微纳技术与精密机械

基于多点调形原理的旋转曲面连续成形

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摘要： 提出采用连续多点成形方法来实现旋转曲面件的高效、柔性成形。阐述了连续多点成形原理,并与传统的旋转曲面加工方法相对比,分析其所具备的特点。以盘形件为研究对象,建立有限元模型,分析成形过程中的等效应力和塑性应变场分布,通过模拟结果和主应变状态来分析皱曲现象。最后,研制相应的成形装置并进行了实验。结果表明:定心装置和柔性辊作用区的等效应力超过了材料的屈服极限,最大值达到213 MPa;成形件中心区域塑性应变值最大,达到0.07;柔性辊作用区塑性应变值次之,为0.03;皱曲区域的壳单元产生的是切向压缩变形,实验结果和模拟结果基本相同,都介于605~615 mm。应力应变场和皱曲的模拟结果与实际情况吻合,表明成形装置能加工出效果良好的旋转曲面件。

关键词： 柔性加工　连续成形　多点成形　数值分析　旋转曲面

Continuous forming for rotary surface based on multi-point adjusting principle

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Abstract: A Continuous Multi-point Forming (CMPF) method was researched to realize high efficiency and flexible manufacturing for rotary surfaces. The principle of CMPF was described and its characteristics were analyzed by comparing with the traditional rotary surface manufacturing method. By taking a disc-shape suface for an example, the Finite Element Model(FEA) was established, and equivalent stress and plastic strain distributions were analyzed. By simulation results and principal strain vectors, the wrinkling was discussed. Finally, the CMPF equipment was developed, and experiments were performed. Results indicate that the equivalent stresses in the region of center fixing and a flexible roller exceed the yield stress, and their maximum value is 213 MPa; the maximum plastic strain is generated in the center region, and its value is 0.07; the plastic strain in the region of flexible roller takes the second place, and its value is 0.03. Furthermore, shell elements in the wrinkling region generate the compress deformation in a tangent direction in 605-615 mm which accord with the simulation results. It concludes that the simulation results of stress field, strain field and wrinkling are in good agreement with practical situations and the CMPF equipment can manufacture good rotary surfaces.

Keywords: flexible manufacturing　continuous forming　multi-point forming　numerical analysis　rotary surface

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