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Replacement of Conventional Material and Need of Composite Material as a Future Material: A Critical Review

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Abstract: ***The objectivity of the engineering is to perform the task in an optimal way and this could be done by selection of prominent material to use in that engineering. When we say material, this means we are going to deal property like physical and mechanical properties under the desirable parameter like cost, availability and also environment. But environment is very important in the process to explore the environment. So finding eco-friendly, renewable kind of material which is fewer hazards and minimizing the use of conventional kind of material is big challenge for us when we do not compromise the quality and cost of it. For this purpose the composite material can be one answer in which natural fiber with less quantity with conventional kind of material are used. Modern testing methods are required to be in use and especially for the composite the test procedure should be strictly follow with eliminating the uncertainty of procedure. As a solution hybrid composite material can be use as it gives improved mechanical, physical and thermal properties and also allow using natural material as per our objective. Scope of this paper is to understand the material characteristics in the sense of future requirement.***
Keywords: **Composite, Environment, Metal, Kevlar, Hybrid composite, STF**

I. INTRODUCTION

The growth of human is actually de-growth of nature because we are not doing proper analysis of work which effects the environment. Human evolution started in the development process but in today human started to upgrade himself. History reviles the progress from wood, stone then metal. The source of metal i.e. mineral ore is limited but natural fiber source are unlimited and renewable too. As metal extraction is costlier and required huge labour work, synthesis of monomer fibers and so polymer fiber is less costly and less labour required as compared. The conventional metal material like steel, aluminum, copper are limited in the earth and also its process and utilization gives bad effect on the environment as research reviles and this is no new for the plastic material.

Now to overcome with this problem we have to find new materials which will more close to nature. But it also true that this cannot fulfil all the desired property as required for engineering purpose so we have to use conventional too but in less quantity. And finally this problem can be solving by accepting the composite as a future material. The composite also has wide area and so many excellent composite are found in working but still need to explore more because where we are this just output of last 20-30 year of research.

II. FACTUAL ANALYSIS OF COMPOSITE MATERIAL

The natural fiber source is natural item like bast, leaf, fruit, stem and stalk, as they are extracted from different parts of the plant. Coir fibers are found between the hard, internal crust and the outer cover of a coconut and collected from the fruit of the cocus nucifera plant. Bast fibers are extracted and collected from the outer cell layers of the stem of the plants. Some examples are flax, jute, ramie, rattan, and vine fibers. Fibers collected from the leaf cells are known as leaf fibers such as pine apple, banana, etc.

The adhesive can be natural or synthetic as per the performance required and working condition. An extraordinary natural adhesive based example is old ancient building in which this kind of natural adhesive are used. One thing more when performing adhesion, chemical grafting can be and one of most promising method to enhance the adhesion between fiber and matrix.

These fibers are processed chemically and with help of adhesive material like epoxy then single or multi layered composite can be form. With this same process the hybrid composite also manufactured but in hybrid composite the two or more different reinforcement may be used. Advanced composites have emerged as new structural materials with a huge engineering application due to their unique capabilities in overall performance and design. The research on composites has generated profound impact on past but in future it will drastically impact on science and technology as other major developments in the history of materials engineering.

In past research the research area was particularly with natural fibers but very less in synthetic fibers and very interesting thing is just a finger count research has been done which include the metal as part of it. Development in the field of hybrid composite which includes natural fiber, synthetic fiber and metallic material are very limited.
Selection parameter as an individual for composite:

A. Availability of source
B. Ease of processing
C. No toxic and No skin etching
D. Good bonding in interlaminate
E. Less susceptibility to water penetration and weathering
F. More or equal mechanical property
G. Biodegradability
H. Good adhesive property
I. Conductivity towards heat and electricity

The concept of interface-less composites is mainly taken to avoid physical deterioration due to poor fiber-matrix adhesion properties as we discussed in case of synthetic fiber, and to achieve improved interfacial, physical, mechanical, economical and eco-logical advantages. With add on this composites consisting of the same material with different reinforcement and matrix phase can bring out high interfacial strength.
Thickness swelling occurred as the water molecules penetrate the natural fiber reinforced composite through micro-cracks and reduce the interfacial adhesion of fiber with the matrix. The hydrophilic nature of cellulose materials and the capillary action will cause the intake of water through micro-cracks when the samples were soaked in water and thus increase the dimension of the composite. The presence of voids also related to the thickness swelling of as the higher the void contents increase the thickness swelling of composites. The water absorption and the thickness swelling of natural fiber reinforced with polyester composites are improved by the incorporation of synthetic fibers. And research proved that the higher Kevlar content in sample resulted in higher fiber-matrix interfacial adhesion thus lower thickness swelling. As a mechanical test the flexural test is useful in quantifying the properties of composite mainly in structural applications. As Higher percentage of voids also related to thickness swelling hence it is also a negative effect on the flexural strength and flexural strength of the composites.
Natural fiber composites compared to synthetic fiber composite possesses inadequate mechanical properties. The solution for this trouble is to use combination of natural as well synthetic fiber to improve the overall properties. So, in this case hybridization aids improvement on the overall mechanical properties of the material and with the use of synthetic fiber we can use natural fiber as an engineering material.
High ultimate strain, short synthesis time, availability in various dimension, recyclability and the ability of thermoplastic matrices to be re-molten and re-processed are some of the driving agents for their increasing uses. But the use of inorganic reinforcements, such as glass and carbon fibers, makes thermoplastic composites no longer recyclable. But in real practical engineering work it is not possible by the only natural reinforcement, so we need to move on hybrid composite where we can try to increase the natural fiber participation rather than conventional plastic and metals. Many novel research works have been found on natural fibers and synthetic fibers composites. It has been found that the mechanical properties like Tensile, compression, flexural strength depends on the reinforcement and fabrication method.
Future scope of this project is to change matrix material like nylon, because Aramid-nylon composites can reveal comparable strength property in the course direction, even though they have substandard strength in the rising direction, as compared to that in aramid-epoxy composites.
Hemp/Jute/Kevlar fibers have found better properties in military and automobile applications. But another fact from research is that the Jute-Kevlar-Epoxy laminate shows less tensile strength, more compressive strength and more flexural strength than the Hemp-Kevlar-Epoxy for the same thick laminate. Jute fiber is an excellent example of the natural fiber as reinforcement material which is the cheapest and most abundantly available natural fibers in India. It is mainly composed of plant materials like cellulose and it can be spun into coarse or strong threads. Retting is a process in which fibers are separated from the stem of the plant. Retting can be classified as mechanical retting, chemical retting, water or microbial retting and steam retting. The retted fibers are then dried in open air and treated by alkali solutions like NaOH for the further improvement of structural characteristics and is used in the composite as reinforcement materials.

Now a days the hybrid composite with jute fiber used in the industrial applications of automotive and other industrial purpose where the components are under the operation of moderate cyclic loadings.

However, it is not possible to visually observe the damage development, since failure take place very abruptly. Post-failure examinations were carried out on selected test specimens using an X-ray diffraction (XRD) and scanning electron microscope (SEM) to study the fracture and failure mechanisms. The rheological analysis can be done for the adhesive gel and gelation time.

In synthetic fiber Kevlar fiber is widely used to form composite material due to its wide variety and better mechanical, physical, chemical and thermal properties. Kevlar has a lower density (1.45 g/cm^3), and therefore specific properties of the Kevlar composites will be much better than with glass fibers (2.52 g/cm^3), which has a much higher density.

The abrasion of the fibers themselves is also very different; but Kevlar fiber has very less abrasion as compare to glass fiber but it leads the poor adhesive with matrix but it can be overcome with the good adhesive material.

It is also found that the mechanical properties can be improved by chemical treatment by the acetone, phosphoric acid solution and water to remove the possible impurities from the surface. And the can also help to increased interfacial thickness.

For high-performance composite applications needed outstanding mechanical, physical properties in its reinforcement material. In this discourse Kevlar fiber, carbon fiber have excellent high specific strength and high thermal resistance and also, at the same time in comparison in these both the Kevlar is more good as for as electrical conductivity is concerned.

III.HYBRID COMPOSITE WITH WIRE-MESH AND STF

If special design and manufacturing processes we can adopt then may be overall properties can be improved because may be by this its chemical inertness can be reduce to increase the interfacial adhesion of Kevlar based hybrid composite. This problem may be solving by another way by introducing the wire mess as the part of hybrid composite. But by doing so we introduce one new thing on which the overall performance depend but as we know as general that the property increases by introducing new reinforcement which has the good property but degree of improvement should be analysis.

Another example of this fiber such as teel fiber and some organic fiber can greatly improve the toughness and flexural strength and this also converts the failure mode of glass fiber from brittle into ductile by controlling crack propagation under different loading or environment condition. The addition of this kinf of natural fiber also reduces the buckling tendency on the surface of the Kevlar composite dominated its failure.

From previous research result it is found that the Kevlar reinforcement composite is widely used in impact resistant like ballistic impact. But also it was found that the impact strength of the hybrid composites was nearly a weighted sum of the impact strength of all the individual components. Therefore, we can conclude that the hybrid system did not show a hybrid effect on impact strength but somehow it improves deboning not happen. The more positive hybrid effect for the strain, flexural tests was found actually for the 3D hybrid composites. Results of flexural tests revealed the existence of a positive hybrid effect in strength and modulus for the 3D braided hybrid composites. And usually less hybrid effect for the shear strength and impact property. Many SEM observations suggested that the Kevlar fiber deformed in a highly plastic manner during impact and it causes permanent shape and size changes but at the same time it absorbed a lot of energy. And in comparison this plastic deformation is very less in the carbon fiber.

Now another kind of composite material is ceramic composite which can help hybrid composite by the application of coating. A characteristic feature of the ceramic-matrix composite is its high resistance to thermos cyclic loadings.

Analysis of the past literature and trends in high-temperature materials science shows that much research effort is presently directed to ceramic composites. Many more research and development in the field of ceramic composite materials (CCMs) and coatings is in progress. The high-temperature matrix like glass-matrix and ceramic-matrix composites has high stability at higher temperatures as above 1200°C also. So, these composites are singular in its kind for manufacturing of high temperature parts and automotive parts. Compared with the best high-temperature metal alloys, ceramic composites have reduced density (about 30–50%) and thermal expansion coefficient (about 60%) and are potentially capable of operating at temperatures of up to 1600– 1650°C.

The properties of the composite material could be improves by use of interphase protective coatings which serve not only for matrix crack deflection, but also enhanced resistance to oxidation and prevented fiber degradation. Controlled deposition of ceramic material like SiC layers it was used to obtain multilayer (hybrid) composite materials.

The large number of coating technics available like Plasma spraying technique, chemical vapour deposition, sol- gel technology, high or low velocity oxy flame and electro chemical deposition techniques. The coating obtained by chemical vapour deposition (CVD) techniques is much higher than those obtained by the sol- gel technology. On the other hand, the sol-gel method makes it possible to prepare volume-doped samples. Also high-temperature CCMs is motivated by economic and technological safety reasons. The high-temperature synthesis involves directed formation, at the micro and Nano levels, of a continuous SiC carcass,

where reinforcing particles are incorporated in the structure of the matrix formed by high-temperature synthesis from the starting components.

The use of carbon fibers for reinforcing glass opens the way to a wide variety of fiber–glass systems. In such systems, the type and structure of the carbon filler strongly affect the properties of the Composite Material.

New armour consists of a ceramic plate, an intermediate ceramic-polymer layer and a polymer fiber lining as a backing material. The advised composite armour systems prepared with a use of particularly selected compositions of the intermediate layer promoting the absorption of the kinetic energy of projectiles provide adequate ballistic protection to multiple hits. Usually ceramic armour systems consist a hard ceramic body used is cracked and broken, and the residual energy is absorbed by the soft reinforced backing material. This backing material also must support the post-impact fracturing of the ceramic body and the defeated bullet. These materials have high mechanical properties (e.g. hardness, Young's modulus, strength). Also ceramic matrix composite materials, which may be reinforced with different fibers and particulates, can help to resist this. This kind of new approach in the field of composite material is same as hybrid composite in case of natural composite.

The results suggested the incorporation of stainless steel mesh could significantly improve the overall properties of the composites if bonding is excellent between laminate. Some cracks can be observed in the cross section, which due to the thermal mismatch between the matrix and stainless steel mesh. The presence of stainless steel mesh can effectively inhibit the propagation of the cracks or extend crack length by crack deflection, which will significantly improve the mechanical properties of composite materials by absorbing more fracture energy particularly the addition of stainless steel mesh to geo-polymer matrix results in significant improvement in mechanical properties of the composites. Supporting effect of stainless steel mesh is more profound at higher volume fractions and tensile strength depends mainly on stainless steel mesh content.

As previously motioned that the impact strength of the hybrid composites was nearly a weighted sum of the impact strength of all the individual components and by this it improve the impact strength.

Wire mesh-epoxy composite enhance the performance of strengthened beams and more improvement in the first crack load as compared to CFRP. This reduces the initiation of micro-cracks in the vicinity of the beam tension face, prevented the propagation of cracks and improves the stiffness. Also the use of this kind of composite indicates better post-yield behaviour and prevented the debonding of the CFRP sheet. The steel and wire mesh-epoxy showed the same values of the strains up to the cracking stage. While the strains of the wire mesh-epoxy increased at values larger than the steel after the first crack. An increase in the first crack load of up to 90% was observed in the study. While these kinds of composite significantly enhance the yield strength and some of researcher found up to 47% increment. The degree of cracking varied through all the length and it mainly depends on the deflection and the stresses values. This kind of composite showed an improvement in both the pre-yield and post-yield loading stages due to the sequential failure in composite laminate. In addition, the presence of wire mesh-epoxy laminate prevented the premature debonding in multilayer hybrid composite. Further research is needed to investigate the use of different amounts of CFRP in the hybrid of wire mesh-epoxy-carbon fiber composite in order to achieve better performance with respect to the ultimate load carrying capacity and ductility. In addition the durability, fire resistance and brittleness of this new laminate need to be investigated.

As we know form the past experience and according the research data available that the energy absorption capacity of the soft composite structure improves significantly. With above understanding additional add on is required on the matrix or reinforcement material at the time of manufacturing of it or at the using time. An application of shear thickening fluid (STF) on high quality reinforcement has provided a potential solution to this problem. Shear thickening fluid is a non-Newtonian fluid and flow behaviour characterized by sudden rise in viscosity when the rate of shear gets over a threshold value.

The application of shear thickening fluid on Kevlar fabrics improves the impact energy absorption as the above stated phenomenon. And also higher shear thickening fluid (STF) concentration gives more batter result. To add on this higher padding pressure applied which reduces the STF add-on% on Kevlar fabrics making the composite lighter and provide more bonding with it whereas the impact energy absorption increases. Shear thickening fluid (STF) was prepared by dispersing silica Nano-particles in Polyethylene glycol (PEG) with varying amount of silica loading (50%, 60% and 70% w/w) which has been referred to as shear thickening fluid (STF) concentration. Ethanol was added at a fixed ratio (STF to ethanol ratio is 1:4 v/v) to reduce the viscosity or may say surface tension so that the shear thickening fluid (STF) can easily be applied on the Kevlar fabrics or other kind reinforcement composite.

Thus the impact performance of Kevlar–STF composites is likely to vary with temperature and shear thickening fluid (STF) concentration as shear thickening plays a very crucial role. The addition of shear thickening fluid (STF) to Kevlar fabrics shows enhanced the penetration resistance of the fabric, for low velocities and small target sizes.

IV. FINDING PRECISE SOLUTION WITH STANDARD TEST PROCEDURE

Ultimately test result speaks about the material. Without favorable precise test result we can't move for the modeling and production. Major testing in way of finding the composite characteristic are mechanical testing, physical testing and thermal testing, chemical testing, rheological testing and non-destructive testing. All the test should be conduct according to some standard like ASTM otherwise there is no predetermined rule valid for any composite.
Some of essential test for composite are as follows:

A. Moisture absorption and moisture expansion test
B. Tensile test
C. Flexural strength test
D. Compressive strength test
E. Impact test
F. Bearing response test
G. SEM analysis, and
H. Thermal test like TGA, DTA, DSC

All tests should be conduct on the benchmark level so the new research fulfils the gap of analysis. Some examples of American Society for Testing and Materials (ASTM) standard for the polymer composite testing are like ASTM D3039, ASTM D790, ASTM D3410, ASTM D5961, ASTM 7078, ASTM D5528, for tensile testing, three point bending testing, compressive testing, bearing response test, shear property test by v-notched rail shear method and Mode-1 interlaminar fracture toughness test respectively.

V. CONCLUSIONS

Taking all the information into account, known failure parameters like moisture, temperature, adhesiveness and improvement parameter like hybrid idea should be examined to increase the overall composite properties. The natural fiber based composite material can be utilized in the commercial filed like cell phone industry, entertainment industry, automobile, building works, house hold daily use material to reduce the usage of hazard material like plastic.
It is found that the hybrid composite material taking considerable part in the industry, aviation, aerospace area and commercial are. The several new researches required in this particular filed for the optimal use of natural resource like ore, mineral and reduce the distortion of environment. Our required of better engineering material can be satisfies if and only if we find renewable, recyclable and smart material.

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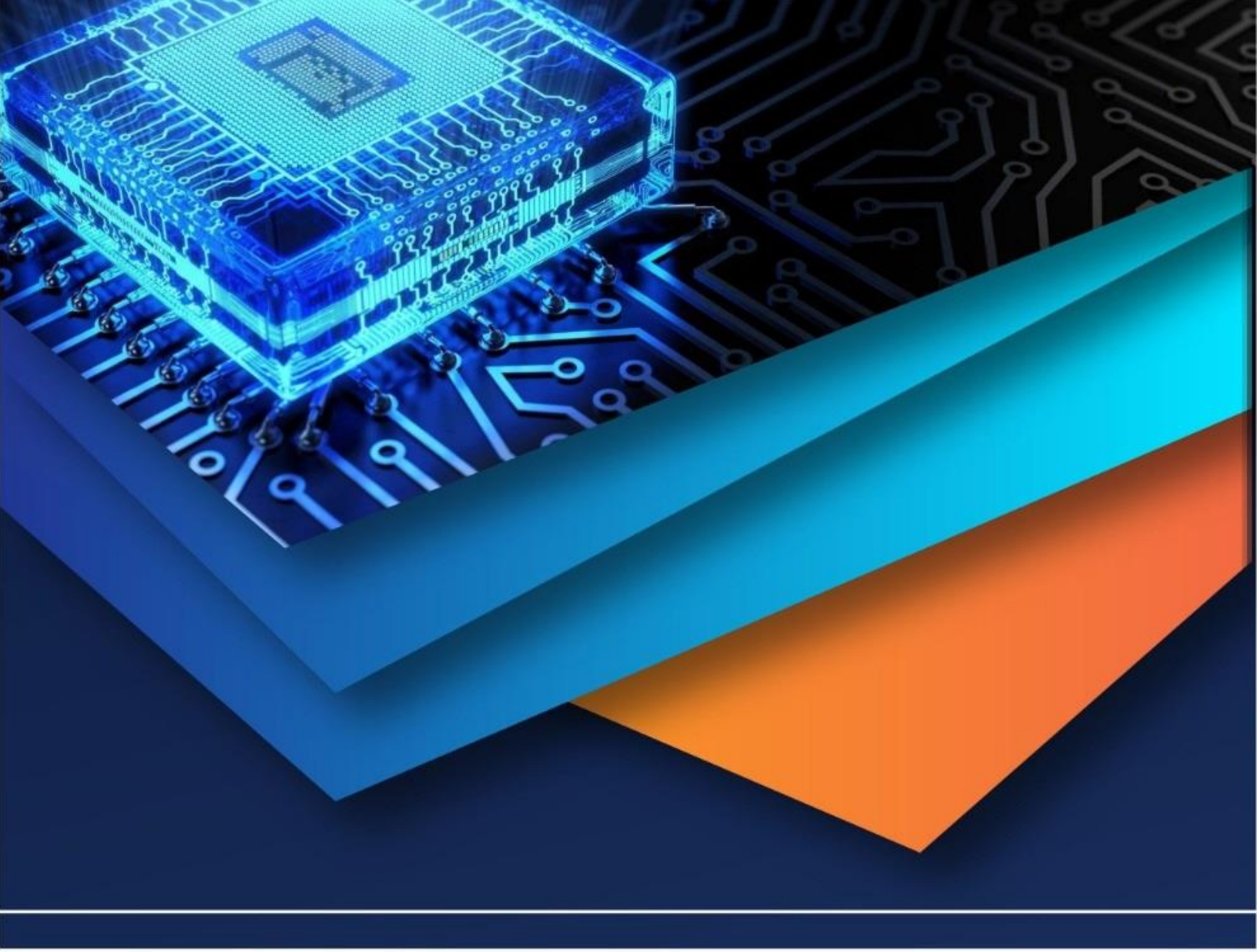
REFERENCES

[1] R. Jeyapragash, "Mechanical properties of natural fiber/particulate reinforced epoxy composites - A review of the literature Materials", vol. 22, p.p. 1223-1227, (2020)
[2] Z. Yu, "Nylon/Kevlar Composites I: Mechanical Properties", Polymer Engineering And Science, vol. 31, no. 16, august, (1991)
[3] C. Belkacemi, "Quasi-static mechanical characterization and fatigue of a composite laminates", Advances in Applied Science Research, vol. 5, no. 3, p.p. 328-335, (2014)
[4] R. L. Woodward, "Resistance To Penetration And Compression Of Fibre-Reinforced Composite Materials", Composites Engineering. vol. 4, no. 3, pp. 329-341, (1994)
[5] E. N. Kablov, "Perspective High-Temperature Ceramic Composite Materials", Russian journal of general chemistry, vol. 81, no. 5, pp. 986-991, (2011)
[6] A. Skopp, "Ceramic and Ceramic Composite Materials with Improved Friction and Wear Properties", Tribology transactions, vol. 38, no. 2, p.p. 233-242, (1995)
[7] N. K. Naik, "Composite structure under ballistic impact", composite structure, vol. 66, p.p. 579-590, (2004)
[8] E. Medvedovski, "Lightweight ceramic composite armour system", Advances in applied ceramics, vol. 105, no. 5, p.p. 241-245, (2006)
[9] Soo-Jin Park, "Effect of Chemical Treatment of Kevlar Fibers on Mechanical Interfacial Properties of Composites", Journal of Colloid and Interface Science, vol. 252, p.p. 249-255, (2002)
[10] Z. YU, "Nylon/Kevlar Composites II: Investigation of Interfaces", POLYMER ENGINEERING AND SCIENCE, vol. 31, no. 16, AUGUST (1991)
[11] O. A. Khondker, "Fabrication and mechanical properties of aramid/nylon plain knitted composites", Composites: Part A, vol. 35, p.p. 1195-1205, (2004)
[12] Y. Z. Wan, "Characterization of three-dimensional braided carbon/Kevlar hybrid composites for orthopedic usage", Materials Science and Engineering, vol. 398, p.p. 227-232, (2005)
[13] M. A. A Ghani, "Mechanical Properties of Kenaf/Fiberglass Polyester Hybrid Composite", Procedia Engineering, vol. 41, p.p. 1654 – 1659, (2012)

[14] Z. Salleh, "Fracture Toughness Investigation on Long Kenaf/Woven Glass Hybrid Composite Due To Water Absorption Effect", Procedia Engineering, vol. 41, p.p. 1667-1673, (2012)
[15] Abhijit Majumdar, "Development of soft composite materials with improved impact resistance using Kevlar fabric and nano-silica based shear thickening fluid", Materials and Design, vol. 54, p.p. 295-300, (2014)
[16] R. YAHAYA, "Effect of fibre orientations on the mechanical properties of kenaf–aramid hybrid composites for spall-liner application", Defence Technology, vol. 12, p.p. 52–58, (2016)
[17] Abhijit Majumdar, "Development of soft composite materials with improved impact resistance using Kevlar fabric and nano-silica based shear thickening fluid", Materials and Design, vol. 54, p.p. 295-300, (2014)
[18] J. Saiteja, "Evaluation of mechanical properties of jute fiber/carbon nano tube filler reinforced hybrid polymer", composite Materials, vol. 22, p.p. 756–758, (2020)
[19] P. Prabaharan GRACERAJ, "Investigation On Fatigue Strength Of The Jute Fiber Reinforced Hybrid Polymer Matrix Composites", U.P.B. Sci. Bull., Series D, vol. 78, no. 1, (2016)
[20] Tejasvi Anant, "Attention on hot corrosion & high temperature oxidation of alloys with its affecting parameters: A review", International journal of advanced in management, technology and engineering science, vol. 8, no. 3, p.p. 1508-1515, (2018)
[21] Ismail M. I. Qeshta, "Flexural behaviour of RC beams strengthened with wire mesh-epoxy composite", Construction and Building Materials, vol. 79, p.p.104-114, (2015)
[22] Jingkun Yuan, "Novel geopolymer based composites reinforced with stainless steel mesh and chromium powder", Contruction on building material, vol. 150, p.p. 89-94, (2017)
[23] N. Karunagaran, "Energy absorption and damage behaviour of surface treated glass fibre/stainless steel wire mesh reinforced hybrid composites Materials", vol. 22, p.p. 1078-1084, (2020).



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