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钢/聚丙烯/钢板拉深中塑料变形的有限元分析

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摘要: 利用弹塑性大变形有限元法模拟钢/聚丙烯/钢复合层板的拉深成形过程, 研究了聚丙烯板材内的塑性应变发展过程、等效应力分布和总应变能密度分布, 分析了不同变形区域的塑性变形特征. 研究表明: 拉深中复合板的聚丙烯板材分为5个变形区, 即凸缘区(I), 凹模圆角区(II), 凸模与凹模间隙区(III), 凸模圆角区(IV), 凸模底部区(V); 其中, V区是非塑性变形区, I区、II区和III区沿径向伸长变形, 沿周向压缩变形, 沿厚向收缩变形; IV区沿径向伸长变形, 沿周向伸长变形, 沿厚向收缩变形; III区 ϵ_i 值为0.40-0.47, 是塑性变形程度最大的区域, 且发生了显著的剪切变形; II区和IV区的部分区域也存在明显的剪切变形.

关键字: 钢; 聚丙烯; 复合层板; 拉深; 有限元法

Deformation analysis of the plastic core in steel-polypropylene-steel laminated sheet during the deep drawing process by finite element simulation

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Abstract: The deep drawing process of the steel-polypropylene (PP)-steel laminated sheet is simulated by the updated elasto-plastic Lagrange finite element formulation. The development of the plastic strains, the distributions of the equivalent stress and the total strain energy density in PP of the laminated sheet are revealed, and the deformation characteristics in PP is analysed. The results show that there are five regions in the formed PP, i.e., the flange region (I), the die entry region (II), the clearance region (III), the punch radius region (IV) and the punch bottom region (V). Region V is in non-plastic deformation. Region I, and II and III are in plastic deformation of radial extension, and circumferential and thickness compression. Region IV is in plastic deformation of radial extension, circumferential extension, and thickness compression. Region III has the most serious plastic deformation and strong shear deformation with the equivalent plastic strain of 0.40 to 0.47, part of region II and IV neighboring to region III has obvious shear deformation also.

Key words: steel; polypropylene; laminated sheet; deep drawing; finite element method

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