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Determining the optimal area-dependent blank holder forces in deep drawing using the response surface method

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ABSTRACT

Metal forming processes are often currently highly automated mass production processes for manufacturing a wide variety of metal parts from various industries. Maximizing product quality and consequently minimizing waste and production costs are major goals for those companies exploiting metal forming processes. On the other hand, sheet metal parts become more complex especially because of complex product designs and the usages of higher strength steels that have less formability. Therefore, metal forming processes need to be optimized. This research study demonstrates an optimization system for optimizing the sheet metal forming process using the Finite Element Method (FEM) combined with the Response Surface Method (RSM). The proposed optimization system was tested on an industrial example from the household appliances industry. In this study, it is described as to how to determine optimal area-dependent blank-holder forces in deep drawing process in order to obtain the best possible quality of the drawing part. The optimization system consists of three main steps: modeling, screening, and optimization. The results showed that with better preferences regarding the blank-holder forces, better results can be achieved. Forming and spring-back criteria were taken into account. The number of required numerical simulations using the RSM combined with the Design of Experiment was not critical and was much smaller than using other conventional optimization methods. Therefore, reasonably accurate results can be achieved in a relativity short time, which is one of the main advantages of this method.

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Izvirni znanstveni članek

Določanje optimalnih krajevno odvisnih sil pridrževanja pri globokem vleku z uporabo metode odzivne površine

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POVZETEK

Preoblikovanje pločevine je danes visoko avtomatiziran velikoserijski izdelovalni postopek za izdelavo različnih pločevinastih izdelkov. Maksimiranje kakovosti izdelka in posledično minimiziranje odpada ter proizvodnih stroškov so glavni cilji podjetij, ki se ukvarjajo s preoblikovanjem pločevine. Po drugi strani pa izdelki iz pločevine postajajo vse bolj zapleteni, predvsem zaradi čedalje zahtevnejših oblik in vse večje uporabe visokotrdnostnih pločevin, ki imajo manjšo zmožnost preoblikovanja. Zato se vedno pogosteje pojavlja potreba po optimizaciji postopka preoblikovanja pločevine. Ta raziskava prikazuje sistem za optimizacijo postopka preoblikovanja pločevine z uporabo metode končnih elementov (angl. Finite Element Method – FEM) v kombinaciji z metodo odzivne površine (angl. Response Surface Method – RSM). Predlagan optimizacijski sistem smo preizkusili na praktičnem zgledu iz industrije gospodinjskih aparatov. V delu je opisano, kako določiti optimalno krajevno odvisno silo pridrževanja pri globokem vleku, da bi dobili najboljšo kakovost vlečenca. Optimizacijski sistem sestavljajo trije glavni koraki: modeliranje, presejanje (angl. Screening) ter optimizacija. Rezultati so pokazali, da je mogoče z boljšo konfiguracijo sil pridrževanja dobiti boljše rezultate. Pri optimizaciji so bili upoštevani tako preoblikovalni kriteriji kot tudi kriteriji elastičnega izravnavanja. Število potrebnih numeričnih simulacij se je z uporabo metode odzivne površine in načrtovanjem eksperimentov še zmanjšalo in je tako dosti manjše kot pri drugih običajnih optimizacijskih metodah. Zaradi tega lahko dobimo razmeroma natančen rezultat v kratkem času, kar je ena od glavnih prednosti te metode.

PODATKI O ČLANKU

Ključne besede:
Preoblikovanje pločevine
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Metoda odzivne površine

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