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Stress and Thermal Analysis of Hollow Die Plate by Ansys

Pritam A. Narlawar

BE Mechanical

A.S. Nilawar

Associate Professor, Mechanical Engineering Department R.C.E.R.T Chandrapur. M.S.

Abstract: *This paper deals with the structural and thermal analysis of a **Hollow Die Plate** which is used as a hot die for moulding. The thickness of the plate plays an important role in stress and thermal analysis. So it should be as low as possible so as to make it economical for use with minimum thermal resistance. Due to low thickness the resistance to heat flow is also low thus improves the heat transfer rate. The stress analysis is done for 10 mm thickness of the plate followed by its analytical verification. The thin plate as considered is within the allowable limit thus safe. Further the thermal analysis of thin plate is done to find the temperature variation through the plate. The results are verified by the analytical method.*

Keyword: *Stress Analysis, Thermal Analysis, FEM, Hollow Die Plate.*

1. INTRODUCTION

Flat plate Die:-It is a hollow die which is used to mould thin plate/sheets of metal/paper/green leaf. For the purpose of moulding the most essential thing which is required is the heating. The heat which is used/required is the unconventional one instead of conventional heat. Thus for unconventional heating the die is kept hollow.

Now from the cost economy point of view and from thermal resistance point of view the thickness of the flat plate die is optimised with the help of ansys software. During moulding the mould is subjected to bending stress due to which the die in this case the thin flat plate may get bends due to excessive stress. Thus in order to have safe die for use the maximum bending stress is calculated.

The final optimised dimensions obtained is then verified by the analytical method. After this the thermal analysis of the flat plate is done by ansys software. Then again the values obtained by ansys is verified by the analytical method.

2. ANSYS

ANSYS is a general purpose software, used to simulate interactions of all disciplines of physics, structural, vibration, fluid dynamics, heat transfer and electromagnetic for engineers. So ANSYS, which enables to simulate tests or working conditions, enables to test in virtual environment before manufacturing prototypes of products. Furthermore, determining andimproving weak points, computing life and foreseeing probable problems are possible by 3D simulations in virtual environment. ANSYS software with its modular structure as seen in the table below gives an opportunity for taking only needed features. ANSYS can work integrated with other used engineering software on desktop by adding CAD and FEA connection modules.

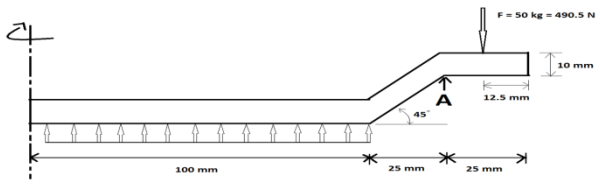
3. FEM

In the present world a need for optimization of any mechanical element is very essential from economic as well as mechanical point of view. For this purpose there occurs a need of finite element method (FEM). It is also known as finite element analysis (FEA). From an engineering standpoint, the FEM is a method for solving engineering problems such as stress analysis, heat transfer, fluid flow and electromagnetics by computer simulation. Millions of engineers and scientists worldwide use the FEM to predict the behavior of structural, mechanical, thermal, electrical and chemical systems for both design and performance analyses.

4. Structural Analysis

Stress is defined as the internal resistance set up by a body when it is deformed. Stress analysis is a general term used to describe analyses where the results quantities include stresses and strains. It is also known as a structural analysis.

5. BY ANALYTICAL METHOD



Taking moment at point A,

M = F*x

= 490.5*12.5

= 6131.25 N mm

Now, $Z = \frac{b*h^2}{6}$

Where, b= πD (circumference)

H=10 (plate thickness)

$\therefore$ Z=$\frac{\pi*250*10^2}{6}$

= 13089.97 mm^2

Bending stress at point A,σ_b=$\frac{M}{Z}$

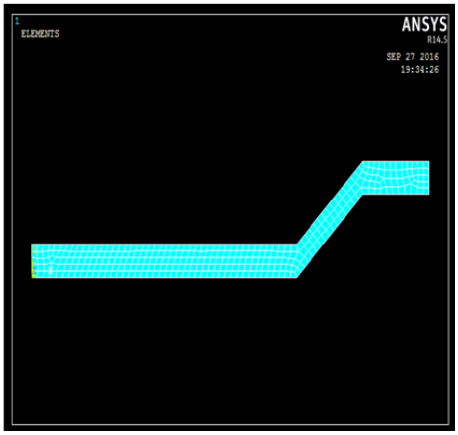
σ_b=$\frac{6131.25}{13089.97}$

σ_b= 0.4684Nmm^2

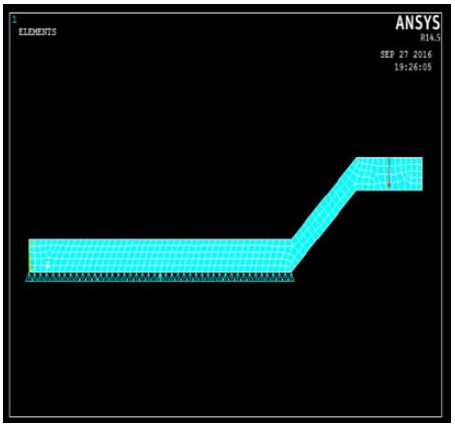
σ_b= 0.4684 MP$_a$

6. BY ANSYS

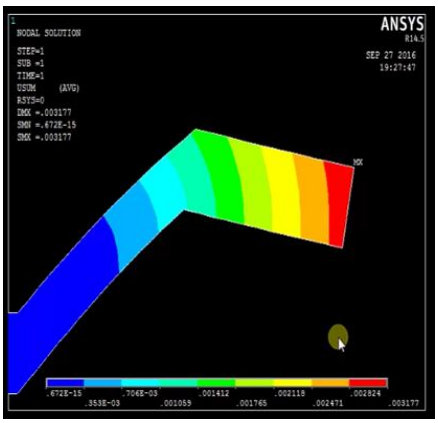
The following are the images of the stress analysis performed on the flat plate:-



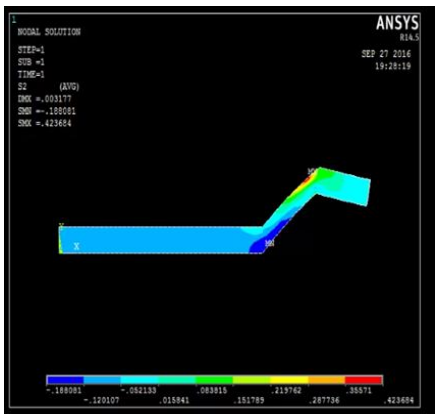
Meshed Area



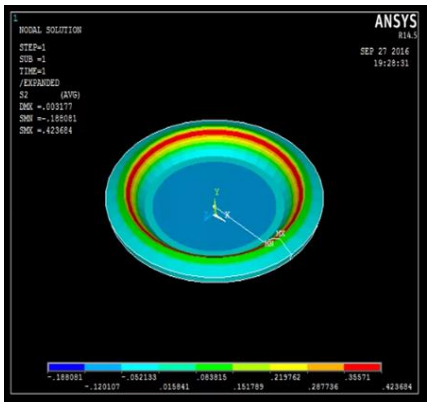
Applying Load



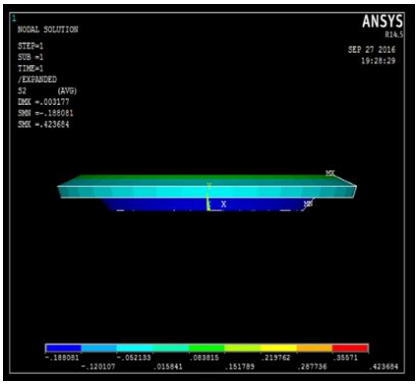
Zoomed View of final result



Without Expansion view



Isometric View



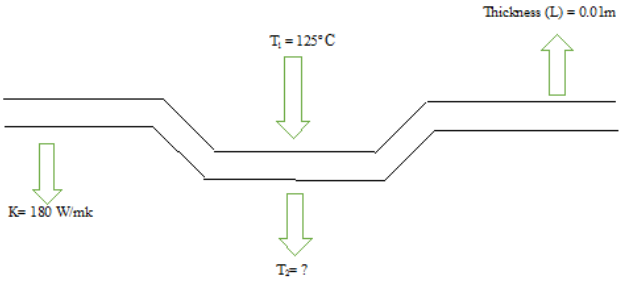
Front view

7. THERMAL ANALYSIS

Stress in a body or structure due to inequalities of temperature. Thermal stresses are created when a change in size or volume is constrained due to change in temperature. Thermal stresses are created by thermal expansion or concentration forces and pressure created by thermal stresses can be quite large.

Thermal analysis is a branch of materials science where the properties of materials are studied as they change with temperature.

8. BY ANALYTICAL METHOD



We know that, Under steady state condition,

$Q_{conduction} = Q_{convection}$

$[KA_c(T_1 - T_2)]/ L = hA_c\Delta T$

$[K(T_1 - T_2)]/ L = h\Delta T$

$[180(125-T_2)] / 0.01 = 10 (T_2 - 35)$

$[180(125-T_2)] / 0.01 = 10T_2 - 350$

$22500 -180T_2 = 0.1T_2 - 3.5$

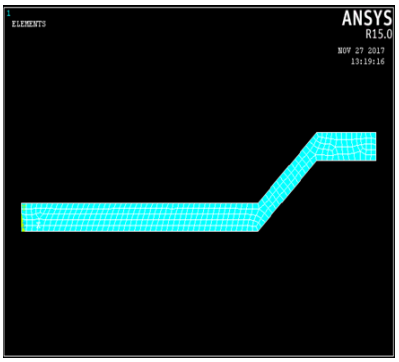
$22500 + 3.5 = 0.1T_2 + 180 T_2$

$22503.5 = 180.1T_2$

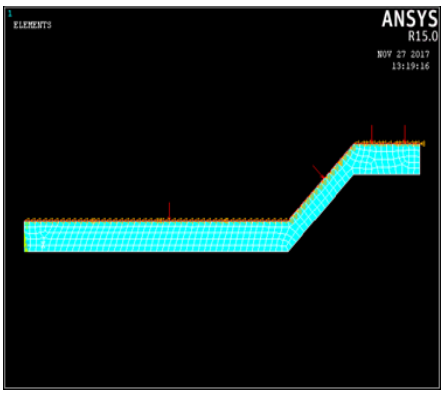
$\therefore T_2 = 124.95\ ^{o}C$

9. BY ANSYS

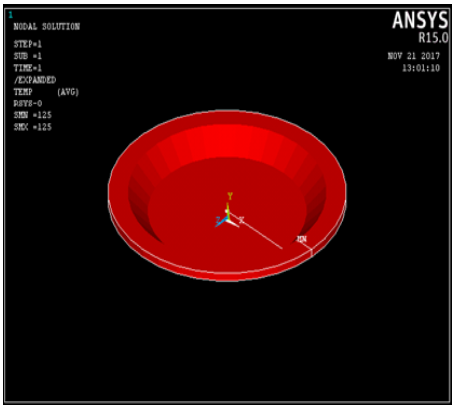
The following are the images of Thermal Analysis performed on the flat plate:-



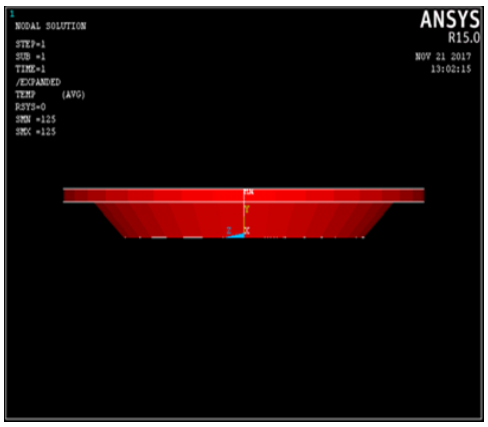
Meshed Area



Applying Load



Isometric view



Front view

10. RESULT

The stress analysis value of Flat plate die by analytical method is found out to be 0.4684 MPA and that by ansys is 0.4237 MPA.

The thermal analysis value of Flat plate die by analytical method is found out to be 124.95^{o} C and that by ansys is 125^{o} C.

11. RESULT DISCUSSION

The error in Stress values by Analytical method and Ansys is found to be – 9.56%.

The error in Thermal Analysis values by Analytical method and Ansys is found to be 0.04%.

Both the errors are within the permissible range of 5 to 10 %.

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