A project report on

Structural analysis of fixed wing drone(UAVs)

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Contents:

Abstract:

"Unmanned aerial vehicle (UAVs) better known as drones are one of technological marvel of our age .They can document the aftermath disaster without putting additional people at risk but UAVs having short flying time like fixed wing type, multi rotor and other types of UAVs due to it's materials weight , going to become a impractical for typical consumer. To find feasible and required materials for them, bending and torsional properties of different composite materials are studied and presented in this paper. Mainly structural analysis of balsa wood and carbon fibre sandwich composite is tested with finite element's software(ANSYS).The finite element method was employed to determine total deformation, equivalent strain ,shear strain ,equivalent stress, shear stress, directional stress of sandwich composite beam and wing of fixed wing type drone for different layers of carbon fibre "

Introduction:

What are they and who uses them? Some call them drones, some apply the label "quadcopters" as a blanket term—though they can have any number of rotors or even be planes—the FAA calls them "unmanned aerial systems" (UAS). I prefer to call them "unmanned aerial vehicles" (UAVs), a neutral term broad enough to safely include pretty much the whole gamut, from Hubsan nano drones up to commercial and military aircraft weighing hundreds of pounds and basically the size of small manned planes.

Fig.DJI Phantom 4 Quadcopter

UAVs are and aren't new. Starting somewhere around 2013, a new trend emerged in the tech toy and aerial imaging market—an explosion in popularity of compact multi-rotor RC aircraft, perhaps most notably the **DJI Phantom 4**, a compact quadcopter featuring a gimbal-stabilized aerial camera. RC enthusiasts will, of course, cry foul. They will point out RC—unmanned—aircraft have been around for decades—nay, longer*—not to mention that pilots have been equipping them with cameras for FPV since cameras got small and video transmitters got cheap. While this is true, the market was always a niche one, the exclusive realm of dedicated model-builders (a handful of professional users aside) to whom few on the outside paid much attention or of whom they were even aware.

If there is one overwhelming breakthrough that put consumer and prosumer UAVs on the map, it was computerized flight-control systems and multi-rotor technology, the latter not possible without the former. Traditional RC aircraft require skill to fly and many become quite expensive (you may have to remortgage your house to pay for some). Many are powered by tiny gas engines, some even turbines, and fly at scaled speeds competitive with manned aircraft. Multi-rotor UAVs, as distinct for helicopters by virtue of the complexity of their control systems, require a computer to regulate control input. Unlike planes, there is no rudder, no ailerons; just propellers. The only way to modulate flight is by spinning the rotors at different speeds, and there is just no way to do this manually. A side effect of this fly-by-wire implementation is that they can basically pilot themselves, especially when equipped with GPS, optical flow, and other guidance systems. This means just about anyone can fly; though I suppose it's an open question if just anyone shouldfly.

Because they can follow very precise flight patterns, as well as hover in a fixed position (assuming GPS or optical flow), it was inevitable that one of the most popular-use cases for multi-rotors would be imaging. And, as luck would have it, at the same time, HD and 4K cameras have gotten really compact and really cheap (compared to the quality that they pump out), making strapping one to a UAV pretty much a no-brainer.

"***Drones***" can be classified on a different basis – say based on 'usage' like Drones for Photography, Drones for aerial Mapping, Drones for Surveillance etc. However, the best classification of 'Drones' can be made on the basis of aerial platforms. Based on the type of aerial platform used, there are 4 major types of drones.

1.Multi Rotor Drones

2.Fixed Wing Drones

3.Single Rotor Helicopter

4.Fixed Wing Hybrid VTOL

1.**Multi Rotor Drones**:-

Out of all the 4 drone types (based on aerial platform), multi-rotor drones are the easiest to Multi Rotor drones are the most common types of drones which are used by professionals and hobbyists alike. They are used for most common applications like aerial photography, aerial video surveillance etc. Different types of products are available in this segment in the market – say multi-rotor drones for professional uses like aerial photography (whose price may range from 500USD to 3K USD) and there are lots of variants for hobby purposes like amateur drone racing, or leisure flying (price range from 50USD to 400USD). manufacture and they are the cheapest option available as well.

Fig : Quardcopter drone

Multi-rotor drones can be further classified based on the number of rotors on the platform. They are Tricopter (3rotors), Quadcopter (4rotors), Hexacopter (6rotors) and Octocopter (8 rotors). Out of these, Quadcopters are the most popular and widely used variant.

Although easy to manufacture and relatively cheap, multi-rotor drones have many downsides. The prominent ones being it’s limited flying time, limited endurance and speed. They are not suitable for large-scale projects like long distance aerial mapping or surveillance. The fundamental problem with the multicopters is they have to spend a huge portion of their energy (possibly from a battery source) just to fight gravity and stabilize themselves in the air. At present, most of the multi-rotor drones out there are capable of only a 20 to 30 minutes flying time (often with a minimal payload like a camera).

2.Fixed Wing Drones:

Fixed Wing drones are entirely different in design and build to multi-rotor type drones. They use a ‘wing’ like the normal airplanes out there. Unlike multi-rotor drones, fixed wing type models never utilize energy to stay afloat on air (fixed wing types can’t stand still on the air) fighting gravity. Instead, they move forward on their set course or as set by the guide control (possibly a remote unit operated by a human) as long as their energy source permits.

Fig: fixed wing drone

Most fixed wing drones have an average flying time of a couple of hours. Gas engine powered drones can fly up to 16 hours or higher. Owing to their higher flying time and fuel efficiency, fixed wing drones are ideal for long distance operations (be it mapping or surveillance). But they can not be used for aerial photography where the drone needs to be kept still on the air for a period of time.

The other downsides of fixed-wing drones are higher costs & skill training required in flying. It's not easy to put a fixed wing drone in the air. You either need a 'runway' or a catapult launcher to set a fixed wing drone on its course in the air. A runway or a parachute or a net is again necessary to land them back in ground safely. On the other side, multi-rotor drones are cheap – anyone with a few hundred dollars to spare can buy a decent quadcopter. Flying a quadcopter doesn't require special training. You just take them to an open area and fly it. Guiding and controlling a quadcopter can be learned on the go.

3.Single Rotor Dones:

Single rotor drones look very similar in design & structure to actual helicopters. Unlike a multi rotor drone, a single roter model has just one big sized rotor plus a small sized one on the tail of the drone to control its heading. Single rotor drones are much efficient than multi rotor versions. They have higher flying times and can even be powered by gas engines. In aerodynamics, the lower the count of rotors the lesser will be the spin of the object. And that's the big reason why quadcopters are more stable than octocopters. In that sense, single rotor drones are much efficient than multi-rotor drones.

Fig: single rotor drone

However, these machines comes with much higher complexity and operational risks. Their costs are also on the higher side. The large sized rotor blades often pose a risk (fatal injuries have been recorded from rc copter accidents) if the drone is mishandled or involves in an accident. Multi-rotor drones, often owing to their small rotor blades have never been involved in fatal accidents (though a scar on human body is likely). They also demand special training to fly them on air properly (though they may not need a runway or a catapult launcher to put them on air).

4.Hybrid VTOL:

These are hybrid versions combining the benefits of Fixed wing models (higher flying time) with that of rotor based models (hover). This concept has been tested from around 1960's without much success.

However, with the advent of new generation sensors (gyros and accelerometers), this concept has got some new life and direction.

Fig: Hybrid VTOL

Hybrid VTOL’s are a play of automation and manual gliding. A vertical lift is used to lift the drone up into the air from the ground. Gyros and accelerometers work in automated mode (autopilot concept) to keep the drone stabilized in the air. Remote based (or even programmed) manual control is used to guide the drone on the desired course.

There are some versions of this hybrid fixed wing models available in the market. However, the most popular one is drone used in Amazon commercials (for its Prime delivery service).

How they work

UVAs break, with some variation, into these components:

Main Controller (MC):

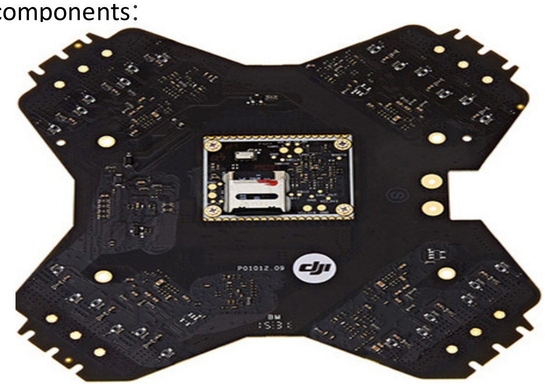


Fig. DJI ESC Center Board and MC V2 for Phantom 3 Professional/Advanced Quadcopte

The heart of the flight-control system, this can be thought of as the “brains” of the UAV. It is an embedded computer (many run Linux) that has custom software for controlling the aircraft, sometimes user-reprogrammable through a software development kit (SDK). In some designs, the MC is a separate module with connection ports. On others, especially consumer products, there may be a single circuit board (PCB) that includes the MC, gyros/sensors, electronic speed controllers (ESCs), and other core flight electronics.

With modular designs, some form of connectivity—analogous to SATA ports inside a computer—is provided, allowing peripherals and user upgrades to be installed. CAN-Bus is widely used. This is an automotive serial interface technology developed in the 1980s that has been repurposed in a diverse range of control-by-wire vehicles including, among other things, combines.

Modular systems have the advantage that they can usually be replaced or upgraded. Early on, a major part of DJI’s business model was selling its **Naza-M** and triple-redundant **A3 Pro** flight controllers to third-party UAV makers and individual multi-rotor builders.

Gyros/Sensors:

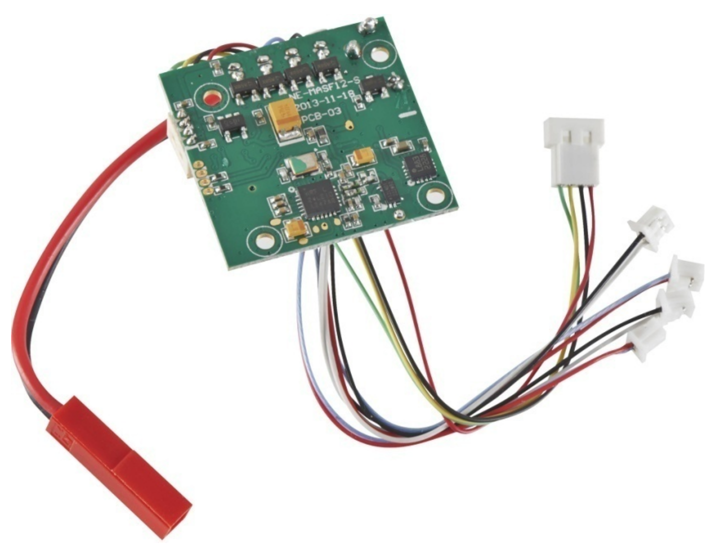


Fig. Heli Max TAGS-FX Control Board for 230Si Quadcopter

For autonomy to work, the MC needs to track how the aircraft is flying. To accomplish this, some form of sensor array is provided. Generally, it will include accelerometers, inertial measurement units (IMUs), and gyros, and may also work in conjunction with positional data from an optical flow system or GPS/compass. Basically, these sensors tell the UAV how fast its acceleration is changing, in what direction, and whether it is right-side up. Those familiar with motorized gimbal camera stabilizers may recognize the same sensor technology being employed here as in gimbals.

Electronic Speed Controllers (ESCs):

Fig.- HUBSAN ESC for H501S X4 FPV Quadcopte

Each motor has an ESC (though some designs put all on one board). In its most basic form, an ESC regulates power going to the motor with which it is paired. More sophisticated systems can also relay data back to the MC, such as vitals about how the motors are performing. With six or more rotors, active feedback makes it possible to keep flying (enough to land safety) if one motor fails.

Receiver:

Fig.-Spektrum AR400 4-Channel DSMX RC Aircraft Receiver

This receiver is for the radio control system. It pairs (“binds”) with the controller the pilot or operator holds, which logically, if confusingly, is known as the “transmitter.” Modern receivers typically operate in the 2.4GHz range (like other license-free radio systems, such as Wi-Fi) and have four or more channels, extra channels enabling custom functionality to be relayed via the control signal, in addition to basic piloting inputs. In the hobby world, these extra channels might be used for anything from retracting/extending landing gear to firing off a smoke generator. In aerial imaging applications, the extra channels can sometimes be dedicated to gimbal or camera control.

Motors:

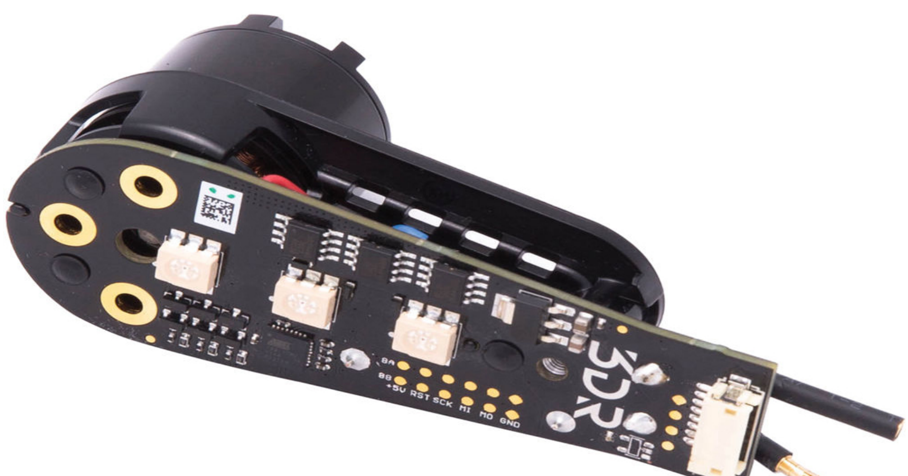


Fig.-3DR Motor Pod for Solo Quadcopter

In most cases, these are brushless electric motors. The motors are usually paired, each pair a set containing one clockwise (CW) motor partnered with one counterclockwise (CCW) rotating motor, though they may be sold individually. It is important when replacing them or building your own system to use the correct rotational direction in the correct position. This can get confusing, because the propellers are often designated CW or CCW based on which way they screw on, not which way they rotate—which is probably the opposite direction.

Propellers:

Fig.-veho Self-Tightening Propeller Blades for Muvi Drone

Light UAVs use plastic propellers, which resist breaking on impact because they are flexible, and they are safer. Heavier models use carbon fiber or other more rigid materials (planes frequently use wood or nylon/glass). Carbon fiber propellers are dangerous, even deadly, and should be used only by experienced pilots and well away from people. Unless extreme performance is a concern, the benefits of carbon fiber over plastic are marginal on multi-rotors.

Transmitter:

Fig.3DR 2.4 GHz, 9-Channel Transmitter for IRIS Quadcopter

This is the radio controller. For an increasing number of tech toy and entry-level UAVs, the "transmitter" is simply the combination of a mobile app and a Wi-Fi-enabled tablet or smartphone (**Parrot** uses Wi-Fi control for all of its quadcopters). UAVs equipped with receivers, such as **Spektrum** and **Futaba**, can work with a range of transmitters. This allows the user to select the best fit, depending on what features they are looking for and what their budget might be. It should be noted: these tend to be proprietary, so with a Brand X receiver you'll probably need a Brand X or, at the very least, a Brand X-compatible transmitter. Systems that include a transmitter (as well as other basic accessories required for flying) are dubbed "ready-to-fly," and are the simplest to jumpstart the beginner.

When investing in a transmitter, generally, compatibility can be determined by referring to the specs for the receiver. It will need to support the same protocol as the receiver and support at least as many channels as the receiver requires. So, for example, a DSMX 4-channel receiver will work happily with a DSMX 6-channel transmitter. For advanced configurations, one also needs to consider secondary systems that will need to inter-operate with the transmitter, such as a **telemetry radio**.

Transmitters can range anywhere from simple two-joystick jobs for remote-control toys up to highly sophisticated pieces of electronics with advanced programming to support myriad aircraft configurations, expandable model memory, telemetry displays, audible feedback, and trainer ports. In many ways, high-end transmitters are more complex than aircraft they fly.

Other hardware systems that are not essential to the archetypical UAV but are nonetheless common, include:

- GPS
- Optical flow
- Obstacle avoidance
- Telemetry/OSD
- Ground station

GPS:

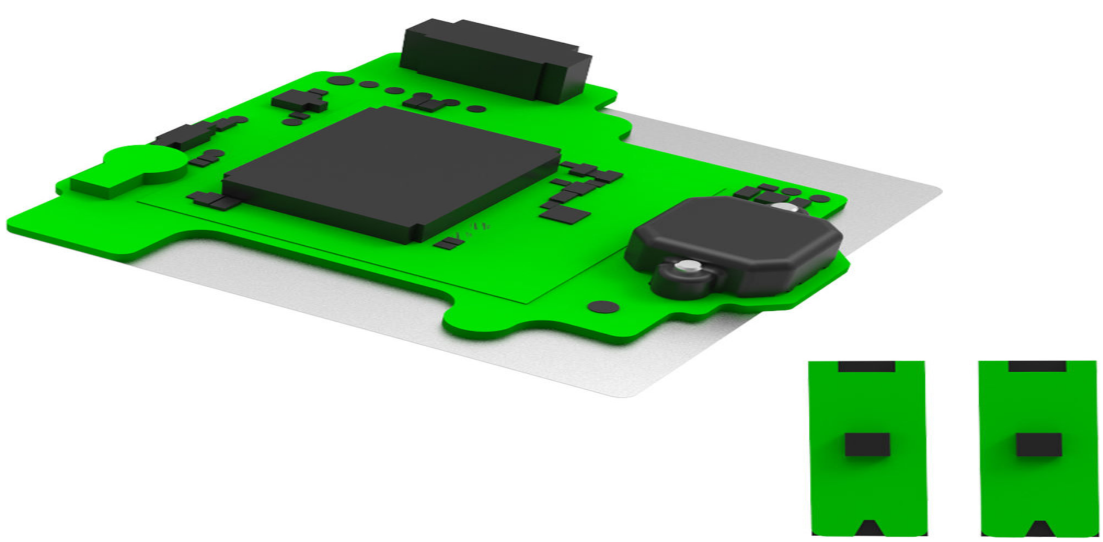


Fig.-Parrot GPS Board for BeBop 2 Drone

Once you transcend the toy category, GPS—often generically referred to as GNSS to include GLONASS and other systems—is pretty standard on multi-rotors. By providing (relatively) precise positional data, GPS enables flight modes including fixed hovering, auto return home, orientation control, and safety “bubbles” that limit how close the UAV can get to the pilot. GPS also provides an extra level of granularity to further enhance flight stability. UAVs that are equipped with GPS can generally fly without it, but will lose some of their autonomy. Thus, they are more dependent on the skills of the pilot to stay airborne. For GPS to work, a compass is also required to provide bearing, and compass calibration may involve a baroque but essential pre-flight routine.

Optical Flow:

Fig.- DJI Vision Positioning Module for Inspire 1 Quadcopter

Optical flow—known as **Vision Positioning** on DJI-based systems—is designed to do indoors close to the ground what GPS does outside at higher altitudes. In classic implementation, there is a camera taking high-frequency still images to keep track of its relative position, using a technique called “motion estimation.” Since current optical flow can only provide relative positional data within limited bounds, it will not give you full autonomous functions, such as return home, but does enable fixed hovering. In addition to optical flow, some systems, like DJI’s, also feature an ultrasonic emitter and microphone to augment vision data à la sonar.

Although designed to promote indoor flying, optical flow does not enable safe operation near, or especially over, people. It relies on an unobstructed view of the floor (or other static surface) and with current systems is only good at heights up to 7' or so, which would put the UAV directly over the average person’s head, not to mention collide with many basketball players. Furthermore, Ultrasonic systems should not be used around animals with acute hearing, such as dogs, as the emissions are audible and can cause discomfort or be frightening.

Obstacle avoidance:

While GPS and sensors enable UAVs to basically fly themselves, they work on the assumption of unobstructed air space. Starting in 2015, we began to see the first consumer collision avoidance systems.

Yuneec's adaptation of **Intel® RealSense™**, for example. Obstacle avoidance provides awareness of the surrounding environment, not only helping the UAV to not bump into anything, but also memorizing a 3D map that can be called up later when updating an autopilot flight line. This technology puts UAVs one frightening step closer to the science fiction/horror nightmare of full vehicular autonomy.

It should be noted that having obstacle avoidance is no reason to throw safety out the window or willfully operate in the vicinity of objects into which one might crash. Hardware and software are fallible, and even with the best systems, the UAV can only react so quickly. With aircraft exceeding speeds of 50 mph and no "brakes," so to speak, a lot can go wrong—and fast

Fig.- YUNEEC Typhoon H Hexacopter with Intel® RealSense™, GCO3+ 4K Camera, and Backpack

Telemetry/OSO:

Fig.- An example of First Person View

Telemetry is data about your flight—speed, altitude, battery voltage, etc. This can be viewed in several ways. The old-school way is via a display built into transmitter. In some cases, the telemetry will operate on its own radio system with a unique frequency, so a transmitter with a dedicated telemetry receiver or the ability to install one is required. More recent is on-screen display (OSD), an addition to FPV that superimposes select data over the video feed from the flight camera. In this case, an OSD module is required, through which the video feed will pass after leaving the camera, and before arriving at the video transmitter.

Ground station:

Fig.- DJI 2.4G Bluetooth Data Link for DJI iPad Ground Station

A **ground station** is an all-in-one solution for control, FPV, telemetry data, and even full autonomous flying. It may be unified into one air-end and one ground-end component or may require a complex assortment of hardware. Ground stations center around desktop software or an app. In many cases, the software alone is all that is required for operation; though a transmitter can often be tied to it for direct manual control.

In spite of the restriction on BVR, which rules out many commercial applications, for aerial video and photo it is still possible to take advantage of "waypoint" flying to set highly controlled flight patterns for the sake of predicable, repeatable shots, even while keeping the aircraft within visual range.

Safety:

UAVs are airborne vehicles that can travel at high speed—up to 50 mph or so for multi-rotor camera platforms, and much faster for fixed-wing planes and RC rotorcraft (i.e., conventional helis). Inherently, they have the potential to be very dangerous. Most safety advice takes the form of common sense, but common sense that all too often gets ignored. Here are some general tips to consider:

• Follow all pre-flight calibration steps very closely, especially compass and GPS calibration

• Maintain visual contact at all times—FPV does not count as "visual contact"

• Stay below 400' above ground level (AGL); in certain locales, even lower

• Do not fly over people, private property, or in urban settings

• Do not fly within 5 miles of airports, in restricted airspace, or near helipads

• Learn how to control your aircraft manually, even if you plan to use autopilot functionality in practice; consider investing in a "starter" aircraft or flight simulator software to get experience flying

Beyond these general tips, your best resource will be other fliers. In particular, consult RC clubs in your local area and contact members of organizations like the AMA for advice. Even if you don't see yourself as a hobbyist, RC clubs will have the best advice in terms of dos and don'ts, and should be able to direct you to courses, should you wish to learn from an instructor or need assistance troubleshooting.

Beyond multi-rotors:

The buzz these days, of course, surrounds multi-rotor configurations, usually quadcopters. But the RC world has known several Jurassic types that long predate these newcomers:

• Planes

• Sailplanes/Gliders

• Helis

Planes:

Fig.- E-flite Carbon-Z Cub BNF Basic

Planes are fixed-wing, usually with a single nose rotor, like a miniature Cessna. The motor may be a small heat engine or, especially in smaller, lighter categories, electric. Jet-inspired turbine engines are also available, but not recommended for the faint of heart.

Sailplanes/Gliders:

Once launched-tossed into the air-gliders take advantage of thermals, soaring like hawks. A simple battery-powered rudder/elevator system gives the pilot control, making them true RC aircraft, not simply glorified paper airplanes. Be aware of cheaters, though. Occasionally motorized aircraft will sell themselves as gliders. These imitators feature broad, glider-style flight surfaces, enabling extending glide times with the motors shut off. These fake gliders are sometimes used in commercial applications, such as mapping, due to their long range.

Helis:

Fig.- **Swann Bubble Bomber RC Helicopter**

Do not confuse helis with multi-rotors. Helis have a control surface modeled after real helicopters and, as such, are very difficult to fly. There is one or more main rotor to provide lift, plus a tail rotor to counteract torque from the main rotor. So-called multi-rotors, in contrast, have symmetrical-sized propellers, usually arranged in clockwise/counterclockwise pairs.

Outliers:

Fig.- Xcraft X PlusOne Platinum

Not everything fits neatly into a category, of course. The Xcraft X PlusOne, for instance, can't decide whether it is a plane or a multi-rotor. It features four horizontally-oriented rotors and takes off and lands vertically. But once safely in the air, a transformation happens. The X PlusOne tilts 90-degrees and flies "forward," a static, wing-shaped body providing lift. This unorthodox arrangement enables the X PlusOne to achieve speeds of up to 60 mph. There are no ailerons, elevons, rudders, or kindred flight surfaces in the usual sense. Instead, variations in motor speed are what maneuver it.

There are no formal definitions, and if there is one thing we gear heads are known for, it's endless semantic debates over correct jargon usage. In terms of camera-equipped UAVs and those capable of carrying cameras (excluding the serious RC hobby market), we can *again* roughly break classes down as follows:

1.Consumer

Prosumer

Professional

Consumer:

Fig.- HUBSAN H108 SPYDER Quadcopter

Here the term "consumer" encompasses the "tech toy" category, as well as what we might regard as "starter" hobby aircraft. They are compact, 350-sized maximum (**), or smaller for quads. While many have cameras, these cameras are primarily for showing off to friends and FPV; they lack stabilization and, therefore, are not suitable for most dedicated video or photo use. They tend not to have GPS or much in the way of autonomy, but offer "fun" features-you decide whether they are gimmicks or not-such as one-button flips and the ability to "easily" perform other acrobatic maneuvers.

Prosumer:

"Prosumer," somewhat nebulously, covers the lower end of aircraft, mostly quadcopter and a handful of hexa-rotors, which are designed specifically with video and photo in mind. A common implementation is to combine a GoPro HERO or similar action camera with a 2- or 3-axis gimbal for stability. I would put these in the "prosumer" category, as some users may be enthusiasts looking for more than what the entry level offers, while others may be shooters who are primarily into capturing great images, as opposed to being RC geeks. Generally, I would hesitate to consider most of these hobbyist vehicles, since virtually all are multi-rotors-and multi-rotors, deserved or otherwise, have a reputation in the RC community of being somewhat graceless-more about enabling VTOL and fixed camera angles and less about performance or skilled technical flying. However, there is nothing stopping hobbyists from tricking quads out and flying them for the sheer enjoyment of flying.

Fig.- YUNEEC Typhoon H Hexacopter with GCO3+ 4K Camera

Professional:

Fig.- YUNEEC Typhoon H Hexacopter with GCO3+ 4K Camera

Professional UAVs will include most hexa-rotors and virtually all octo-rotors and up. These are designed specifically to carry payloads, such as cameras. In terms of platforms that can be purchased through retail outlets such as B&H, pro UAVs max out at about a 25-lb payload in stock configuration. This is enough to satisfy even high-end production requirements. Thanks to compact, high-speed recording media such as CFast and the miniaturization of camera electronics, cinema-quality acquisition is possible in cameras that fall within this weight range.

We concerned with short flying time of drone by virtue of it's material weight

Why we concerned with short flying time?

Ans: because, short flying time is going to become impractical for typical consumer ,navigator and Indian Air force.

Short flying time is impractical because short flying time drone takes more time in doing a particular task another reason is high fuel consumption rate i.e high power consuming rate. For same capacity of battery, flying time will be more for light weight drone than heavier weight drone .So, light weight drone will be more practical than heavier weight drone and also light weight drone will be cost effective in case if we talk about cost of input power.

Justification for cost effective-If drone will have light weight it will fly for longer time for same capacity of battery .As number of batteries required to travel particular distance in particular time for light weight drone will be less .Hence, it will reduce the operating cost of a drone .

3.literature review in a nut cell:

There may be existence of another problem but here only we will elabolately discuss about weight of drone which is related to material selection for drone

By the market analysis it proved that consumer have a issue related to weight of drone in other word, short flying time .Because of short flying time user have to spend more time in setting up the drone for flying again in performing a given task .Earlier it was not a big issue but as along as time is going on application of drone becoming more and more . Our age of technology marvel consumer facing a problem with drone short flying time .This problem bring some hindrance in doing in our busy life .These days people have very less time ,they always try to do work in a short time and in sophisticated manner .So sort flying time becoming a big issue. For instance a photography drone if it have short flying time then navigator will take more time to capture image and analysis them and making a conclusion from that analysis.

So by considering above issue we trying to do some research on that which is presented in this paper.

4. Objectives:

Selection of required material for increasing the flying time of drone by structural ,model, dynamic and crash and others analysis of it's materials by fine element method .

Here we will considered various materials for structural load analysis by finite element method so that we will be able find most appropriate materials

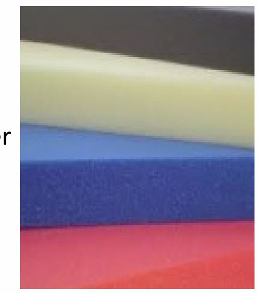
5.Methology:

Below are the more common materials found in multi-rotor drones. This list does not include all possible materials which can be used and should be looked at as a guideline / opinion as to the use of each material to make the frame of a drone. Ideally the frame should be rigid with as minimal vibration transmission as possible.

Wood

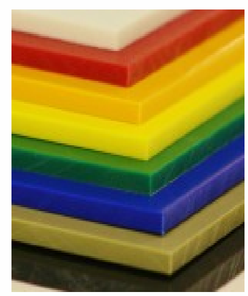
If you want your frame to be as inexpensive as possible, wood is a great option, and will greatly reduce build time and additional parts required. Wood is fairly rigid and has been a proven material time and time again. Although the aesthetics may suffer, replacing a broken arm after a crash is relatively easy and "dirt cheap". Painting the arm helps hide the fact that it's wood. Ensure you use wood which is straight (no twisting or warping).

Foam



Foam is rarely used as the sole material for the frame and there tends to be some form of inner skeleton or reinforcement structure. Foam can also be used strategically; as propeller guards, landing gear or even as dampening. There are also many different types of foam, and some variations are considerably stronger than others. Experimentation would be needed.

Plastic



Most users can only access and work with plastic sheets (rather than 3D plastic shapes or objects). Plastic tends to flex and as such is not ideal. Used strategically (such as a cover or landing gear), plastic can be a great option. If you are considering 3D printing the frame, consider the time needed to print the part (versus buying a plastic frame kit), and how rigid the part will be in the air. 3D printing parts (or the entire frame) has so far been more successful on smaller quadcopters. Using plastic extrusions may also be an option for small and medium sized drones.

Aluminum

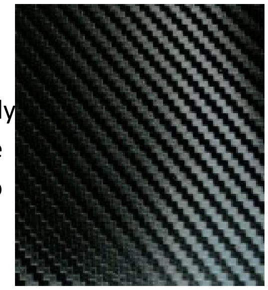
Aluminum comes in a variety of shapes and sizes; you can use sheet aluminum for body plates, or extruded aluminum for the support arms. Aluminum may not be as lightweight as carbon fiber or G10, but the price and durability can be quite attractive. Rather than cracking, aluminum tends to flex. Working with aluminum really only requires a saw and a drill; take the time to find the right cross section (lightweight and strong), and try to cut out any non-essential material.

G10

G10 (variation of fiberglass) is used as a less expensive option than carbon fiber, though the look and basic properties are almost identical. G10 is mostly available in sheet format and is used largely for top and bottom plates, while tubing in carbon fiber (as compared to G10) is usually not much more expensive and is often used for the arms. Unlike Carbon Fiber, G10 does not block RF signals.

PCB

Printed Circuit Boards are essentially the same as fiberglass, but unlike Fiberglass, PCBs are always flat. Frames <600mm sometimes use PCB material for top and bottom plates, since the electrical connections integrated into the PCB can reduce parts (for example the power distribution board is often integrated into the bottom plate). Small quadcopter frames can be made entirely out of a single PCB and integrate all of the electronics.



Carbon Fiber

Carbon fiber is still the #1 sought-after building material due to its light weight and high strength. The process to manufacturer carbon fiber is still quite manual, meaning normally only straightforward shapes such as flat sheets and tubes are mass produced, while more complex 3D shapes are normally "one off". Carbon fiber impedes RF signals, so be sure to take this into consideration when mounting electronics (especially antennas).

Silica Aerogel:

World lightest materials(density 0.12 to 0.15 g/cm^3) plus excellent thermal resistance, very fragile and brittle in nature .

Balsa wood:

Balsa is the tree *Ochroma pyramidale* or the light-weight wood.

It is soft, and buoyant. It is even lighter than cork and thus has long been used for lifebelts, and life preservers. It was famously used by Thor Heyerdahl in his raft Kon-Tiki. Indeed, the name balsa derives from Spanish for a raft.

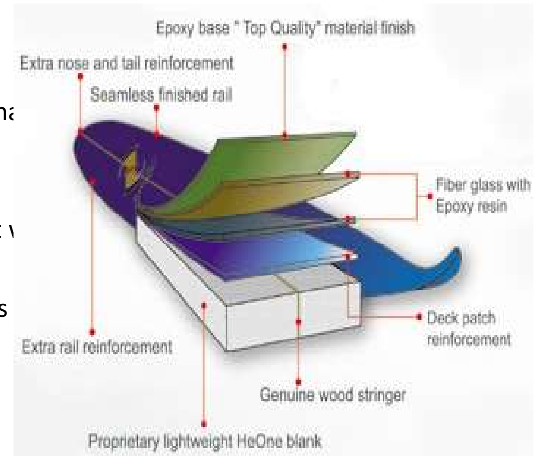
As a light and soft material, it is also a very popular material for model building. As cork is low in density but high in strength, it is also used when making wooden crankbaits (fishing lures) for fishing.
Balsa wood has good insulating properties, and thus is used for refrigerators, and cold-storage rooms, and it also is good for insulating for sound.
Balsa wood is used to make very light, stiff structures in model bridge tests and for the construction of light wooden airplanes, most famously the World War II de Havilland Mosquito. In modern airplanes, it is used for constructing passenger compartments. Balsa also is used in the floorpan of the Chevrolet Corvette Z06 sandwiched between two sheets of carbon fiber. In table tennis blades, a balsa layer is typically sandwiched between two pieces of thin plywood. Balsa wood is also used for making high-quality balsa surfboards.

As drone tend to be smaller than conventional aircraft and with a limited fuel capacity their flight time to be significant lower than those of manned counterparts .The issue becomes even greater when considering the payloads of vehicle which range from a set of hellfire missile to small camera for civilian use.

In order to improve this ,a reduction of weight in aircraft is paramount and use of conventional aerospace materials such as aluminium 6061-T6 might not be a feasible design option in the construction of UAVs. As a result composite materials take a control role in the design and manufacture of drones.

Composite materials:

- A composite are materials made of two(a matrix or bider and a reinforce)



or ,composite with different physical or chemical properties .

- When these materials are combined the new materials ha different characteristic from the individual components.

- The individual components remain separate and distinct v finished structure .

- Composite material especially polymer matrix composites reinforced with continue fibre are most appropriate choice Mostly used matrices materials are polymer metal ,ceramics and carbon while fillers materials are glass ,carbon , aramid and boron.

By thoroughly study of different materials behaviour and their physical and chemical properties we choose a feasible a composite materials made of Balsa (Ochroma pyramide) wood and carbon fibre on the basis of their physical and chemical properties.

So now onwards we will be describe about complete study *of* ***balsa wood and carbon fibre composite materials*** **:-**

We consider a rectangular beam of dimention 60 mm*100 mm*900 mm

Beam is fixed supported at one end and elliptical variable pressure load is applied on it's a surface .

Elliptical equation can be defined as follows-

F(x)= Ka* sqrt(L^2-x^2)

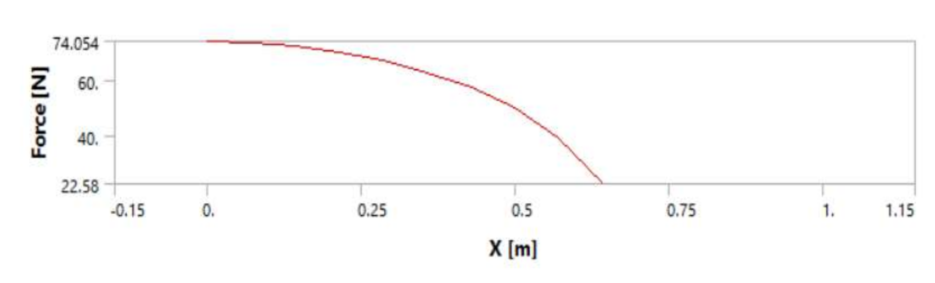
Where 'Ka' is lift profile coefficient

On taking total load of 2 kg

If we assume beam as wing and total lift force on one side is 2kg then required equation for elliptical profile will be-

One side Lift strength= 109.71*sqrt(.675^2 -x^2)

Graph for load Vs distance from fixed support :



	X [m]	Force [N]
1	0.	74.054
2	7.1429e-002	73.638
3	0.14286	72.377
4	0.21429	70.224
5	0.28571	67.093
6	0.35714	62.839
7	0.42857	57.213
8	0.5	49.749
9	0.57143	39.418
10	0.64286	22.58

Material Data

TABLE 19
carbon fibre > Constants

Density	1875 kg m^-3
Thermal Conductivity	1000 W m^-1 C^-1
Resistivity	1.e-005 ohm m

TABLE 20
carbon fibre > Isotropic Elasticity

Temperature C	Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa
	3.5e+011	0.3	2.9167e+011	1.3462e+011

TABLE 21
carbon fibre > Tensile Yield Strength

Tensile Yield Strength Pa
5.e+009

TABLE 22
carbon fibre > Compressive Yield Strength

Compressive Yield Strength Pa
2.e+009

Balsa wood

TABLE 23
Balsa wood > Constants

Density	225 kg m^-3
Thermal Conductivity	5.23e-002 W m^-1 C^-1

TABLE 24
Balsa wood > Isotropic Elasticity

Temperature C	Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa
	9.e+008	0.31	7.8947e+008	3.4351e+008

TABLE 25
Balsa wood > Tensile Yield Strength

Tensile Yield Strength Pa
1.e+006

TABLE 26
Balsa wood > Compressive Yield Strength

Compressive Yield Strength Pa
1.e+006

TABLE 27
Balsa wood > Tensile Ultimate Strength

Tensile Ultimate Strength Pa
7.3e+007

TABLE 28
Balsa wood > Compressive Ultimate Strength

Compressive Ultimate Strength Pa
7.95e+006

Complete static load analysis report for *Bending strength* and *torsional strength* of above rectangular beam are

For bending strength:

*Assuming total load 2 kg and environment temperature 22 degree Celsius

1.For rectangular ***balsa wood*** having dimention 60 mm*100 mm*900 mm:

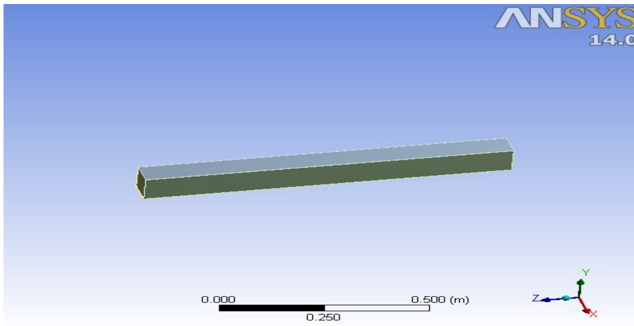


Fig: sample of beam

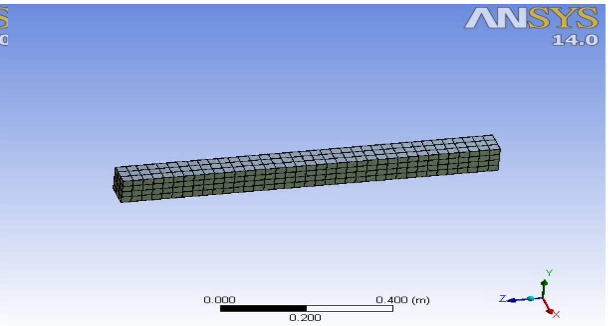


Fig: meshed beam

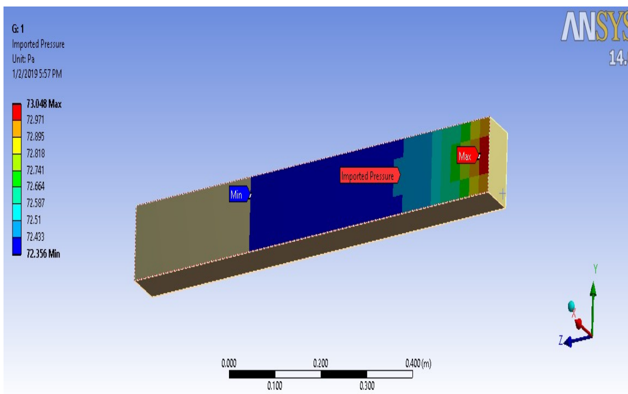


Fig: Load distribution

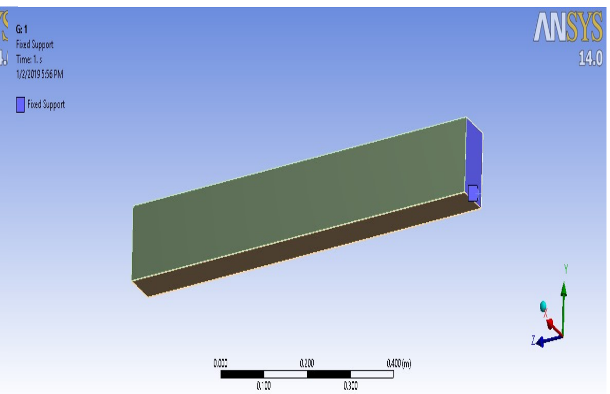


fig: fixed support

Solution table :

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*	*Shear Elastic Strain*	*Shear Stress*
State	Solved				
Scope					
Scoping Method	Geometry Selection				
Geometry	All Bodies				
Shell		Top/Bottom			
Layer		Entire Section			
Definition					
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress	Shear Elastic Strain	Shear Stress
By	Time				
Display Time	Last				
Calculate Time History	Yes				
Identifier					
Suppressed	No				
Orientation				XY Plane	
Coordinate System				Global Coordinate System	
Results					
Minimum	0. m	1.0247e-014 m/m	3.4881e-006 Pa	-5.0061e-007 m/m	-2675.5 Pa

Maximum	6.4038e-005 m	1.9058e-005 m/m	17152 Pa	5.0169e-007 m/m	2540.5 Pa
Minimum Occurs On	Part1	part 2-4	Part1		part 2-3
Maximum Occurs On	part 2-2	Part1	part 2-2	Part1	part 2-1
Information					
Time	1. s				
Load Step	1				
Substep	1				
Iteration Number	1				
Integration Point Results					
Display Option		Averaged			

Fig:Total Deformation

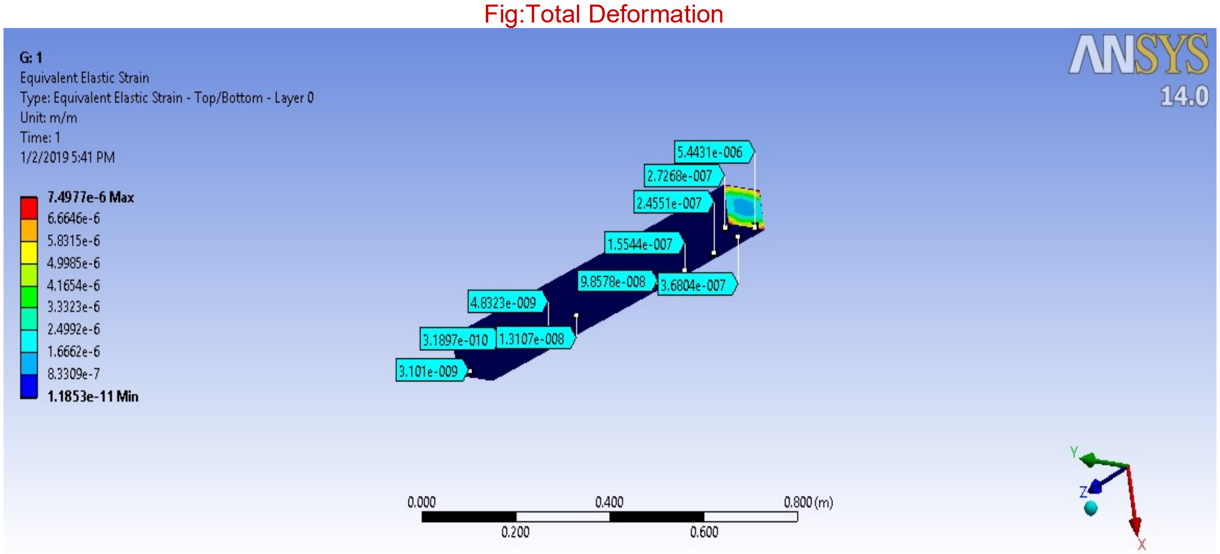


Fig:Equivalent Elastic Strain

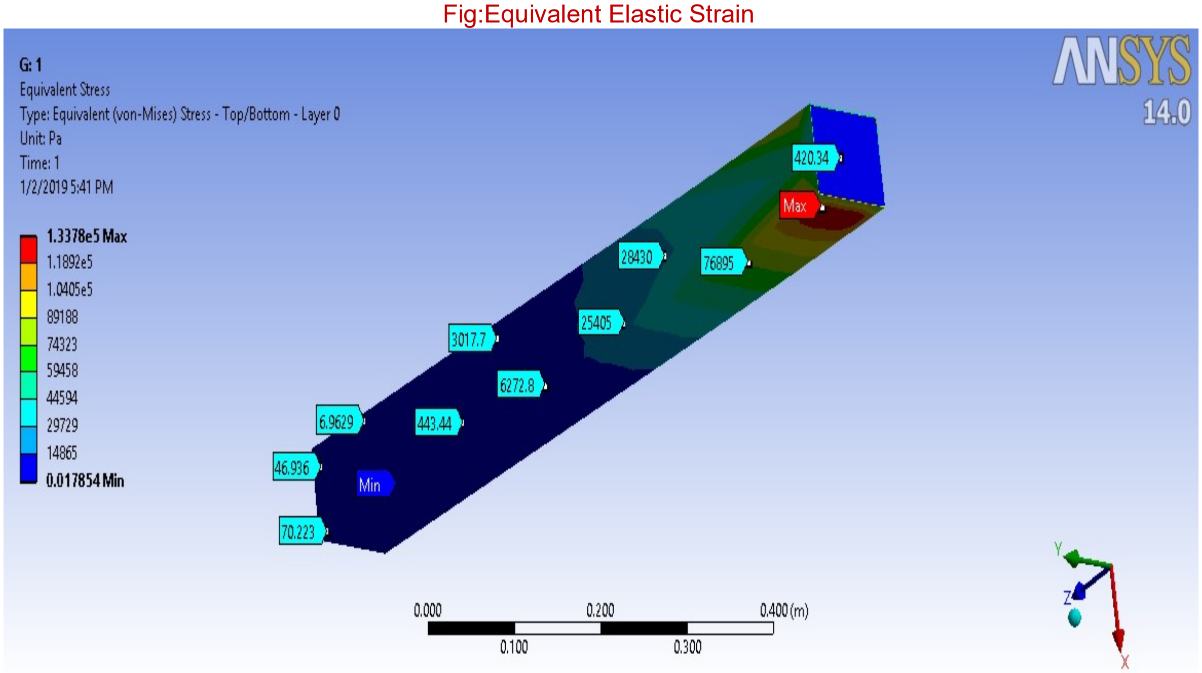


Fig: Equivalent Elastic Strain

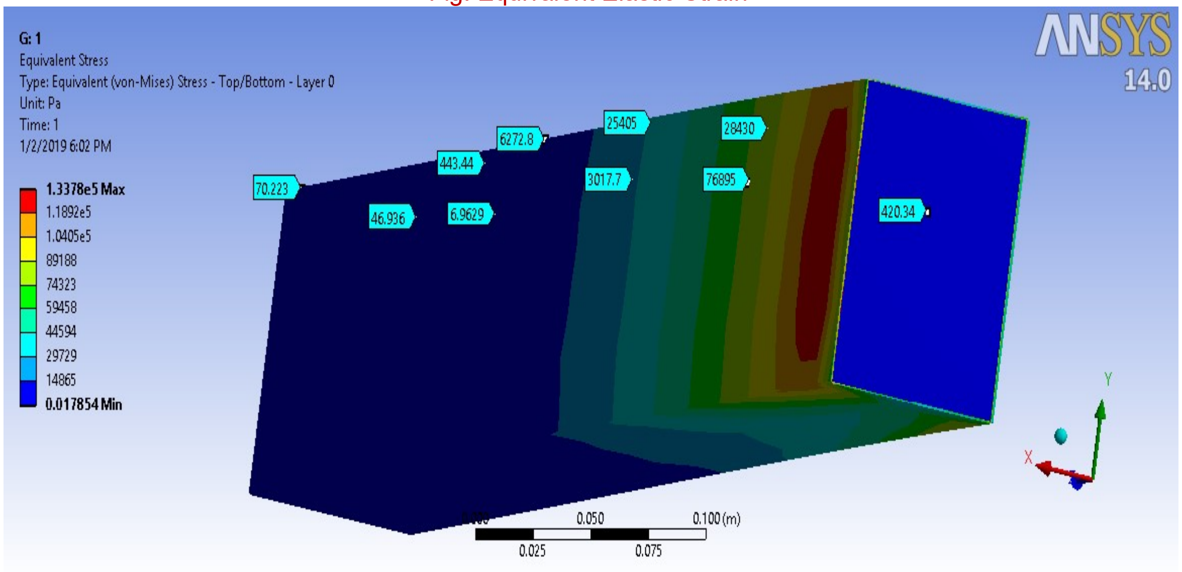


Fig:Shear Elastic Strain

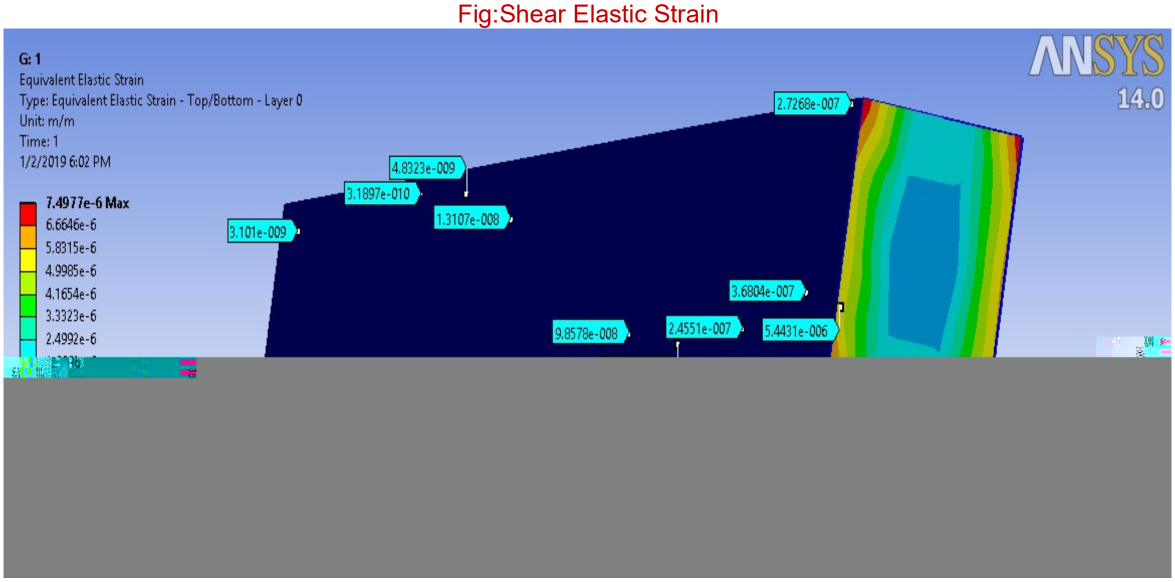


Fig :Shear Elastic Strain

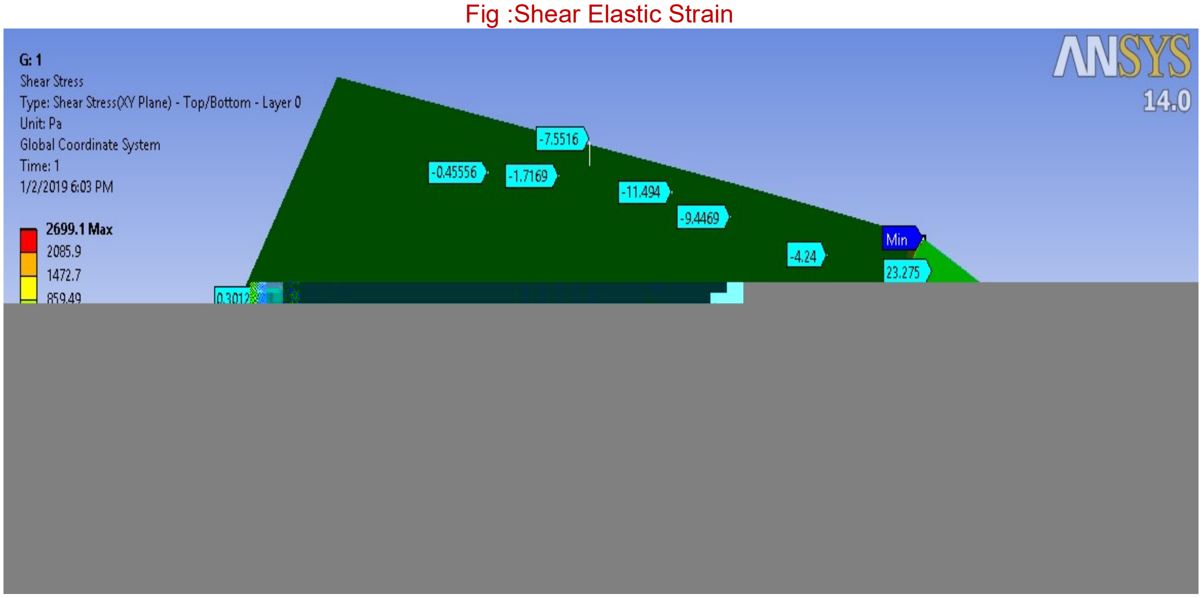
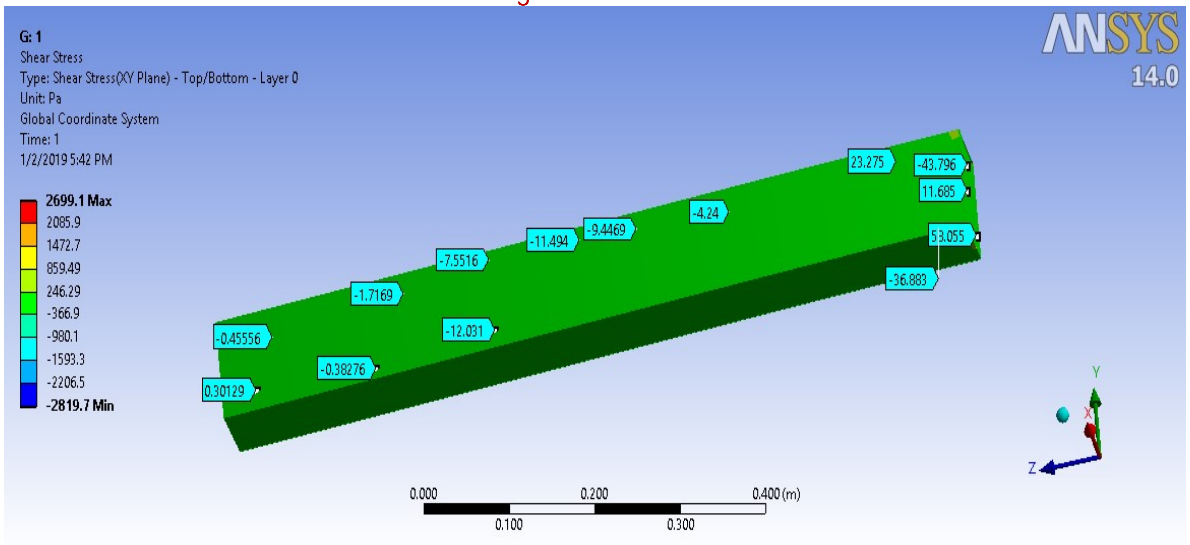


Fig: Shear Stress



2.For ***composite material*** of **balsa wood** with .5mm of carbon **fibre layer:**

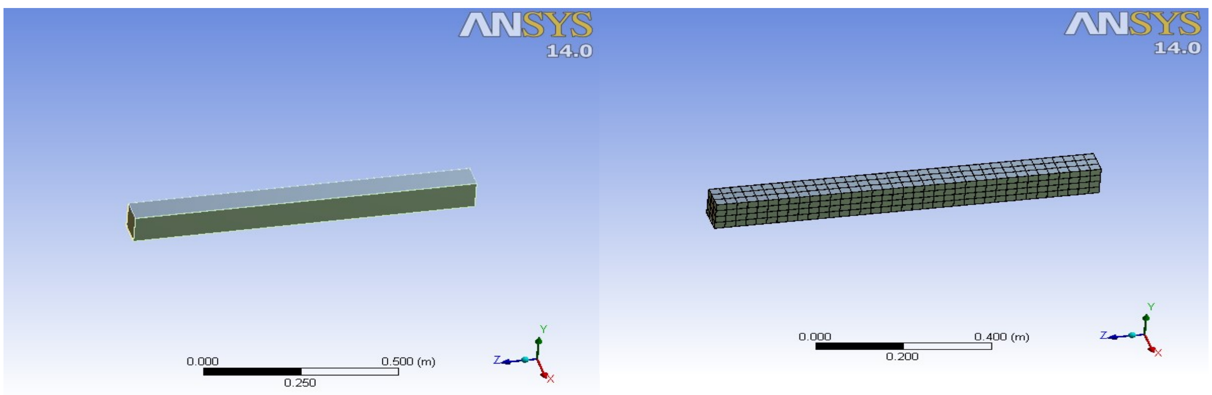


Fig: composite material sample

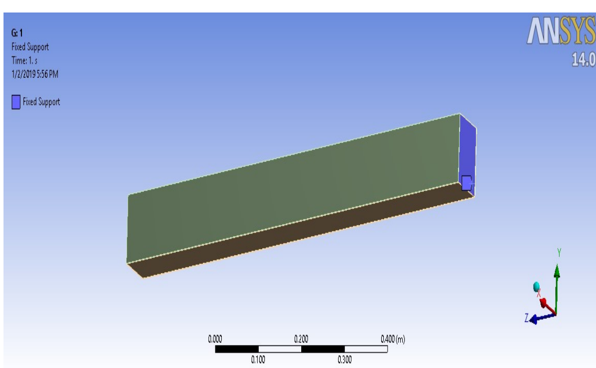


Fig: composite with fixed support

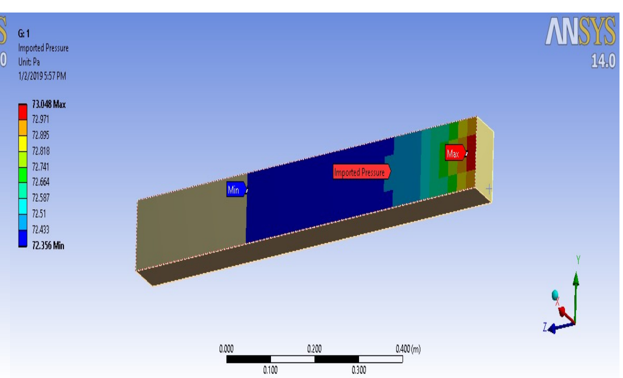


Fig: Load distribution

Solution table

Definition					
Type	Total	Equivalent	Shear Elastic	Equivalent (von-	Shear Stress

	Deformation	Elastic Strain	Strain	Mises) Stress	
By	Time				
Display Time	Last				
Calculate Time History	Yes				
Identifier					
Suppressed	No				
Orientation			XY Plane		XY Plane
Coordinate System			Global Coordinate System		Global Coordinate System
Results					
Minimum	0. m	1.5723e-011 m/m	-5.1617e-007 m/m	1.457e-002 Pa	-2493.9 Pa
Maximum	2.8906e-006 m	7.5518e-006 m/m	5.175e-007 m/m	1.3606e+005 Pa	2473.5 Pa
Minimum Occurs On	Part1	part2-4	Part1		part2-1
Maximum Occurs On	part2	Part1		part2	part2-3
Information					
Time	1. s				
Load Step	1				
Substep	1				
Iteration Number	1				
Integration Point Results					
Display Option		Averaged			

Fig:Total Deformation

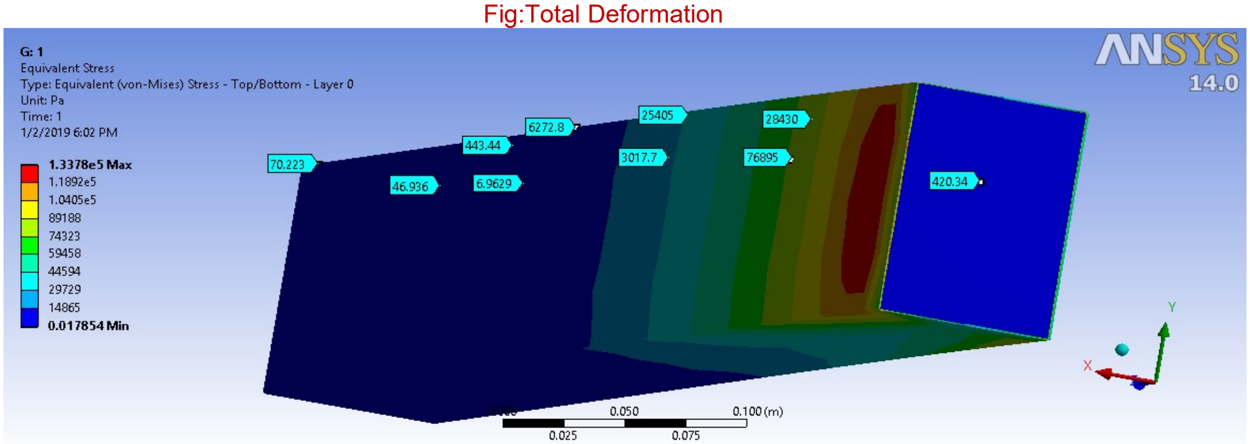
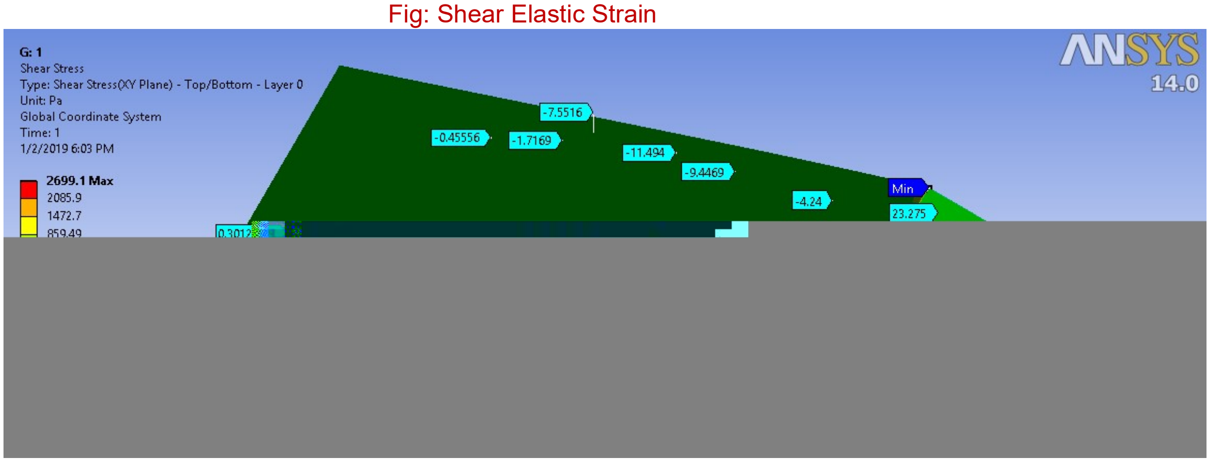


Fig: Shear Elastic Strain



Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*	*Shear Stress*
State	Solved			
Scope				
Scoping Method	Geometry Selection			
Geometry	All Bodies			
Shell		Top/Bottom		
Layer		Entire Section		
Definition				
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress	Shear Stress
By	Time			
Display Time	Last			
Calculate Time History	Yes			
Identifier				
Suppressed	No			
Orientation				XY Plane
Coordinate System				Global Coordinate System
Results				
Minimum	0. m	1.1853e-011 m/m	1.7855e-002 Pa	-2819.7 Pa
Maximum	2.6475e-006 m	7.4977e-006 m/m	1.3378e+005 Pa	2699.1 Pa
Minimum Occurs On	Part1	part2-4	Part1	part2-3
Maximum Occurs On	part2-2	Part1	part2-2	part2-1
Information				
Time	1. s			
Load Step	1			
Substep	1			
Iteration Number	1			
Integration Point Results				
Display Option		Averaged		

Fig:Total Deformation

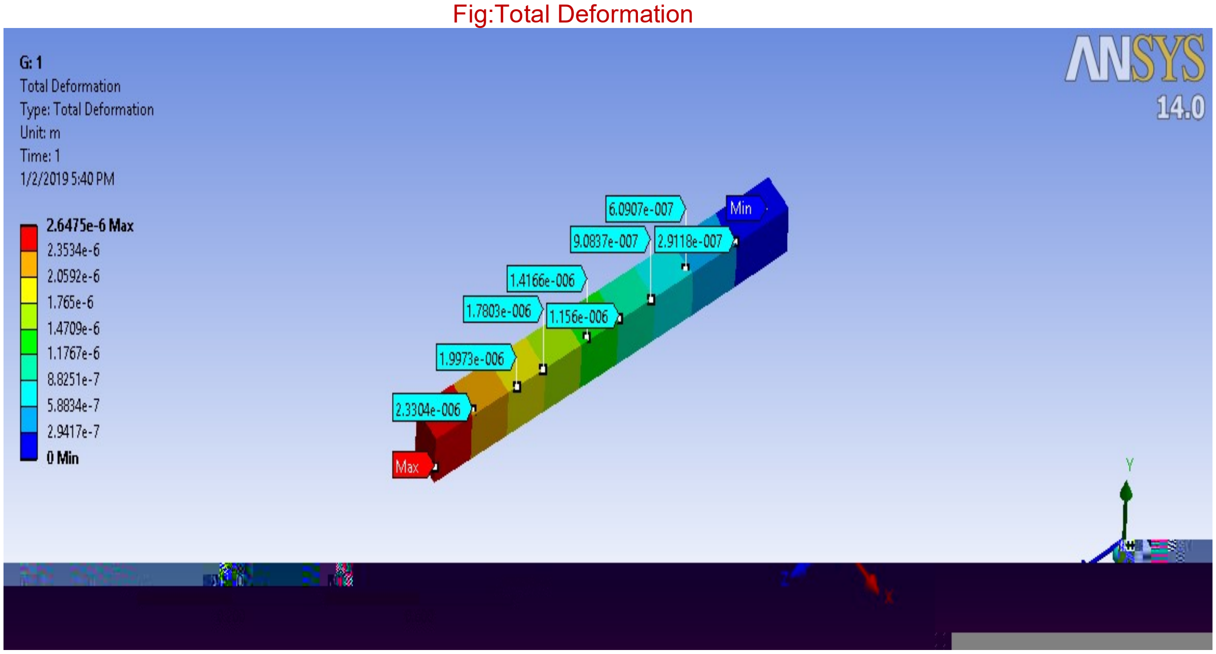


Fig:Equivalent Elastic Strain

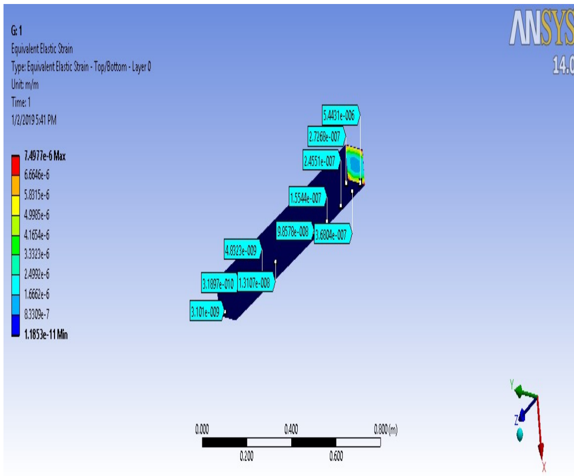


Fig :Equivalent Elastic Strain

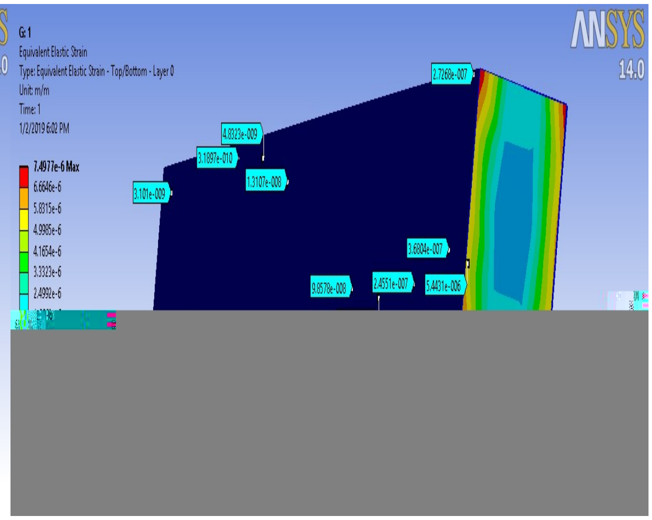


Fig: Equivalent Stress

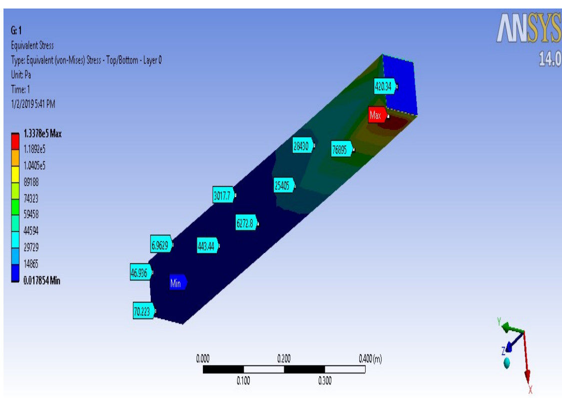


Fig: Equivalent Stress

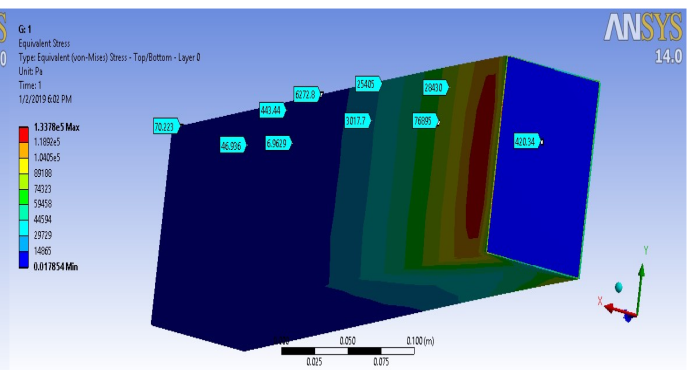


Fig: Shear Stress

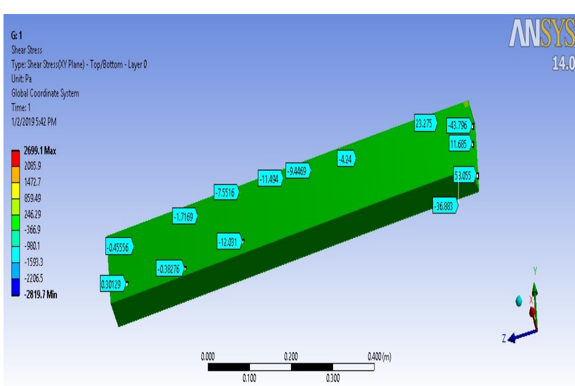
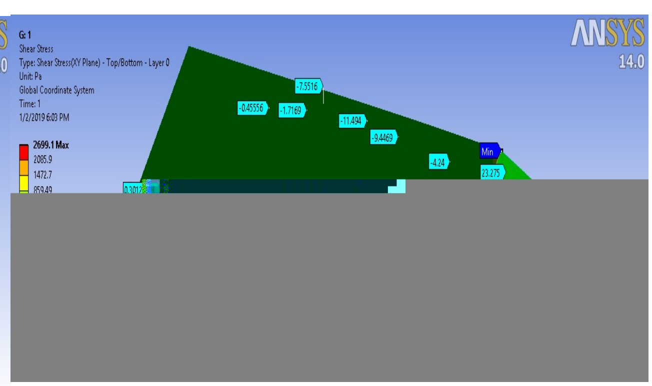


Fig: Shear Stress

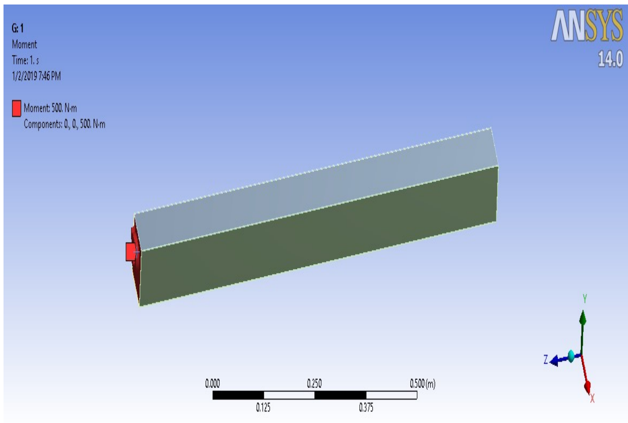


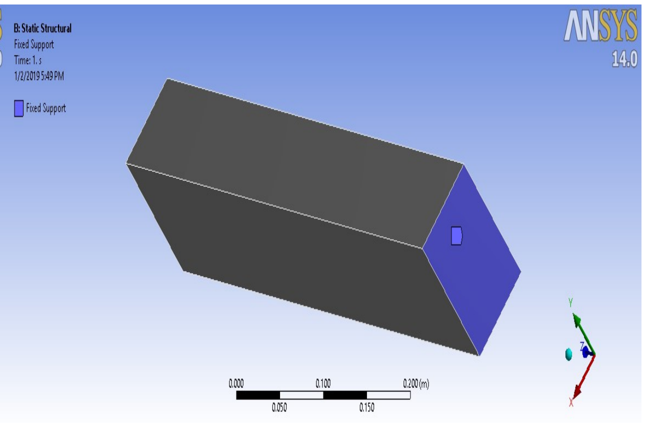
For torsional strength:

Consider **500** Nm ***moment*** acting at outer surface of beam:

1. 1.For rectangular ***balsa wood*** having dimention 60 mm*100 mm*900 mm:

Fig:**Moment applied at one face** Fig: Fixed Support at one end





Solution table :

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*	*Vector Principal Stress*
State	Solved			
Scope				
Scoping Method	Geometry Selection			
Geometry	All Bodies			
Definition				
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress	Vector Principal Stress
By	Time			
Display Time	Last			
Calculate Time History	Yes			
Identifier				
Suppressed	No			
Results				
Minimum	0. m	1.5361e-005 m/m	0.21805 Pa	
Maximum	1.122e-002 m	8.7032e-003 m/m	7.8328e+006 Pa	
Information				
Time	1. s			
Load Step	1			
Substep	1			
Iteration Number	1			
Integration Point Results				
Display Option		Averaged		

Total Deformation > Image

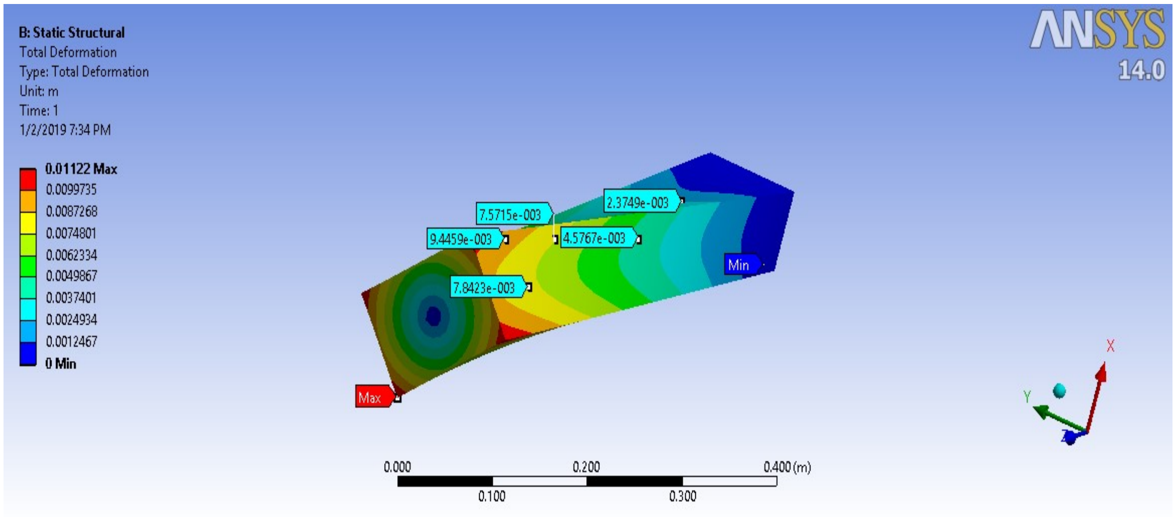


Fig:Equivalent Elastic Strain

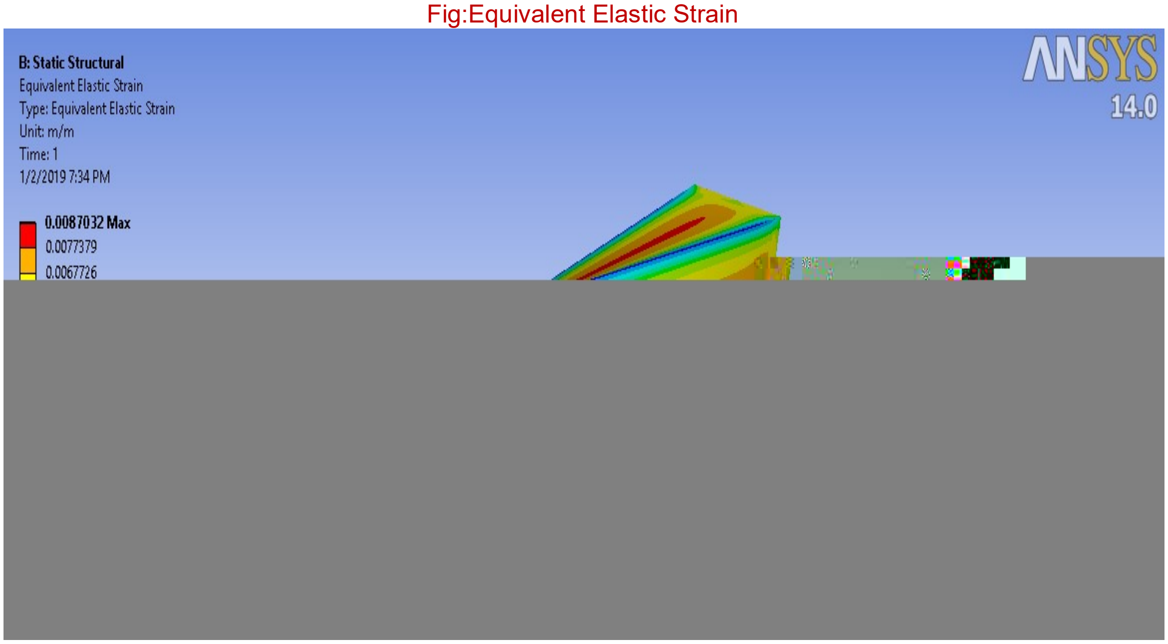


Fig:Equivalent Stress

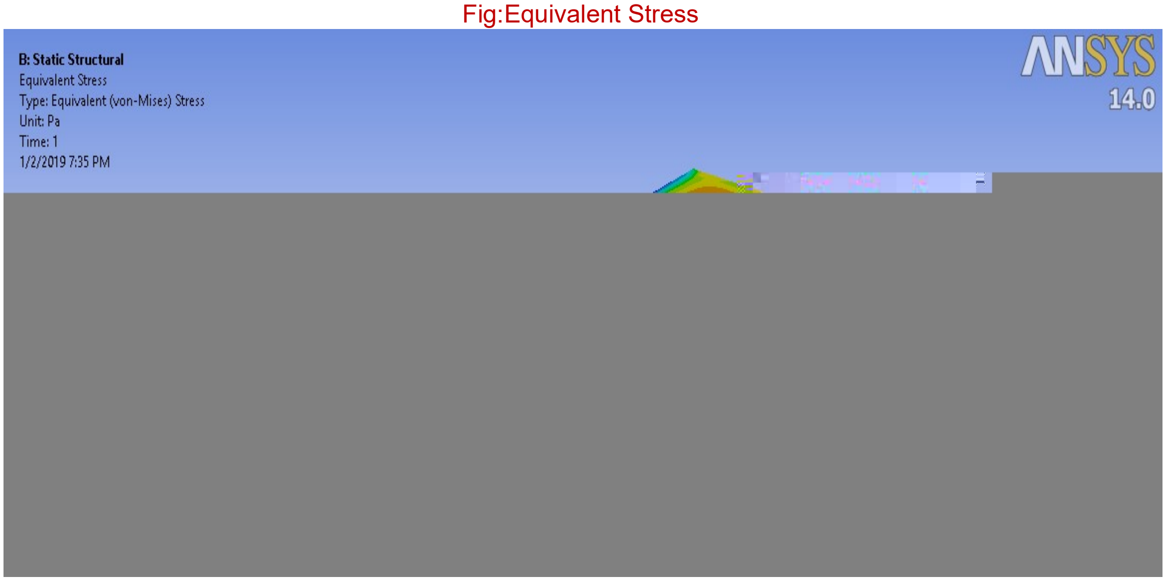
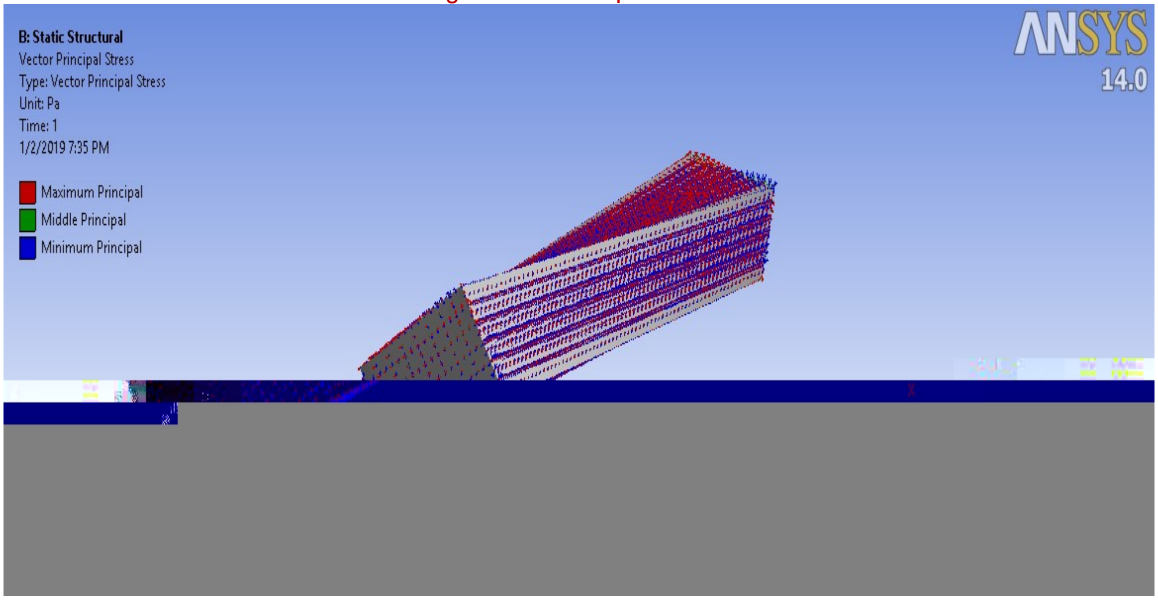


Fig: Vector Principal Stress



2.For ***composite material*** of **balsa wood** with .5mm of carbon **fibre layer-**

Observation table :

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Shear Elastic Strain*	*Equivalent Stress*	*Shear Stress*
State	Solved				
Scope					
Scoping Method	Geometry Selection				
Geometry	All Bodies				
Shell		Top/Bottom			
Layer		Entire Section			
Definition					
Type	Total Deformation	Equivalent Elastic Strain	Shear Elastic Strain	Equivalent (von-Mises) Stress	Shear Stress
By	Time				
Display Time	Last				
Calculate Time History	Yes				
Identifier					
Suppressed	No				
Orientation			XY Plane		XY Plane
Coordinate System			Global Coordinate System		Global Coordinate System
Results					
Minimum	0. m	5.492e-005 m/m	-8.1313e-003 m/m	59.265 Pa	-6.0091e+006 Pa
Maximum	3.4973e-004 m	6.1144e-003 m/m	8.3179e-003 m/m	1.0732e+008 Pa	5.8384e+006 Pa
Minimum Occurs On	Part1				part2-3
Maximum Occurs On	part2-1	Part1		part2-2	
Information					
Time	1. s				

Load Step	1
Substep	1
Iteration Number	1
Integration Point Results	
Display Option	Averaged

Fig: Total Deformation

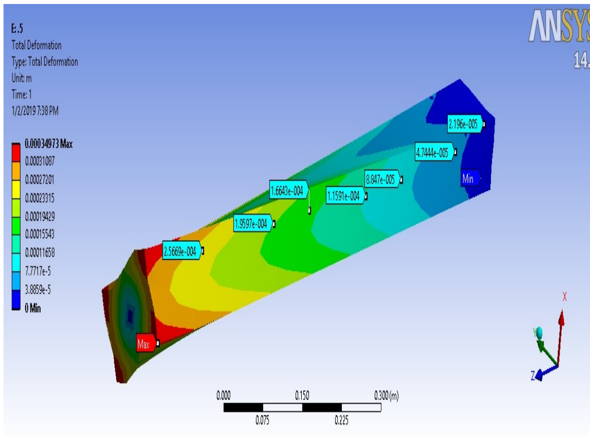


Fig: Equivalent Elastic Strain

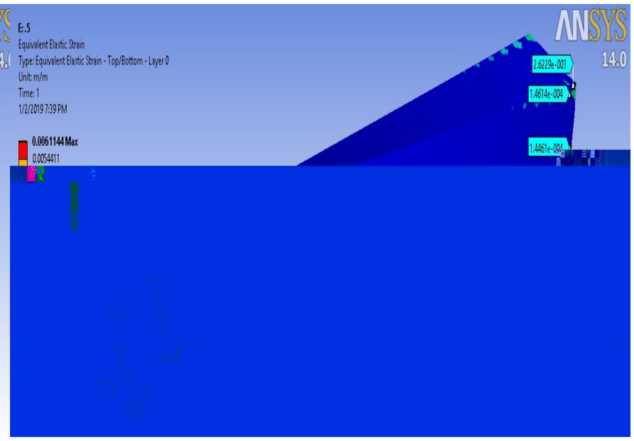


Fig: Shear Elastic Strain

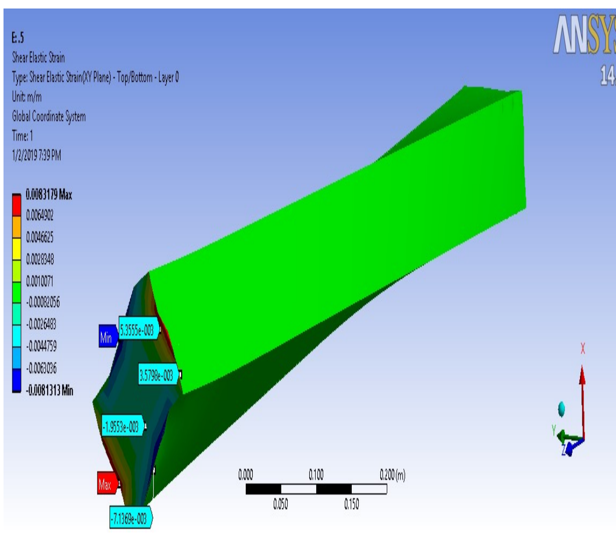
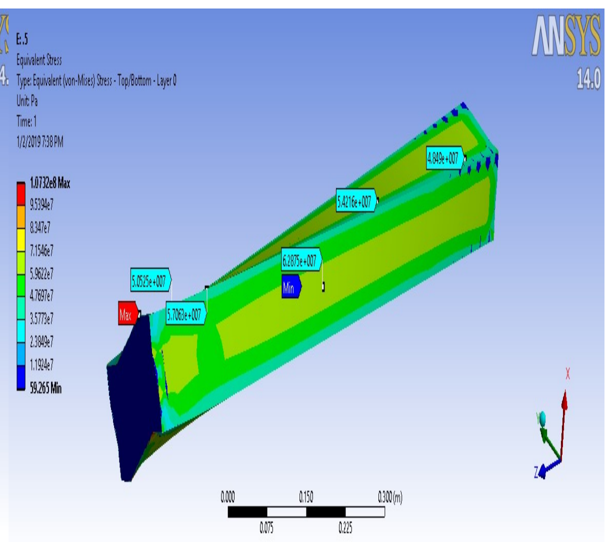


Fig: Equivalent Stress



3. For **composite material** of *balsa wood* with .75mm layer *of carbon fibre*

Observation table :

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*	*Shear Elastic Strain*	*Shear Stress*
State	Solved				
Scope					
Scoping Method	Geometry Selection				
Geometry	All Bodies				
Shell		Top/Bottom			
Layer		Entire Section			
Definition					
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress	Shear Elastic Strain	Shear Stress
By	Time				

Display Time	Last				
Calculate Time History	Yes				
Identifier					
Suppressed	No				
Orientation				XY Plane	
Coordinate System				Global Coordinate System	
Results					
Minimum	0. m	3.4858e-005 m/m	13278 Pa	-8.1051e-003 m/m	-5.8726e+006 Pa
Maximum	3.4216e-004 m	6.1147e-003 m/m	1.3164e+008 Pa	8.323e-003 m/m	6.7556e+006 Pa
Minimum Occurs On	Part1				part 2-1
Maximum Occurs On	part 2-3	Part1	part 2	Part1	part 2
Information					
Time	1. s				
Load Step	1				
Substep	1				
Iteration Number	1				
Integration Point Results					
Display Option		Averaged			

4. **composite material** of *balsa wood* with 1mm layer of *carbon fibre*

Observation table:

Object Name	*Total Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*	*Shear Stress*
State	Solved			
Scope				
Scoping Method	Geometry Selection			
Geometry	All Bodies			
Shell		Top/Bottom		
Layer		Entire Section		
Definition				
Type	Total Deformation	Equivalent Elastic Strain	Equivalent (von-Mises) Stress	Shear Stress
By	Time			
Display Time	Last			
Calculate Time History	Yes			
Identifier				
Suppressed	No			
Orientation				XY Plane
Coordinate System				Global Coordinate System
Results				
Minimum	0. m	2.0994e-005 m/m	18891 Pa	-6.0713e+006 Pa
Maximum	3.3727e-004 m	6.1072e-003 m/m	1.4503e+008 Pa	7.8094e+006 Pa
Minimum Occurs On	Part1			part2
Maximum Occurs On	part2-3	Part1	part2	
Information				
Time	1. s			
Load Step	1			
Substep	1			

Iteration Number	1	
Integration Point Results		
Display Option		Averaged

Fig:Total Deformation

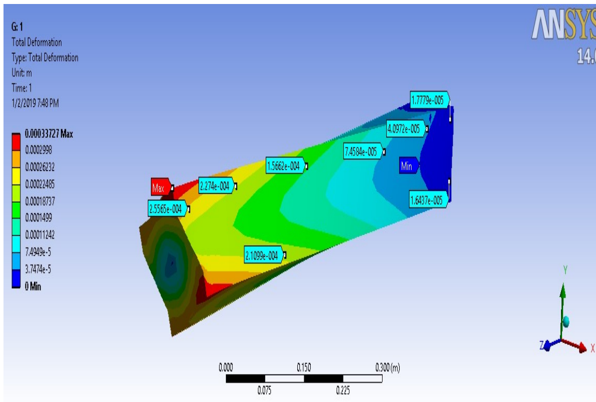


Fig: Equivalent Elastic Strain

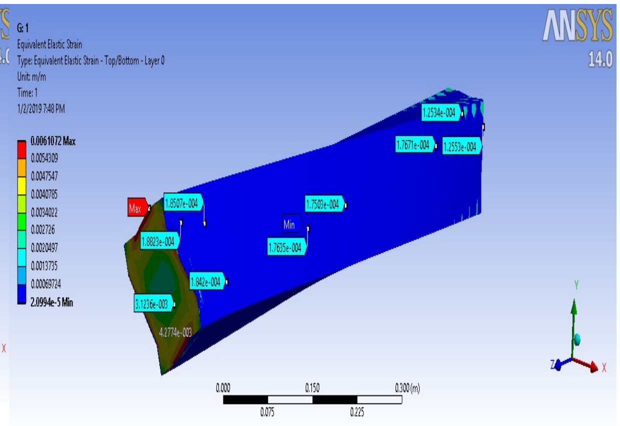


Fig:Equivalent Elastic Strain

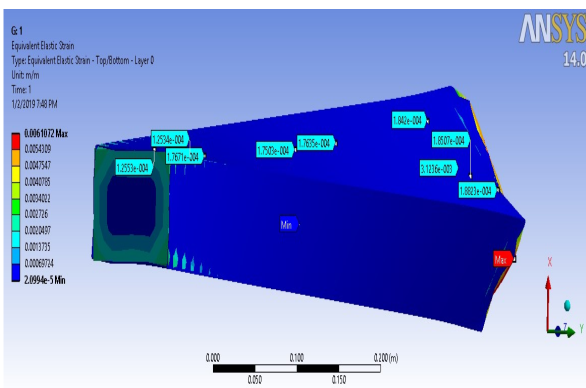


Fig :Equivalent Stress

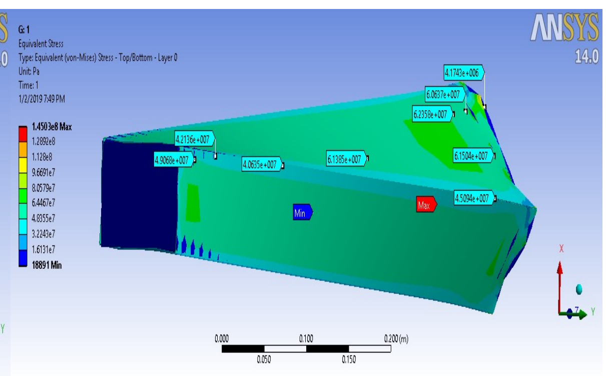
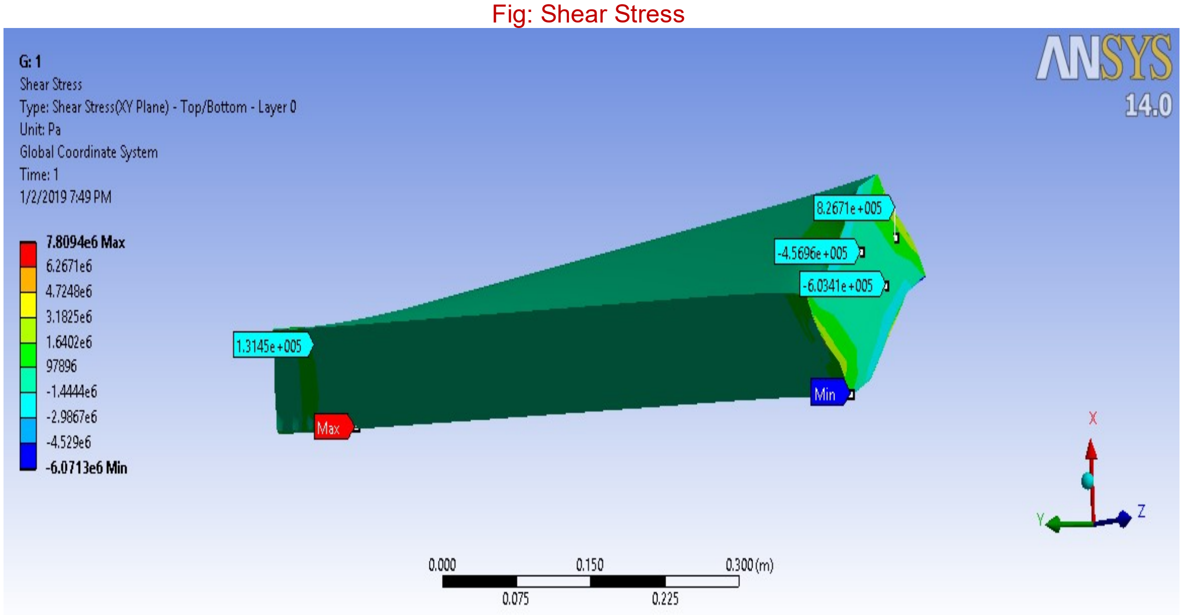


Fig: Shear Stress



Result:

Data analysis:

(a.) For Bending –

	Max. Deformation	Max. Elastic strain	Max. Equivalent stress
1.For balsa wood	6.4038e-005 m	1.9058e-005 m/m	17152 Pa
2.Composite with.5 mm carbon fibre layer	2.8906e-006 m	7.5518e-006 m/m	1.3606e005 Pa
3.Composite with .75 mm carbon fibre layer	2.7509e-006 m	7.5147e-006 m/m	1.3485e005 Pa
4. composite with 1 mm carbon fibre layer	2.6475e-006 m	7.4977e-006 m/m	1.3378e005 Pa

From this data it is clear that as carbon layer thickness increases max. deformation ,max. Elastic strain , Max. equivalent stress decreases it means on increasing carbon fibre layer bending strength of composite beam increases but at same time weight of beam slightly increase, also.

(b.) For torsion(moment)–

	Max. Deformation	Max. Elastic strain	Max. Equivalent stress
1.For balsa wood	1.222e-002 m	8.7032e-003 m/m	7.8328e006 Pa
2.Composite with.5 mm carbon fibre layer	3.4973e-004 m	6.1144e-003 m/m	1.0732e008 Pa
3.Composite with .75 mm carbon fibre layer	3.4216e-004 m	6.1147e-003 m/m	1.3164e008 Pa
4. composite with 1 mm carbon fibre layer	3.3727e-004 m	6.1072e-003 m/m	1.4503e008 Pa

From this data it is clear that as carbon layer thickness increases max. deformation ,max. Elastic strain , Max. equivalent stress decreases it means on increasing carbon fibre layer torsional strength of composite beam increases but at same time weight of beam slightly increase, also.

Thus, we found a composite material of balsa wood and carbon fibre which is lighter in weight have more strength(bending and torsional) as compared Balsa wood .On increasing thickness layer of carbon fibre strength of composite increases but same time weight of composite also increases.

Conclusion:

We successfully studied all about what is UAVs or drone, different parts of drone,how it work, how types of exist ,use of application of drone ,for who it is applicable ,why drone need in this days, future scope of drone , what are the different types of forces act on drone and different concept applied in making it, Nature of load acting on drone ,what are the advantage and disadvantage from this in day today life ,what are the facing drone users ,what are the various feasible manufacturing material can be used for drone manufacturing and which material will be best one and which is usually used yet, which type of improvement need in current drone ,how to make drone for performing well in different operation which is impossible or not properly to do by human being or dangerous like data collection from remote places and other navigation and control purposes, what are the innovation required for drone. As I think rocket propulsion can be very efficient concept for making drone faster as our technology growing very fast so in this age faster drone may be very beneficial for mainly for military purpose and by fat drone we can make observation in less by collecting data from drone. I found different feasible material which can be used for drone and how to make more strength material by using composite material concept .Which tests were accomplished by finite element test(ANSYS) software .I have analysised for different shape and different materials . Out of them I found some composite material which most feasible for drone manufacturing Like composite of balsa wood and carbon fibre for that data analysis are also included in this paper .On results analysis of different composite materials and various pure materials it can conclude that this time composite material of balsa wood with carbon fibre will be most feasible and efficient manufacturing material for UAVs .As composite of balsa wood and carbon fibre have high bending and torsional as compare to other material, also it has high corrosive resistance ,easily mould in different shape ad size

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