Review on impact of lift generation over various chord for tapper wings

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Abstract: Wings are the major structural member in the aircraft which decides the performance and aero dynamical characteristic of aircraft. Several methods and mechanisms were carried out for a decade to increase the performance of aircraft in order to achieve high lift to drag ratio. They achieved better lift to drag ratio with constant wing for entire flying, but not a single aircraft runs in a mechanism where the wing area will vary according to the flying condition. Nowadays researchers are looking for the mechanism which relates the adaptive technics for different flying condition. Based on the flight operational mode the wing cross section need to vary for better performance. The object of the study is to find the better mechanism for the variable camber technology. Extensive literature has been carried out to analyses the mechanism, and different operating condition flow behavior has been discussed. In addition airfoils flow behavior with respect to operational condition has been shown.

Index Terms – Aerodynamics, Morphing Wing, Fluttering behavior.

I. INTRODUCTION

The aerodynamic performance of an aircraft is mainly depends upon its wing configuration, a traditional type wing without new technology it is hard to improve it’s performance .The traditional wing configuration has a fixed shape in high-speed flight. But the flight condition doesn’t remain constant during a typical flight. During the time of climb and cruising, the speed, altitude and the atmospheric pressure changes accordingly, such as during cruising, the aircraft weight changes considerably as fuel being consumed. Therefore to ensure optimal performance of a flight under different condition, traditional wing with one fixed wing shape can’t help. Consequently, while designing a traditional wing profile we must take multiple design consideration. An AEROF IOL is a cross-sectional shape of a wing profile which generates aerodynamic forces when moving through a fluid. The aerodynamic force acting perpendicular to the direction of motion is the lift and the force acting parallel and opposite to the direction of motion is the drag. The point at the front of the Airfoil has maximum curvature is the leading edge and the point rear of the Airfoil with minimum curvature is the trailing edge. The straight line connecting these two edges is the chord line. The line drawn through the locus of points midway between the upper and lower surface of the Airfoil is the mean camber line. Variable-camber is a design feature for some of the aircraft wings that have the ability to change the camber of the Airfoil during flight. This is may be used to increase the maximum lift coefficient thereby enhance the performance of the aircraft. Even though flaps on the trailing or leading edge can also vary the overall camber, but they do not vary the main lifting surface in the same way that a variable-camber wing does. Therefore variable-camber technology is considered to be an effective way to improve the aerodynamic performance of an aircraft under various flight conditions.

II. VARIABLE CAMBER MECHANISM:

This article conducts an optimization study for reducing the total drag and actuator energy of a Blended-Wing-Body (BWB) NASA N +2 aircraft during cruising by the application of variable- camber continues trailing edge flap (VCCTEF) developed by NASA. By adding the absolute hinge moments for all actuators used in BWB can give the total actuator energy for the BWB under cruising. By taking absolute hinge moment as the as the design variable, the total actuator energy can be converted to a linear programming problem. In this optimization study, different VCCTEF configuration of varying deflection angle and degrees of actuation independence, also the performance of different VCCTEF configuration for the BWB with different fuel levels 80,50,20 and 0% of the maximum fuel loads during cruising has going to studied and compared[1].

Four different cases are studied for this system:
(I) VCCTEF-I: δ1 = δ2 = δ3 (Equivalent to traditional single element flap)
(II) VCCTEFS-II: δ1 = δ2 and δ3
(III) VCCTEF-III: δ1 and δ2 = δ3 and
(IV) VCCTEF-IV: δ1, δ2 and δ3.

The multi objective optimization study for minimizing total drag and total actuator energy , shows that VCCTEF configuration with three independent segments exhibits minimal total drag for the BWB with different fuel level during cruising along with minimal total actuator energy with optimal wing shape. The VCCTEF with two independent segments also seems to be efficient in design. But it is limited due to the large hinge moment generation leads to increase in actuator weight owing to the weight penalty of actuators.
The modern aircraft technology is the reduction of DOCs by reducing the fuel consumption. The goal influences the aerodynamic performance of the aerodynamic efficiency of the wing, in order to avoid the wave drag produced when critical Mach number exceeded supersonic region and a Shockwave is appeared on airfoil. To compensate this problem super critical Airfoils are invented. Improperly placed or shaped bump will create a double shock system. The VC- SCB combination gives a great improvement in lift to drag ratio in its design region compared with the clean airfoil or the VC airfoil. To check the possibilities of using the bump on wings, the coming investigation are planned to 3D in future.

III. ISSUES ASSOCIATED WITH VARIABLE CAMBER TECHNOLOGY:

The issues faced by the hydraulic machinery is that how to improve the hydraulic performance. The performance of an aircraft mostly affects the hydraulic machinery. In present, the effect of camber on hydraulic performance of nacAX415 Aerofoil was assessed. By increasing the camber we can increase the lift difference between upper and lower chamber, by this we can improve the lift [3]. Therefore for improve the hydraulic performance, we can consider the change of lift to drag ratio. Aerofoil’s performance is affect by overall geometry. But the camber has the greatest effect on it. So to improve the hydraulic performance of Aerofoil, other influencing factors and cavitation should consider comprehensively. This invention relates to variable cambered Aerofoil and more particularly to a mechanism for varying the camber of the forward section of the Aerofoil. A Variable camber Aerofoil includes a four bar linkage camber altering mechanism and a flexible panel in the lower skin of the Aerofoil. It provides continuously adjustable variable-camber Aerofoil that has a low drag contour, free of breaks and gaps in all positions [4]. The variable-camber Aerofoil comprises a front spar assembly that extends span wise through the Aerofoil. A variable-camber Aerofoil constructed in accordance with the present invention includes a leading edge region having two forward sections that are adjacent one another. The camber of forward sections can be altered to modify the lift characteristics of Aerofoil, While the thickness of forward sections varies in the span wise direction, the mechanism and structural components used to alter the camber of each of the forward sections is substantially identical. Due to the kinematic configuration of the linkage, the structure can be deflected into a set of desirable aerodynamic positions when the rotary actuator actuates the camber altering linkage, thus allowing the variable-camber Aerofoil to be efficiently used in a variety of flight modes. This structure is also desirable to eliminate aerodynamic drag caused by multiple breaks on Aerofoil lower surface during flight in order to increase efficiency and flight performance of Aerofoil [5]. This mechanism is simple; it decrease maintenance and manufacturing, and also has a desirable weight.

IV. DIFFERENT CHARACTERISTIC OF VARIABLE CAMBER TECHNOLOGY:

The actuation modeling and response characterization under aerodynamic loads in high-dynamic-pressure airflow. A parametric study of aerodynamic response is employed to optimize the kinematic parameters of the Aerofoil [6]. A novel, high-load-output, bidirectional variable-camber Aerofoil employing a type of piezo ceramic composite actuator known as a Macro-Fiber Composite [8557-P1-type] is presented. The novel Aerofoil employs two active surfaces in the top and bottom surfaces of the Aerofoil, which are pinned at the trailing edge, and a single four-bar (box) mechanism as the internal structure; implementing eight actuators in a bimorph configuration to construct the active surfaces. The box mechanism generates deflection and camber change as predicted. Once the thickness of Aerofoil is chosen, voltage could be applied to induce camber in both directions from a zero-camber state. Finally, the Aerofoil tested in this study is a rapid-prototyped Aerofoil with some roughness along the span wise direction. It is known that the NACA 0009 Aerofoils used have a smoother surface. Theoretical (2-D) L/D for the novel Aerofoil at 15 m/s Figure shows a comparison of lift over drag with actuation voltage. The maximum theoretical L/D is 42.6 for the 10% thick Aerofoil at 1300 V. This operation point corresponds to a camber of 4.12% and an AOA of 7.21 deg. The 2% thin Aerofoil shows the lowest L/D trend due to early stall and LE separation. There are several benefits of using camber control via solid-state active materials over trailing-edge control using conventional control surfaces in small air vehicles. The low Reynolds number flow regime can result in flow separation that reduces the effectiveness of a trailing-edge control surface. Power-limited aircraft such as small UAVs and MAVs cannot afford to lose energy through control surface drag; thus smart materials can be employed for shape and flow control in UAVs or MAVs by use of power systems and novel actuators. The opportunity for flow control is inherent in the active material due to its direct effect on circulation and its high operating bandwidth. Actuators can be effective in dynamic LSB control and any application in which flow vectoring is desired; thus opening possibility for dynamic actuation that may have significant advantages. This method take advantage of aerodynamic loads to reduce control input moments and increase control effectiveness. MFCs demonstrate adequate control authority for aerodynamic shape control.
V. STATIC AERODYNAMIC CHARACTERISTIC OF MORPHED WING:

This article conducts a study to analyses the static aerodynamic characteristics of a symmetrical Aerofoil that has been morphed using the single and double corrugated variable camber morphing concept. In this analysis two different CFD solvers and X foil were used. During dash flight phase, a low, non-morphed baseline Aerofoil performs better than morphed Aerofoil, but during loiters and take off, morphed Aerofoil exhibit superior performance with respect to the baseline Aerofoil. There exists a morphing angle at which the L/D ratio becomes maximum for any angle of attack. But at higher morphing angle flow separation can occur, leads to increase in pressure drag which will restrict the gain in lift achieved through camber. Single and double corrugated variable-camber Aerofoil exhibit almost identical aerodynamic characteristics for the same morphing angle.

VI. CONCLUSION:

The Literature shows the importance of the optimization of aerofoil in the Aircrafts. The chord line variation in the aerofoil improvises the lift generation during the lift will be the upcoming technics in the airline industry. The morphing wing technology proves the better performance efficiency in the aircraft. The adjustability of the chord adapts with the different requirement of the aircraft flying. Still the method adaptability during the flying needs to be implemented and analysed using different NACA series. The manure ability of the fighter aircraft will be highly beneficial using this technics if the proper chord changing method implemented.

REFERENCES


