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Analytical methodology for efficient design of pulsed electromagnetic blank holding system

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Pulsed electromagnetic blank holding system is a new developed facility using pulsed attractive Lorentz force as blank holding force for sheet metal forming process. The system consists of two electromagnetic coils series-connected and a RLC circuit energizing them. The key metrics of the system are the peak value and pulse width of the pulsed blank holding force. In this paper, an analytical methodology was proposed for efficient design of the system. To meet this goal, an analytical model was built to establish an easily-accessible mapping between the design space (i.e., the geometric parameters of the coils, and the electrical parameters of the RLC circuit) and the target space (i.e., the magnitude and pulse width of the blank holding force). In the model, the inductances, resistances and inductance gradient of the coils were analytically expressed in terms of the geometric parameters of the coils. The inductances and the resistances, combined with the RLC circuit parameters, deduce the expression of the discharge current. Then, the calculated discharge current and the inductance gradient were used to calculate the pulsed attractive Lorentz force (the blank holding force). Finite element analysis and experimental measurement have been performed to validate the proposed model, showing well accuracy of the model.

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