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TEMPERATURE DISTRIBUTION IN A VERY SOFT-CAST STEEL FLAT SOLID IS INVESTIGATED NUMERICALLY AND BY EXPERIMENTATION

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ABSTRACT

Optical device bending is a complicated method in flat solid forming within which a optical device heat supply is employed to form the metal sheet. during this paper, temperature distribution in a very soft-cast steel flat solid is investigated numerically and by experimentation. optical device heat supply is applied through curvilineal ways in sq. flat solid elements. Finite part (FE) simulation is performed with the ABAQUS/CAE commonplace software package package. Material property of AISI 1010 is employed in metallic element model and experiments. The aim of this study is to spot the response associated with deformation and characterize the result of optical device power with relevancy the bending angle for a sq. sheet half. associate degree experimental setup together with a Nd:YAG optical device Model IQL-10 with most mean optical device power of five hundred W is employed for the experiments to verify metallic element analysis results. it's determined that numerical results square measure comparatively in sensible agreement with the experimental results. Results additionally show that increasing optical device power will increase the bending angle.

1.INTRODUCTION

Laser forming may be a method of bit by bit adding plastic strain to a metal element to get the required form. It will be used for forming straight bends in high strength metals like metal rather than hot brake forming. This method involves scanning a targeted or partly defocused light beam over the surface of a piece piece to cause localized heating on the bend line. The sharp thermal gradients within the material cause the sheet to bend either toward or aloof from the optical device supply. The ensuing deformation of the fabric, which is, bending toward the light beam, is permanent. By continuance the optical device forming method, either with overlapping or parallel scans, bend of desired angle and radius will be obtained. The bending angle is within the vary of zero.5-1.5 degree in one pass. this can be the increment of the method. Therefore, there's a stronger management on bending angle with none spring back result. Eliminating the spring back during this method may be a major advantage over mechanical bending. massive bending angles will be obtained by various optical device passes. Kyrasanidi et al. [1] introduced associate degree analytical model for the prediction of distortions caused by the optical device forming method through constant investigation and method optimisation. Zhang and Michaleris [2] have compared Eulerian approach with Lagrangian approach as a result of each approaches will be applied within the modeling of optical device forming processes, whereas Cheng and statue maker [3] targeted on simplified analytical solutions. completely different thermo-mechanical simulations are given by Hu et al.[4], Shichun and Zhong [5], Zhang et al. [6] and Hsieh and statue maker [7] however a number of the earliest works on optical device forming of flat solid into two-dimensional form square measure attributed to Namba [8, 9]. The optical device forming method was 1st sculpturesque by Vollertsen et al victimisation each the finite distinction methodology (FDM) and Finite part methodology (FEM) [10]. Vollertsen has prompt a semi empirical model to predict bending angle as a perform of fabric and optical device parameters [11, 12]. Kyrsanidi et al [13] have developed a numerical model of the optical device forming method for steel by employing a coupled transient thermal-structural metallic element analysis. Edwardson [14] presents associate degree investigation into the 2 and 3 dimensional optical device forming of bimetallic elements. during this paper, 1st a numerical model victimisation FEM is projected for simulating the optical device bending method. It includes 3 dimensional nonlinear transient couple thermo-mechanical analysis taking under consideration the temperature dependency of the thermal and mechanical properties of the fabric. The results of this numerical model square measure then compared with the experimental results of the optical device bending method performed with a Nd:YAG optical device .

FINITE PART MODEL

The assumptions created for the numerical modeling square measure as follows: The work material properties square measure isotropic , the optical device works in a very continuous wave mode, no melting happens within the optical device forming method and no external forces square measure applied to flat solid.

Mises criterion is employed because the yield criterion within the simulation method. additionally to those, the flat solid is flat and freed from residual stresses.

ELEMENT AND MESH

Three dimensional nonlinear coupled thermo-mechanical solid components with eight nodes C3D8T square measure used for thermal and structure analysis. For the analysis, identical mesh model is employed. As shown in Fig. (1), to realize an honest accuracy close to the warmth supply, fine meshes square measure necessary. to scale back the run time, the coarse meshes square measure used removed from the warmth supply and 3 components square measure used across the thickness of the sheet to realize applicable accuracy. Moreover, the warmth generated by plastic deformation is negligible as a result of it's tiny compared with heat input by the light beam. The structural analysis will then be decoupled from thermal analysis. The thermal analysis is completed 1st with a 3 dimensional heat conductivity equations to get temperature filed, so the results square measure used because the thermal loading for the mechanical analysis.

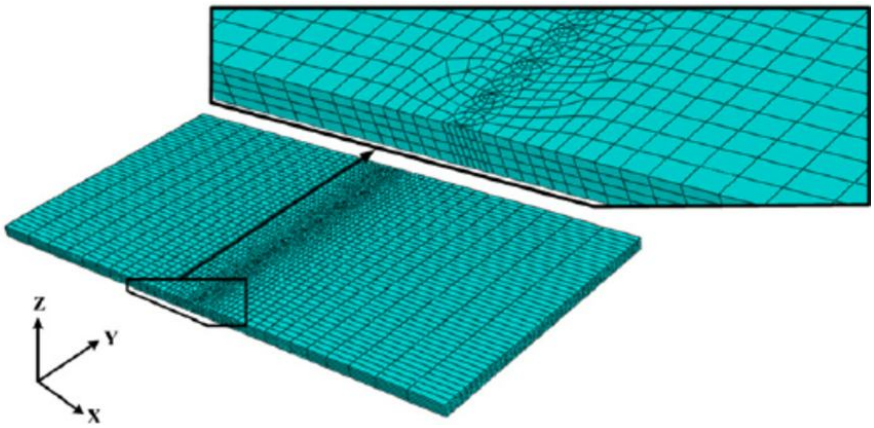

Fig:-1 Metal sheet mesh general view.

THERMAL BOUNDARY CONDITIONS

The thermal load is given within the sort of thermal flux which may be roughly expressed by a sq. form perform, and warmth flux generated by the light beam is applied solely to the highest surface of the flat solid. The boundaries square measure sculpturesque by natural heat convection and radiation.

Mechanical Boundary Conditions

In mechanical analysis, necessary constraints square measure intercalary to eliminate rigid body movement in keeping with the fixture employed in real experiments. The boundary conditions square measure zero displacement at one aspect of the flat solid that is totally strained and also the different aspect is taken into account free.

MATERIAL PROPERTIES

Thermal properties (thermal physical phenomenon, heat energy and convective heat transfer) and mechanical properties (modulus of physical property, Poisson�s quantitative relation, density and yield stress) square measure temperature dependent and shown in Tables(1and 2).

EXPERIMENTAL SETUP A Nd: YAG optical device with most optical device power of five hundred W was used for experiments as shown in Figs. (2) and (3). The wave length of Nd:YAG optical device light-weight is 1064nm and operative with vi.3mm nominal beam diameter. The light beam is transmitted by fibre optic beam delivery of 800 µm core to the work surface. The experimental optical device bending method has been organized wherever the optical device head is stationary and also the work set on the machine table could move in 2 directions x, y within the horizontal plane relative to the optical device head that is aligned on the z axis. As shown in Fig. (3) a CNC shaping machine table was used for work table and inserting the work on the table and additionally to be ready to program the bending path. The CNC shaping machine table is 160x510mm with T-slots that facilitate fastening the work on the table. The optical device heat at the top of the fibre optic was mounted at the top of the immobilized spindle of the shaping machine. the protection precaution for victimisation the Nd:YAG optical device is vital and also the work table of the shaping machine and optical device head were hid in a very metal cabin as shown in Fig. (2) with a door for access. Shielding supports the protection of optical components once operative in associate degree industrial setting. The fumes and shielding gas (pure Argon) were exhausted by the fan mounted on prime of the cabin. The cabin was equipped with a camera and lightweight to be ready to observe optical device bending method on a tv screen outside the enveloped cabin. The cabin is provided with safety switches to prevent the operation once the cabin door opens.

Fig:-2 The Nd:YAG laser rig with the X-Y table controller.

2.COMPARISON BETWEEN NUMERICAL AND EXPERIMENTAL RESULTS

The numerical results for the bending angle square measure compared with results obtained from experiments to verify the validity of the numerical simulation. Fig. (4) shows the temperature field as a result of the primary pass and NT11 is that the parameter that shows temperature in FEM contours. Fig. (5) shows the distortion going down when the primary pass. this means that the 2 corners of the free finish of the sheet square measure distorted over the centre of the sheet. U3 is that the parameter showing displacement in FEM contours. Numerical and experimental results square measure shown in Fig. (6). It will be seen that the numerical and experimental results square measure in fairly sensible agreement. This Figure additionally shows that increasing the optical device power will increase the bending angle.

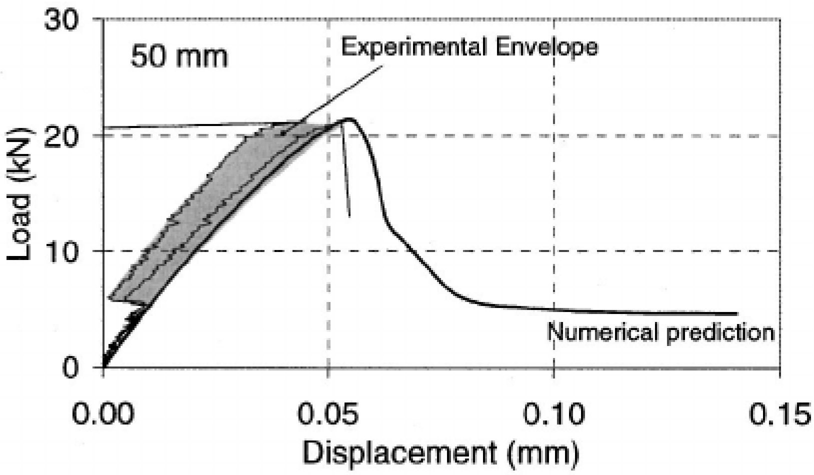

Fig:-3 Comparison between experimental and numerical results.

3.CONCLUSIONS

In this paper, a 3 dimensional FEM model for 3 dimensional thermo-mechanical simulation of the optical device bending has been developed. Experiments were conducted by Nd:YAG optical device to validate the simulation results. A numerical model is projected for simulating the optical device forming method that features the nonlinear transient coupled thermal-mechanical analysis with the temperature dependency of the thermal and mechanical properties of the fabric. The light beam is sculpturesque as a step-wise moving heat supply. Numerical result for bending angle is compared therewith obtained from the experiments to verify the validity of the numerical model. The numerical and experimental results square measure comparatively in sensible agreement. Increase in optical device power semiconductor diode to a rise in bending angle.

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