# Impact and Flexural Properties of Chemically Treatment Date

Abo-El Hagag A. Seleem[1,3], W. W. Marzok[1], A. M. Hashem[2]
[1]Production Engineering and Design Department, Faculty of Engineering, Minia Universities, Minia, Egypt, 61111
[2]Mechanical Engineering Department, Faculty of Engineering, South Valley University, Qena, 83523
[3]Sun Miser petroleum company, Egypt

**Abstract**– In the current decade, Composite materials reinforced using natural fibers have been used in a lot of industrial applications such as aerospace, automobiles, furniture and construction. Natural fiber composites from the annually renewable natural fibers and biodegradable matrices have been developed in the past decade. Since the region of the pharaohs, the date palm trees are used in many a lot of fields such as ropes, scuttle, the boats…etc. Now our study for date palm trees have been used to reinforce epoxy to be used in advanced industrial applications. It is used deed a chemical treatments to date palm trees with adding(CH3COOH, HCl, and alkaline NaOH ) with three different concentrations 10% and 20 % and 50 % at boiling temperature (100 $^{o}$C) for 1hr and 2hrs respect .then added epoxy for mixture . Then, these mixtures put under load 3ton for 48 hr. After that, we cutting every kind of different treatments DPT reinforced epoxy according to test specimens by grinding machine to be ready for start test in machine. Flexural strength through three-point bending test is established. Drop weight impact test is performed to measure the depth of penetration through specimens' body, therefore, the effect of fallen load on the topography of the specimen and damage will be observable. The results showed that the impact strength is nearly better in case boiling for 2hr than case boiling 1hr. The same results for flexural strength that good results in case boiling 2hr more than case 1hr

Keywords: (DPT)date palm tree , Composite materials , topography , flexural strength



## 1 INTRODUCTION

The production of natural fibre reinforced epoxy composites also has important economic potential with many applications in different fields .Composite material consist of two materials or more than and have two phases; reinforced phase (fiber, particulates) and the matrix phase (polymer, ceramic or metal). Natural fibres have advantages as low cost, light weight and environmentally alternatives to glass fibres in composites .The Date palm tree fibres reinforced polymer as a composite material have been investigated in [1-3].

Asadzadeh et al. [4] reinforced different types of polymers by using DPT fibre to investigate their effect on bending strength. They used five levels of fibre volume fraction, these fibres were mixed by coupling agent to increase the debondablity and interfacial adhesive between polymers. The results gave enhancement in bending properties and a decrease in breaking elongation.

fibres, Betelie et al. [5] studied the fracture toughness of natural fibre reinforced epoxy. They fabricated a standard compact tension specimen which was obtained from a composite plate manufactured using hand molding method technique. The results showed that with increasing fibre volume fraction the fracture toughness had getting enhancement. Natural fibres as a reinforcement phase with a polymer matrix to create friendly environmental product were attractive in many works [6-11].

Alsaeed et al. [12] used fibre pull out test method to measure interfacial adhesive of DPT fibre with epoxy resin. DPT fibre had given treatment by NaOH alkaline solution treatment with (0-9%) concentrations. SEM analysis investigated the surface morphology and fibre damage. The results recommended that optimum treatment of DPT was at 6% concentration, while 10 mm length was the optimum embedded length.

AL-Sulaimanal [13] investigated the mechanical properties, water absorption and machinability of DPT leaves reinforced polymer composite laminates. They fabricated the composite laminates using three different fabrication methods. The polymer resins were phenol-formaldehyde resin and a two-component Bisphenol resin. They observed that both tensile and flexural strength had to get enhancement, while in Bisphenol resin gave better results. Fatigue behaviors for Bisphenol resin had to get better. Water absorption also for Bisphenol resin was better than phenol-formaldehyde resin. Machinability for all composites was enhanced.

The fracture toughness of reinforced composite polymer was studied in many works [14-16], but these

studies were about scaling of specimen geometry with holes to nominal tensile strength. They extracted an analytical and numerical model to predict the nominal strength using cohesive zone model. Their results were in good agreement with the experimental results.

Hassan et al [17] studied the mechanical properties (tensile and flexural strength) of GLARE which is types of fiber metal laminate composite material based on aluminum. It measured the tensile and flexural strength under the static status of loading.

Ling et al [18] studied various curing cycles on the static three-point flexure and tensile strength of cross-ply laminates of stacking sequences $[0/90]_{3s}$. they concluded that there was an optimum time for allaying curing pressure which would give beast results for mechanical properties.

Giovanni and Roberto [19] studied the impact and dynamic behavior of glass fiber reinforced epoxy unidirectional and woven laminates. They used the drop weight fallen impact test. it was recorded the stored energy and absorption energy. It concluded that the considered materials, under the considered loading conditions, show no sensitivity to the strain rate effect.

Tien-Wei and Yu-Hao [20] investigated the impact behaviors of E-glass reinforced composite material. The test was performed using a drop weight fallen test. the results were based on fractography and recording the load history with time to measure the absorption energy.

Baucom et al [21] experimentally studied the damage performance of composite laminates using repeating drop weight test. the test was carried out on 2-D plain-woven laminates and 3-D orthogonally monolith ones. The results showed that the 3D composites had the greatest resistance to penetration and dissipated more total energy than the other systems.

1.2 Objective of the present study

The main goals of the present study are:

a) To investigate the effect of different chemical treatments of both acetic and alkaline solutions at different boiling 1hr and 2hr on Flexural strength through three-point bending test.

b) It is also to study the Drop weight impact test is performed to measure the depth of penetration through specimens' body

The scope of paper consist of; the first paragraph about treatment for DPT and adding epoxy by using molding technique that is explained, the second scope summarized the standard bending and Drop weight impact test , the third scope explained examination is displayed then the main results are related. Finally, the recommended conclusion is cited.

2.Material Processing and testing

2.1 Date palm tree chemical treatment

The used materials are date palm tree fibres (see Fig. 1) that surrounding the stems collected from Qena City at upper of Egypt, these fibres have the physical and mechanical properties listed in Tables 1 and 2. Firstly, the fibres get cleaning from dust by a water bath and leave to dry in room temperature. They manually get dismantled into bundles of virgin fibre, then get wished again and were dried for 24 h in room temperature as shown in Fig. (2- a). The fibre gets chopped for small pieces using electrical mixing for 15 min (Fig. (2-b)). The grinding fibres are then chemical treatment by three different types of solutions. The chemical treatment is carried out to enhance the surface of natural fibre to increase its debondablity with the polymer matrix. The interface bonding between fibre and polymer is a dominated role in determining the mechanical properties of natural fibre. The fibre is immersion in three concentrations 10 %, 20 % and 50 % of the acetic solution of HCL, CH3COOH and alkaline solution of Na OH at boiling temperature (100 $^{o}$C) for 1 hr. and 2 hr. The produced plate is nearly 3.5 mm average thickness for all test specimens

Table 1 Physical properties of the date palm fibers with other natural types [22]

| **fibre types** | **Coir** | **Date palm** | Hemp | Sisal |
|---|---|---|---|---|
| **Density (g/cm$^3$)** | **1.15–1.46** | **0.9–1.2** | **1.4–1.5** | **1.33–1.5** |
| **Length (mm)** | **20–150** | **20–250** | **5–55** | **900** |
| **Diameter (μm)** | **10–460** | **100–1,000** | **25–500** | **8–200** |
| **Specific modulus (approx..)** | **4** | **7** | **40** | **17** |
| **Annual world production (10$^3$)** | **100** | **4,200** | **214** | **378** |
| **Cost per weight (USD/Kg)** | **0.3** | **0.02** | **1.2** | **1** |
| **Thermal conductivity (W/mK)** | **0.047** | **0.083** | **0.115** | **0.07** |

Table 2 Mechanical Properties of the date palm and

other natural fibres[22]

| Properties | ϕ(diameter) µm | $\sigma_u$ MPa | E GPa | $\delta_{at}$ breake % |
|---|---|---|---|---|
| Jute | 25-200 | 393-773 | 13-26.5 | 1.16-1.5 |
| Flax | 10-40 | 600-2000 | 12-85 | 1-4 |
| Sisal | 50-200 | 468-640 | 9.4-22 | 3-7 |
| Coir | 100-450 | 131-175 | 4-6 | 15-40 |
| Rau-date.palm fiber | 100-1000 | 58-203 | 2-7.5 | 5-10 |

**$\sigma_u$=tensile strength, $\delta$ =elongation, ϕ=diameter, E=Young's modulus**

Fig. 1. Photograph of a) date palm tree b) stems surrounding by fibre c) fibres [24]

Fig. 2. a) Fibre bundles b) Fibre chopped [24]

## 2.2.Prpration Sample compaction molding

Firstly ,prepare The DPT powder then mixed with epoxy resin with percentage 1:2 % for each weight respect by using compaction molding technique. we note putting thin aluminum foil surrounding the paste and inside wall of the mold frame as a release agent, the dimension of steel mold frame is 300 × 200 mm × 10 mm depth (see Fig. 3). Then putting the paste inter the mold and spread till required depth and covering with aluminum foil upper surface of the past .Then put a block steel cover with thickness 3mm to close external surface of mold frame with small clearance to prevent any leakage by using aluminum foil cover surrounded under block steel cover .Also used cover of leather to close any holes in body of mold frame to prevent epoxy leakage .Then pressed the paste in mold frame by starting compaction molding technique using manual hydraulic press under 3ton load and its maximum capacity is 5 ton .After many trial ,these condition are chosen to get the best working parameters and kept the pressed paste in room temperature for 48 hours .Then exit the product out mold frame .The dummy bloock dimension as 279mm X 197 mm x 10mm (see Fig. 3-b).[ 24].

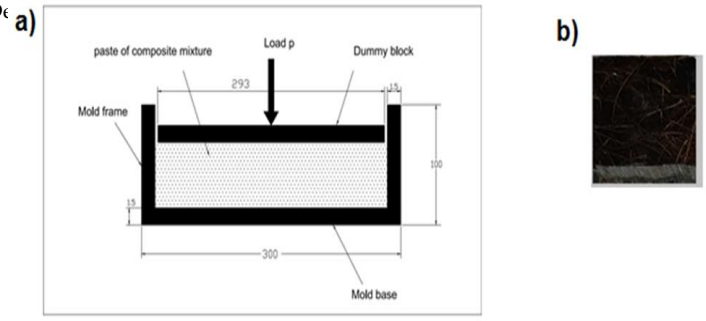


Fig. 3 Compaction molding

## 2.3. Mechanical testing

The bending tests are carried out according to and ASTM D790 – 10 [25] for both previous cases. The tests are performed at universal testing machine (machine model WDW-100) of load capacity 200 kN as shown in Fig.5. and at a controlled speed of 1 mm/min. Figs. 4-a,b. show standard bending specimen geometry fo r bending.[ 24]

$$_b = (3p\,l) / (2w\,h^2) \quad \ldots . (eq\ 1)$$

Where p maximum bending force, l beam length

$$l = L1, \quad \ldots (eq2)$$

$$L1 = L2 + 50 \quad \ldots (eq3)$$

$$, L2 = 20h \quad \ldots . (eq4)$$

, (w) specimen width=50mm, (h) thickness.

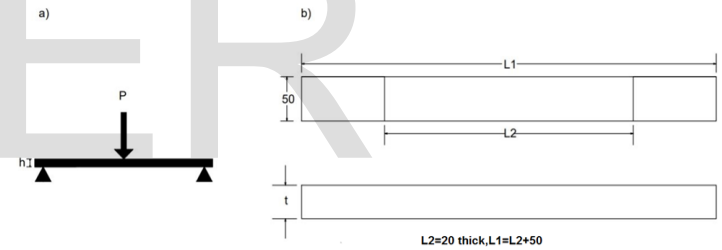


**Fig. 4 .Drawing of three-point bending test a) load set up, b) specimen .**

**Fig.5. Image for bending test machine**

## 2.4.Drop weight impact test

Fiber reinforced epoxy have advantages such as low

specific corrosion and density and high specific modulus and strength ,so that it use in a lot of applications such automobile and transportation .Very important to get high quality results in mechanical properties for this material ,so must be design a best mechanism as standard test.. DPTF reinforced epoxy have energy absorption capacity can be calculated by toughness test in the form of impact test .Generally, impact test have common ways such as Charpy and Izode tests ,they have several restrictions including the necessity of using notch in the specimen and limitation on the magnitude of applied load . In my study, Drop Weight Impact Testing (DWIT) is the way used in impact test [26] . Drop Weight Impact Testing depend on falling a weight on the specimen to measure energy absorption capacity of materials. continue adding impact loads, found a different responses in DPTF reinforced epoxy with metal 's weight in form of deformation for specimen surface. The different modes of failure occurs in specimen such as matrix cracking , delamination and fiber breakage that follow because of applied metal's weight in impact test with different falling for weight. This may be attributed to the fact that, in metals, the impact energy is absorbed by plastic deformation while in composites the energy is absorbed by different failure modes [23].

The details of Drop Weight Impact Testing device is shown in Fig.6. It contains two steel rods of 1000 mm long bolted over steel rigid plate the upper end of the rods constrained by a steel beam. The impactor is attached between the two steel rods by a cross steelhead. The cross-steel head was made to can be release and slides over the two rods with the impactor pin to free fallen into the specimen surfaces. The penetration occurs on specimen surface in form a indentation depth is measured. The indentation depth is a measure to the energy absorption through the material. The law of energy conservation is allied to measure the fallen load velocity and time of strike. The specimen dimensions are square of 30 mm length of the three tested material of stacking sequence of DPT fiber reinforced epoxy. Three different heights used for falling are 0.5, 1, and 1.5 meters and the metal's weights are 0.5and 1 Kg .

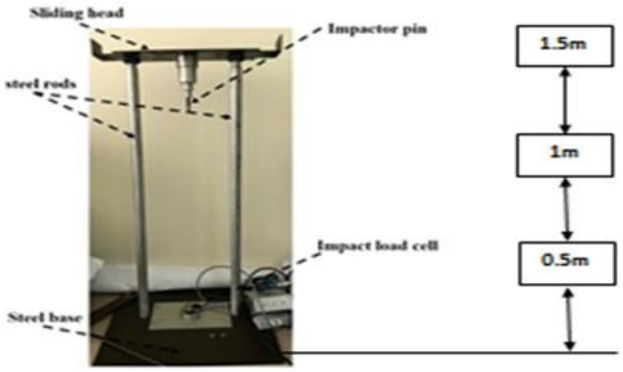


Fig.6. Simple drop weight impact tester [24]

## 3. Results and discussion

### 3.1. Bending test

It observed from.Fig.11. to. Fig.13. specimen DPT treatment with HCL,CH3COOH and NAOH at boiling points 1hr,2hr ,that bending load for specimen at boiling point 2hr more than other specimen treatment at boiling point 1hr ,this due to adhesion matrix ,bridging DPT with resin at this case .it observed maximum bending load at DPT treatment NAOH at concentration 50% ,this is matrix cohesion , high stiffness between DPT and risen and so on HCL 50% for 2hr .

It is observed from Fig.7 to Fig.10.that the delamination also can be attributed to the fact that epoxy resin has better diffusability and debondability adhesive used in manufacturing the DPT .It observed transfers crack (that mean crack continue around specimen )in the risen Several models have been proposed for a polymer composite system in which a crack initiates in the matrix. For a given composite fiber reinforced where the fibre is gripped by the polymer matrix, a matrix crack is halted by fiber. Upon increasing the load, crack starts to pass around the fiber without breaking the interfacial bond. Interfacial shearing and lateral contraction of the fibre result in de-bonding and a further increment of crack extension. After considerable de-bonding the fibres break at some weak points within the matrix and further crack extension occurs. The total failure of the composite happens when the broken fibre end is pulled out against the frictional grip of the matrix [27].

It observed that Delamination is separation of adjacent layers due to weakening of interface layer between them and it is mode of failure when a material fracture into layers ,in composite material and delamination the adhesion between layers of DPTF and risen ,often faills first causing the separation for DPTF and risen .The causes of delamination is loading generat-

ing transvers stresses the interface and it is weaker in transvers strength as compared to the layers ,hence its failure is dominated by the transverse stresses. It observed that found Adhesive fracture due to the fracture occurring in the matrix does not result in DPTF breaking but only slight fiber /matrix detachment. Longitudinal crack in resin is a transverse crack and usually caused by shrinkage stresses in high constraint area.

This table 3 presents comparison different flexural stress and flexural young's modulus of bending test calculation (MPa)for different treatment DPTF reinforced epoxy

Table 3 comparison the flexural strength of bending test of Date Palm tree fiber reinforced epoxy with stander deviationand young's modulus

| Specimens with treatments | Averagethe flexural.strength of.bendingtest (MPa) | S. D | Elastic Modulus, E (GPa) |
|---|---|---|---|
| **(HCl 10% 1hr)** | 11.58 | 2.95 | 1.6 |
| **(HCl 10% 2hr)** | 12.79 | 3.29 | 2.4 |
| **(HCl 20% 1hr)** | 11.44 | 2.98 | 8.35 |
| **(HCl 20% 2hr)** | 12.6 | 3.24 | 3.075 |
| **(HCl 50% 1hr)** | 15.22 | 3.85 | 0.8 |
| **(HCl50% 2hr)** | 17.91 | 4.48 | 12.1 |
| **(Acetic acid 10% 1hr)** | 14.22 | 3.61 | 31.4 |
| **(Acetic acid 10% 2hr)** | 15.35 | 3.88 | 3.9 |
| **(Acetic acid 20% 1hr)** | 11.77 | 3.05 | 2.5 |
| **(Acetic acid 20% 2hr)** | 14.16 | 3.6 | 9.01 |
| **(Acetic acid 50% 1hr)** | 12.25 | 3.16 | 5.7 |
| **(Acetic acid 50% 2hr)** | 15.3 | 3.86 | 1.7 |
| **(Na OH 10% 1hr)** | 12.52 | 3.23 | 16 |
| **(Na OH 10% 2hr)** | 12.68 | 3.26 | 1.5 |
| **(Na OH 20% 1hr)** | 12.6 | 3.24 | 10.7 |
| **(Na OH 20% 2hr)** | 13.46 | 3.44 | 5.17 |
| **(Na OH 50%1 hr)** | 16.72 | 4.2 | 15.6 |
| **(Na OH 50%2 hr)** | 18.29 | 4.57 | 6.34 |

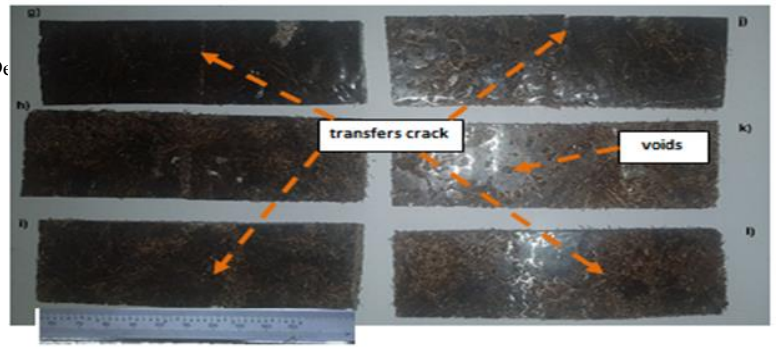


**Fig .8. Modes of failure with matrix cracking (from a to f) .( CH3COOH, concentration 10%,20%,50%,for boiling 1hr and 2hr ,respectly)**

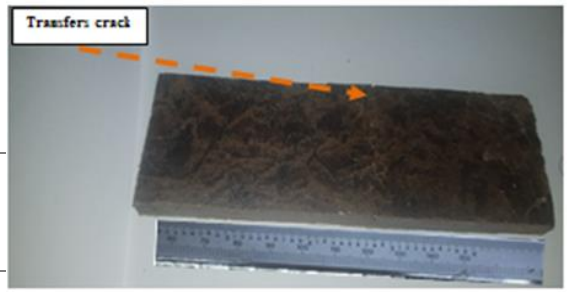


**Fig.9. Modes of failure with matrix cracking .( HCL, concentration 50%,for boiling 1hr )**

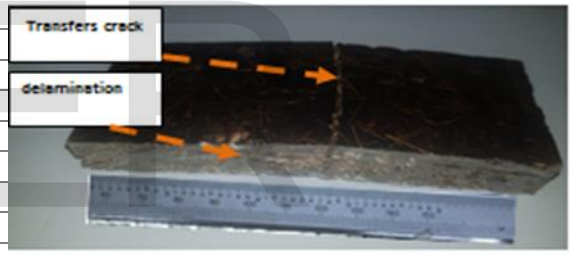


**Fig.10. Modes of failure with matrix cracking .( HCL, concentration 20%,for boiling 1hr**

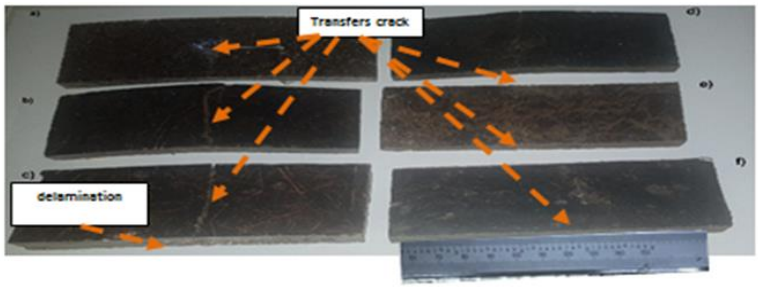


**Fig.7. Modes of failure with matrix cracking (from a to f) .(Hcl concentration 10%,20%,50%,for boiling 1hr and 2hr ,respectly)**

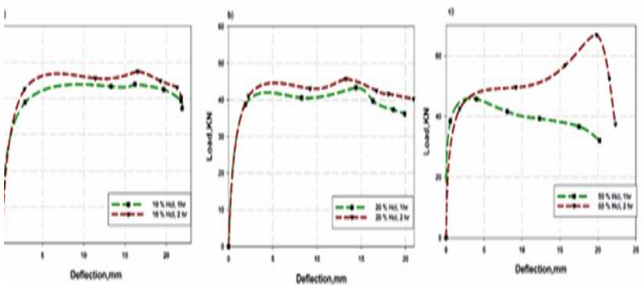

**Fig.11. Load deflection relation of DPTRE at HCL treatment at a) 10% b) 20 % c) 50 %**

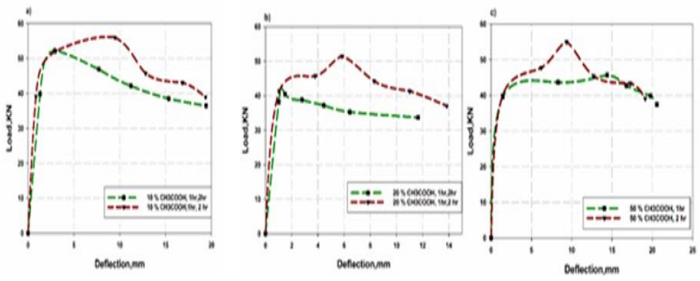

**Fig.12. Load deflection relation of DPTRE at CH3COOH treatment at a) 10% b) 20 % c)50%**

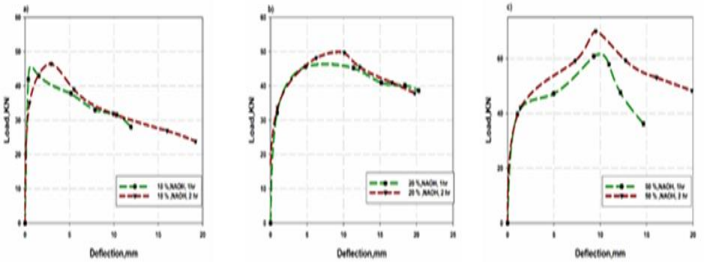

**Fig .13. Load deflection relation of DPTRE at NAOH treatment at a) 10% b) 20 % c) 50 %**

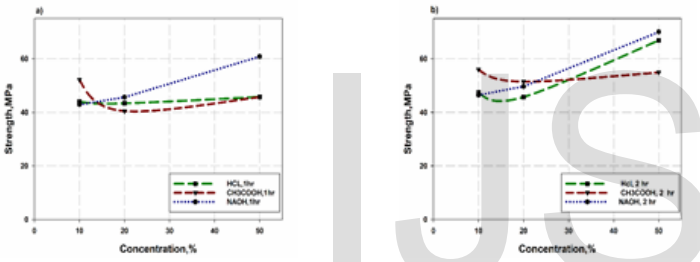

**Fig.14. Strength -concentration for HCL,CH3COOH and NAOH relation at 1 hr,2hr**

### 3.2. Drop weight impact test

Fig.21 to Fig. 23 show impact velocity of fallen loads(0.5 kg and 1kg) and different fallen distant(0.5 m ,1m and 1.5 m) over the surface of DPT fiber reinforced epoxy for concentration HCL,CH3COOH and NAOH 10%,20% and 50% for boiling 1hr ,2hr respectly, it is observed that depth of the indentation through the thickness increases with increasing velocities, this is due to increase of impact movement energy (K.E=1/2 m $v^2$) which some of these energy stored through the specimen in form of crack depth, and others went in impact noise and temperature. The depth gives light increase with increasing load than the velocity, this may be due to energy change just one time with the velocity. The depth of indentation may be taken as a measurement to the stored energy through material. Therefore ,some of the specimen nearly give same tend at boiling 1hr and 2hr with different mass ,(Fig.21. c,d,e),(Fig.22. a,b,c,d,e,f),(Fig.23. d) but other specimen the different increase with impact mass increase and for boiling 1hr,2hr. It is observed that depth of the indentation through the thickness decreases with increasing boiling for treatment from 1hr to 2hr as (Fig.21 b,c,d,e,f ),(Fig.22),(Fig.23 a,b,d,e,f) and this due to good adhesion in matrix between DPT and epoxy .Composite material gives different behavior than metal under impact load. The elastic response in Metal under impact load was getting short, while plastic deformation is long. Whereas, in composite elastic response then softening with different shape of failure modes were occurs, such as delamination, bridging, and matrix cracking. Thus the absorption energy in metal dissipated in plastic deformation while in composite material the energy was observed in many failure modes [23] This may be attributed to the fact that, in metals, the impact energy is absorbed by plastic deformation while in composites the energy is absorbed by different failure modes [23].

Velocity(V) = falling distance(m) / Time(s)

$$v = d/t \quad \ldots.(eq5)$$

Potential energy(P.E) = m (kg) * g (gravity m/s) * h(Hight of weight before falling) (m)

$$P.E = m.g.h \quad \ldots..(eq6)$$

KineticEnrgy(K.E)(Joule)$=1/2\{m(kg) * v^2 (m^2/s^2)\}$

$$K.E = 1/2\,(m.v^2) \quad \ldots\ldots(eq.7)$$

**Table 4 comparison the crack depth(mm) and Velocity (m/s) in variable each Falling distance(m) ,Weight (kg) and time(s)with stander deviation and**

| Specimen | Falling distance(m) | Weight (kg) | time(s) | Velocity (m/s) | crack depth(mm) | Stored energy ,K.E (Joule) | SD (crack depth) |
|---|---|---|---|---|---|---|---|
| (HCL 10% 1hr) | 1.5 | 1 | 0.9 | 8.829 | 1.75 | 38.97 | 1.224 |
| (HCL 10% 1hr) | 1 | 1 | 0.7 | 6.867 | 1.3 | 23.57 | 1 |
| HCL 10% 1hr) | 0.5 | 1 | 0.23 | 2.2563 | 0.9 | 2.64 | 0.707 |
| HCL 10% 1hr) | 1.5 | 0.5 | 0.91 | 8.9271 | 1.1 | 19.92 | 1.224 |
| HCL 10% 1hr) | 1 | 0.5 | 0.89 | 8.7689 | 0.85 | 11.45 | 1 |
| (HCL 10% 1hr) | 0.5 | 0.5 | 0.21 | 2.0601 | 0.5 | 1.06 | 0.707 |
| (HCL 10% 2hr) | 1.5 | 1 | 0.9 | 8.829 | 1 | 38.97 | 1.224 |
| (HCL 10% 2hr) | 1 | 1 | 0.899 | 8.85719 | 0.8 | 23.61 | 1 |
| (HCL 10% 2hr) | 0.5 | 1 | 0.233 | 2.28573 | 0.3 | 2.61 | 0.707 |
| (HCL 10% 2hr) | 1.5 | 0.5 | 0.94 | 9.2214 | 1.7 | 21.25 | 1.224 |
| (HCL 10% 2hr) | 1 | 0.5 | 0.88 | 8.4748 | 1.25 | 10.45 | 1 |
| HCL 10% 2hr) | 0.5 | 0.5 | 0.24 | 8.829 | 0.8 | 1.33 | 0.707 |
| HCL 20% 1hr) | 1.5 | 1 | 0.91 | 8.887 | 1.87 | 38.84 | 1.224 |
| (HCL 20% 1hr) | 1 | 1 | 0.71 | 2.3544 | 1.35 | 24.25 | 1 |
| (HCL 20% 1hr) | 0.5 | 1 | 0.22 | 8.9271 | 0.85 | 2.32 | 0.707 |
| (HCL 20% 1hr) | 1.5 | 0.5 | 0.92 | 8.9951 | 1.45 | 20.38 | 1.224 |
| (HCL 20% 1hr) | 1 | 0.5 | 0.75 | 2.1682 | 0.95 | 13.63 | 1 |
| (HCL 20% 1hr) | 0.5 | 0.5 | 0.23 | 9.0262 | 0.85 | 1.27 | 0.707 |
| (HCL 20% 2hr) | 1.5 | 1 | 0.89 | 7.3675 | 1.85 | 38.11 | 1.224 |
| (HCL 20% 2hr) | 1 | 1 | 0.71 | 2.2563 | 1.23 | 24.25 | 1 |
| (HCL 20% 2hr) | 0.5 | 1 | 0.22 | 8.7309 | 0.82 | 2.32 | 0.707 |
| (HCL 20% 2hr) | 1.5 | 0.5 | 0.9 | 8.9951 | 1.15 | 19.48 | 1.224 |
| (HCL 20% 2hr) | 1 | 0.5 | 0.71 | 2.1682 | 0.89 | 12.12 | 1 |
| (HCL 20% 2hr) | 0.5 | 0.5 | 0.28 | 8.829 | 0.45 | 1.82 | 0.707 |
| (HCL 60% 1hr) | 1.5 | 1 | 0.91 | 8.9271 | 1.25 | 38.48 | 1.224 |
| (HCL 60% 1hr) | 1 | 1 | 0.71 | 8.9951 | 1.19 | 24.25 | 1 |
| (HCL 60% 1hr) | 0.5 | 1 | 0.22 | 2.1682 | 0.9 | 2.32 | 0.707 |
| (HCL 60% 1hr) | 1.5 | 0.5 | 0.89 | 8.7309 | 1.1 | 19.05 | 1.224 |
| (HCL 60% 1hr) | 1 | 0.5 | 0.7 | 6.867 | 0.95 | 11.78 | 1 |
| (HCL 60% 1hr) | 0.5 | 0.5 | 0.21 | 2.0601 | 0.8 | 1.06 | 0.707 |
| (HCL 60% 2hr) | 1.5 | 1 | 0.91 | 8.9271 | 0.9 | 38.48 | 1.224 |
| (HCL 60% 2hr) | 1 | 1 | 0.7 | 6.867 | 0.7 | 23.57 | 1 |
| (HCL 60% 2hr) | 0.5 | 1 | 0.21 | 2.0601 | 0.6 | 2.12 | 0.707 |
| (HCL 60% 2hr) | 1.5 | 0.5 | 0.9 | 8.829 | 1.2 | 19.48 | 1.224 |
| (HCL 60% 2hr) | 1 | 0.5 | 0.7 | 6.867 | 0.9 | 11.78 | 1 |
| (HCL 60% 2hr) | 0.5 | 0.5 | 0.23 | 2.2563 | 0.85 | 1.27 | 0.707 |
| (Acitic acid 10% 1hr) | 1.5 | 1 | 0.89 | 8.7309 | 1.88 | 38.11 | 1.224 |
| (Acitic acid 10% 1hr) | 1 | 1 | 0.88 | 8.7689 | 1.42 | 22.9 | 1 |
| (Acitic acid 10% 1hr) | 0.5 | 1 | 0.28 | 2.5508 | 1.14 | 3.25 | 0.707 |
| (Acitic acid 10% 1hr) | 1.5 | 0.5 | 0.92 | 9.0262 | 1.3 | 20.38 | 1.224 |
| (Acitic acid 10% 1hr) | 1 | 0.5 | 0.7 | 6.867 | 0.89 | 11.78 | 1 |
| (Acitic acid 10% 1hr) | 0.5 | 0.5 | 0.21 | 2.0601 | 0.75 | 1.06 | 0.707 |
| (Acitic acid 10% 2hr) | 1.5 | 1 | 0.9 | 8.829 | 1.24 | 38.97 | 1.224 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (Acitic acid 10% 2hr) | 1 | 1 | 0.7 | 6.867 | 1.35 | 23.57 | 1 |
| (Acitic acid 10% 2hr) | 0.5 | 1 | 0.29 | 2.8443 | 1.15 | 4.04 | 0.707 |
| (Acitic acid 10% 2hr) | 1.5 | 0.5 | 0.9 | 8.829 | 1.34 | 19.48 | 1.224 |
| (Acitic acid 10% 2hr) | 1 | 0.5 | 0.7 | 6.867 | 0.95 | 11.78 | 1 |
| (Acitic acid 10% 2hr) | 0.5 | 0.5 | 0.22 | 2.1582 | 0.7 | 1.16 | 0.707 |
| (Acitic acid 20% 1hr) | 1.5 | 1 | 0.9 | 8.829 | 1.33 | 38.97 | 1.224 |
| (Acitic acid 20% 1hr) | 1 | 1 | 0.69 | 6.7689 | 0.9 | 22.9 | 1 |
| (Acitic acid 20% 1hr) | 0.5 | 1 | 0.22 | 2.1582 | 0.65 | 2.32 | 0.707 |
| (Acitic acid 20% 1hr) | 1.5 | 0.5 | 0.91 | 8.9271 | 0.95 | 19.92 | 1.224 |
| (Acitic acid 20% 1hr) | 1 | 0.5 | 0.7 | 6.867 | 0.75 | 11.78 | 1 |
| (Acitic acid 20% 1hr) | 0.5 | 0.5 | 0.23 | 2.2563 | 0.35 | 1.27 | 0.707 |
| (Acitic acid 20% 2hr) | 1.5 | 1 | 0.9 | 8.829 | 0.92 | 38.97 | 1.224 |
| (Acitic acid 20% 2hr) | 1 | 1 | 0.7 | 6.867 | 0.8 | 23.57 | 1 |
| (Acitic acid 20% 2hr) | 0.5 | 1 | 0.28 | 2.7468 | 0.6 | 3.77 | 0.707 |
| (Acitic acid 20% 2hr) | 1.5 | 0.5 | 0.9 | 8.829 | 0.85 | 19.48 | 1.224 |
| (Acitic acid 20% 2hr) | 1 | 0.5 | 0.7 | 6.867 | 0.65 | 11.78 | 1 |
| (Acitic acid 20% 2hr) | 0.5 | 0.5 | 0.21 | 2.0601 | 0.35 | 1.06 | 0.707 |
| (Acitic acid 50% 1hr) | 1.5 | 1 | 0.9 | 8.829 | 1.14 | 38.97 | 1.224 |
| (Acitic acid 50% 1hr) | 1 | 1 | 0.7 | 6.867 | 1.55 | 23.57 | 1 |
| (Acitic acid 50% 1hr) | 0.5 | 1 | 0.21 | 2.0601 | 1.25 | 2.12 | 0.707 |
| (Acitic acid 50% 1hr) | 1.5 | 0.5 | 0.9 | 8.829 | 0.8 | 19.48 | 1.224 |
| (Acitic acid 50% 1hr) | 1 | 0.5 | 0.7 | 6.867 | 0.97 | 11.78 | 1 |
| (Acitic acid 50% 1hr) | 0.5 | 0.5 | 0.22 | 2.1582 | 0.65 | 1.16 | 0.707 |
| (Acitic acid 50% 2hr) | 1.5 | 1 | 0.9 | 8.829 | 0.35 | 39.97 | 1.224 |
| (Acitic acid 50% 2hr) | 1 | 1 | 0.7 | 6.867 | 1.35 | 23.57 | 1 |
| (Acitic acid 50% 2hr) | 0.5 | 1 | 0.2 | 1.962 | 1.16 | 1.92 | 0.707 |
| (Acitic acid 50% 2hr) | 1.5 | 0.5 | 0.9 | 8.829 | 0.85 | 19.48 | 1.224 |
| (Acitic acid 50% 2hr) | 1 | 0.5 | 0.7 | 6.867 | 1.14 | 11.78 | 1 |
| (Acitic acid 50% 2hr) | 0.5 | 0.5 | 0.21 | 2.0601 | 0.75 | 1.06 | 0.707 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (NA OH 10% 1hr) | 1.5 | 1 | 0.9 | 8.829 | 0.43 | 38.97 | 1.2247449 |
| (NA OH 10% 1hr) | 1 | 1 | 0.7 | 6.867 | 3.7 | 23.57 | 1 |
| (NA OH 10% 1hr) | 0.5 | 1 | 0.21 | 2.0601 | 2.8 | 2.12 | 0.7071068 |
| (NA OH 10% 1hr) | 1.5 | 0.5 | 0.9 | 8.829 | 2 | 19.48 | 1.2247449 |
| (NA OH 10% 1hr) | 1 | 0.5 | 0.7 | 6.867 | 1.5 | 11.78 | 1 |
| (NA OH 10% 1hr) | 0.5 | 0.5 | 0.2 | 1.962 | 1 | 0.96 | 0.7071068 |
| (NA OH 10% 2hr) | 1.5 | 1 | 0.9 | 8.829 | 1 | 38.97 | 1.2247449 |
| (NA OH 10% 2hr) | 1 | 1 | 0.72 | 7.0632 | 0.97 | 24.54 | 1 |
| (NA OH 10% 2hr) | 0.5 | 1 | 0.26 | 2.5506 | 0.75 | 3.25 | 0.7071068 |
| (NA OH 10% 2hr) | 1.5 | 0.5 | 0.9 | 8.829 | 0.5 | 19.48 | 1.2247449 |
| (NA OH 10% 2hr) | 1 | 0.5 | 0.7 | 6.867 | 0.8 | 11.78 | 1 |
| (NA OH 10% 2hr) | 0.5 | 0.5 | 0.23 | 2.2563 | 0.45 | 1.27 | 0.7071068 |
| (NA OH 20% 1hr) | 1.5 | 1 | 0.9 | 8.829 | 1.45 | 38.97 | 1.2247449 |
| (NA OH 20% 1hr) | 1 | 1 | 0.7 | 6.867 | 1.15 | 23.57 | 1 |
| (NA OH 20% 1hr) | 0.5 | 1 | 0.21 | 2.0601 | 0.85 | 2.12 | 0.7071068 |
| (NA OH 20% 1hr) | 1.5 | 0.5 | 0.9 | 8.829 | 0.9 | 19.48 | 1.2247449 |
| (NA OH 20% 1hr) | 1 | 0.5 | 0.7 | 6.867 | 0.6 | 11.78 | 1 |
| (NA OH 20% 1hr) | 0.5 | 0.5 | 0.21 | 2.0601 | 0.3 | 1.06 | 0.7071068 |
| (NA OH 20% 2hr) | 1.5 | 1 | 0.9 | 8.829 | 1.25 | 38.97 | 1.2247449 |
| (NA OH 20% 2hr) | 1 | 1 | 0.69 | 6.7689 | 1.1 | 22.9 | 1 |
| (NA OH 20% 2hr) | 0.5 | 1 | 0.23 | 2.2563 | 0.75 | 2.54 | 0.7071068 |
| (NA OH 20% 2hr) | 1.5 | 0.5 | 0.9 | 8.829 | 0.97 | 19.48 | 1.2247449 |
| (NA OH 20% 2hr) | 1 | 0.5 | 0.7 | 6.867 | 0.8 | 11.78 | 1 |
| (NA OH 20% 2hr) | 0.5 | 0.5 | 0.21 | 2.0601 | 0.45 | 1.06 | 0.7071068 |
| (NA OH 50%1 hr) | 1.5 | 1 | 0.9 | 8.829 | 1.89 | 38.97 | 1.2247449 |
| (NA OH 50%1 hr) | 1 | 1 | 0.7 | 6.867 | 1.45 | 23.57 | 1 |
| (NA OH 50%1 hr) | 0.5 | 1 | 0.22 | 2.1582 | 0.95 | 2.32 | 0.7071068 |
| (NA OH 50%1 hr) | 1.5 | 0.5 | 0.9 | 8.829 | 1.75 | 19.48 | 1.2247449 |
| (NA OH 50%1 hr) | 1 | 0.5 | 0.7 | 6.867 | 1.4 | 11.78 | 1 |
| (NA OH 50%1 hr) | 0.5 | 0.5 | 0.23 | 2.2563 | 0.9 | 1.27 | 0.7071068 |
| (NA OH 50%2 hr) | 1.5 | 1 | 0.9 | 8.829 | 2.6 | 38.97 | 1.2247449 |
| (NA OH 50%2 hr) | 1 | 1 | 0.7 | 6.867 | 1.95 | 23.57 | 1 |
| (NA OH 50%2 hr) | 0.5 | 1 | 0.21 | 2.0601 | 1 | 2.12 | 0.7071068 |
| (NA OH 50%2 hr) | 1.5 | 0.5 | 0.9 | 8.829 | 0.95 | 19.48 | 1.2247449 |
| (NA OH 50%2 hr) | 1 | 0.5 | 0.7 | 6.867 | 0.6 | 11.78 | 1 |
| (NA OH 50%2 hr) | 0.5 | 0.5 | 0.21 | 2.0601 | 0.35 | 1.06 | 0.7071068 |

**Fig.15.Circle point damage through the surface for HCL,(concentration10%,boiling 2hr) .a)m =1kg,h =0.5m , b) )m =1kg, h =1m ,c) )m =1kg, h= 1.5m , d) )m=0.5 kg, h= o.5m ,e) )m= 0.5kg, h= 1m, ,f) )m= 0.5kg, h =1.5m**

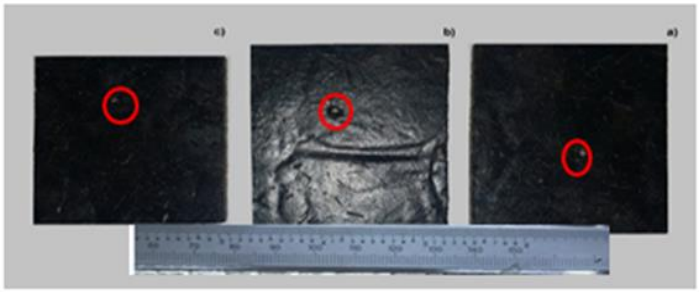

**Fig.16.Circle point damage through the surface for HCL,(concentration20%,boiling 2hr) a) m= 1kg, h= 0.5m , b) m=1kg, h= 1m , c) m=1kg, h= 1.5m ,**

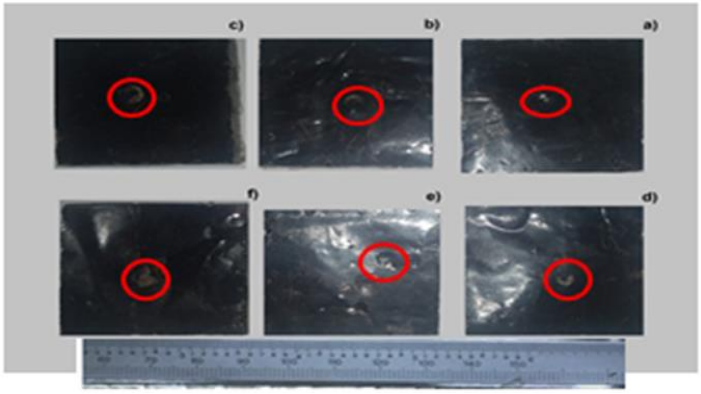


**Fig.17.Circle point damage through the surface for HCL,(concentration50%,boiling 1hr) .a) m= 1kg, h=0.5m ,b) m =1kg, h= 1m ,c) m= 1kg, h= 1.5m , d) m= 0.5 kg, h= o.5m ,e) m= 0.5kg, h= 1m, ,f) m=0.5kg, h=1.5m**

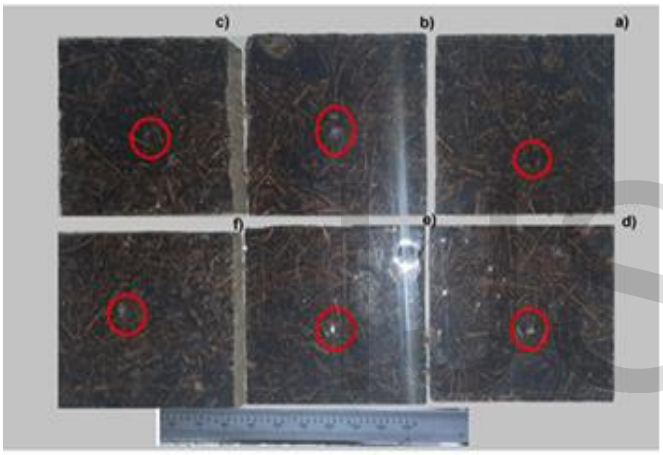


**Fig.18.Circle point damage through the surface for CH3COOH,(concentration20%,boiling 2hr) .a) m= 1kg, h=0.5m ,b) m= 1kg, h= 1m ,c) m= 1kg, h= 1.5m , d) m= 0.5 kg, h= o.5m , e) m= 0.5kg, h= 1m, , f) m=0.5kg, h= 1.5m**

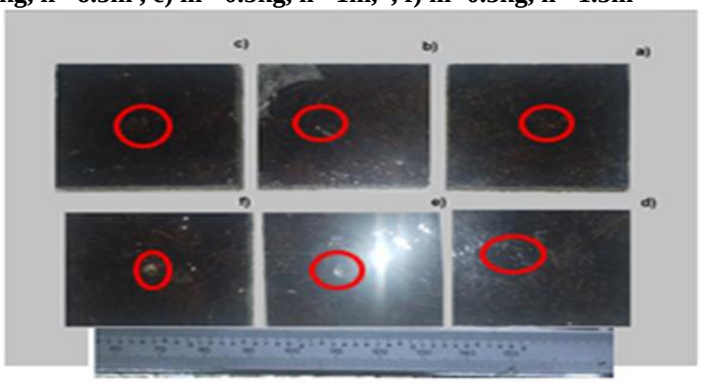


**Fig.19.Circle point damage through the surface for NAOH,(concentration10%,boiling 1hr).a) m 1kg, h 0.5m ,b) m1kg, h1m ,c) m1kg, h 1.5m , d) m0.5 kg, h o.5m , e) m 0.5kg, h 1m ,f) m 0.5kg, h 1.5m**

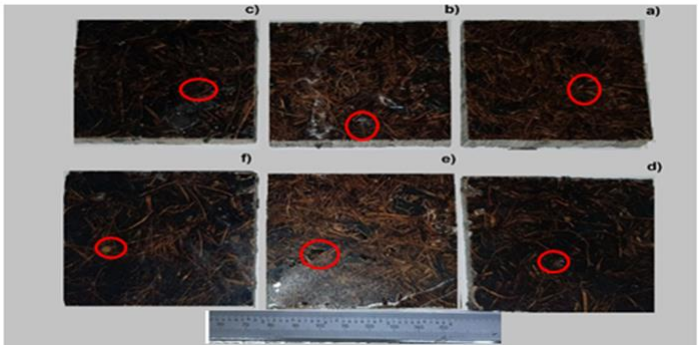


**Fig.20.Circle point damage through the surface for NAOH,(concentration50%,boiling 2hr a) m=1kg, h= 0.5m ,b) m=1kg, h=1m ,c) m= 1kg, h=1.5m ,d) m= 0.5 kg, h= o.5m ,e) m= 0.5kg, h=1m, ,f) m=0.5kg, h=1.5m**

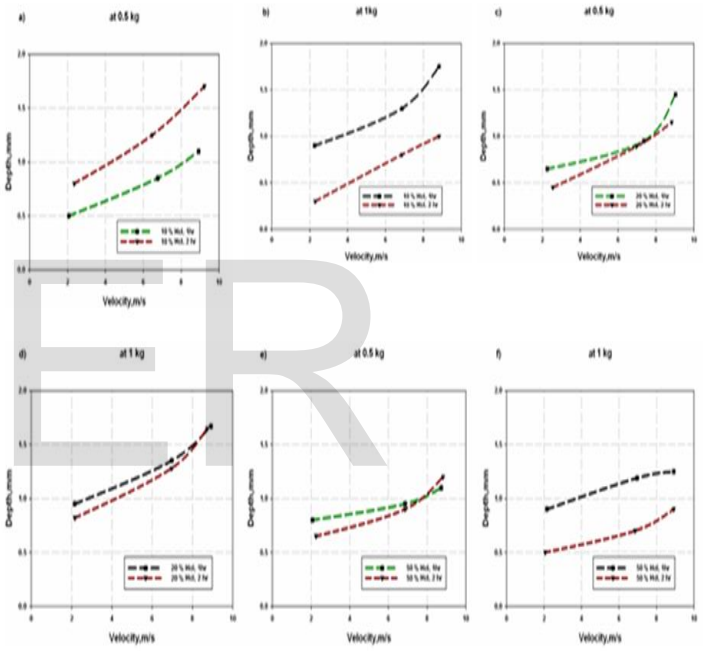


**Fig.21. Penetration of damage variation with impact strike velocity for HCL without rubber curves for concentration 10%,20%,50% for boiling 1hr,2hr**

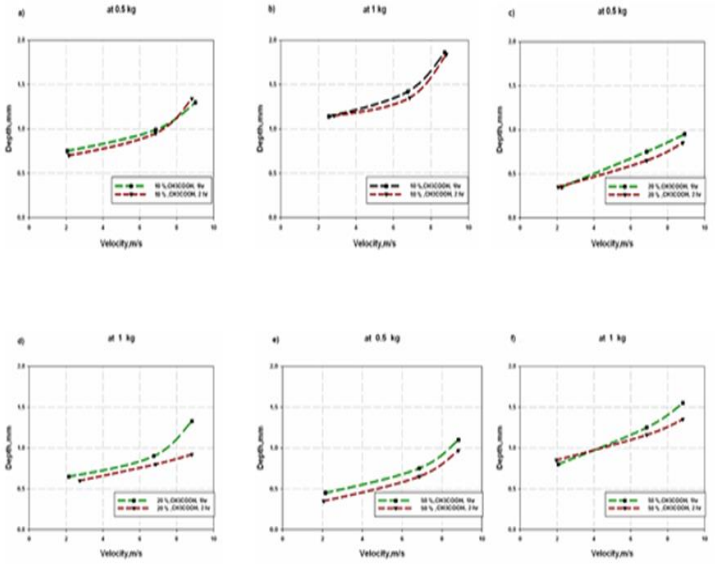

**Fig.22. Penetration of damage variation with impact strike velocity for CH3COOH without rubber curves for concentration 10%,20%,50% for boiling 1hr,2hr.**

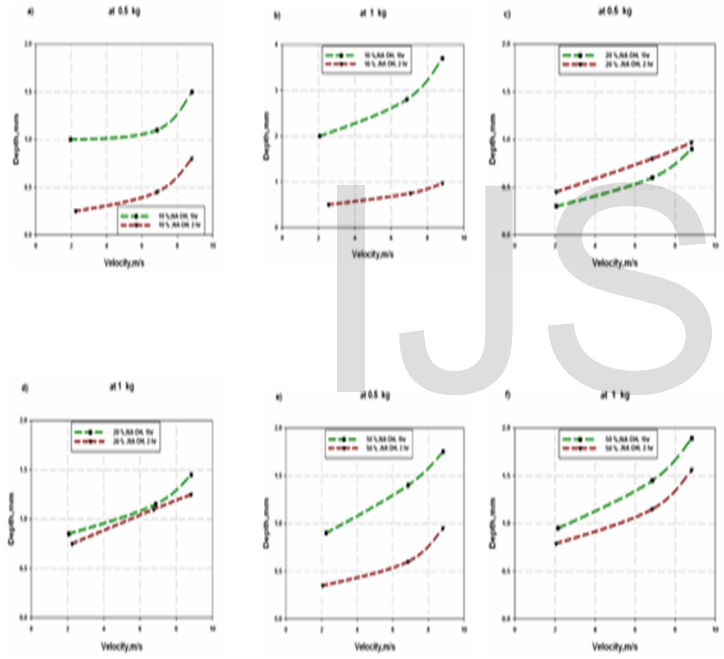

**Fig.23. Penetration of damage variation with impact strike velocity for NAOH without rubber curves for concentration 10%,2 0%,50% for boiling 1hr,2hr**

## Conclusion:

Date palm tree fibres (DPTF) are used as a natural reinforcement to be an attractive agent in the composite material industry. The chemical treatments program which was introduced in the present paper gives a good enhancement for the date palm tree fibres reinforced epoxy which enhancement their debondablty with the epoxy resin. The tensile properties of a composite reinforced by DPTFs which has been treatment by HCL chemically give better results and are more compatible adhesive with the polymer matrix in all concentration and time period, although they give quite little strength, while in other NaOH and CH3COOH the fibre fractured, therefore, the strength sharply decreases. The same results are concluded for fracture toughness which gives their relationship with the composite tensile strength.

## References


[1] H. Kaddami, A. Dufresne, B. Khelifi, A. Bendahou, M. Taourirte, M. Raihane, *et al.*, "Short palm tree fibers – Thermoset matrices composites," *Composites Part A: Applied Science and Manufacturing*, vol. 37, pp. 1413-1422, 2006.

[2] B. Abu-Sharkh and H. Hamid, "Degradation study of date palm fibre/polypropylene composites in natural and artificial weathering: mechanical and thermal analysis," *Polymer Degradation and Stability*, vol. 85, pp. 967-973, 2004.

[3] S. Mahdavi, H. Kermanian, and A. Varshoei, "Comparison of mechanical properties of date palm fiber-polyethylene composite," *BioResources*, vol. 5, pp. 2391-2403, 2010.

[4] M. Asadzadeh, "Bending properties of date palm fiber and jute fiber reinforced polymeric composite," *International Journal of Advanced Design and Manufacturing Technology*, vol. 5, p. 59, 2012.

[5] A. A. Betelie, Y. T. Megera, D. T. Redda, and A. Sinclair, "Experimental investigation of fracture toughness for treated sisal epoxy composite," *AIMS MATERIALS SCIENCE*, vol. 5, pp. 93-104, 2018.

[6] I. B. Amor, Z. Ghallabi, H. Kaddami, M. Raihane, M. Arous, and A. Kallel, "Experimental study of relaxation process in unidirectional (epoxy/palm tree fiber) composite," *Journal of Molecular Liquids*, vol. 154, pp. 61-68, 2010.

[7] F. M. Al-Oqla and S. M. Sapuan, "Natural fiber reinforced polymer composites in industrial applications: feasibility of date palm fibers for sustainable automotive industry," *Journal of Cleaner Production*, vol. 66, pp. 347-354, 2014.

[8] N. Srinivasababu, J. S. Kumar, and K. V. K. Reddy, "Manufacturing and Characterization of Long Palmyra Palm/Borassus Flabellifer Petiole Fibre Reinforced Polyester Composites," *Procedia Technology*, vol. 14, pp. 252-259, 2014.

[9] V. K. Thakur and M. K. Thakur, "Processing and characterization of natural cellulose fibers/thermoset polymer composites," *Carbohydr Polym*, vol. 109, pp. 102-17, Aug 30 2014.

[10] D. A. R. Mahmoud, "Utilization of Palm Wastes for Production of Invert Sugar," *Procedia*

*Environmental Sciences*, vol. 34, pp. 104-118, 2016.

[11] T. Masri, H. Ounis, L. Sedira, A. Kaci, and A. Benchabane, "Characterization of new composite material based on date palm leaflets and expanded polystyrene wastes," *Construction and Building Materials*, vol. 164, pp. 410-418, 2018.

[12] T. Alsaeed, B. F. Yousif, and H. Ku, "The potential of using date palm fibres as reinforcement for polymeric composites," *Materials & Design*, vol. 43, pp. 177-184, 2013.

[13] F. A. Al-Sulaiman, "Mechanical properties of date palm fiber reinforced composites," *Applied Composite Materials*, vol. 9, pp. 369-377, 2002.

[14] Y. Mohammed, M. K. Hassan, and A. Hashem, "Analytical model to predict multiaxial laminate fracture toughness from 0 ply fracture toughness," *Polymer Engineering & Science*, vol. 54, pp. 234-238, 2014.

[15] Y. Mohammed, M. K. Hassan, and A. Hashem, "Effect of stacking sequence and geometric scaling on the brittleness number of glass fiber composite laminate with stress raiser," *Science and Engineering of Composite Materials*, vol. 21, pp. 281-288, 2014.

[16] M. K. Hassan, M. Y. Abdellah, S. K. Azabi, and W. Marzouk, "Fracture Toughness of a Novel GLARE Composite Material," 2015.

[17] K. H. Mohamed, Y. A. Mohammed, S. Azabi, K., and W. W. Marzouk, "Investigation of the Mechanical Behavior of Novel Fiber Metal Laminates," *International Journal of Mechanical & Mechatronics Engineering IJMME-IJENS*, vol. 15, pp. 112-118, 2015.

[18] L. Liu, B.-M. Zhang, D.-F. Wang, and Z.-J. Wu, "Effects of cure cycles on void content and mechanical properties of composite laminates," *Composite structures*, vol. 73, pp. 303-309, 2006.

[19] G. Belingardi and R. Vadori, "Low velocity impact tests of laminate glass-fiber-epoxy matrix composite material plates," *International Journal of Impact Engineering*, vol. 27, pp. 213-229, 2002.

[20] T.-W. Shyr and Y.-H. Pan, "Impact resistance and damage characteristics of composite laminates," *Composite structures*, vol. 62, pp. 193-203, 2003.

[21] J. a. Baucom and M. Zikry, "Low-velocity impact damage progression in woven E-glass composite systems," *Composites Part A: Applied Science and Manufacturing*, vol. 36, pp. 658-664, 2005.

[22] W. Ghori, N. Saba, M. Jawaid, and M. Asim, "A review on date palm (phoenix dactylifera) fibers and its polymer composites," *IOP Conference Series: Materials Science and Engineering*, vol. 368, p. 012009, 2018.

[23] F. Taheri-Behrooz, M. Shokrieh, and H. Abdolvand, "Designing and manufacturing of a drop weight impact test machine," *Engineering Solid Mechanics*, vol. 1, pp. 69-76, 2013.

[24] Mohammed Y. Abdellah, Abo-El Hagag A. Tensile and Fracture Properties of Chemically Treatment Date Palm Tree Fibre Reinforced Epoxy

[25] Wisnom, M.R., Khan, B., Hallet, S.R.. Size effects in unnotched tensile strength of unidirectional and quasi-isotropic carbon/epoxy composites. Composite Structures.; Vol. 84, Pp. 21-28, 2008.

[26] F.Taheri-Behrooz, M. Shokrieh, and H. Abdolvand, "Designing and manufacturing of a drop weight impact test machine," Engineering Solid Mechanics, vol. 1, pp. 69-76, 2013.

[27] Kim J-K, Mai Y-w. High strength, high fracture toughness fibre composites with interface control—a review. Compos Sci Technol 1991;41: 333–78.