EXPERIMENTAL AND NUMERICAL ANALYSIS OF METAL RADIATED BY AN INFRA-RED HEATER

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ABSTRACT
In this paper, an experimental and numerical technique have been used to study heat generation of mild steel plate radiated by an infra-red heater. Initially, an experiment has been conducted to determine temperature distribution at the selected points on the workpiece. Then, a finite element model (FEM) has been developed to replicate the conducted test. Thermal distribution results from FEM shows good agreement with the experiment results. The result proves the validaty of all the input parameters in the developed FEM model.

Keywords: Finite Element Analysis · Experimental analysis · Heat transfer ·

INTRODUCTION

Heat-assisted bending is one of latest technology has been applied in metal forming processes. One of the advantage of this process is to reduce bending force and increase part stiffness. The process is performed by applying controlled heating on plate surface prior to bending process. Heat generates thermal stresses (without melting) inside the workpiece as additional to contribute to reduce forming forces. The part stiffness is increased due to development of thicker bending region after the forming process. This fact could be achieved with producing distint temperature gradient inside the plate during the bending process. The most crucial heating technique is from a laser heating system that seems to be the best type of heat source for the heat-assisted bending process. This due to an establishment of a huge temperature gradient along the part thickness [known as temperature gradient mechanism (TGM) (Geiger,2004).

Instead of using laser, heat-assisted bending could be established by using different type of heat source, including the infra-red heater. Considerable research were carried-out numerically and experimentally to investigate heat generation on the metal surface under localised heating condition. Researches by Hao and Li was focused on numerical analysis that used to determine on how to model power input based on Gaussian distribution (Hao & Li, 2009). Meanwhile, Cheng *et. al* conducted similar research as Hao and Li to determine heat generation inside the workpiece under localised heating condition (Cheng *et. al*, 2006). Beside Gaussian distribution model, the other assumption for heat intensity such as a uniform square, and a point heat source as described (Vollertsen, 1994) The uniform square heat source uses the same peak intensity, while the point heat source was obtained by assuming that the radius of the Gaussian heat source approaches zero. In this paper, a finite element method has been used to replicate experimental result to model temperature contour inside the metal plate, with intention to establish TGM profile using infra-red heater as a heat source.

EXPERIMENTAL WORK

Specimen preparation

In experiment, the testpieces were cut to size 100 mm x 30mm. The primary measurements were involved temperature investigation at different locations, from which temperature gradient can be obtained as a function of time. The eight channels data acquisition device was used to cater all the planned data points required in this experiment. Thermocouples type K placed in eight locations where four of them were fitted on the front plate (heated area) and the others on the rear plate (cooled area) The location for every thermocouple and their distance from the centre line are shown in Figure 1.

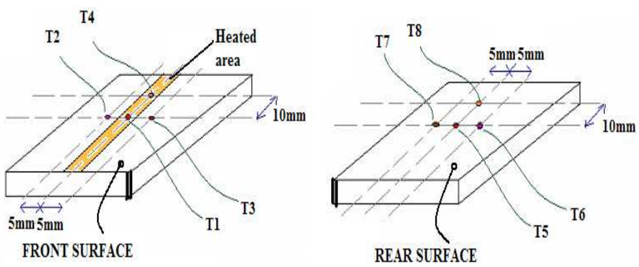

Figure-1. Thermocouple locations on both sides of specimen

In this experiment, halogen heater model LineIR 5209-10, manufactured by Research Incorporated, USA has been used (Research inc, 2009). The main components of the heater comprises of the heating module, cooling system and electrical system. The heating module or halogen lamp used are composed of a coiled tungsten filament (length 254 mm), contained in a quartz tubular enclosure (diameter 10 mm) filled with Argon gas and coated on its back with a aluminum reflector in order to increase the heat flux received by the product.