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Fabrication and Testing Of Composite Powder Materials from Tamarind Seeds and Palm Date Seeds Using Epoxy

Mr. Pediredla Sudhir Kumar & Mr. T.Naresh Kumar

[1] PG Scholar, Department of MECH,Mallareddy Engineering College (AU), main campus, maisammaguda, Hyderabad, Telangana, INDIA, PIN-500100
E-Mail Id: sudhir.kumar995@gmail.com

[2] Assistant Professor, Department of MECH,Mallareddy Engineering College (AU), main campus, maisammaguda, Hyderabad, Telangana, INDIA, PIN-500100
E-Mail Id: nareshpiler@gmail.com

Abstract:

Dates from date palm (Phoenix dactylifera) trees are popular for providing a staple food for millions of people around the world, and tamarind (TamerindusIndica) is the other product which is used as food ingredient as pulp tamarind. Here we will use both tamarind and dates seed powders as the composite material, which are mostly treated as waste in our day to day life. As the composite material consists of matrix and reinforcement, in this the particulates tamarind and dates seed powders are used as reinforcement and matrix used is Araldite Standard Epoxy resin AW106 along with hardener HV953. The reinforcement used is tamarind dates seed powders are mixed with the matrix taken in the fixed ratios, with different proportions. Then the composite is fabricated and tested for strength and hardness. The tests performed are impact and Rockwell hardness test. Different compositions of the matrix and epoxy is fabricated and compared among composites prepared and result is shown. Composite materials are substitute for the conventional plastics and possess higher mechanical properties then those materials.

Introduction:

Definition and characteristics:

Composite materials can be characterized as the blend of various materials manufactured together frame a one of a kind material, every material hold

their unique mechanical, substance properties. A basic composite is a material framework comprising of at least two stages on tiny scale, one of the stage is generally spasmodic, stiffer and more grounded and is called fortification while less solid and weaker stage is ceaseless for the most part in fluid shape is called Matrix.

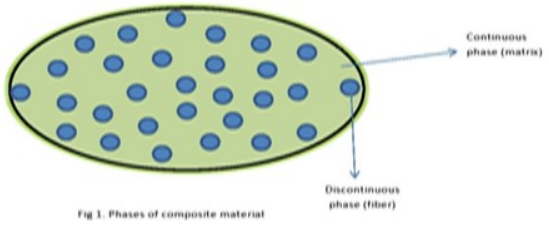


Fig 1. Phases of composite material

A standout amongst the most imperative parameters is the volume (weight) portion of fortification, or the fiber volume proportion. The scattering of the stronghold chooses the consistency of the material structure. The times of the composite material depend upon the sort of the composite material application. The structure is the essential load bearing constituent directing the mechanical properties of the material. If there should be an occurrence of elite basic

composites, the typically constant fiber support is the foundation of the material that decides its firmness and quality toward the filaments. The network stage gives assurance to the fiber. In this undertaking the tamarind seeds and the Palm date seeds powders goes about as the filaments and epoxy pitch goes about as the network.

Historical development:

Truly, the idea of sinewy fortification is exceptionally old. Press bars were utilized to strengthen workmanship in the nineteenth century, prompting the advancement of steel fortified cement. There are scriptural references to straw-strengthened earth in antiquated Egypt. The principal fiberglass vessel was made in 1942; strengthened plastics were likewise utilized as a part of flying machine and electrical segments as of now. The main boron and high quality carbon filaments were presented in mid 1960s, with utilizations of cutting edge composites to flying machine parts. The metal framework composites, for example, boron aluminum were presented in 1970. Dupont created Kevlar strands in 1973.Now composites advances and the development take placed to develop the newer metal matrix and ceramic matrix composites, as well as the carbon/carbon composites, for high temperature applications. These composite products are designed to have high mechanical performance and environmental stability with low weight.

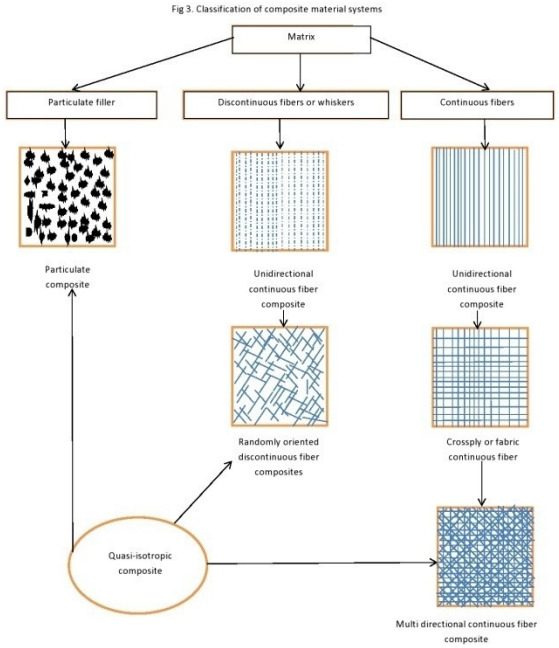
Fabrication technology:

A standout amongst the most vital strides in the use of composite materials is the creation procedure. An assortment of manufacture strategies reasonable for a few applications is accessible. They include autoclave molding, filament winding, pultruson, and resin transfer molding. This requires more stringent and extensive quality control procedures, and skilled labors.

Fig2. Fabricated natural seed panel

Types and Classification of Composite Materials

Two phase composite materials are classified into three broad categories depending on type, geometry, and orientation of the reinforcement phase. The classification is shown in fig 3 below.



Present and future scope

The technology of composite materials has experienced a rapid development in the last two decades. Some of the underlying reasons and motivation for this development are; significant progress in material sciences and technology in the

area of fibers, polymers, and ceramics; requirements for high performance materials in aircraft and aerospace structure. The initial driving force I the technology development weight savings. The usage of conventional and new composite materials is intimately related to the development of fabrication methods. The assembling procedure is a standout amongst the most essential stages in controlling the properties and guaranteeing the nature of the completed item. Quality control assessment and mechanization are being presented in the assembling procedure.

Newer high volume applications, such as in the automotive industry, will expand the use of composites greatly. The energy for conservation motivates more use of lightweight materials and products.

Identification of the problem

Natural reinforced fibers are one of the examples of composite materials. Natural composite materials are made from the available materials found in nature, which are bio degradable when they are decomposed. It will not produce any harm to the environment as the plastic reinforced composite materials. The best part of natural composite material it is mostly freely available in nature and gives high strength and hardness as the metals. The fundamental point is to deliver a low weight and high quality material to the world, regardless of whether it is a characteristic composite or metal composites or glass fiber fortified or earthenware composites. Be that as it may, when it is regular composites it is more compelling as far as cost and additionally the weight.

Objective of the project

The project objectives are:

1. Experimental procedure used to fabricate a natural composite fiber.
2. To find and verify the strength and hardness of the natural composite prepared, impact and harness test performed.
3. Three different compositions are fabricated with different fiber ratios and epoxy resins respectively.
4. Comparing the composites among themselves, and also compared with the other composites.
5. Future investigation can be made on fire and water resistance also.

Application and composition of composite materials

Why composite material?

1. Weight reduction up to 20 to 50%.
2. Single-shell shaped structures give higher quality at bring down weight.
3. High effect protection. For example, Kevlar (aramid) defensive layer shields planes have decreased coincidental harm to the motor arches that convey fuel lines and motor controls.
4. High warm steadiness
5. High harm resilience improves mishap survivability
6. Resistant to weakness/erosion
7. Structural segments made of composite materials are anything but difficult to gather.
8. Recycling utilized parts from decommissioned flying machines is another choice accessible when utilizing aviation composites.
9. The Boeing Company is especially associated with enhancing the ecological execution of

the planes by embracing reusing of all the air ship materials made utilizing composites.

10. Although reusing of an air ship structure is a mind boggling and costly process, it might spare cash in buying costly direct parts
11. With expanding fuel costs, business aviation producersare under strain to upgrade the execution of flying machines, for which weight decrease is a key factor.
12. Based on the propel that is being made in composite advancement techniques, it is likely that the plane of tomorrow will be created using composite materials.
13. However, there are as yet a couple of snags to overcome before composites can supplant aluminum and other metal mixes absolutely, particularly if there ought to emerge an event of significant planes.
14. Composite innovation keeps on progressing, and the development of new sorts of composites, for example, carbon nanotubes and basalt structures will additionally quicken composite utilization.
15. However, concerning aviation, this new material won't have the capacity to totally supplant conventional metallic compounds until the point that methods are acquainted with diminish their manufacture and support costs.

Preference of Tamarind seeds and Palm Date seeds

Tamarind seed is an underutilized by result of the tamarind mash industry. Just a couple of ventures utilize the Tamarind seed, as tamarind portion powder for estimating material in the material, paper, and jute businesses. In spite of the fact that numerous utilizations of this seed are conceivable, there have been not really some other uses for it including utilizing it as an added substance in nourishment definitions. The superb gelling cum cement attributes of decorticated seed powder can prompt a few applications in composite materials.

Chemical properties, properties of tamarind seed

Seed color: LB = Light brown and

DB = Dark brown respectively each value is a mean of three determinations.

Means followed by similar superscript letters in a column are not significantly different at ($P \geq 0.05$)

	Seed Sample	
Parameters (%)	**Light Brown (LB)**	**Dark Brown (DB)**
Moisture	10.99b ± 0.1002	11.21a ± 0.0058
Protein	20.23b ± 0.5658	23.75a ± 0.0839
Oil	3.90a ± 0.0500	3.17b ± 0.0462
Ash	2.50a ± 0.0000	2.17b ± 0.0577
Fiber	3.08a ± 0.0493	2.51b ± 0.0058
Carbohydrate (by difference)	59.303b ± 0.4041	57.33a ± 0.2452

Table1. Proximate chemical composition of the Tamarind seed.

The research and development activities in each country are primarily focused on the utilization of the locally available sources of natural fibers and the natural fibers which are unused. Date seeds, which constitute 6-15% of the total weight of the ripe palm date. Both the date seed and date palm wood is investigated recently in many experiments to utilize it. The date seed is rich in high fiber and nutrients. It is an unused byproduct of which can produce a high strength material. Most of the world is using the date seed powders as feed for the animals.

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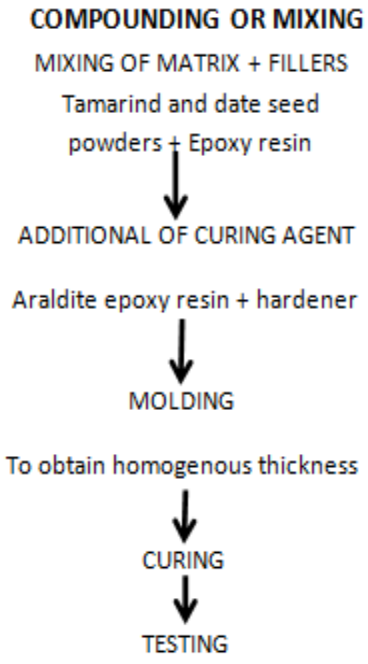
Composition of date seeds

Varieties	Moisture%	Protein%	Fat%	Ash%	Carbohydrate%
Mabseeli	3.1	3.9	5.0	1.0	87.0
Um-sellah	4.4	5.4	5.9	1.2	83.1
Shahal	5.2	2.3	5.1	0.9	86.5
Fard	10.3	5.7	9.9	1.4	72.7
Khalas	7.1	6.0	13.2	1.8	71.9
Lulu	9.9	5.2	10.5	1.0	73.4
Degletnoor	9.4	5.0	9.2	1.0	75.4
Allig	8.6	4.7	11.6	1.1	74.1
Ruzeiz	5.4	6.4	9.7	1.0	77.5
sifri	4.5	5.9	10.0	1.1	78.5
Average	6.8	5.1	9.0	1.1	78.0

Table2 Date seed composition

Methodology:



Reinforcement

As discussed above the project is made out of the date seeds and tamarind seeds powder. In daily use we use dates as a staple food and tamarind in daily cooking, the seeds of both dates and tamarind we usually through away as a waste product, in which the date seeds are rich high fiber, it shows high strength at extreme conditions, whereas the tamarind seed act as a natural adhesive which binds the component and gives high strength and resistance. They are corrosive resistant and fire proof. These are natural bio-degradable materials are included with feasible framework and are made into a composite material.

The mechanical properties as the intense and inexhaustible materials can be utilized to make substantial, 3-D objects with complex shapes. These seed powders can separate totally inside around two weeks subsequent to being disposed of in the earth and even discharge supplements amid its breakdown that plants can utilize. The seeds powder fiber is blended with a fortified framework to shape the polymer composite material, shabby and simple to make on vast scales and wouldn't take up arrive like plant-based bio plastics. A reasonable network is added to the date and tamarind seeds powder then the quality of the fiber increments to oppose the composite material and withstand the conditions of the earth as it is biodegradable.

Availability of Matrix-Epoxy resin

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Araldite AW 106 / Hardener HV 953 U

Key points

- Multi-purpose use
- Long life
- Low shrinkage
- Good resistance to dynamic loading
- Bonds a wide variety of materials

Description

Araldite AW 106 / Hardener HV 953 U are a multipurpose, two components (Epoxy, Hardener), good at room temperature curing, liquid adhesive of high strength and toughness. Araldite AW 106 / Hardener HV 953 U suitable for materials like metals, ceramics, glass, rubber, plastics and most other materials in common use. It is a good adhesive for the craftsman as well as most industrial applications.

Product data

	Araldite® AW 106	Hardener HV 953 U	Mix
Color (visual)	neutral	pale yellow	pale yellow
Specific gravity	ca. 1.15	ca. 0.95	ca. 1.05
Viscosity at 25°C (Pas)	30-50	20-35	30-45
Pot Life (100 gm at 25 C)	-	-	ca. 100 minutes

Table3 specification of epoxy resin

Processing

Pretreatment: If the strength and durability of a bonded joint depends on what kind of treatment on the surface is done before bonding. At least, joint surfaces should be cleaned with a good DE-greasing agent such as acetone, iso-propanol (for plastics) or other DE-greasing agents in order to remove all traces of oil, grease and dirt. Low grade alcohol, gasoline (petrol) or paint thinners should never be used, because it reacts quickly and can be harmful. The strongest and most long-lasting joints are obtained by either mechanically abrading or chemically etching the DE-greased surfaces.

Application of adhesive

The resin/hardener blend might be connected physically or by utilizing robot to the dry joint surfaces. A layer of glue 0.06 to 0.12 mm thick will ordinarily confer the best lap shear quality to the joint. The joint parts ought to be set and dried in a settled position when the glue has been connected.

Mixing ratios of Epoxy and Hardener

The best case is a 1/1 ratio with even viscosity, worst case is a 10/1 ratio with a wide viscosity difference. It also depends on the type of epoxy resin/Hardener used. The type of cartridge can also have a dramatic effect on dispense quality, especially when used in a pulsing mode. Larger and thin walled cartridges can induce a lead/lag effect where resin/hardener show an extreme ratio change in a very short period due to the expansion and relaxation of the cartridge barrel. The thicker walled cartridges show much less tendency to produce this lead/lag effect which is a primary cause on intermittent tacky on small, Potting or casting.

Mix ratio	Parts by weight	Parts by volume
Araldite® AW 106	100	100
Hardener HV 953 U	80	100

Table4 mixing ratio of epoxy resin

Appearance and odor: Clear slight yellow, slightly viscous liquid with a slight ammonia-like odor

Solubility in water: slight.

Experimental Procedure

Reinforcement Preparation

The date seeds were separated from their fruits manually or mechanically, thereafter washed and cleaned to remove contaminants and they were dried and grinded with hammer mill to obtain filler powder. The filler powder were made to pass through wire mesh screen to obtain a fine particle size, thereafter oven dried at temperature of about 60°C before the use so as to reduce the moisture content. Samples were thereafter stored in desiccators.

Fig4. Seeds of Date Palms

Fig5.Date seeds powder

The Tamarind seeds were separated from their Tamarind pulp, thereafter washed cleaned to remove contaminants and they were dried and roasted at 90°C and grinded with hammer mill to obtain filler powder. It is then filtered to fine particles, thereafter oven dried for some time to reduce the moisture content. Samples were thereafter stored in desiccators.

Fig6. Tamarind and tamarind seeds

Fig7. Tamarind seeds powder

Reinforcement that is used in the composite material is this completely dried powder which is mixed with the matrix suggested possessing the particulate reinforced matrix. This seeds powder will have good strength when compared to other biodegradable materials.

The reinforcement is processed for the date seed and tamarind seed powder, as mentioned earlier the matrix that used is Araldite Standard Epoxy resin AW106 along with hardener HV 953 IN in the constant ratios as in general best case is a 1/1 ratio with even viscosity, worst case is 10/1 ratio with a wide viscosity difference.

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Fig8. Epoxy resin Araldite AW106, hardener HV959

Molding

At the point when hand blending the epoxy pitches and the hardeners, it is best to empty the tar into the blending vessel first in a compartment. The pitch and hardener are included the proportions and blended in the compartment for a period until the point that we get a decent vertex amidst the arrangement in the holder. At the point when a decent vertex is gotten in the arrangement then the seeds powder is added to the vertex of the framework in the holder. The powder blended into the network is mixed utilizing a mix stick physically or by utilizing mechanical machine until the point when it frames a decent blend. It doesn't require any temperature or heat. The blend ought to be blended with no air pockets and it must be perfect and free from clean also. It should make a uniform conveyance all through the synthesis by scratching the sides and base of blending vessel every now and again.

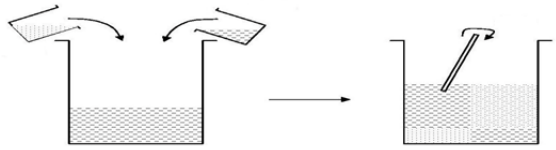

Fig9. Mixing of epoxy resin and hardener

After the items have been blended altogether, the blend ought to be filled the shape or utilized as a part of the cement step. Regularly, the final result must be absolutely free of voids and air pockets. The readied composite material is filled the form of the required shape. The state of the form is secured out as a composite material. This ought to be done in various proportions of the powders. Utilizing these strategy three test examples is manufactured, utilizing the accompanying proportions appear in the accompanying tables.

Sl.no	Materials used	Sample 1 Dimensions	Ratio %
1	Tamarind seed powder	15MM THK X 130LG	40
2	Date seed powder	15MM THK X 130LG	20
3	Epoxy	15MM THK X 130LG	40

Table5 specimen 1

Sl.no	Materials used	Sample 2 Dimensions	Ratio %
1	Tamarind seed powder	15MM THK X 130LG	40
2	Date seed powder	15MM THK X 130LG	30
3	Epoxy	15MM THK X 130LG	60

Table6 Specimen 2

Sl.no	Materials used	Sample 1 Dimensions	Ratio % (Equal quantity)
1	Tamarind seed powder	15MM THK X 130LG	------
2	Date seed powder	15MM THK X 130LG	-------
3	Epoxy	15MM THK X 130LG	-------

Table7 specimen 3

Curing

The mould is dried for 24 hours and rested in the room temperature. After it dries take out the natural composite panels. The composite panels procured out are hard and high in strength. Fig 10 shows the after curing process of the natural composites mixture of tamarind and date seed powders along with epoxy resin.

Fig10. After curing natural composite panels

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Testing

Impact testing

In real work on, building segments amid the examination are constantly subjected to different sorts of burdens specifically static and dynamic burdens. Dynamic burdens are recognized by high rate of alter in stack size and course. Invert occurs if there should be an occurrence of static burdens. In the hardness test and malleable tests, stack is expanded gradually that relates to the conduct of material under pretty much static stacking condition. Wide range rate of stacking can be utilized as a part of tractable test. Rate of stacking drives the strain rate thus rate of solidifying which can influence mechanical conduct of material.

The toughness test simulates service conditions often encountered by components of the system used in transportation, agricultural, and construction equipment. A material high effect protection is said to be an intense material. Strength is the capacity of a material to oppose both crack and twisting. Sturdiness is the mix of quality and malleability. To be intense a material must displays both genuinely great quality and malleability to oppose splitting and misshappening under effect stacking. Indents are had purposefully in effect test examples to expand the stress concentration in order to build inclination to break as the majority of the mechanical segments have stretch raisers. To withstand an effect compel, a scored material must be extreme.

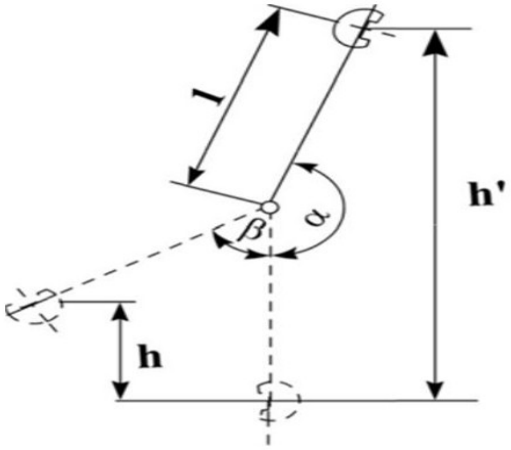

Fig11.Principle diagram of toughness test

To study the behavior of material under dynamic load conditions toughness test is frequently conducted. There are two methods used for toughness testing namely Izod and Charpy test, based on common principle applying the load at high rate and measuring the amount of energy absorbed (kgm. or joule) in breaking the sample due to impact. However, there are some differences also in these methods in terms of sample size and shape, method of holding of the sample and maximum energy content of pendulum that hits the sample during the test.

Sl. No.	Toughness test	Sample	Holding
1	Izod	Held vertically on anvil as cantilever	Cantilever type and notch faces the pendulum
2	Charpy	Held horizontally on anvil as simply supported beam	Simply supported type and notch is opposite side of pendulum impact

Table8showing types of impact tests

Here we discuss about the Charpy test method having a v-notch and is mounted on the machine in specific way as the pendulum hits the sample from back of the notch in Charpy test.

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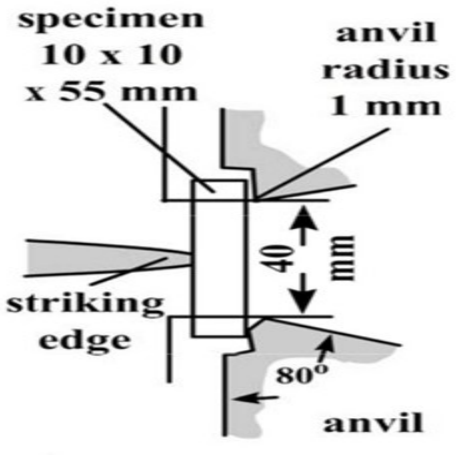

Fig12. Standard specimen for Charpy test

Results of impact tests are conveyed in terms of either amount of energy absorbed (Nm) or amount of energy absorbed per unit across sectional area (Nm/cm2) by standard sample. These tests are useful for comparing the resistance to impact loading of different materials or the same material in different processing conditions such as heat treatment, procedure and mechanical working etc. Resistance to the impact loading of a material appreciably depends on the surrounding temperature. Therefore, temperature toughness test is conducted must me reported with results.

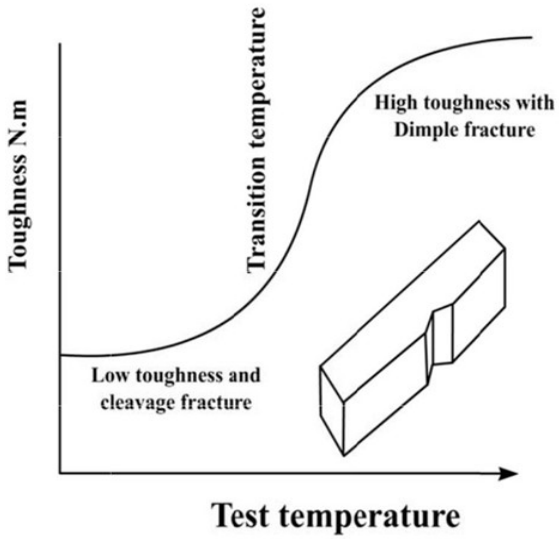

Fig13. Schematic diagram showing influence of test temperature on toughness

For Charpy v-notch test I used the ASTM D-256 test procedure, and the equipment used is:

Krystal Elemec.

Model no: KI300.

S.no: 98/1081.

Range -168J for Izod.

Fig14. Krystal elment

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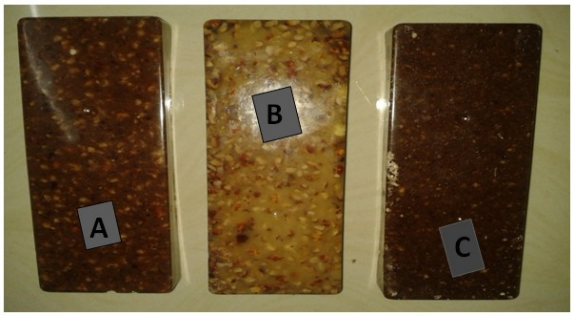

Fig 15. Before impact testing specimens A ,B,C.

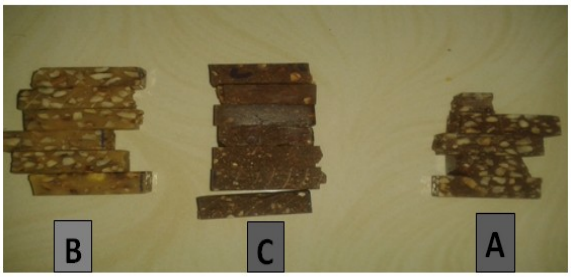

Fig16.Specimens B, C, A shown after impact testing.

Rockwell Hardness Test

The fig.18 demonstrates the Rockwell shore hardness analyzer. The Rockwell hardness test strategy comprises of indenting the test material with a jewel cone or steel ball indenter. The indenter is constrained into the test material under beginning minor load F0 (Fig.18 A) as a rule 10 kgf. At the point when balance has been achieved, a demonstrating gadget, which takes after the developments of the indenter reacts to changes top to bottom of entrance of the indenter, is set to a datum position. While the underlying minor load is as yet connected an extra real load is connected with coming about increment in infiltration (Fig 18. B). at the point when adjust has again achieved, the extra real load is expelled yet the underlying minor load is as yet kept up. Evacuation of the extra significant load permits an incomplete recuperation, so diminishing the profundity of infiltration (Fig 18. C). the changeless bring up inside and out of entrance, is utilized to process the Rockwell hardness number.

Fig17. Shore hardness tester

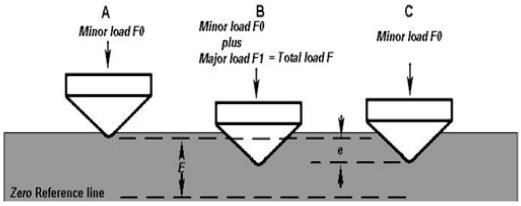

Fig18. Rockwell Principle

HR = E – e

F0= preliminary minor load in kgf

F1= additional major load in kgf

F= total load in kgf

e= permanent increase in depth of penetration due to major load F1 measured in units of0.002 mm

E= a constant depending on form of indenter: 100 units for diamond indenter, 130 units for steel ball indenter

HR = Rockwell hardness number

D= diameter of steel ball

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Here for hardness testing I have used the ASTM D 2240:2003 test procedure to test the specimens, and the equipment used is:

SHORE HARDNESS TESTER.

Model no: SHR-GOLD.

S.no: 17773.

Standard Block: 50 Shore D

Test reports:

Test reports after testing in laboratory are shown below

Results and Conclusion

Results

Specimens are taken as per the proportions shown in fig.19 by showing the variations in epoxy resin quantity as well as the tamarind and date seed powders. The specimens A, B, C is made with the powders of different compositions. Each specimen weight approx. 140 Gms and dimensions are 15MM THK X 130MM LG.

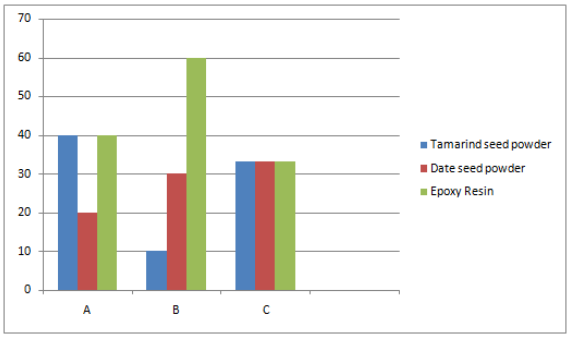

Fig19. Weight percentage variations of specimen

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Charpy impact tests are performed on each specimen for three trails as per ASTM D-256 on range- 168J for Izod capacity KRISTAL ELMEC equipment. Each specimen is machined as per standard dimensions need and a V-notch is made on three test pieces of each specimen A,B,C. The results obtained are shown in fig.20for each specimen the impact result obtained is slightly different and maximum on specimen C is observed.

Specimen	Observed values(Joules)
A	2,2,2
B	2,4,2
C	4,4,2

Table9 observed values impact test

Shore Hardness test is also performed as per standard ASTM D-2240 on SHR-GOLD equipment and the standard block is 50 SSHORE D. the three specimens are taken each for three trail test pieces and the hardness test is done using intender D. The results obtained varied on comparing each other. The specimen C with equal quantity of tamarind and date seed powders showed greater hardness compared to other two specimens A and B, which shown in fig 20.

Specimen	Shore "D" Hardness
A	48,48,49
B	49,50,50
C	51,50,51

Table10observed values of hardness test

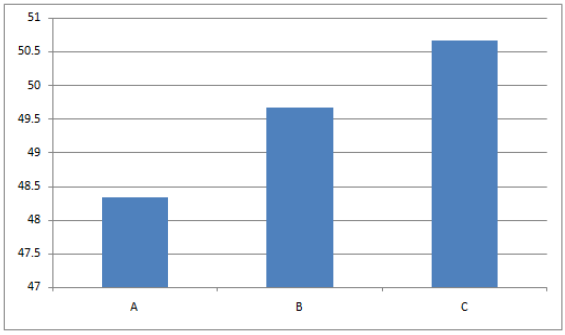

Fig20. Shore hardness test, Avg. Hardness VS Specimen

An observational experiment is also experimented by placing the above composite in water for 48 hours and it is observed that there is a not much absorbance of the water by the composite; minute moisture can be seen on the internal structure of the composite. This shows that this composite material there is an advantage of using this as water proofing material where it can be treated as roofing material, internal automobile accessories and many other various uses can be found.

Conclusion:

When the matrix is added with both the Tamarind and date seed powders respectively, it's seen that it has a good uniform distribution throughout the surface. When the load is applied on a composite material, the load is carried by the matrix and it is transferred to the reinforcement from the matrix throughout the composite. This may be formed by chemical reaction or mechanical bonding. In most cases, more than one type of bonding occurs.

The natural composite made with reinforcing both tamarind and date seeds powder together by varying along with the epoxy resin in different proportions did not have much variation in toughness and hardness as shown in the above results. But when compared among the three specimen results (A,B,C), the specimen with equal quantity of all three materials taken (i.e. specimen C) had attained the highest average toughness and hardness while tested.

It is also tested roughly by placing the above composite in water for 48 hours and it is observed that there is a slight absorbance of the water by the composite. The weight of the composite is compared before and after placing in water, there is a minute

increase in the weight (i.e. 0.1%). This shows the fabricated composite is a slow absorbent of water. But compared to the other composites it shows better results. From the above results the above prepared, composite can be used as the as false roofing instead of the thermocol and Plaster of Paris.

The above natural composite prepared can also bear the fire while the thermocol cannot withstand under fire conditions. The tamarind and date seed powder composite can be a best replacement for termocol, Plaster of Paris and it give a grandeur look to the sealing. The fig. 21 shows how we can use the composite as the false roofing. Further testing of the above composite material in various aspects, such as automobile industries, construction industries, it can be of great use in the market in various fields.

Fig21. Showing the example of false roofing

Future Scope

Much more research can be done using different combinations to increase the strength and hardness of materials. Due to great need of composite materials in various fields in order to cut off cost and weight, quality of the materials plays major role in replacing existing range of materials, and also it can be tested in the automobile industries. Furthermore investigation can be done on the fire proof and the water absorption of the composite.

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