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DESIGN AND ANALYSIS OF PLIANT WING

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Abstract - *In this project we are going to convert the traditional flaps with the bendable bits. As we all know, Wright brother's first aircraft was one of the greatest advancement for the human history and also the beginning of a new era in transportation. Flaps are mostly used during the takeoff and landing of the aircraft and it also has the capability to produce lift at a wide range. In this project, by keeping the entire wing in the stable position we are going to bend only the control surfaces. We are going to use tapered wing for the designing process. In this we are going to merge both flaps and aileron. Due to the flexibility of the wing, the wing can change its shape so that the lift remains undisturbed in all climatic conditions. In this we will be giving a suitable flow so as to get a required output. Due to the fixing of the patches only the control surfaces will be flexible. Due to the flexibility of the wing it can maximize the lift-to-drag ratio. And it can also boost up the fuel efficiency at a wide range. And one of the major advantages is that it can reduce noise produced during the takeoff and landing.*

Key words: Tapered wing, Drag Reduction, Lift-to-Drag Ratio, Noise Reduction.

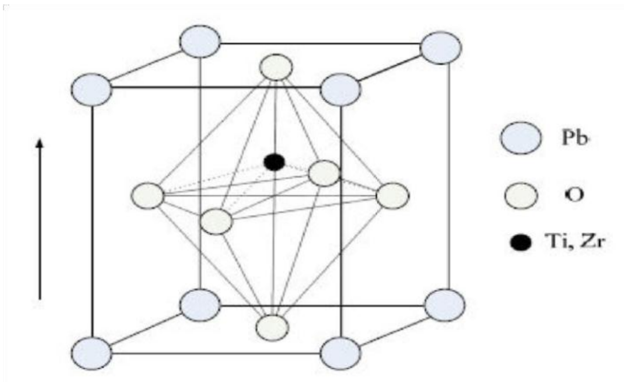
1. INTRODUCTION

A wing is a type of fin that produces lift, while moving through air or some other fluid. As such, wings have streamlined cross-sections that are subject to aerodynamic forces and act as an airfoil. A wing's aerodynamic efficiency is expressed as its lift-to-drag ratio. The lift a wing generates at a given speed and angle of attack can be one to two orders of magnitude greater than the total drag on the wing. A high lift-to-drag ratio requires a significantly smaller thrust to propel the wings through the air at sufficient lift. The basic principle of the wing generates at high air pressure in the bottom of the wing and low air pressure in the top surface. As such, wings have streamlined cross sections that are subject to aerodynamic forces and act as an airfoils

1.1 PIEZOELECTRIC PATCH:

Piezoelectric effect is defined as the production of electric charge as a response to the applied strain on the material. Generation of strain or dimension change on the material as a response to the applied electric field is called inverse piezoelectric effect. The materials which are said to have the piezoelectric property exhibit both piezoelectric and inverse piezoelectric behavior. Piezoelectricity is a linear reversible phenomenon which allows exchange of electrical and mechanical energy. Manmade piezoelectric materials do not exhibit piezoelectric property until they undergo a special process called poling.

Figure 1: Unit cell of PZT cell



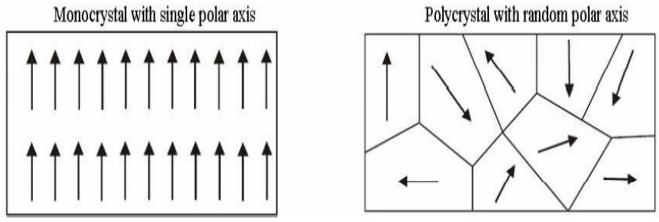


Figure 2: Difference between single and poly crystal.

Curie temperature the orientation of unbalanced dipoles in the piezoelectric crystal vanishes and the unit cell becomes symmetric. In order to produce man made piezoelectric material, the piezoelectric material should undergo poling process. In poling process, piezoelectric materials are heated above their Curie temperature and a strong electric field is applied in a direction called polarization direction. By the effect of the strong electric field, the random orientation of dipoles is aligned. Note that it is not a full alignment of all the grains. After the alignment of dipoles in the grains on the material, cooling of material while keeping the electric field is done. Below Curie temperature, the surviving polarity on the material is permanent. By this process a material that exhibits piezoelectric property below Curie temperature is ready to use. A figure describing the poling process

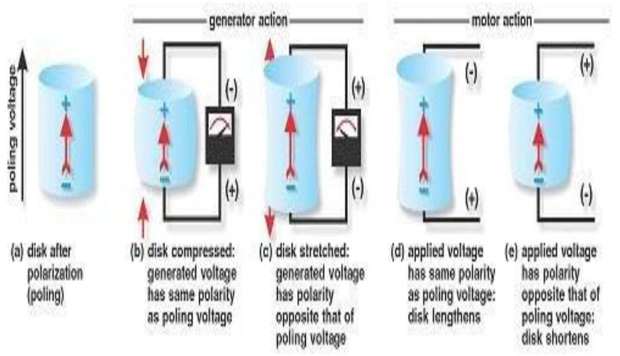


Figure 3: Operation modes of piezoelectric material

There are many forms of piezoelectric actuators namely patch actuators, bimorph actuators, stack actuators, mechanically amplified stack actuators, MFC (Macro Fiber Composite) actuators, piezo tube actuators, piezo-motors and special design type actuators. An appropriate type of actuator can be selected based on the need of force and the displacement requirement of the application. A quick comparison chart for the typical force and displacement values of different piezoelectric actuator types.

A common practice in the application of this scientific fact is the piezoelectric patch actuators. Those actuators are polarized in their thickness direction and exposed to electric field also in their thickness direction. Usually the polarization direction of a piezoelectric actuator is denoted as axis number 3, which is the thickness of a patch actuator as shown in Figure 4.6. This makes the length and width of the piezo actuator to be named as axis 1 and axis 2.

The case 1 involves the checking of the components by connecting that indicates showing the condition that the fault. A common practice in the application of this scientific fact is the piezoelectric patch actuators. Those actuators are polarized in their thickness direction and exposed to electric field also in their thickness direction. Usually the polarization direction of a piezoelectric actuator is denoted as axis number 3, which is the thickness of a patch actuator.. This makes the length and width of the piezo actuator to be named as axis 1 and axis 2. Bimorph piezo actuators are manufactured by placing two piezoelectric patches on top of each other. Bimorph actuators consist of two piezoelectric layers that work in opposite direction. This makes the bending motion possible. Bimorph configuration can be achieved by parallel connection or series connection of piezoelectric layers. A schematic representation of the bimorph bender actuators

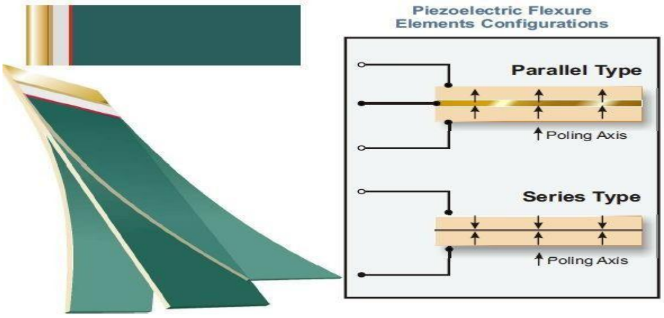


Figure 4: Bimorph bender actuator

Another form of piezoelectric actuators is piezo stack actuator. Piezo stack actuators are manufactured by stacking single layer piezo plates on top of each other. The applied voltage to the piezo stack is divided individually for each layer. The electric field applied to each piezo layer is in the polarization axis, namely axis number 3. The motion of the stack is also utilized in the axis number 3. This is called 3-3 operation mode for each piezo layer. The cumulative force/displacement generated from the stack is the summation of the force/displacement coming from each layer. This makes higher force levels and/or displacement levels possible from piezoelectric materials by stacking a number of piezo layers.

PZT is the one of the most common material used in the piezoelectric actuators, but since it is in the form of a ceramic, it is brittle. Brittleness of hard piezoelectric materials is a disadvantage in terms of usage. It is impossible to deform and apply a hard PZT plate on the surface of a curved member.

The case 2 involves the condition that checks during the on state of the vehicle. The vehicle that shows the fault or normal status during the running condition involves the motion of the vehicle. The (absolute) permittivity (or dielectric constant) is defined as the dielectric displacement per unit electric field. The first subscript gives the direction of the dielectric displacement, the

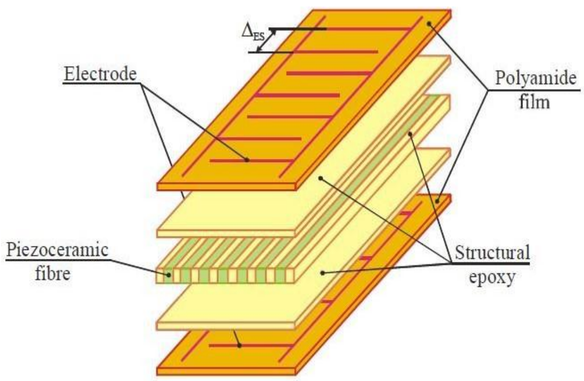


Figure 5: Internal structure of MFC

Second gives the direction of the electric field. The case 2 involves the checking of the vehicle and displaying the status as either normal or fault detected.

The first case of this condition involves the checking of the vehicle during the running condition when the parts of the vehicle is correct and involves not any damage in it.

Piezoelectric materials have the ability to generate electric charge as a response to the applied strain. They also have the ability to deform upon an applied electric field. The amount of electric charge generated per unit electrode area of the piezoelectric material as a response to applied strain and the amount of deformation of the piezoelectric material as a response to applied electric field between its electrodes can be computed using piezoelectric constitutive equations.

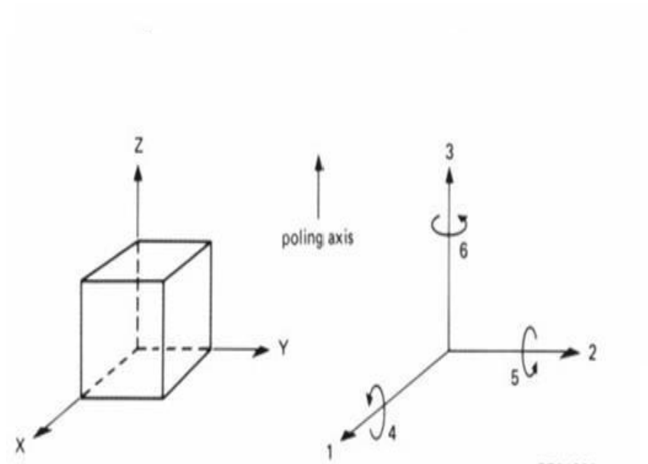


Figure 6: Designation of axes

The piezoelectric voltage constant is defined as the electric field generated in a material per unit mechanical stress applied to it. Alternatively, it is the mechanical strain experienced by the material per unit electric displacement applied to it. The first subscript refers to the direction of the electric field generated in the material or to the applied electric displacement; the second refers respectively to the direction of the applied stress or to the direction of the induced strain.

The changes in wing architecture which could directly simplify the manufacturing process and fuel consumption by improving the wing's aerodynamics .In order to increase the aerodynamic efficiency in response to variations in speed, altitude, air temperature and other flight conditions, we have designed an aircraft with an Aero elastic Wing with shape changing control surfaces, which uses the power of the airstream to twist itself for better roll control during flight. It gives details of the tools will be used for present study and proposed design of RC plane with flexible wing. The design of RC plane with flexible wing model involves lot of trial and error at different stages. A trainer aircraft basically will have a high wing design, simple sturdy construction, excellent plans and instructions having high stability in the air in order to make flying easy. Parameter selection changes for each type of aircraft. Usually the only assembly to be done is joining the wing halves, adding the tail surfaces, mounting the radio system, engine and landing gear, and connecting the control surfaces. Flaps, which are panels on the trailing edge of the wing, are used during takeoffs and landings to generate lift at low speeds. . Ailerons are segments on the trailing edge near the wing tips. Operated in pairs, one on each wing, they cause one wing to go up and the other to go down, to make the aircraft roll into a turn.

2 METHODOLOGY

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3 BLOCK DIAGRAM FOR THE DESIGNING PROCESS

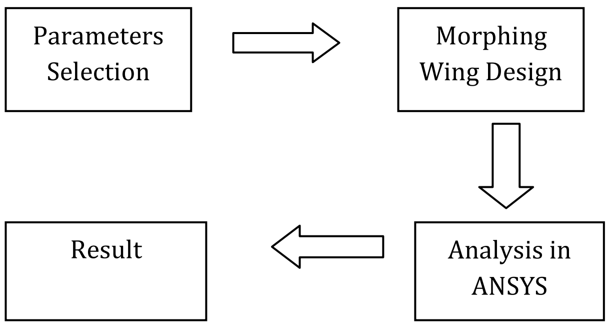

Figure 7: Overall block diagram

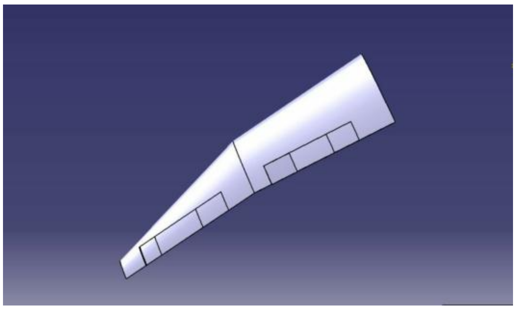

Figure 8: Isometric view of Tapered wing

In this for creating an aircraft wing structure we are using NACA 2412 series. First of all we are taking NACA 2412 wing parameters so as to create wing section.

In this flaps are mostly used during the takeoff and landing of the aircraft. Because this has the capability to produce lift at a wide range.

In this the experiment will be done in the tapered wing section. In this we are going to merge the control surfaces i.e. aileron and flaps into bendable bits. Keeping the entire wing in the stable position only the control surfaces will be flexible. Due to the flexibility of the wing it can change its shape during the mid flight too. One of the major advantages is that it can boost up its fuel efficiency, at a wide range. And another major advantage is that it can reduce the noise that is produced during the takeoff and landing. It can also withstand any of the climatic condition. It will be maestro new invention for the new modern era

4 ANALYSIS IN ANSYS

In this, the analysis was done in the ANSYS software. In this we have fixed the patch in the control surfaces, this helps to increase the flexibility. The wing has 1.6m chord length and 3.3m total length is modeled by using CATIA modeling software, then it will be imported into ANSYS via IGS file. In an ANSYS the material has been selected by engineering data sources. There are two materials selected for analysis. The materials are Aluminum and PZT 5H. Wing interior parts (8 Ribs & 2 Spars) and skin structure material assigned by Aluminum. Piezoelectric patch material is assigned by PZT 5H properties.

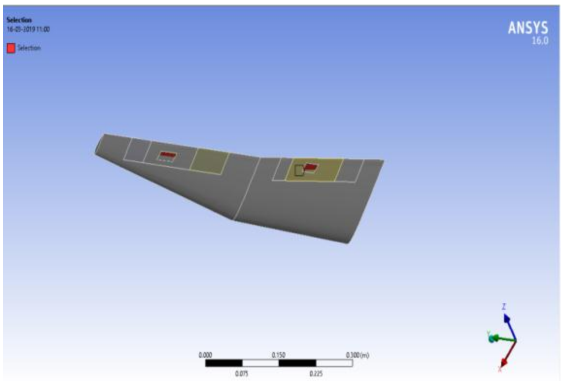

Figure 9: Tapered wing

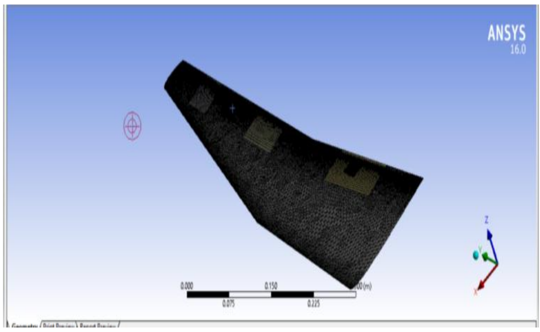

Figure 10: Mesh modeling

5 RESULT

Due to the flexibility of the wing it can maximize the lift-to-drag ratio. And it can also boost up the fuel efficiency at a wide range. And one of the major advantages is that it can reduce noise produced during the takeoff and landing

5.1Total Deformation

This figure describes about the deflection due to piezoelectric patch at 100 voltage. In this for effective voltage evaluation the maximum voltage given is 1.291*10-7, and minimum voltage is given is 0.

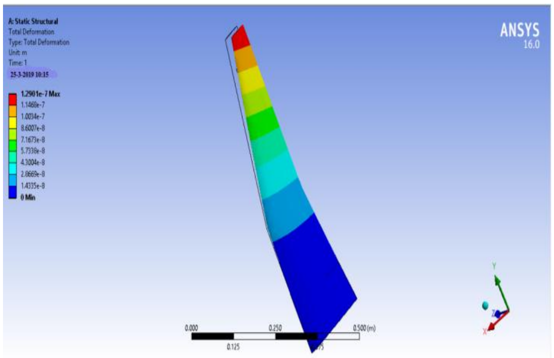

Figure 11: Deflection due to Piezoelectric Patch

5.2 Equivalent Elastic Strain

This figure describes about the equivalent elastic strain due to piezoelectric patch from (0 to 150) voltage. In this for effective voltage evaluation the maximum voltage is given upto 5.935*10-9, and the minimum voltage is given upto 2.0123*10-13.

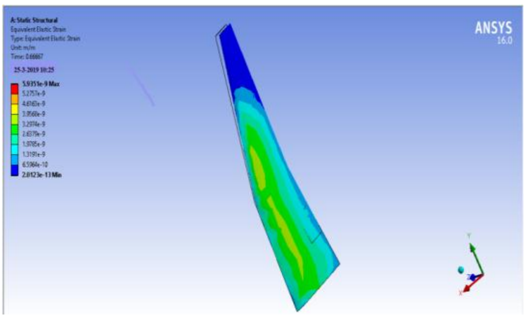

Figure 12: Equivalent Elastic Strain due to Piezoelectric Patch

5.3 Equivalent Stress

This figure describes about the Static structural due to piezoelectric patch at 100 voltage. In this for getting the effective voltage the maximum voltage is given upto 420.34 and the minimum voltage is given upto 0.0073

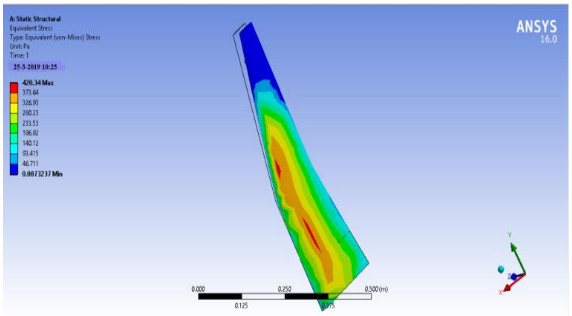

Figure 13: Static Structural due piezoelectric patch

6 CONCLUSION

In this project, by keeping the entire wing in the stable position we are going to bend only the control surfaces. We are going to use tapered wing for the designing process. In this we are going to merge both flaps and aileron. Due to the flexibility of the wing, the wing can change its shape so that the lift remains undisturbed in all climatic conditions. In this we will be giving a suitable flow so as to get a required output. Due to the fixing of the patches only the control surfaces will be flexible. Due to the flexibility of the wing it can maximize the lift-to-drag ratio. And it can also boost up the fuel efficiency at a wide range. And one of the major advantages is that it can reduce noise produced during the takeoff and landing.

REFERENCES

1. Alessandro Vicini,(1999), "Airfoil and Wing Design Hybrid Optimization Strategies", AIAA Journal, Vol.37, No.5, pp. 634-640.
2. Warren F. Phillips, (2006), "Minimizing Induced Drag with Wing Twist, Computational-Fluid-Dynamics Validation", Journal of Aircraft, Vol. 43, No. 2, pp 437-4.
3. P. Gamboa, (2009), "Optimization of a Morphing Wing Based on Coupled Aerodynamic and Structural Constraints", AIAA Journal, Vol. 47, No. 9, pp 2087-2101.
4. Mostafa Abdalla, (2010), "Mechanism for Warp-Controlled Twist of a Morphing Wing", Journal of Aircraft, Vol. 47, No. 2, pp 450-456.
5. Amin Moosavian, (2013), "Design and Motion Control of Fully Variable Morphing Wings", Journal of Aircraft, Vol. 50, No. 4, pp 1189-1199.
6. Amit Jain et al, (2014), "Preliminary Design Study of Wing", International Journal of Aerospace and Mechanical Engineering, Volume 1 – No.1, September 2014.
7. W. Stalewski, et al (2014), "Design of a turbulent wing for small aircraft using multidisciplinary optimisation", Institution of Aviation, Vol 66 No 3, pp. 185–201.
8. J.Y. Richard, (2010), "Aircraft morphing wing concepts with radical geometry change", IES Journal, Vol. 3, No. 3, pp 188–195.
9. Shuvendra Mohan2 et al, (2017), "Design Development and CFD Simulation of a Variable Twist Wing", IJIR Journal, Vol-3, Issue-5, 2017.
10. Mohammed Sanjid2, (2018), "Performance Analysis of Winglet Using CFD", IRJET Journal, Volume: 05 Issue: 04, pp 4154-4158.