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Analysis of Crack on Aeroplane Wing at Different Positions using ANSYS Software

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***Abstract*—The present study revivals the analysis of crack on aeroplane wing at different positions. Also states the deformation of wing structure against the different positions of crack on aeroplane wing. For this study the NACA 4412 Clark-y profile is used to generate aerofoil shape of aeroplane A320. Again the model is generated in CATIA v5 R21 software for further analysis. The ANSYS is used to carry out harmonic response analysis for prediction of deformation against pre loading condition at different positions of crack on wing. This shows the variation in results for different positions of cracks on wing to decide the maximum deformation of wing structure.**

***Index Terms*—NACA 4412, Harmonic response, Deformation, frequency response**

I. INTRODUCTION

Aeroplane wing is most important part of aeroplane so the analysis of the aeroplane wing is important. Most of time aeroplane wings influenced by the large stresses and due the large stress developed at the wings of aeroplane, accidents are going to happen. So the harmonic analysis is used to determine the steady state response of loads that vary harmonically and to determine that your design can overcome the resonance. In this presented work the design of wing model of A320 with specification of NACA 4412 is generated with cracks at different position. As very less work is done on crack analysis of aeroplane wing so the attempt is made to do the study in this area, the analysis is done using harmonic response module in ANSYS 16.0.

Peruru et al. [1] studied the structure of wing of aircraft and also carried out the stress and fatigue analysis for different materials like aluminum 6061-T8, s2 glass and carbon epoxy. Rajappan et al. [2] studied the aircraft wing model for FEA analysis to calculate the maximum and minimum von misses stress for different loading conditions. The contour deflections are shown for X, Y, and Z directions by taking the example of NACA 4415 aerofoil shape with different thickness. Habib et al. [3] studied fatigue crack growth prediction on A310 aircraft wing using static analysis. The comparison between predicted and actual crack growth is predicted and states that the Paris law model is effective. Ramesh Kumar et al. [4] studied the stress analysis of wing structure and identify the maximum stress at the root of wing which is lower than the yield strength of the material. Shreenivasa et al. [5] studied the fatigue analysis of the cracked and uncracked model and shows the life of aeroplane again different loading conditions. It states that in 0.2mm crack model life is very less and damage is very high. Reddy et al. [6] studied the stress analysis of fuselage frame with wing structure and total lift load is calculated then this load is applied to the finite elements model.Various researchers have used softwares like ANSYS, Comsol for the analysis of components like journal bearing, microchannels, etc. [7-10].

As very less work is reported on the crack analysis of aeroplane wing. So, an attempt is made for the study of analysis of aeroplane wing with cracks at different positions.

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II. METHDOLOGY

A. Modeling:

CATIA is widely used software in the field of design. The model generated in this software is easy to visualize and understand. The surfacing module is very useful to create various shapes with our specifications.In this present work the study is carried out on the NACA 4412 wing structure of aeroplane A320. The visual 3D model is modeled in the CATIA Software by using standard Clark-y profile. The wing model is as shown fig. 1.

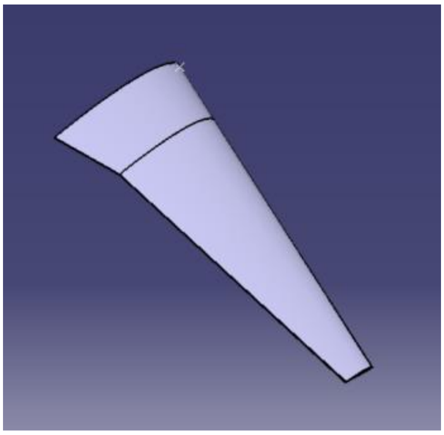

Fig.1 Model of wing

B. Meshing:

Meshing is the very important stage in the analysis. The mesh affects the accuracy and speed of solution. Meshing is the process used to divide the product into finite elements for better solution. The unstructured mesh is used for the analysis of crack on wing. The meshing is as shown in fig. 2 below,

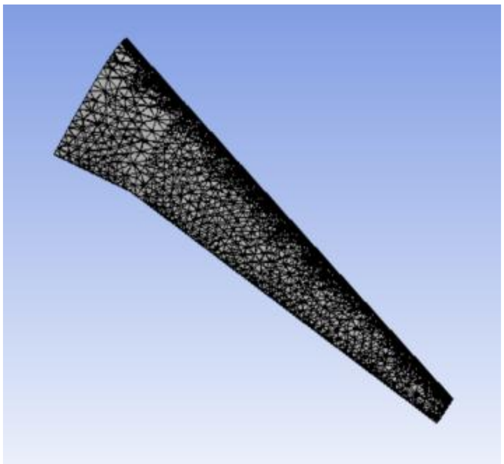

Fig.2 Meshing

C. Analysis:

Generally, lift means upward action in any direction Lift force is nothing but sum of all forces acting on a body to move in a perpendicular direction of flow. While moving in air the wings of aeroplane are influenced by aerodynamic force which is not necessarily to be aligned with the vertical this force is resolved into two perpendicular components then the component which perpendicular to free stream velocity known as lift force. Lift force generated by an object is based on size of object and pressure variation of fluid around body. Lift should be high to takeoff and landing safely with low velocity.

To predict the steady state dynamic response of a structure depends upon harmonically varying loads, harmonic analysis is carried out. It is thus helps to verify whether the designs can overcome the harmful effects of forced vibrations or not.

Boundary conditions:

Force: 20 KN

Frequency range: 0 to 200 Hz

III. RESULT AND DISCUSSION

The analysis of crack on aeroplane wing at different positions using ANSYS software has been carried out and the results are presented in this section.

A. Wing without crack

Harmonic frequency response is calculated in ANSYS as shown in fig. 3 and fig. 4 below for given range of frequency. The maximum deformation is found to be 46.605 mm.

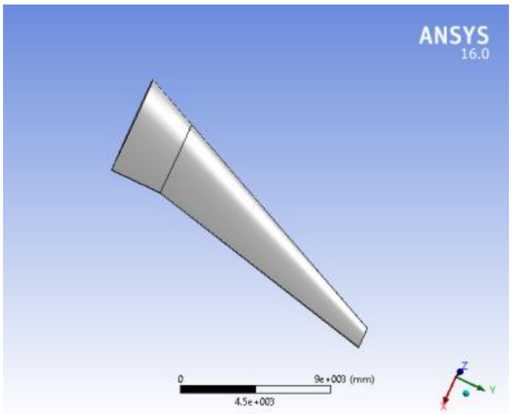

Fig.3 Wing without crack

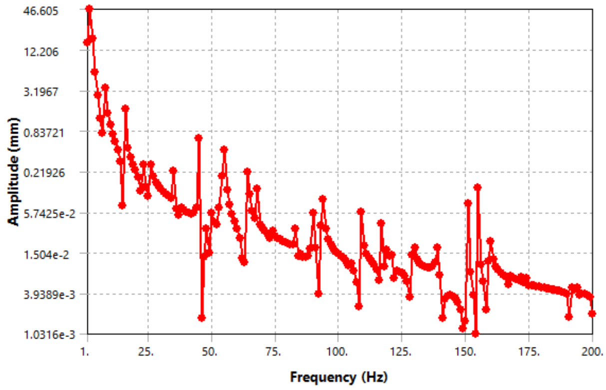

Fig.4 Frequency response

B. Crack on upper side of wing

For the analysis of wing the crack is generated at different positions like at start, middle and tip.

i. Crack at Start:

The crack is generated at the start of wing for analysis. The shape of crack is elliptical having 2mm depth which is shown in fig. 5.

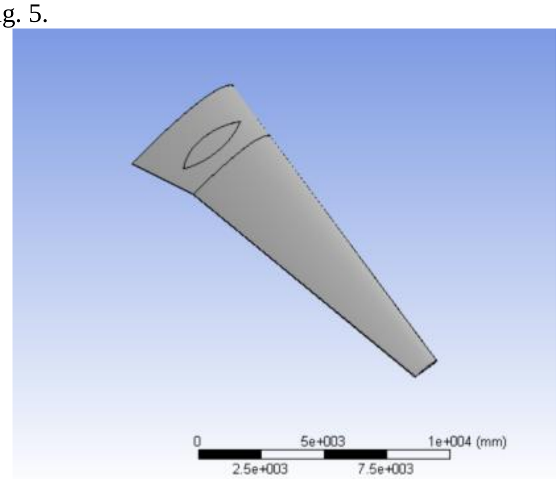

Fig.5 Crack at start

The frequency response for crack at start between given range of frequency where maximum deflection is found to be 153.21 mm which is shown in fig. 6.

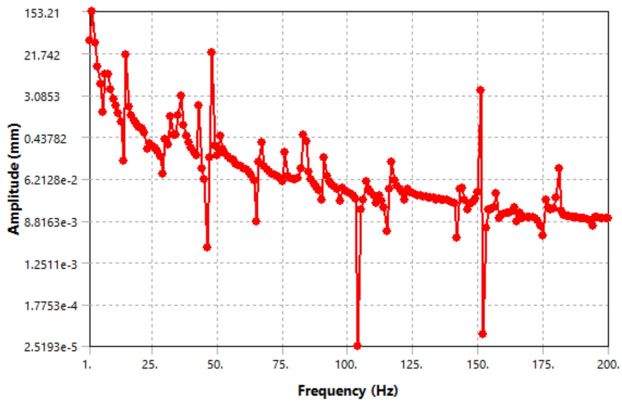

Fig.6 Frequency Response

ii.Crack at middle:

The crack is generated at the middle of wing for the analysis which is shown in fig. 7. For the given range of frequency the maximum deflection is calculated as 49.517 mm which is shown in fig. 8.

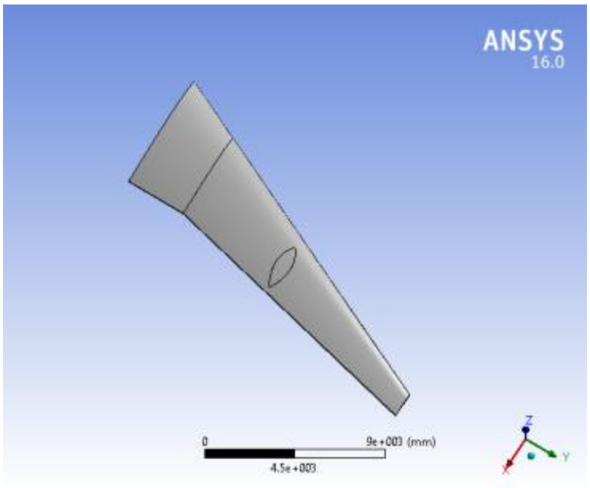

Fig.7 Crack at middle

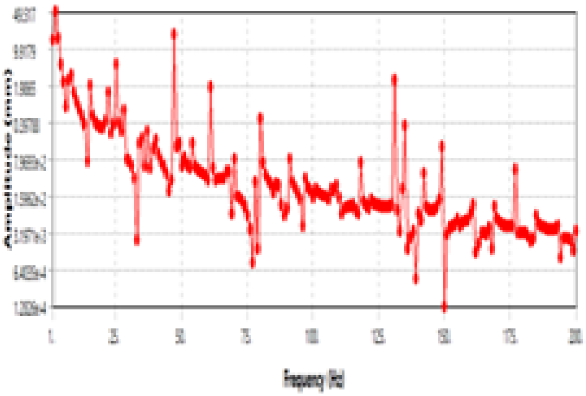

Fig.8 Frequency response

iii.Crack at tip:

The crack is generated at the tip of aeroplane wing for analysis which is shown in fig. 9. The maximum deflection observed for the given range of frequency is 144.2 mm which is shown in fig 10.

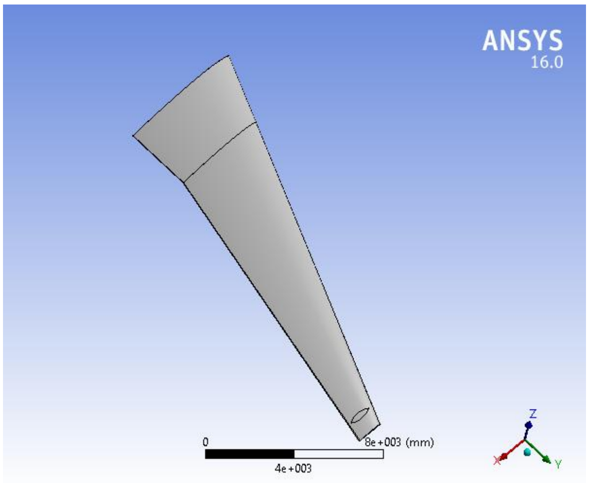

Fig.9 Crack at tip

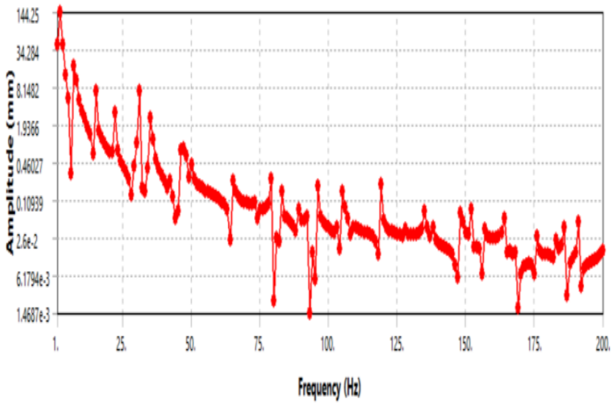

Fig.10 Frequency response

C. Crack on bottom side of wing

i.Crack at start:

The crack is generated at the start of wing at bottom surface for the analysis which is shown in fig. 11. For the given range of frequency the maximum deflection is calculated as 156.17 mm which is shown in fig. 12.

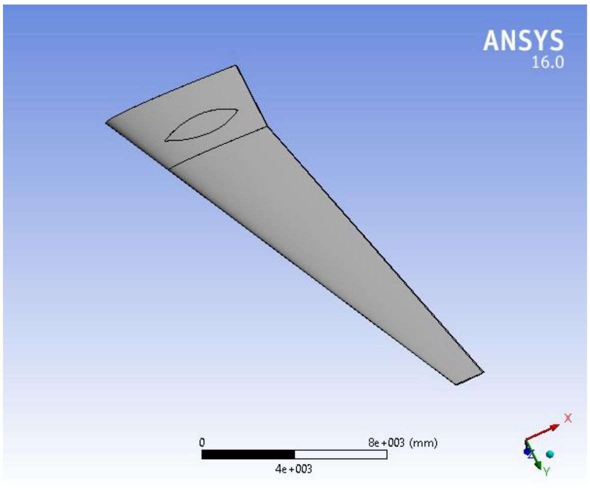

Fig.11 Crack at start

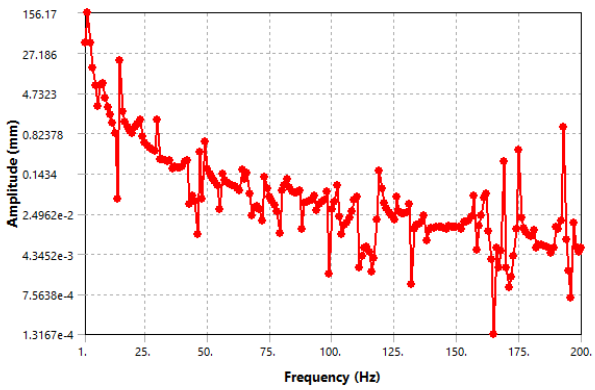

Fig.12 Frequency response

ii.Crack at middle:

The crack is generated at the middle of wing at bottom surface for the analysis which is shown in fig. 13. For the given range of frequency the maximum deflection is calculated as 54.682 mm which is shown in fig. 14.

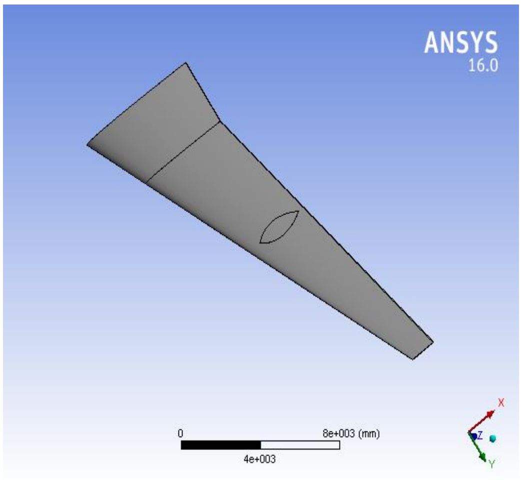

Fig.13 Crack at middle

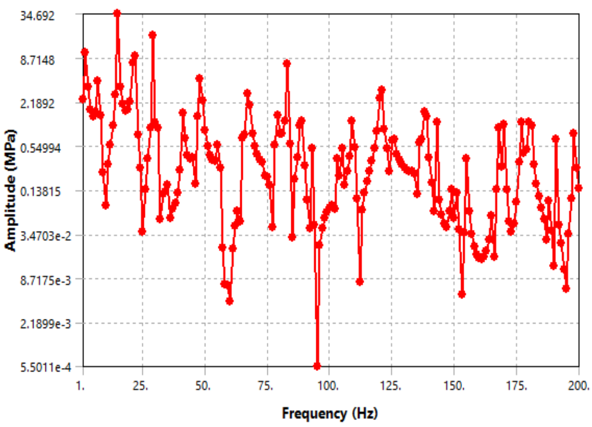

Fig.14 Frequency response

iii.Crack at tip:

The crack is generated at the tip of wing at bottom surface for the analysis which is shown in fig.15. For the given range of frequency the maximum deflection is calculated as 127.66mm which is shown in fig. 16.

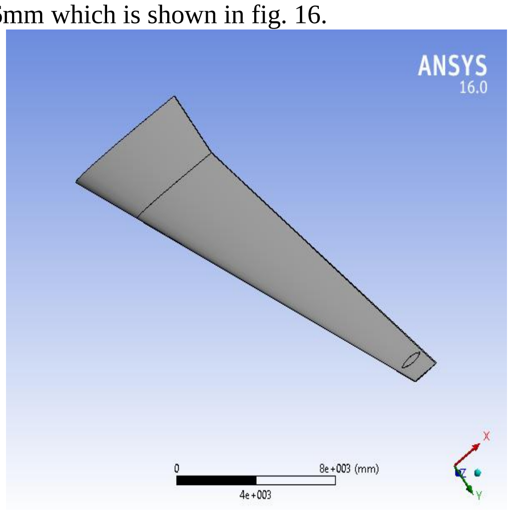

Fig.15 Crack at tip

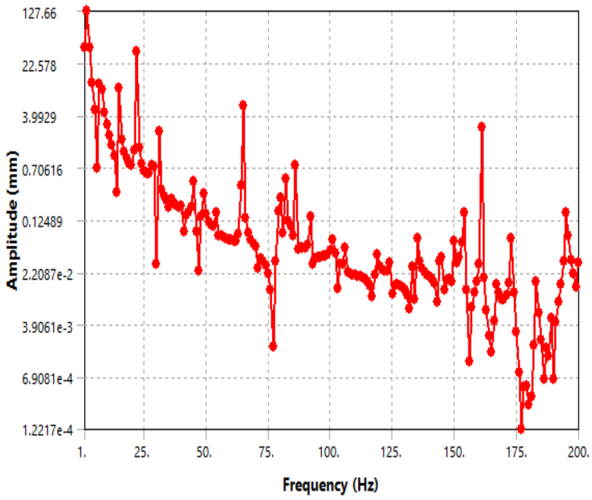

Fig.16 Frequency response

Table 1. Deflection of wing

Crack position	Start	Middle	Tip
Upper surface	153.21mm	49.517mm	144.25mm
Bottom surface	156.17mm	54.682mm	127.66mm

Above table 1 shows the deflection of wing at different positions at upper and bottom surface of wing.

IV. CONCLUSION

The analysis of crack on aeroplane wing at different positions using ANSYS software has been carried out. The three position considered are wing without crack, crack on upper side of wing and crack on bottom side of wing. The deflections at start of wing are maximum as compared to deflections at tip & middle of the wing. Also, because of geometry of wing, the crack length at the tip is less as compared to crack length at start and middle. So, it is concluded that the small crack at tip of wing affects more than the cracks at start and middle on the wing.

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