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Cost Modeling of Laser and Abrasive Water Jet Cutting Processes

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Extended Abstract

Over the past years, unconventional machining has had several breakthroughs and astonishing technological advancements. This turned into an increasing number of industrial applications and corresponding research topics. Among unconventional machining methods, Laser Beam Machining (LBM) and Abrasive Water Jet Machining (AWJM) have attracted noticeable attention due to their unique capabilities such as high productivity and precision. Numerous articles have discussed their advantages and limitations compared to traditional machine tools. In parallel to these studies, cost modeling of machining process has to be considered to facilitate the selection of manufacturing methods from an economical point of view. An appropriate estimation of manufacturing cost is essential for manufacturers and costumers for making informed decisions. Different efforts have been made to estimate cost of non-conventional manufacturing processes (Johan Berglund. 2006, S. H. Yeo et al. 1997). However, limited studies have reported on the modeling and estimation of cutting cost for LBM and AWJM.

To address this need, the current work focuses on the cost modeling of LB and AWJ cutting processes. Quantitative comparison of two technologies is provided along with qualitative discussions. The proposed model has the capability to accurately estimate the final unit cost per meter for various machining parameters and the initial cost inputs. The model considers the following two major cost components: (i) the fixed costs, which include capital cost, cost of interest, insurance, space, and maintenance; (ii) the variable costs, consisting of abrasive powder, nozzle, orifice, and water for AWJM, and assist gas, lens, and nozzle for LBM, in addition to common costs such as cost of labor, material, and electricity. The model is derived from general calculation formulas used in manufacturing economics. Having each of fixed and variable costs (€/hr) multiplied by total time of cutting for one meter length part, the costs converted to euro per part, and final cost is calculated by summation of all sub costs.

Calculations show that the cost per meter decreases from 15 € to 13 €, as water pressure increases from 15 to 25 MPa for AWJM. This trend is due to the increase of jet flow rate, which causes higher material removal rate and consequently lower cost per meter. This justifies the reduction of final cost, as the consumption of abrasive particles increases. It is found that the cutting cost decreases by increasing the number of parts cut per unit of time. The same result obtained when the number of working shifts per day increased. The model has shown that the higher the purity of the cutting gas, the higher is the cutting speed; similarly, the lower is the cost per part in LBM. A reduction of 12% in the total cost was observed when cutting speed increased by 20%. The cost comparison of two unconventional manufacturing technologies based on various input parameters reveals that LBM in cutting mild steel sheets with thicknesses up to 1.5 cm is the optimum choice. However, it is important to note that optimum

economical solution strongly depends on customer requirements, concerning also about the quality of the product.

References

Johan Berglund. (2006). Cut Cost Calculation. Master of Science Program, Industrial Economics.

S. H. Yeo, B. K. A. Ngoi, L. S. Poh and C. Hang. (1997). Cost-Tolerance Relationships for Non-Traditional Machining Processes. “Int J Adv Manuf Technol”.