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Design of Dragon Fly Aircraft

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Abstract *: In This Project , A New Pictorial Model Of An Aircraft Is Designed By Referring The Existing Aircrafts Like The Assumed Model. This Is An Innovative Idea Of Using Two Wings In An Aircraft. Among The Two Wings, One Is A Forward Swept Wing And The Other Is Elliptical Wing. This Idea Is Based On The Structure Of Dragon Fly. Three Aircrafts, Two With Forward Swept And Other With Elliptical Wing, Taken For Reference . Among The Forward Swept Wing And Elliptical Wing, One Will Be Kept On The Front Side And Other One On The Rear. This Is Based On The Canard Wing Configuration. Design Of Dragonfly Aircraft Involves Three Stages- Preliminary Design, Conceptual Design And Detailed Design. In Preliminary Design The Basic Idea Of Design Is Drawn Roughly. In Conceptual Design Based On The Calculations On Reference Aircrafts, A Conceptual Configuration Is Optimized And Design Is Drawn As Per The Configuration Using Solid Works Software. In Detailed Design The Designed Model Is Analyzed Using Gambit And Fluent To Check The Conditions For Flying. This Model Will Be Same As A Dragon Fly.*

I. INTRODUCTION

From the structure of the dragon fly wings ,which are of different kind. One is an elliptical and the other is forward swept . These two different wings are tried to match in a single aircraft , using the canard concept. The existing forward swept, elliptical wing, aircrafts are theoretically analysed and then the configurations of dragon fly will be proposed.

Dragon fly

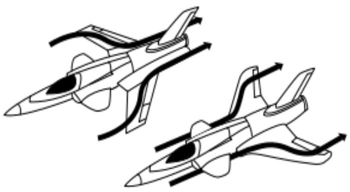
(http://www.google.co.in/imghp?hl=en&tab=wi).

II. CHAPTER-2 LITERATURE SURVEY

2.1 Canard

In aeronautics, **canard** (French for "duck") is an airframe configuration of fixed-wing aircraft in which the forward surface is smaller than the rearward, the former being known as the "canard", while the latter is the main wing(http://en.wikipedia.org).

2.2. Forward-swept wing



Airflow over a forward-swept wing and conventional swept wing(http://en.wikipedia.org/wiki/Forward-swept_wing).

A **forward-swept wing** is an aircraft wing configuration in which the quarter-chord line of the wing has a forward sweep(http://en.wikipedia.org/wiki/Forward-swept_wing). Perceived benefits of a forward-swept wing design include

- Mounting the wings further back on the fuselage, allowing for an unobstructed cabin or bomb bay, as the root of the wing box will be located further aft, and
- Increased maneuverability, due to airflow from wing tip to wing root preventing a stall of the wing tips and ailerons at high angle of attack. Instead, stall will rather occur in the region of the wing root on a forward-swept wing.
- This reversed span wise airflow should reduce wingtip vortices, generating less drag and allowing a smaller wing(http://en.wikipedia.org/wiki/Forward-swept_wing).

  Possible drawbacks of a forward-swept wing include
- When using a conventional metal construction: A reduced divergence speed or, in order to avoid this, an increased wing weight, as wing stiffness needs to be increased.
- A forward-swept wing becomes unstable when the wing root stalls before the tips, causing a pitch-up moment, exacerbating the stall. This effect is more significant with a large forward-sweep(http://en.wikipedia.org/wiki/Forward-swept_wing).

2.3. Elliptical wing

An elliptical wing is a wing plan form shape that minimizes induced drag. Elliptical taper shortens the chord near the wingtips in such a way that all parts of the wing experience equivalent downwash, and lift at the wing tips is essentially zero, improving aerodynamic efficiency due to a greater Oswald efficiency number in the induced drag equation (http://en.wikipedia.org/wiki/Elliptical_wing).

Merits:

1. Lower drag & better lift distribution
2. Improved Maneuverability
3. Structurally More efficient with root and Lighter overall structure(http://en.wikipedia.org/wiki/Elliptical_wing).

Demerits:

1. The compound curves involved are difficult and costly to manufacture.

2.The pure elliptical shape as a superior plan form may be a myth. A truncated ellipse, same span, same area, has, for all practical purposes, the same induced drag. Trapeze plan forms with 0.4 or 0.5 taper ratios are induced drag equivalent, too.

3.The wing's uniform lift distribution causes the entire span of the wing to stall simultaneously, potentially causing loss of control with little warning. To compensate, aircraft such as the Super marine Spitfire used a modified elliptical wing with washout, though such compromises increase induced drag and reduce a wing's efficiency. Note, though, that the typical tapered wing plan form has to employ more washout than the elliptical plan form wing to see similar stall performance, which puts the tapered wing at a disadvantage(http://en.wikipedia.org/wiki/Elliptical_wing).

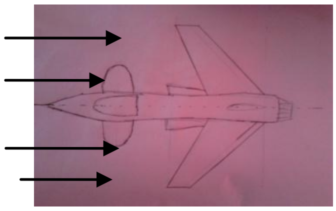
III. CHAPTER-3 REFERENCE AIRCRAFTS

S.NO	SPECIFICATIONS	SU-47(SUKHOI)	X-29(GRUMMAN)	SUPERMARINE SPITFIRE
1	LENGTH	22.6m	14.7m	9.12m
2	WING SPAN	15.16m	8.29m	11.23m
3	HEIGHT	6.3m	4.26m	3.86m
4	WING AREA	61.87mxm	1.54mxm	22.48mxm
5	EMPTY WEIGHT	16375kg	6260kg	2308 kg
6	MAX.TAKE OFF WEIGHT	35000 kg	8070kg	3071kg
7	POWER PLANT	2-turbofan	turbo fan	turbo prop
8	MAX SPEED	1.6 mach	1.6 mach	.8 mach
9	RANGE	3300km	560 km	1840 km
10	SERVICE CEILING	18000m	16,800 m	11300m
11	CREW	1	1	1
12	PICTURE			

IV. CHAPTER-4 PRELIMINARY DESIGN OF DRAGON FLY AIRCRAFT

4. Preliminary design

On considering the basic view of the dragon fly, to design the aircraft we roughly sketched the outline of the dragon fly aircraft.



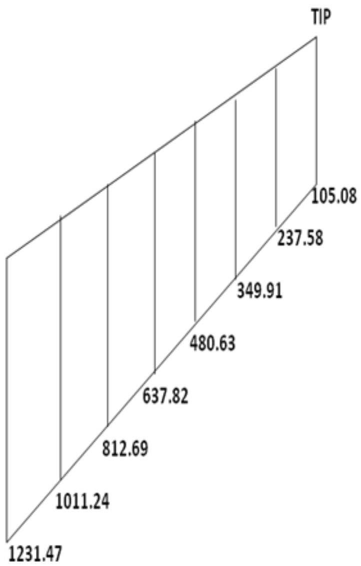
Sketched design of dragonfly aircraft

V. CHAPTER-5 CONCEPTUAL DESIGN OF DRAGON FLY AIRCRAFT

5.1. Calculations on Sukhoi – 47

Altitude (m)	Coefficient of Lift (C_L)	Coefficient of Drag (C_D)
Sea level	.0076	.0037
2000	.0097	.0047
4000	.0125	.0061
6000	.0163	.0079
8000	.0217	.0105
10000	.0292	.0142
12000	.0400	.1944
14000	.0548	.0266
16000	.0754	.0366
18000	.1028	.0499

(a)

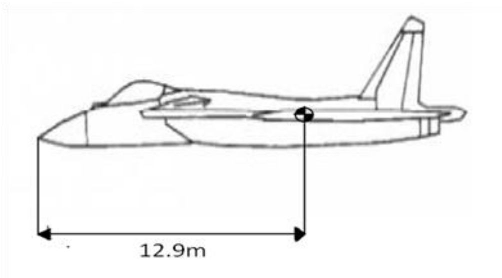


(b)

Station	Weight (kg)
0	1231.47
1	1011.24
2	812.69
3	637.82
4	480.63
5	349.91
6	237.58
7	105.08

(c)

The lift and drag at different altitudes **Wing weight distribution-(b,c) Location**
From the leading edge of the aircraft…..

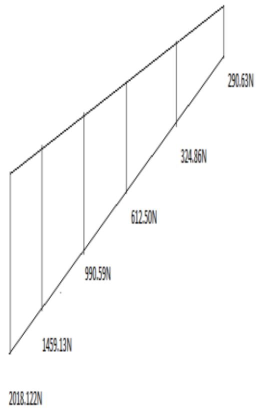


Neutral point	14.47 m
Aerodynamic centre	16.97 m
Centre of gravity	12.9 m

Location of C.G, AC, NP on Su-47

5.2. Calculations on Grumman X-29

Altitude (m)	Coefficient of Lift (C_L)	Coefficient of Drag (C_D)
Sea level	.0074	.0051
2000	.0094	.0065
4000	.0122	.0085
6000	.0159	.0110
8000	.0211	.0147
10000	.0284	.0198
12000	.0353	.0270
14000	.0532	.0371
16000	.0726	.0510



Station	Weight (kg)
0	2018.12
1	1459.13
2	990.59
3	612.50
4	324.86
4.145	290.63

(b) **(c)**

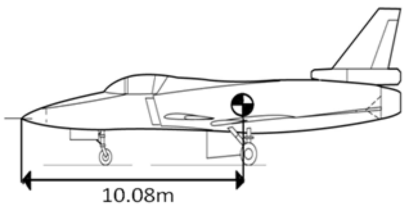
(a)

The lift and drag at different altitudes

Wing weight distribution-(b,c)

Location

From the leading edge of the aircraft…..

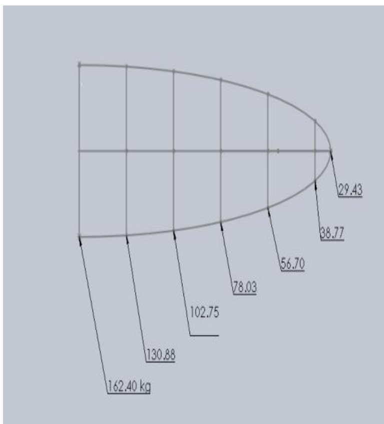


Neutral point	10.27 m
Aerodynamic centre	12.38 m
Centre of gravity	10.08 m

Location of C.G, AC, NP

5.3.Calculations on Supermarine spitfire

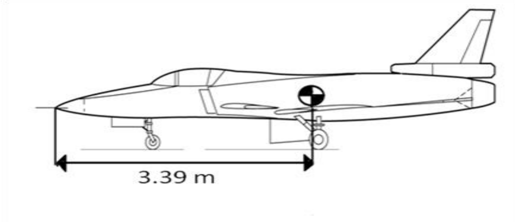
Altitude (m)	Coefficient of Lift (C_L)	Coefficient of Drag (C_D)
Sea level	.0026	.00002
2000	.0033	.00003
4000	.0043	.00004
6000	.0057	.00005
8000	.0075	.00007
10000	.0102	.00010
12000	.0139	.00014



Station	Weight (kg)
0	162.40
1	130.88
2	102.75
3	78.03
4	56.70
5	38.77
5.615	29.43

The lift and drag at different altitudes **Wing weight distribution Location**

From the leading edge of the aircraft…..

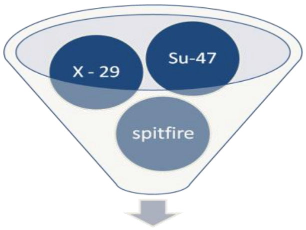


Neutral point	3.477 m
Aerodynamic centre	3.477 m
Centre of gravity	3.397 m

Location of C.G, AC , NP

5.4. Optimization

On analyzing the reference aircrafts…



Optimization of Reference aircrafts

Based on the calculations on the reference aircrafts taken and the requirements of the design, Two aircrafts are finally taken into account as a reference to design a dragon fly aircraft.

5.5. Conceptual Design

X-29 **Supermarine Spitfire** **Dragonfly aircraft**

Conceptual design of dragonfly aircraft

VI. CHAPTER-6 DETAILED DESIGN OF DRAGON FLY AIRCRAFT

6.1. Optimized configuration

	Grumman x-29	Spitfire
Payload	1810 kg	3000 kg
Length	14.7 m	9.12 m
Wing span	8.29 m	11.23 m
Height	4.26 m	3.86 m
Wing area	17.54 m²	22.48 m²
Empty weight	6260 kg	2309 kg
Max.take off weight	8070 kg	3071 kg
Power plant	Turbofan	Turboprop
Max. speed	1.6 mach	0.8 mach
Range	560 km	1840 km
Service ceiling	16,800 m	11300 m
Crew	1	1

Shows the optimized configuration of reference aircrafts

In this table, the specifications of both Super marine spitfire and Grumman X-29 is compared and then the configuration is optimized.The red color shows the selected configuration from both the aircrafts.

6.2. Detailed configuration

For main wing….

Payload	1810 kg
Length	14.7 m
Wing span	8.29 m
Height	4.26 m
Wing area	17.54 m^2
Empty weight	6260 kg
Max.take off weight	8070 kg
Power plant	Turbofan

Shows the configuration of dragonfly aircraft main wing

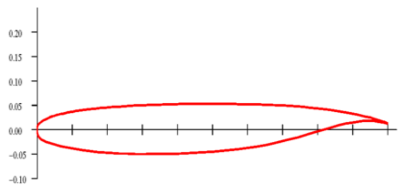
For canard wing….

Wing span	4 m< 8.29 m
Wing area	15 m^2< 17.54m^2

Shows the canard wing configuration of dragonfly aircraft

6.3. Airfoil used:

For main wing-----GRUMMAN K-2



Airfoil used in Grumman

(http://people.rit.edu/~pnveme/EMEM831n/Tutorial_2/HW2Pdf_20003/Fullonecfd_hw2.pdf)

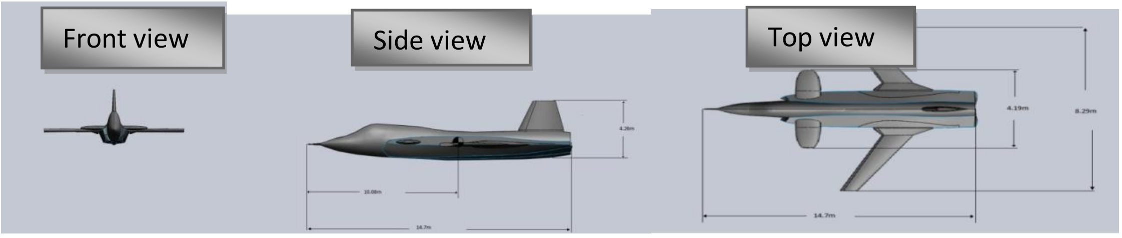
Camber	:	2.4%
Trailing edge angle	:	5.0°
Lower flatness	:	13.0%
Leading edge radius	:	2.9%
Max C_L	:	0.91
Max C_L angle	:	12.5
Max L/D	:	26.2
Max L/D angle	:	3.0
Max L/D C_L	:	0.486

6.4. Detailed design

By using solid works software…..

Detailed design of Dragon fly aircraft

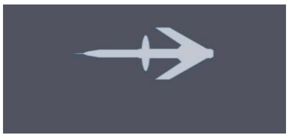
According to the conceptual configurations of the dragon fly aircraft and also by referring the preliminary model the conceptual design of the aircraft is made as shown above.



Three views of Dragon fly aircraft

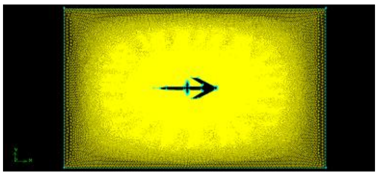
VII. CHAPTER-7 ANALYSIS

7.1. Steps in analyzing the model
2D – Design of the dragon fly aircraft
By using solid works, the top view of the model is drawn in a plane surface and it is trimmed as shown below. And then it is saved as IGS file.



2D design of the dragon fly aircraft

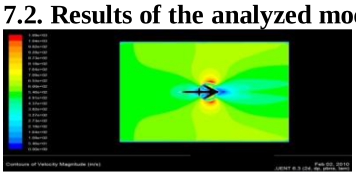
Meshed model



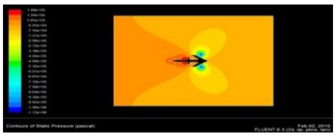
Meshed Model

- The 2D model is imported in the gambit.
- Then it is meshed by using triangular mesh.
- Then velocity-inlet and outflow-outlet is defined.
- The meshed model is read in fluent.
- The equations are specified.
- Then it is iterated.

7.2. Results of the analyzed model



Velocity Plot over 2D model



Pressure plot over 2D model

Flow pattern over 2D model

The above flow pattern shows that this structure can produce lift.

CHAPTER.8. CONCLUSION & FUTURE ENHANCEMENTS

VIII. CONCLUSION

Thus by taking the reference aircrafts like Sukhoi-47, X-29, and Super marine spitfire, the conceptual design is made. Also the detailed design is done by using the 2-d model with the help of analysis software. Now this aircraft has the wings as in a dragon fly, hence called as dragon fly aircraft. Elliptical wing is used as a stability canard. This is also an improvised model of Grumman.The analysis part shows that this combination of wings can fly.

8.1. Future Enhancement

This new combination of wings will give way for more future dual wing aircrafts with different combinations. Also the use of an elliptical wing will increase in future. The advantage and use of forward swept wing will increase. This aircraft shows that even elliptical wing can be used as a combination for high speed aircrafts and pave way to create a high speed elliptical wing aircrafts. This project will be helpful in exploring the new concepts on the elliptical as well as forward swept wing. The stability canard acts as a intermediate between the lift and control canard. This gives way for more canard (stability) options.

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