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DESIGN AND AERODYNAMICS ANALYSIS OF PLANE FLAPS

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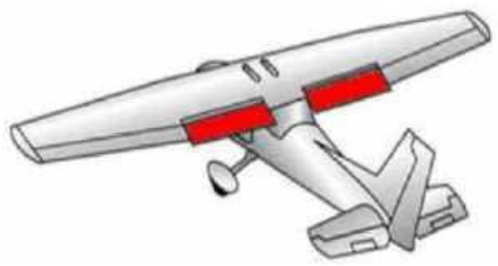
Abstract - High lift devices (HLD) are designed to expand the flight envelope by changing the local geometry (mechanization wing), they generally camber changes depending on the phase of flight (landing, take-off). As controls, the aircraft they developed aeromechanical has effects with implications for the resistance structure of the wings, and the most important effect is the twisting of the wing. The article desires an analysis of the 2D aerodynamic profile with changes in curvature at trailing edge. This study extends an existing semiempirical approach to high-lift analysis by examining its effectiveness for use with a three-dimensional aerodynamic analysis method.

HIGH LIFT DEVICES

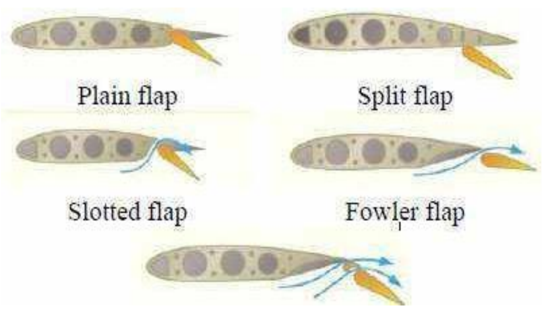
High lift devices used for bearing surfaces are designed to expand the flight envelope by changing the local geometry (wing mechanization) according to phases of flight of the aircraft. The methods used to increase the maximum lift coefficient Camas rely on either modifying the profile geometry (passive systems) or boundary layer control (active systems) or the combination of both methods. High lift studies systems based solely on increasing the bearing surface (type wing folding or telescoping wing). In carrying devices high lift continuity conditions are imposed to the lifting surfaces produces by the drag increase when high lift is un-prancing and keeping balance during turning to avoid decoupling aerodynamic moments. Bank-angle modulation, also known as bank-angle steering, modifies the orientation of an entry vehicle with a non-zero lift-to-drag ratio (L/D) in order to control the direction of its lift vector. Bank angle is the angle between the lift vector and the local vertical. Controlling a vehicle's bank angle changes a vehicle's trajectory by modifying the magnitude of its vertical lift allowing it to satisfy trajectory constraints, such as downrange distance or peak heating. An entry vehicle performs attitude maneuvers to modify the bank angle via Reaction Control System (RCS) thrusters located around the vehicle.

FLAPS OF CESSNA



In a previous study we demonstrated the utility of a semi-empirical approach to high-lift analysis using a vortex-lattice analysis combined with empirical relationships for lift effectiveness that account for non-linear effects such as large deflection angles and viscosity.4 The vortex-lattice analysis is valid for conventional aircraft configurations, but it may be desirable to use a three-dimensional potential flow solution for some unconventional aircraft, such as a blended wing-body or double-bubble fuselage, or for aircraft with low aspect-ratio or highly-swept wings. In addition, a three-dimensional analysis potentially enables the use of the pressure-difference rule for prediction.

TYPE OF FLAPS



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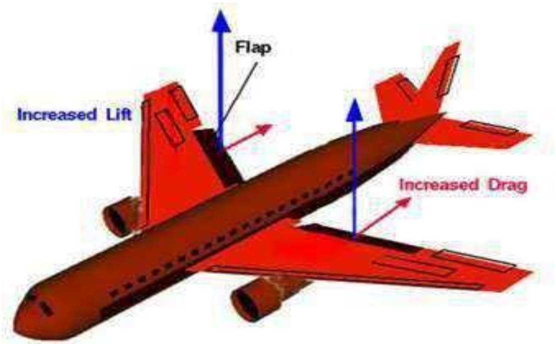
A morphing droop nose installed on the wing of an existing Regional Aircraft provides significant aerodynamic benefits because this kind of medium-size civil aircraft are usually not equipped with conventional leading edge devices. Moreover, the morphing droop nose allows redesigning the baseline wing shape that can be optimized considering only the flight conditions that do not require the shape changes introduced by the morphing. This second aspect provides an additional advantage in terms of aerodynamic benefit because different external shapes can be defined to optimize the aerodynamic performances in different flight conditions. The different shapes can be designed separately considering that the morphing allows the transition between them, preserves the shape continuity, and avoids any type of step and gap. This advantage is greater in the case of the laminar wing where the wing can be optimized for the high-speed conditions and the same wing, equipped with the morphing droop nose, for low- speed conditions. summarizes the results obtained during this work and is organized in three main parts: the optimization of the wing, followed by the flap system design; the morphing droop nose shape optimization; and the performance assessment at the aircraft level in high-lift configurations by advanced chimera techniques and aerodynamic computations.

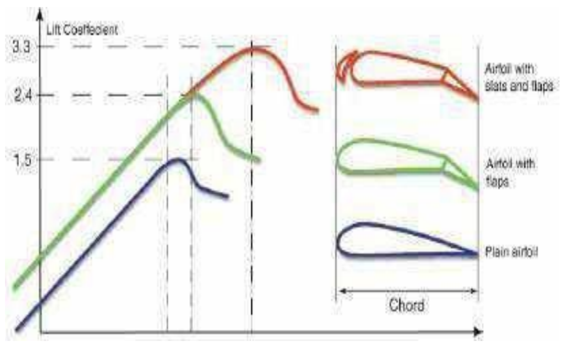
PROPOSED METHOD

The operation of the wing flaps of curvature increase will cause an increase in lift at the same speed and the ratio T / FX is changed due to the change value. In this case Pressure Center (CP) moves downstream as the steering angle of the flaps increases, thus changing the ratio Fz / G, so it induces a dive time. When using flaps for negative cycle (up to 50, 100) we have increased cruise by about 5% (transport planes) or better maneuverability for aerobatic maneuvers (aerobatics aircraft).To increase the effectiveness of flaps we are using some constructive solutions and methods (operational or concept stage): - Flaps with multiple.



FLAPS EFFECTS

The operation of the wing flaps of curvature increase will cause an increase in lift at the same speed and the ratio T / Fx Fx is changed due to the change value. In this case Cp (pressure center) moves downstream as the steering angle of the flaps increases, thus changing the ratio Fz / G, so it induces a dive time, see



changing the ratio Fz / G

MULTIPLE SLOTTED FLAPS

The first step consists of determining the hinge line about which the flap deflects. The hinge line is defined by the forward attachment points. As illustrated in Fig. 2a, the forward and aft attachment points are positioned in stream wise direction,

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at c fa and c a respectively, from the leading edge. Subsequently, the flap deflection δ f is applied. However, difference in span wise overlap and gap, such as during conical deployment, require the flap to be rotated along two other axes. As shown in Fig. 2b, the initial hinge line is rotated by θ o and θ g to account for the varying gap and overlap, respectively. The origin of these axes is called the base point, which is a point on the hinge line, translated by η base from the inboard edge. The initial positioning procedure of the flap is shown in Fig. 3. First a hinge line is created between the forward attachment points.

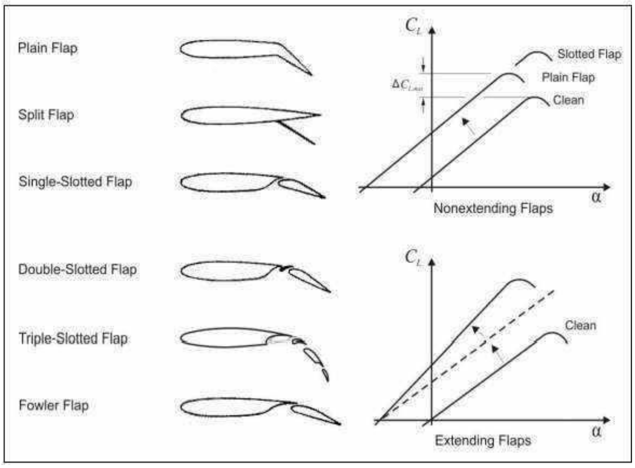
SIZING OF MECHANISM LINKS

Based on the maneuver envelope, three limiting normal load coefficients exist for the flap load factor with retracted flaps at dive speed and a load factor 2.0 with fully deployed flaps at the flap placard speed. When retracted, part of the flap surface is overlapped (nested in the cove), therefore not generating any aerodynamic load. However, the bottom and top exposed surface do, as they are part of the clean wing. Concluding from the critical load cases, the reduced exposed flap surface still produces significant lift at dive speed. When the flap is deflected the normal load needs to be estimated. This load case (2.0 g at with flaps fully deployed) forms the basis of the sizing method in this section.

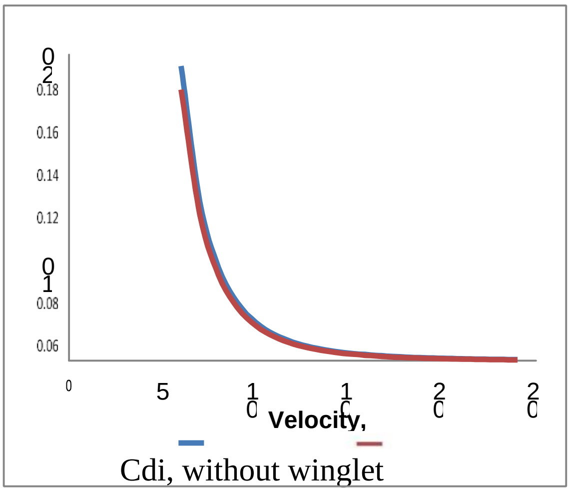
DESIGN OF PLANE FLAPS

A flap is a high-lift device used to reduce the stalling speed of an aircraft wing at a given weight. Flaps are usually mounted on the wing trailing edges of a fixed-wing aircraft. Flaps are used to reduce the take-off distance and the landing distance. Flaps also cause an increase in drag so they are retracted when not needed. The flaps installed on most aircraft are partial-span flaps; span wise from near the wing root to the inboard end of the ailerons. When partial-span flaps are extended they alter the span wise lift distribution on the wing by causing the inboard half of the wing to supply an increased proportion of the lift, and the outboard half to supply a reduced proportion of the lift. Reducing the proportion of the lift supplied by the outboard half of the wing is accompanied by a reduction in the angle of attack on the outboard half. This is beneficial because it increases the margin above the stall of the outboard half, maintaining aileron effectiveness and reducing the likelihood of asymmetric stall, and spinning.

LEADING EDGE HIGH LIFT SYSTEMS



The total drag of A320 aircraft's wing which comprises of parasite drag and the lift induced drag is calculated with and without winglets. The induced drag for both wing and without winglets are plotted against the velocity. It could be seen from the figure 21, decrement in drag for the aircraft with winglets is found to be less but of considerable amount. The total drag reduction observed from the calculation is about 8-10% during the high lift coefficient conditions where the role of induced drag is very high. The aspect ratio plays a significant role in induced drag as it is the main factor which is responsible for the span efficiency. In this case, the wing plan form without winglet has its aspect ratio of 9 whereas the other with winglet has 11, which is one of the main causes for the induced drag reduction Induced drag coefficient, Cdi for wing with winglet and without winglet against the velocity of the aircraft, V m/s



TRAILING EDGE HIGH LIFT SYSTEMS

The plain flap is simply a pivoted rear section of an airfoil. Typically the flap depth cF amounts to 30% of the chord. The plain flap increases lift by increasing the airfoil camber. Ailerons, elevators and rudders are plain flaps has been applied to the winglet templates for the automation process and the results have been discussed in this section. As the input parameter has been given as "no winglet" in the global parameter set, there is no tip device attached to the end section of main wing as shown in figure. Different trailing edge high lift systems

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A FUTURE BOEING 777X ON THE GROUND WITH FOLDED WINGS

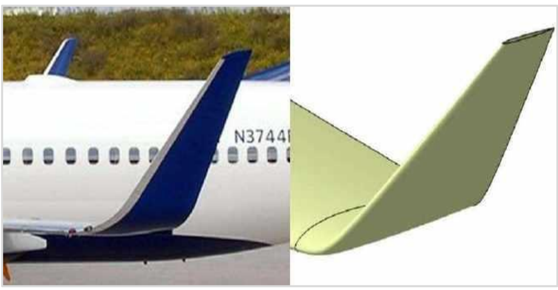
Now, the input has changed to "blended" and so the surface model of blended base is instantiated. Moreover if the user needs to be placed upon the base, the number of panels needed should be given in the input field "no of blend panel". The instantiated model is in figure 26b as there are two panels placed on the base section. On the other hand, figure shows the blended model without a panel could be another option for the user.

Each element of the wing, including the high-lift system, experiences a circulation effect from surrounding elements. The trailing-edge flap causes a change in circulation upon deflection and help the wing itself produce more lift by causing an upwash effect on the flow at the trailing-edge. The circulation also produces lift by causing a local increase in the flow velocity which yields higher negative pressure on the upper side of the wing. The lift produced by the flap airfoil itself is rather small compared to the indirect lift production that the flap causes by influencing the flow structure experienced by other elements. The high-lift system produces wakes similar to the main wake produced by the wing. If the wakes from different elements interfere with each other there is a higher risk of flow separation due to a thicker boundary layer being created, which cannot withstand larger pressure gradients. When the flow separates there will be no contribution to the lift from that part of the wing and, if the separation is significant enough, the aircraft will stall. Probably the most important feature of the high-lift system is the so called fresh boundary layer effect, which is the main reason it can produce such a significant amount of lift. The fresh boundary layer effect is present when the wake from the different elements does not coincide and each element instead creates a new boundary layer. Since this boundary layer is thinner than for a single airfoil of equivalent length, the boundary layer is resistant to larger pressure gradients and thus, generates more lift.

COMPARISON OF CAD MODELS

The parametric model created for different types of winglets could adapt various geometry shapes accordingly with the given parameters. Below are some of the winglet models compared with the existing winglet of aircraft.
Comparison Boeing 737 winglet with parametric blended winglet

CONCLUSION



The main effect of flaps is a generating flow vortex separation on the upper side especially in areas of the surface with air turbulence. Their drive and side effects such as increased dive time decrease the horizontal speed, increasing speed dissension, so intervention is required to prevent these effects by correlating flight control (throttle and stick).Aircraft flight control systems Coandă effect can make 3D maneuvers throughout the flight envelope. Next Generation on HLD is morphing concepts combined with smart materials that will increase the efficiency reaction rate of HLD.

A knowledge-based engineering application has been created that implements a design process which results in the preliminary geometric and kinematic design of four different types of trailing edge flap mechanisms: dropped-hinge, four-bar, link-track, and hooked-track. It has been demonstrated that each of these mechanisms can be automatically designed for a given set of design requirements: mechanism position, desired flap position in take-off and landing configuration, material choice and the flap placard speed.

FUTURE WORK

Since the results presented in this work for induced drag calculation are only through basic formulas which only depend on area of the winglet, a flow analysis could be done in order to determine the lift-off performance, vorticity

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reduction and also to find the parasite drag associated with size of winglet. Based on the type of analysis, user interface can be created. If the analysis is to be done on Tornado, an Excel user interface should be linked with MATLAB and CATIA.

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