RESEARCH ARTICLE OPEN ACCESS

Experimental Investigation on Flow Characheristics of Naca0012 Aerofoil &Naca0018 Aerofoil -A Comparative Study

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ABSTRACT
The present experimentation involves the comparative study on flow characteristics of NACA 0012 and NACA 0018 aerofoils at different angle of attack when the aerofoil is positioned at the centre of the wind tunnel. Aerofoils are fixed in the wind tunnel and adjusted for the required angles of attack & the lift and drag forces are measured to calculate drag and lift coefficients. Lift coefficient increases as the Angle of Attack increases for both the aero foils. Drag coefficient first increases then decreases and increases as the angle of Attack increases for aerofoil NACA0012 and has a maximum value at Angle of Attack 30°. But for aerofoil NACA0018, drag coefficient first increases then maintains constant value and then decreases as the angle of attack increases and has a minimum value at Angle of Attack 30°. For measurement of static pressure, aerofoils are placed at the centre position of the wind tunnel and readings are noted for different angle of attack for both the models. The coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at some points of chord length and lower at other points of chord length for all the Angles of Attack.
Key words: Aerofoil, Angle of Attack, lift coefficient, drag coefficient, pressure coefficient.

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I. INTRODUCTION

Aerospace industry is increasing relying on advanced numerical flow simulation tools for analyzing all the components of aircraft. The main part which helps in producing lift is wings. So, the shape of the aerofoil should be designed in such a manner so that maximum lift can be achieved. In this project, standard symmetrical aerofoils NACA0012 and NACA0018 are taken for experimental investigation as they are better suited for frequent inverted flight. Although a new generation of aerofoils has emerged as a result of improved understanding of aerofoil performance and the ability to design new aerofoils using computer methods, the NACA aerofoils are still useful in many aerodynamic design applications. Aerofoils are widely used in many engineering applications. They are more significant in designing aerodynamic devices, construction of fans, compressors and turbines. Fluid flow analysis over an aerofoil surface is being an important research topic over a period of time.

Aero foils are commonly used in aviation, wind turbines, and other applications where lift and drag forces need to be controlled and manipulated.A device that provides reactive force when motion relative to surroundings air can lift or control a plane flight. It is a curved surface that generates lift as it moves through the air by altering the direction and speed of the air flowing over it. The shape and size of an aerofoil can vary widely, depending on the specific application and intended use.

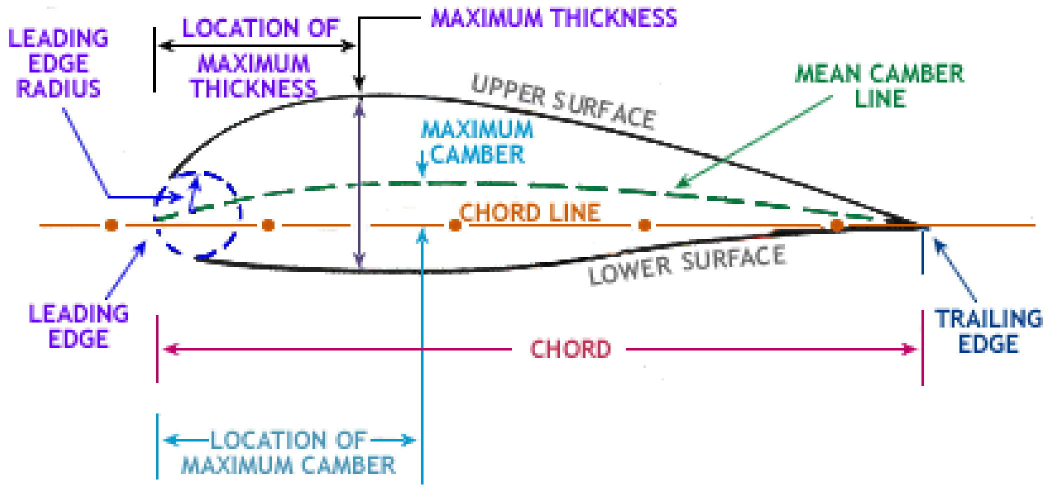


Fig.1: AEROFOIL TERMINOLOGY

The nomenclature of aerofoil has been labeled in Fig.1.That flat surfaces in the wind could produce the sideways force that we now call lift was a very ancient observation. Two early applications of it, the windmill and the fore-aft rigged sail, date back at least 800 years. Thin surfaces restrained by a supporting structure naturally bellied out under air pressure, assuming what we now call a “cambered” — that is, arched — shape. The fact that camber was actually beneficial seems first to have been appreciated — at least in writing — by an English civil engineer of the 18th century, John Smeaton, who noted that curving the surfaces of their blades improved the performance of windmills. Any object with an angle of attack in a moving fluid such as a flat plate, a building or a deck of the bridge, will generate an aero dynamic force (called lift) perpendicular to the flow. Aero foils are more efficient lifting shapes, able to generate more lift (up to a point), and to generate lift with less drag.

NACA (NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS)

NACA 0012 Where,

0 Camber in percent chord.

0 Maximum camber located in length of chord.

12 Thickness in terms of percentage (12%).

B.Raghava rao and Rangineni Sahitya [1] conducted numerical and experimental investigation of lift, drag coefficients and pressure distribution on NACA0012 aerofoil at different Angles of Attack for low and high Reynolds Numbers. At low angles of attack, the dimensionless lift coefficient increased linearly with angle of attack. Flow was attached to the aerofoil throughout this regime. At an angle of attack of roughly 15 to 16°, the flow on the upper surface of the aerofoil began to separate and a condition known as stall began to develop and the same behaviour at all angles of attack until stall.

Comparison of Aerodynamic Behavior between NACA 0018 and NACA 0012 aero foils at Low Reynolds Number through CFD Analysis has been conducted by Abdus Shabur et.al. [2]. It was found that C_L/C_D ratio is always higher for NACA 0012 than NACA 0018 aero foil. At the same time, with the increase of Reynolds’s number, C_L/C_D ratio increases for both the aero foils. It was clear from the study that NACA 0012 generates more lift than NACA 0018 for the same Reynolds number.

Diksha Singh et.al. [3] carried out an experimental investigation to enhance the performance of an Aerofoil NACA 4311 by surface modification. Initially the aerodynamic performance of three different shapes viz. cambered, flat and symmetrical shaped aerofoil was checked experimentally. Based on this investigation it was concluded that symmetrical aerofoil gave quite better performance than cambered and flat shaped aerofoil.

Modeling and flow simulation of NACA23021 has been carried out by Sri Ram Deepak Akella et.al[4] to know the effect of aerodynamic performance by varying the surface temperature at different speeds using solid works and flow simulation. It was concluded that changing the surface temperature of the aero foil will lead to change the Ratio of Co-efficient of lift vs. Co-efficient of Drag.

Hasif Hasan khan et.al,[5] conducted simulation studies on two aero foils NACA0012 and NACA0018 at two Reynolds numbers 300000 and 700000 to investigate the turbulence kinetic energy under two air stream velocities. From this work, it was observed that NACA0018 aero foil produces significantly more turbulence than the NACA0012 aerofoil.

M. A. M. Razman et al. [6] conducted experimental investigations on NACA 0012 and NACA 0018 aero foils using Wind Tunnel to study the flow characteristics. From this work, it was observed that NACA 0018 had higher lift and drag coefficients compared to NACA 0012, which indicates that NACA 0018 is better suited for applications that require higher lift and drag.

Numerical Analysis of Flow over NACA 0012 and NACA 0018 Aero foils at Low Reynolds Numbers has been done by M. S. Alam et al. [7].From this, it was concluded that lift and drag coefficients of NACA 0018 are higher compared to NACA 0012, which was consistent with the results of the wind tunnel test conducted in the previous study.

S. S. Sankar et al. [8] conducted an experimental study using wind tunnel on NACA 0012 and NACA 0018 aero foils with surface roughness to know their aerodynamic characteristics. The results showed that surface roughness had a significant effect on the lift and drag coefficients of both aero foils, but NACA 0018 was less sensitive to surface roughness compared to NACA 0012.

"Effect of Angle of Attack on Lift and Drag Coefficients of NACA 0012 and NACA 0018 Aero foils: An Experimental Study" was conducted by S. K. Jha et al. [9] using a wind tunnel test. From this work, it was observed that NACA 0018 had higher lift and drag coefficients compared to NACA 0012 at all angles of attack, which was consistent with the results of the previous studies.

Overall, the literature suggests that NACA 0018 aerofoil has higher lift and drag coefficients compared to NACA 0012 aerofoil, making it more suitable for applications that require higher lift and drag. However, surface roughness and angle of attack can have a significant effect on the aerodynamic characteristics of both aero foils.

In this project, experimental investigations are carried out over the surfaces of NACA0012 and NACA0018 aerofoils to determine lift, drag and pressure coefficients and comparisons are made between the two by plotting graphs using Minitab.

OBJECTIVES OF THE PRESENT STUDY:

(1) To calculate lift and drag coefficients over the surfaces of NACA0012 and NACA0018 Aerofoil at different angles of attack when the aerofoil is positioned at the center of the wind tunnel.

(2) To obtain the relationship between the coefficients of lift and drag and angles of attack for both the aerofoil models.

(3) To obtain the relationship between the coefficient of pressure and the chord length for different angles of attack for both the aerofoil models.

II. EXPERIMENTAL SET UP

This experiment consists of study of flow characteristics over NACA 0012 and NACA 0018 aerofoils fixed in the wind tunnel adjusted for the different angles of attack. The wind tunnel having an induced blower fan run by the aid of D.C motor. The details of experimental set up, aerofoil models and instruments are given below.

2.1 WIND TUNNEL

Fig.2: WIND TUNNEL

Wind tunnel is generally used for testing the models of various shapes like aerofoil, cylinder, cascade of blade etc... In a wind tunnel the important part is test section. The aim is to obtain the truly rectilinear flow across the test section. The object to be tested is placed in test section. The wind tunnel can be of section type or blower type.Test section size is 30cm x30cmx100cm with a flexi glass having strength and rigidity. The section is made of wood. The wind tunnel is of suction type with an axial flow fan driven by a variable speed DC motor. It consists of an entrance section with a bell inlet containing a strength screen and a straw honey combs. This section is followed by a nozzle section; test section is diffuse section and a duct containing the axial flow fan. The whole unit is supported on steel frame. The complete wind tunnel except the section is constructed of Mild Steel. Maximum Reynolds number is 2500000.

Fig.3: BELL INLET

2.1.1 WINDTUNNEL ACCESSORIES:

- NACA 0012aerofoil (axial cord-16cms, span-24cms) with a linkage mechanism and a digital 2-component force measuring transducer.
- NACA 0012aerofoil (axial chord-16cms, span-24cms) with pressure determine the pressure distribution at various points on the surface of the aerofoil.
- NACA 0018aerofoil (axial cord-16cms, span-24cms) with a linkage mechanism and a digital 2-component force measuring transducer.
- NACA 0018aerofoil (axial chord-16cms, span-24cms) with pressure determine the pressure distribution at various points on the surface of the aerofoil.
- To determine the lift/ drag characteristics with a dual display, both the lift and drag are measured simultaneously.
- Prandtl type pi-tot static tube with transfer mechanism to measure the flow velocity in test section.
- Altech multi limbed manometer for measuring the static pressure distribution in the aerofoil.

2.1.2 SPECIFICATIONS of Wind Tunnel

- The total length wind tunnel is about 6m
- The axial flow fan and duct is 1.2m long.
- The maximum height is about 2m.
- Test section of 30cmx30cm cross section and 100cm length with thick flexi glass window.
- The test section velocity is varied by changing the speed of the DC motor.

Fig.4: AEROFOIL MODELS

Clamping devices:

Clamp (tool), a device used to hold an object in a fixed position.

A clamp is a fastening device to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure.

Fig.5: Aerofoil model with clamping device.

2

.2 MANUFACTURING OF NACA 0018 AEROFOIL

2.2.1CRUCIBLE:

A crucible is a refractory container used for metal, glass and pigment production as well as a number of modern laboratory processes, which can withstand temperatures high enough to melt or otherwise alter its content.

2.2.2FURNANCE:

Heat the aluminum into liquid state above melting and blower is on to supply air. Coal is used as fuel in the furnace to melt the Aluminum. By igniting coal, furnace is started and blower is on to supply air sufficiently. Furnace is started with igniting the coal and required amount of air is supplied with the help of blower. After 3hours the crucible is placed in a furnace. The aluminum alloy was kept in the crucible and waited up to melting of aluminum.

2.2.3PATTERN MAKING:

Pattern is the full size model of casting to be made. It gives its shape the mould cavity where the molten solidifies to desired forms and size. The design of casting should be as simple as possible to make the pattern easy to draw from the sand.

2.2.4MOULD MAKING:

Castings are produced when the molten metal is poured into mould cavity and left to solidify. Casting is the one of the cheapest methods producing parts to a given shape. It takes an advantage of molten metal to form of the mould.

2.2.5 CORE MAKING:

Cores are bodies of sand designed to form holes and cavities in casting. Cores are placed in the mould cavity before pouring to form the interior surface of the casting and are removed from finished part during shakeout and further processing.

2.2.6 POURING:

After that the molten is poured in to the mould cavity to get the required shape. Then it allowed to solidifying in the atmosphere.

Fig.6: NACA 0018 AEROFOIL

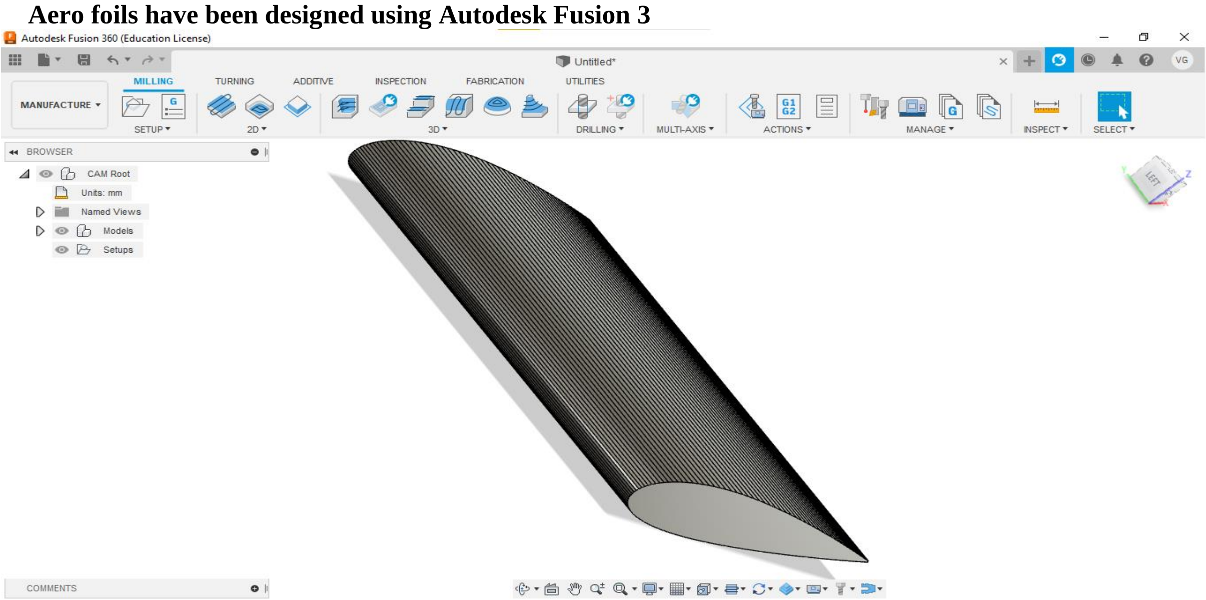
FOR STATIC PRESSURE:

- Holes are made with the drill bit of 2 mm on 12 various points on the aerofoil.
- The copper tubes are arranged in the holes.
- The outer ends of the copper tubes are connected to manometer limbs with the plastic tubes.

Fig.7: STATIC PRESSURE ARRANGEMENT

2.3. DESIGN OF NACA0012 AEROFOIL

Aero foils have been designed using Autodesk Fusion 3



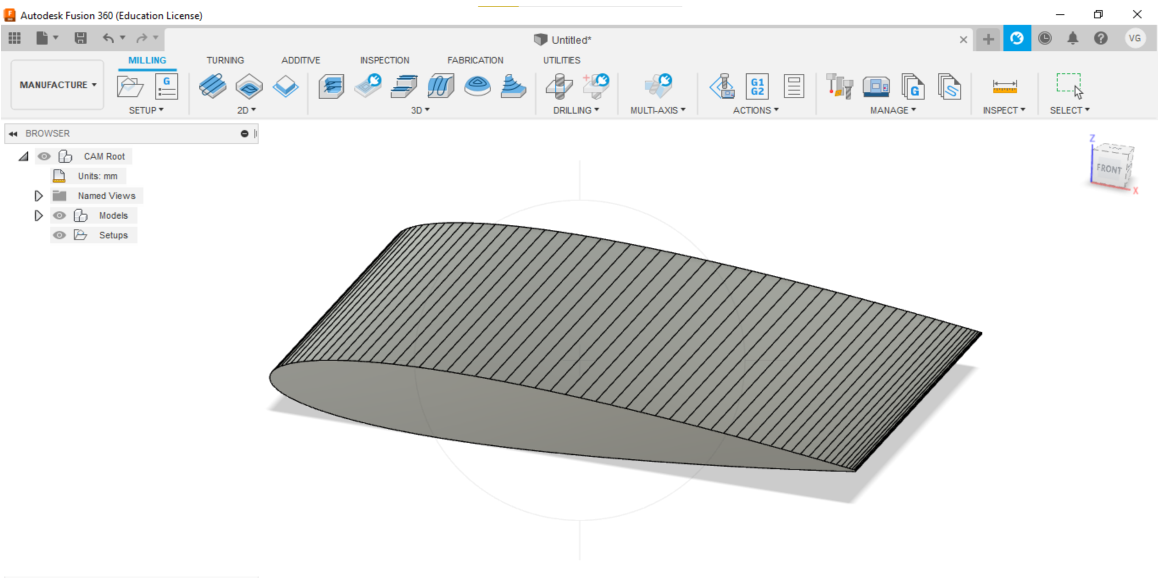


Fig.8: Design of Aerofoil models

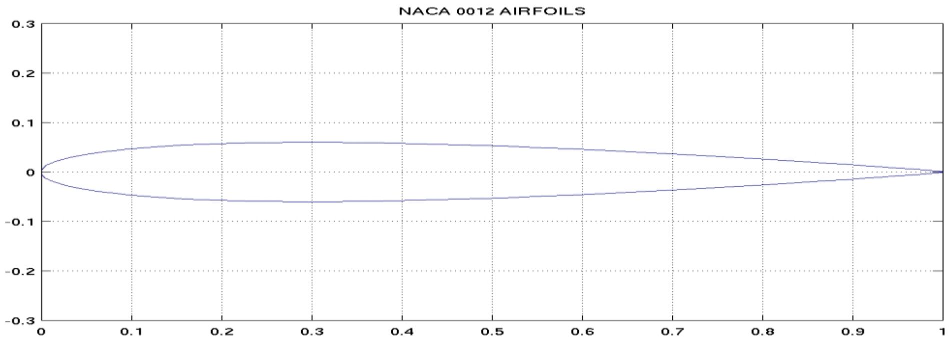


Fig.9: Profile of NACA 0012 AEROFOIL

2.3.1:NACA0012 aerofoil was made with 12 gauge G.I.Sheet. Sheet was bent as per the profile shown above. The sides of model were welded with holding plates and unwanted material removed by grinding process. A Clamp is made for holding the aerofoil in the wind tunnel.

Fig.10: NACA 0012 AEROFOIL WITH CLAMP

For static pressure measurement, holes are made with the drill bit of 2 mm at different points on the surface of the aerofoil. Copper tubes are arranged in the holes and the outer ends are connected to manometer limbs with plastic tubes by marking numbers from 1 to 12.

Fig.11: NACA 0012 AEROFOIL ARRANGMENT WITH PRESSURE TAPS

2.4 INSTRUMENTS

2.4.1 PITOT TUBE: is used to determine velocity of flow. The air velocity was measured using a pi-tot tube placed at a suitable position in the air flow path of the test section. The air velocity was calculated using the relation -13√q Where ‘q’ is the pi-tot tube reading in cm.

Fig.12: PITOT TUBE

2.4.2 TRANSDUCER: A transducer is a device that converts energy from one form to another. Usually a transducer converts a signal in one form of energy to a signal in another. This Transducer Gives Lift forces and Drag forces.

Fig.13: TRANSDUCER

2.4.3 MANOMETER: A manometer is an instrument used to measure and indicate pressure. The most basic and simplest form of an analog is the U-Tube manometer, a glass or rubber tube bent in the shape of a "U" where numbers are listed and spaced every inch on each side, and water is placed in between the bends of the "U".

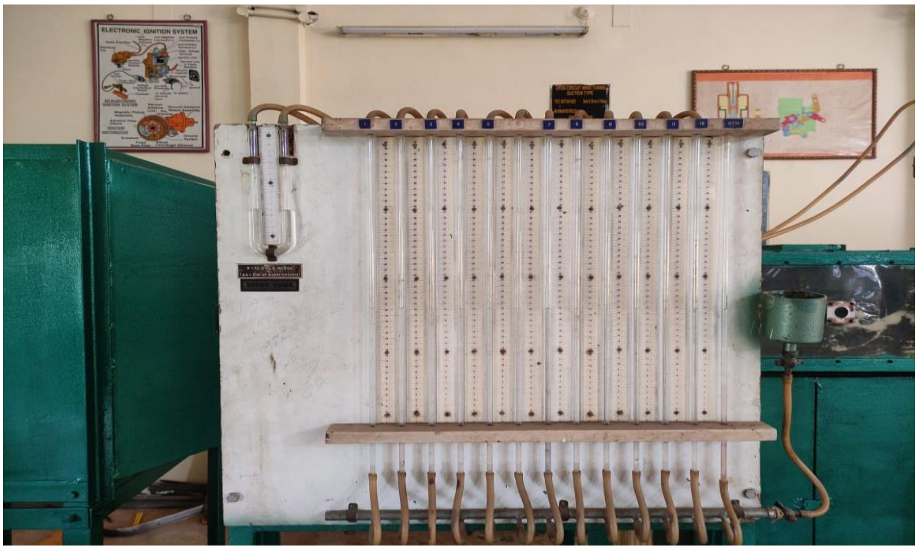


Fig.14: MANOMETER

2.4.4 CONTROL PANEL:
An electrical control panel is an enclosure, typically a metal box or plastic molding which contains important electrical components that control and monitor a number of mechanical processes.

Fig.15: CONTROL PANEL

III. EXPERIMENTAL PROCEDURE

3.1 PROCEDURE FOR LIFT AND DRAG CO-EFFICIENTS

The Aerofoil is fixed in the centre position of the wind tunnel. The angle of attack is kept at zero initially. The transducers are connected to the display device where the lift and drag force can be read directly. The motor is started and the Voltage is increased gradually about 280V and the manometer deflection from the pi-tot tube is noted. The lift and drag force are noted from the display devices. The angle of attack is altered to different angles of 10°, 20 °, 30 °,-10 °,-20 °,-30 ° and the readings of the lift and drag force are noted. The Current is set to 5A.The Lift and Drag Coefficients are calculated. The graphs would be plotted in Minitab at various angles.

Table 3.1: Lift and Drag Forces for NACA0012

Angle of attack	Lift force (kgf)	Drag force (kgf)	Pi-tot tube reading(cm)	Lift coefficient	Drag Coefficient
0^0	-0.56	-0.35	7.5-4.3	-0.044	-0.738
10^0	0.89	-0.27	8.0-4.0	0.056	-0.455
20^0	1.62	-0.16	8.1-3.9	0.102	-0.269
30^0	1.72	-0.12	8.2-3.8	0.108	-0.202
-10^0	-1.56	-0.31	7.8-4.0	-0.103	-0.550
-20^0	-1.32	-0.88	7.5-4.3	-0.104	-1.855
-30^0	-1.05	-0.98	7.3-4.5	-0.094	-2.362

Table 3.2: Lift and Drag Forces for NACA0018

Angle of attack	Lift force (kgf)	Drag force (kgf)	Pi-tot tube reading(cm)	Lift coefficient	Drag Coefficient
0^0	-0.39	-0.14	7.4-4.4	-0.032	-0.314
10^0	0.60	-0.19	7.8-4.2	0.042	-0.356
20^0	1.40	-0.55	7.9-4.1	0.093	-0.976
30^0	1.98	-0.68	8.1-3.9	0.119	-1.092
-10^0	-1.64	-0.25	7.9-4.1	-0.109	-0.496

-20^0	-1.40	-0.70	7.5-4.3	-0.110	-1.476
-30^0	-1.23	-0.88	7.2-4.5	-0.111	-2.199

3.2 PROCEDURE FOR COEFFICIENT OF PRESSURE

The surface of the aerofoil is to be drilled at different points for inserting tubes inside the aerofoil for the determination of static pressure. All the tubes of the aerofoil are dragged through the hole of the Flexi fiber glass of the wind tunnel. These tubes are connected to the manometer tubes in order to get the static pressure distribution. The Plastic tubes are connected to manometer. The velocity and pressure readings are to be taken from Pitot tube and manometer respectively. This procedure is to be repeated for different angles of attack at 0, 10, 20, 30,-10,-20,-30.The COP is calculated from the pressure values.

3.3 CALCULATION FOR LIFT AND DRAG COEFFICIENT

Coefficient of Lift, $C_L = \frac{FL}{1/2\rho AV^2}$

Where,

$F_L =$ Lift force = -0.33kgf
ρ=Density =1.169kg/m^3
A =Projected area =0.04m^2
V =Velocity =13√q
q=manometer reading (cm)

$C_L = \frac{-0.33}{\frac{1}{2}*1.169*0.04*(13\sqrt{2})^2}$

C_L = -0.041

$C_D = \frac{F_D}{1/2\rho AV^2}$

Where,

C_D = drag coefficient
F_D = drag force = -0.011kgf
ρ = density = 1.163kg/m^3
A = area of cross section = 0.0015m^3
V = Velocity =13√q
q = manometer reading (cm)

$C_D = \frac{-0.11}{\frac{1}{2}*1.169*0.0015*(13\sqrt{q})^2}$

C_D = -0.0139

3.4 CALCULATION FOR COEFFICIENT OF PRESSURE

COP (C_{Pl}) = (P_{ref} –P)/q

Where,
C_{P1} = Coefficient of pressure
Pref = reference pressure (atmosphere)
P_1 = pressure at point 1
q =manometer reading (cm)
C_{P1} = (23.5-17.1)/2
C_{P1} = -1.52

IV. RESULTS AND DISCUSSION

4.1

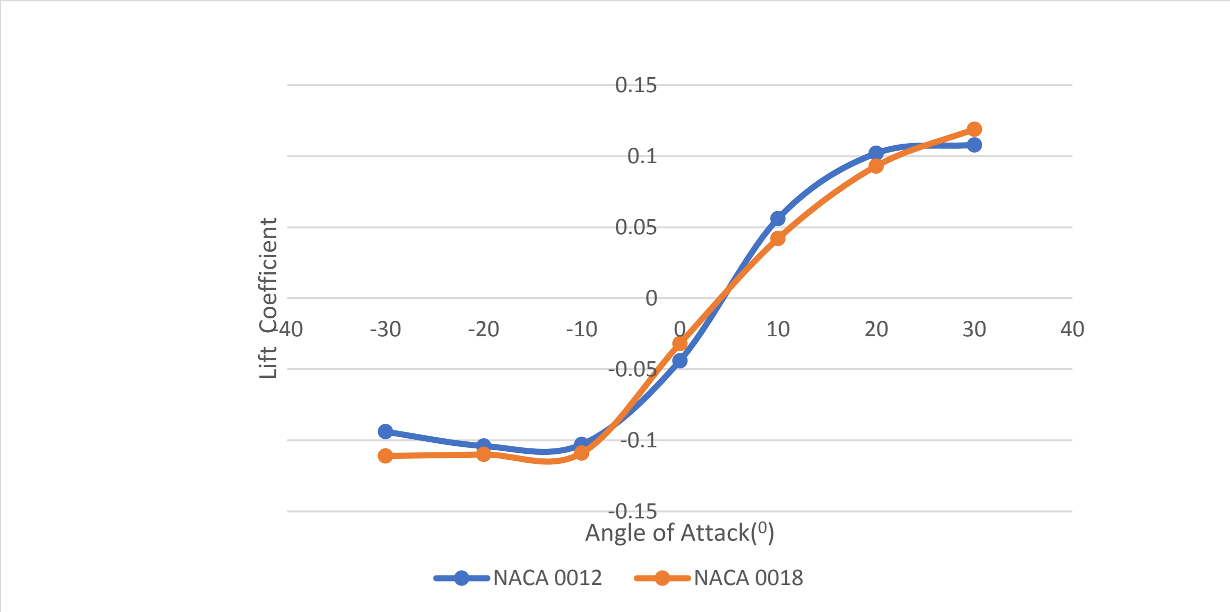


Fig.17: Relationship between Lift Coefficient and Angle of Attack for both the aero foils NACA0012 &NACA0018.

From the Fig.17, it was observed that Lift coefficient increases as the Angle of Attack increases for both the aero foils. But Lift Coefficient values of NACA 0012 Aerofoil are higher than that of NACA0018 Aerofoil for angles of attack -30º,-20º,-10º, 10o, 20º & lower for the angles of attack 0º, 30º.

4.2

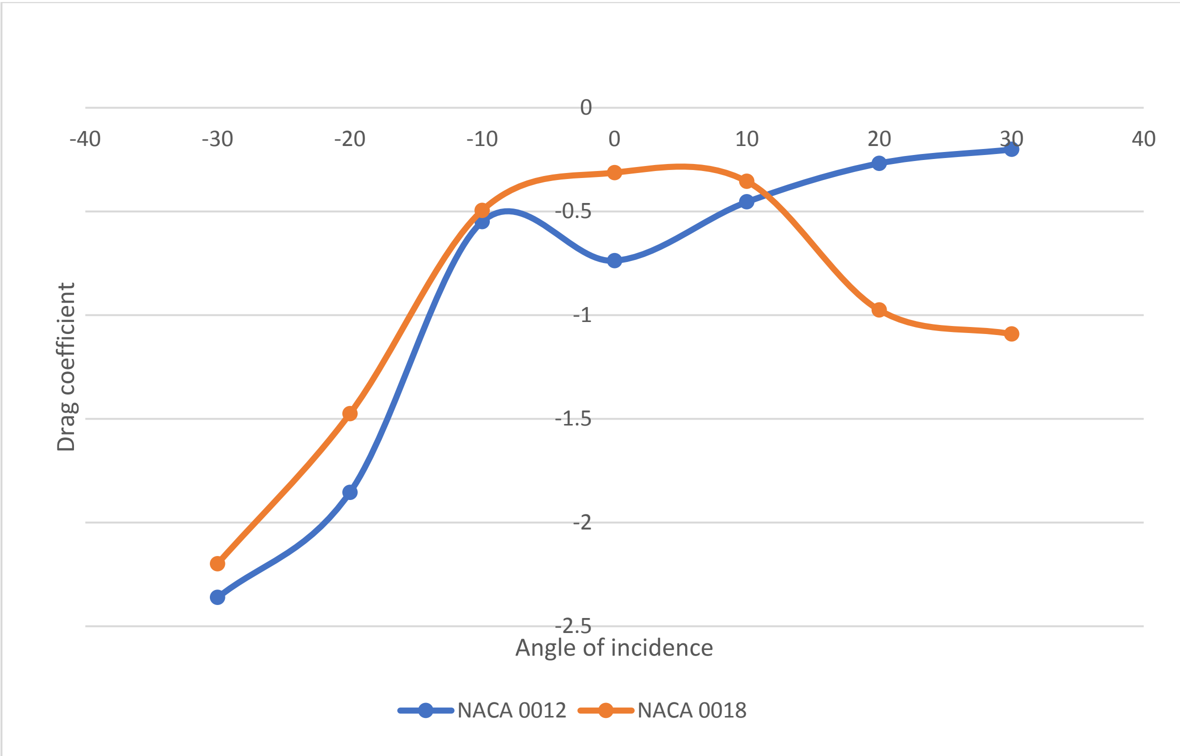


Fig.18: Relationship between Drag Coefficient and Angle of Attack for both the aero foils NACA0012 &NACA0018.

From the Fig.18, it was observed that Drag coefficient first increases then decreases and increases as the angle of Attack increases for aerofoil NACA0012 and has a maximum value at Angle of Attack 30º. But for aerofoil NACA0018, drag coefficient first increases then maintains constant value and then decreases as the angle of attack increases and has a minimum value at Angle of Attack 30º.Also the drag coefficient values of NACA0012 aerofoil are less compared to NACA0018 Aerofoil except at an angle of 20º, 30º. & greater for NACA0018 aero foil at angles of attack -30º,-20º,-10º, 0º, 10º.

4.3

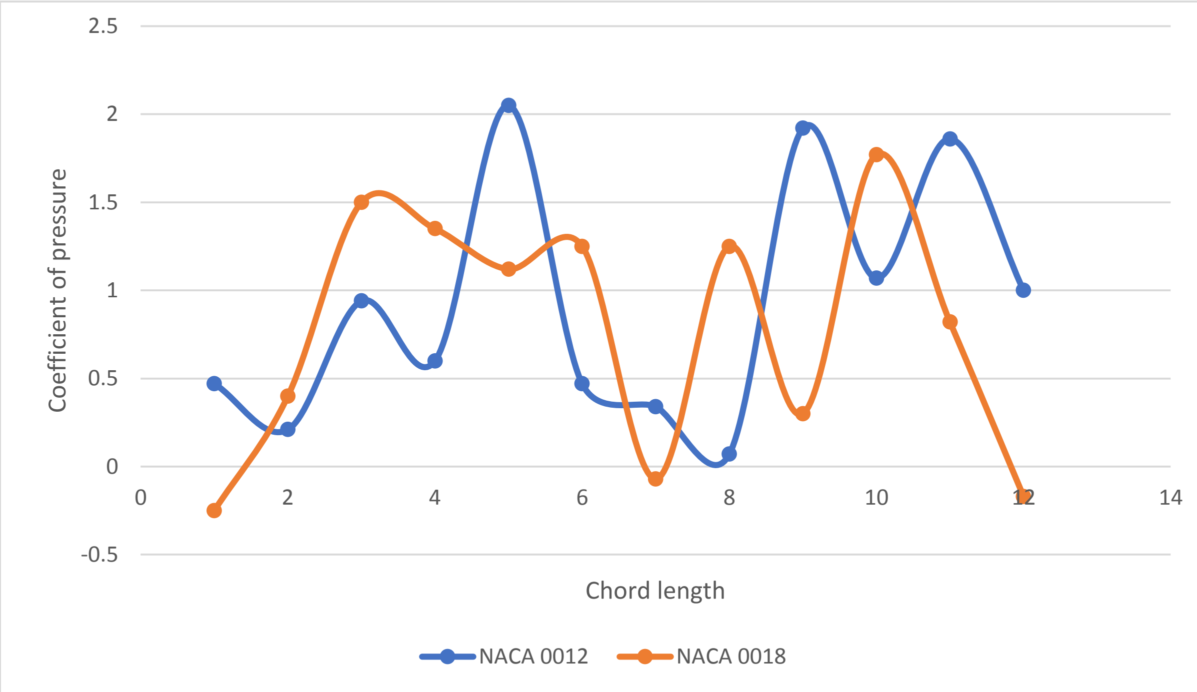


Fig.19: Variation of Coefficient of Pressure with Chord length for both the aero foils NACA0012 &NACA0018 at an angle of attack 0º

From the Fig.19, it was observed that the coefficient of pressure values of NACA0012 aerofoil are first decreases and then increases and decreases & follow the same trend along the chord length where as the coefficient of pressure values of NACA0018 aerofoil are first increases and then decreases and increases & follow the same trend along the chord length at an angle of attack 0º .Further the coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,5,7,9,11,12 of chord length and lower at points of 2,3,4,6,8,10 of chord length at an angle 0º.

4.4

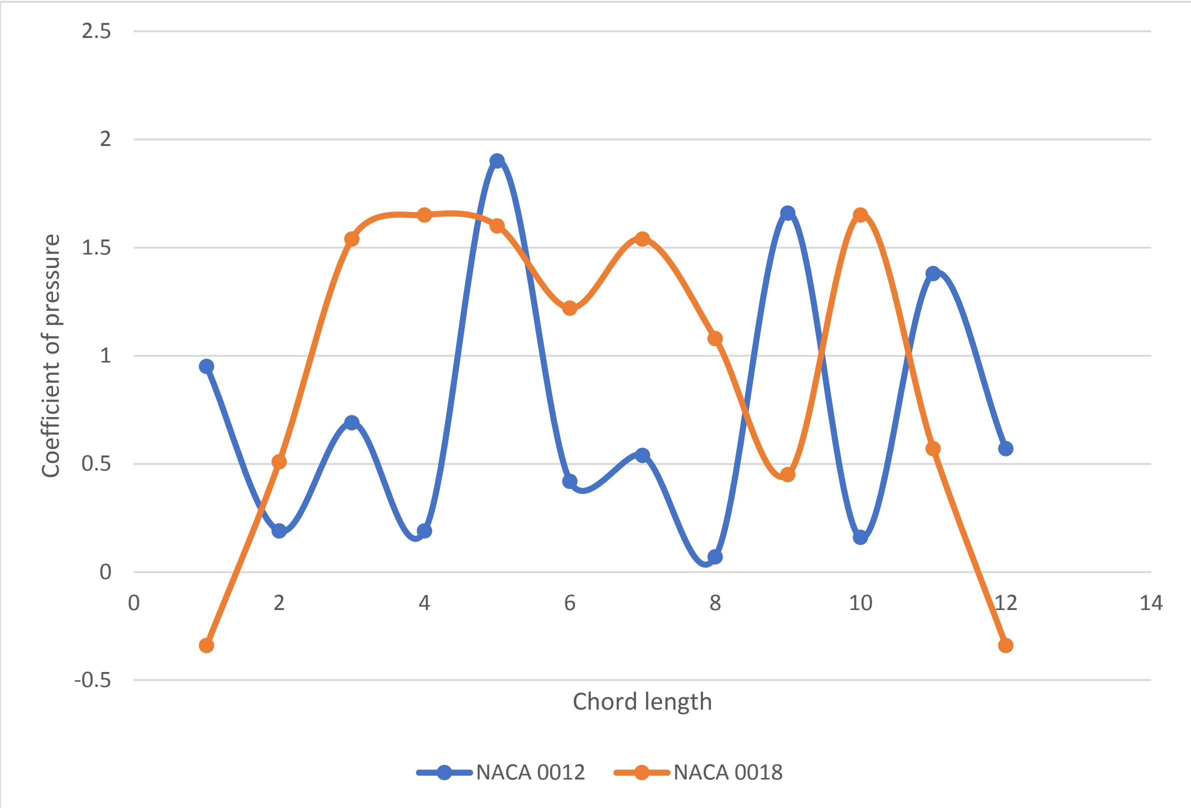


Fig.20: Variation of Coefficient of Pressure with Chord length for aero foils NACA0012 &NACA0018 at an angle of attack 10º

From the Fig.20, it was observed that the coefficient of pressure values of NACA0012 aerofoil are first decreases and then increases & follow the same trend along the chord length where as the coefficient of pressure values of NACA0018 aerofoil are first increases and then decreases & follow the same trend along the chord length at an angle of attack 10º .Further the coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,5,9,11,12 of chord length and lower at points of 2,3,4,6,7,8,10 of chord length at an angle 10º.

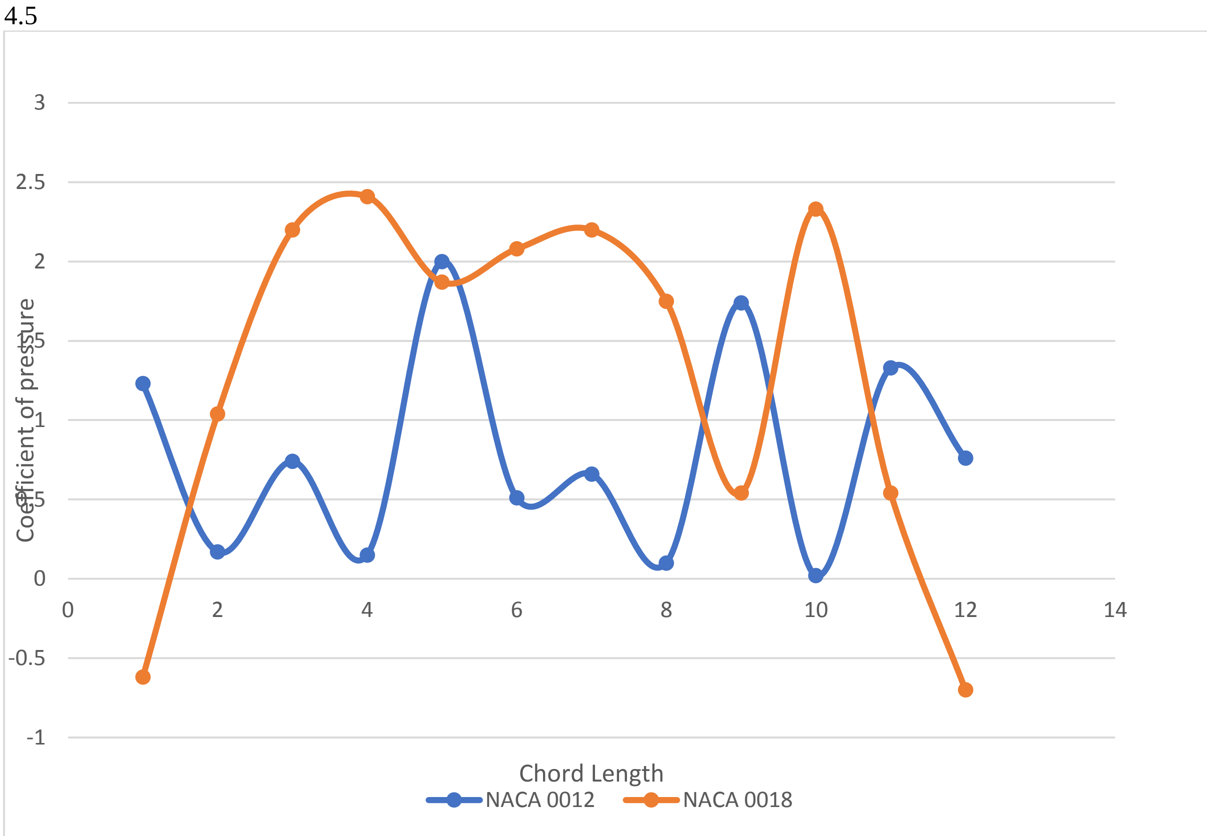


Fig.21: Variation of Coefficient of Pressure with Chord length for aero foils NACA0012 &NACA0018 at an angle of attack 20°

From the Fig.21, it was observed that the coefficient of pressure values of NACA0012 aerofoil are first decreases and then increases & follow the same trend along the chord length where as the coefficient of pressure values of NACA0018 aerofoil are first increases and then decreases & follow the same trend along the chord length at an angle of attack 20° .Further the coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,5,9,11,12 of chord length and lower at points of 2,3,4,6,7,8,10 of chord length at an angle 20°.

4.6

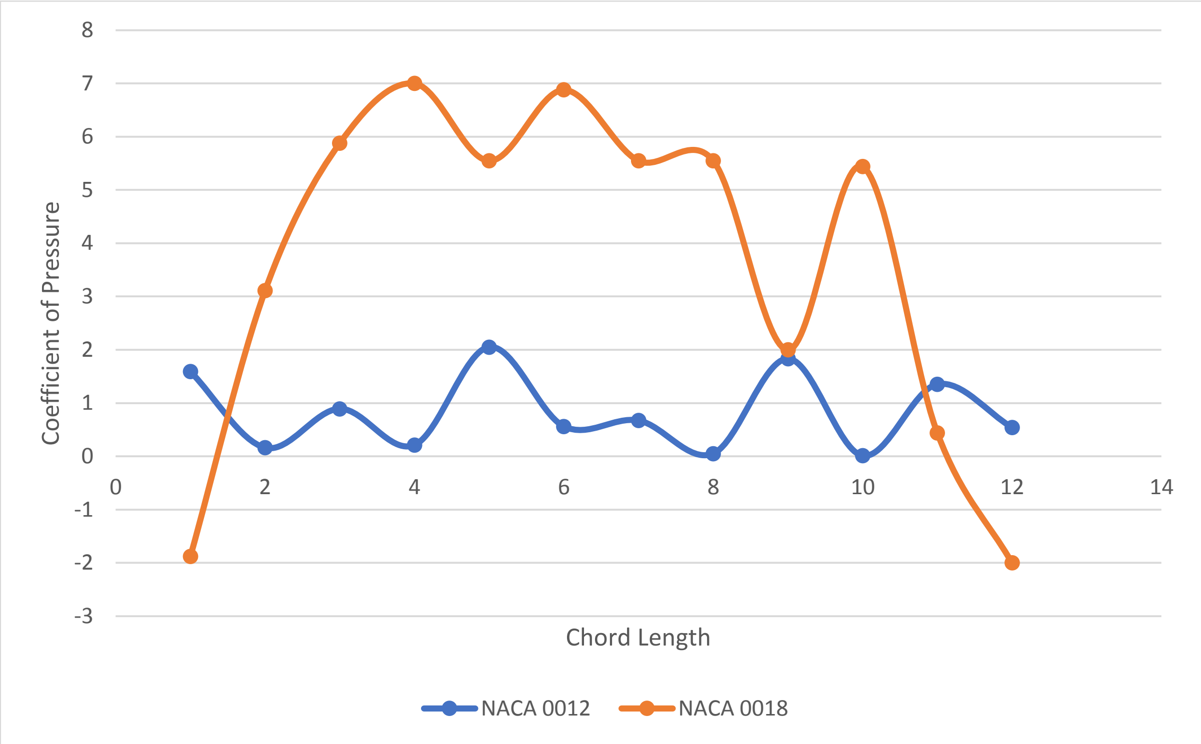


Fig.22: Variation of Coefficient of Pressure with Chord length for aero foils NACA0012 &NACA0018 at an angle of attack 30º

From the Fig.22, it was observed that the coefficient of pressure values of NACA0012 aerofoil are first decreases and then increases & follow the same trend along the chord length where as the coefficient of pressure values of NACA0018 aerofoil are first increases and then decreases & follow the same trend along the chord length at an angle of attack 30º .Further the coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,11,12 of chord length and lower at points of 2,3,4,5,6,7,8,9,10 of chord length at an angle 30º.

4.7

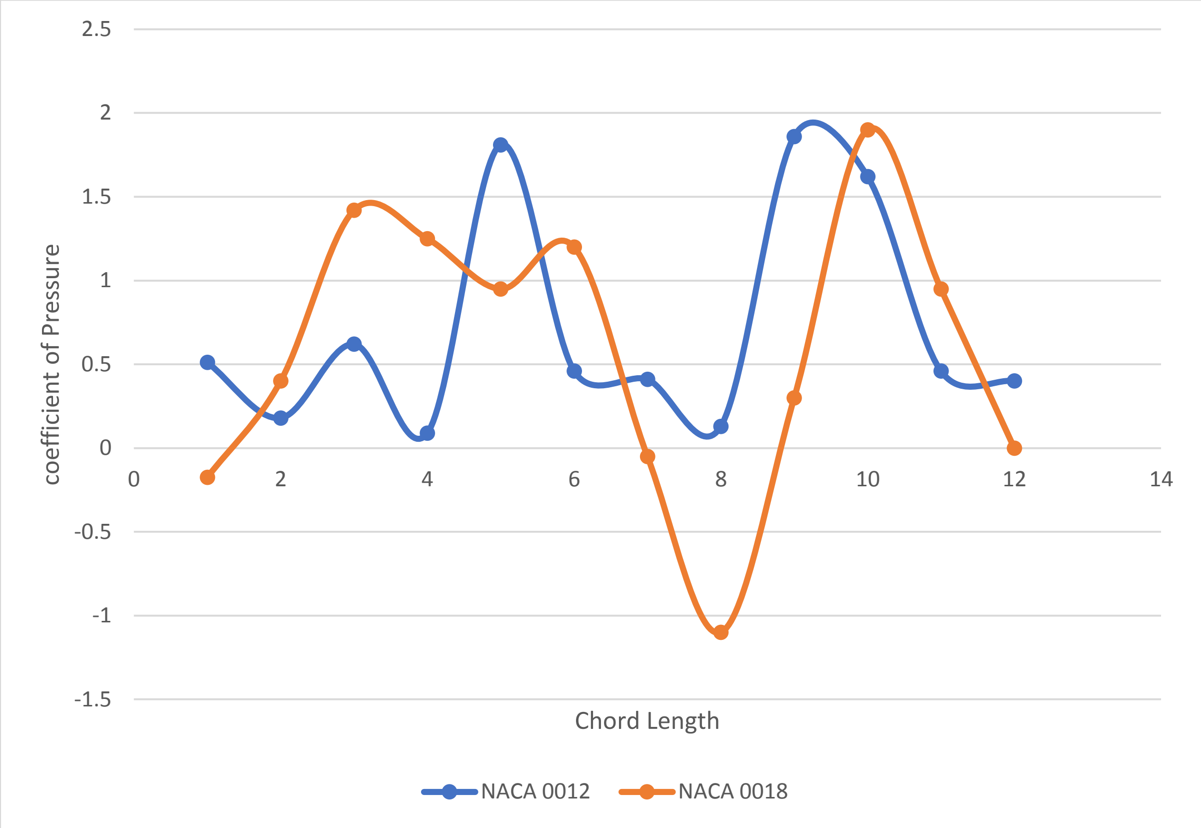


Fig.23: Variation of Coefficient of Pressure with Chord length for aero foils NACA0012 &NACA0018 at an angle of attack -10º

From the Fig.23, it was observed that the coefficient of pressure values of NACA0012 aerofoil are first decreases and then increases & follow the same trend along the chord length where as the coefficient of pressure values of NACA0018 aerofoil are first increases and then decreases & follow the same trend along the chord length at an angle of attack -10º .Further the coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,5,7,8,9,12 of chord length and lower at points of 2,3,4,6,10,11 of chord length at an angle -10º.

4.8

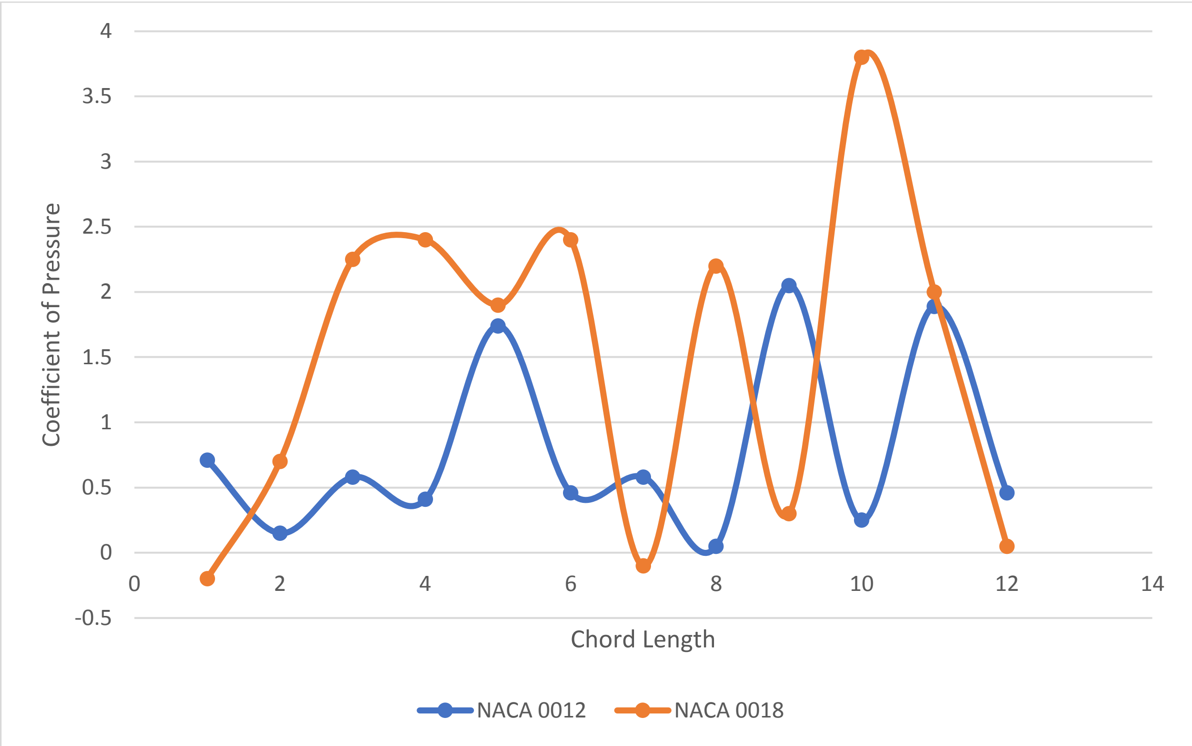


Fig.24: Variation of Coefficient of Pressure with Chord length for aero foils NACA0012 &NACA0018 at an angle of attack -20^o

From the Fig.24, it was observed that the coefficient of pressure values of NACA0012 aerofoil are first decreases and then increases & follow the same trend along the chord length where as the coefficient of pressure values of NACA0018 aerofoil are first increases and then decreases & follow the same trend along the chord length at an angle of attack -20^o .Further the coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,7,9,12 of chord length and lower at points of 2,3,4,5,6,8,10,11 of chord length at an angle -20^o.

4.9

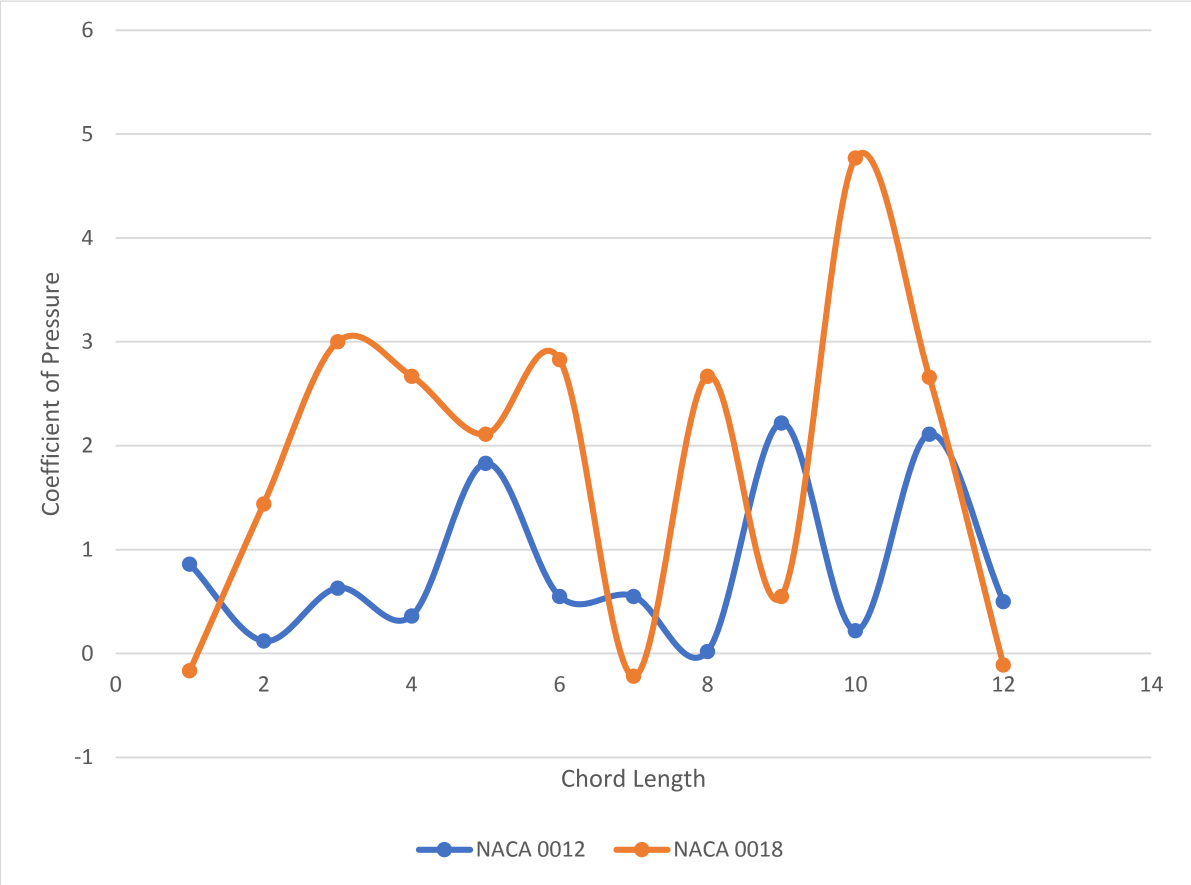


Fig.25: Variation of Coefficient of Pressure with Chord length for aero foils NACA0012 &NACA0018 at an angle of attack -30^o

From the Fig.25, it was observed that the coefficient of pressure values of NACA0012 aerofoil are first decreases and then increases & follow the same trend along the chord length where as the coefficient of pressure values of NACA0018 aerofoil are first increases and then decreases & follow the same trend along the chord length at an angle of attack -30^o .Further the coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,7,9,12 of chord length and lower at points of 2,3,4,5,6,8,10,11 of chord length at an angle -30^o.

V. CONCLUSIONS

Experiments are carried out to study the flow characteristics over two aero foil models NACA0012 and NACA0018 at angles of attack -30^o,-20^o,-10^o, 0^o,10^o,20^o,30^o and comparisons are made between them. The following conclusions are drawn from the study.

LIFT AND DRAG COEFFICIENTS:

It was concluded that Lift coefficient increases as the Angle of Attack increases for both the aero foils. But Lift Coefficient values of NACA 0012 Aerofoil are higher than that of NACA0018 Aerofoil for angles of attack -30^o,-20^o,-10^o,10^o, 20^o & lower for the angles of attack 0^o,30^o.

Further it was observed that Drag coefficient first increases then decreases and increases as the angle of Attack increases for aerofoil NACA0012 and has a maximum value at Angle of Attack 30^o. But for aerofoil NACA0018, drag coefficient first increases then maintains constant value and then decreases as the angle of attack increases and has a minimum value at Angle of Attack 30^o.Also the drag coefficient values of NACA0012 aerofoil are less compared to NACA0018 Aerofoil except at an angle of 20^o,30^o. & greater for NACA0018 aero foil at angles of attack -30^o,-20^o,-10^o,0^o, 10^o.

COEFFICIENT OF PRESSURE:

The coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,5,7,9,11,12 of chord length and lower at points of 2,3,4,6,8,10 of chord length

at an angle 0º.
The coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,5,9,11,12 of chord length and lower at points of 2,3,4,6,7,8,10 of chord length at an angle 10º.
The coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,5,9,11,12 of chord length and lower at points of 2,3,4,6,7,8,10 of chord length at an angle 20º.
The coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,11,12 of chord length and lower at points of 2,3,4,5,6,7,8,9,10 of chord length at an angle 30º.
The coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,5,7,8,9,12 of chord length and lower at points of 2,3,4,6,10,11 of chord length at an angle -10º.
The coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,7,9,12 of chord length and lower at points of 2,3,4,5,6,8,10,11 of chord length at an angle -20º.
The coefficient of pressure values of NACA 0012 aerofoil are higher than that of NACA0018 aerofoil at points of 1,7,9,12 of chord length and lower at points of 2,3,4,5,6,8,10,11 of chord length at an angle -30º.

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