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Investigation on Method of Blank Size Calculation in Sheet Metal Development

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ABSTRACT: For the sheet metal industry prior calculation of sheet blank size is essential in order to arrive at correct length, calculation of neutral fibre length is the key factor. Considering the length of the neutral fibre in the bent section and adding straight lengths gives the total required blank size. This eliminates wastage of raw material and reduces the product cost. This benefits both manufacturer and customer.

I. INTRODUCTION

This paper attempts to focus on a method of calculation of blank size to arrive at the accurate length required for sheet bending considering the deformation zone along the length and thickness of sheet [1] between the punch and Die in Air bending. Calculation method confirms this concept based on the outcome result during the bending process and this method matches the theoretical method. It includes the position of neutral fibre in the bent region, and shifting of these fibres towards the inner radius of the bent portion.

Among a sufficient number of available literatures on bending theory, this paper mainly focuses on calculation of required sheet length for bending operation in sheet metal fabrication to impart required bend angle, accurate size and shape. Material behaviour in bending operation is quite complicated to calculate the required Blank length in advance for finished bent product. Elongation and thickness reduction shows how neutral fibre can be used for blank size calculation (Fig 1).

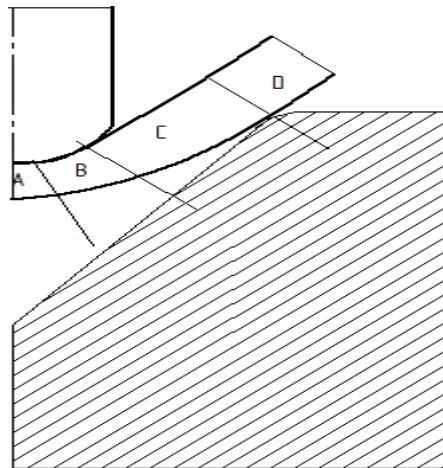
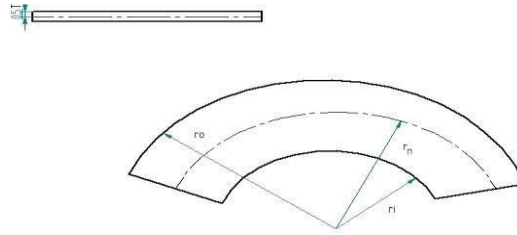


Fig 1

During bending, in plastic zone (**region A**) the sheet under the punch lengthwise undergoes more plastic deformation than other zones, also conforms circular shape of punch nose resulting in elongation and thickness reduction. Henceforth prediction of accurate bending allowance must be carried out in this zone. It is also observed that part of the sheet undergoes elastic deformation and part undergoes plastic deformation in Elasto-plastic zone (**region B**). Due to part plastic deformation, bending allowance calculation is essential although the profile is neither circular nor straight after unloading. Both plastic and elasto plastic zones are considered for bending allowance calculation.

Region C and **Region D** do not contribute to bending allowance calculations as this is Elastic and Rigid. These two regions do not undergo permanent deformation. This paper reveal the simple method of calculating Blank size in the average sheet thickness, considering the Bending allowance based on the theory of shifting Neutral fibre towards inner radius (fig 2)



ro- outer radius

rn- neutral radius, is the distance between neutral fiber and centre of arc in the bent portion ri- inner radius

Fig 2

The neutral fibre exists at 0.5T in the sheet prior to bending. In the bent sheet the neutral fibre moves towards the inner side and the amount of shift depends on the ratio r_n/T and coefficient 'C'. The layers below this neutral fibre undergo compression and layers above this undergo elongation. Due to this phenomenon, blank size calculation is essential before bending the sheet for required shape in the final product. If 'r' is small and T is constant for the given degree of bend the neutral axis shifts closer to the compression side. This is the condition in most of the situations in real practice. This concept gives a correct method of calculation of the length of neutral fibre considering the degree of bend to arrive at the exact length required in the bent region. The total required length is calculated by adding this arc length of neutral fibre.

II. METHOD

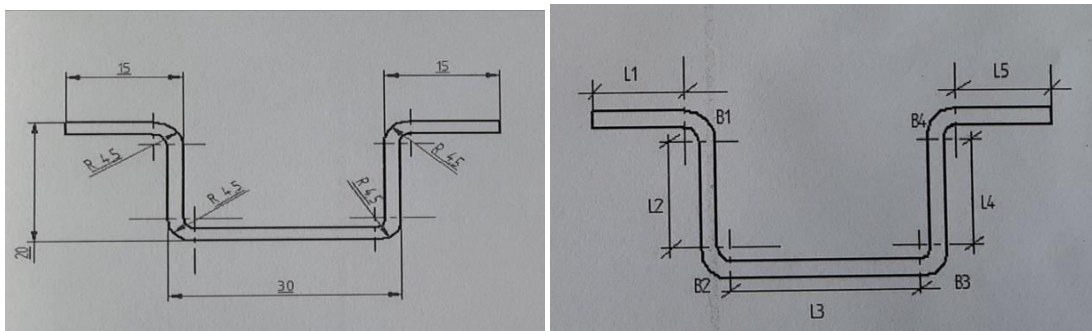


Fig 3

For the Hat section of Thickness 2 mm shown in the fig 3. The Blank size is calculated considering the lengths of neutral fibre at B1, B2, B3 and B4, ratio r_iT and corresponding Constant (C). The final blank size arrived is $L=L_1+B_1+L_2+B_2+L_3+B_3+L_4+B_4+L_5$ considering $r_i=2.5$ mm.

For the given r_iT ratio that is $2.52= 1.25$ the constant C is 0.43[2]. Using the general equation for the length of arc at the neutral

bending line is given by $L_n=\pi \times \text{bend angle } 180 \times (CT+r_i)$

Thus $B_1=\pi \times 90/180 \times 0.43 \times 2+2.5=5.27$ mm $L_1=15-4.5=10.5$ mm $B_2=\pi \times 90/180 \times 0.43 \times 2+2.5=5.27$ mm $L_2=20-4.5-$

$4.5=11$ mm $B_3=\pi \times 90/180 \times 0.43 \times 2+2.5=5.27$ mm $L_3=30-4.5-4.5=21$ mm $B_4=\pi \times 90/180 \times 0.43 \times 2+2.5=5.27$ mm

$L_4=20-4.5-4.5=11$ mm

$L_5=15-4.5=10.5$ mm

the total blank size is thus calculated as



$$L = 10.5 + 5.27 + 11 + 5.27 + 21 + 5.27 + 11 + 5.27 + 10.5 = 85 \text{ mm}$$

III. RESULTS AND DISCUSSION:

From the above theoretical calculation it is found that it is possible to calculate blank size to the accurate length for the given hat section and with this accurate size and shape obtained in real practice.

IV. CONCLUSION

It is possible to calculate required blank size prior to bending operation to avoid wastage of material in Industries thereby production cost can be reduced.

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