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THERMAL HEALTH MONITORING OF STIFFENED PLATE OF VARIOUS MATERIALS

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Abstract
In this thesis, the Thermal health monitoring of material stiffened plate by using Ansys Software Analysis. Numerical analysis of a plate is carried out from the point of view. The numerical analysis include the thermal analysis, on healthy of varing thickness stiffened plate structure. The thickness changes are made with resulting calculation as deformation, thermal strain and thermal stress of plate and the stiffener. The results of numerical analysis have been compared. The dynamic strain data was captured from numerical. The thickness Vs deformation, Thermal stress and Thermal strain data were analyzed.In thermal steady state analysis, the deformation of the Aluminium alloy decreasing as thickness of the structure increases and thermal stresses are also decreasing as thickness of the structure decreasing.

Keywords
Composite /Alloy Material, Stiffened Plate, Thermal Health Monitoring.

I. INTRODUCTION

Health monitoring (SHM) is a process that detect, locate, and quantifying damage in structures at an early stage in order to avoid failure of structure before damage. Most SHM methods are based on the identification of deviations from a “normal” or “healthy” condition.The SHM of the composite materials involves intergradations of networks of sensor or sensing element within the composite structures for prediction, localization, assessment and evaluation of various damages induced in the composite materials [1].

Thermal Analysis of Aluminium alloy for thickness 3mm, 4mm& 5mm can be analysedinAnsys.The result as deformation, Thermal Stress dada and thermal Strain Data can be analyzed can making the conclusion.The thermal steady state response of plate with in thermal environment is analyzed inANSYS using solver mechanical APDL. For thermal monitoring of the structure, the thermo-couples may be used.

II. LITERATUREREVIEW

Serker and Wu [10] 2010,have presented a SHM strategy applicable to bridges. This method was based on continuous strain (static and dynamic) data obtained by distributed long-gage FBG sensor. The main concept of the proposed damage identification technique was that the ratio of the strain between two measurement locations under some loading configuration is constant for a certain condition of the structure. Therefore, damage can be identified in a certain location of a structure from the change in the strain ratio. An experimental study was carried out to verify the present method for damage identification. Finally, the proposed SHM strategy was implemented to a highway bridge in Japan. Monitored results under the normal operating conditions in changing environmental condition are presented in this paper. The real time monitoring results of the highway bridge shows the potentials of the proposed SHM strategy for the long-term and continuous monitoring of structure [10].

Wayne Baker [13]2004 ,reports on an ongoing research program into the development of life extension strategies for Australian military aircraft. Proposed SHM systems have been numerically simulated to assess feasibility, given physical and optical limitations of the components.

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International Journal of Engineering Technology Research & Management

Seth S. Kessler, [5]The potential role of the frequency response of a composite structure in a Structural Health Monitoring system has been investigated in this paper. A finite element model was built to numerically explore the effects of various types of damage on the normal modes of test coupons, and analogous experiments were performed using a scanning laser vibrometer and impedance meter to verify these results. Good correlation was found between the model and the experimental results for low frequencies, however coalescing modes at higher frequencies made comparison impractical.

III. Methodology, Design and Modelling

Initially, the model of the stiffened composite plate was created in Ansys. In the designing and modelling for thermal stress, strain, & deformation with respect to thickness considering general thickness of plate as simple and strip data as 3, 4 & 5mm. The dimensions of plate and strips as Length 1060mm, width 640mm & strip length 140, thickness 3,4,5mm taking simultaneously for analysis. The modelling as shown in figure below

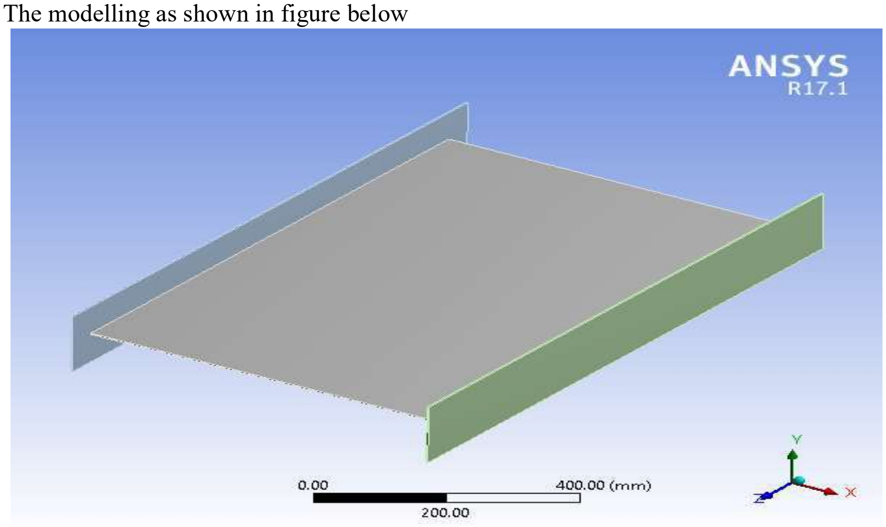

Figure-1.3-D representation of Stiffened Plate thickness 3mm

In simple plate analysis in Ansys taking 2476 Nodes, Elements 301.The Material Data taking for Aluminum Alloy constant as shown in table

Density	2.77e-006 kg mm^-3
Coefficient of Thermal Expansion	2.3e-005 C^-1
Specific Heat	4.34e+005 mJ kg^-1 C^-1
Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Resistivity	1.7e-004 ohm mm

Other parameters details as Compressive Ultimate Strength 0 MPa, Compressive Yield Strength 280 MPa, Tensile Yield Strength 280 MPa, Tensile Ultimate Strength 310 MPa, Zero-Thermal-Strain Reference Temperature 220C, Young's Modulus 71000 MPa, Poisson's Ratio 0.33, Bulk Modulus 69608 MPa, Shear Modulus 26692 MPa, Relative Permeability 10000.

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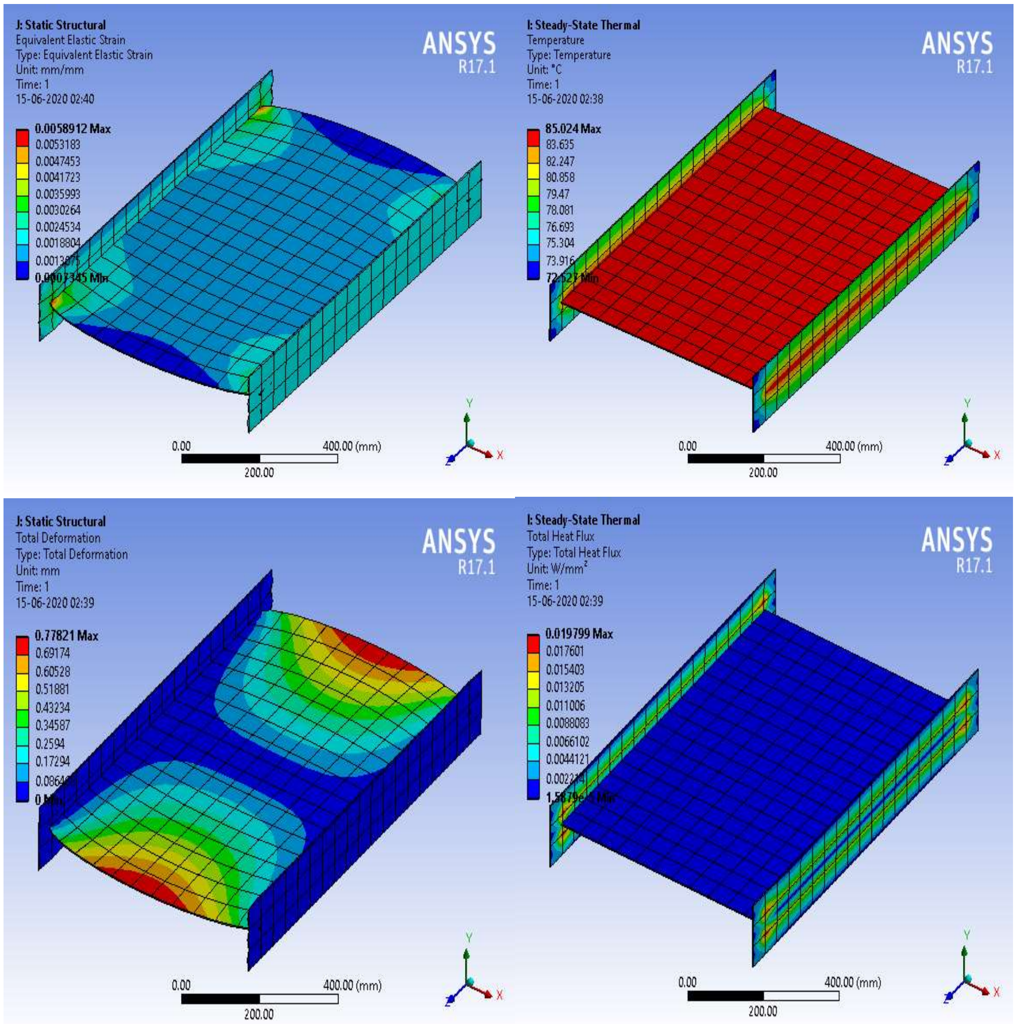

Figure-2.Contour plot of strain, temperature, total defornation and heat flux of plate strip.

IV. RESULT DISCUSSION

The responses of stiffened composite plates in thermal environment have been investigated using ANSYS 17.1.The flat plate as well as stiffeners have been modelled using the Ansys various parameters. First the various boundary condition applied in order to find the suitable temperature range to conduct modal analysis as well steady state thermal analysis for conducting health monitoring purpose.The various results of the different thickness plate as shown previous contour plot and numerical data from the analysis as below

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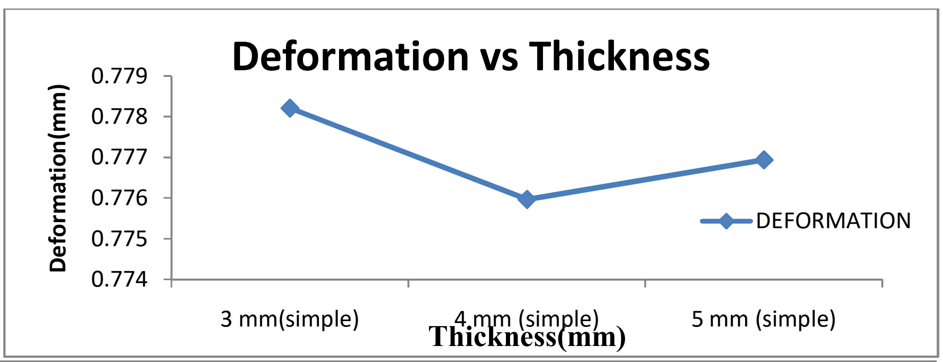
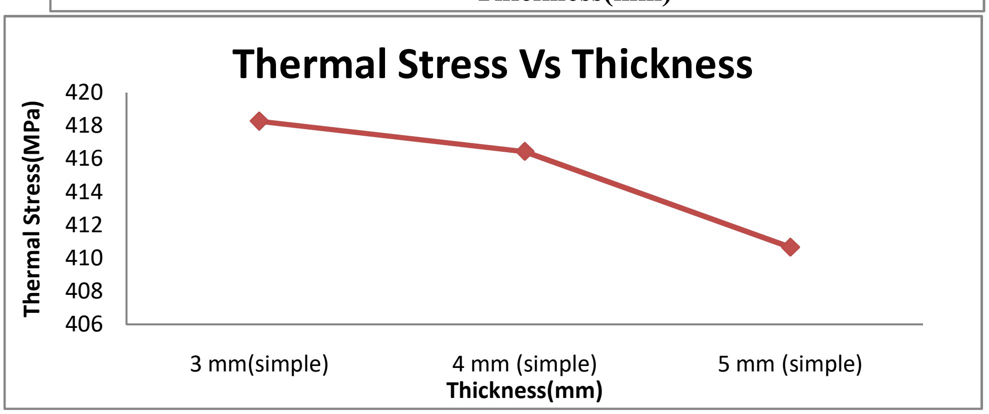
International Journal of Engineering Technology Research & Management

Sr. No.	THICKNESS	DEFORMATION (mm)	THERMAL STRESS (MPa)	THERMAL STRAIN (mm/mm)
1.	3 mm(simple)	0.77821	418.28	$5.8912*10^{-3}$
2.	4 mm(simple)	0.77597	416.45	$5.8656*10^{-3}$
3.	5 mm(simple)	0.77694	410.67	$5.7841*10^{-3}$

From the above numerical data, considering the atmospheric temperature 22^0C and at surface 85^0C for convection results. In the simple plate and strip of thickness 3mm the maximum deformation are 0.77821 and the thermal stress developed in the plate and strip are as 418.28MPa and the change in length to the original length at the temperature range for simple plate and the thermal strain as 5.8912*10-3 is observed.

As per the above table data of thickness 4mm & 5mm then various values are shown. All the simple plate strip data can be graphically shown as below. From the graphs as Deformation, Thermal strain and Thermal stress Vs Thickness are plotted in graphs
respectively.





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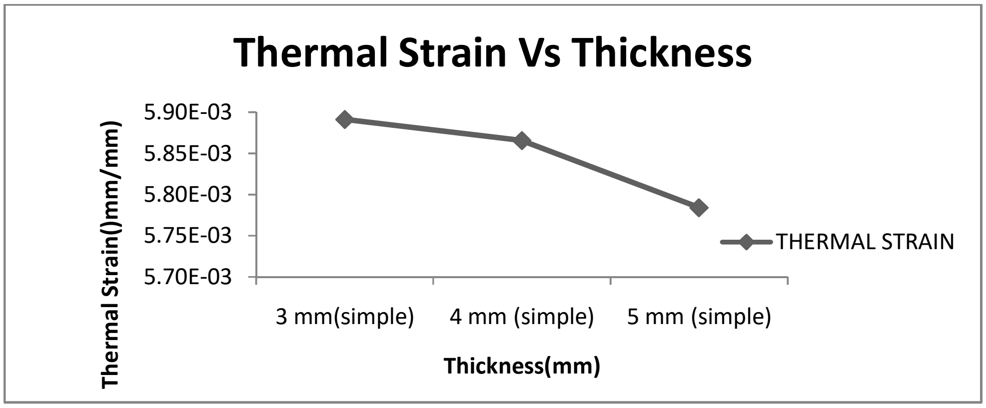
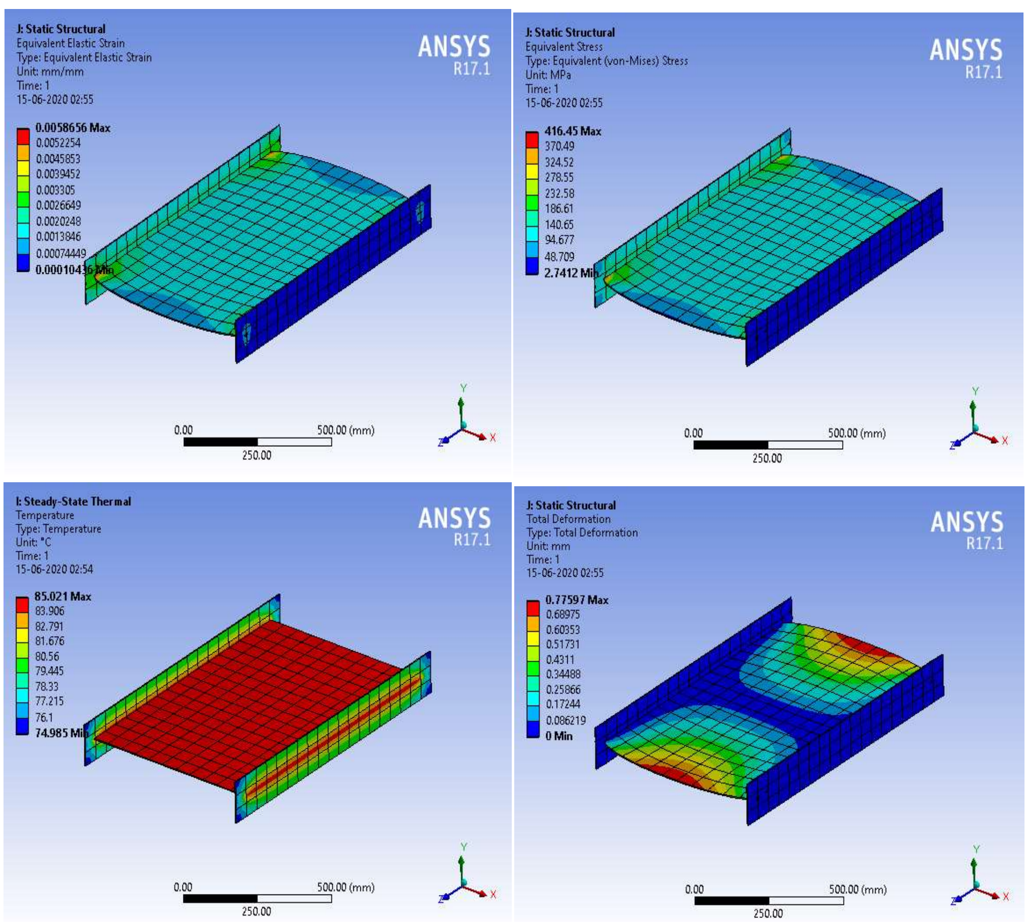


4 mm Simple plate results of strain, stress, temperature, total deformation and Heat flux contour plot as shown in respective figure



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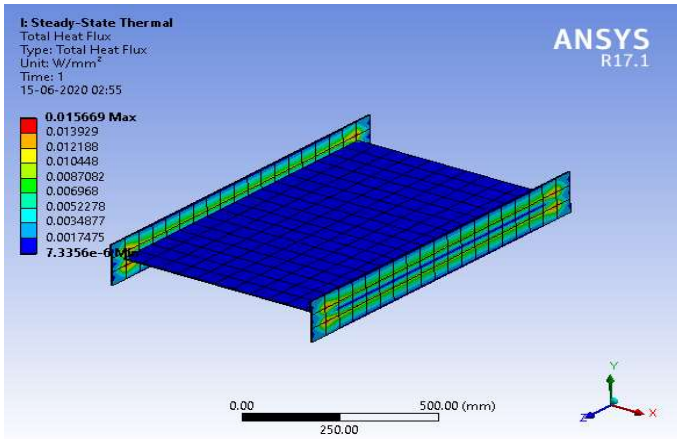
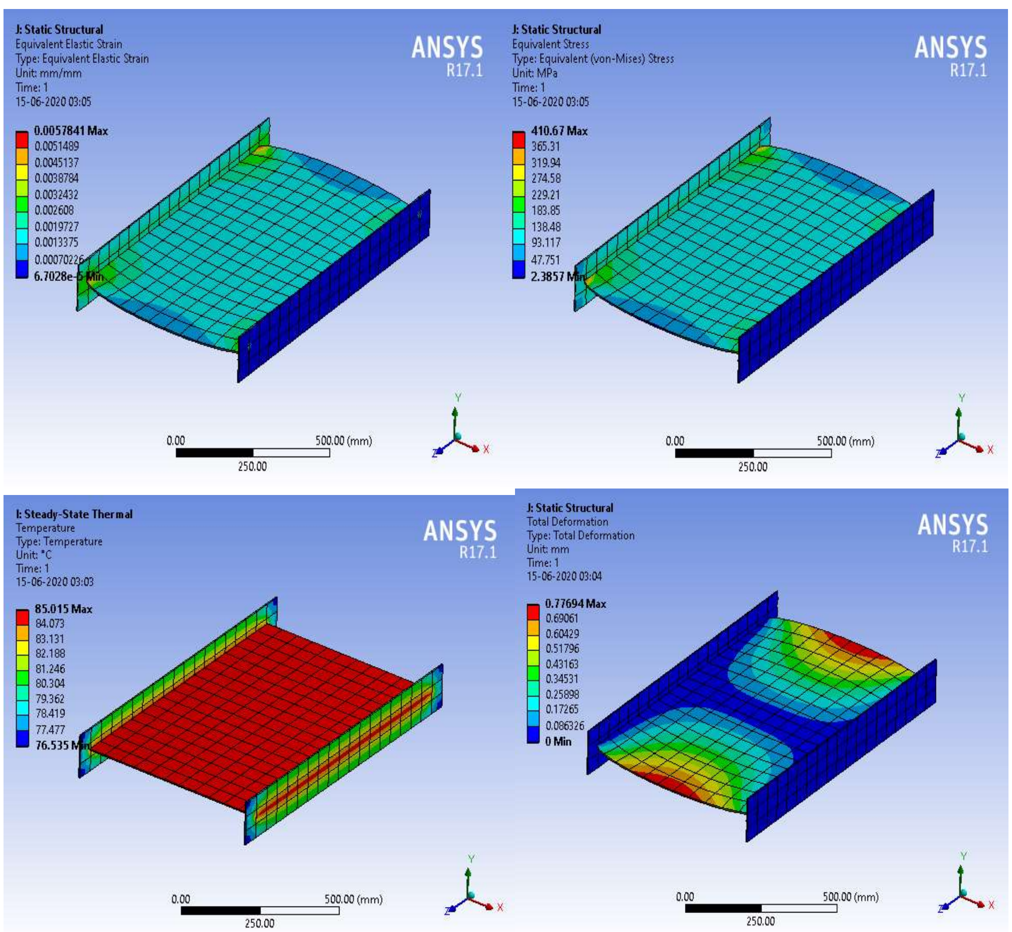


5 mm Simple plate results of strain, stress, temperature, total deformation and Heat fluxcontour plot as shown in respective figures



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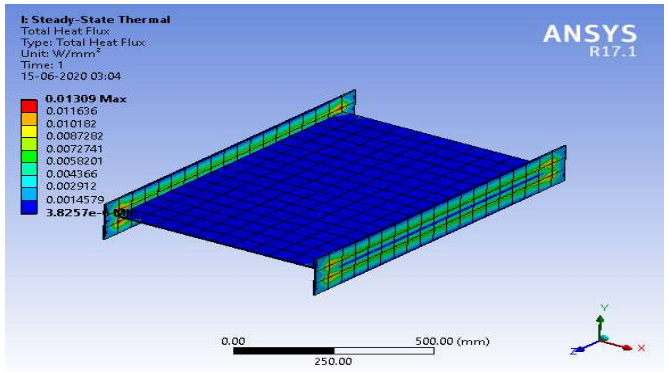

CONCLUSION

From the thermal steady state response of plate with in thermal environment is analyzed inANSYS using mechanical APDL solver for thermal monitoring of the structure. The metallic applications of stiffened plate can be replaced by the composites and alloy material. From the analysis as weight of the metal part are more but some composite material can be used in place as structural or thermal application purpose which has less weight and same performances parameters can be achieved. Here the aluminum alloy material data analysis with thickness parameter fixed at 3mm, 4mm, 5mm the thermal strain, thermal stress are decreasing as increasing the thickness of the plate of stiffenedstrips.In thermal steady state analysis, the deformation of the Aluminum alloy decreasing as thickness of the structure increases and thermal stresses are also decreasing as thickness of the structure decreasing.

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