Thermal Analysis of Plate And Beam By Using Finite Element Method

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Abstract- *Thermal analysis plate and beam made up of various materials with thermal load application and different boundary conditions are analyzed in this research. Finite element formulation is carried out in the analysis and the FEM formulation is done in the analysis section of the ABAQUS. In this study, flat Square plate without cut-out which can be assumed as perfect plates which are made up steel, aluminium materials are analysed. Finally comparison has been done between the results obtained from ABAQUS results for isotropic square plate without cutout. A study on the structural properties such as deflections and thermal behaviour of different materials has been conducted during the analysis which will be helpful in various fields of engineering.*

Keywords- Thermal, FEM, ABAQUS

I. INTRODUCTION

In many constructions and industrial areas such as buildings, ships, bridges, railway coaches, aircrafts and automobiles the plate structures are widely being used. The failure of the plates can leads to catastrophic disasters. Generally these failures are occurred due to bending and excess stress on it. Therefore it is necessary to study the behavior of these kinds of plates properly. Traditionally, the material used for the plate construction is steel. Steel is the most economical material from a pure manufacturing point of view. But when the cost of operations and maintenance during its usage comes into account, the interest of cost in a life cycle perspective has increased. When changing traditional steel into alloy or composite design there is a remarkable reduction of structural weight and it is the major added advantage. Therefore, a detailed comparison on the structural behavior of aluminum material with steel is incorporated with this study. The deflections and stresses of rectangular plate and square with different boundary conditions are subjected to the action of uniformly distributed loads is studied, which is a major problem because of its technical importance. This study analyzes the deflections of isotropic rectangular plate with different boundary conditions and varying aspect ratios. The accurate knowledge in the properties like deflections, stresses and stress concentrations are required for the design of plates with imperfections like cut-out and any abrupt change in the geometry of the plate under loading results in the stress concentration.

II. ANALYSIS

Thermal analysis for plate when it is a flat square plate having all sides fixed. The deflection and Equivalent stress due to thermal loading are now evaluated using the finite element software,abaqus.First steady state thermal analysis is performed on plate. Model is generated with all the dimensions being unity, the generated model using ABAQUS.After generatng model, material properties of steel material are assigned as described in table as follows ,

Table.1 Properties of Material

Property	Steel	Aluminium
Density(kg m^-3)	7850	2270
Co. of Thermal Expansion	1.2x10^-5	2.3x10^-5
Young's Modulus (Mpa)	2x10^5	7.1x10^4
Poisson's Ratio	0.3	0.33
Thermal Conductivity	60.5(W m^-1 C^-1)	60.5(W m^-1 C^-1)

Once the model is generated the next step is to mesh the whole geometry so that further loading and the boundary conditions are specified. Meshing looks as in figure 1

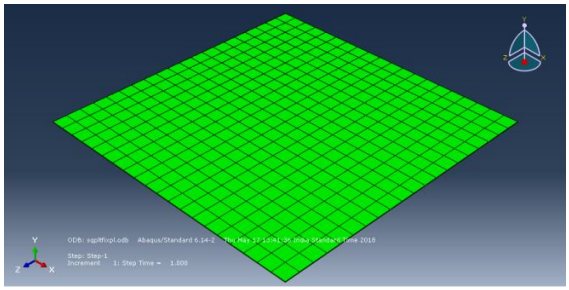

Fig. 1 Plate with mesh areas

Once the model is meshed, the next is specifying the boundary conditions. 100 ° C Temperature is applied on top side and 0 °C on remaining sides as shown in fig 2

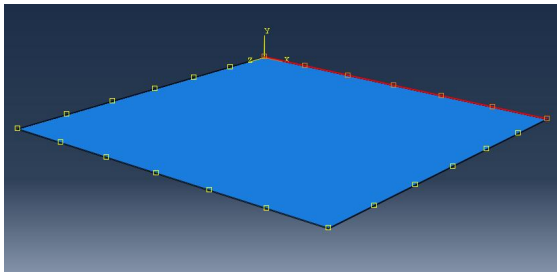

Fig.2 Boundary Condition

Once the boundary conditions are specified, the model is selected and the solution option solves for all possible results. Here temperature distribution is result. The temperature distribution is as in figure no 3,

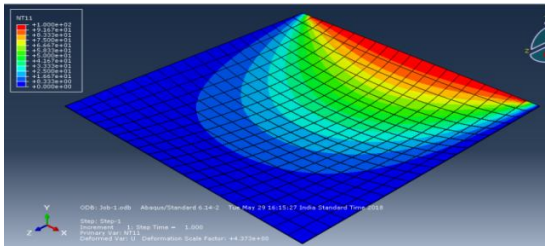

Fig. 3 Temperature distribution

This completes steady state thermal analysis. Then coupled static thermal and displacement is performed on same plate. Here two cases are considered. In first case all sides of plate are fixed and in second case opposite two sides are fixed and remaining are simply supported. Geometry and material properties are taken from steady state thermal analysis. Then further is done. Using same model, meshing is done. Then boundary conditions are applied as follows.

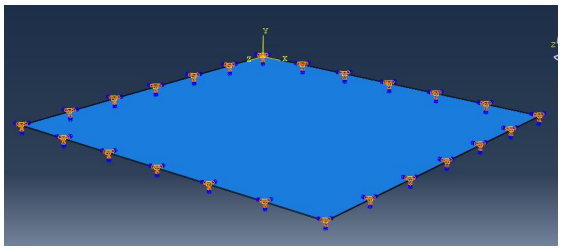

Fig. 4 Boundary condition in first case

Once the boundary conditions are specified, the model is selected and the solution job option solves for all possible results. Then all the results including the stresses and deformations are viewed. Equivalent stress, total deformation for steel for first case is described in figure5&6.

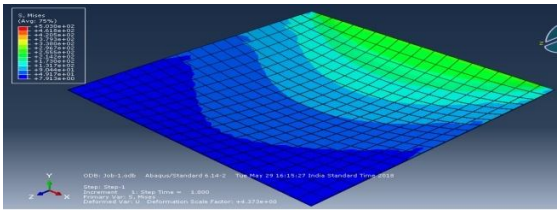

Fig.5 Stress in plate in steel

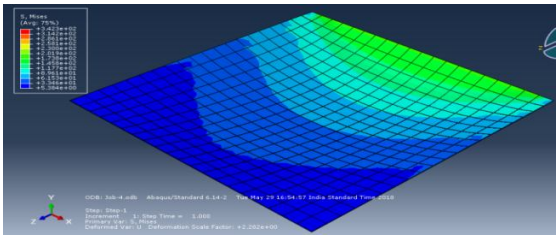

Fig.6 Stress in plate in aluminium

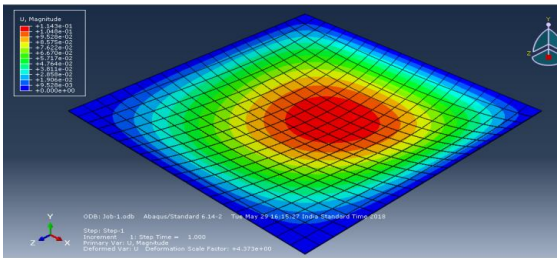

Fig. 7 Deformation in steel

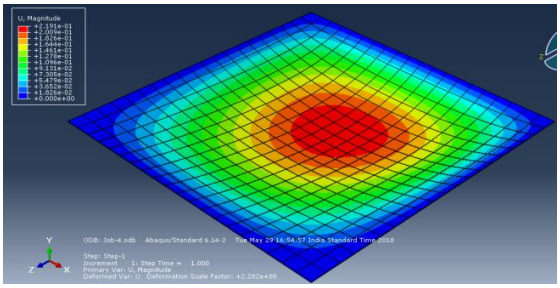

Fig.8 Deformation in aluminium

III. RESULTS AND DISCUSSION

The thermal analysis performed on square plate. The stresses and deformation variation along length and width are described with comparison of the results in ABAQUS for steel and aluminium material. The fig. 9 shows the Stresses along X axis variation for steel and aluminium.

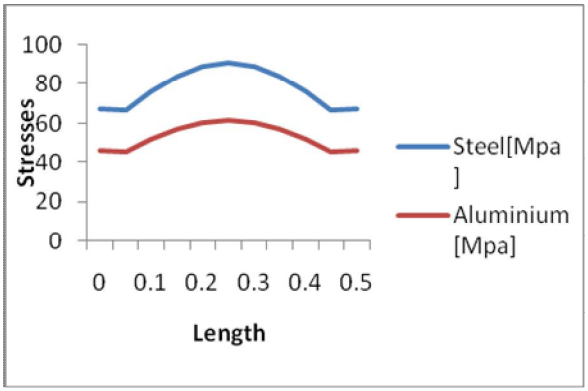

Fig 9 Stresses along X axis

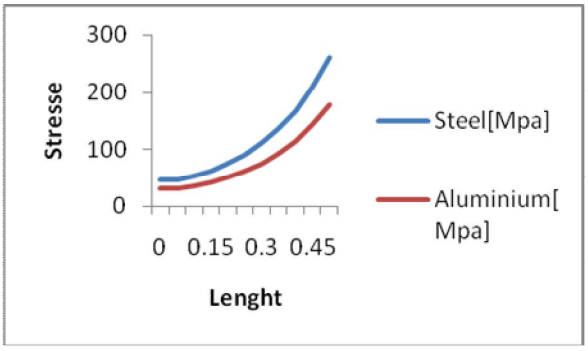

Fig 10 Stresses variation along Y axis

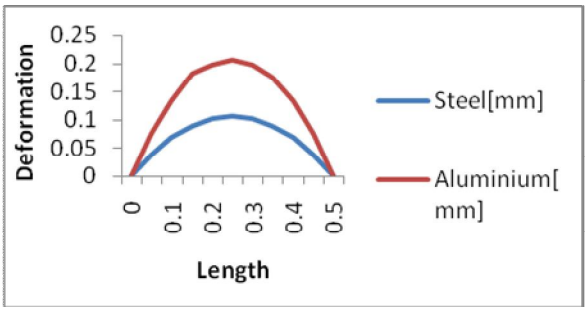

Fig 11 Deformation along X axis

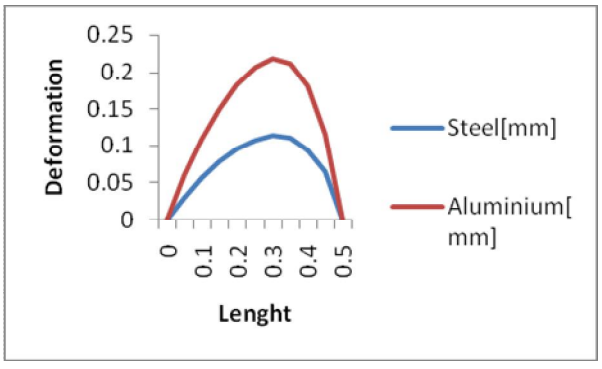

Fig 12 Deformation along Y axis

Know for the second case when two sides are fixed and two free the stresses and deformation are given as follows,

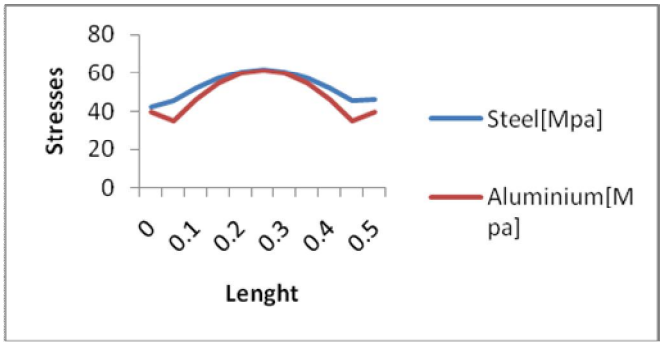

Fig 13 Stresses along X axis

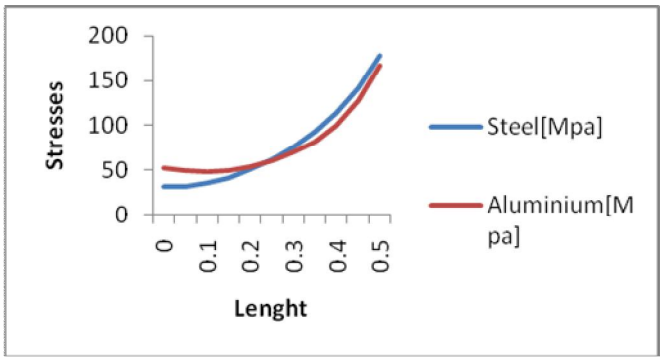

Fig 14 Stress long Y axis

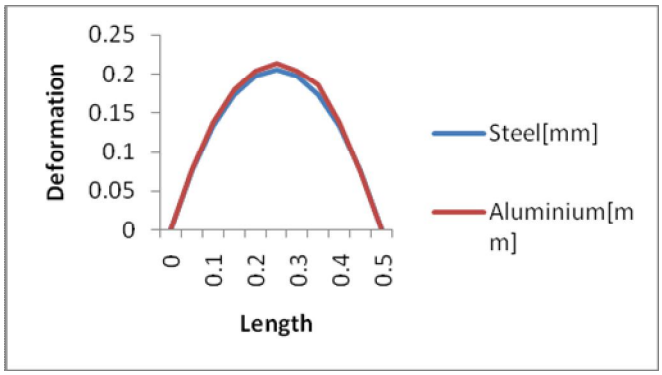

Fig 15 Deformation along X axis

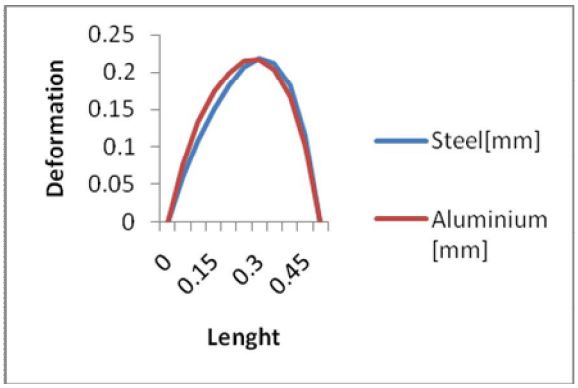

Fig 16 Deformation along X axis

There is a huge difference for stresses in steel and aluminium material whereas the deformations are nearly same not much difference in them.

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