

Morphing Wing Design

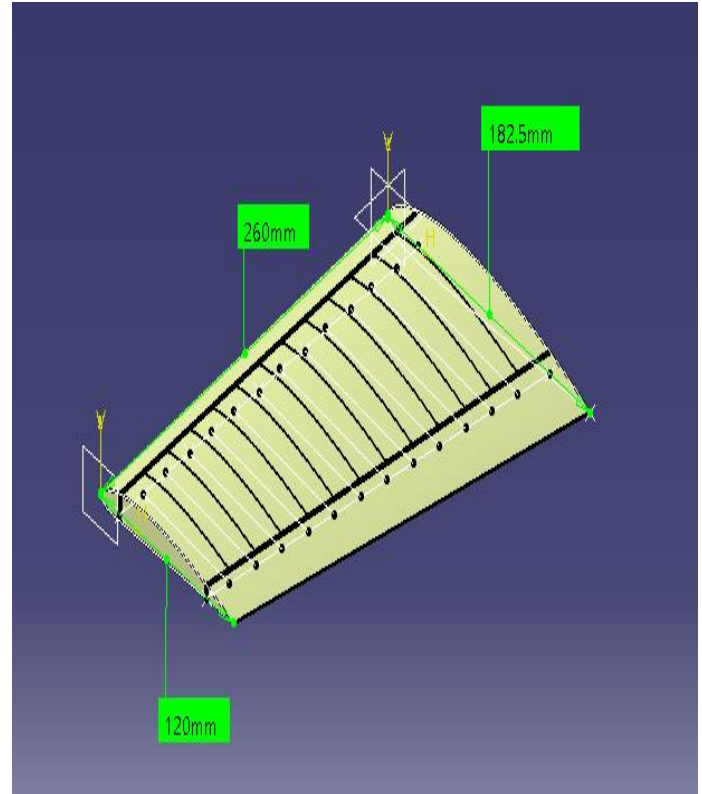
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I. INTRODUCTION

The present report is to provide a telescoping wing that can be retracted to less than 30% of the extended wing span, which makes it feasible for the use in a road vehicle that travel on highways. Another objective is to provide a telescoping wing in which the spar retains its full carrying capability in the retracted as well as in extended conditions. At last to provide a telescoping wing wherein in during extension and retraction of the wing, all carrying loads elements of the spar remain connected to each other by three linear and two rotational axis, and only one rotational degree of freedom is required for accomplishing extension and retraction of the wing.

II. DESIGN OF THE WING

The software used to calculate coefficient of pressure is XFLR5 and the software used for design and structural analysis is CATIA V5. The XFLR5 software allows quick analysis of a wing. The software computes airfoil performances as Xfoil and lets you know the performance of the wing. After quick analysis on XFLR5 and recording the values of pressure coefficient, the user would only have to launch a CATIA V5 program to get the skin of the wing with the applied pressures. Once the skin is obtained the user can create the inside structure of the wing. Two airfoils were used NACA 4415 on the main wing tip and Extension wing root and tip, NACA 4418 on the main wing root. Main wing of the span was 26 cm with an extension of 13 cm. Chord of the main wing root is 15 cm, main wing tip is 9 cm, extension wing root is 9.125 cm and extension wing tip is 6 cm. Aspect ratio of main wing is 2.16, with extension is 3.18. So the net percentage increase is 72.73%



A. *CL* vs *AOA*

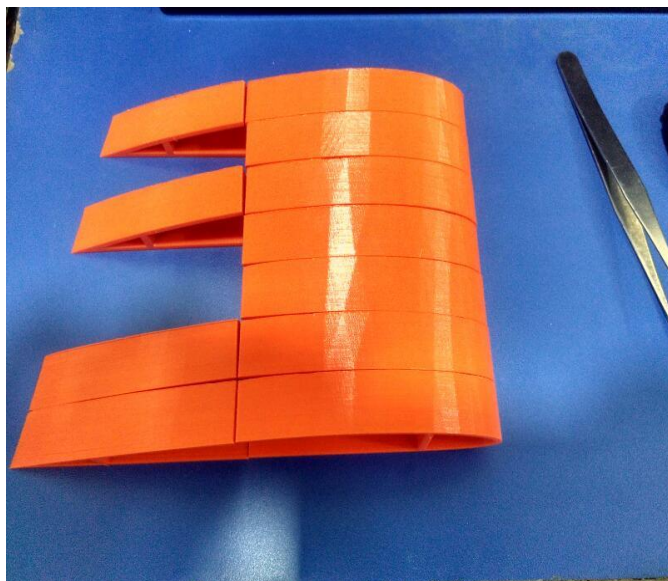
Serial no	Angle of Attack	CL
1	0	0.2
2	3	0.34
3	6	0.49
4	9	0.63
5	12	0.78
6	15	0.92

B. CD vs AoA

Serial no	Angle of attack	Cd
1	0	0.0057
2	3	0.0167
3	6	0.0347
4	9	0.0547
5	12	0.088
6	15	0.122

III. MANUFACTURING

The 3 D printing process turns the whole object into thousands of tiny slices, the making it up from the bottom up slice by slice those tiny layers stick together to form a solid object. Polylactic acid is used for fabrication. The model id=s fabricated in units and then assembled. Some of the properties are Density(1.3), Elastic Modulus 3.5 GPa, Elongation Break 6%, Flexural modulus 4 Gpa, Flexural Strength 80 Mpa, Glass tension temperature 60 C, heat Deflection temperature 455 kPa.



IV. EXPERIMENTAL DETAILS

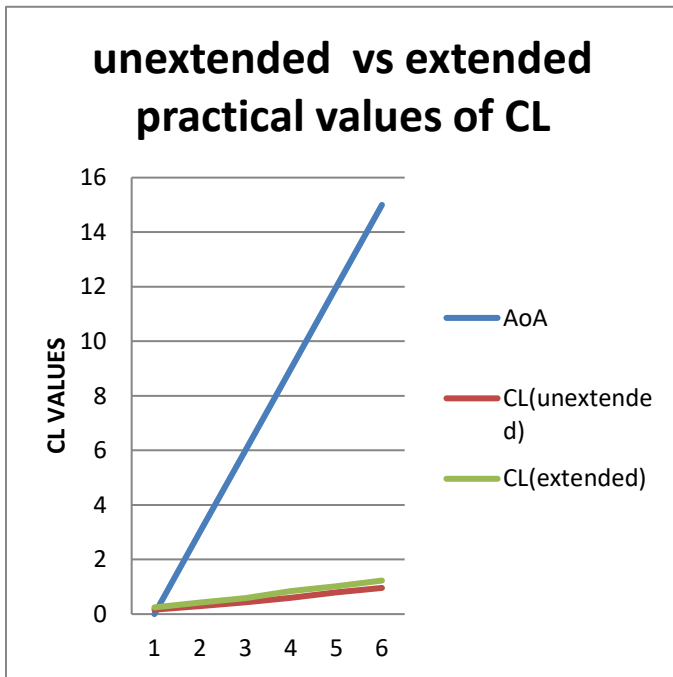
Experiment was conducted in Subsonic wind tunnel. Speed of the wind tunnel was 15m/s. Probes were attached at 6 locations on the main wing and 3 on the extension wing. Readings were taken from 6 different angle of attack (0, 3 , 6 , 9 , 12 , 15). The pressure is calculated at the ports on the top and bottom surface. Values of coefficient of pressure are calculated.



A. Unextended Vs Extended: Practical Cl and CD values

Ao A	CL(unexten ded)	CL(exten ded)	CD(unexten ded)	CD(exten ded)
0	0.1640	0.2460	0.0039	0.0058
3	0.2980	0.4201	0.1285	0.0147
6	0.4360	0.5880	0.0275	0.0289
9	0.5990	0.8503	0.5190	0.0605
12	0.7950	1.02	0.0914	0.0870
15	0.9600	1.23	0.133	0.1267

V. ANALYSIS OF EXPERIMENTAL RESULT



- We can conclude that the values of CL are consistently higher for the extended wing compared to unextended wing. This must be because of the increase of the lift generating wing surface area of the extended wing. Extended wing has better CL at all angles of attack compared with un-extended.
- Extended wing has slightly higher CD compared to un-extended wing.
- Extended wing has a definite increase in CL / CD compared with un-extended.
- Recommended for use in small Aircrafts like UAVs and MAVs.