6 Analysis of Deep Drawing Quality Steel Using Incremental Hole Flanging with Different Pre-Cut Hole Diameters

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6.1 INTRODUCTION

The process of flanging involves deforming the edges of a metal sheet to produce a curved and reinforced edge, resulting in enhanced structural integrity. The process can be partitioned into multiple sub-operations, such as hole flanging, shrink flanging, tube flanging, and stretch flanging [1]. Among these techniques, conventional hole flanging (CHF) has found widespread use in a variety of automotive and aerospace industries [2].

The production of short vertical or conical flanges involves the plastic deformation of a blank that has a pre-cut hole, utilizing a conical or dome-shaped punch. The aforementioned flanges ultimately establish a connection with the primary components of the mainframe. The hole expansion ratio (HER) is a metric used to measure the degree of flanging of a hole. It is used to quantify the deformation of the flanged portion. This ratio is dependent on the inner diameter of the final flange (d_f) and the original pre-cut hole diameter (d_i), as demonstrated in Eq. 6.1 [3]:

$$HER = \frac{d_f}{d_i} \tag{6.1}$$

The limiting forming ratio (LFR) is a common metric used to characterize a material's formability CHF. The LFR is equivalent to the maximal HER at which the material will not fail. According to Eq. 6.2 [4], it is the ratio between the