

INVESTIGATION OF MESH LAYER OVER AN AIRCRAFT ENGINE INTAKE

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering

in

Aeronautical Engineering

By

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**DEPARTMENT OF AERONAUTICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A” by NAAC | 12B Status by UGC | Approved by AICTE

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119.

MARCH - 2021



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **NIKHIL KUMAR (37260026) & SHRAWANI SHRIPRASAD CHOUGULE (37260039)** who carried out the project entitled " **INVESTIGATION OF MESH LAYER OVER AN AIRCRAFT ENGINE INTAKE** " under our supervision from DECEMBER 2020 to MARCH 2021.

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We, NIKHIL KUMAR (37260026) & SHRAWANI SHRIPRASAD CHOUGULE (37260039) hereby declare that the Project Report entitled “**INVESTIGATION OF MESH LAYER OVER AN AIRCRAFT ENGINE INTAKE**” done by us under the guidance of **Mr. RAKESH VIMAL M** M.E., Ph.D. is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering in Aeronautical Engineering.

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ABSTRACT

The aim of this project is to protect the aircraft from the birds strike and to maintain streamline flow at the entrance of the engine. The theoretical scope of this project is to save the peoples life from accident of aircraft by bird strike. In this project we are forming a mesh (or) honey-comb structure before the cowling area of engine which protect the engine from the strike and provide Laminar flow to the power plant. If the mesh structure is near by the inlet portion it creates turbulence. Here is one spring whose formation is small spiral from both end side and bigger spiral at the center line which is known as volute spring. By using Volute spring we create a better lateral stability and also increase the distance between the mesh structure and the cowling part of the engine so that the turbulence is decreased. Volute spring is used to absorb the shock created by the moving mesh structure and it protect the structure from being damage by the birds strike. This simple design is going to solve complex problems. This paper is all about to stop the crash by birds strike and save the life of the people. This design is proposed for enhancing the bird strike situation for an aircraft. This design doesn't require any human interference to operate.

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CHAPTER :- 1

INTRODUCTION

1.1 SYSTEM USED TO PREVENT BIRD STRIKE:-

There are various techniques which we used for preventing birds from striking with the aircraft as we find that the technology which comes today's all are based on the earlier techniques as well as the area where birds striking probability is more is the aircraft engine area and the another major area is the wings section as well we can see that nose is also have the good probability of colliding with the birds so inventors find out various technique through which we can get the rid from these bird strike condition in the air.

1.2 BIRD DETECTION RADAR TECHNOLOGY:-

The newest technology which tell all of us about the birds in every situation like if the weather is foggy or smoggy or mist is there even we are not able to see outside at that time also these radar technology will work very nicely . Here we find that S-band (100mm) radars which can detect the very good range of 6-8 nm for the purpose of striking the bird in the atmosphere this technique is so precise that it can find various birds at a single moment of time and also tell us about the quantity of the number s based on the signal result. The newest software analysis of the data of different flying objects and materials can be classified on the basis of typically flight behaviour. You can understand how safe is to use this technique because it differentiate birds from all types of insects and predators . A small bird is always a big problem for an aircraft because if it went inside the turbine it will create so many problem which we never think of it is just as dangerous as if a very big large birds strike. The signals get reflected by the striking from the birds body and later when the signal return to the system we can enables the number and size of the birds to be classified and in this way numbers is calculated.

1.3 ACOUSTICS METHODS :-

Acoustic methods which was also known as sonic, vibration, mechanical impedance testing these all ever depend on exciting vibrations in a specimen by a local impact and then while the measuring different property of the vibrations which we think was existed, e.g. resonant **frequency**, decay time, etc.

1.3.1 DIRECTIONAL ACOUSTIC SYSTEMS:-

As we all know that the Long Range Acoustic Device, it passes the sound signals up to a multi range of 159 dB and it can be beamed in a straight manner within a range up to 1,500 meter's. It can produce the sound of birds and other different types of voices that make birds fearful and make those birds to flew away from that area. The LRAD is an awesome product for various types of people. We think that only trained operators can operate it but it is very user friendly and everyone can use it if we get guidance once. The LRAD full for is LONG RANGE ACOUSTIC DEVICE.

1.3.2 PREDATOR CRY SYSTEMS:-

These scavengers or so called predator and the warning sound effect of the birds to be controlled. The habitation effect was decreased by the modulating the sound of the birds, and changing the frequencies and the various intensity. Predators main purpose is to flew away all the small birds but predators see those all birds as a meal for them and which make those predators to go for their lunch also.

1.4 VISUAL METHODS:-

The idea of using the visual method is to manipulate the character of the light by vary the different pulse rate and wavelengths of the electro spark electromagnetic spectra and tune that to change the specific bird kingdom different birds. The lights would alarm and make the birds can detect and avoid the aircraft as soon as possible. Some changes to the light might be not observable to humans. Result what we come to know that dead birds in airports says that they were trying to not confront the planes when they were

hit by the aircraft. Different research shows that birds can detect the light at 540nm wave length particularly well. The TOM510 system is with its green light(greenish yellow) which was very effective. The laser is inserted in downward direction so that it is completely safer than other plan.

1.5 PYROTECHNICS (SCREAMERS AND BANGERS) :-

Every airport in the US, UK, LA and many more across the world, use pyrotechnics every day to remove the birds from the airport runway and nearby area, National coordinator of the airport wildlife hazards programme they are trying to make the birds scare from the screamer and bangers. "The big and bushy, bang kind of material immediately grabs the attention and pushes them to and fro." Bangers produce a huge impact of noise production, others make a mild murmuring sound, while some emit lights - different birds respond differently and some even take flight at the sight of the wildlife venture. A shot from a pistols barrel can travel 40-45 yards before exploding, while 12-gauge shotgun will reach 75-105 yard.

1.6 HABITAT MANAGEMENT:-

The beauty of places and the greenery of some places determine the bird population. This will be inspired by specific measures e.g. shrub's vegetation, the holding of water reservoir and canals in nearby, passive bird control measures on building. Scare crow like dogs are used to chase birds in the runway when dogs were firstly used in the past, there has been a 17% -18% drop in bird strikes. Often birds will only breeze because hostile predators are missing in their surroundings. The use of falcons with different teams distributed over every day and can generate hostilities in the affected territory.

1.7 BIRD ROBOTS:-

Predators can control the birds at a certain extent but sometime they also became a risk to an aircraft. Therefore, in recent days inventors used different types of AI technology to prevent bird strike. The bird robot is controlled by highly experienced pilots because it also have to keen look over the upcoming aircraft and it also have to maintain the distance from the birds as well as aircraft. The models are able of long ranges and durable and high flight.

CHAPTER – 2

LITERATURE SURVEY

PAPER 1:- Exploiting avian vision with aircraft lighting to reduce bird strikes Bradley F. Blackwell¹ *, Travis L. DeVault.

Chromatic and achromatic contrast was easily discriminated by the birds of that area, where as the partly across different ambient light condition additionally chromatic contrast are higher with lights on than with lights off. They use composite material to reproduce bird numerically impact for the test. The assumed strength that nacelle of the airplane engine which is not that much strong to bear the impact force of a 4lb bird on its structure so, subsequently as a result , the event was exactly reproduce and produce and proficiency approached were shown. This finding collaboration of our assumption that some of the visual, given of our best human perception, have the Canada geese would perceive the most aircraft with most severance lights on as more contrasting than with lights off. Therefore it is important to guarantee that aircraft were able to landscape leaves after the incidence of bird spike also. The experimental test are very expensive and very costly in case of bird proof structure and the certification also very expensive. The finite element analysis and smoothed particle hydrodynamic are the methods which is used for the particular Birds strike experiment for correct and successful development of the analysis regarding this. The bird proof structure is being developed or the thought of developing this structure is proposed in this paper the front part of the aircraft are most exposed to the risk of the bird strike just like engine of the bird the fan of the engine and nose of the engine and wing leading edge of the wing. These are some part of the aircraft were the bird strike happen mostly and for that only in this paper they are planning to prepare a bird proof body structure of aircraft.

PAPER 2:- Liquid jet impaction on the single-layer stainless steel wire mesh in a rotating packed bed reactor Ying-Chun Xu^{1,2} | Yan-Bin Li^{1,2} | Ya-Zhao Liu^{1,2}.

The liquid flow behaves in the packing zone of a moving packed bed reactor like some swirl rotation in the reactor zone. It affects the mass transfer working. Moreover the interaction between the rotating and liquid is yet visible. Due to packings of various zone it becomes a difficult structure. In this paper they ever studied the liquid flow behavior's when a liquid jet impacted on a rotating single layer SSM by high speed photography and CFD simulation. Experimental results shows that the liquid flow would be deformed to liquid alignment, liquid sheet and liquid droplet after the impaction over the new water droplet forms highly over the rest area of the reactor zone. The volume of fraction multiphase model was differently selected above to capture the most of the gas-liquid interface in this simulation. In this paper we came to know about liquid flow behaviour and packing zone of rotating packed bed rotor which is more significant and effective then the mass transfer performance of the aircraft. Numerical simulation has been going to be more effective way to study the liquid flow behaviour in ERP and it is more effective method. In respect to save the computational cost of this process of vertical fiber of SS which is simplified to square a circle or two horizontal fiber and it is very ignored in 2D packing physical model. The microscale characters of the liquid distribution, liquid hold up and gas pressure drop which is going to be targeted while concluding the result the 2D model is going to lose Precision since it is not spreading the liquid film along the packing of the surface which is not calculated without and axial dimension of the model. The volume of fraction (vof) which is multiphase model is being selected to Grab the gas liquid interface while calculating the simulation. The governing equation of this paper in support of the material spotting controlling of the simulation. The calculation from the boundary what we found is great we got approximately the equal to one and it is satisfying the requirement of SST model. The pressure velocity coupled equation is being held by the simple method of momentum equation in second or second order differential equation. By this paper we come to solution that the fluid (water) movement is quite similar to air and same results.

PAPER 3 :- An Innovative Design by Single-Layer Superaerophobic Mesh: Continuous Underwater Bubble Antibuoyancy Collection and Transportation Yuzhen Ning, Di Zhang, Shuang Ben.

Single layer superaerophobic mesh which produce continuous underwater antibuoyancy bubble collection which transport with in time to time. There been progress in adjusting underwater bubble. Here in this paper we inspired by mechanism of H₂O spinder's gas storage. Gas produced by syringe pump penetrate mesh pore and get together to form a gas column in tube. The change of pressure is cyclic process which repeats itself from the water state to the gas state in USM device. This was assembled with an asymmetric U-tube. The normal gas containment and transporting system provide a new idea for generating new technologies for pipe application and sensors and for protection of environment. This particular paper demonstrates than underwater bubble collection and transportation technique. Bubble collected by the device and was also sealed by the device only. Which assembled with a single layer SUM and tube. Through this technology bubble were continuously stored at lower out of the device and will be transported above water. Further we have understood the behaviour of Underwater bubble and manipulating gas bubble which are going to play important role in a fundamental scientific research and the industrial application which we are studying in this paper some progress is a controlling the underwater bubble and continuous bubble at the collection of transportation remains challenging target the bubbles. The gas bubble is supplied by pump and which is going to vibrate in U shape device and it can gather together to form single layer underwater for assembled with a quartz tube. The maximum storage collapse occur when does column reach at its peak. The pump like a manner to transfer double continuously from water face to the gas space in OU smd device which is asymmetric you too which is used for this experiment to understand the behaviour of the water bubble. Further the result of this experiment is being concluded from the experimental analysis and theoretical analysis also. This word demonstrate the behaviour of the underwater bubble antibias collection and transport strategy of the underwater bubble and continuous gas bubble transportation is being realized and this is it respective regarding to the water or air interference. The asymmetric transportation and collection of the gas in the water. Throughout this design gas bubble is continuously collected at the lower side and is transported above the upper side of the water.

PAPER 4:- Bird strike onto the Composite Intake of a Turbofan Engine Authors: Marco ANGHILERI* Luigi-M L CASTELLETTI*

The biggest menace for any flight is the bird strike incident which affected the safety of the passenger. All the crew member who were travelling with the flight with whom bird strike happen. Putting that point in mind. It is possible to design a high efficiency and bird-proof design which are fully justified. In this project we go with a 4lb bird and want to know the effect produced by the 4lb bird on to a nacelle which was made of composite material. This is basically required for the component certification. Which was ingratiated using LS-Dyna 9.70. We found that the dynamic behaviors of the certain specified material has deep impact on the mechanism failure of the structure. They use composite material to reproduce bird numerically impact for the test. This paper is not successful because of the assumed strength of the nacelle of the airplane engine is not that much strong to bear the impact force of a 4lb bird on its structure so, subsequently as a result , the event was exactly reproduce and produce and proficiency approached were shown. We should take efforts to provide design with high efficiency but roof structure are fully justified in this paper the work is done regarding to this. In this paper for LLB boat is used on a Nacelle made of a composite material which is required for the certification of the component which has been investigated by the using ls-dyna software. The size of the bird really matters in this case because there are many size of birds which is present in the atmosphere because of them this collision is happening. Therefore it is important to guarantee that aircraft were able to landscape leaves after the incidence of bird spike also. The experimental test are very expensive and very costly in case of bird proof structure and the certification also very expensive. The finite element analysis and smoothed particle hydrodynamic are the methods which is used for the particular Birds experiment for correct and successful development of the analysis regarding this. The bird proof structure is being developed or the thought of developing this structure is proposed in this paper. The front part of the aircraft are most exposed to the risk of the bird strike just like engine of the bird, the fan of the engine and nose of the engine and wing leading edge of the wing. The result of this paper is given that the birds practiced is actually one of the most expensive certification test and the value of the intake and subsequent

vibration are allowed in this paper. There interaction between the bird and Inlet was defined using Note surface and by the smoothed particle hydrodynamics and finite element analysis.

PAPER 5:- Modelling of Bird Strike on an Aircraft Wing Leading Edge Made from Fibre Metal Laminates – Part 2: Modelling of Impact with SPH Bird Model M. A. McCARTHY1,, J. R. XIAO2, C. T. McCARTHY

The laminates have various type of varieties but out of others variety. Fiber metal laminates was the one which has layers of the different aluminum alloy and glass fiber with high strength composite which always been possess marvelous impact portentous. It is also suitable for airplane different section likely to be used to impact as or bird strike .In a consecutive complete search project we obtained that aircraft wing lading structure edges was designed with a glass based FML slein. Which was built and subjected for text also which already have been modeled with finite element analysis. And in second part of this project paper the SPH(Smooth Particle Hydrodynamics) was used for modeling bird and impact used for modeling bird and impact used in paper 1 for modeling of leading edges skin .The post simulation shows model of supportive test article and load transformed were in good arrangement with experimental needs. A model is generated were all things are made of glass fiber metal laminates. And results compared with text program. The smooth particle hydrodynamics method were effective always said that it will be used for modeling bird strike on their type of various structure. There was a failure test. So no further information from this paper just fiber metal laminates are used for good result in aircraft.

PAPER 6:- Impact damage modelling of composite Aerospace structures subject to bird Strike. Authors : Javid Bayandor, Mathew Joosten

Aerospace design and manufacturing process which might needs to be very affective for seen and on the velocity impact condition enforced by objects. Out of all the events of Birds strike this is the important one. If it is too much expensive so instead of that numerically model is prepared which produce sufficient accuracy to present the real scenario and significantly decrease the

cost of testing. The small number of test required for approval of project. This study integrates marvelous capabilities which is offer by the multi fluid structure methodology. Smoothed particle Hydrodynamics and determination enable the domination of tricked laminar structure. In Modeling phase did domination by the middle which were carried out by a rigid steel structure as a certified aim. When modeling and validation happen then SPH Bird was created and mixed with seismic fabric composite which was at leading edge of structure. And when movement start for analysis we can observe the destruction element which was somewhere applied although between the wing fabric structure and SPH model. One of the most pre predict methodology has been aiming to let disclose the intricacies of the structure and about their failure and mechanisms as we see in bird strike phenomenon involving various composite targets. Here the part all studies tell you about the resulting impact after damage. But the word investigated the feasibility of the intimate through SPH modeling. In future work which you were considering effect of fibers composite materials at erode dependently. And the conclusion which we got here after is we can also go with numerical method for strike analysis and we don't have to expand huge money for testing and all.

PAPER 7:- Bird strike analysis on typical helicopter windshield with different lay up. Authors-Riza Hidayati , Amersh Eyvazian

In this research paper the birds collide with a helicopter windshield is going to investigated by applying the SPH method. In this test the thickness we provide to windshield which is going to prevent the birds from penetrating the wind shield. The sudden effect of inclined angle on the various integrity of multi windshield is investigated. The impact on various component of helicopter like tail rotor and main Rotor and fuselage windshield tell it's quality . As we know that most windshields shows 35% to 39% off strike rate and damage rate. In other hand side windshield showed 17% to 6% for all type of aircraft. Looking at high percentage of windshield damage in all other component of helicopter and other high percentage of human lives and injuries due to bird Strike to helicopter so it is very needful and necessary to Investigation on bird strike windshield impact. This is the reason behind why it is necessary to make sure that helicopter can

resist against bird strike impact. The requirement identified as 29.8 631 which state this the Rotor should designed at the end. And make sure that having capability for safe and successful flight. Warbeck is the among first researcher who founded the experimental and theoretical behaving of a bird under impact. The result from this research that was used for the reference and for the comparison with numerical result. This result is very useful for Aerospace industry.

PAPER 8:-Helicopter main rotor blade root end under high velocity body impact. Author - D Chandra Naik, R Vijay Kumar

A numerical and theoretical simulation methodology which is successfully progressed to model the bird strike blade rotor root. Under very high velocity impact. This paper shows the state of composite modeling based on the application of nonlinear explicit finite element to analyses the main response. The damage behavior of soft body impact is depending upon the size of the bird, shape , location of impact and the speed of fan blades at that time. The striking the bird is event of high intensity for short period of time. And bird model is considered as hydrodynamic for length and diameter ratio which is 2. This analysis done using Auto-Dyn to get bird resistance to withstand 1.0 kg bird at critical flight conditions. The standards given by the FAA that aircraft design must carry extensive bird strike which is done by testing and analysis for facing all types of component which need to prove a certain level of bird strike . The certified test is carried out before delivering the aircraft. In order to protect crew members and passengers from bird strike accident there are regulatory authorities including FAA (Federal Aviation Administration) and EASA (European Aviation Safety Agency) they have registered regulations regarding this bird strike Safety. In past time bird strike certification is very long time consuming and expensive process just because there is only method i .e physical bird strike testing. Now a day we use simulation to do it. Birds strike simulation saved really many companies design time and money which is required for the testing. Usually test needs to repeat many times just to check whether component of helicopter is working or failed. The important properties related to idealized bird strike are complex and widely unknown.

PAPER 9:- Benign exclusion of birds using acoustic parametric arrays . Authors- Eric A. , Mark Hinders.

No bird areas are important in aviation safety and agriculture to and the facilities maintenance. Mostly all barter highly vocal and released on auditory communication in every aspect of their life history. In voice paper we are creating noise specially targeted to be within vocal range for the species of Birds. In contradictory, birds will be less able to communicate and they will move to more suitable area were they meant for their protection but this can cause noise pollution. In this paper they created well controlled sonic nets using mix of speakers and acoustic parametric arrays. This is done for better understanding and interaction with birds. And this will not cause any harm to the environment also. Here we combine finite difference solutions of the KZK equations with 3 - D acoustic finite integration simulation. This simulation Allow us to propagate nonlinear acoustic beam to real world target. In this paper we discuss initial experiment with parametric and in a really on the exclusion of starting from food source. Removing board from certain areas can be important for aviation safety, Agricultural and facilities maintained. The aircraft strike with birds creates a serious economic and safety problem and very important issues now we are facing. Currently there are many techniques for removal of bird, which includes targeted more kills of Birds, Scaring the birds by noise devices and many more things. But these things are not good for environment also. In agriculture farmer use harmful chemicals to kill birds which is not good for our health. And this have Limited effect Work, Basically this is short terms techniques. And which also cause environmental issues. Our approach to this problem is very unique. Numerical simulation to understand the indirection of the sound field and environment we combine different solution of the equations with clearly at quarry stick finite integration simulation for our better understanding. Seems there are ready physical properties of sound which we got from experiment and an acoustics measurements.

PAPER 10:- Strategy to design bird proof spinners. Authors- Macro R, Luggi N

In the Aerospace industry the most dangerous event is bird Strike. It is very serious for flight safety which can cause damage to lives of human, every year it is setting remarkable losses. Even though nowadays modern aircrafts are certified and tested for bird impact resistance then also it can cause bird Strike. Modern aircraft are designed to carry Aerodynamic parts just like propeller and spinner which mostly collapse after bird strike incidents. So no test or no certified process can stop the bird strike incidents which are happening very eventually. Whereas the collision of spinner is not a much concern as the fly on home capability is not compromised. In this presented paper they gave and introduced a strategy to design Birds proof spinner. The spinners are very effective and evaluated by means of LS-Dyna. A smooth particle hydrodynamics model of bird was initiated at a starting of development and validation. After that the cause and impact of a bird strike on composite spinners are calculated and evaluated. The investigation regarding this is also done. Particularly to capture the complex value of the system and dynamic behavior of composite material which is used in Aircraft construction was validated against specific dynamic test which are carried out for the certification of the aircraft. It can cause influence of spinner motion which is also investigated and another investigation was difference between motionless and revolving spinner where pointed out in this paper. Improvement to the design of the reference spinner which is based on the basic idea of deflecting the bird in space of bagging the bird which were developed and the performance of that incidence numerically evaluated by the analysis of LS Dyna. Now we can have looked over result which is obtained from this paper, it was concluded that composite material and rotational motion of the spinners and spin movement of propeller spinner can be exported to design Birds proof spinner. Moreover the observation that observed that increasing thickness of a spinner is not only against the weight of constraints typical of aircraft construction but also in effective regarding this. Further the statistic shows that but stipe still represent a serious trade for safety of aerospace industry and for flight safety. Every year the collision between aircraft and bird causes remarkable losses of livelihood of human and crew member as well as the financial losses of that

particular aircraft company. Bird strike impact is very highly energy character resized by load with high intensity of short duration so it causes more loss. This paper gives us a strategy to design both group spinners which is introduced by using LS-Dyna. Using LS-Dyna or numerical model of bird which can allow a simulating a complex and very complex event such as bird Strike on the structure in rotational motion was initially developed so we can evaluate this.

PAPER 11:- Bird strike analysis of aircraft engine fan. Author - Y.N. Somethin , P.V. Chupin

Safety in accidental condition of the aircraft is very important requirement in our aviation jet engine. Bird is striking into the engine in a flight condition. In this case characterized by a high-speed impact of the very small bird for short duration the speed of the bird is high so the impact is very dangerous. The destruction caused by this accident is very huge. The bird is strike on the rotating blade of a fan which can cause dynamic deformation of the blade and this element of the fan can cause disintegration construction of that fan. The investigation of the bird Strike impact incidence is very important and which should be employed during design stage of the development process of the aircraft. This is an analysis of numerical result and their verification by comparison with experimental data of these harmful incidents. The solution is implemented using lozenge engine SPH approach to a model bird paper. The obtained result tell us that denoted approach are quiet very close to each other and it also shows that force between bird and blades and as well as Birds deformation behavior. The result which is obtained using SPH approach and bird move along axis of the fan towards blade with velocity of 80 meter per second. The conclusion says that numerical simulation of the Turbojet engine fan blade dynamic deformation is due to medium size of bird strike incidents which were performed using Ls-Dyna. The simulation was implemented with Ls-Dyna and the values of the fraction Coefficient between board and the fan of the Turbojet is obtained using this analysis. Using properties of water, forward material which allowed obtaining result regarding experimental data which is agreed with this. The analysis and the calculation which shows no direct dependence between strain in the blades and the Turbojet engine and coefficient of traction. BEST general agreement

which is given between numerical and experimental data which is obtained from the fractional Coefficient value which is obtained equal to zero. The fraction value should not exceed 15%. The strain obtained using land Raman and SPH approaches with fabrication. Coefficient which is given as zero are really close to each other and have equal agreement with experimental curves. In other hand side sap's approach of the numerical result which is similar to experimental data.

PAPER 12:- Efficient hybrid surface / volume waste generation using suppressed marking direction method. Authors- YASUSHI ITO , K. SONI

The given paper describes about the user friendly hybrid mesh generation method. This method is proposed to improve the quality of a mesh at concave corner of surface and in the volume and such aircraft wing body functions at suppressed emerging direction method. Good quality semi structured quadrilateral faces which can be created around the selected geometrical characteristic with in minimum user investigations by the using a advancing layer type method. This method is special treatment at concave corners of the faces. The hybrid volume 1 generation method is proposed by multiple searching direction approach which is used to generate high quality hybrid mesh. Nowadays we have very advanced hardware performance and the flow solver algorithm unstructured mesh which is using very widely in computational fluid dynamics simulations. The structured is preferred for very long duration of time which is because of their implicate cell connectivity information which is greatly contributes to the numerical efficiency and the accuracy of the nation which is generated by various methods. Furthermore this is always challenging and very time consuming process of producing structured and high quality mesh of complex geometry. It is always looked for to improve the efficiency and the accuracy of the unstructured mesh with flavor of structured mesh in the hybrid Mesh which is proposed for viscous flow simulation which is widely using in aerospace industry and agro industry also. The side of this is any isotropic tetrahedral measures had also widely used for viscous flow simulation to produce mesh generation method in more count. In those entire message anisotropic right hand angle triangle tetrahedral are placed on a slip wall and isotopic tetrahedral in the reminder of domains of structured mesh. Most of the entire

hybrid Mesh can easily convert into anisotropic tetrahedral measures by subdividing prisms hexa-hederal and pyramids into the tetrahedral structure. Among the typical hybrid and anisotropic mesh generation the quality of the element around the convex and concave corner becomes a very major problem because of only single direction is only allowed at each node of no flip walls. This is because it is very critical to new generation of hybrid and anisotropic mesh generation with quality elements. Very similar approach is needful to improves the quality of such elements for hybrid Mesh because more solvers are available in the market. The three-dimensional surface models which usually have small number of singular points which is valid for semi structured elements which cannot be replaced by using conventional hybrid mesh generation methods for quality type of mesh generation. Generic 3 element airfoil is one of its type for the production of quality generation. To change the mesh density they use the subdivide boundary ages and they divide it into many sections. The hybrid surface match has more nodes in the code wise direction in the leading and the trailing age of the aircraft. The two masses are similar Trends but new mesh provides slightly higher suction peak at the leading edge and the trailing edge of the aircraft and smaller pressure jump at the trailing edge of the aircraft. This is probably due to higher resolution element due to further investigation in wind tunnel model. The significantly improve the quality of the at the corners edges, leading edge, trailing edge of the mesh concave coronavirus. Where these are automatically detected to make quadrilateral around them for more like a structured grid which is supposed to give by merging direction method.

PAPER 13:- Analysis of the bullet nose of an Aero engine for bird impact through virtual and Rapid prototyping. Authors - RAJIV JAIN , A.N. MAJILA

Flying is Basic part from the Birds life. But nowadays ironically birds are striking the aircraft engine so it is causing very disastrous condition for the aircraft industry. So aircraft engine have to design to survive from this accident. The design of the bullet nose of an engine during the bird Strike is the one of the best idea which is presented in this paper. A finite element analysis model which was developed for this purpose of developing aero-engine of bullet nose. It was then fine tune through experiments on a bullet known using laser engineer net

shopping which we called as lens. From this approach several designed and many alternative would be evaluated virtually and only few physical experiments which are required for the validation and certification of this model. The outcome of this project is not only very Rapid but it is also safe. Human have many desires just like to fly like a bird against the gravity. In initial days it took many attempts to exact mimic the flapping wings which are failed. This leads to fixed wing flying operator construction and further it cause the development from which the basic design of aircraft came out. The further development of rotary wing flying vehicle over aircraft MBPS and associated avionics systems to had inspiration from biological systems only. This ideas are really fascinating lovely appreciate harmless and relatively light Bolt are ionic threat to air travel. Bird strike or bird hit which is refers to the collision of the bird flag a bird or group of a bird to the manmade flying machine which aircraft such as helicopter, spacecraft. However birds are lightweight still the impact of their collision with animals with the aircraft that can create a Dent in a body or engine failure of the aircraft. And also birds are chopped in the engine which can damage the aircraft or helicopter engine. Bird Strike have led to many accidents in a civil and fighter aircraft which cause expensive repair of that aircraft and harm to the human being and cabin crew members as well as pilots. One of the latest major incidents of a bird strike which is registered in US Airways of flight 1549 on 15 January 2009 which is collide with the bird and cause harmful accident this flight was flying to Canada still this plan is in takeoff position and it lost the Thrust in a both engine and fell down. Flight was consists of 150 passengers and few crew members they are rescued safely. The Airways guideline gives many instructions for this accident but it will not reduce the number of birds strike incidents. So in this paper they came with the design of the engine which is bullet nose aero engine with streamline the flow inlet air to avoid Aerodynamic losses. It not only controls the airflow Desire and way but also plays important role in deflection with collide with the bird strike incidence and also save the aircraft from bird strike and for the impact of it. Similarly aircraft industry is facing requirement from certifying Agencies and on the other hand side there is very tough competition in the market for the low cost aircrafts and the certification of this bird strike test in very low cost manner . Therefore there is a need to carry out the design and evaluation in the environment. For this particular reason on behalf to save the

aircraft from danger accident and also to save the human lives. The design of physical Bullet nose for bird strike both for finite turning and F.E.A model to gain the confidence in simulation results which got clearly. To present the investigation studies of the bird strike at radial location Halfway from the engine Centre axis of the bullet nose which is given in this paper with certain data such as the impact speed of 150 meter per second target object is in client at angle of 45 degrees from horizontal and the time of collapse is 1.5 microseconds for a projectile effective length of the given model. In this section initial energy variation of the projectile which is obtained from F.E.A model which is given in this paper the speed of the photography result are compared with experimental and numerical data and techniques on the bullet knows model this is also provided in this paper. The kinetic energy of the projectile motion of the bird just very before the impact with the engine and the total energy of the bird of the projectile is compared in this section and it is converted into Strain energy of the bullet nose and rest energy is converted into the formation of the bird projectile during impact. Therefore this investigation represents the numerical procedure adopted to show variation of the kinetic energy of the projectile and the Strain energy of the bullet nose during the impact event of the bird strike on the nose of the aircraft. Basic is a event when it takes place when aircraft it travels in the air jet planes are more prone to hit the bird during its travelling most of the take off period and landing period which is low attitude period and this areas are known as the bird areas means in which area birds are mostly active. The produced design of the bullet nose aero engine is for safety against but Strike impact or bird strike incidence which is presented in this paper. But are approximated to a cylindrical lump and its impact over the bullet nose aero engine after the incidence is studied by using finite element analysis. DU results we got from finite element analysis simulation which is validated through to actual experiments. The numerical result and the experimental results indicate the bullet nose can observe only some kinetic energy and which convert into another form of energy so this is also conservation of energy or converting energy from one form to another from. This model of bullet nose Aero engine is very useful and needful for agro industry specially nowadays when industry require more profit and safe flights and safety of the passengers crew members it cetera. The criteria of this are very beneficial for the aero industry.

PAPER 14:- Bird strike simulation on novel composite leading-edge design. Author- A F JOHNSON, M HALZOPAL

This paper gives a methodology for the numerical simulation of the bird strike event on the novel leading edge structure of a horizontal tail plane is presented and demonstrated likewise. The innovative idea of leading edge design which is basically based on tense skin concept. Compressing one or more fold composite sub laminate that unfolded during the bird impact is a basic idea of tense skin. Thus providing high energy absorption is the basic concept behind this. The simulation technique is basically based on nonlinear dynamic finite element analysis and which is performed in three steps which is given in this paper. First EP deals more with the development and advancement of the material which is suitable for damage repairing model. The highest strain is produced during this impact and this behavior is noticed in detail. The second step which is going to deal with development of finite element modeling procedure for the simulation of complex valued mode which is cellular during the birds strike and unfolding mechanism of static vibration which is based on tensor. This is going to represent complete leading edge composite structure. The third step going to deal with numerical simulation of bird strike analysis and mesh density of high impact areas substitute bird flexibility and material damage and contact interprets parameter. The numerical result it is going to give good qualitative and quantitative agreement with experimental test. Novel fiber reinforced composite leading edge is a main concept which is in to develop the impact resistance of the structure of the wing in case but strike is going to invest or is going to strike. The design concept is based on absorption of major portion of the kinetic energy which is produced by the striking of the bird on the leading edge skin and it is going to protect the ribs and inner leading edge structure from damage. The leading edge of the aircraft wing is specially fabricated from composite panel which is name at Spencer skin panel which is going to comprising the folded layers which are going to unfold during the impact. There are many difficulties Richard being placed in the development of revenue legal model for the complex type of unfolding mechanism of the composite richest answers king. In addition to this problem the proper representation of the actual behavior of the leading edge laminate and sub laminate interface as degree of bonding between

laminated and Fern laminated tensile skin and tinsel fold is almost impossible to be directly made by open measurements. The modeling drawback includes the difficulty in definition of proper anisotropic ply damage model for the numerical model which is the very large deformation going to observe in the skin of the leading edge during the impact and after the impact also. In the behavior of the leading edge structure under investigation which is employing behavior is going to represent by laminated shell element. Which is made up of several plies is going to be associated with fly material model. Basically there are two types of damage model are calibrated and developed first one is by ply in which include epoxy carbon epoxy fiber fabric at 17 and second one is hybrid model for epoxy fabric layer these two are going to design on foot and to stretch the very high strain before failure of the aircraft engine. The conclusion of this paper for the bird strike methodology for the novel composite leading edge structure and simulation is presented in this paper the leading edge design is based on 10 star skin concept which is very high energy absorbing characteristics and very advanced concept is being used in industry. The description of the finite element model is given in this paper which is very successful development and validated material. The damage and determination of the model for the composite fabric skin which is denser skin material which is used in the most crucial part of the aircraft and is going to be reliable for the aircraft. Leading edge structure and substitute bird strike development are complex thing of the finite element model which is going through simulation method logi during the model development phase there are many travels are drawn which has remained. During the development of this model the average shell element size and the impact area of the compact interference parameter and substitute Board model parameter are the basic needs which are going to provide by them and will get the result. The course of the leading edge structure which can be sufficient for an ordinary static stress analysis which is required for local reinforcement at highly compatible area because of the difficulties in adjusting the contact of interference area full stop the stiffness between does keep Sab laminated and laminated is going to differ. The average size of the element is highly located at the Central area of the leading it does it can be reduced from 10 or less. Although this enforcement model which is presented in this paper is resulted in more element and calculation of time it can contribute in associating the desired accuracy and

quality in the simulation. The physical contact between laminate and Sub Laminate of the tensor skin is given by the interference algorithm. In general the number of contact of the interference is defined on the thickness and dimensions of the possible contact area which is gain on the simulation efficiency of the model.

PAPER 15:- Modelling of bird strike on the aircraft wing leading is made from fiber metal laminate part 2 to modelling of impact with SPH bird model. Authors- MICHAEL A, J.R. XIAO

Fiber metal laminate going to report possess excellent impact and aircraft parts likely to be subjected. In the second part of the paper there are two parts on basis of which we are going to do analysis. That is finite element model is being developed for simulating Bird test using smoke particle dynamics for modeling the bird. The material developed in the path to one of the paper for the Modeling the leading ages skin there are many parameters which are used for the bird modeling and obtained from the system identification analysis of the strike plate. Protest simulation is accurately predicted that but is not vibrate at the leading edge of the skin. It correctly tells us from the one of the fine metal analysis like it would be for more than other. The post is of the simulation include a model of the structure which is going to support the test article and which is going to predict the clouds transform to supporting structure where very good agreement with experimental values which is being present in the this paper. The smooth particle hydrodynamic bird model is used to show no signs of instability and the this model is very correctly modeled and breakup of the bird into a particles. The rivet which are connecting to the skin of the rear side where we have to profound effect on the performance of the structure of the aircraft and the structure is depend upon the design the model. The introduction part of this paper is introduced about the bird strike. And our significant rate for the Civil and military aircraft and which take an important role in an aircraft certification process. As new material such as composite material fiber metal laminate introduced in the aircraft parts at risk from both spike and many other activities such as certification requirements original return the metallic material is going to be used or is needed to exceed the amount of a complexity value of behavior. As material

is going to be introduced, because of very high cost of birds type testing and also high cost for the certification of the birds tight incidence there in account for the complex value of behavior of such materials in order to achieve a substantial reduction in the cost at the time of associated. With generating new equipment's and for the qualifying aircraft to meet such requirement need the accurate techniques. Basically in part 1 of the paper a collaborative research is done on the program within you founded project name as crahivi is going to describe and concerning novel leading edge of the aircraft wing structure with glass based basically fml skin and fiber metal laminate material is going to be used. The alternative consistency of this material are piles of thin aluminum alloy or fiber epoxy on laminate materials. It have been seeing reported possess excellent impact resistance and therefore candidate which is going to choose the aircraft and for the aircraft part likely to be subjected at high velocity impact for the Runway debris and birds strike element at the time of a bird incidence bird which right at the engine of the aircraft and it will create high impact for the very short duration. But very high amount of energy is being created at that time the energy is created that is kinetic energy and this energy is going to convert into another form of the energy that when it is going to strike on the engine. The leading edge of the staff have within designed and manufactured the subjected to the bird strike which is going to prevent the aircraft on the bird Strike. The second part of this paper is going to concern or deal with Birds striking modeling it tell and fml skin. Basically the birds modeling represents the unique difficulties in term of controlling number of instability and the modeling of the fluid dynamics and fluid behavior of the bird and it is going to deal with several distortions. As the bird is going to break into a many degrees particle this particle can cause damage to the engine for this particles can Choke of the engine. To avoid such problem like fluid behavior and stimuli simulation terminated prematurity to excessive compression of the element which eventually lead to negative volume and author implemented plated Limited elements by element where Limited from simulation. The result of this paper is to be concluded in two parts that is a pre-analysis and post-analysis. A model is being created for the bird impact on two leading edge of the wing structure and is made from the glass based fiber laminate so the result is going to be compared with experimental metal taste program and theoretical values which is being calculated during the work. The work in novel is

found by using fml material and the leading edge scheme which is use of continue damage by the mechanism modeling incorporating from the Strain energy which is rate effect of glass fiber layers by the use of smooth particle hydrodynamics for the modeling of the bird a system identification method for determining bird properties from impact of a flat plate and the modeling. This paper is in the support of a structure and load of the various cells which is also created from the various type of material and the simulation is done in free simulation test and the other simulations are done input simulation test and result of both is being compared and conclusion is being obtained from the comparison of the both values. And based on comparison we come to know the practical and theoretical answers are very much similar so it conclude the bird strike modelling is based on both result.

Chapter-3

AIM AND SCOPE OF INVESTIGATION

3.1 AIM: -

The aim of this research paper is to protect the aircraft from the birds strike and remain maintain streamline flow at the entrance of the engine. The theoretical scope of this paper is to save the people life from accident by giving a design which save the aircraft. To prevent the birds strike we are forming a mesh (or) honey-comb structure before the cowling area of engine which protect the engine from the birds strike and provide Laminar flow to the power plant. If the mesh structure is near by the inlet portion it create turbulence so by using Volute spring we create a better lateral stability and also increase the distance between the mesh structure and the cowling part of the engine so that the turbulence is decreased. Volute spring is used to absorb the shock created by the moving mesh structure and it protects the structure from being damage by the birds strike. This paper is all about to stop the crash by birds strike and save the life of the people as well as that highly invested aircraft from being crashed just because of small incident we have to save the life of the people and birds which get affected by accident because this is ours and their nature too and they also have rights to stay and live their life in this mother nature.

3.2 SCOPE: -

In past two-decades around 106 civilians death was confirmed worldwide and there is huge loss faced by the aeroplane companies which was around \$1.2 billion a year in damage. And around 14,661 collision of wildlife in 2018 was reported that's all together comes up to 40 collision a day. This mesh layer decrease the rate of strike because the birds are the frequent flyers and we can't control them but with this layer we absolutely decrease the numbers of accident occurs by those birds strikes and it can save the people's lives. This layer used in the subsonic aircraft or passenger aircraft to prevent people from the accident. To prevent the birds strike we are forming a mesh (or) honey-comb structure before the cowling area of engine which protect the engine

from the birds strike and provide Laminar flow to the power plant. If the mesh structure is near by the inlet portion it create turbulence so by using Volute spring we create a better lateral stability and also increase the distance between the mesh structure and the cowling part of the engine so that the turbulence is decreased. Volute spring is used to absorb the shock created by the moving mesh structure and it protects the structure from being damage by the birds strike. This paper is all about to stop the crash by birds strike and save the life of the people as well as that highly invested aircraft from being crashed just because of small incident we have to save the life of the people and birds which get affected by accident because this is ours and their nature too and they also have rights to stay and live their life in this mother nature. Here when the birds strikes the mesh layer they have some momentum and with that larger momentum they breaks the mesh structure and get entered inside the compressor blade and again harm the blades structure and made the engine failure. So for not suffering from that certain problem we will go through the different method that is related to the basic physics concept which is the concept of momentum if the force is applied for a short period of time it get more impulse and if the time duration is increased then the impact of the force is decreased so based on this concept we introduced one another part in it that is Volute sprig. When the bird get stopped by the mesh layer, birds body exert huge impact force over the layer because of its own velocity and the suction created by the aircraft engine and another one the velocity of the aircraft so all together totally three forces are working against the mesh layer so to prevent the mesh layer from breaking we use volute spring which maintain the lateral stability of the mesh layer and absorb the shock produced by the birds strike. We use here simple concept of physics which is known by momentum. To reduce the impact of the force we increase the time of contact with the mesh layer so mesh layer experience less impact force and we can save the mesh layer from damage. We use bed shocker to provide support to the mesh layer and the volute spring to prevent mesh layer from going down by the earth's gravitation or at the time of landing there is bounce back of the aircraft landing gear so to prevent it from going down we give a support of bed shocker.

CHAPTER-4

EXPERIMENTAL AND METHODS; ALGORITHMS USED

4.1 ALGORITHM USED:

The algorithm used here is of the following steps

4.1.1 Initial design

4.1.2 3-D model

4.1.1 INITIAL DESIGN:-

The initial design of the Honeycomb or Mesh layer structure are made by studying various types of designs used in the different field of aspects like in liquid jet engine or any super aerobic design so by studying from different field we experience about the design and their drawbacks. The initial design of this project was designed with a Simple square like mesh structure which looks alike general Wind Tunnel diffuser so the basic idea we got from there only. During the initial design the study was done only one the basic thing that why birds strike happen mostly and which part of Airplane is mostly got affected by the bird strike. Then the idea of this Honey-comb like Mesh Layer come to exist which now we have to transform it into a reality which is going to be used in an Airplane engine cowling area. So in other words it is going to change the turbulence flow into laminar flow also which generally a wind tunnel do so these are the basic properties of the honey comb like mesh layer which we are going to create here. The main task of the project was to design a Layer which will protect the aircraft and also maintain the streamline flow which has more stable flow when normal air is passed through it. We just go with five basic designs on which we will prefer the best one for Mesh Layer.

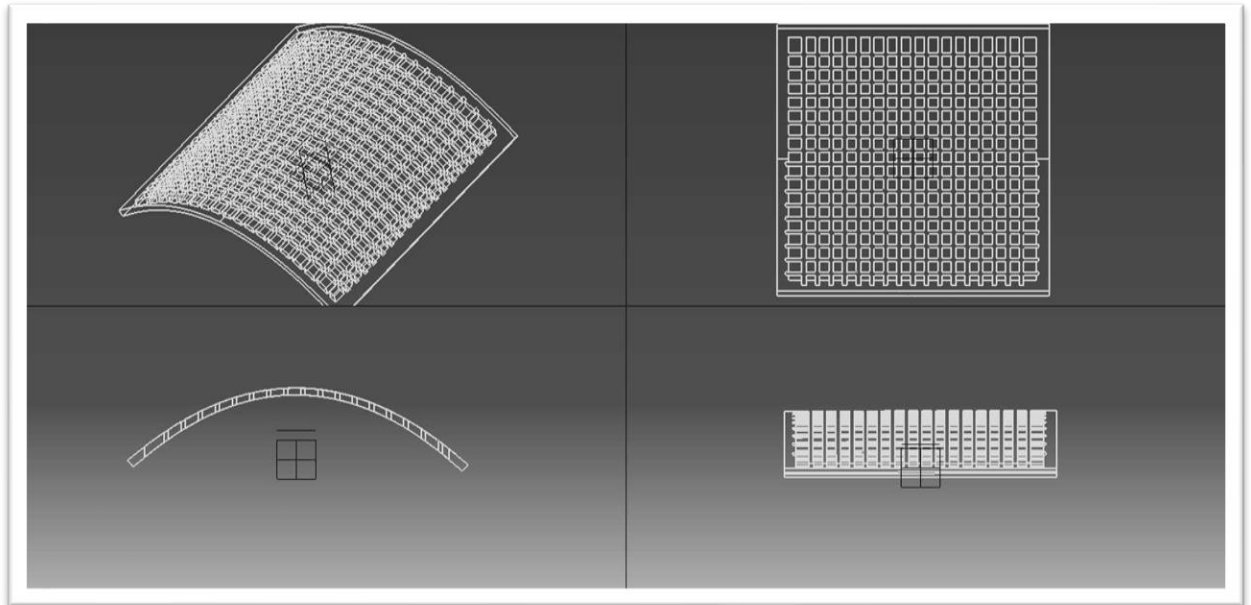


Fig 4.1- HONEY COMB STRUCTURE.

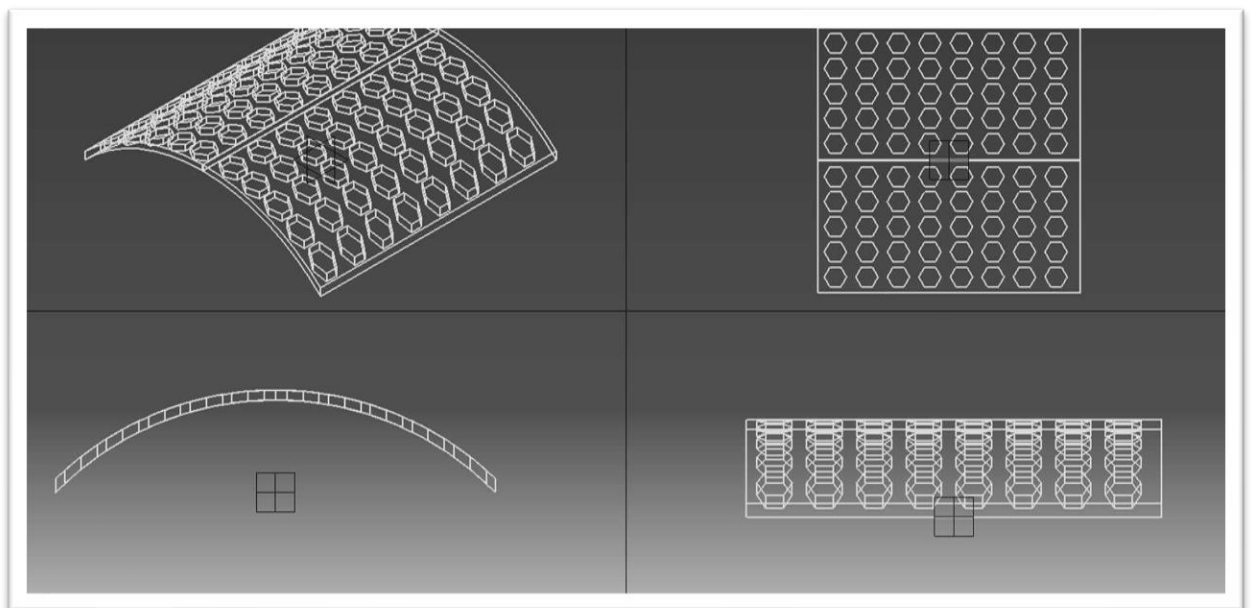


Fig 4.2- HEXAGONAL SHAPE IN CLAMSHELL

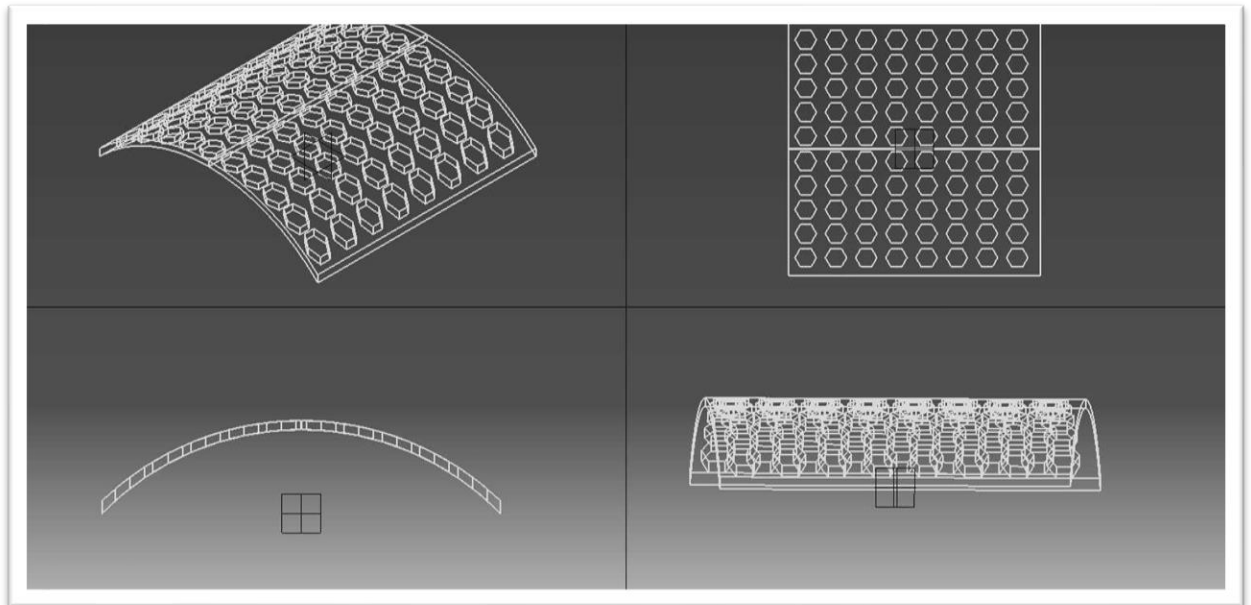


Fig 4.3:- HEXAGONAL SHAPE WITH LESS FRONT AREA.

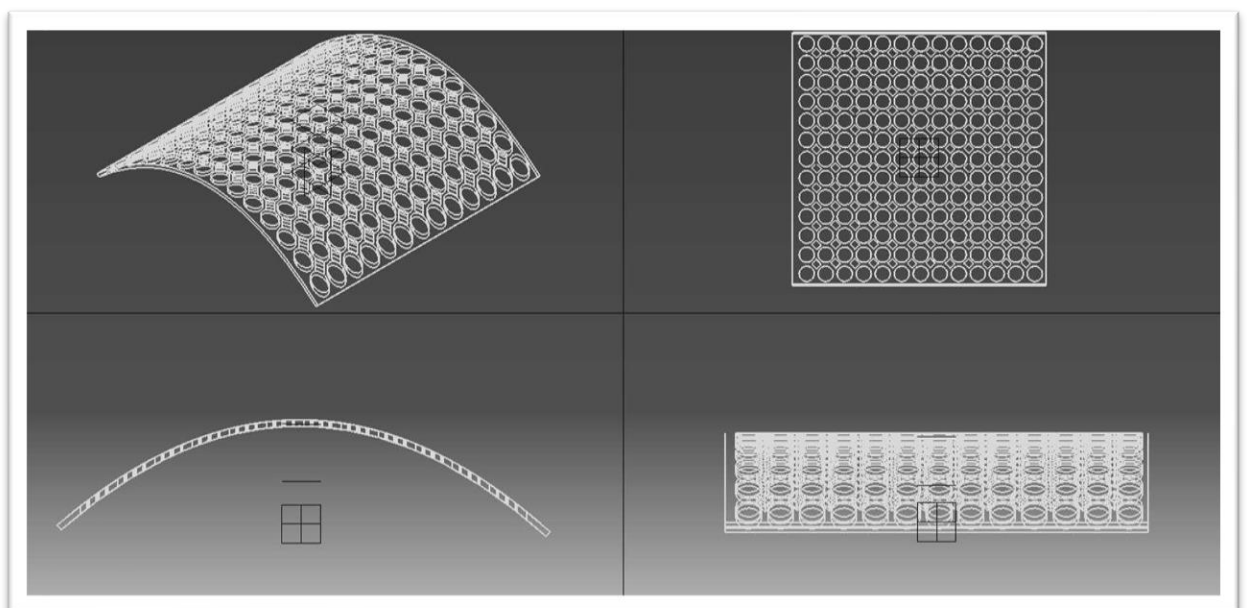


Fig 4.4 Circle And Square Collaboration

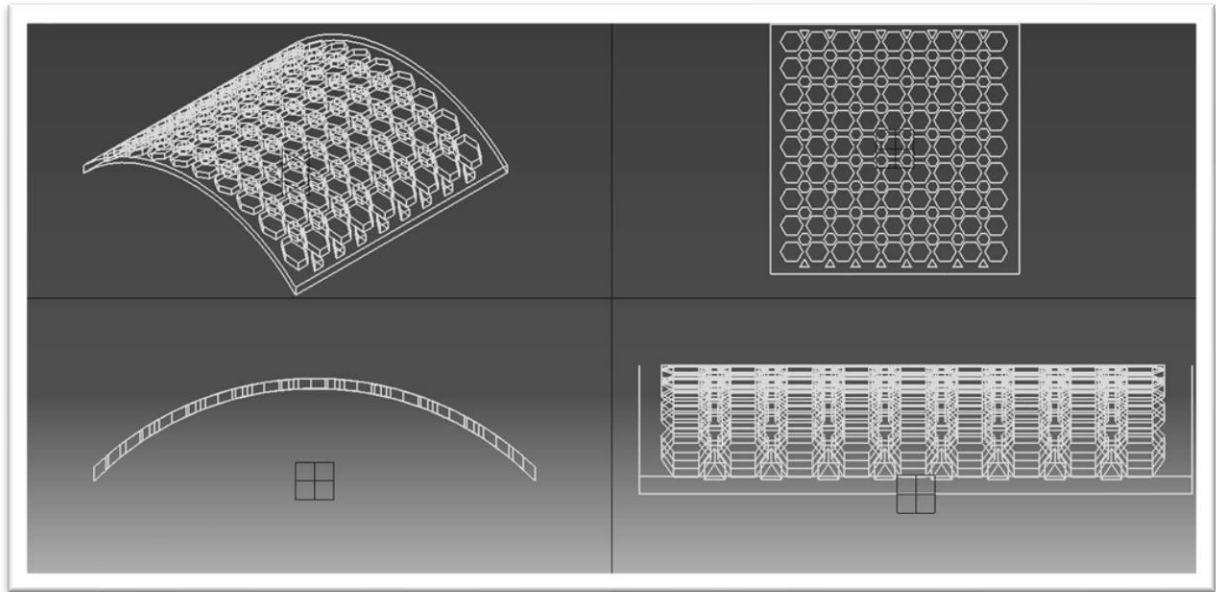


Fig 4.5:- TWIN HEXAGONAL SHAPE

4.1.2. 3-D MODEL:-

Thus from the above which we have done during the initial design a 3-D model is made using a software CATIA V5 which is a designing software by DASSAULT SYSTEMS. The MESH LAYER different model are prepared by using Catia software and the entire mesh layer and entire flow is made in software called ANSYS and the outer body is assigned as domain. The 3-D model for the different shapes of mesh layer is designed and is showed.

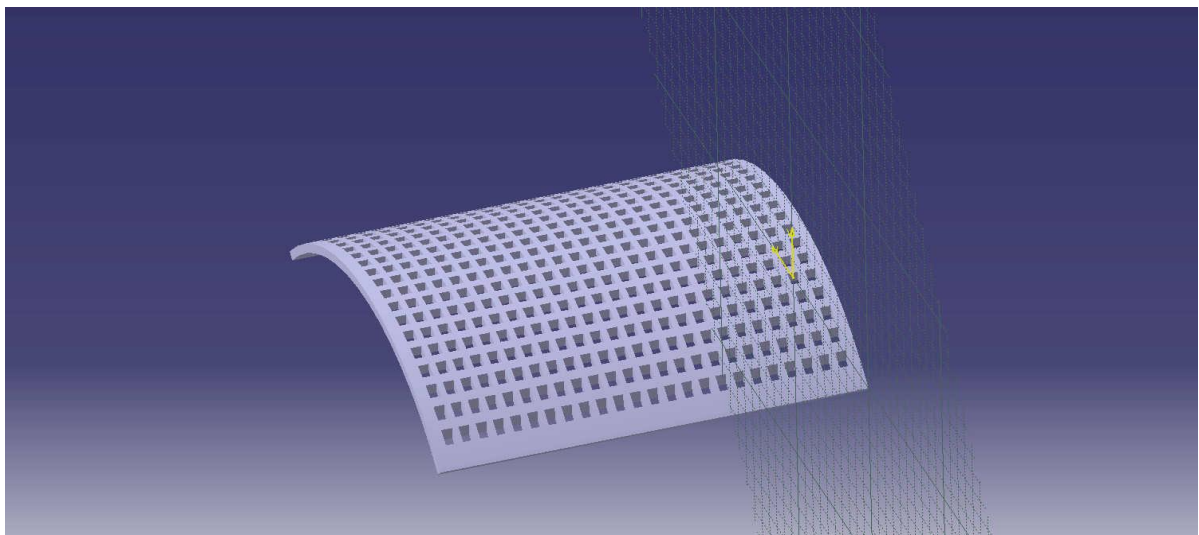


Fig 4.6:- Honey Comb Structure.

From the fig:-4.6 we can see a 3-d model of Square mesh is presented here. The length and breadth of the mesh layer is 200mm and 200mm with the thickness of 5mm. The curvature is according to the requirement. And the length and breadth of the inside small square is 5cm only.

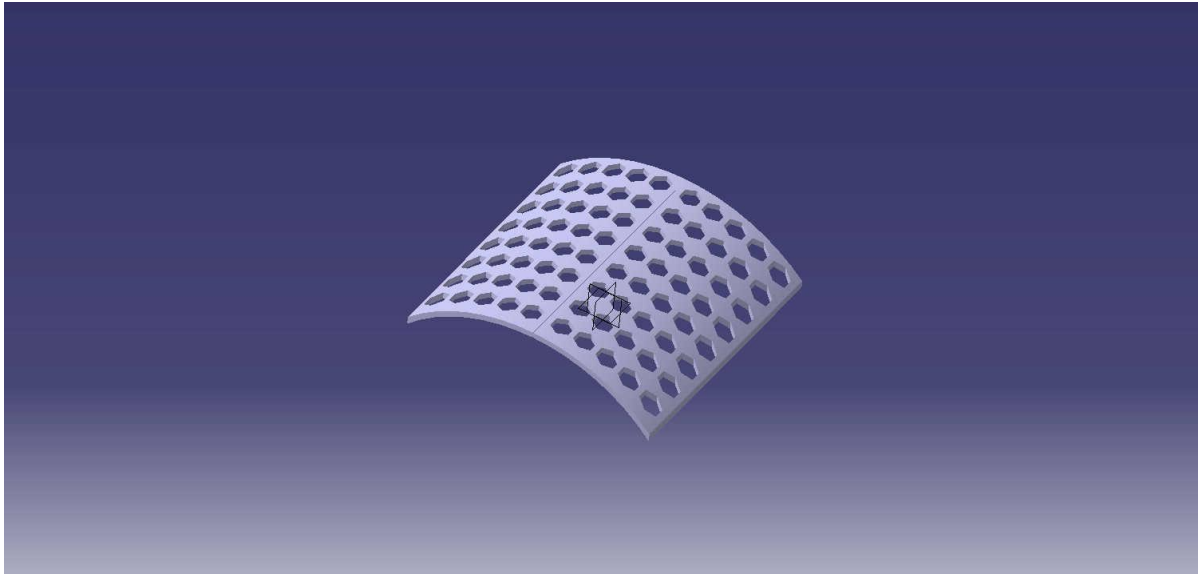


Fig 4.7:- Hexagonal Shape In Clamshell

From the fig:-4.7 we can see a 3-d model of Hexagon with Clamshell design is presented here. The length and breadth of the mesh layer is 200mm and 200mm with the thickness of 5mm and the curvature is according to the requirement. Whereas the Hexagonal each length side is 8.5mm. And further dimensions like the total length of the hexagon in the entire clamshell design is like 18mm only. All the further details re entirely provided in the design onwards.

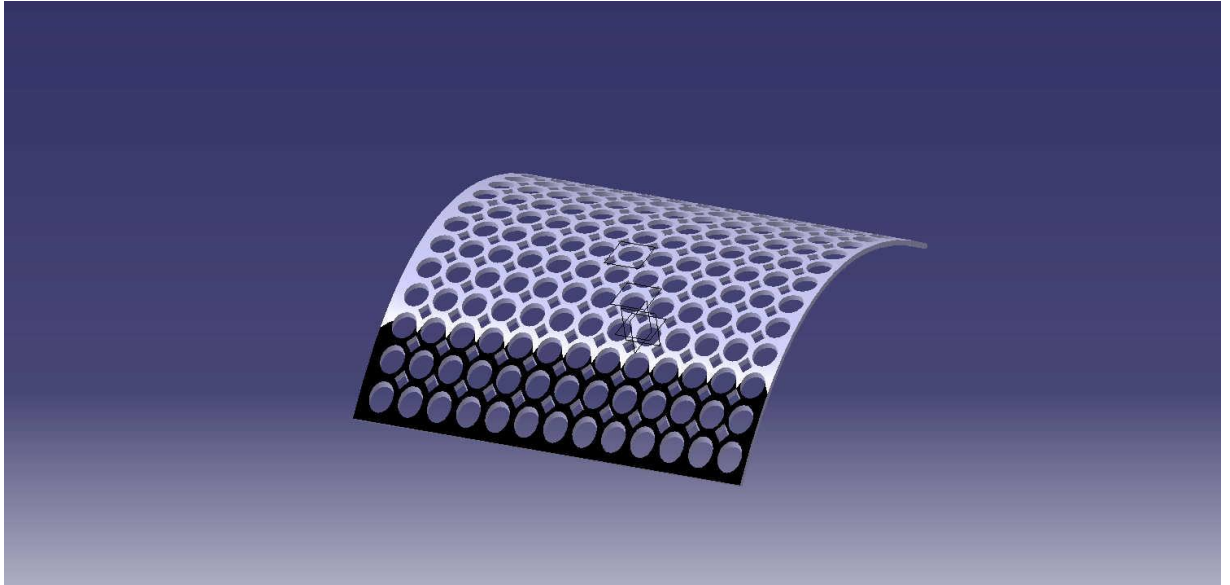


Fig 4.8:- Circle And Square Collaboration.

From the fig:-4.8 we can see a 3-d model of Circle and square collaboration design is presented here. The length and breadth of the mesh layer is 200mm and 200mm with the thickness of 5mm. The curvature is according to the requirement. Whereas the Circle and square collaboration each diameter is 12mm and square side 12mm.

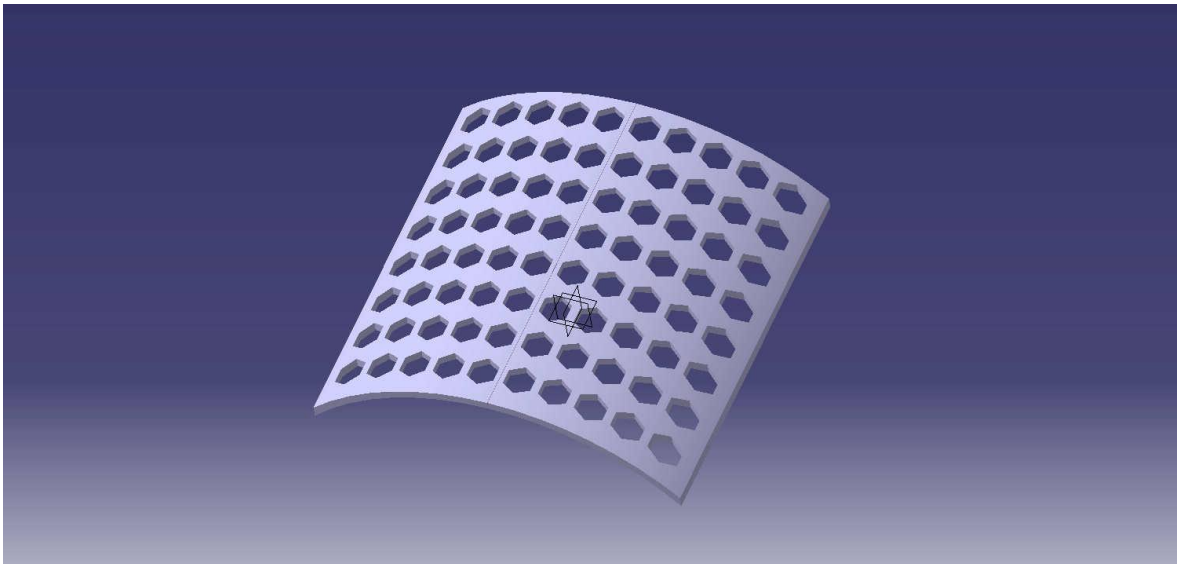


Fig 4.9:- Hexagonal Shape With Less Front Area.

From the fig:-4.9 we can see a 3-d model of Hexagon with Clamshell design with less front area is presented here. The length and breadth of the mesh layer is 200mm and 200mm with the thickness of 5mm. The curvature is according to the requirement. Whereas the Hexagonal each length side is 8.5mm. And

further dimensions like the total length of the hexagon in the entire clamshell design is like 18mm only. All the further details re entirely provided in the design onwards but the number of instances are increased in this design.

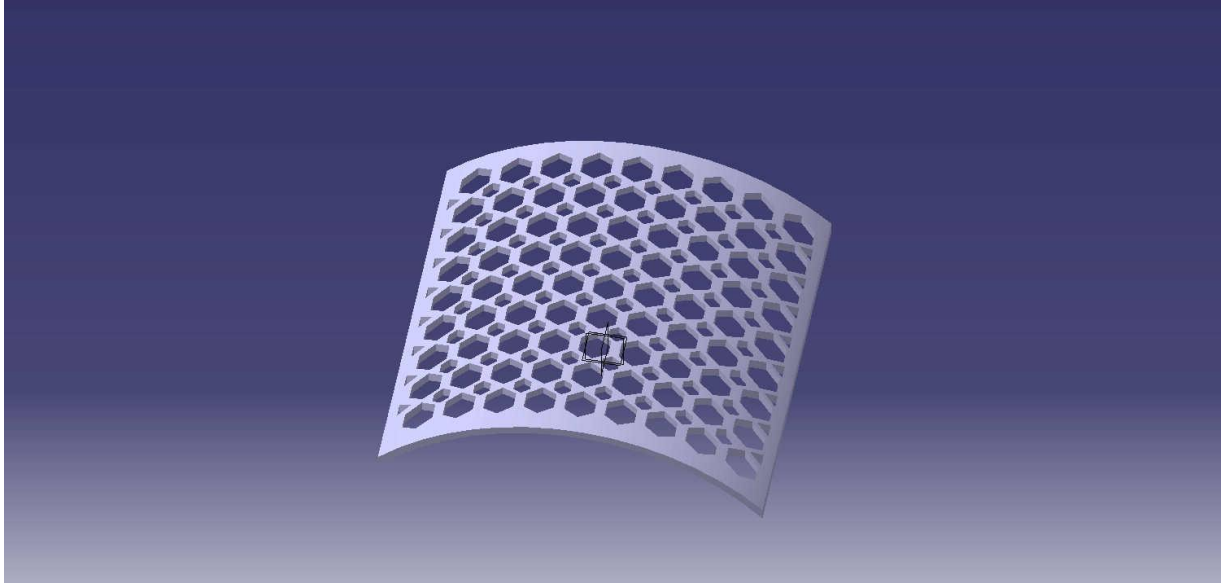


Fig 4.10:- Twin Hexagonal Shape

From the fig:-4.10 we can see a 3-d model of Hexagon with Clamshell design is presented here. The length and breadth of the mesh layer is 200mm and 200mm with the thickness of 5mm. The curvature is according to the requirement. Whereas the Hexagonal each length side is 8.5mm. And further dimensions like the total length of the hexagon in the entire clamshell design is like 18mm only. All the further details are entirely provided in the design onwards.

CHAPTER – 5

RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS

The flow and structural analysis are done in ANSYS 19.2 software and the results are compared with the different types mesh design which we already mentioned in the above context. Numerical results have been obtained using the experimental methods, like Wind Tunnel velocity calibration test with this we can calculate velocity difference brought during the test. Meshing was done using ANSYS FLUENT. To simulate over the more number of iterations we need fine mesh for the clear and absolute result so by using Ansys fluent we got our result. Here is the image of the simulation result for all the design which we already discussed in the earlier context like in Ansys we went for pressure difference and the velocity contour, velocity streamline and velocity vector images are also attached below:-

5.1 Square Mesh Analysis Images:-

5.1.1 Pressure contour

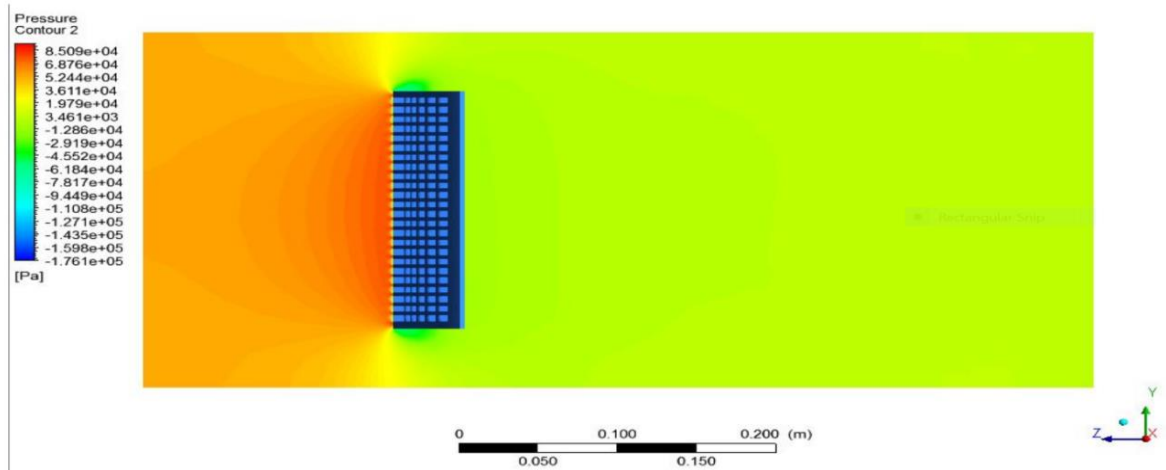


Fig 5.1.1 Square Mesh Pressure Contour Analysis Image

From fig.5.1.1 you can understand the pressure difference between the area after the mesh layer and before the mesh layer. As we can check here the pressure value before the mesh layer is $8.509e+04$ and after the mesh layer. We can check that pressure value decrease from that value to the $1.979e+04$ so there is nice fall in the pressure. We can understand that it will definitely put a good amount of

pressure over the mesh layer. That's why this material is prepared by Lexan Polycarbonate which is a good resistance and it can take that pressure variance.

5.1.2 Velocity Contour

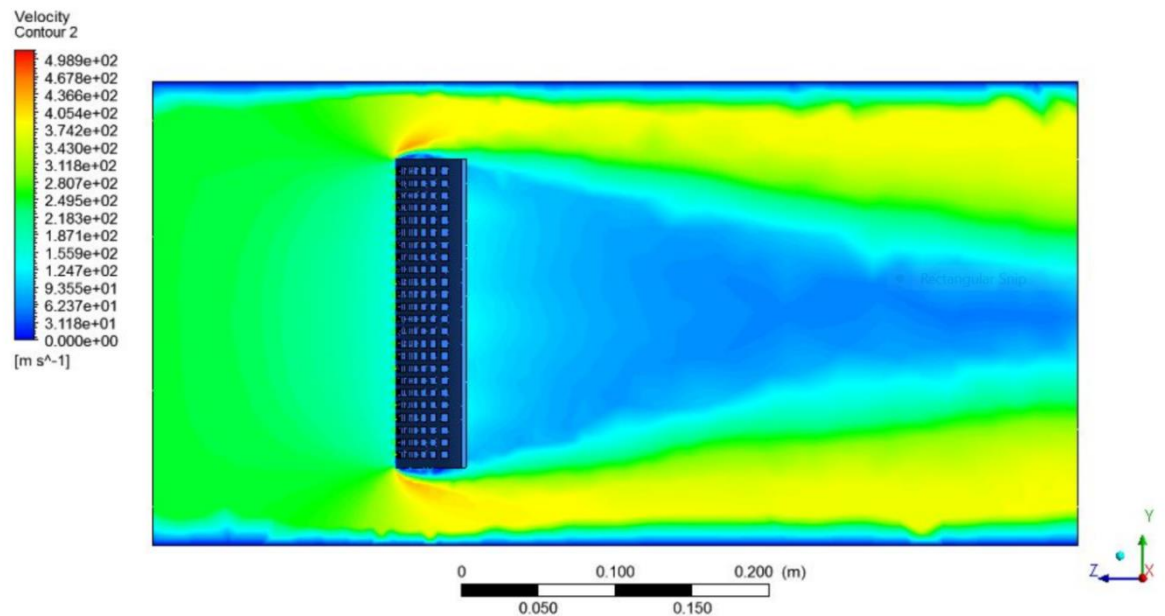


Fig 5.1.2 Square Mesh Velocity Contour Analysis Image

From fig.5.1.2 you can understand that the velocity contour with the mesh layer does not create that much reddish color or yellow color. Which means that drag creation is very less due to the design of the layer. We can understand that it will definitely create a good flow for the aircraft engine.

5.1.3 Velocity Vector

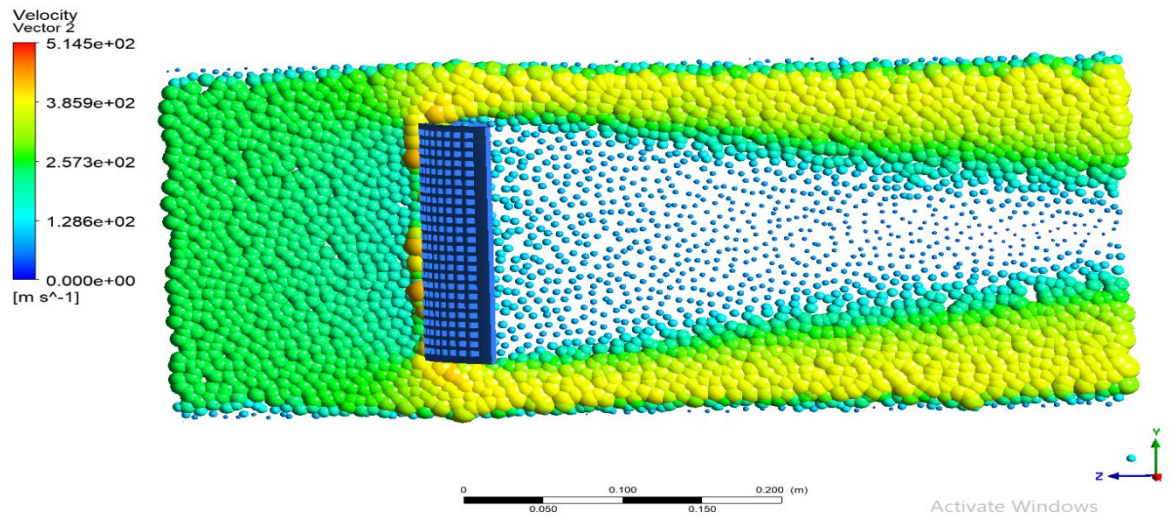


Fig 5.1.3 Square Mesh Velocity Vector Analysis Image

From fig.5.1.3 you can understand that the velocity vector with the mesh layer does not create that much greenish blue color. Which means that flow is continuous but in the image we can observe that before the mesh layer there is good greenish blue color bubbles present there. Which show that air flow is good there but after the mesh layer we can observe that there is more gap between the greenish blue bubbles. So this tell us that there is very less amount of airflow is there so that's it is less considerable for the final result.

5.2 Circle and Square Mesh collaboration Analysis Images:-

5.2.1 Pressure contour

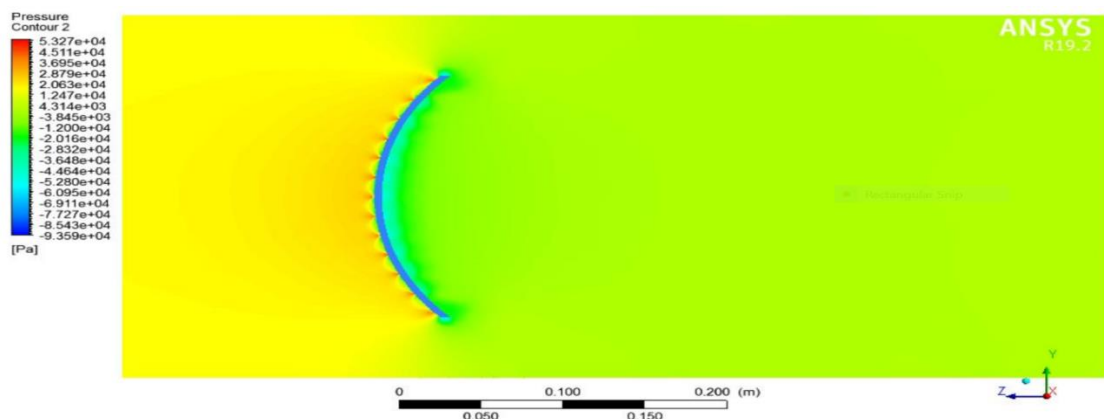


Fig 5.2.1 Circle And Square Mesh Pressure Contour Analysis Image

From fig.5.2.1 you can understand the pressure difference between the area after the mesh layer and before the mesh layer. As we can check here the pressure

value before the mesh layer is 5.327×10^4 and after the mesh layer we can check that pressure value decrease from that value to the -1.200×10^4 . So there is nice fall in the pressure and we can understand that it will definitely put a good amount of pressure over the mesh layer.

5.2.2 Velocity Contour

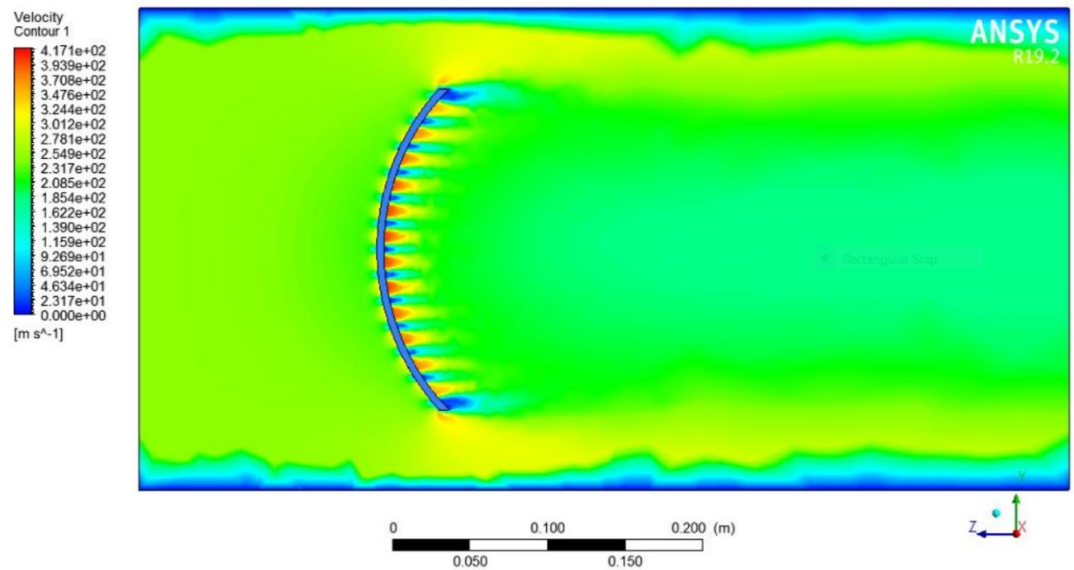


Fig 5.2.2 Circle And Square Mesh Velocity Contour Analysis Image

From fig 5.2.2 you can understand that the velocity contour with the mesh layer does not create that much reddish color or yellow color. Which means that drag creation is very less due to the design of the layer and one more thing which we can observe here is the elongated yellow rays with greenish red shows. The flow and the creation of drag in that region and after that region we can see a good greenish color flow which show that it will definitely create a good flow for the aircraft engine.

5.2.3 Velocity Vector

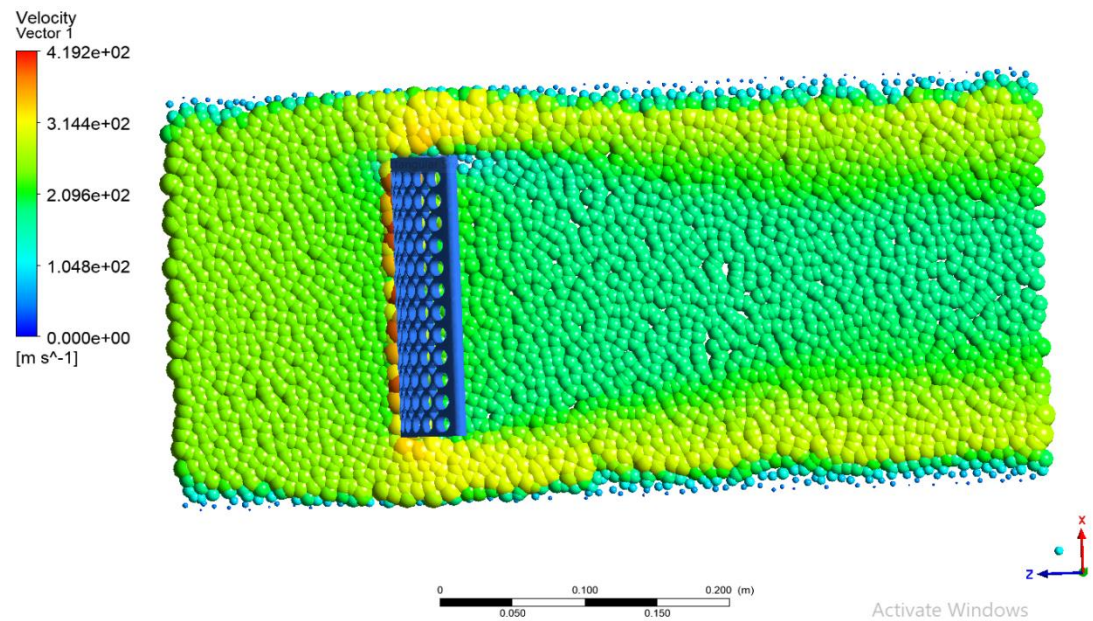


Fig 5.2.3 Circle And Square Mesh Velocity Vector Analysis Image

From fig.5.2.3 you can understand that this is the velocity vector image of the circular design mesh. We can observe here that before the mesh layer there is numerous amount of bubbles are there. We can also observe that at the face of the mesh layer there is reddish and brown color bubbles are there. It shows that the drag creation at that place due to the design of the layer and when we look after the mesh layer there is very good flowing bluish and green color air flow bubbles present there. Which shows that there is very good amount of airflow is there so might be this one is also used for the final result.

5.3 Hexagonal Shape in clamshell design Analysis Image

5.3.1 Pressure Contour

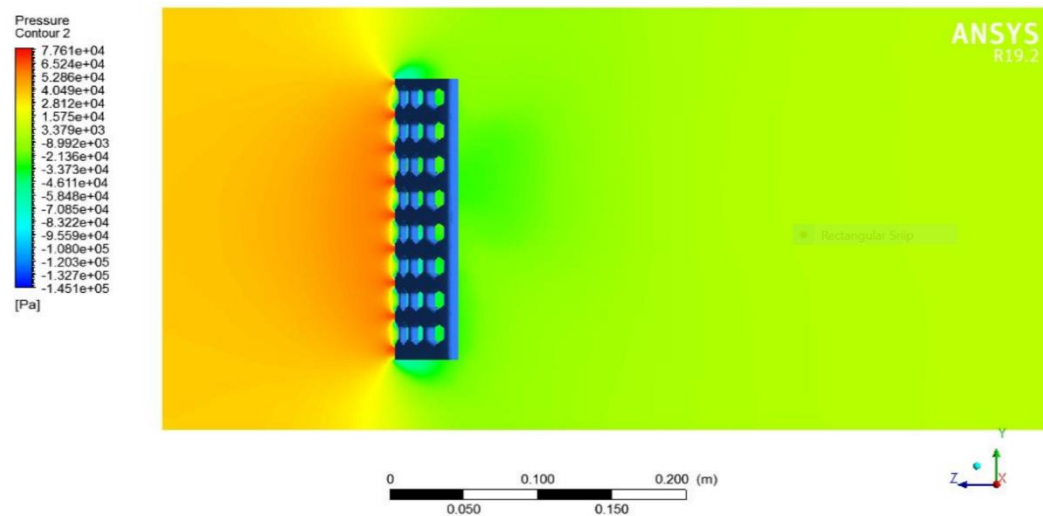


Fig 5.3.1 Hexagonal Mesh Pressure Contour Analysis Image

From fig.5.3.1 you can understand the pressure difference between the area after the mesh layer and before the mesh layer. As we can check here the pressure value before the mesh layer is $7.761e+04$ and after the mesh layer. We can check that pressure value decrease from that value to the $-2.136e+04$. So there is nice fall in the pressure and we can understand that it will definitely put a good amount of pressure over the mesh layer.

5.3.2 Velocity Contour

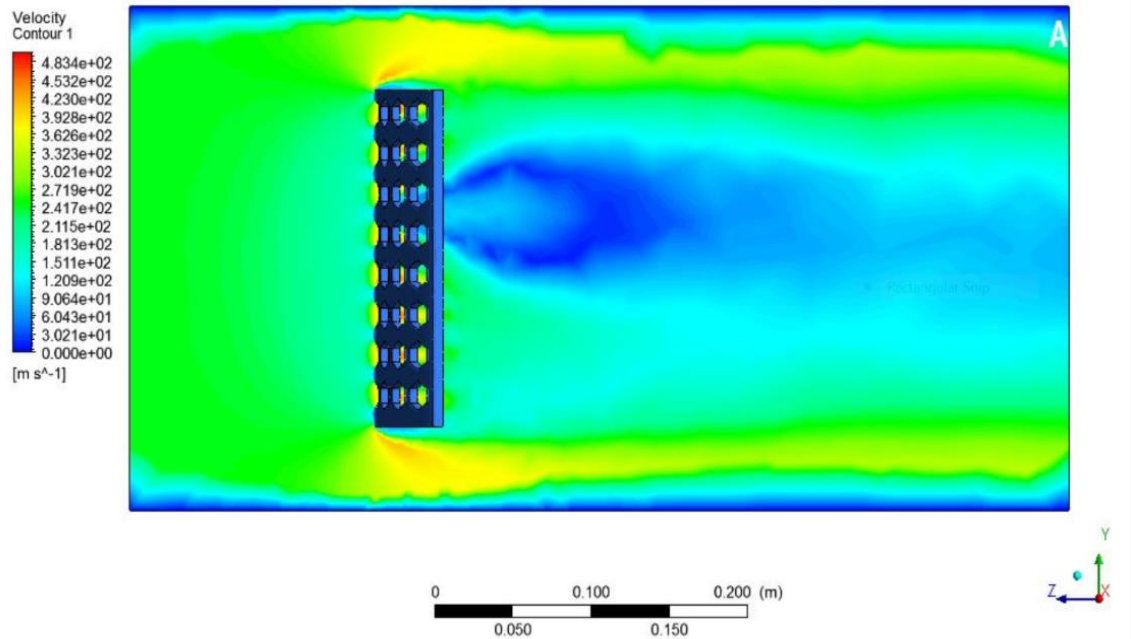


Fig 5.3.2 Hexagonal Mesh Velocity Contour Analysis Image

From fig.5.3.2 you can understand that the velocity contour with the mesh layer does not create that much reddish color or yellow color. It means that drag creation is very less due to the design of the layer and one more thing. We can observe here is the elongated bluish rays with dark green huge ball shape which shows that the swirl drag formation is there which is not good for any engine.

5.3.3 Velocity Vector

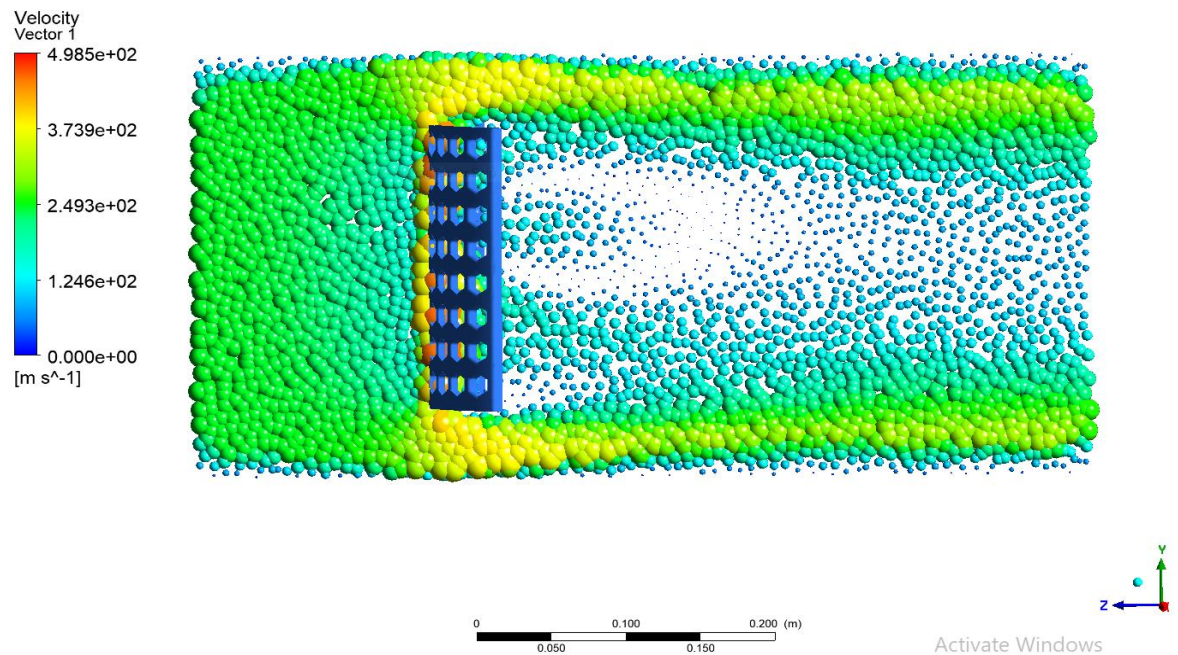


Fig 5.3.3 Hexagonal Mesh Velocity Vector Analysis Image

From fig.5.3.3 you can understand that this is the velocity vector image of the hexagonal design mesh. We can observe here that before the mesh layer there is numerous amount of bubbles are there. We can also observe that at the face of the mesh layer there is reddish and brown color bubbles are there which shows that the drag creation at that place due to the design of the layer. When we look after the mesh layer there is very less flow of bluish and green color air flow bubbles are there and elongated bluish bubbles are there. It shows that there is very formation of turbulence there and so this design is not suitable for final result.

5.4 Hexagonal Shape in Clamshell Design with Less Front Area

5.4.1 Pressure Contour

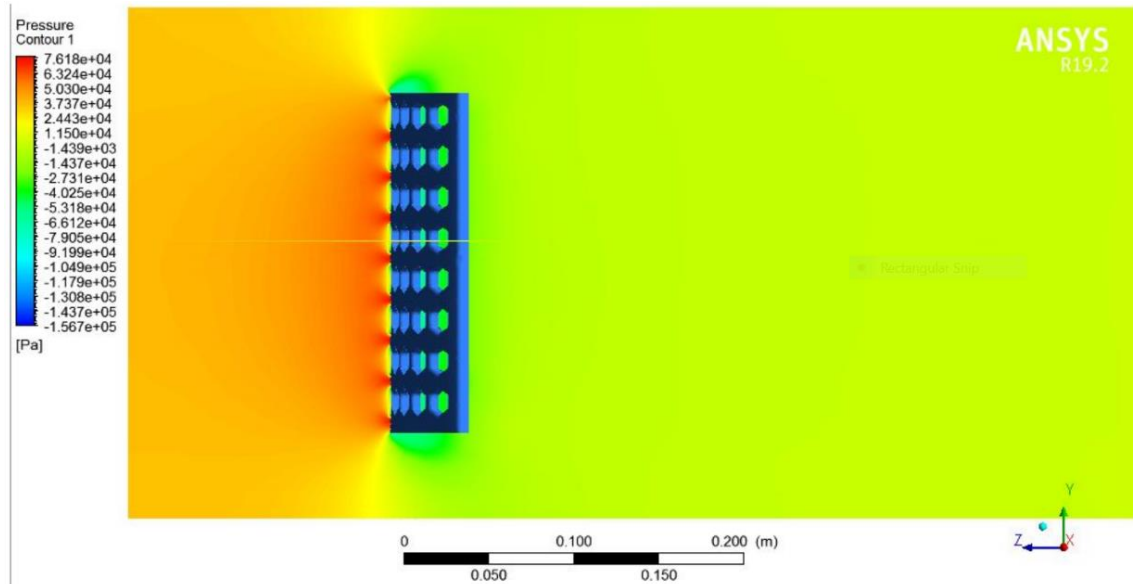


Fig 5.4.1 Hexagonal With Less Front Area Pressure Analysis Image

From fig.5.4.1 you can understand the pressure difference between the area after the mesh layer and before the mesh layer. As we can check here the pressure value before the mesh layer is 7.618×10^4 and after the mesh layer. We can check that pressure value decrease from that value to the -2.731×10^4 . So there is nice fall in the pressure and we can understand that it will definitely put a good amount of pressure over the mesh layer.

5.4.2 Velocity Contour

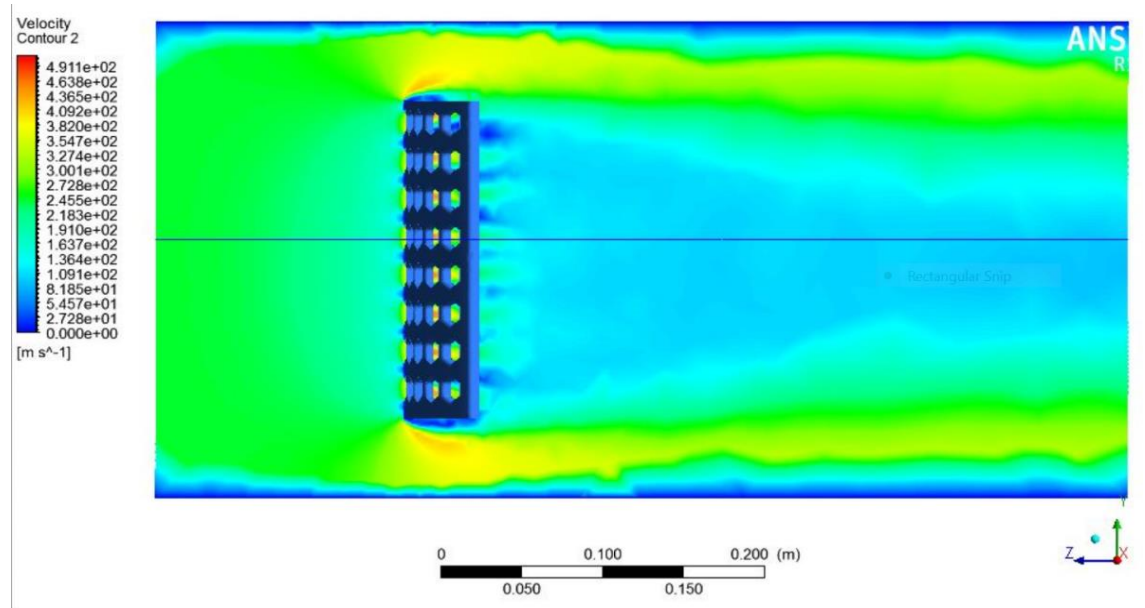


Fig 5.4.2 Hexagonal With Less Front Area Velocity Contour Analysis Image

From fig.5.4.2 you can understand that the velocity contour with the mesh layer does not create that much reddish color or yellow color. Which means that drag creation is very less due to the design of the layer. One more thing which we can observe here is the elongated bluish rays with light green shows that the flow get disturbed after touching the layer. So it start creating drag which later elongate and take the form of turbulence which create drag in that region and after that region. We can see a greenish color rectangular flow which show that it will definitely create a zone where air flow is less so it is not good for final result.

5.4.3 Velocity Vector

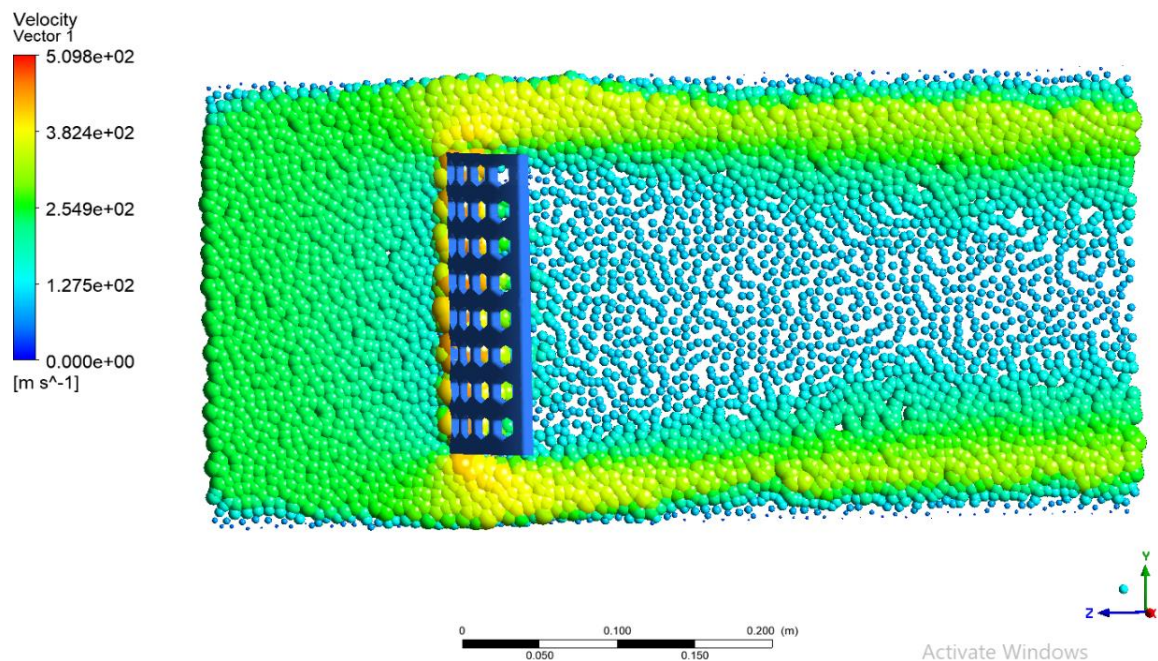


Fig 5.4.3 Hexagonal With Less Front Area Velocity Vector Analysis Image

From fig.5.4.3 you can understand that the velocity vector with the mesh layer does not create that much greenish blue color. Which means that flow is continuous but in the image. It is clear that before the mesh layer there is good greenish blue color bubbles are there. Which show that air flow is good there but at the face of the layer there is dark yellow color bubble which show the drag formation sign. So it might create drag and after the mesh layer we can observe that there is vital gap between the greenish blue bubbles. So this tell us that there is very less amount of airflow is there and that's it is less considerable for the final result.

5.5 TWIN HEXAGONAL DESIGN ANALYSIS IMAGE

5.5.1 Pressure Contour

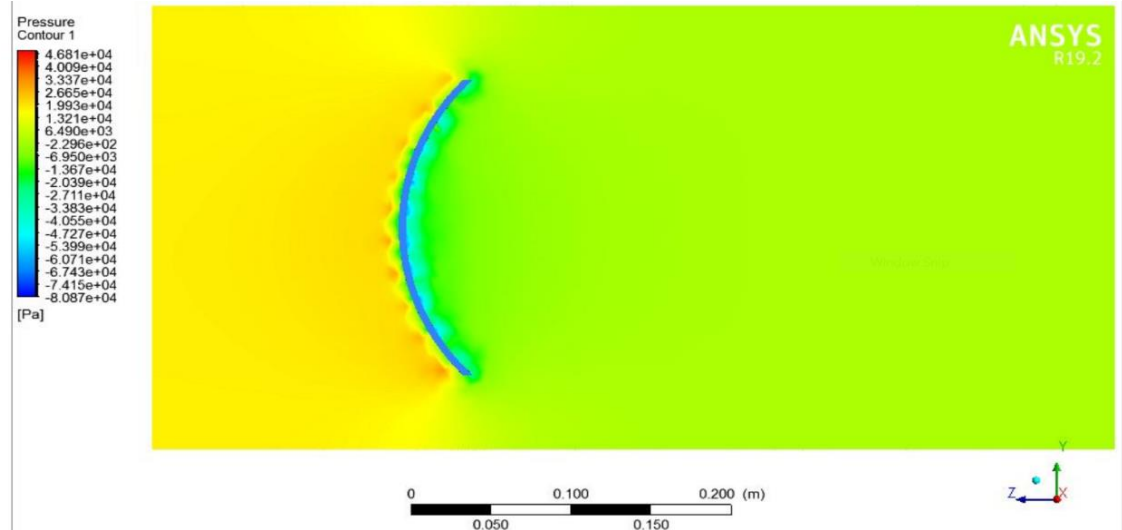


Fig 5.5.1 Twin Hexagon Pressure Contour Analysis Image

From fig.5.5.1 you can understand the pressure difference between the area after the mesh layer and before the mesh layer. As we can check here the pressure value before the mesh layer is $1.995e+04$ and after the mesh layer. We can check that pressure value decrease from that value to the $-2.039e+02$. So there is nice fall in the pressure and we can understand that it will definitely put a very good amount of pressure over the mesh layer.

5.5.2 Velocity Contour

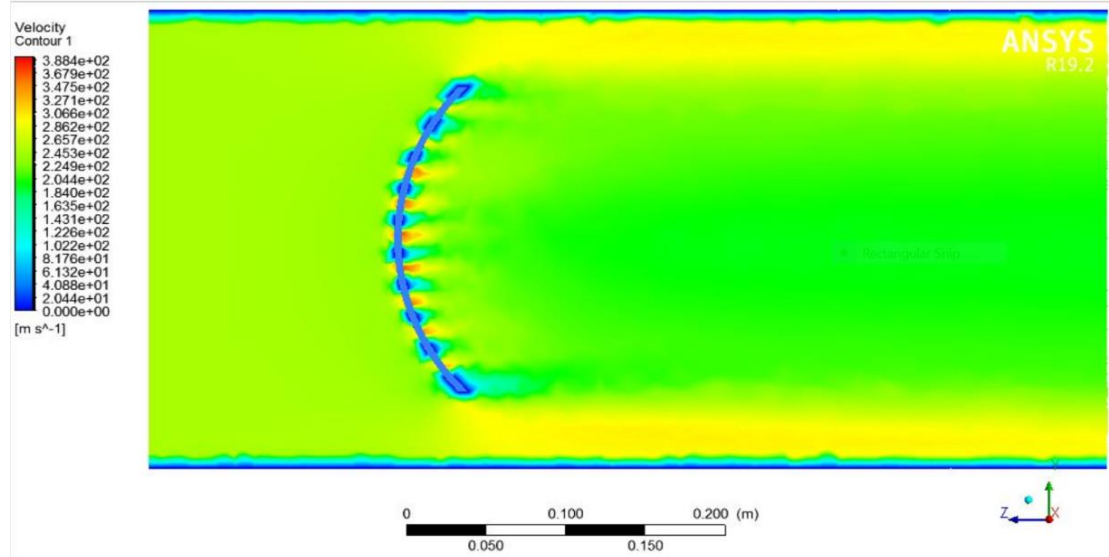


Fig 5.5.2 Twin Hexagon Pressure Contour Analysis Image

From fig.5.5.2 you can understand that the velocity contour with the mesh layer does not create that much reddish color or yellow color. Which means that drag creation is very less due to the design of the layer and one more thing. Which we can observe here is the elongated yellow rays with greenish color triangle which shows that the flow creation in that region is very good. After that region we can see a good greenish color flow with a parallel zone of green color band which show. It will definitely create a very good flow zone for the aircraft engine so this is one of the best result out of all the layers.

5.5.3 Velocity Vector

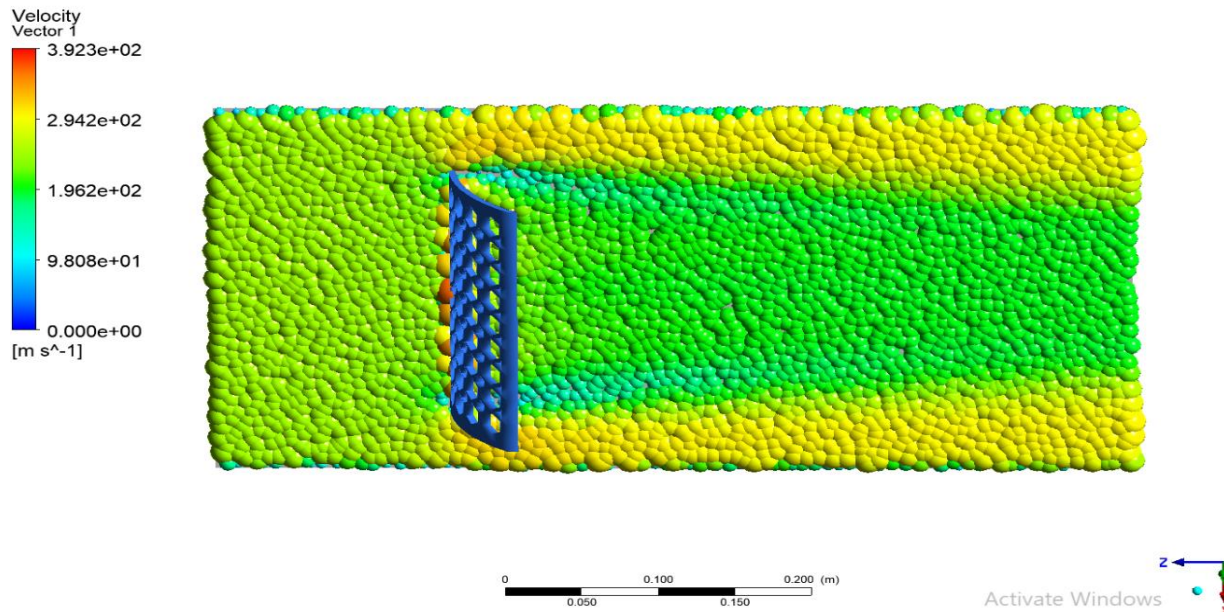


Fig 5.5.3 Twin Hexagon Pressure Contour Analysis Image

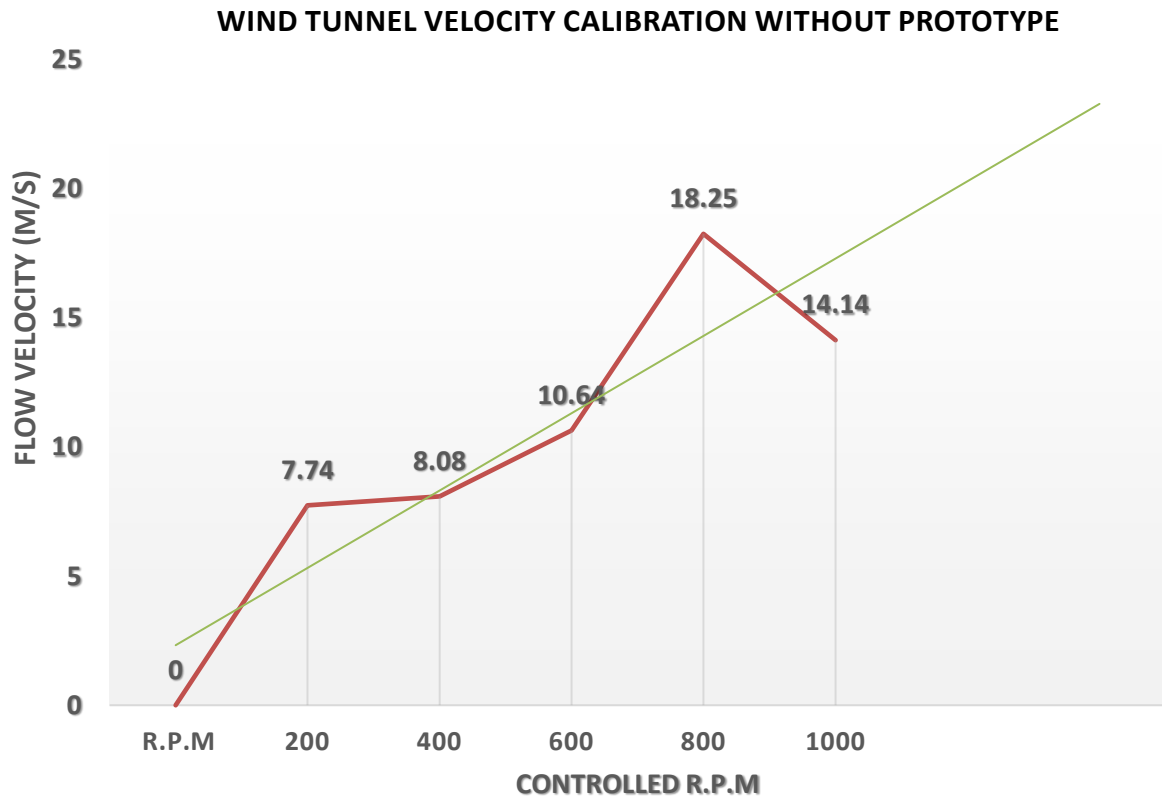
From fig.5.5.3 you can understand that this is the velocity vector image of the Twin hexagonal design mesh. We can observe here that before the mesh layer there is huge amount of bubbles are there. We can also observe that at the face of the mesh layer there is brown color bubbles are there. Which shows that the very less amount of drag creation is going to happen at that place due to the design of the layer. When we look after the mesh layer there is fine flowing of green color air flow bubbles and there is no any gap or voids is present there in later zone where air flow is there. It shows that there is very good amount of airflow is there. So out of all the design this one is used for the final result due to base on its result. As we come to know that on the basis of the performance and the result we selected **TWIN HEXAGONAL** design for our final testing. Which is the experimental Wind Tunnel velocity calibration test.

5.6 EXPERIMENTAL TEST RESULT

VELOCITY CALIBRATION WITHOUT PROTOTYPE				
SL.NO	Controlled RPM	Inclined Manometer Reading (10^{-2}).	Difference Value (h)	V (m/s)
1	200	0.9	0.0045	7.74
2	400	1.7	0.0065	8.08
3	600	3.5	0.0085	10.64
4	800	6	0.025	18.25
5	1000	9	0.015	14.14

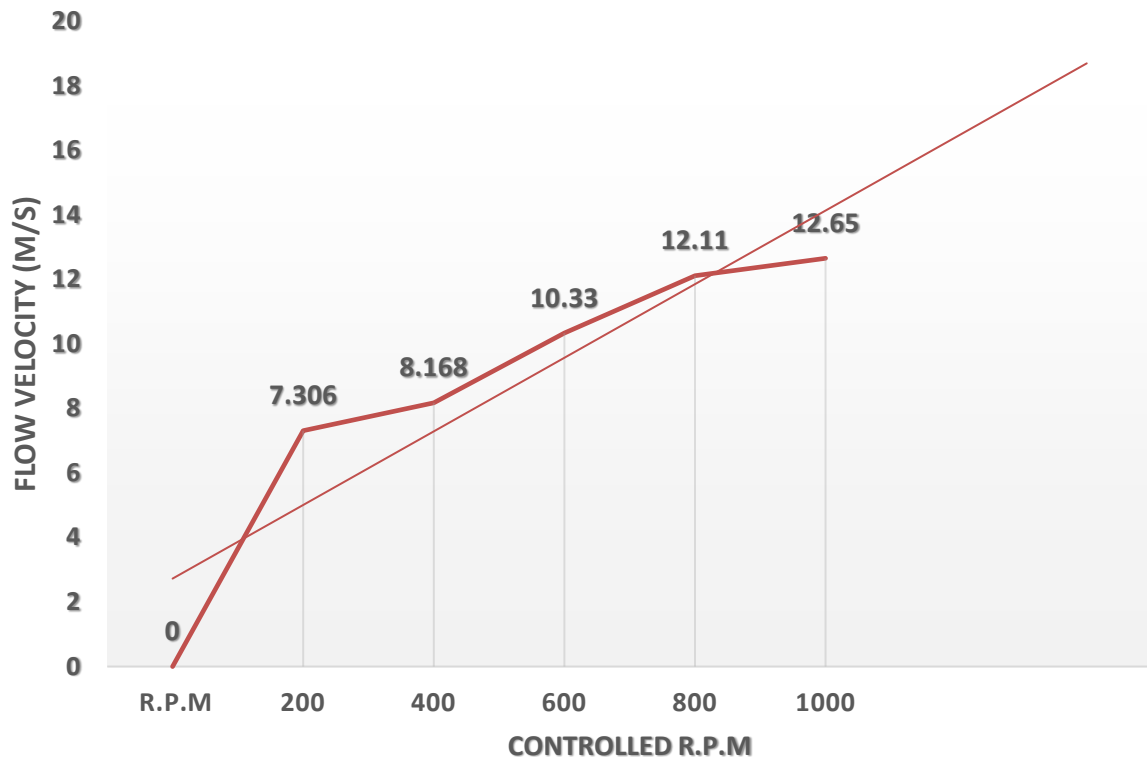
VELOCITY CALIBRATION WITH PROTOTYPE				
SL.NO	Controlled RPM	Inclined Manometer Reading(10^{-2}).	Difference Value (h)	V (m/s)
1	200	0.8	0.004	7.306
2	400	1.8	0.005	8.168
3	600	3.4	0.008	10.33
4	800	5.7	0.011	12.11
5	1000	8.2	0.007	12.60

5.6.1 GRAPH BASED ON EXPERIMENTL RESULT



By observing the following graph, we can understand that without prototype the flow velocity differ excessively. It bring huge ups and down in velocity chart as we can see in the graph at the RPM of 200. We find that flow velocity is somewhat about between the range of 7 to 8. When we keenly look into it we come to know that it's like 7.74. So like that only when we go for 400 and 600 RPM we obtain that there is a consistency between the range of 8 to 10. But when the RPM touched the 800 target then the velocity take a biggest hype and brake the consistency of the flowing wind pattern. This inconsistency of the velocity flow shows that the drawback of the air circulation without the present of mesh layer.

WIND TUNNEL VELOCITY CALIBRATION WITH PROTOTYPE



By observing the graph we can understand that with the prototype the flow velocity is stable. As we can see in the graph at the RPM of 200 we find that flow velocity is between the range of 7 to 8. So like that only when we go for 400 and 1000 RPM we obtain that a smooth increasing in the flow velocity. And it maintain the laminar flow for the aircraft engine and it makes all the turbulence air flow inside the engine into laminar and a streamline flow which also increase the efficiency of the aircraft engine.

CHAPTER :-6

CONCLUSION AND SUMMARY

A new design is proposed for enhancing the bird strike situation for an aircraft. This design doesn't require any human interference to operate. It will work by their mechanical procedure. Its Twin Hexagonal design surface is basically designed to engage the bird at the mesh layer surface onwards & don't let them enter inside the engine. And if any bigger or smaller bird strike with too much of force so the volute spring which was already installed there, will bounce back that bird and no bird will hit the engine afterwards. The one of the best property of this mesh layer is that it will protect engine from bird strike and another property of this design is that it will maintain streamline flow all over the engine intake part. Thus we can achieve a flight where no any fear of bird strike or emergency landing or any accident after installing this design in subsonic passenger aircraft.

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