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# Multi-section Wing Design: A Novel Design to Decrease Fuel Consumption in Aircrafts

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**Abstract—***In aviation industries, the main objective is to reduce the weight of an aircraft and to use materials of less weight, since reducing aircraft's weight reduces the amount of fuel it consumes and increases the speed. Many attempts are being made to increase the fuel efficiency of an aircraft. One of the factors that affect fuel efficiency is lift to drag ratio (L/D) as a particular aircraft's required lift is set by its weight, delivering that lift with lower drag leads directly to better fuel economy, climb performance and glide ratio. In this paper a concept of multisection wing is proposed which will increase the effectiveness of an aircraft by increasing lift to drag ratio and replacing high lifting devices (flaps and slats) giving same application but with decreased weight. So Various aerodynamic characteristics of multi section wing have been studied and compared with conventional fixed wing to verify its effectiveness.*

## 1. INTRODUCTION

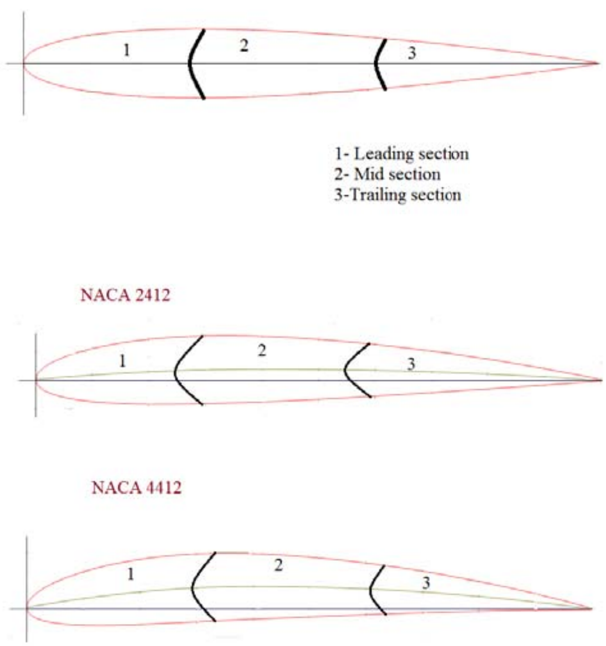
Aviation provides the only worldwide transportation network. Aviation transports close to 2 billion passengers annually and 40% interregional exports of good (by value).We have seen some amazing advances, none more so perhaps than the improvement in fuel efficiency. We can now transport people distances once thought impractical at speeds once believed impossible using relatively small amounts of energy. But our drive for even greater fuel efficiency is pushing the industry further still .The main aim of the present aviation industries is to reduce the weight of the aircraft and to use materials that are of less weight. People who design airplanes are greatly concerned with weight, since reducing a craft's weight reduces the amount of fuel it needs and increases the speed it can reach. Even a small decrease in the weight of the aircraft makes the aircraft more efficient. The other major factor that affects efficiency is lift to drag ratio (L/D).Since a particular aircraft's required lift is set by its weight, delivering that lift with lower drag leads directly to better fuel economy, climb performance and glide ratio. So there has been a great deal of research to achieve this goal.The most complex structure in the entire aircraft is its wing. The wing contains different devices on it to change its operating characteristics. The most common devices currently used in most of the aircraft are high lift devices such as leading edge slats and trailing edge flaps. Slats on the leading edge when deployed, allow the wing to operate at a higher angle of attack whereas flaps on trailing edge when deployed increases the camber or curvature of the wing. These devices have shown a reasonable increase in L/D ratio and decrease in the fuel consumption.Everything in aircraft design comes with a cost attached. Flaps increase lift but they also add drag and weight. We need flaps and slats only during takeoff and landing. During cruise phase flaps and slats are not required but add weight to aircraft which increases fuel consumption. So there is a method by which we can eliminate this unwanted fuel consumption and induced drag using multi-sectional wing design as it will give us benefits of both flaps and slats without inducing drag. Using multi-sectional wing we can get the required geometry of the wing without using any external components by which we get considerable weight reduction and increase in lift to drag ratio (L/D) that decreases the fuel consumption.

This research is to verify how a multi-sectional wing improves the aerodynamic properties when compared to the conventional flat fixed wing. We have selected NACA 0012 airfoil which is divided into three sections having one degree of freedom. By using this wing we can change the camber and angle of attack by changing the angular position of three sections of wing.

## 2. DESIGN OF MULTISECTION WING

Multi-section wing can be designed by selecting a symmetric airfoil (NACA 0012) which is divided into three sections having one degree of freedom. Each section of the wing is capable of moving and changing its angle with respect to the adjacent section. The concept of this wing is to change the camber and angle of attack of the wing by deflecting the leading and trailing edge sections of the wing as required by the different flight conditions. Three sections of the wing must be attached properly with a material which is flexible and elastic in nature so that it let the sections move and get them back in their initial positions. Sections should be so rotated that there is no flow disruptions. One can use spars and actuators to connect the airfoils and make them work accordingly as a multi section wing. Divided sections can be connected using sub spars so that they can move freely.

NACA 0012




*NACA 0012 converted to NACA 2412 and NACA 4412*

Keeping the thickness constant we can see that the single airfoil (NACA 0012) is converted to many different NACA airfoils with same thickness but different camber percentage. Therefore increasing the camber percentage we can get increased lift to drag ratio. Thus the wing can achieve the geometry that we obtain from flaps and slats.

## 3. COMPARISON OF THE PARAMETERS

**Values at**

Altitude = 0 m, Density = 1.225kg/cu m,

Pressure = 101.261kPa, Temperature = 15 C,

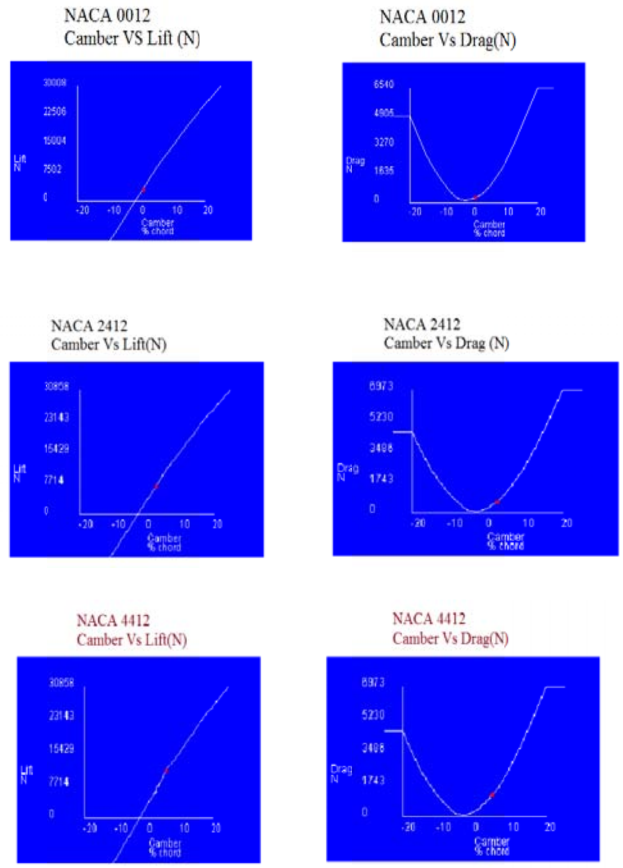
Airspeed = 160 km/hr, Chord = 1.524 m,

Span = 6.096 m,

Surface Area = 9.29 sq m

| AIRFOIL | NACA 0012 | NACA 2412 | NACA 4412 |
|---|---|---|---|
| Angle of attack | 2 | 3 | 4 |
| Thickness | 12 | 12 | 12 |
| camber % | 0 | 20 | 40 |
| Lift (L) [N] | 2733 | 6669 | 10383 |
| Drag [D] | 270 | 605 | 863 |
| L/D | 10.088 | 11.019 | 12.0312 |

**Plots**




## 4. CONCLUSION

The lift obtained is higher in variable camber wing than rigid wing. The flexibility of wing helps to reduce drag in variable chamber wing. In the variable camber wing the increase of lift and decrease of drag gives higher lift to drag ratio than that of rigid wing. The drag seen in plots is lesser than the lift. Hence the effectiveness of the variable camber wing is considerably greater than that of fixed wing.

## 5. ACKNOWLEDGEMENTS

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