



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJIRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 3, March 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 7.512**

9940 572 462

6381 907 438

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# Design and Optimisation of Gurney Flap for Maximum L/D Ratio on an Airfoil for Low Reynold Number

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**ABSTRACT:** This project deals with the aerodynamic performance of airfoil at low Reynolds number. This study represents that by adding of gurney flap we are optimizing the characteristics of the airfoil which is totally different than typical airfoil which in resulting increases of L/D ratio. This study also focuses on obtaining maximum L/D ratio at minimum drag. We are using NACA 2412 airfoil and analysing it with the gurney flap by using a commercial computational fluid dynamic (CFD) software.

**KEYWORDS:** NACA 2412 airfoil, GURNEY flap, Modified GURNEY flap, CDF analysis, Comparison, etc

## I. INTRODUCTION

High lift devices are used to increase the coefficient of lift of the airfoil by geometrical changes (camber and/or chord), and/or boundary layer control. These are mainly flaps (trailing edge devices) and slats (leading edge devices). There is a need to design devices with less mechanical complexities, since these systems are quite complex consisting of leading-edge slat and two or three trailing-edge mini flaps resulting in high maintenance cost and weight, without diminishing the performance in comparison to the classical ones. In order to reach high CL during takeoff and landing, it is necessary to develop newer devices to increase the lift and to control boundary layer separation. One such technology can be a Gurney mini flap, which consist in a plate with a height of the order of 1-2%*c*, located on the lower wing surface, at the trailing edge or as close as possible to it. It improves the lift of the airfoil at a small drag penalty. Overall, the lift over drag coefficient increases over a large range of angle of attacks. Also it alleviates the static and dynamic stall of the airfoil. Lift enhancement without drag penalties is a must in aeronautical applications. Increases in glide ratios with a relatively small drag penalty are not acceptable, although in some instances small drag reduction is possible. Gurney flap and trailing-edge flap, have been studied extensively by researchers to maintain the high lift required, especially, for approach and landing and takeoff.

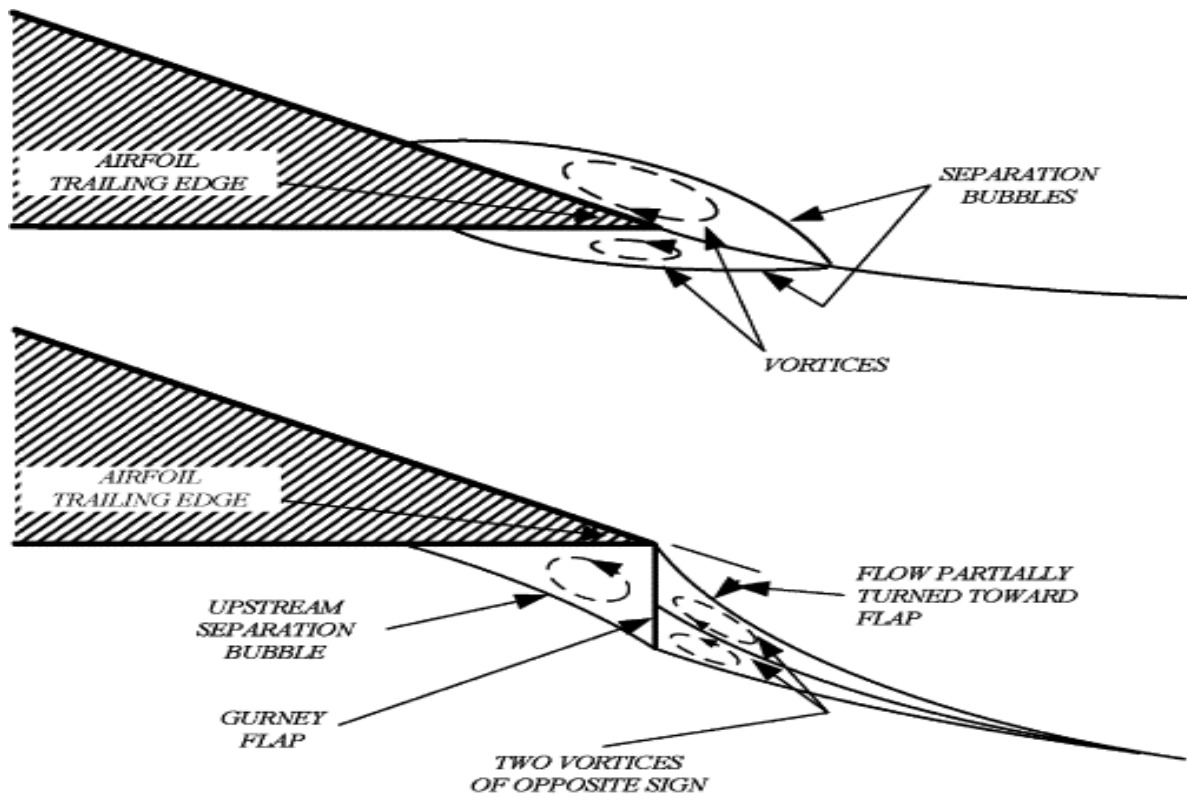


Figure.1-Airfoil trailing edge

## II. METHODOLOGY

This project is composed of following steps:-

- (1) Design of NACA 2412 airfoil with gurney flap
- (2) CFD analysis of the above airfoil.
- (3) Design of modified GURNEY flap
- (4) CFD analysis of above airfoil
- (5) L/D Comparisons of the above airfoils

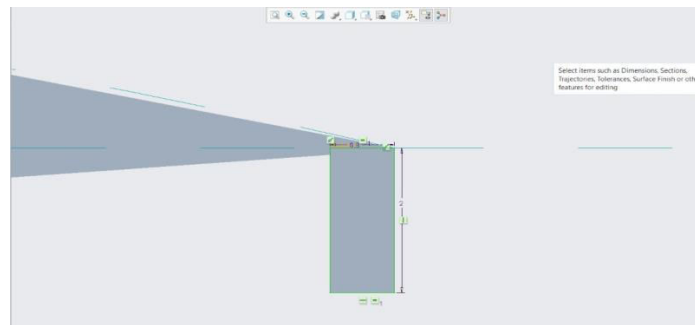


Figure 2-Gurney Flap With The Naca 2412 Airfoil

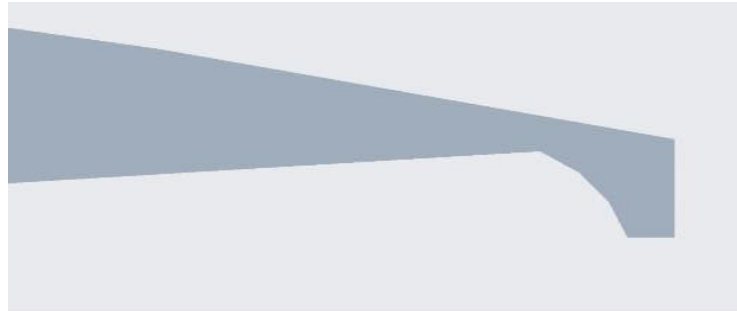


Figure3-Modified GURNEY flap with NACA 2412

### III. BOUNDARY CONDITIONS

The boundary conditions taken for CFD analysis were as follows:-

- 1) Design parameters
- 2) Chord length 100mm
- 3) Gurney flap (L):- 2mm
- 4) Span 100mm
- 5) Inflow velocity = 20.48 m/s.
- 6) Air was considered as an ideal fluid with a constant density of  $1.225 \text{ kg/m}^3$ .
- 7) Dynamic viscosity was kept at  $1.7894 \times 10^{-5} \text{ kg/ms}$ .
- 8) Gurney flap is of 2% of chord length.

For computational analysis ratio was taken as 1:10 (100cm=10cm)

### IV. MODELLING

For modelling purposes CAD software CREO is used. A NACA 2412 airfoil is fitted with a Gurney flap initially at  $0^\circ$  and  $10^\circ$  angle of attack and then is modified with a curve on the gurney flap. The meshing is done on Ansys 18.1 and mesh size is kept 9mm throughout the analysis.

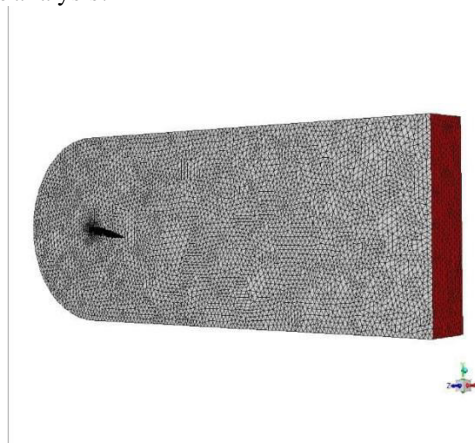


Figure4-Meshing of airfoil

### V. EXPERIMENTAL RESULTS

By performing CFD analysis in Ansys 18.1 we found some configuration values of lift and drag on the surface of our airfoil. We conducted the experiment in two variable angle of attack which are  $0^\circ$  and  $10^\circ$ . Results are shown in below figures.

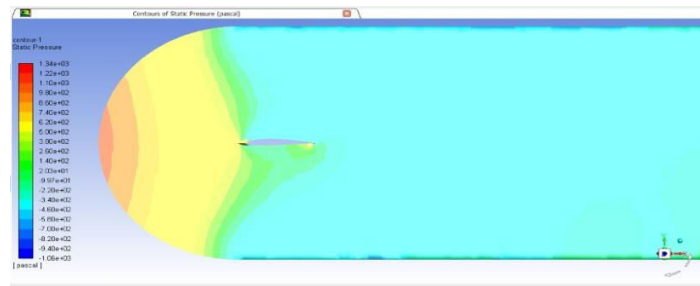


Figure 5 Total pressure at  $0^{\circ}$

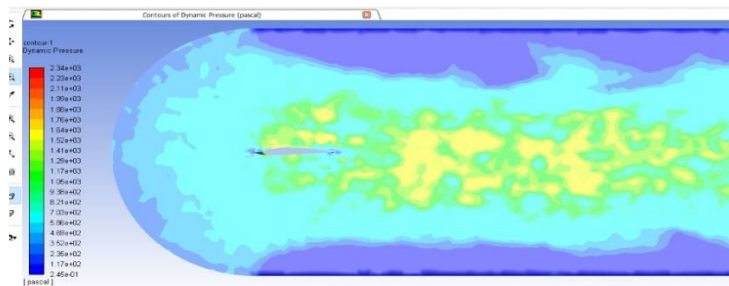


Figure 6 Dynamic pressure at  $0^{\circ}$

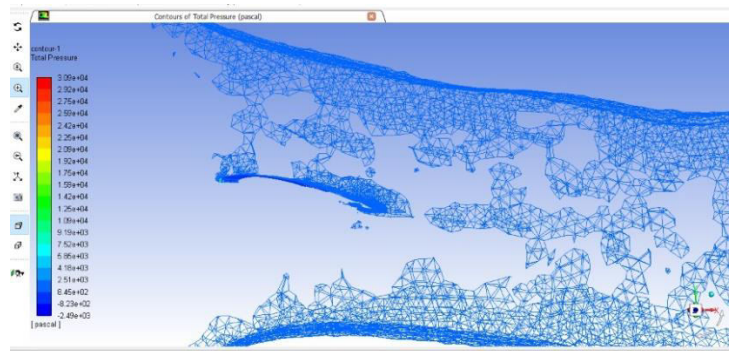


Figure 7 Total pressure at  $10^{\circ}$



Figure 8 Static pressure at  $10^{\circ}$

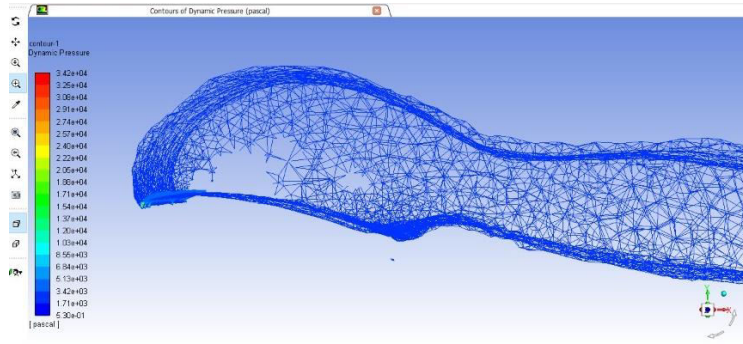


Figure 9 Dynamic pressure at  $10^0$

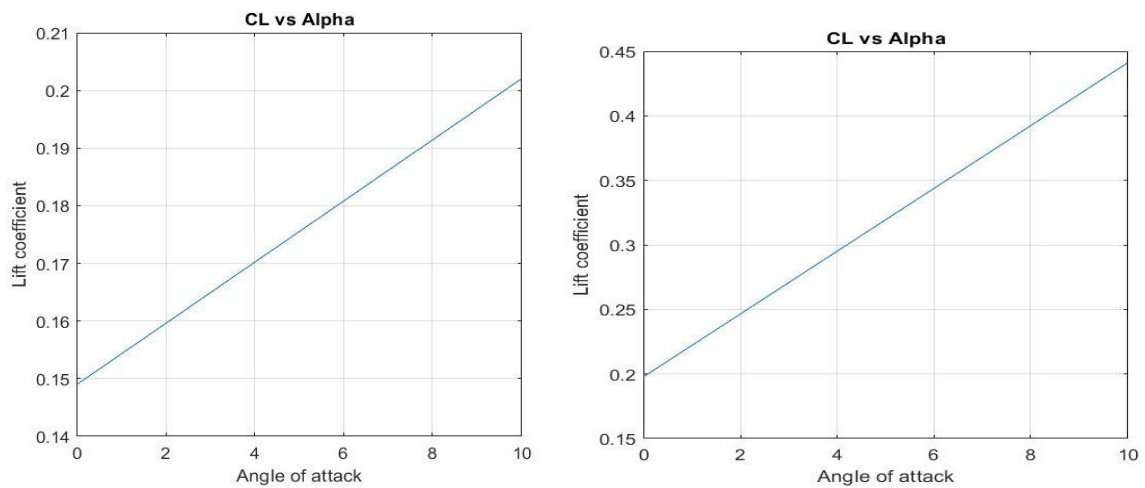


Figure 10 For typical Gurney flap Figure- 11 Modified Gurney flap

The results which we obtained from the CFD analysis were than compared as shown below

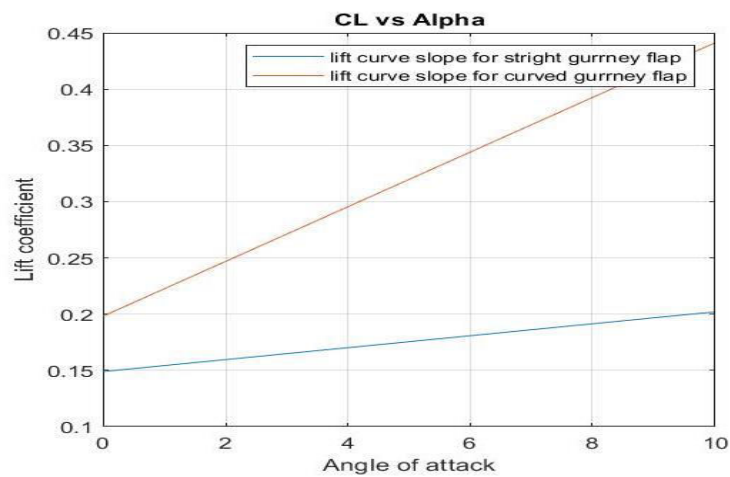


Figure-12 Comparison of  $c_l$  vs Alpha for typical and modified GURNEY flap



The LIFT and DRAG values we obtained upon comparison are as follows

1) 0 DEGREE LIFT & DRAG :-

LIFT	3.84 N
DRAG	0.58 N

2) 10 DEGREE LIFT & DRAG :-

LIFT	5.20 N
DRAG	1.1 N

Figure-13 LIFT and DRAG for  $0^0$  and  $10^0$  (typical gurney flap)

1) 0 DEGREE LIFT & DRAG :-

LIFT	5.09 N
DRAG	0.76 N

2) 10 DEGREE LIFT & DRAG:-

LIFT	11.33 N
DRAG	0.67 N

Figure 14 LIFT and DRAG for  $0^0$  and  $10^0$  (modified gurney flap)

**VI. CONCLUSION**

As seen from above comparison we can conclude that for  $0^0$  angle of attack in typical GURNEY flap we get  $L/d = 37.4664$

For modified GURNEY flap at  $0^0$  angle of attack we get  $L/D = 49.9$

Therefore the percentage increase in  $L/d$  value for  $0^0$  angle of attack is 5.7071%

Similarly for  $10^0$  angle of attack we get  $L/D$  increment of 15.8482%

Thus a high lift wing NACA 2412 fitted with curved Gurney flap produces more lift in less time and at lower speeds than normal airfoil..



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