

Technology for Building Digital Twins with Circulation of Information between CAE and Production Robots

-Proposal for ICDT to Enable Information Circulation between Design and Manufacturing-

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To achieve the performance and quality defined during the design phase in mass production processes, it is important to connect design information and manufacturing information. One challenge, however, is that there are discrepancies between the design conditions derived from CAE and the actual behavior of production robots. In addition, the communication of design intent and the feedback of manufacturing insights are insufficient. This study proposes an Information Circulation Digital Twin (ICDT) that establishes a bidirectional connection among CAE, a robot teaching simulator, and actual machining.

The concept of the ICDT is shown in Fig. 1. The ICDT introduces a concept called “drive parameters,” a set of unified evaluation metrics that link robot motions and machining states, to convert machining conditions determined through CAE into robot motions. It also feeds correction and quality data acquired from actual machining back to CAE. This establishes a closed-loop information flow between design and manufacturing.

To verify the effectiveness of the proposed method, an evaluation was conducted with actual equipment, focusing on the roll hemming process for an automobile hood. A schematic diagram of the drive parameters applied to the roll hemming process is shown in Fig. 2. CAE analyses were performed using indentation depth and flange height as design variables, and the relationship with hemming quality was organized into a phase diagram. The phase diagram is shown in Fig. 3. The results showed that the acceptable range is within 3 to 5 mm for indentation depth and 3 to 5 mm for flange height. The results also confirm that applying the machining conditions derived from the phase diagram to an actual robot via the drive parameters leads to the stable formation of a rope hem profile consistent with the CAE’s prediction.

These results demonstrate that the proposed ICDT can reproduce actual forming behavior in CAE and effectively apply the machining conditions designed in CAE to production robots. Therefore, the proposed ICDT is effective as a digital twin platform that enables information circulation between design and manufacturing.

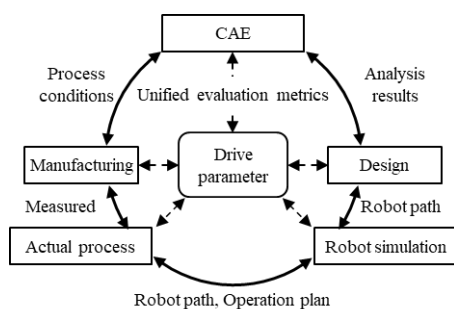


Fig.1 Concept of the information circulation digital twin

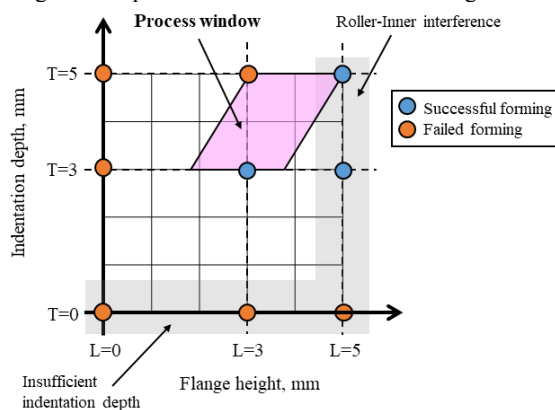


Fig.3 Process Window of Hemming Quality as a Function of Indentation Depth and Flange Height

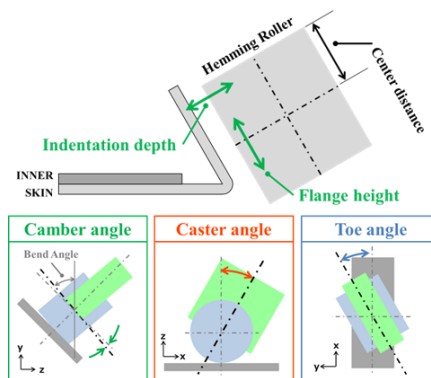


Fig.2 Schematic diagram of drive parameters

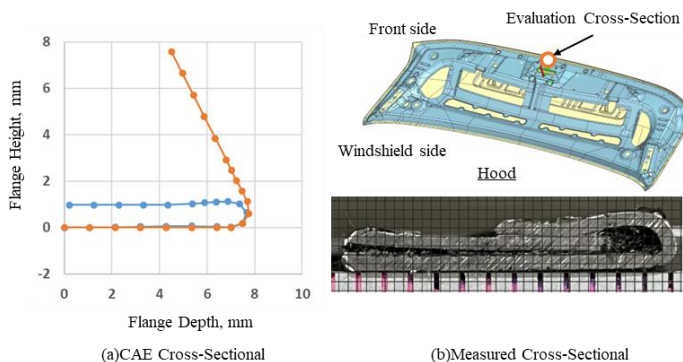


Fig.4 Comparison of roll edge hemming profiles