International Journal of Emerging Technologies in Engineering Research (IJETER)
Volume 3, Issue 3, December (2015) www.ijeter.everscience.org

Fabrication and Performance of Fiber Reinforced Composite Material by Using Sunhemp Natural Fiber

Murali Krishna Yantrapati
Assistant Professor, Geethanjali Institute of Science and Technology, Gangavaram, S.P.S.R Nellore, India.

Narendra Kumar Jinka
Assistant Professor, Geethanjali Institute of Science and Technology, Gangavaram, S.P.S.R Nellore, India.

Abstract – Engineering achievement has always been closely associated with the availability of suitable materials of construction. Materials with unusual combinations of properties that cannot be meet by the conventional metal alloys, ceramics and polymeric materials. Materials of aerospace under water and transportation are particularly used in the properties like low density, stiffness, abrasion and impact resistance the composite materials can achieve these properties. We have chosen the natural fiber as the reinforcement having better properties than artificial fibers which are abundantly available in nature. So we studied the properties of natural fibers and selected sun hemp fiber because of easily availability and its maximum tensile strength. We fabricated this natural fiber in random oriented distribution. Finally the tensile and flexural tests are conducted and proved these natural fibers are superior to artificial fibers which are also degradable. We had selected the sun hemp as natural fiber because it has maximum tensile stress as compared to other fibres like jute, coir etc., and finally these tests are proved that it has more tensile strength and flexural strength than other fibres.

Index Terms – Aerospace, Alloys, Polymeric Materials.

1. INTRODUCTION

Historically, technical developments have centered around two main areas, firstly the development of more powerful and efficiently energy sources and secondly to obtain maximum possible motive power from the available energy. The second development is heavily dependent on the properties of the engineering materials. For example in aircraft and aerospace industries, a union of opposites i.e., lightweight in combination with high stiffness is demanded. In pressure vessels technology, high strength and corrosion resistance are both prerequisites for efficient operation.

1.1. Definition

A composite in its most basic definition is a material made up of two or more constituent materials. A composite material is a combination of at least two chemically distinct materials with a distinct interface separating the components. Concrete is a composite. It's made of cement, gravel, and sand, and often has steel rods inside to reinforce to it.

1.2. Formation

A composite can occur either naturally or may be synthetically produced. For example: Wood is naturally occurring, water plasticized composite consisting of oriented cellulose fibers in continuous cross-linked matrix of lignin.

In case of synthetically produced composites the reinforcement may be a metal as in the case with steel-reinforced concrete.

Long ago, people living in South and Central America had used natural rubber latex, polyisoprene, to make things like gloves and boots, as well as rubber balls, which they used to play games that were a lot like modern basketball. But if you've ever worn rubber gloves, you know that a raincoat made from rubber latex would be really uncomfortable. So sometime in the middle of the nineteenth century, a fellow by the name of Charles Macintosh came up with a clever idea.

1.3. Advantages of Composite Material

- High specific strength and stiffness
- Low specific gravity (light weight)
- Multiple load path and damage tolerance
- High fatigue strength
- Resistance to corrosion
- Part consolidation allows reduced number of assemblies and fastener count
- Possibility of molding complicated shape
- Ease of repair
- High dimensional stability
- Smooth outer surface
- Low coefficient of thermal expansion
- Resistance to fatigue damage, good damping characteristics

1.4. Limitations of Composite Materials:

- Poor erosion resistance
- Poor/no electrical resistance
- Degradation of characteristics in moisture
- High cost of material
- Special efforts for tooling, shop facilities, new inspection techniques, skilled man power.

1.5. Importance of Fibers

A common fiber-reinforced composite is Fiberglass reinforced. Its matrix is made by reacting polyester with carbon-carbon double bonds in its backbone, and styrene. We pour a mix of the styrene and polyester over a mass of glass fibers.

The styrene and the double bonds in the polyester react by free radical vinyl polymerization to form a cross-linked resin. The glass fibers are trapped inside, where they act as a reinforcement.

1.6. Importance of Matrix

The matrix holds the fibers together. A loose bundle of fibers wouldn't be of much use. Also, though fibers are strong, they can be brittle. The matrix can absorb energy by deforming under stress. This is to say, the matrix adds toughness to the composite. And finally, while fibers have good tensile strength (that is, they're strong when you pull on them), they usually have awful compression strength. That is, they buckle when you squash them. The matrix gives compression strength to the composite.

1.7. Composite

A homogenous material created by the synthetic assembly of two or more materials (selected reinforcing elements and compatible matrix resin) to obtain specific characteristics and properties.

The two phases that make up a composite are

(i) MATRIX

(ii) REINFORCEMENT

The matrix is the less strong phase being strengthened by the stronger reinforcing phase. Reinforcements can have various geometries like particles, fibers, flakes etc. The reinforcement basically enhances the flexural strength.

1.8. Sunhempfiber

Hemp fibers are longer, stronger, more absorbent and more mildew-resistant than cotton. Hemp can displace cotton which is usually grown with massive amounts of chemicals harmful to people and the environment. 50% of all the world's pesticides are sprayed on cotton.Fabrics made of at least one-half hemp block the sun's UV rays more effectively than other fabrics.

Fig 1: Sun hemp fibers for transportation

2. LITERATURE SURVEY

There are two types of resins. They are

1. Polyester resin.

2. Epoxy resin.

With our convenience we had taken polyester resin to fabricate our project because it has high bonding strength and having high viscous in nature and also low cost when compared to epoxy resins. The following is an extract from some old craft leaflets that still may be useful.

“Clear plastic, or to give it its correct name polyester resin, is the newest and most exciting craft material to have appeared on the horizon for many years. It is such a versatile substance that you can manufacture with it a wide range of objects, from useful articles for the home, to jewellery and ornaments in the form of mementoes inside crystal-clear resin.

The raw materials and equipment needed are not expensive to buy, nor do you need a special workroom or any complicated machinery. However usual health and safety precautions apply. Polyester resin is easy to use once you have mastered the few basic rules of the craft.

2.1. Resin

This is usually sold be weight in cans or in thick, lightproof containers, when they have a life of about six months. They should be kept in a cool place, and, as they are flammable they must not be used near a naked flame. Most craft kits sold in hobby shops contain the very clear embedding resin, but it is also possible to obtain thicker resins for laminating and moulding work, and a thyrotrophic paste resin which will stay in place on a vertical surface without dripping off. It can be added to ordinary resin to stop it flowing uncontrollably but it will make clear resin opaque.

2.2. Catalyst

Resin has to have catalyst added to it before it can harden. Once the catalyst has been added to the resin, hardening (sometimes called curing) begins, giving you about half an hour before it begins to gel. The stages of setting are: liquid, jelly, and soft rubbery consistency, and very hard.

2.3. .Molds

As polyester resin is a liquid until the catalyst is added to it causing it to cure, it has to be contained until it hardens. This means that a mould of some kind will be always be needed. Moulds can be purchased from craft shops, household utensils can be used, or you can improvise by setting the resin in frozen food containers and the like. Look around the kitchen. Spoons, ashtrays, dishes, waxed milk cartons, egg cups, foil trays, acetate box tops, detergent containers, can all serve as moulds. Pottery, Pyrex, polyurethane, glass,gypsum plasters, metal, epoxy resin or silicone rubber, are all suitable mould materials.

When pouring resin onto a flat surface, an excellent container can be made by sticking masking tape round the edge of a waxed board, or by building a low bank of modelling clay round the edge of a piece of acetate.

2.4. Release Agents

Resins bond extremely well to most surfaces, so in spite of the fact that the resin will slightly shrink when cured, it is important to treat the surfaces of all moulds with a release agent before pouring in the resin. Wax is one of the best of all release agents. Polish the surface of the mould twice with no silicone wax, until there is a high shine, then, with a sponge add a thin film of PVA Water-soluble release agent. Do not leave any ridges of wax or the resin will reproduce their impression. Once the release agent has been applied to the mould, do not touch it, or the protective film will be broken If you have an awkwardly shaped mould, run hot candle wax evenly round the inside before Pouring in the resin, to ensure an easy release. Cellophane, acetate and waxed paper are all good release materials.

2.5. Glass Fibre Chopped Strand Mat (CSM)

When reinforced with glass fibre, resin is strong, flexible and weatherproof, whereas by itself unless it is in block form it will break easily. When making mats, trays, lampshades, panels or anything with a flat exposed surface, therefore, it is best to reinforce the polyester resin with glass fibre. Glass fibre mat comes in various weights and widths, and can be cut with scissors. A layer of resin is applied to the mold, and left to cure, and then a layer of CSM is applied. It is stippled with a brush loaded with resin; until the mat becomes impregnated with it, when its white surface gradually changes appearance until it is almost transparent. When dry, the glass fibre gives the hard resin a slightly milky appearance. A very fine glass fibre mat is best for finished surfaces, and for translucent panels.

2.5.1. Colours

Pigments for use with resins come in many types. They can be transparent, opaque and also metallic, pearly and luminous. It is not advisable to use colours other than those specifically made for use with resins. Colours can be mixed completely in the resin, marbled for interesting effects, or layered to give depth.

2.5.2. Cleaner

Brushes and tools become rock hard if they are not cleaned immediately after use, so it is important to have in a good supply of cleaner. This is bought in craft shops as resin solvent, but acetone will also clean off resin. To clean brushes, wash them in solvent, wipe on rags or paper, and then wash in detergent and hot water. Don't use wet brushes for further work, but wait until they are dry. Water can inhibit cure. Never pour resin solvent that has been used for cleaning brushes down the sink. Resin solvent has toxic fumes, and should not be used in unventilated or confined space. It is also flammable and must be used away from naked flames. Dispose of by pouring onto paper or other dry material, and dispose of appropriately. Do not use resin solvent on hands. To clean hands, use a hand-cleaning product, a cleansing cream or wash hands well in soap and water.

2.6. Safety Precautions

- Always follow the manufacturer's instructions implicitly.
- Sensitive skins may be irritated by resin, so a good barrier cream or protective cream or protective gloves are advisable. Don't use resin solvent to clean hands, clean instead with cleansing cream.
- Catalysts may irritate the skin, so take care not to splash or spill them. If you do drop some on the skin, wash off at once. If catalyst should splash in the eyes, wash them immediately with clean water for 15 minutes, and then do not fail to consult a doctor.
- Using small amounts of resin for craftwork is not likely to cause vapour irritation, but work in a well-ventilated but warm room if possible.
- Resin, hardener and resin cleaner are all flammable. Keep away from naked flame.
- Do not pour resin down a drain. Soak up with dry material and dispose of appropriately.
- Use goggles to protect the eyes when polishing and sanding with a high-speed drill.
- Use a facemask to protect lungs from dust when sanding with a high-speed drill.

2.7. Types of Natural Fibers

- Sisal (Castro, 1981)
- From Agave Sisalana in Mexico
- –Durability problems caused by chemical decomposition in alkaline environment
- Coir (Balaguru, 1985)
- Coconut husks
- Very durable to natural weathering
- Increases modulus of rupture of concrete (MOR)
- Bamboo (Ghavami 2005; Rodrigues, 2006)
- E is very similar to that of concrete
- Susceptible to volume changes in water
- Increases ultimate tensile strength and MOR
- Jute (Balaguru, 1985)
- Grow in India, Bangladesh, China, and Thailand
- –Increases tensile, flexural and compressive strengths, as well as flexural toughness
- Akwara (Balaguru, 1985)
- Abundant in Nigeria
- No dimensional changes due to variations in water

- Alkali resistant
- No changes in flexural or compressive strengths
- Impact strength 5 to 16 times greater than unreinforced cement matrix
- Elephant Grass (Balaguru, 1985)
- Very durable – good rot and alkali resistance as well as small dimensional changes
- Increases flexural and impact strength
- Sun hemp(India)
- -increases tensile strength
- -increases flexural strength
- -very durable and good strength

2.8. Applications of Sun Hemp

Hemp production is easy to achieve organically. Therefore many of the ecological problems in chemical farming of other fibres are obviated. Hemp quickly grows up to 5 metres in height with dense foliage which blocks weed growth. This means herbicides are not needed and the field is weed free for the next crop. Unlike cotton hemp does not have a high water requirement. The hemp plant has a deep tap root system which enables the plant ot take advantage of deep subsoil moisture, thus requiring little or no irrigation. Hemp has been produced for thousands of years as a source of fibre for paper, cloth, sails/canvas and building materials. Natural fibre from the hemp stalk is extremely durable and can be used in the production of textiles, clothing, canvas, rope, cordage, archival grade paper, paper, and construction materials.

2.9. Hemp as Clothing and Textiles

China is currently the prime producer of hemp textile. China has had an uninterrupted hemp trade for approximately 6000 years. Other countries are now producing hemp textiles to a lesser extent. The once major hemp textile industry has now almost completely disappeared from the Western world. Currently the bulk of our demand for textiles is met by cotton and synthetics, both of which have serious environmental problems associated with them.

3. METHODOLOGY

We chosen hand layup method for fabrication

HAND LAY-UP: The process of placing and working successive plies of reinforcing material or resin-impregnated reinforcement in position on a mold by hand.

3.1. Materials

In the present work polyester resin, accelerator (cobalt napthenate), catalyst (methyl ethyl ketone peroxide) and styrene monomer (after removing the inhibitor) were used as matrix components.

3.1.1. Accelerator

A material which, when mixed with a catalyzed resin, will speed up the chemical reaction between the catalyst and the resin. Also known as "promoter".

3.1.2. Catalyst

A substance which changes the rate of a chemical reaction without itself undergoing permanent change in its composition; a substance which markedly speeds up the cure of a compound when added in minor quantity compared to the amounts of primary reactants (hardener, initiator or curing agent).

3.1.3. Polyester

Thermosetting resins, produced by dissolving unsaturated, generally linear, alkyd resins in a vinyl-type active monomer such as styrene, methyl styrene and diallyl phthalate. The resins are usually furnished in solution form, but powdered solids are also available.

3.2. Procedure

1. Prepare the glass mould for the fabrication of plastics

For making the test specimen different sample plates were prepared for tensile test, flexural test and density, of the glass mould of dimensions 150 * 150 * 4mm thick plates were cut and a mould cavity of 120 * 120 * 4mm is made by fixing 4mm thick glass plates of width 15mm and thickness 4mm on four sides of the plate using araldite. The mould has to be solidified in normal temperature. The post curing process will be done in furnace by maintaining the temperature 70.

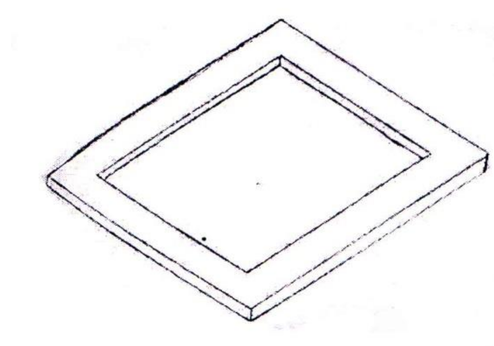


Fig 2: Preparation for Mould

2. The unsaturated polyester resin and styrene were mixed in the ratio of 100 and 25 parts by volume respectively. Later to this 0.5 parts each of accelerator and catalyst were added to the mixture.

3. The synthetic (glass) fibers were cut into required size and weighed accurately in each case. The sample plates prepared by varying the weight fraction of synthetic fibers.

NOTE: The resin and mold releases used in this experiment are skin and eye irritants. Do not allow either substance to touch exposed skin.s

4.First pour the polyester resin in to the jug so that stir the resin with a stirrer.

5. And then after few minutes catalyst of blue color liquid is mixed in the resin so that we can get color change of the mixture.

6. And finally accelerator is mixed in to the resin for dry of the mixture so that we obtain the liquid and then pour the liquid in the mould.

7. Close the mould with a glass plate on the mould and put the weight on the mould

8. Then procuring will be done for solidification of the resin with the time of six hours.

9. Then post curing will be done with a time of 3 hours in the vacuum furnace so that brittleness of the material will be reduced and finally bonding will be increased for the material.

10. And then remove the material from the vacuum furnace.

11. Then the materials tested by using tensile test and stiffness test by using universal machines.

3.3. Testing

3.3.1. Tension Test Using Tensometer

The tensile strength was determined by using microteck tensometer with precision cage arrangement.

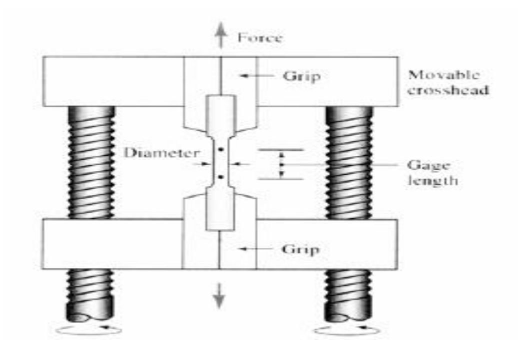


Fig 3: Specimen under Tension

3.3.2. Specimen for Tensile Test

Tensile test was performed to evaluate the ultimate tensile strength. A specimen of dumbbell shape with standard specification was cut from the composite plate ready-made. The cut tensile specimen was held in eccentric roller grips and the load was applied on the specimen gently and the mercury ran in the glass column from zero point. As the load increase, fracture occurred in the gauge length portion of the test specimen. The load at break was noted from the scale at the time of failure. The same procedure was repeated for other specimens cut from the same composite plate. Later, the average load at the break was noted and tensile strength was calculated on the basis of the following formula.

$$\text{Tensile Strength} = \frac{Average\,load\,break\,(kgs)}{Cross\,section\ area\ in\ gauge\,length\ portion\,(cm)^2}$$

3.3.2. Flexural Test on Simply Supported Beam

Flexural strength was determined using three point simply supported bending equipment attached with precision dial gauge and digital load indicator.

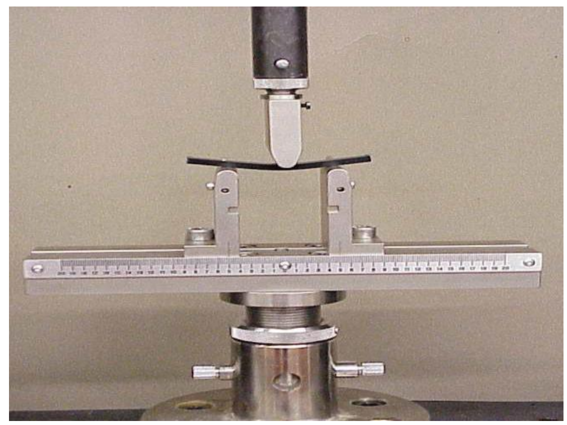


Fig 4:specimen under simply supported beam for stiffness

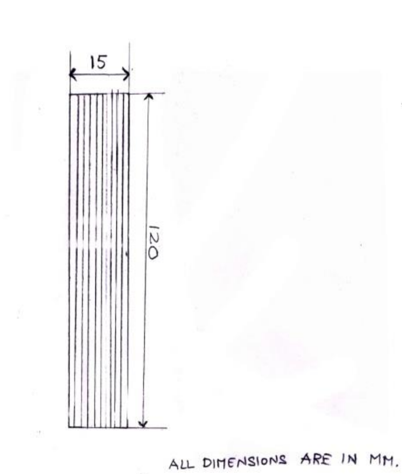


Fig 5 SPECIMEN FOR FLEXURAL TEST

A flat sample was made using the glass mould. The sample was placed on the knife-edges of the equipment and the system acts as simply supported beam. The specimen was loaded in uniform fashion by adding weights in an ascending order. As the load increases deflection was observed. This deflection was measured using a precision dial gauge with an accuracy of 0.01 mm. This gauge was fixed on a stand with magnetic base and placed at 1/4 length of the test specimen, and deflection was noted for every increase in weight. The test was repeated in the descending order and the average deflection was noted. The stiffness and young's modulus were calculated the formula.

$$E = (11WL^3) / (768YI)$$

$$\text{Stiffness} = \frac{Weight\,(kg)}{Deflection\,(mm)}$$

Where E = Young's modulus

W = Load applied (kgs)

L = Span length of beam (mm)

Y = Deflection (mm)

I = Moment of inertia of beam

The moment of inertia for the rectangular cross section is given by

$$I = \frac{bd^3}{12}$$

Where b and d are the breadth and thickness of the test specimen in mm respectively.

4. RESULTS AND DISCUSION

The tensile load at break for a composite with different weight fraction of synthetic fibers is presented in table 1. The tensile strength was calculated using the equation.

$$Tensile\ Strength = \frac{Load\ at\ Break\ (Kg)}{Cross\ section\ of\ the\ specimen\ (cm2)}$$

The variation of tensile strength at break with percentage weight fraction of fiber is shown in the graph.1. From figure and graph it is clearly evident that tensile strength is increasing with increase in percentage weight fraction of glass fiber. As the glass fiber possesses high tensile properties, the tensile properties of composite increases with percentage increase in glass fiber.

The stiffness of a composite with different weight fraction of glass fibers is presented in table 3. The stiffness was calculated using equation

$$Stiffness = \frac{Weight\ (kg)}{Deflection\ (mm)}$$

The variation of young's modulus with increase in percentage weight fraction of glass fiber is shown in graph 2. It is clearly evident that young's modulus increases with increase in percentage weight fraction of sun hemp fiber.

4.1. Tensile Test

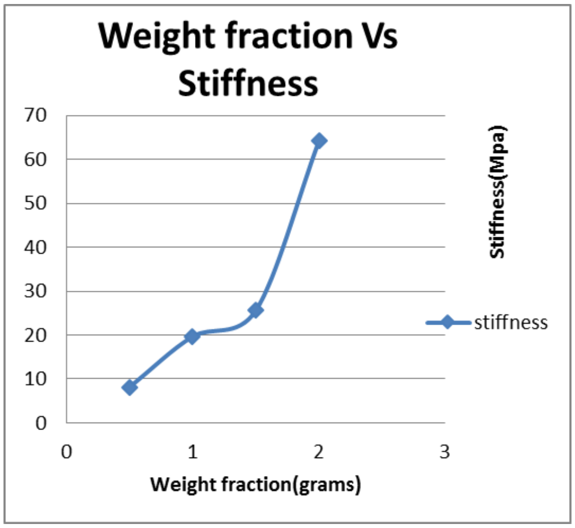
Weight fraction(gm)	Tensile stress(Mpa)
0.5	10.394
1.0	11.791
1.5	12.682
2.0	13.654

4.2. Flexural Test

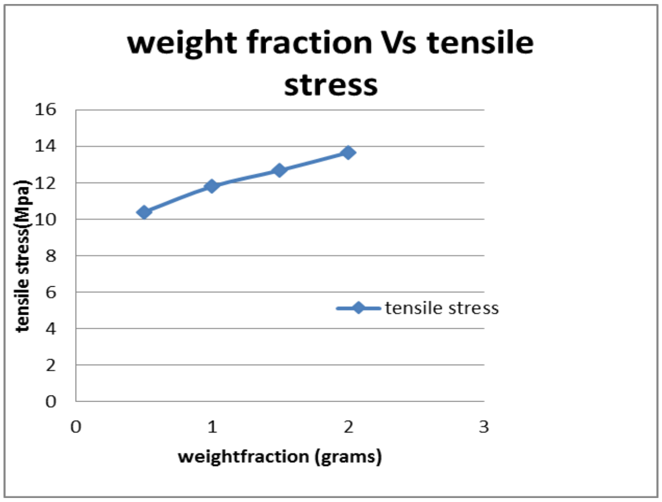
Weight fraction(gm)	Stiffness(Mpa)
0.5	8.187
1.0	19.694
1.5	25.608
2.0	64.187

4.3. Graphs

4.3.1. For Stiffness



4.3.2. For Tensile Stress



5. CONCLUSION

The fabrication and testing of sun hemp natural fiber reinforcement of composites was done successfully and the sun hemp has high tensile strength and also high stiffness when compared to other natural fibers. By this fabrication and testing of natural fiber (sunhemp) reinforced composites we can improve the tensile strength and stiffness of the matrix.

We had chosen sun hemp as natural fiber because it has maximum tensile strength and flexural strength when compared to other fibers like jute, coir etc., Sun hemp is easily cultivated and abundantly available in India's we concluded that this natural fiber is used for many applications to improving strength factors.

REFERENCES

[1] Plastic Engineering: R.J.CRAWFORD.
[2] Identification and Testing of Plastics: A. S. ATHALYE
[3] Plastics-microstructures properties and applications : N. J. MILLS
[4] Plastics Technology: WILLIAM.J.PATTO
[5] Material Science Engineering : WILLIAM. D.
[6] Composite materials : S.C.SHARMA
[7] Polymer Science: GOWARIKAR
[8] Bulletin of material science Published by INDIAN ACADEMY OF SCIENCES
[9] Indian Journal of engineering and material science Published by NATIONAL INSTITUTE OF SCIENCE COMMUNICATION AND INFORMATION RESOURCES, **CSIR**
[10] Google Search
[11] www.compositetek.com
[12] www.wikipedia.com
[13] www.fadooengineers.com