Critical Analysis of a Blended Body Aircraft

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ABSTRACT

The blended body aircraft concept is extremely fuel efficient along with other benefits. Flying airplanes to high altitudes requires high lift arising need of better design, increased wingspan and reduced drag. Aircraft with Blended wing body suit the need to fly at high altitudes. It has better stealth properties due to the triangular shape. This study is related to the investigation of a concept airplane by changing the design parameters. Analysis has been done using designing softwares CREO & ANSYS.

Keywords: Blended body aircraft, darg, lift, wingspan.

INTRODUCTION

There is need of Blended Wing Body in future as conventional aircraft lack fuel efficiency, high Lift to Drag (L/D) ratio, high payload carrying capacity. There is need of major technological breakthrough in aerodynamic geometry. Hence, there has been a need to develop a new composite structure to push the boundaries of current technologies and to breathe new life into civil transportation. Blended Wing Body (BWB) bridges the gap between future requirements. The BWB concept is extremely fuel efficient with lower operating costs, lower production costs, reduced airspace congestion, lower fares, reduced environmental impact and improved safety .It has higher lift to drag ratio. Improved efficiency will directly impact the operating cost. BWB body reduces tight bends directly reducing manufacturing cost.

WORK ALREADY DONE

Adam Kosík presented CFD calculations with the help of ANSA and Open FOAM. All results presented were generated to simulate fluid flow around a twin-engine turboprop EV-55 Outback. The main objectives were to control the aerodynamic characteristics of the aircraft. Zoran A. Stefanović used a CFD code that is used for the analysis of new light aircraft in different phases of flight. Different calculations and methods for new light aircraft are developed for different flight phases. S. Rajiv Rao worked on the vertical take-off and landing model of the V-22 Spray tilt-rotor aircraft using CFD techniques. Studies have been conducted at various angles of attack from 0 to 20 degrees and the lift coefficient and drag coefficient are calculated for each angle of attack. Abhishek Patil calculated the 3D turbulent flow field over sharp-edged finials with rhomboidal planforms and a moderate pitch angle. The braking force and lift force were analyzed at different angles of attack of 0,4,8,12 degrees and the aerodynamic properties were predicted, viz. pressure distribution, skin fraction distribution, flow and Cl values of the biconvex delta wing cross section. Karna S. Patel et al. studied a CFD analysis of the flow over a NACA 0012 airfoil and concluded that no lift is produced at zero degree AOA. Toshihiro Ikeda et al. studied experimentally and numerically that the BWB configuration has better flight performance due to a higher lift-to-drag ratio and could improve existing conventional aircraft in the areas of noise emissions, fuel consumption and Direct Operating Cost per service.. Thomas A. Reist et al. concluded that an elliptical lift distribution is on the wing eliminates shocks and drag reductions are achieved by trimming and stabilizing the basic design. Luis Ayuso Moreno et al. compared the performance and operational problems of the latest generation of conventional very large aircraft. The results predict about a 20 percent increase in the efficiency of transportation productivity. Kai Lehmkuehler et al. experimentally studied a design methodology using fast panel methods proved to be viable for an unusual configuration. Harijono Djojodihardjo et al. studied and concluded that aerodynamically, the BWB is much better than conventional aircraft as it has at least a 20% higher "lift-to-drag ratio" because a single body produces uniform lift and no other surfaces are attached to the body, reducing skin friction pulls considerably. Akash Sharma numerically analyzed the flow over the surface of a 2-D Blended Wing Body for a given set of boundary conditions and the obtained results safely meet the theoretical standards.

METHODOLOGY

The BWB airplane is considered to be the next generation airliner .An airplane is controlled by the various forces acting on it like lift force, braking force, weight and thrust. The wing profile affects the overall aerodynamics of the aircraft, affecting landing/takeoff, stall, and cruise speed. Lift is generated by the passage of different velocities of air above and below it. The angle of attack of the airfoil cause the wind to flow quickly over it and then under the airfoil. The pressure difference between the top and bottom of the airfoil generates the lifting force. The entire surface of the wing, both upper and lower, is affected by the air flow. The down force acts throughout the wing, which provides the lift of the wing.

Aircraft design includes various design parameters. This study is related to the investigation of a concept airplane by changing the design parameters using CFD software results. The mixed body aircraft CAD model is developed in Creo design software and CFD simulation is performed using ANSYS CFX. The values of aerodynamic force, lift force and pressure is determined for two aircraft with different taper ratios and different angle of attack is computed. Here the study is focused on the design of the delta wing of aircraft while maintaining constant parameters of the other bodies of the aircraft.

RESULT ANALYSIS

A creo model design with two different taper ratios of 0.125 and 0.4 is used. For analysis pressure, lift force and drag force is computed. CL vs angle of attack and CD vs angle of attack are important factors of study. Drag force and lift force generated by aircraft is computed with low taper ratio of 0.125 by increasing angle of attack from 00,50,100,150, 180,200. Then Drag force and lift force generated by aircraft is computed with high taper ratio of 0.4 by increasing angle of attack from 00,50,100, 150, 180,200.

Angle of Attack	Pressure (Pa)	Drag Force (N)	Lift Force (N)	C_L	C_D
0^0	1836	3.932	14.73	.0006354	.00016
5^0	1843	4.37	17.32	.0007471	.00018
10^0	1821	6.73	19.93	.0008597	.00029
15^0	1876	10.47	23.12	.0009974	.00041
18^0	1947	12.73	26.89	.001160	.00054
20^0	1938	14.35	26.29	.0011303	.00061

CASE 1: Taper ratio= 0.125

Angle of Attack	Pressure	Drag Force	Lift Force	C_L	C_D
0^0	1849	4.77	19.18	.000660	.000164
5^0	1889	4.97	23.47	.000808	.000171
10^0	1896	6.94	20.31	.000699	.000239
15^0	1919	10.19	28.75	.000990	.000351
18^0	1966	12.90	26.56	.000915	.000444
20^0	2071	15.89	31.17	.001074	.000547

CASE 2: Taper ratio= 0.4

CONCLUSION

To meet the goals of green aviation: fuel efficiency, emissions and noise, there is a definite need of new solutions. The study finds number of alternatives including engine modifications, alternative fuels, and changing accent but nothing. BWB aircraft is the optimal solution discovered. The lift and drag depend on the airfoil shape, the velocity distribution and on the wing area. It is possible to calculate the aerodynamic properties of differently sized airfoils or wings if all forces and moments are normalized .Stall angle with low taper ratio is found to be at 180 angle of attack and stall angle with high taper ratio is found to be at 150 angle of attack. Formation of vortex has been noticed at back portion of aircraft .Turbulence kinetic energy is found to be maximum at front portion of wing with value of 32.65 m^2/s^2. More analysis of different parameters can be done using CFD for comparisons and optimal solutions.

REFERENCE

1. Abhishek Patil ,Piloo Raghu Kumar, Aditya Kodkani and Sekhar Majumdar "CFD ANALYSIS OF LOW SPEED TURBULENT FLOW PAST A DELTA WING "IJRAME Volume 2,No.11, 2014
2. Adam Kosík Evektor s.r.o., Czech Republic "THE CFD SIMULATION OF THE FLOW AROUND THE AIRCRAFT USING OPENFOAM AND ANSA" 5 th ANSA & μETA International Conference
3. Akash Sharma, Tejas Alva and Srinivas G "Flow Analysis of Blended Wing Body (BWB) Using CFD Technique" Journal of Basic and Applied Engineering Research,
4. Harijono Djojodihardjo and Alvin Kek Leong Wei "Conceptual Design and Aerodynamic Study of Blended Wing Body Business Jet" ICAS 2012
5. Ivan A. Kostić, Zoran A. Stefanović, Olivera P. Kostić "Aerodynamic Analysis of a Light Aircraft at Different Design Stages" ,FME Transactions ,94-105, 2014
6. Karna S. Patel, Saumil B. Patel, Utsav B. Patel, Prof. Ankit P. Ahuja "CFD Analysis of an Aerofoil" International Journal of Engineering Research Volume No.3, Issue No.3, pp: 154-158, 2014
7. Luis Ayuso Moreno, Rodolfo Sant Palma and Luis Plágaro Pascual "aerodynamic study of a blended wing body; comparison with a conventional transport airplane" ICAS 2006.

8. R. H. Liebeck "Design of the Blended Wing Body Subsonic Transport" , Journal of Aircraft Volume 41, I No 1, 2004
9. Pranav Mahamuni, Akhilesh Kulkarni, Yash Parikh, "Aerodynamic Study of Blended Wing Body " , International Journal of Applied Engineering Research , Volume 9, No 24 ,pp. 29247-29255,2014
10. S. Rajiv Rao1, Vajrala Bhargavi, Sarla Srinath, Bharathraj Reddy Dere "Analysis of Vertical Take - off & Landing Aircraft using CFD", IJERT Vol. 3 Issue 9, 2014
11. Thomas A. Reist and David W. Zinggy "Aerodynamic Shape Optimization of a Blended-Wing-Body Regional Transport for a Short Range Mission" 31st AIAA Applied Aerodynamics Conference. June 24-27, 2013, San Diego, CA.