0-30) of solid glass microscopic, the modulus, wear characteristics (wear resistance and coefficient of friction), and density were assessed. Five samples of each formulation were looked at for all tests. From the aforementioned tests, the following conclusions were made: The results were comparable to other experiments using epoxy resins but different fillings. The bending strength of SGM/Epoxy composites declined with the increase of the particles loading, save for 5% by weight. This behavior results from the resin's ability to easily enclose the glass in a modest quantity of (5 percent by weight) powder particles. With an increase in the weight ratio of the material SGM particles in compounds, composites' compressive strength rises. Formula 30 percent by weight was used to produce the highest compressive strength rating (8.6 percent higher than the compressive strength of cured epoxy [15].

To investigate the impact of particles on the mechanical properties of epoxy resin, Radwan created a composite material from epoxy resin reinforced with aluminum particles (PT 100). epoxy that has been strengthened with aluminum (Al) filler particles that are different weight percentages (10%, 20%, 30%, and 40%). Measurements of compressive strength, Vickers hardness, and density were analyzed and contrasted. Silicone rubber molds are used to create samples for compression testing in accordance with ASTM D-396 and Vickers testing in accordance with ASTM E92 international standards [16].

To examine the impact of particles on the mechanical properties of epoxy resin, Sefiu AdekunleBelloa creates a composite material reinforced epoxy resin with aluminum particles (PT 100). epoxy that has been strengthened with aluminum (Al) filler particles that are different weight percentages (10%, 20%, 30%, and

40%). Measurements of compressive strength, Vickers hardness, and density were analyzed and contrasted. Silicone rubber molds are used to create samples for compression testing in accordance with ASTM D-396 and Vickers testing in accordance with ASTM E92 international standards. [17].

Sarkar, Pujan Using an INSTRON 8801 tester in accordance with ASTM standards, an experimental investigation of the mechanical characteristics of glass epoxy and aluminum powder reinforced with glass epoxy composites was conducted. Fiber reinforced, glass epoxy, and 5–15% weight percent aluminum powder in a fixed weight ratio The classic hand-laying method followed by the light pressure casting procedure are used to create glass-filled epoxy composites. Aluminum powder as a filler, according to experimental findings. The mechanical qualities are influenced by the substance. In composite materials, increasing density and vacuum While the addition of aluminum powder results in a progressive decline in tensile strength. Interlayer shear strength (ILSS), bending strength, and microscopic hardness of materials with 5 and 10 weight percent aluminum content. With the addition of more aluminum, up to 15% by weight, improving trends were seen in composite materials compared to unfilled glass epoxy compound. aluminum and glass epoxy 5 percent of the total. The greatest increase in tensile modulus is seen at a weight-added aluminum concentration of 5 percent. It falls off while the compound filled with 10% aluminum exhibits an improvement in tensile modulus. 5% of the weight is aluminum. The greatest increase in tensile modulus is seen at a weight-added aluminum concentration of 5 percent. It falls off while the compound filled with 10% aluminum exhibits an improvement in tensile modulus. 5% of the weight is aluminum. The greatest increase in tensile modulus is seen at a weight-added aluminum concentration of 5 percent. It falls off while the compound filled with 10% aluminum exhibits an improvement in tensile modulus. [17-18]. Al_2O_3 nanoparticles were used as filler for PMMA and HDPE to enhance of the mechanical properties of nanocomposites comparing with pure resin. Experimental results illustrated those nanocomposites with a weight fraction of Al_2O_3 nanoparticles recorded the optimal tribological and mechanical characteristics [19-20].

Unsaturated polyester compound reinforced with randomly woven glass-E (woven glass-E) with a volume ratio of 20% was created by Huda A. Albakry, and various mechanical properties were researched. The mechanicals examined under conventional circumstances include Brinell's modulus, Yunck's modulus, shock resistance, hardness, and compressive resistance (B. H). By contrasting the data, it was discovered that the material's resistance to the forces it was subjected to increased. After unsaturated polyester reinforcement, the shock resistance, Brinell hardness, and compressive strength for each. The mechanical characteristics of hardness, shock, compressibility, and resistance to The loads of the glass fiber-reinforced material compared to their pre-reinforcement equivalents [21-35].

According to DR. FAIK H. ANTER's research, unsaturated polyester resin was used as a material to create composite materials with a polymeric basis by hand molding. a 25% volume fraction foundation reinforced with woven glass fibers in the shape of a mat or random type (glass E). The fatigue of an unreinforced polyester sample is reduced by adding one, two, or three layers of randomly arranged woven glass fibers, either in the form of a mat or at room temperature. The results of the fatigue test demonstrated that for all samples, whether dry or submerged in water, the number of fatigue cycles required to reach the point of failure decreases as the number of reinforcement layers increases. Less of these cycles occur in samples submerged in water compared to dry ones. The quantity of fatigue failure cycles for samples that have been submerged in water or less Whether supported by regular or random glass fibers, the number of fatigue cycles for acute failure of dry samples. And that there has been an increase in this number. the quantity of reinforcing layers. After being submerged in water, samples with random and uniform tolerance become stretchier. To cycle through the failure of the adult for random, dry samples, or flood them with water on a regular basis for the same tolerance layer [22].

The goal of Ali I. Al-Mosawi's research is to determine how altering the fiber reinforcement ratio affects the mechanical characteristics of composite resin materials. Bidirectional Kevlar Knitted Braids Reinforced with Conbextra Epoxy (10-EP) 0°–45° (Surface Density 340) (As cm^3/g was initially retrieved, these characteristics comprised hardness, shock resistance, tensile strength, and flexural resistance.) Phenol-formaldehyde resin's mechanical qualities prior to fiber reinforcement, following which the resin was strengthened using various Kevlar fiber weight ratios. [23] (Twenty, Forty, and Sixty Percent) Examining how this affects the aforementioned attributes, as depicted in the graphs:

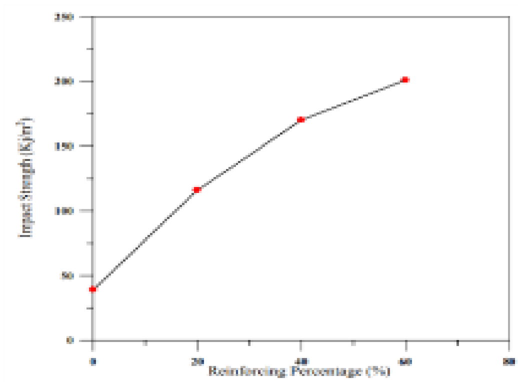

Fig.2 Results of Impact strength

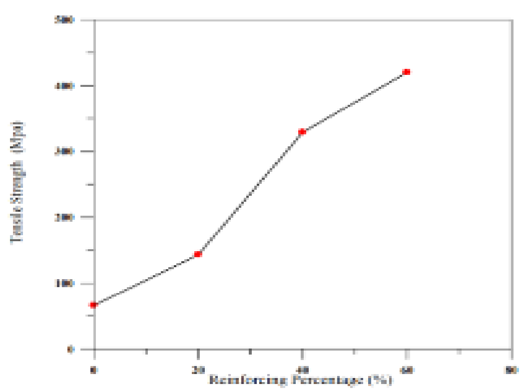

Fig.3 Results of tensile strength

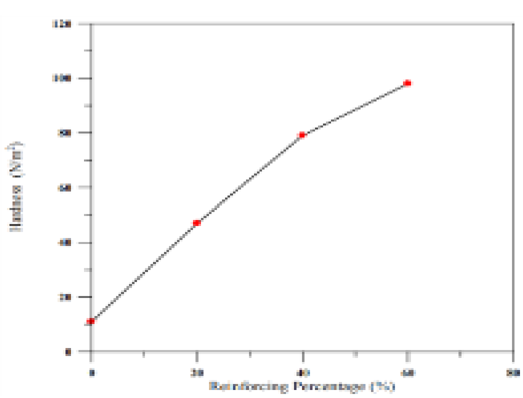

Fig.4 Results of Hardness strength

Shabib Kazem Matar, the polymer-based hybrid composite materials, were created using the hand casting method and were mostly made of unsaturated polyester resin that was then bonded with glass fibers. As a first set of samples, there were mats of the type (GLASS-E) with a predetermined volume fraction (10 percent) and graphite particles. As a second group of samples, there were mats 49 made of Kevlar fibers in place of fiberglass. A collection of mechanical tests was conducted at room temperature to examine the effects of the selected volume fractions of 0%, 5%, 10%, 15%, and 20% for graphite particles with a mixture of different particle sizes ranging from (25 m - 106 m) on the properties of the manufactured composite materials (tensile, compression and shock tests). and hardness, shear stress, and bending strength). The study's findings demonstrated that as fracture severity rises, the values of (tensile stress, compressive stress, modulus of tensile elasticity, fracture toughness, and hardness) also rise. Volumetric graphite particles also rise at low volume fractions of graphite particles for both samples, but the values of (modulus of compressive elasticity, bending strength, and shear stress) decrease. decrease Shock resistance for both samples with increasing volume % of graphite particles is depicted. The findings demonstrated that the values for the following parameters: tensile stress, modulus of tensile elasticity, modulus of compressive elasticity, shock resistance, and toughness Compared to their counterparts reinforced with glass fibers instead of Kevlar fibers, the fraction is larger for hybrid composite materials reinforced with graphite particles and Kevlar fibers, notwithstanding the fact that the (resistance) values were noted The reinforced hybrid composites have greater compressive strength, hardness, bending strength, and shear stress. Graphite and glass fiber reinforcements are evaluated in comparison to their counterparts reinforced with Kevlar fibers. The most significant findings that have been made They were outlined as follows during this research: - Particles of graphite are added to materials a polyester-based hybrid composite base material that is unsaturated and fiber-reinforced Values of increased due to the use of glass or kevlar fibers Except for the shock resistance values, all mechanical properties (including tensile, compression, fracture toughness, hardness, shear stress, and toughness curvature) were completed in the research. Particles of graphite were used to minimize itWith an increase in the volume fraction, the values of all the mechanical properties indicated in the first increase. Excluding impact resistance figures for graphite minutes. The values of (compressive strength, bending strength, shear stress, and hardness) are higher for hybrid composite materials reinforced with graphite particles and glass fibers than for their reinforced counterparts with Kevlar fibers instead of glass. It decreases with an increase in the volume fraction of minutes graphite. Tensile strength, shock resistance, fracture toughness, elastic and compressive modulus values are higher for hybrid composite materials reinforced with graphite particles and Kevlar fibers than for their equivalents reinforced with glass fibers. At fractures, the values of (compressive elastic modulus, stress shear, and bending strength) decline. high particle density of graphite [24-33].

M. K. Gupta supported a study looking at the mechanical, thermal, and water absorption characteristics of glass fiber reinforced polymer composites (GFRPCs). To manufacture composite material using the hand lay-up method, strengthen with numerous layers of woven fiberglass resin or epoxy. characteristics for absorbing water N. Abed Jameel Their water absorption, absorption, diffusion, and permeability coefficients were investigated. On the other hand, mechanical tests were performed in accordance with ASTM standards for tensile, flexural, and shock testing. Additionally, thermo gravimetric analysis (TGA) and dynamic mechanical analysis were used to study the thermal properties (DMA). The outcomes demonstrated that water absorption, with more woven fiberglass layers in epoxy resin, the mechanical and thermal qualities improve. The mechanical, thermal, and water absorption characteristics of manufactured glass compounds are examined. The results show that the generated glass compounds' ability to absorb water increases as more layers of glass fibers are woven into the epoxy resin. Maximum number of layers of fiberglass. (G12) [25].

The mechanical characteristics of a polymeric composite material made of hardened earldite resin in the following ratios were examined by the researcher in relation to various fiber reinforcement ratios: varying amounts of non-continuous glass fiber reinforcement (20%, 40%, 60%). Ratios were employed. Models for mechanical testing, such as those for shock resistance, tensile strength, and compressive strength, require reinforcement (20%, 40%, and 60%). Materials consulted for the study: 1.2 g/cm density, non-continuous glass fibers (random or shredded), type CY223 earldite resin. It was found that adding glass fibers strengthened the resin's mechanical qualities, increasing their values. Due to their fragility, resins are typically thought to have low shock resistance; nevertheless, when reinforced with fibers, the value of shock resistance rises and returns. This enhances resistance since the fibers will absorb much of the impact energy that is applied to the overlying material. Consequently, as the proportion of fiber reinforcement grows to (40 %), the shock resistance increases (60 %). However, the addition of fibers significantly boosts the tensile strength of these materials because the fibers' low ductility allows them to carry the majority of the applied stress, hence enhancing the tensile strength of the overlaying material. Due to the fibers taking up more space inside the resin and allowing for a better distribution of the force applied to them, the tensile strength increases as the proportion of fibers added increases. While the distribution of eryldite resin's compressive strength test When glass fibers are used to reinforce tempered materials, the compressive strength increases significantly because of the stress placed on the fibers and the effectiveness of the bonding between the base material and the reinforcing fibers. As the number of additional fibers increases, the composite material's compressive strength rises. [26].

Epoxy resin served as the basic material for the polymeric compounds that Roaa Issam Ibrahim Al-Rawi created, and glass fibers were added in various weight ratios. As reinforcement materials, there were (11 percent, 10 percent, 8 percent, 6 percent, and 4 percent). The polymeric composites were compared before and after the reinforcing, and it was discovered that the more All mechanical property values increased because of the fiber content (impact resistance, hardness, modulus of elasticity, compressive strength). The most significant finding from this study was All of the mechanical parameters measured in the research that were increased because of the addition of glass fibers to the epoxy are:

Properties (impact resistance, hardness, modulus of elasticity, compressive strength) increase with an increase in the weight ratio of the fibers [27].

The effect of adding glass powder to grain size (35 m) is studied in this research. A mixture of unsaturated polyester and polyurethane with variable size fractions (10%, 20%) A composite material made of (90%) unsaturated polyester as the foundation material and (10%) reinforced polyurethane was created using the manual lifting technique. The bending test and Shore D hardness test findings demonstrated that adding glass powder as a reinforce to polymer had a substantial impact on mechanical characteristics. It has been demonstrated that when the volume fraction of glass powder increased, the values of the elastic modulus, impact strength, and hardness increased as well. A light microscope with a magnification of (40X) was used to analyze the samples, and the results revealed that all the fractures seemed to be brittle fractures because polyester and glass are both brittle materials [28-33].

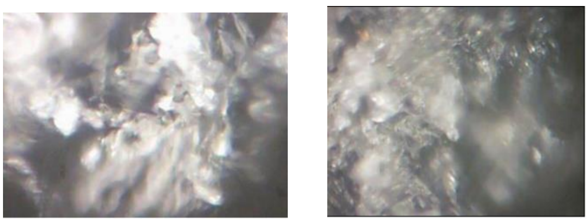

Fig.5 Right side left side of the (UPE/PU) blend's fracture surface contains 10% of the volume of glass powder

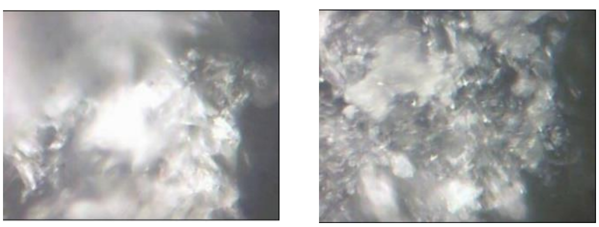

Fig .6 Right side left side of the (UPE/PU) blend's fracture surface contains 20% of the volume of glass powder

Al-Rawi, Khaled Rashad the hand casting method of creating a composite material with a polymeric basis was investigated by the researchers. A resin epoxy was used to create the composite material, which was then strengthened with magnesium oxide (MgO) powder in varying weight fractions (0, 5%, 10%, 15%, 20%, and 25%). (percent) The research demonstrates that the values of the modulus of bending elasticity (EB) rise with the increase in the weight fractions of the magnesium oxide additive. The three-point bending test and the exact hardness test were performed on it. Additionally, there is a linear link between the rise in particle weight fractions and the hardness. The hardness of the compound increases as the weight ratios of increase (MgO) additive [29].

Epoxy resin was used as the matrix material in the study of the mechanical characteristics of ceramic-reinforced polymer composites. The reinforcing particles were silica with a particle size of (53-63) m and alumina with a particle size of (106-150) m, and their percentages by weight were 20 percent, 30 percent, and 40 percent, respectively. It was put through tensile, compression, bending, impact, and hardness testing. The findings of the laboratory testing show that the composite materials have better mechanical properties than the base material since their elastic modulus is substantially higher. It was discovered that the reinforcement of the modulus of elasticity increases as the proportion of the reinforcing material increases. [30] At the maximum percentage, alumina compounds had a greater modulus of elasticity than silica compounds. For the elasticity of the compound, which is 182 percent higher than the base material and contains 40% alumina. The compressive strength of compounds reinforced with 30% and 40% by weight is just a little bit greater than the matrix materials. And that when the proportion of reinforced material grows, the hardness of composite materials also rises. The mechanical qualities were discovered to have improved, and they are closely correlated with the amount of reinforced material. When compared to composite materials reinforced with a similar amount of silica, the characteristics of compounds reinforced with alumina are substantially better (quartz). At 40% alumina, the compound has the maximum hardness and fracture toughness [39].

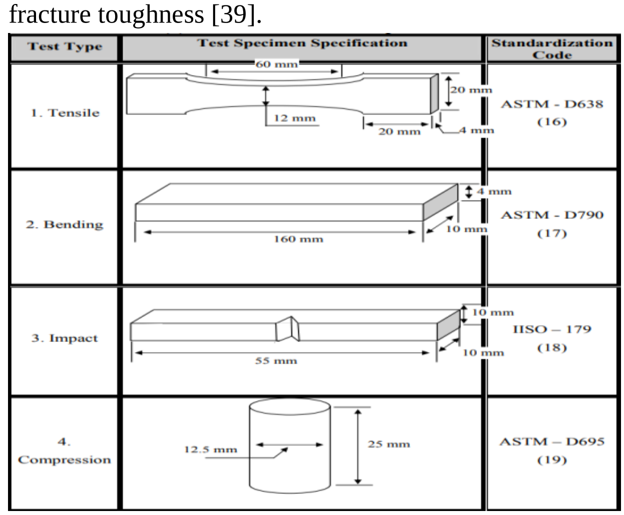

Fig.7 molds of tests

The tensile and bending strengths of composite materials are significantly lower than those of the base material; the tensile strength of the composite material is reduced by 19–65 % as compared to the base material, while the bending strength is reduced by 17–65 %. Twenty percent silica or alumina reinforced materials have compressive strengths that are one to two percent lower than the matrix material, whereas thirty and forty percent of the reinforcing materials have compressive strengths that are four to eight percent higher. In direct proportion to the weight of the reinforced material, the hardness of the materials and the fracture toughness of the composite materials are both significantly higher than those of the matrix material. The fracture toughness of the composite material has increased by 10-133 percent, while the toughness of the material has improved by 26-129 percent compared to the matrix material. Alumina has a substantially higher alumina concentration than silica-reinforced composites. In direct proportion to the weight of the stiffener section, the composites' toughness is also significantly greater than the matrix material's. The toughness of the composites increases by 30-118 percent as compared to the matrix material. Alumina-reinforced composites have a substantially higher hardness than composites reinforced with silica in comparable amounts [26].

4 Conclusion:

1- According to the debates above, it was discovered: 1. At the moment, it's important to use these two kinds of epoxy and polyester resins along with a variety of reinforcements made of natural, organic, inorganic, mineral, and non-metallic materials in different forms, like powders and various kinds of shredded and continuous fibers with various weight ratios. However, it was discovered through the research discussed that adding any kind of fibers to resins improves their mechanical properties compared to the same type that is only available in powder form. Mechanical properties mainly depend on hardeners and additives like fillers and plasticizers. Adding any kind of powder increases the mechanical properties such as tensile strength, hardness, bending and impact strength.

2- Adding synthetic fibers like glass fibers, carbon fibers, and graphite to these two types of resins in varying weight ratios improves their mechanical characteristics, such as tensile strength, hardness, bending, and impact strength, which makes them more useful in real-world applications since fibers are primarily in charge of bearing external loads.

3- The additions with a high weight percentage, whether they were powders or fibers, decreased the tensile strength in some tests, but increased the resistance to hardness in others. This is because the powders and fibers reduce and close the spaces between the particles of the base material, which prevents the polymer particles from moving freely and increases the hardness

4- Compared to industrial fibers like glass, carbon, and graphite fibers, the addition of natural plant fibers produces results of high strength and efficiency with an increase in the weight of the fibers for a specific amount and percentage. Natural fibers are also used in industry, such as the furniture packaging industry, as an alternative to industrial fibers because they are plentiful and less expensive. It is used to make automobile bodies since it is lightweight, especially composite composites that have Arica fibers included.

References

[1] M.R.M.Asyrar," Mechanical properties of oil palm fibre-reinforced polymer composites," Journal of Materials Research and Technology", Volume 17, Pages 33-6, March–April 2022.

[2] Shohel Rana1," Effects of aluminum and silicon carbide on morphological and mechanical properties of epoxy hybrid composites" Polymers and Polymer Composites journal, Volume 30, 2022.

[3]Hisham A. chlobe," Studying the Mechanical Properties of Composites Using Natural Additives with Epoxy", Journal of Advancements in Material Engineering, Volume-6, Issue-2 (May-August 2021.

[4]Fouly, Ahmed, Ahmed Nabhan, and Ahmed Badran. "Mechanical and Tribological Characteristics of PMMA Reinforced by Natural Materials." Egyptian Journal of Chemistry 65.4 (2022): 1-2.

[5]DARAMOLA, 2.O.S. AKINTAYO," MECHANICAL PROPERTIES OF EPOXY MATRIX COMPOSITES REINFORCED WITH GREEN SILICA PARTICLES", International Journal of Engineering, ISSN: 1584-2673, 2017.

[6]Aleksandra Jel," Determination of Mechanical Properties of Epoxy Composite Materials Reinforced with Silicate Nanofillers Using Digital Image Correlation (DIC)" Polymers journal. https://doi.org/10.3390/polym14061255,2022.

[7]SURESH J S," INVESTIGATION ON MECHANICAL PROPERTIES OF EPOXY/POLYESTER BASED COMPOSITES", International Journal of Advances in Science Engineering and Technology, Vol-5, Jan.-2017.

[8]Aseel Mahmood Abdullah," EFFECT OF ALUMINA PARTICLES ON THE MECHANICAL PROPERTIES OF DISCONTINUOUS GLASS FIBER REINFORCED UNSATURATED POLYESTER COMPOSITES", AL-Qadisiyah journal for engineering sceiences,Vol. 4,No.1,2011.

[9]Abdulla dieaa asiy," Study of the mechanical properties of unsaturated polyester reinforced with titanium and alumina powder" Babylon University Journal of Engineering Sciences, Vol.23, No.1,p.p.62-52,2015.

[10]Huda A. Albakry," Studies of the Mechanical Properties of Unsaturated Polyester Composite Reinforced by Randomly Woven Fiber Glass and Effect of Acidic Solutions on some of its Physical Properties,Rafidain Journal Science,Vol.23,No.1,page 114-129,2012.

[11]Amer Karnoub," Mechanical properties of composite material laminates reinforced by woven and non-woven glass fibers", XIII International Scientific and Practical Conference "State and Prospects for the Development of Agribusiness – INTERAGROMASH, Volume 175, 2020.

[12]Eyad, N. M. A., W. Y. Ali, and A. Nabhan. "Mechanical Properties of cervical Fusion plates fabricated from Polyethylene reinforced by Kevlar and Carbon Fibers." KGK-Kautschuk Gummi Kunststoffe 74.6 (2021): 42-47.

[13]DR. FAIK H. ANTER," STUDY OF MECHANICAL PROPERTIES FOR UNSATURATED POLYESTER REINFORCED WITH GLASS FIBER", Al-Anbar University Journal for Sciences Al-Sarfa, Vol.8, No.1, ISSN: 1991-8941,2014.

[14]Mariana Domnica Stanciu, "Mechanical Properties of GFRPs Exposed to Tensile, Compression and Tensile–Tensile Cyclic Tests", Polymers journal,2020.

[15]Sunny Bhatia," Mechanical and wear properties of epoxy matrix composite reinforcedwith varying ratios of solid glass microspheres", Journal of Physics: Conference Series, Vol.1240,2019.

[16]H. Radhwan,"Experimental study mechanical behaviour of epoxy resin composites filled with aluminium particles", AIP Conference Proceedings 2129, 020157, https://doi.org/10.1063/1.5118165,2019.

[17]Pujan Sarkar," Mechanical Characteristics of Aluminium Powder Filled Glass Epoxy Composites", International Journal of Engineering and Technologies, Vol. 12, pp 1-14,2017.

[18]Dr. Sihama Issa Salih," Evaluation Mechanical Properties of Polymer Composites Reinforced by different Metal Powders", The 5th International Scientific Conference for Nanotechnology and Advanced Materials and Their Applications ICNAMA, Eng. &Tech.Journal, Vol.33, Part (B), No7, 2015.

[19]Nabhan, A., A. K. Ameer, and A. Rashed. "Tribological and mechanical properties of HDPE reinforced by Al_2O_3 nanoparticles for bearing materials." Int. J. of Advanced Science and Technology 28.18 (2019): 481-489.

[20]Gallab, Mahmoud, et al. "Effect of Low Content of Al_2O_3 Nanoparticles on the Mechanical and Tribological Properties of Polymethyl Methacrylate as a Denture Base Material." Egyptian Journal of Chemistry 65.8 (2022): 1-6.

[21]Huda A. Albakry," Studies of the Mechanical Properties of Unsaturated Polyester Composite Reinforced by Randomly Woven Fiber Glass and Effect of Acidic Solutions on some of its Physical Properties", Rafidain Journal of Science, Vol.23, No.1, page 114-129,2012.

[22]DR. FAIK H. ANTER," STUDY OF MECHANICAL PROPERTIES FOR UNSATURATED POLYESTER REINFORCED WITH GLASS FIBER", Anbar University Journal of Pure Sciences, Vol.8, No.2,2014.

[23] Ali I. Al-Mosawi," Study of Some Mechanical Properties for Polymeric Composite Material Reinforced by Fibers", Al-Qadisiyah Journal for Engineering Sciences, Volume 2, Issue 1, Pages a14-a24,2009.

[24] Shabib Kazem Matar," Studying mechanical properties for polymer matrix composite material reinforced by fibers and particles", Engineering and Technology Journal, Vol.28, No,4,2010.

[25]M. K. Gupta," Investigations on Properties of Glass Fibre Reinforced Polymer Composite", American Journal of Polymer Science & Engineering, | Vo l u m e 6, ISSN 2572-5734,2018.

[26] Abed N. Jameel," THERMAL AND MECHANICAL PROPERTIES OF POLYMERIC COMPOSITE", The Iraqi Journal for Mechanical and Material Engineering, Vol.13, No.2, 2013.

[27] Ruaa Issam Ibrahim Al-Rawi," Preparation Polymeric Composites from Epoxy with Randomly Woven Fiber Glass and Studies the Mechanical Properties", Al-Rafidain Science Journal, Vol.28, No.3, 2021.

[28]Bushra H. Musa," Effect of Glass Powder on Some Mechanical Properties of Polymer Matrix Composite Material", Journal of Al-Nahrain University Vol.17 (2), pp.108-115 Science, June 2014.

[29]Khaled Rashad Al-Rawi," A study of some mechanical properties of the MgO-Epoxy. complex", Journal of Al-Nahrain University, Vol.17, No.1, Page10-14,2014.

[30]Dr. Ibtihal-Al-Namie," Study the Mechanical Properties of Epoxy Resin Reinforced With silica (quartz) and Alumina Particles", The Iraqi Journal for Mechanical and Material Engineering" Vol.11, No.3, 2011.

[31]Abdul Nour Jamil," Thermal and mechanical properties of a fibre-reinforced polymeric composite", The Iraqi Journal for Mechanical and Material Engneering, Vol.13, No.2, 2013.

[32]Metin Tanoglu, "Compressive mechanical behaviour of E-glass/polyester composite laminates tailored with a thermoplastic preforming binder", Materials Science and Engineering journal, Vol.363, page335-344, (2003).

[33]Ali Muhammad Ali and others., Mechanical Prosperities of Unsaturated Polyester/Fill Compounds Armed with Fiberglass, Tishreen University Journal of Scientific Research and Studies - Engineering Sciences Series, vol. 37, No. 1, 2015.

[34]Ahmed Jassim Mohammed, Study of the effect of adding aluminum powder on some mechanical properties and combustion resistance of unsaturated polyester, Vol. 7, No. 13 and 14, p. (61-70) A, (2018).

[35]R.B. Ashok, C.V. Srinivasa, B. Basavaraju," A review on the mechanical properties of areca fiber reinforced composites", Science and Technology of Materials, Vol.5 ,120–130 (2018).

[36]Umar Nirmal, Jamil Hashim," Betelnut fibres as an alternative to glass fibres to reinforce thermoset composites: A comparative study", Vol 82, Issue 11, 2012.

[37]G.K. Sathishkumar, Mohamed Ibrahim," Synthesis and Mechanical Properties of Natural Fiber Reinforced Epoxy/Polyester/Polypropylene Composites: A Review, JOURNAL OF NATURAL FIBERS, https://doi.org/10.1080/15440478.2020.1848723

[38]Zainab Fadil Kazem and Lena Fadil Kazem, Study the effect of nitric acid on enriched and unenriched polyester, The Iraqi Journal for Mechanical Engineering, Vol.11No. 2, 2011.

[39]Dipen Kumar Rajak, Durgesh D. Pagar,” Fiber-Reinforced Polymer Composites, Manufacturing, Properties, and Applications”, Polymers Jurnal, Volume 11, Issue 10 ,12 October 2019.

[40]Joshi, SV, Drzal, LT, Mohanty, AK. Are natural fiber composites environmentally superior to glass fibre reinforced composites? Comp Part A: Appl Sci Manufact 2004, 35: 371–376.

[41]Elshemy, Esraa A., and Ezzat A. Showaib. "Effect of Filler Loading on Erosive Characteristics of Epoxy/SiO_2 Coatings." Solid State Technology 63.4 (2020): 7824-7833.

[42]Ahmad A. Khalaf, Hamid M. Mahan,” Effect of Hybrid Materials Configuration on The Mechanical Properties of Composites”, Volume 25, Issue 5, January 2022.

[43]Taha, Mohamed, et al. "Evaluation of eco-friendly cellulose and lignocellulose nanofibers from rice straw using Multiple Quality Index." Egyptian Journal of Chemistry 64.8 (2021): 4707-4717.