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Toward flexible coil design for electromagnetic forming of both sheet and tubular metal by combining of coil and field shaper: Principle, Optimization, and Experimental validation

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Electromagnetic forming (EMF) is a metal forming process based on pulsed magnetic field. Instead of using mechanical force as in conventional forming process, EMF shall reshape metal workpiece by using a pulsed Lorentz force which is induced by a pulsed magnetic field. By adjusting the geometry configuration of the field generator (namely, coil), the Lorentz force with manifold spatial patterns can be generated, providing a high design freedom for diverse forming missions. And the introducing new spatial pattern for the Lorentz force by novel coil design is amongst the fundamental problems in EMF research.

In this paper, we introduce a new coil design for EMF process, which could be simultaneously used for the forming mission of both sheet and tubular metal workpieces. To be specific, the proposed design could be used to reshape the local geometry features for a circular hole in sheet metal workpiece, as well as the local geometry feature for the end of tubular metal workpiece. The proposed coil design consists a solenoid coil and a field shaper. While the solenoid coil is the primary field generator, the field shaper is a dedicated tool made from highly conductive materials, which is used to further reshape the spatial pattern of the magnetic field. And the core of the design is to optimize the geometry of the field shaper. We shall firstly detail the design procedure, including an illustration on process principle and an optimization on the system parameter. And then, we shall validate the feasibility of the proposed process by experiments on the developed protype.

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