Simulation of an electromagnetic sheet shearing system

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I. Introduction

- To shear the sheet with a cross-section of 85 mm×10 mm, the peak of electromagnetic force generated by the system should be at least 100 tons, and the shear work is supposed to be more than 1.7 kJ.

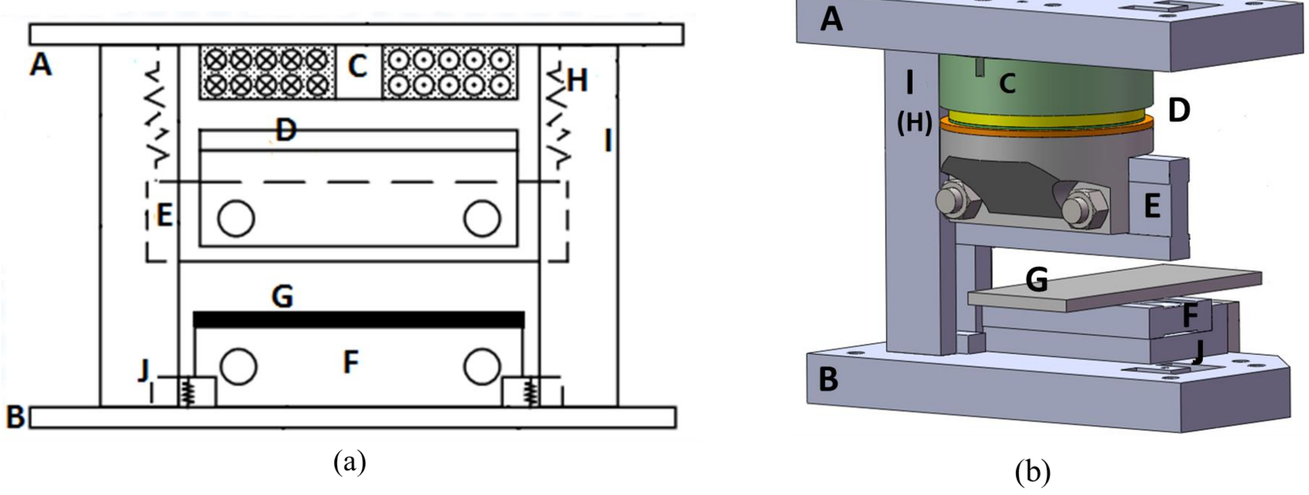

Fig. 1. the schematic diagram of EMS system: A-upper body; B-lower body; C-coil; D-driver plate; E-upper blade; F-lower blade; G-steel plate; H-springs; I-roller bearings.

II. Design model

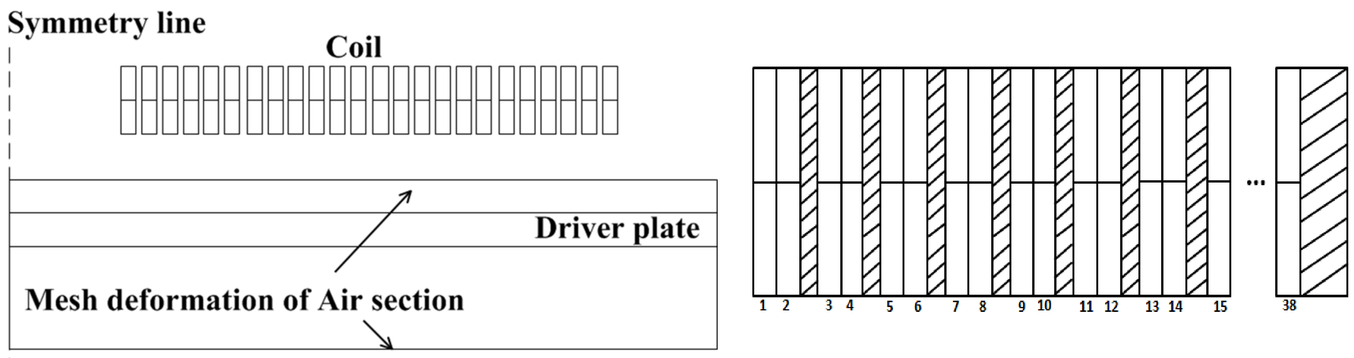

Fig. 2. 2D axisymmetric finite element model

Parameters	Values	unit
Power supply voltage	15	kV
Power supply capacitance	320	μF
Crowbar resistance	0.2	Ω
Line inductance	5	μH
Line resistance	30	mΩ
The radius of driver plate	85	mm
The height of driver plate	10	mm
The inner radius of the coil	10	mm
The height of the coil	12	mm
Clearance between the coil and the driver plate	5	mm

Table 1. The main parameters of the simulation

- "Global ODEs and DAEs" model
- "Magnetic Fields" model
- "Heat Transfer in Solids" model
- "Moving mesh" model
- "Solid Mechanics" model

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III. Results

- The peak value of the force is more than 100 tons, the pulse of the force is about 1 ms, the shear work is greater than 1.7 kJ, all meeting the need for design.

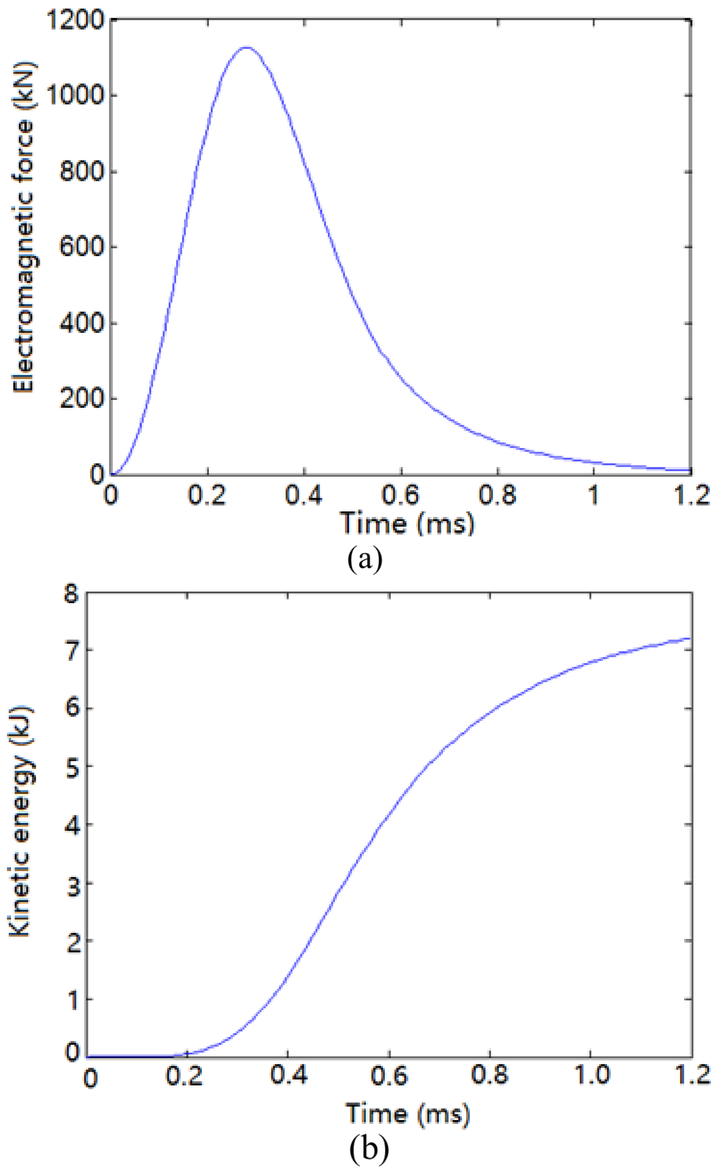

Fig. 3. Calculated values of the driver plate for a voltage of 15 kV: (a) force; (b) kinetic energy

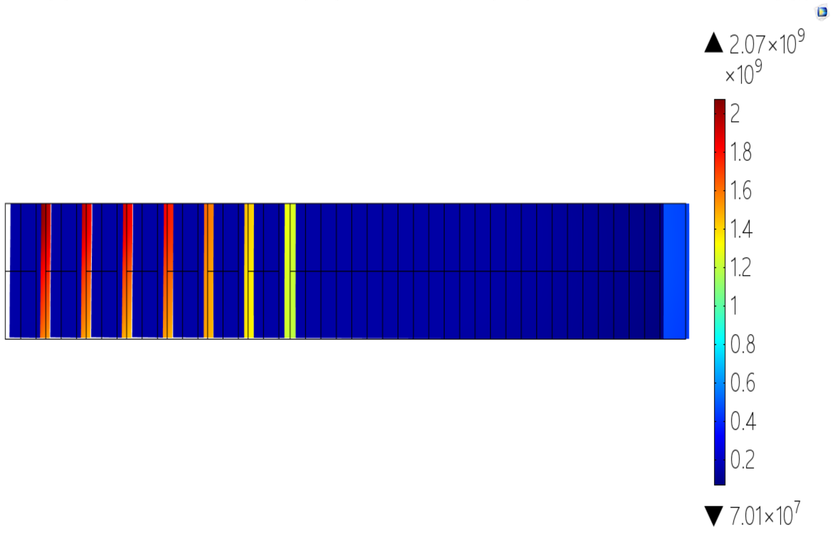

Fig. 4. The von Mises stress distribution in the cross-section of the coil

- The maximum von Mises stress in the Zylon is about 2 GPa, ensuring the long coil service life.

IV. Conclusion

- The designed electromagnetic sheet shearing system has the capacity to shear the steel plates with a thickness of 10 mm.

Reference

1. M. Kamal, *A uniform pressure electromagnetic actuator for forming flat sheets*, Ph.D. dissertation, The Ohio State University, 2005.