Enhancing aerodynamic performance of low reynolds number aerofoil using Micro Vortex Generators.

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MICRO VORTEX GENERATORS:

- Vortex Generators that can fit within 50% height of the boundary layer are known as MVG's

- These are also called as LOW PROFILE VORTEX generators or SUB PROFILE BOUNDARY LAYER VORTEX GENERATORS

- MVG's are known for improving the health of the flow or simply improving the flow conditions.

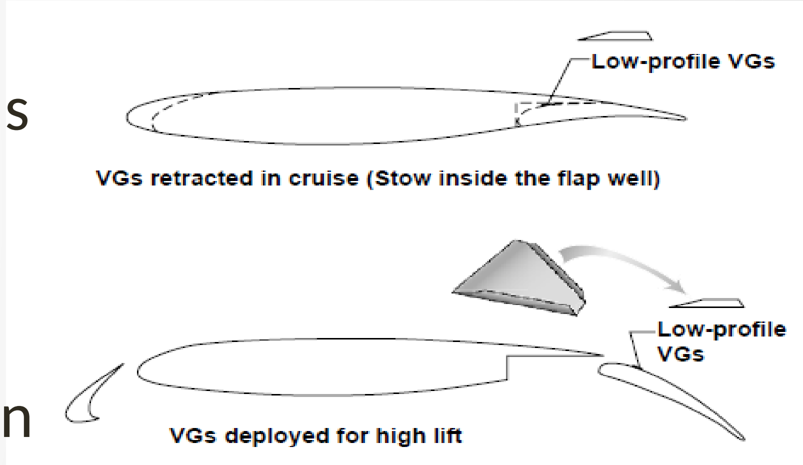
HOW DO MVG’s HELP:

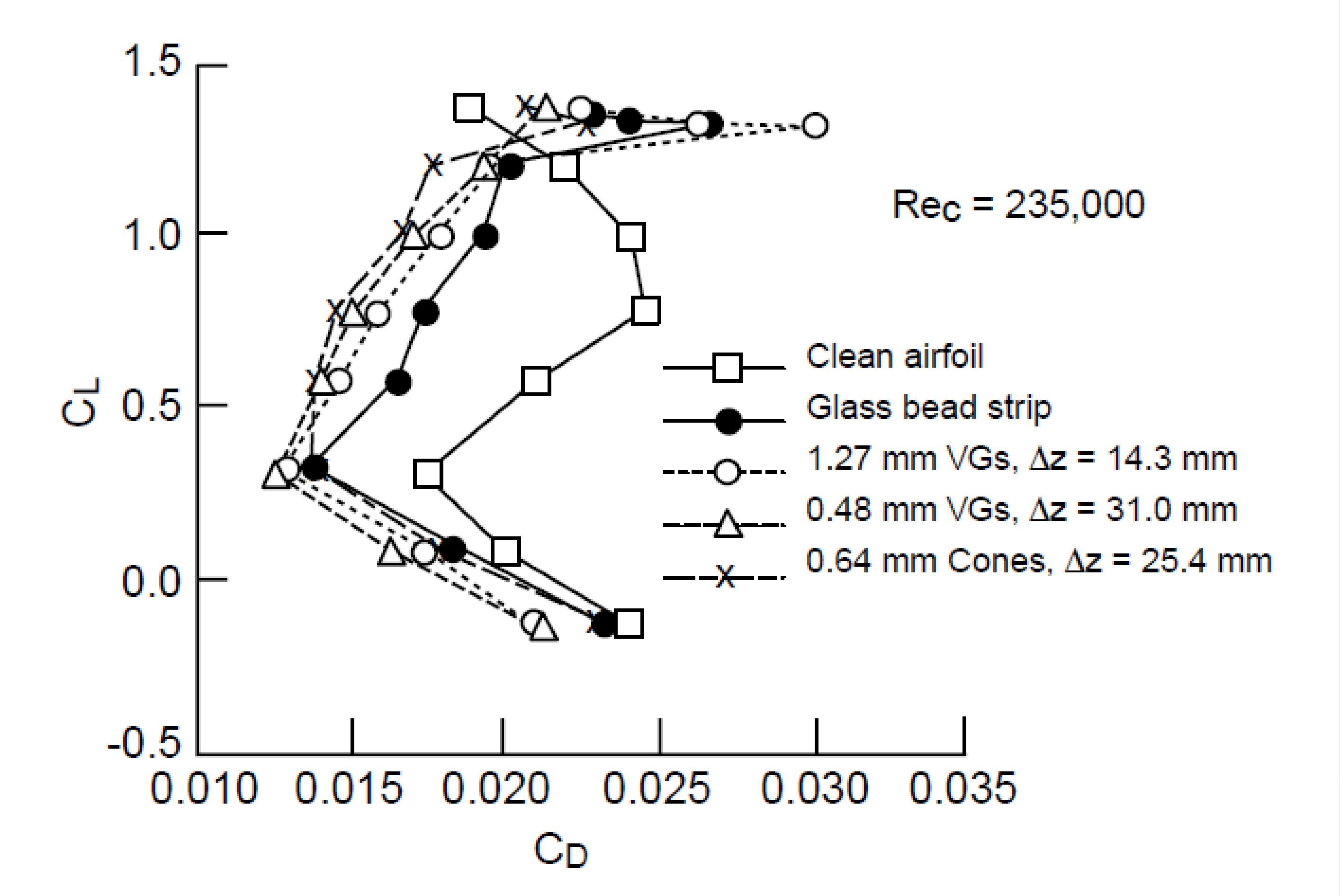
- For reduction of drag and improving the flow quality there is a need to reduce and/or control the boundary layer over the surface . Introducing Micro Vortex generators is one of the techniques to reduce the complications in flow caused due to boundary layer.
- Robustness and very less low profile drag are the obvious advantages of Micro Vortex Generators
- As the flow control involves formation of a micro vortex that is generated by the MVG there is no need of any actuating system making MVG’s simpler and easy to implement.

AREA OF APPLICATIONS IN AEROSPACE SECTOR:

- **Airfoil/wing Applications (Low Reynolds number):**

Many of the modern airfoils have the capabilities to operate for a low range of Reynolds number, such airfoils find its application in UAV's, HALE aircraft wings, wind turbine blades and compressor blades.





(Liebek LA2573A) low Re airfoil showing improvement in Aerodynamic performance

Other application areas:

- **HIGH SWEPT WINGS**
- **TRANS SONIC AIRFOILS**
- **SHOCK WAVE BOUNDARY LAYER INTERACTION**
- **NOISE REDUCTION**
- **REDUCTION IN ENGINE DISTORTION**
- **ENHANCING HEAT TRANSFER**

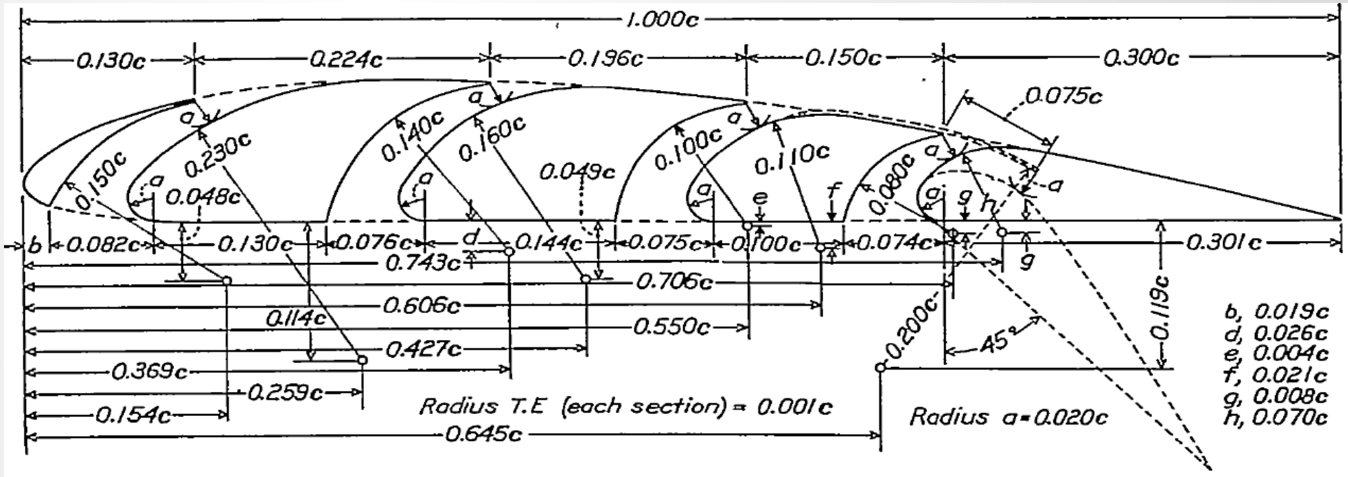
HYPOTHESIS:

- For **Low Re number flow** over the airfoil remains Laminar and **Laminar flows offer less resistance to adverse pressure gradient**, such cases are **more susceptible to flow separation**. The separated shear layer is characterized by formation of **vortices due to Kevin Helmothz mechanism**. My present works propose is to find the **optimal location** of a low proflie passive **MVG** by the use of CFD so that aerodynamics **performance of the wing may be improved**.

CFD of CLARK Y using MVG's on flap:

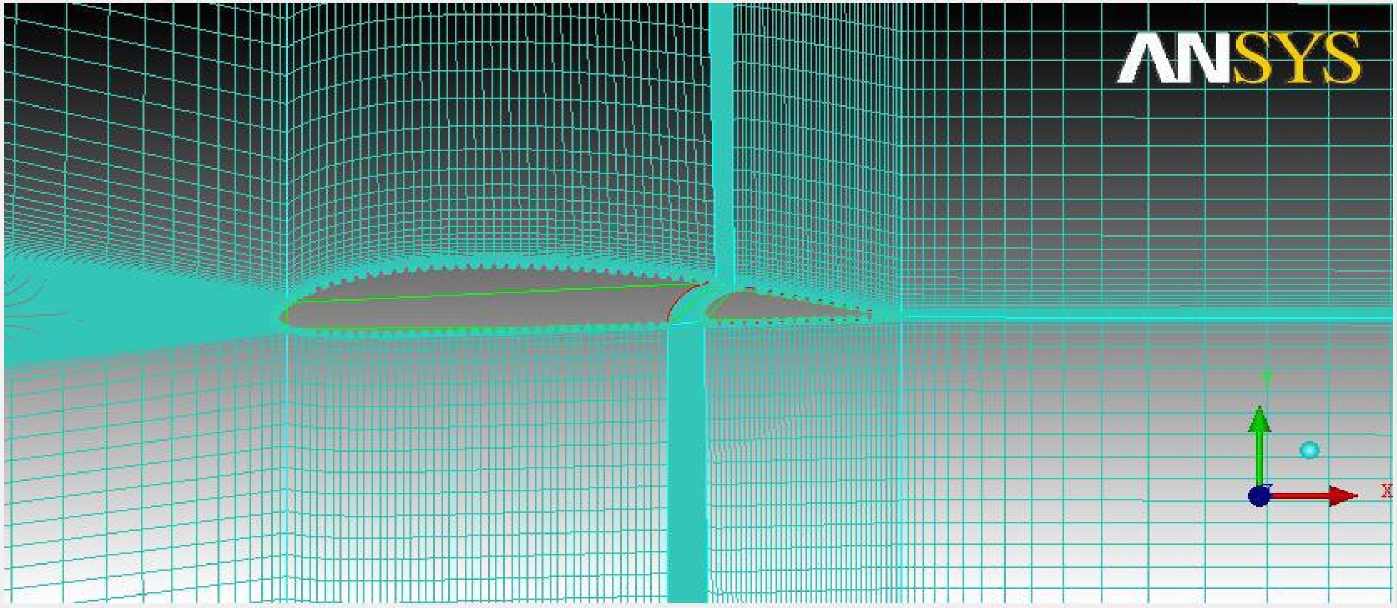
- Main aim is to improve the aerodynamics of the flap, by delaying separation and improving the lift on it

- **Geometric Modeling:**



Clark Y geometry (NACA report)

- **Meshing :**



Structured Mesh Over Airfoil

Domain and Mesh around the Airfoil

PARAMETER	VALUE
Total Nodes	159825
Total faces	228624

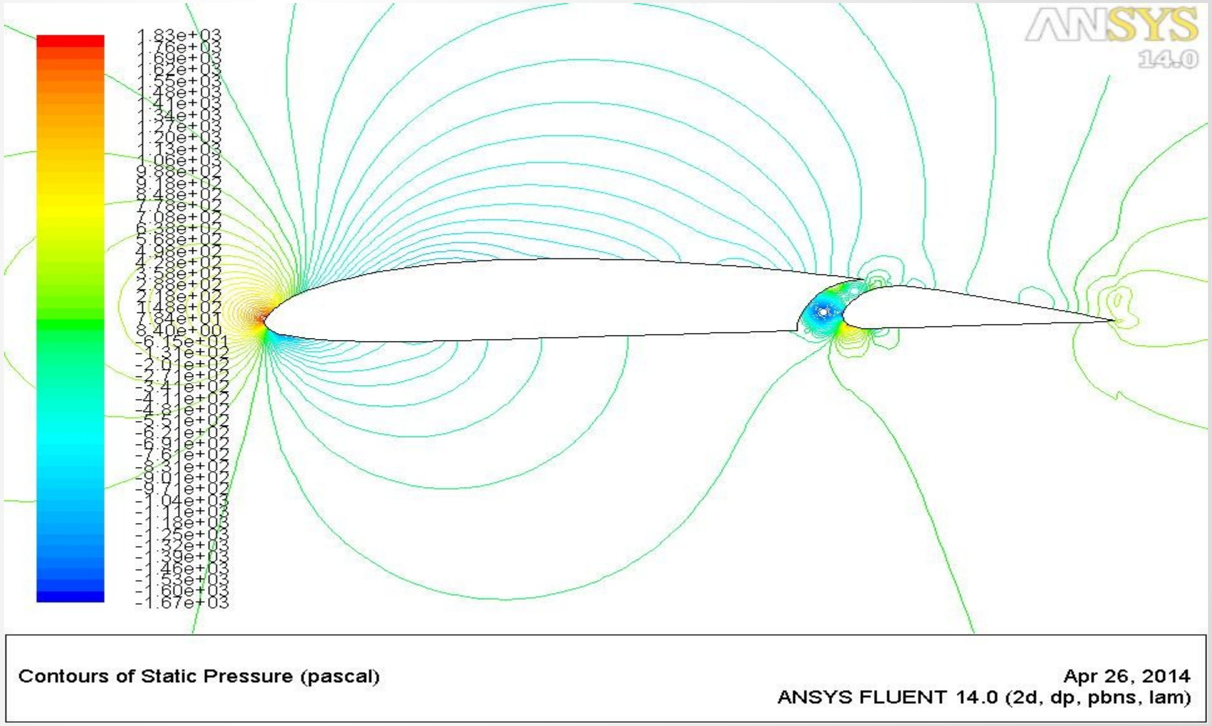
- **Boundary Conditions:**

PART / ZONE	BOUNDARY CONDITION
INLET	*Velocity inlet*
	Velocity = 55 m/s
OUTLET	*Pressure outlet*
	Gauge pressure=0 pa
Airfoil	*No slip wall*
Fairfield	*Wall*
	Stationary wall with zero shear

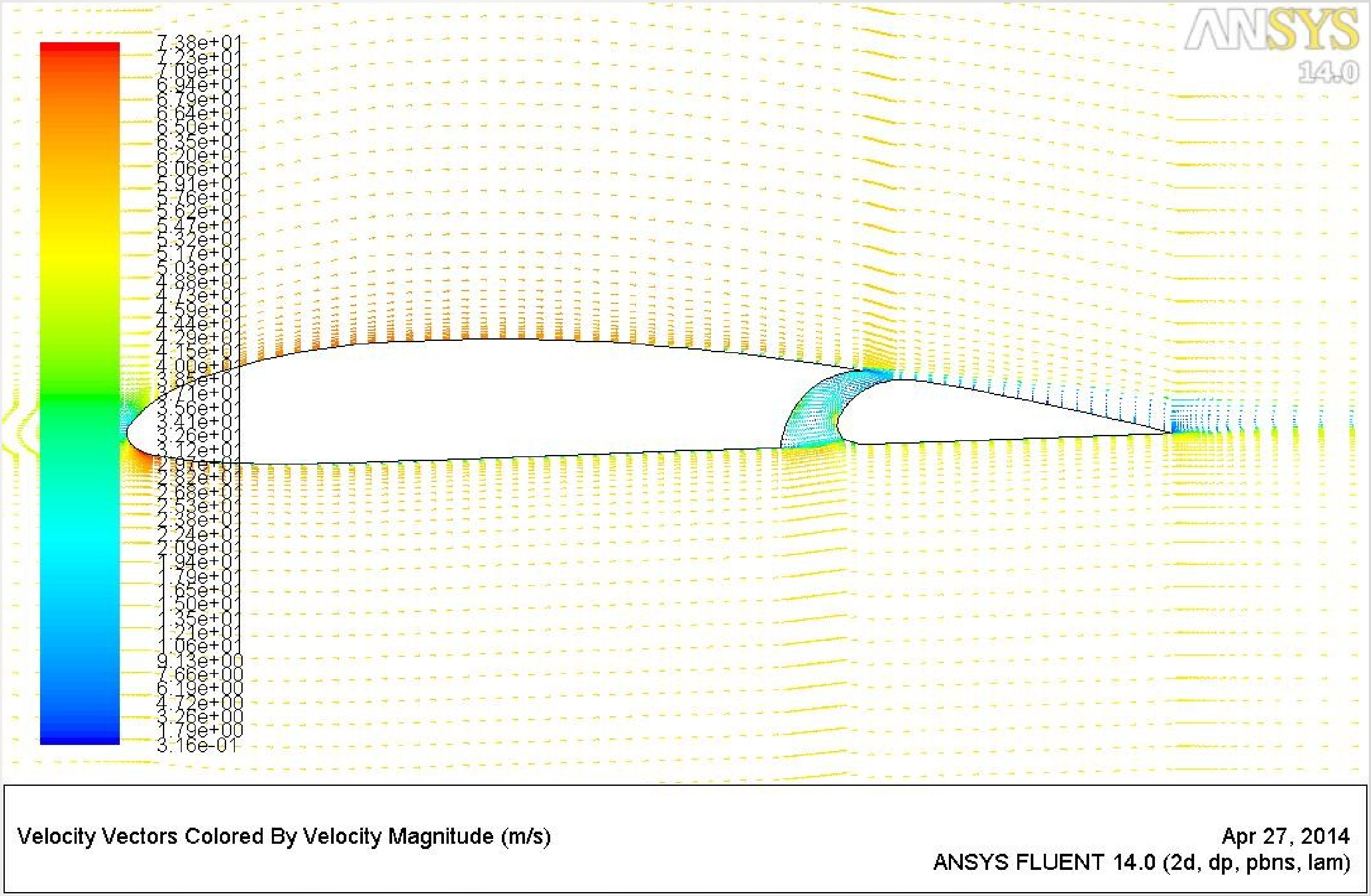
- **Solver:**

Solver used	ANSYS FLUENT
Solver model	Laminar
Energy	Off
Solving strategy	SIMPLEC
Convergence criteria	1e-5

- **Results and discussion:**

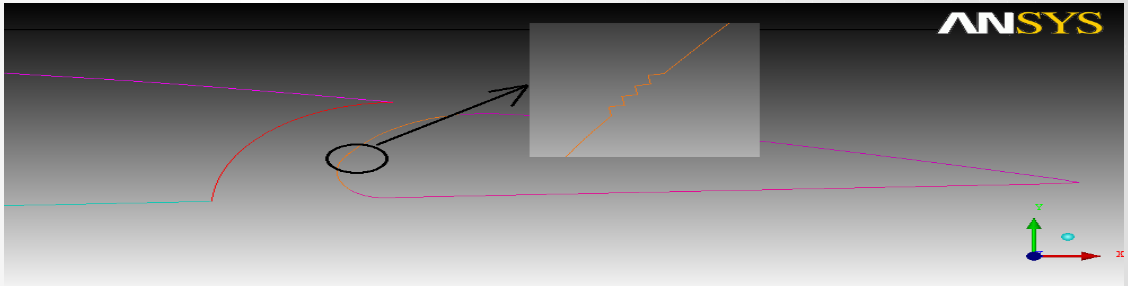


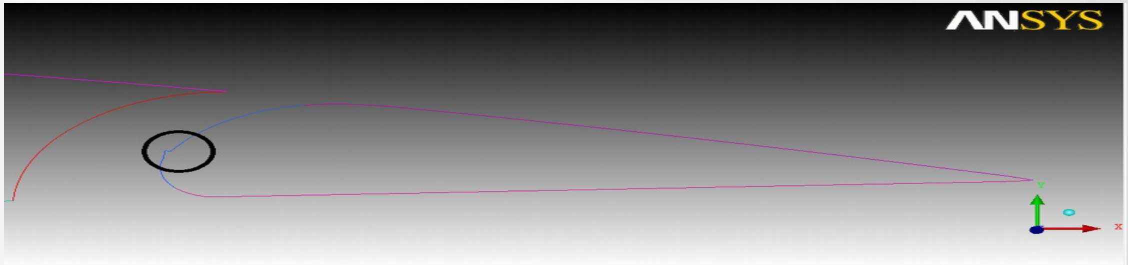
Pressure contour for slotted Clark Y

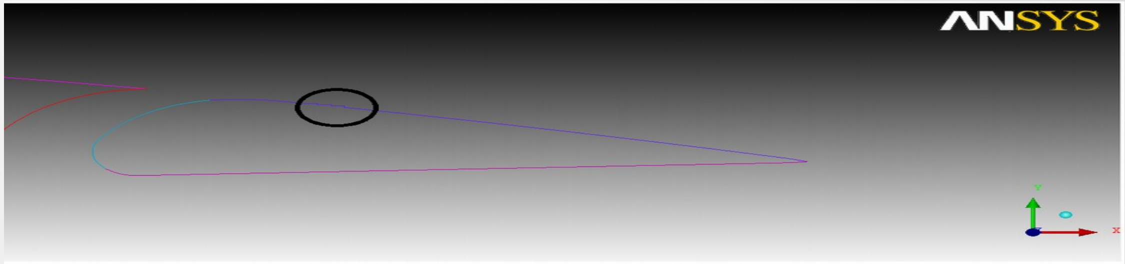


Velocity Field around the airfoil

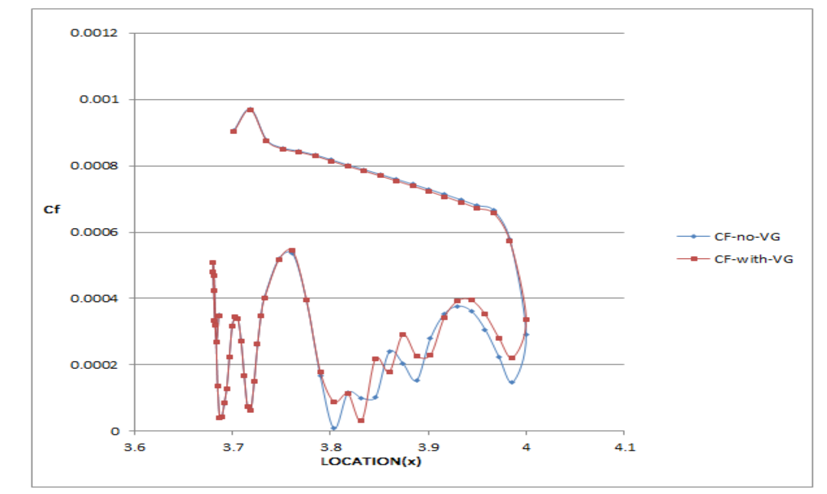
- **Different Modifications Made:**



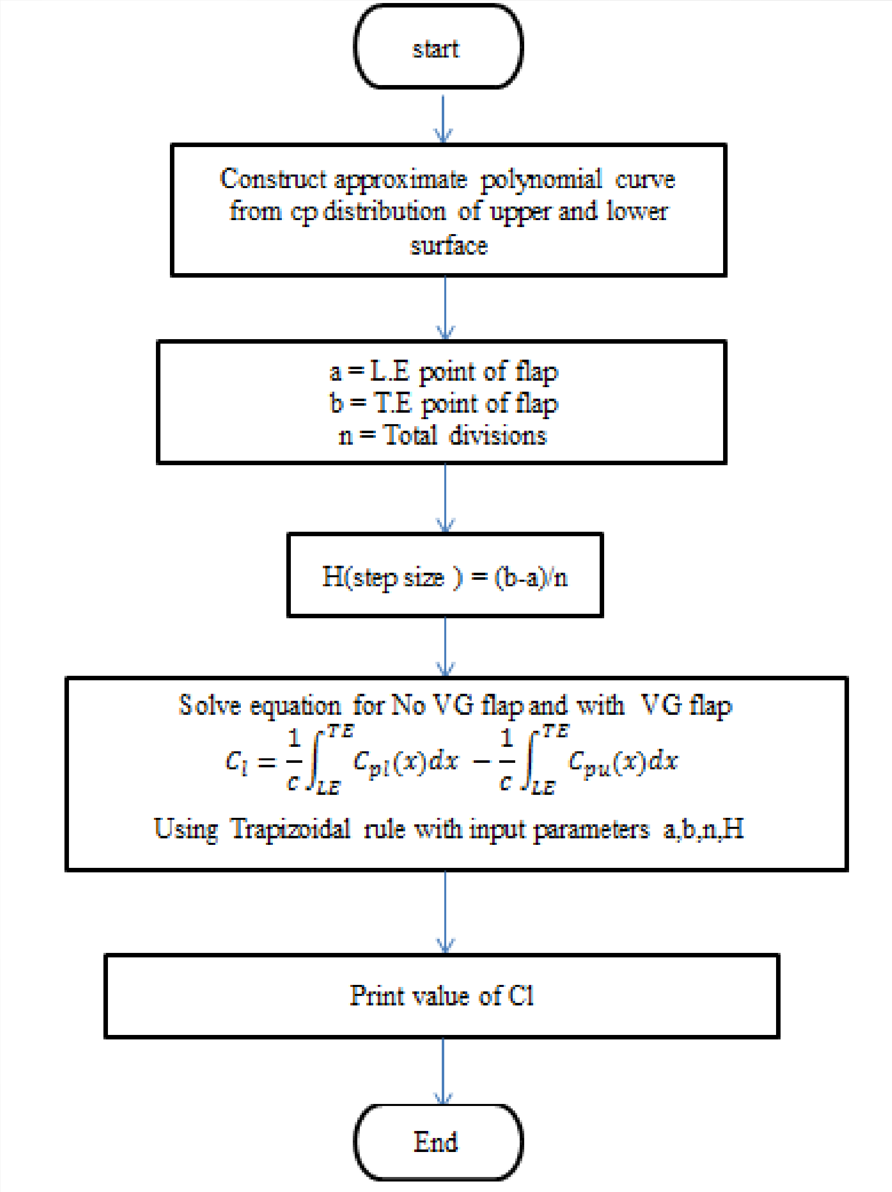




- Case 3 with 3 Wishbone MVG’s on the flap upper surface at about 25% of flap chord showed improvements in flow.



Separation point delayed


start
Construct approximate polynomial curve from cp distribution of upper and lower surface
a = L.E point of flap
b = T.E point of flap
n = Total divisions
H(step size) = (b-a)/n
Solve equation for No VG flap and with VG flap
$C_l = \frac{1}{c}\int_{LE}^{TE} C_{pl}(x)dx - \frac{1}{c}\int_{LE}^{TE} C_{pu}(x)dx$
Using Trapizoidal rule with input parameters a,b,n,H
Print value of Cl
End

Source	Cl Values
ANSYS FLUENT	
Flap without MVG	0.1146
Flap with a MVG	0.15319
FORTRAN code	
Flap without MVG	0.1110461
Flap with MVG	0.140627

Comparing ANSYS and Fortran Code results

Conclusion:

- Drag was observed to increase from 0.03150 to 0.03617 i.e 15 % increase in drag.
- A 25% increase in flap lift was observed which contributed to 13% increment in overall lift of the airfoil
- Overall aerodynamic efficiency was increased from 3.6 to 4.2 for the flap

THANK YOU

Any

Questions?