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Study of Transonic Flow Characteristics Over NACA2412 and Modified NACA2412

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Abstract:- **The study is conceived to identify the transonic flow characteristics while understanding the Aerofoil geometry influence on the performance characteristics in the form of pressure distribution and the shock wave properties estimation. The transonic flow features estimation includes the shock and its location prediction for NACA2412. The study extended to redesigning the base NACA2412 Aerofoil by modifying the leading edge, camber location, suction and pressure surfaces to delay the shock and also to improve the aerodynamic efficiency. The shock delay directly improves the lift and drag of the Aerofoil and also eliminates the inadvertent loading of the Aerofoil. Ansys CFX has been used extensively to study the flow behavior since superiority in wide range of flows.**

Keywords:-- **CFD(Computational Fluid Dynamics), NACA(National Advisory Committee for Aeronautics)**

I. INTRODUCTION

Aircraft has been playing a major role of this world since it was first time demonstrated by the Wright brothers in the year of 1902. Until World War I, in depth studies into the effects of airflow over wings did not occur. A National Advisory Committee for Aeronautics is formed to understand the physics and aerodynamic features of the wing. In the year 1933, NACA had tested 78 Aerofoil shapes in their wind tunnels and their data was being published in its Technical Report. From this report a four-digit scheme for defining the basic geometry of the Aerofoil was created. Similar naming scheme was also used to define the other Aerofoil families, such as the five-digit Aerofoil and six digit Aerofoil

The cross section view of air wing of the airplane is called Aerofoil. Aerofoil is a very important role in creating lift for airplane, jet airlines and helicopters etc. The possibility of the airplane of a flight depends on the body of the air wing structure. The air is split and passes through the above and below the wing. The basic idea of the lifting of airplane behind is higher pressure at lower side of the air wing and lower pressure at top surface of the air wing of the airplane. Since the higher air pressure is always moves towards the lower air pressure. Aerofoil is not only important role of lifting of airplane and also important role of race cars like Benz. Ferrari and etc the car wing of the Aerofoil is different from the airplane Aerofoil. The basic idea of the race car is behind is lower pressure at lower side and higher pressure at the top surface. It causes negative lift means downward force because of this speed of the cars is significantly improved.

a very important role. It is also depended up on the structure of the air wing. At such time shock may occur on top surface of the Aerofoil, this shock may effect on the lift of airplane. When shock wave occurs after shock wave the flow losses its dynamic pressure because of the large flow separation ,this creates a gain static pressure and loss of the airplane lift. So we have to reduce this shock if we not reduce such kind of shock, the Aerofoil will not create sufficient lift required for the airplane to attain its altitude. So my objective is to try and reduce this shock or eliminate this shock, or else it will have a significant effect on lift as well as drag ratio, and also to eliminate the inadvertent loading on the Aerofoil.

In this project, I am going to select a four digit Aerofoil i.e NACA2412 and try to modify the coordinates of Aerofoil NACA2412 to reduce the effect of shock on the Aerofoil and comparing result in transonic flow and deduce modified NACA2412 good than the NACA2412 by using Anysis cfx FLUENT Software.

Transonic flow is nothing but the flow between sub sonic and supersonic or its combination of supersonic and subsonic. The transonic flow of the mach no. is 0.6 to up to 1 this is called transonic flow.

***1.2 Wing*:**

The wing Aerofoil is attached to the both right and left side of the fuselage of aircraft and the wing are main

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important role for lifting surface and it has support to the airplane flight. There are so many wing design is there based on size shapes. They are used by different manufactures. For each full fill the all certain requirements to the particular performance of the airplane.

Wing structure may vary ti certain provide desirable flight characteristics. For the control the varios speed of the airplane. The wing is attached the balance. Amount of lift generated. Stability to change all the shape. Both trailing edge and leading edge of aerofoil. Either it straight or curved or one side edge can be straight and curved. Either one side or both side edge can be tapered. The tip of the aerofoil wing may be rounded square or even pointed.

The aircraft of the wing is attached to the fuselage may be at the bottom or at the top or mid of the fuselage based on the design requirements. It extended to the perpendicular to horizontal plain of the aircraft fuselage may be slight angle up or down. This angle is called as the wing dihedral. It dihedral angle which affects on the lateral stability of the airplane.

Fig 1: High wing

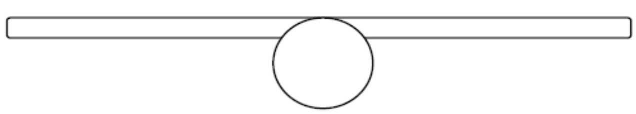


Fig 2: Mid wing

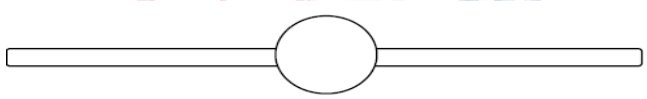


Fig 3: Lower wing

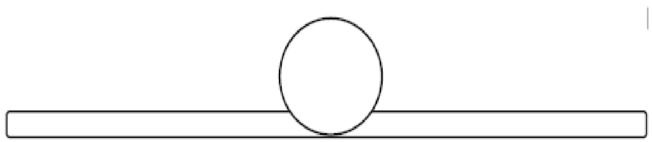
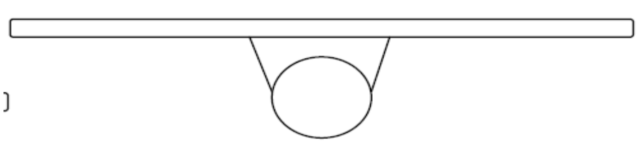


Fig 4: Parasol wing



1.3 Types of NACA Aerofoil:

The main aim to select the Aerofoil section. Which Aerofoil is suitable for wing for airplane among of the list from NACA Aerofoil series. This topic is an ideal to the introduction committee for NACA Aerofoil series. This is the most popular resources and extensively used data base Aerofoil it have been improved by NACA in the between years of 1930s and 1940s. there are some different kind of groups of NACA Aerofoil series. There explained below one by one as shown:

- 4-digit NACA Aerofoils
- 5-digit NACA Aerofoils
- 6-series NACA Aerofoils

1.3.1 Four digit series NACA Aerofoil:

The four digit NACA series Aerofoil are the simple Aerofoil as compared to the five and six digit series Aerofoil. A four digit Aerofoil is also the oldest NACA Aerofoil to generate. It is made up of two parabolas the camber of this four digit series Aerofoil is made up of two parabolas. One parabola is the geometry of the camber from between leading edge to camber maximum camber. And second parabola is the geometry from camber maximum to the trailing edge. In a NACA four digit Aerofoil, the four digit represents the camber maximum in chord percent. The second digit represents the place of camber maximum in tenth of length chord. The last two digits indicate that thickness maximum to chord ratio. In four digit Aerofoil series a zero is first digit it represents that Aerofoil is a symmetrical type of Aerofoil. These although Aerofoils are easy to manufacturing, but they creates high drag compare to the modern Aerofoil.

1.3.2 Five digit NACA Aerofoil:

The five digit NACA Aerofoil are the modern type of the Aerofoil. these Aerofoil are different from the four digit NACA Aerofoil. the five digit Aerofoil are made up like a parabola and a very straight line. In that The first parabola creates the camber shape right from the leading edge and also to the trailing edge. In this five digit NACA Aerofoil the first digit indicates the 2/3 coefficient of ideal lift in tenths, this probably indicates the maximum camber of aerofoil in percent chord. And the second digit represents the location of maximum camber of aerofoil in two hundredths of chord length. And the last two digits mainly indicate the maximum thickness of aerofoil to chord ratio. In five digit Aerofoil series a zero in the first digit it represents that Aerofoil is a symmetrical section of Aerofoil.

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1.3.3 Six digit of NACA Aerofoil:

The four digit and five digit NACA Aerofoil series are designed using by parabola and straight lines. They were not complete to meets acceptation of major aerodynamic aerofoil design requirements. Like as the laminar flow and no flow separation. The NACA researchers committee begins the find out develop new Aerofoil series it is depends on the design requirements. On the other hand, newly added designed for faster aircraft requires more on the efficient Aerofoil. So many Aerofoil's are designed at that time but the six digit Aerofoil of NACA series were found the best one.

The six digit Aerofoil are maintaining the laminar flow above a large amount of the chord. That has to be maintaining lower Cd minimum compare to the four digit Aerofoil and six digit Aerofoil. The six digit Aerofoil of NACA series are designed by the five main digits and also with number six.

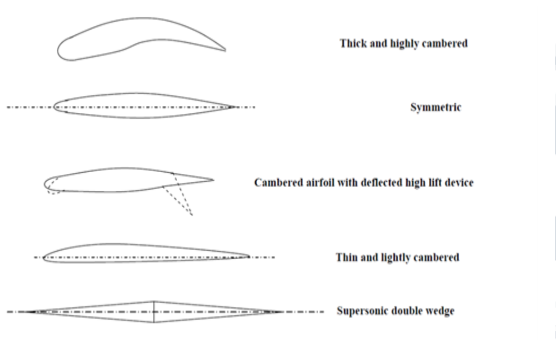

Fig 5: Five sample Aerofoil section

1.4 Aerofoil Selection Criteria:

Selecting an Aerofoil is an important role of the wing design. For a wing being with an Aerofoil selection the clear statement requirements of the flight for flight designs of subsonic requirements are very different from the flight design objective of supersonic flight. For transonic flow region flight designs require a special kind of Aerofoil that meets to that mach divergence requirements. The designs have also considered some other requirements like airworthiness, Manufacturability, Structure, and cost requirements. In common, the some of the following are the criteria to Aerofoil select for a wing with design requirements collection.

1. Lift coefficient an Aerofoil must be maximum.
2. The proper ideal or design lift coefficient of the Aerofoil.
3. The drag coefficient of the Aerofoil should be lowest minimum.
4. The lift-to-drag ratio of the Aerofoil should be highest.
5. The lift curve slope of the Aerofoil should be highest.
6. The pitching moment coefficient should be lowest.
7. The stall quality should be proper in the stall region.
8. The structure of the Aerofoil must be reinforcing able.
9. The thickness of the Aerofoil should not be much thin it spars cannot be inside placed.
10. The cross section of the Aerofoil must be the manufacturable.
11. The requirements of cost should be consider.
12. The Other design requirements should be considered. Such as if the fuel tank has designed to places the inside wing section inboard, the Aerofoil should allow to this sufficient space purpose for this.
13. If a wing is considered with more than one Aerofoil, then two Aerofoils can be integrated in a wing.

1.5 NACA 2412 Aerofoil:

NACA 2412 Aerofoil is the four digit of NACA Aerofoil. it was first time explained by Mr. Anderson in the year of 2001. The NACA 2412 wing section is the family of NACA indicates that National Advisory Committee for aeronautics, this kind of Aerofoil shapes developed by NACA set of experiments in a rotational and systematic way.

In this NACA 2412 Aerofoil first two digits represents the maximum camber of hundredths of chord of aerofoil. Second digit represents the location of leading edge in tenth of chord. The last two digits indicates the maximum thickness of chord of hundredths. Hence, the NACA Aerofoil of NACA 2412 Aerofoil studied the maximum camber is 2% of chord and it located at chord 39.8% to the leading edge. The maximum thickness of last two digits located chord at the 30.1% and chord value of 12%. The NACA 2412 Aerofoil has been used in many different applications.

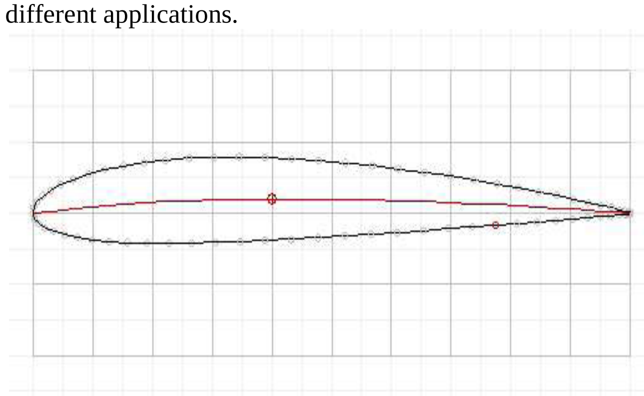

Fig 6: NACA 2412 Aerofoil Station

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1.6 Difference of NACA2412 and modified NACA2412 aerofoil:

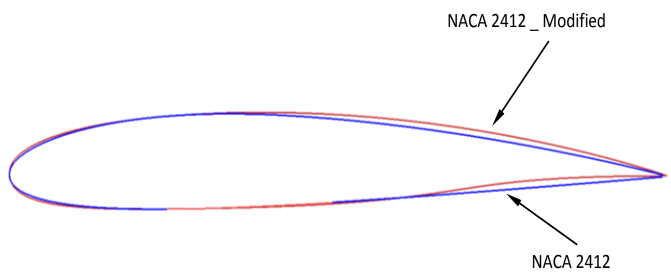

Fig7: Base NACA 2412 aerofoil and modified NACA 2412 aerofoil

The difference of the original NACA2412 aerofoil and modified NACA2412 aerofoil of the figure shows in below. It is different at the trailing edge of the aerofoil. The blue Color shows the original NACA2412 and red color shows the modified NACA2412 aerofoil. The modification done at the lower surface trailing edge of the aerofoil by using the changing coordinates data point. These points are interred changing of the original coordinates points of NACA2412aerofoil.

II. LITERATURE SURVEY

1. Karna S. Patel: worked on the drag and lift forces by using CFD analysis. These lift and drag forces are also determined by experimental techniques using wind tunnel testing, the design model of testing wind tunnel is placed in the test section. This type of experimental process is time consuming, laborious and it costs more than techniques of CFD. Thus they have gone through analytical method and validated through experimental testing. They have presented the analysis of 2D NACA 0012 Aerofoil subsonic flow over a various angles of attack and they operated at of 3×E+06 Reynolds number. The result determined by CFD simulation showed close agreement with experimental results, thus CFD techniques is good alternative to experimental method for determination of lift and drag. Thus the NACA 0012 Aerofoil of flow over the analysis a based on CFD, they concluded that there is no lift force when at the zero degree of Angle of Attack generated. So to increase the value amount of lift and value of lift coefficient they had to the value angles of attack of increase. Thereby also increasing the amount of drag force and also the value of drag coefficient but they found that the amount of increase in drag force and the drag coefficient is much lower compare to lift force.

2. J.Silambarasan**:** worked on this project is to numerically procedure to develop model airflow over wing using by design software hypermesh and FLUENT. Three dimensional models NACA Aerofoil 2412 for the were created, drawn and meshed in hypermesh using model geometry data gathered by the NACA. The FLUENT were read those models into where boundary conditions applied were flows and the discretized Navier-Stokes equations they were solved numerically. Numerical incompressible prediction of turbulent flow on a 3-D wing has been performed with a moving velocity of 50 m/s. CATIA, 3D surface of the wing modeling was used to model of 3D modeling software. FLUENT, the fluid computational dynamics code, which in-corporate k-ε model turbulence and segregated implicit computation solver was used to perform. The aerodynamic analysis was to study performed the flow behavior of the air above the wing. The analysis of wing which is includes the contours of pressure and velocity of the wing that impacts the followed by the coefficient of lift of an evaluation. The main objective of this work to estimate the coefficient of lift and visualization flow is achieved. Lift of Aerodynamics for the NACA 2412 is 0.219 at velocity ranging is between 50m/s. The aerodynamics lifts shows analysis in term of forces or coefficient of lift proportionally increased to the velocity square. The velocity and pressure of contour plot were shown in the visualization analysis as a aerodynamics lift analysis. The velocity for every pattern of visualization depict quite same either for pressure contour plot or velocity contour plot. The wing current lift in is 0.219 and the drag is 0.002. There are many different techniques is to increase the lift the better one way is to changing the co-ordinates based on the aerodynamic considerations.

3. Er. Shivam Saxena**:** In this work by using CFD packages such as Gambit and Fluent he analyzed the flow of Aerofoil at different Reynolds numbers, and also conducted the wind tunnel experiment. He prepared one model for wind tunnel analysis and created a 2D and 3D models in solid work and these models were meshed in Gambit by using geometry data gathered by Aerofoil database available on the internet. Then these models were read into Fluent and by applying flow boundary conditions, the discredited Navier-Stokes equations were solved numerically. To determine the general aerodynamic characteristics of the Aerofoil (NACA 2412) wind tunnel tests were also carried out.

4. Md.Shamim Mahmud**:** worked on stable, high-efficiency, more angle of attack, and Aerofoil. That means improvements novel for accomplishing ,bicamberd surface with two or more profile raised ridges laterally placed to flow of fluid and commonly running parallel to the leading

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edge and trailing edge of the Aerofoil. A first objective of this work is to improve the Aerofoil efficiency to obtain more ratio of useful output work to input energy, This stable more angle of attack Aerofoil is improving safety aviation. Private accident aircraft involve stall of wing. Higher the angles of attack combined with higher lift and drag ratios would glide enhances capabilities.

The second objective of this work is to reduce the mechanical force input requires pitch Aerofoil such as propeller, rotary wings, impeller, and rotors weight saving in the construction. The central aerodynamic more center and negative or low pitches moment of bicambered surface of Aerofoil allows this to fulfilled objective.

III. METHODOLOGY

Civil aircrafts at an air speed of 0.6 and above, they undergo the typical aerodynamics in which the wings face the flow of M > 1 though the free stream Mach number is much less. This is due to the Aerofoil geometry over which the accelerated flow tends to reach adverse pressure gradients. Therefore the super critical Aerofoil are brought in for such applications to avoid these situations unlike traditional Aerofoil. Various Aerofoil design exercises carried out at ARAover the years are described in, concentrating on the part played by the inverse methods.

1. In the first stage, traditional subsonic Aerofoil NACA2412 is selected for the transonic flow analysis.
2. NACA2412 is a 12% thick Aerofoil with its camber at 30%. This study enables the verification of the state-of-art CFD tool capability and also provides the insight on to the shock wave and the post effects.
3. This has been achieved through the Ansys CFD packages.
4. In the later stage, NACA2412 base Aerofoil is modified suitably to match with the transonic flow aerodynamic requirements.
5. Shows the original and modified NACA2412 Aerofoil.
6. The modification is achieved based on the aerodynamic considerations and the associated geometrical requirements described in [1],[2] and [3].
7. The main aim of this design modification is to eliminate the adverse aerodynamics and to increase the lift to drag ratio.
8. This can be achieved by moving the shock into the downstream i.e., towards trailing edge of the Aerofoil.

The ambient conditions used for the analysis are as follows
Mach number (M) = 0.75,
Velocity = 243.255 m/s,
Temperature (T) = 260K,
Pressure (P) = 85419 Pa,
Density (ρ) = 1.1443 kg/m3,
Dynamic Viscosity (μ) = 1.831E-05 kg/m-s and
Reynolds number = 1.52E+07.

IV. NACA 2412 AEROFOIL

4.1 Geometry of the obtained model:

Model created by the NACA2412 Aerofoil in Ansys ICEM CFD software by using the coordinate's data point. This points are published by the NACA group (National Advisor comity for aeronautical), the coordinates points are import into the ICEM CFD software by using robust model of geometry surface created by the points and curve geometry model surface.

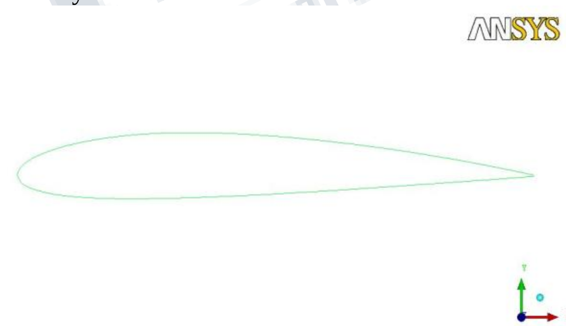

Fig 8: Model NACA 2412 Aerofoil

4.2 Domain:

The domain is created over the model of NACA2412 Aerofoil in Ansys ICEM CFD software by using the lines and points apply the boundary condition to the domain input flow, output flow, top surface, and bottom surface. The domain points are the x direction and y direction the points are:

X	-3	3	-3	3
Y	6	6	-3	3

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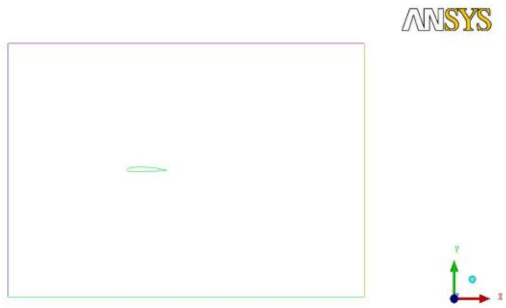

Fig 9: domain over Model NACA 2412 Aerofoil

4.3 Meshing:

Mesh generation is created over the NACA2412 Aerofoil over domain in Ansys ICEM CFD software. mesh generation is the define the number of element for the solver NACA2412 Aerofoil is the 2D element mesh created for this model is quadrilateral mesh element by using the meshing tools. After meshing one more time recomputed the mesh for the fine mesh.

After meshing next step is the solve the mesh created model for solver by using the Ansys fluent software. this fluent software read the mesh created model.

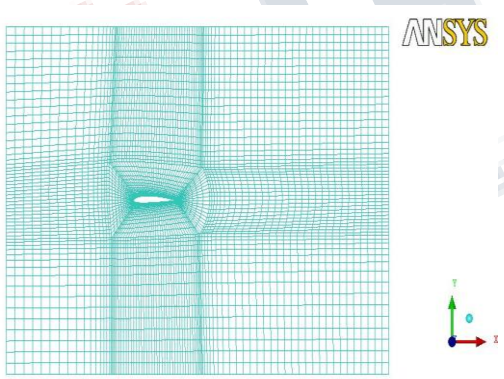

Fig 10: meshing of NCA2412 Aerofoil

V. MODIFIED NACA2412 AEROFOIL

5.1 Geometry Model of Modified NACA 2412 Aerofoil:

Model created by the modified NACA2412 Aerofoil in Ansys ICEM CFD software by using changing the coordinate's data point. These points are interred changing of the original coordinates points of NACA2412Aerofoil. The modification done at the lower surface trailing edge of the Aerofoil And these modified points are import into the ICEM CFD software by using robust model of geometry surface created by the points and curve geometry model surface.

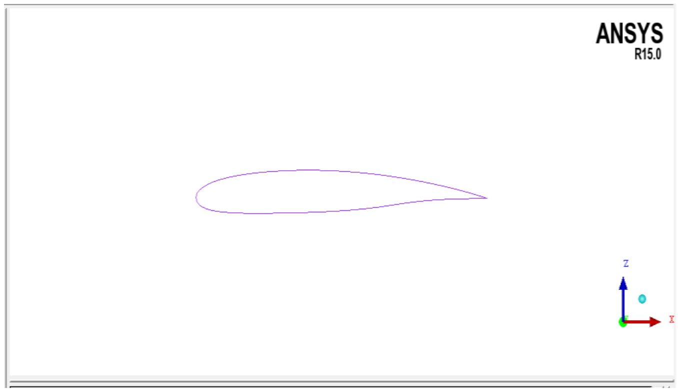

Fig 11:Model modified NACA 2412 Aerofoil

5.2 Domain:

The domain is created over the model of modified NACA2412 Aerofoil in Ansys ICEM CFD software by using the lines and points apply the boundary condition to the domain input flow, output flow, top surface, and bottom surface. The domain points are the x direction and y direction the points are:

X	-3	3	-3	3
Y	6	6	-3	3

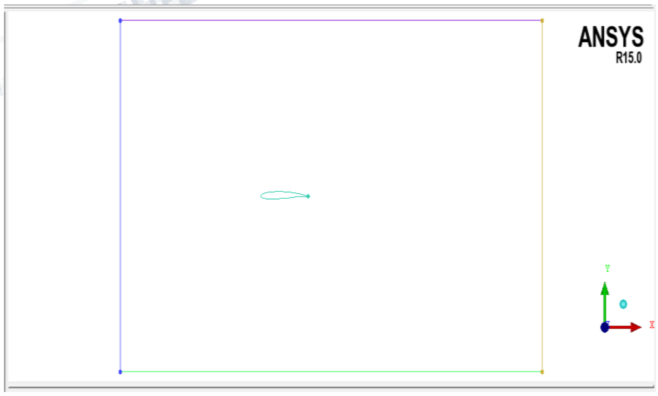

Fig 12: domain over Model Modified NACA 2412 Aerofoil

5.3 Meshing:

Mesh generation is created over the modified NACA2412 Aerofoil over domain in Ansys ICEM CFD software. mesh generation is the define the number of element for the solver modified NACA2412 Aerofoil is the 2D element mesh created for this model is quadrilateral mesh element by using the meshing tools. After meshing one more time recomputed the mesh for the fine mesh. After meshing next step is the solve the mesh created model for solver by using the Ansys fluent software. This fluent software read the mesh created model.

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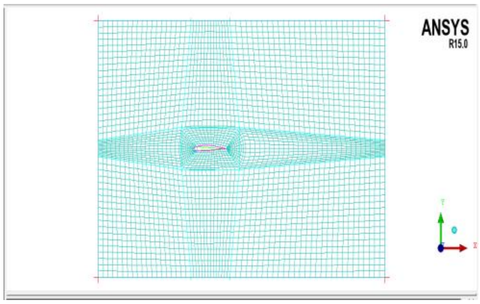

Fig 13: meshing of Modified NCA2412 Aerofoil

VI. RESULTS

6.1 Result summary for NACA2412:

1. Mesh report

Table 1. Mesh Information for NACA 2412_001

Domain	Nodes	Elements
Default Domain	106960	52965

Table 2. Forces and Torques for NACA 2412_001

Location	Type	X	Y	Z
Foil	Pressure Force	3.1854e+00	0.0000e+00	1.1960e+02
	Viscous Force	1.8840e+00	0.0000e+00	2.9428e-02
	Total Force	5.0694e+00	0.0000e+00	1.1963e+02
	Pressure Torque	5.9801e-01	-5.5946e+01	-1.5927e-02
	Viscous Torque	1.4722e-04	3.6151e-02	-9.4186e-03
	Total Torque	5.9816e-01	-5.5910e+01	-2.5346e-02

6.1.1 Contours of Mach number:

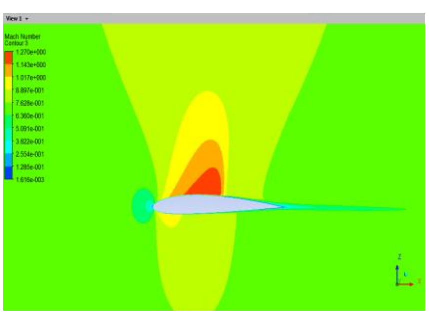

Fig 14: Result for mach Aerofoil NACA2412

The above figure shows the Mach number contours over the Aerofoil NACA2412. As we know for any aerofoil the upper surface experiences higher velocity than the lower surface of the aerofoil , so the the velocity in terms of mach number experienced by the aerofoil is shown in above figure . As the figure shows the midpoint of upper surface has got maximum value of mach number than lower surface of aerofoil where the static pressure is lower, this may be the reason for the shock to be produced on the upper surface of aerofoil, which may reduce the velocity of air passing at the trailing edge which in turn reduces the lift of aircraft and increases the drag , so as to increases the lift of aircraft the shock formed has to be reduced which can be done by modifying the NACA wing.

6.1.2 Pressure:

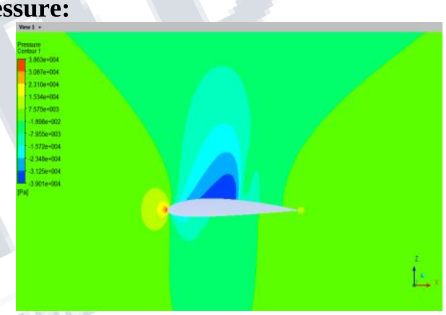

Fig 15: result for pressure Aerofoil NACA2412

The above figure shows the pressure over the Aerofoil NACA2412. The pressure of an Aerofoil is created simply by the air weight per unit area of the Aerofoil. As we see increased air pressure at the midpoint of upper surface, which causes shock to be produced. The pressure of air i.e shock is absorbed at the middle of the aerofoil; this creates increase in drag and also reduces the lift coefficient of airplane.

6.1.3 Velocity:

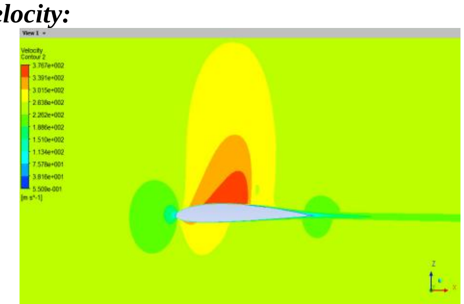

Fig 16: result for velocity Aerofoil NACA2412

The above figure shows the velocity contour for the NACA2412 Aerofoil. The shock point is at the middle of

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the Aerofoil it causes the higher pressure at the top or above surface of the Aerofoil. Lower pressure at the below or bottom surface of the Aerofoil. Its effect on the both lift and drag. The airplane does not lift that much of requirement. And as the drag increases it reduces the speed of aircraft to some extent.

6.2 Result summary of Modified NACA2412:

1. Mesh report

Table 3. Mesh Information for NACA 2412_Modified_001

Domain	Nodes	Elements
Default Domain	106960	52965

Table 4. Forces and Torques for NACA 2412_Modified_001

Location	Type	X	Y	Z
Foil	Pressure Force	2.9627e+00	0.0000e+00	1.6598e+02
	Viscous Force	1.8926e+00	0.0000e+00	3.7161e-02
	Total Force	4.8553e+00	0.0000e+00	1.6602e+02
	Pressure Torque	8.2990e-01	-8.3716e+01	-1.4813e-02
	Viscous Torque	1.8574e-04	4.4892e-02	-9.4608e-03
	Total Torque	8.3009e-01	-8.3671e+01	-2.4274e-02

6.2.1 Contours of Mach number:

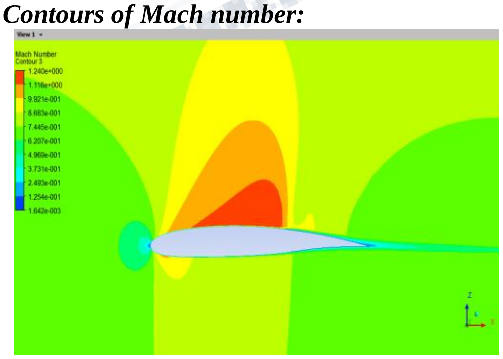

Fig 17: Result for mach Aerofoil modified NACA2412

The above figure shows the Mach number contours over the modified Aerofoil NACA2412. Earlier we discussed about effect of shock on the aerofoils, where the shock formed tries to reduce the lift and drag coefficient of the wing , the above figure shows the results of modified NACA wing , here we can observe that the shock has been reduced to some extent, modifying the geometry has helped us to move the shock towards the trailing edge where its effects are reduced , so now maximum air flows over the wing for maximum lift, earlier this air flow was restricted by the shock formed . so modifying the geometry to move the shock towards has helped us to increase the lift and reduce drag formed by shock

6.2.2 Pressure:

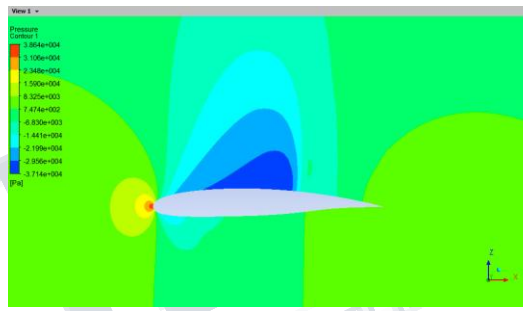

Fig 18: Result for pressure Aerofoil modified NACA2412

The above figure shows the pressure contours over the modified Aerofoil NACA2412. As we know for better lift coefficient the upper surface should have low pressure than the lower surface, in earlier case of NACA wing we saw that the upper surface had low pressure but upto the midway or from the leading edge to the distance where shock is formed, which used to reduce the lift of aircraft. But here we can clearly see that area on upper surface has more low pressure area compared to earlier case, that means the blue contours have moved little towards trailing edge this is because modifying the geometry has moved the shock little towards trailing edge which means air flows over larger area on upper surface and creates low pressure on upper surface, which in turns increases the lift of the aircraft and decreases the drag formed by shock .

6.2.3 Velocity:

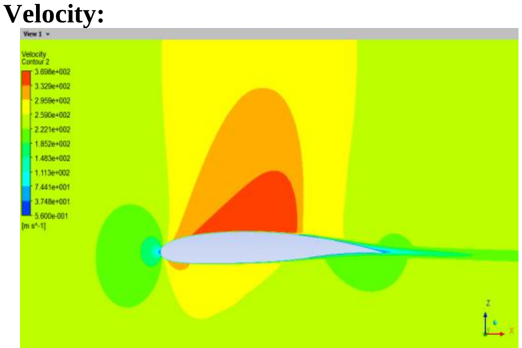

Fig 19: result for velocity Aerofoil modified NACA2412

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The above figure shows the velocity contour of modify NACA2412 Aerofoil. Here the shock point is moves shifted move towards the end of the Aerofoil i.e. trailing edge via lower surface of the Aerofoil therefore it creates less velocity at the upper surface of the Aerofoil. Higher velocity at the lower surface of the Aerofoil. According to the Bernoullis principle above surface will have low pressure and below surface will higher pressure. Hence the value of the coefficient of lift will increases and coefficient of drag reduced as compare to the original NACA2412 Aerofoil.

6.3 Comparing NACA2412 and modified NACA2412:

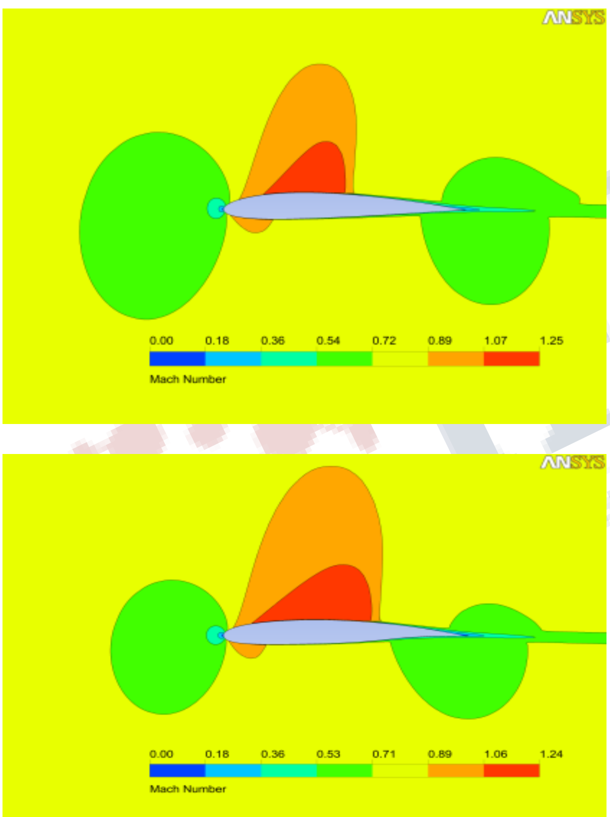

Fig 20: Mach contour on NACA2412 and NACA2412_modified (M = 0.75) and the pressure distribution

The above figure shows the contour mach number of NACA2412 and modified NACA2412. By absorbing the above figure of contour mach number of NACA2412 the shocks absorb is take place on the above surface of the Aerofoil at the middle of the Aerofoil. due to the shock the aircraft lift decreases and drag increases it causes the aircraft will not take that require amount of height.

The original NACA2412 modification is done at the lower surface of trailing edge of the Aerofoil. by using changing the coordinate's data point. These points are interred changing of the original coordinates points of NACA2412Aerofoil. these modification improves the lift of the aircraft and reduce the shock over the Aerofoil.

Now. Absorbing and comparing the figure graph for contour mach number. Here shock absorber is move towards at the near to the trailing edge of the Aerofoil. so it creates the increase the aircraft lift as well as decreases the drag. Sometimes drag also increase but the lift is more than the drag. The transonic flow characteristic of mach no. at 0.75 for mach contour flow creates the separation of shock and Aerofoil.

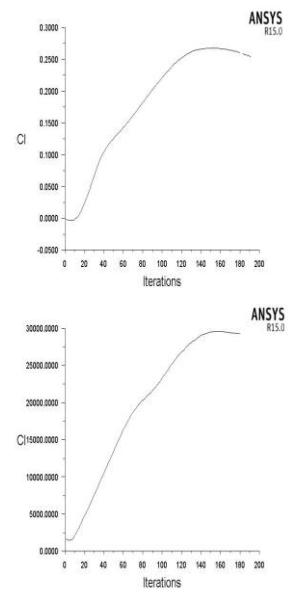

Fig21: lift coefficient for NACA2412 aerofoil and modified NACA2412 aerofoil.

The above figure shows the lift coefficient for NACA2412 aerofoil and modified NACA2412 aerofoil. The graph of lift coefficient is Cl versus iteration. It shows the lift of the aircraft. If coefficient of lift increases the lift of aircraft also increases. By absorbing the above graph of lift coefficient for both aerofoils. The lift coefficient is more in modified NACA2412 as compare to the original NACA2412 aerofoil. Here we conclude that lift coefficient for modified NACA2412aerofoil better than the original NACA2412.

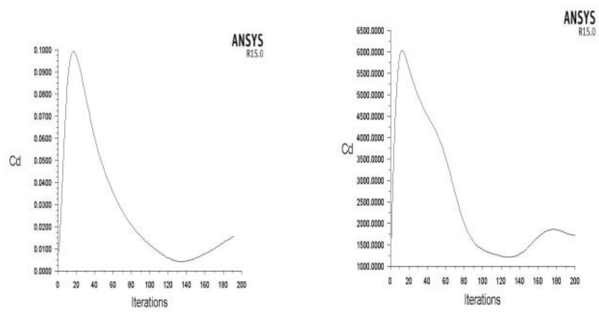

Fig22: drag coefficient for NACA2412 aerofoil and modified NACA2412 aerofoil.

The above figure shows the drag coefficient of NACA2412 aerofoil. The graph of lift coefficient is Cl versus iteration. It shows the drag of the aircraft. Drag is nothing but the backwards force or retarding force its reduce the lift of the aircraft. By absorbing the above graph of drag coefficient for both aerofoil. The drag coefficient is low in modified NACA2412 as compare to the original NACA2412 aerofoil. Here we conclude that drag coefficient for modified NACA2412aerofoil better than the original NACA2412.

VII. CONCLUSION

Based on CFD analysis of transonic flow characteristic over the NACA2412 Aerofoil and modified NACA2412 Aerofoil. By absorbing the graph of lift and drag coefficient we conclude that the amount of lift coefficient of NACA2412 Aerofoil is better than the amount of lift coefficient of modified NACA2412 Aerofoil. The amount drag coefficient of NACA2412 Aerofoil is lesser than the amount of lift coefficient of modified NACA2412 Aerofoil. Hence it improves the aircraft lift when apply the modified NACA2412 Aerofoil instead of the original NACA2412 Aerofoil.

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Domain	Nodes	Elements
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