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A Transfer Learning method for deep drawing force prediction of sheet metal

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Introduction

Deep drawing is a widely used metal forming. Accurately predicting the deep drawing force (DDF) is essential for tool design and process optimization. This study proposes a transfer learning-based data-driven model to efficiently predict DDF under various process conditions. By leveraging analytical formulas for pre-training and fine-tuning with a small amount of high-fidelity data.

Methods

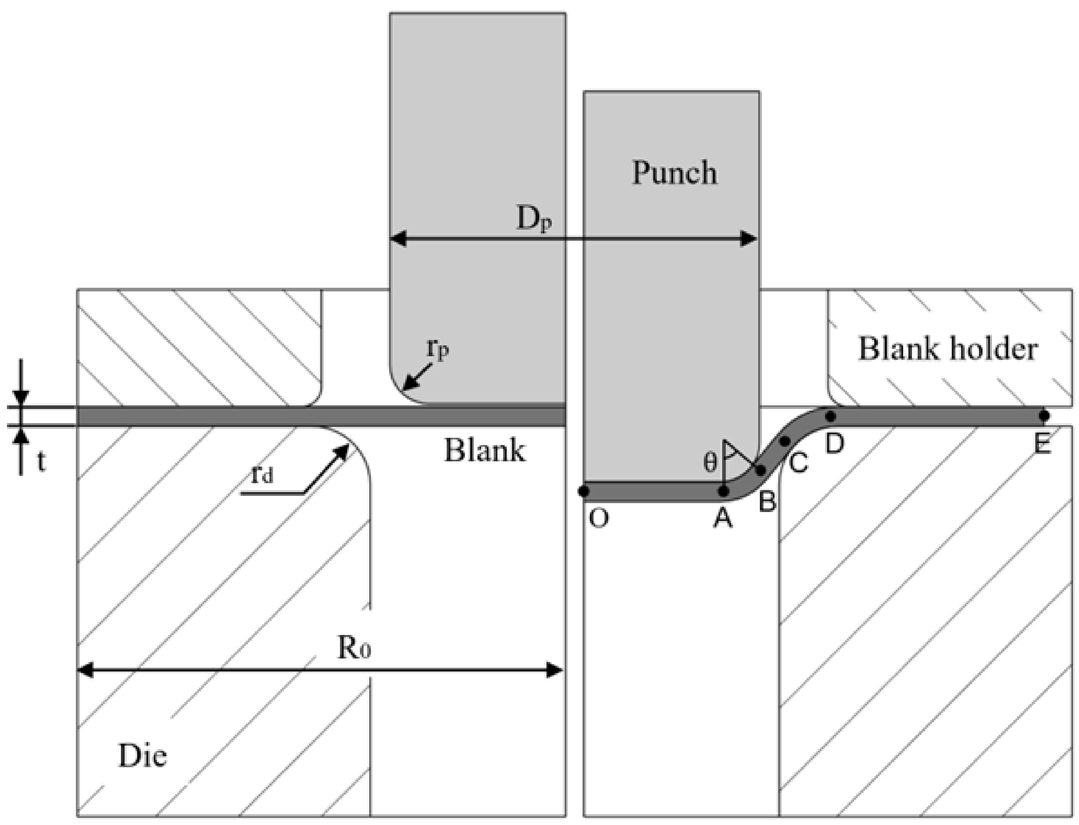
➢Data Generation

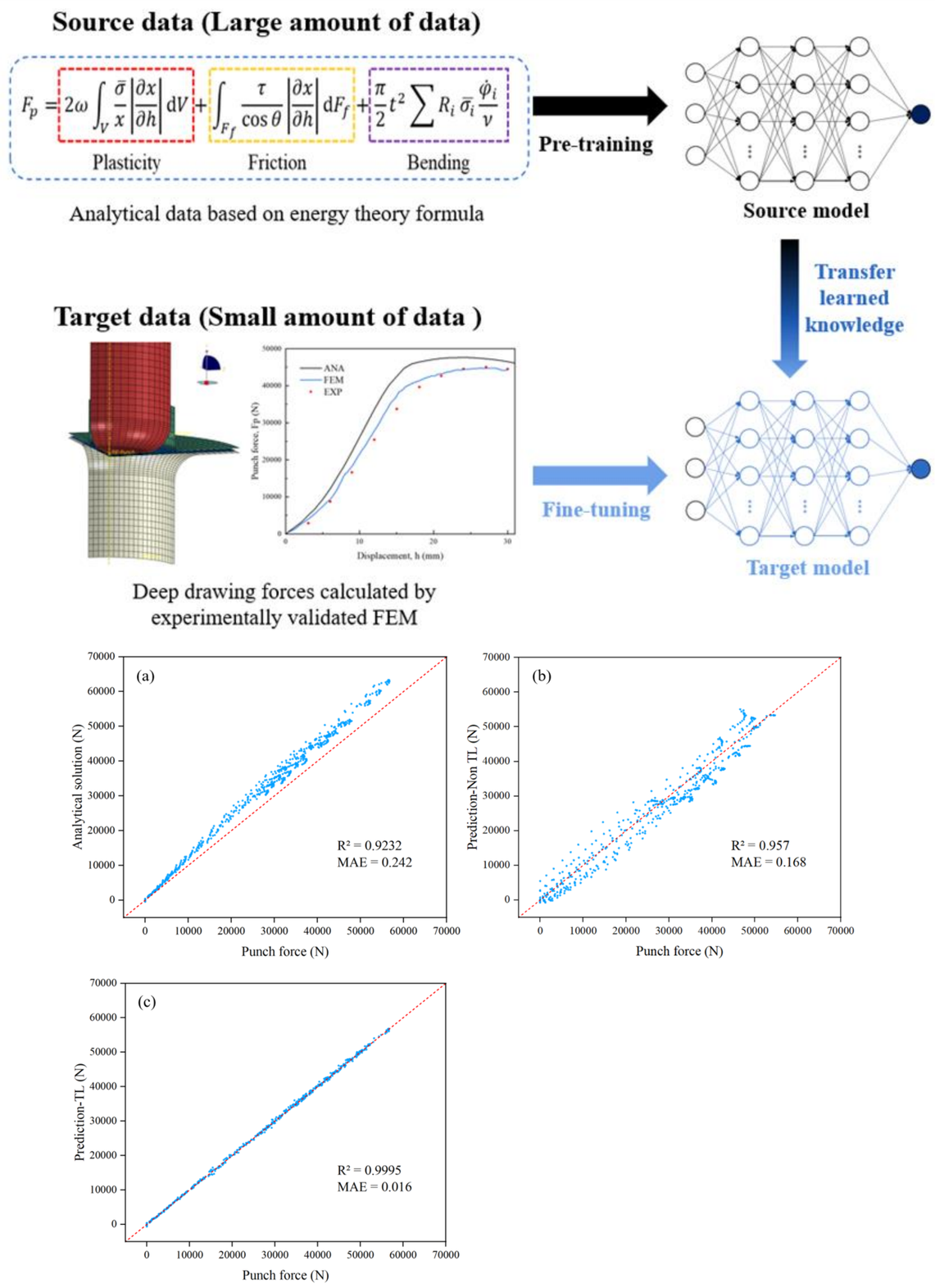
- Source Domain: Large dataset generated using analytical formulas based on the energy method.
- Target Domain: Small high-fidelity dataset obtained from experimentally validated finite element simulations.

➢A deep neural network (DNN) was designed to predict punch force

➢Transfer learning Strategy is utilized to incorporate the target data into the pre-trained model

Graphics / Images





Conclusions

Transfer learning significantly improves the prediction accuracy of deep drawing force under data-scarce conditions. By leveraging analytical knowledge for pre-training and fine-tuning with limited high-fidelity data, the proposed TL model outperforms direct training models in both accuracy and stability. This approach reduces reliance on costly experiments and shows strong potential for generalizing to components with different geometries, offering a promising tool for efficient metal forming process optimization.