21st Benelux Meeting

on

Systems and Control

March 19 – 21, 2002

Veldhoven, The Netherlands

Book of Abstracts

Bram de Jager and Hans Zwart (eds.)
Book of Abstracts 21st Benelux Meeting on Systems and Control
Technische Universiteit Eindhoven, Eindhoven, 2002
ISBN 90-386-2893-5

Weld Pool Control in Laser Welding

Sjoerd Postma
Netherlands Institute for Metals Research
P.O. Box 5008, 2600 GA, Delft
the Netherlands
s.postma@ctw.utwente.nl

Ronald G.K.M. Aarts
University of Twente, Faculty of Engineering
P.O. Box 217, 7500 AE, Enschede
the Netherlands
r.g.k.m.aarts@ctw.utwente.nl

Introduction

The objective of this work is the design of a feedback control system for the laser welding process, which is able to control the penetration depth of the weld. Firstly the possibilities to control the penetration depth of a weld when only partial penetration is demanded, for instance in the case of overlap configurations, will be discussed. Furthermore a controller which is able to guarantee full penetration will be introduced. Full penetration is an important quality in the production of Tailor Welded Blanks.

Experimental set-up

Optical signals emitted from the weld pool area are used as an indication of the status of the welding process, see figure 1. With four, co-axially placed, sensors it is possible to detect the transition from a fully to a partially penetrated weld in the thin mild steel sheets used. Also during partial penetration welding it is possible to relate the sensor signal strength with the penetration depth of the weld, see figure 2.

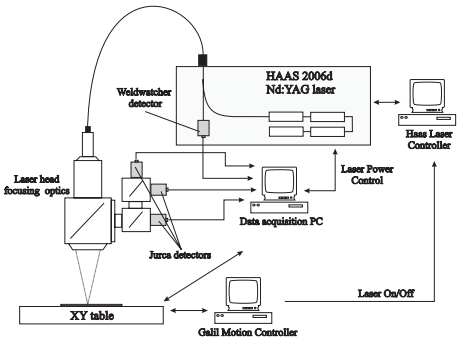

Figure 1: The experimental set-up.

System Identification

Detailed knowledge of the dynamic behaviour of the system is essential when designing a feedback control system. With the use of system identification dynamical models of the laser and the welding process (including sensor dynamics) have been obtained, in both a fully as well as in a partially penetrating parameter region.

Feedback control

Two feedback systems will be discussed. The first controller has been designed based on the identified dynamic model

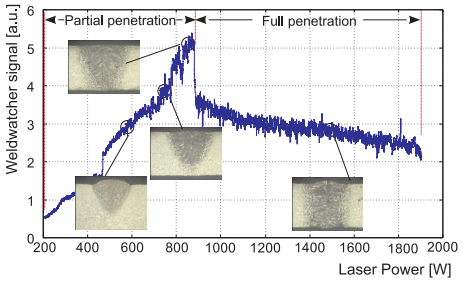

Figure 2: Weldwatcher sensor signal versus laser power at a speed of 100 mm/s. Typical weld cross-sections are included.

of the process. With this system the penetration depth in an overlap weld is controlled [1]. The objective here was to make a weld without penetrating the bottom plate. The system has been tested by varying the welding speed. In figure 3 an example of an experiment using this feedback is shown.

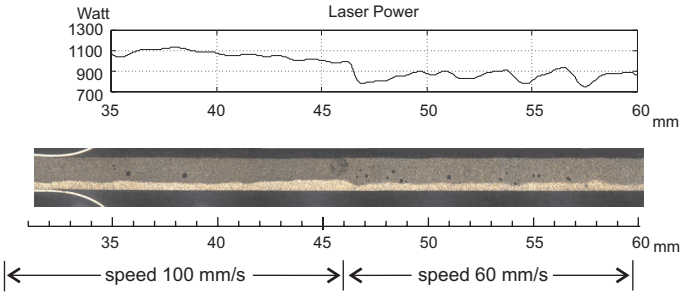

Figure 3: Longitudinal section of a controlled overlap welding experiment and the corresponding laser power.

A second kind of feedback was developed to maintain full penetration, based on a threshold condition indicating the difference between partial and full penetration. This controller is able to maintain full penetration near the edge between partial penetration, using the minimum laser power required for full penetration at a certain welding speed.

References

[1] S. Postma, R.G.K.M. Aarts, A.J.F.M. Hesemans, ”Penetration feedback control in overlap laser welding of sheet metal”, Proceeding of WESIC 2001, pp.495-503, June, 2001