A STUDY ON EFFECT ON SHEET METAL DUE TO NUMBER OF FOLD

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Abstract – *The study is carried out on sheet metal strength when the sheet is folded. Through analytical method is used to find the effect on bending strength and buckling strength after changing the shape of the cross-section of the sheet due to folding at 90°. It has been found after analysis that the bending strength increases with number of folds at high rate and then the rate of increment decreases with increase in number of folds. However the buckling strength increases with every bend.*

***Key Words*: Bending Strength, Buckling Strength , Load applied, Fold.**

1. INTRODUCTION

In the market different shapes are available for industrial purpose. The shapes have different dimensions and shapes. The shapes indicate the strength of the angle keeping the weight constant. The angles used are selected as per their application and strength required for the application. Our study is to show the effect of number of 90° folds to change the shape of cross section on bucking strength and bending strength. The bending is uni axial. The bending methods may be press bending and roller press. The different design criteria and allowance like spring back allowance, bend radius material thickness are considered in designing the pressing tools and die.

1.1 Bending Strength

Bending is a process to change the shape if a structure by applying bending moment through applying point loads. In application only elastic bending is allowed as the deflection and deformation is not permanent. The bending strength depends on the maximum tensile stress of the material and shape of the cross section. The property of the material is constant and cannot be changed. However the shape of cross section can be changed. The change in shape will lead to change in moment of inertia and distance from neutral axis. Here in the study we are going to change the section modulus and hence the change in maximum permissible bending moment. While changing the shape we keep the weight of the specimen constant. Hence the cross sectional area of the different shapes are same.

1.2 Buckling Load

Buckling can be defined as the sudden large deformation of structure due to a slight increase of an existing load under which the structure had exhibited little.

A thin-walled structure is made from a material whose thickness is much less than other structural dimensions. The behavior of a buckling system is reflected in the shape of its load- displacement curve - referred to as the equilibrium path. The lateral or 'out-of-plane' displacement, δ, is preferred to the load displacement, q, in this context since it is more descriptive of buckling.

Nothing is visible when the load on perfect column first increases from zero - the column is stable; there is no buckling, and no out- of- plane displacement. The P-δ equilibrium path is thus characterized by a vertical segment-

The primary path - which lasts until the increasing load reaches the critical Euler load $P_c = \pi^2 EI_{min}/L^2$ a constant characteristic of the column

2. Calculation

We are calculating the effect of folds on bending strength and buckling strength keeping the weight of specimen constant. Bending strength of the angle depends on the section modulus (Z) of the cross section while buckling strength depends upon the radius of gyration of cross section.(K)

Columns are tall, thin structures loaded in compression which fail at stresses below the expected yield strength of the material. Column analysis uses the radius of gyration to calculate failure loads. The radius of gyration is defined as $K = \sqrt{I/A}$; the greater the radius of gyration, the more resistant the column is to buckling failure.

$K^2 = \frac{I}{\text{cross section Area}}$. According to Rankine Theory in general Rankine formula is given by $W = \frac{\sigma_c * A}{1+\frac{a*L^2}{K^2}}$ kN Hence bending Moment (M) is directly proportional to section modulus (Z) while buckling load is directly proportional to square of radius of gyration (K^2).

Table -1: Name of Shape

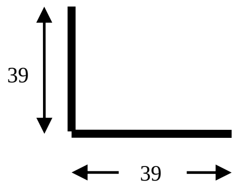
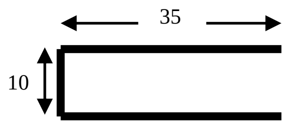
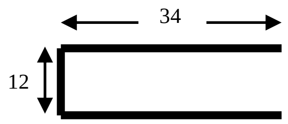
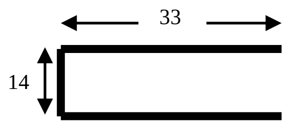
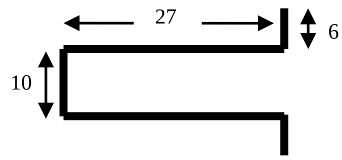
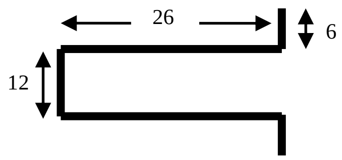
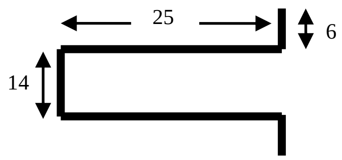
Shape	Name of Shape
	39L39F2T,0C1
	6W35F2T,0C2
	8W34F2T,0C2
	10W33F2T,0C2
	6W27F2T,6C4
	8W26F2T,6C4
	10W25F2T,6C4

Table -2: Number of fold and it effect
Area remain constant 152 mm²

Name of shape	Effect	
	For X Axis	For Y Axis
39L39F2T,0C1	$\bar{Y}$ = 10.49	$\bar{X}$ = 10.49
	I_{xx} = 38149.18	I_{yy} = 38149.18
	Z_{xx} = 3636.7	Z_{yy} = 3636.7
	K^2_{xx} = 251	K^2_{yy} =251
6W35F2T,0C2	$\bar{Y}$ = 5	$\bar{X}$ = 16.19
	I_{xx} = 2322	I_{yy} =17304
	Z_{xx} = 464.4	Z_{yy} =920
	K^2_{xx} = 15.27	K^2_{yy} =113.84
8W34F2T,0C2	$\bar{Y}$ = 6	$\bar{X}$ = 15.31
	I_{xx} =3530.66	I_{yy} =16771.9
	Z_{xx} =588.44	Z_{yy} =897.37
	K^2_{xx} =23.22	K^2_{yy} =110.34
10W33F2T,0C2	$\bar{Y}$ = 7	$\bar{X}$ = 14.46
	I_{xx} =4962.66	I_{yy} =16158.4
	Z_{xx} =709	Z_{yy} =871.54
	K^2_{xx} =32.64	K^2_{yy} =106.30
6W27F2T,6C4	$\bar{Y}$ = 11	$\bar{X}$ = 15.56
	I_{xx} =3538.67	I_{yy} =14568.5
	Z_{xx} =321	Z_{yy} =936.27
	K^2_{xx} =23.28	K^2_{yy} =95.8
8W26F2T,6C4	$\bar{Y}$ = 12	$\bar{X}$ = 14.68
	I_{xx} =4938.66	I_{yy} =14019
	Z_{xx} =411.55	Z_{yy} =955
	K^2_{xx} =32.49	K^2_{yy} =92.23
10W25F2T,6C4	$\bar{Y}$ = 13	$\bar{X}$ = 13.82
	I_{xx} =6562.57	I_{yy} =13434
	Z_{xx} =504.81	Z_{yy} =972.07
	K^2_{xx} =43.17	K^2_{yy} =88.38

In Table No.1 we have given name to shape of angle as per dimension xWyFzt,uCv where x is size of web from inside, y is length of flange, z is thickness of material, u is length of 2 flange, v is number of fold. In Table No. 2 we find the parameters like section modulus (Z) and square of radius of gyration (K) are find to shape of cross section of angle by find moment of inertia and centroid in X and Y both the direction. The formulas used are already mentioned above.

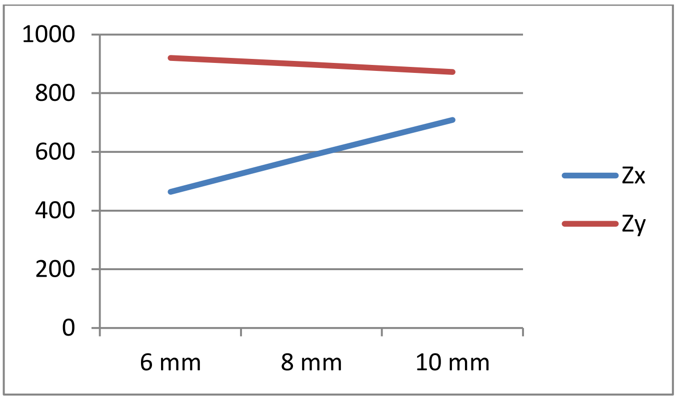


Chart -1: Chart between Different thickness and section modulus of 2 fold section

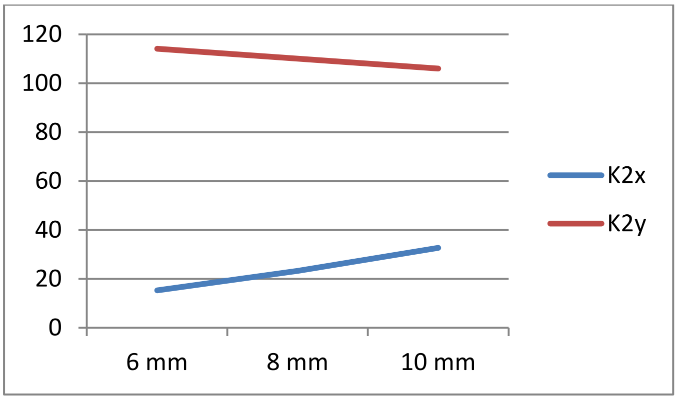


Chart -2: Chart between Different thickness and square of radius of gyration of 2 fold section

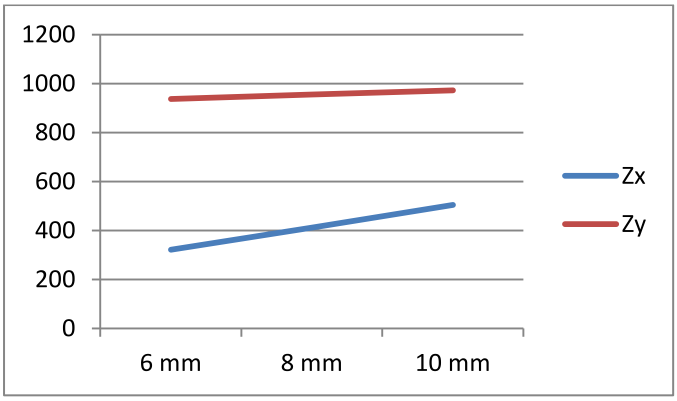


Chart -3: Chart between Different thickness and section modulus of 4 fold section

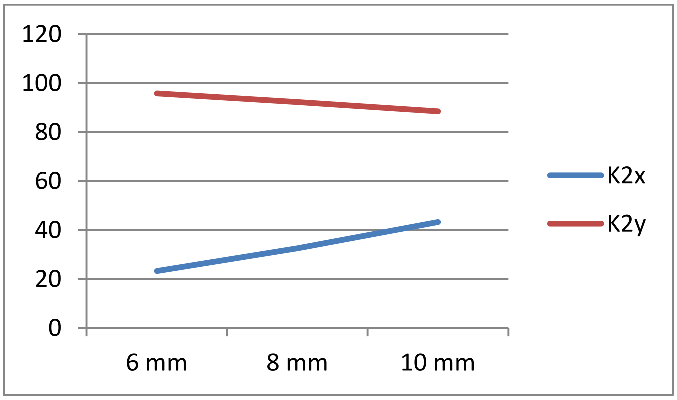


Chart -4: Chart between Different thickness and square of radius of gyration of 4 fold section

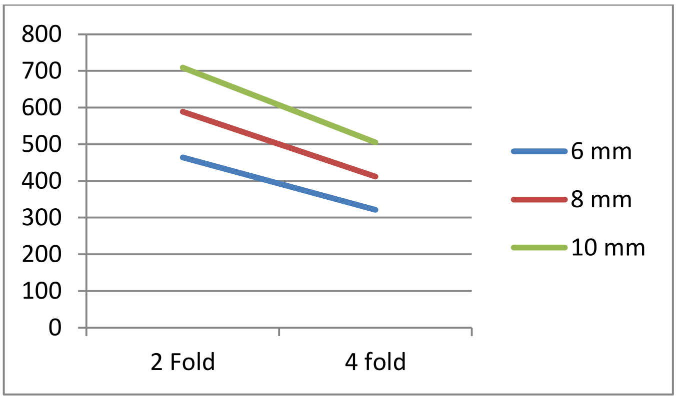


Chart -5: Chart between Different fold and section modulus (Z_x)of 6,8,10 mm width of web

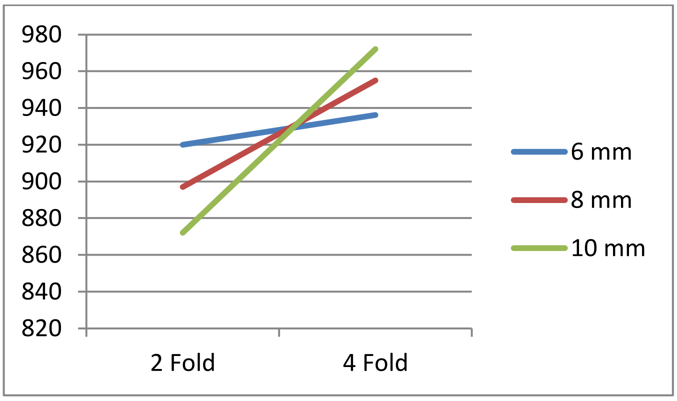


Chart -6: Chart between Different fold and section modulus (Z_y)of 6,8,10 mm width of web

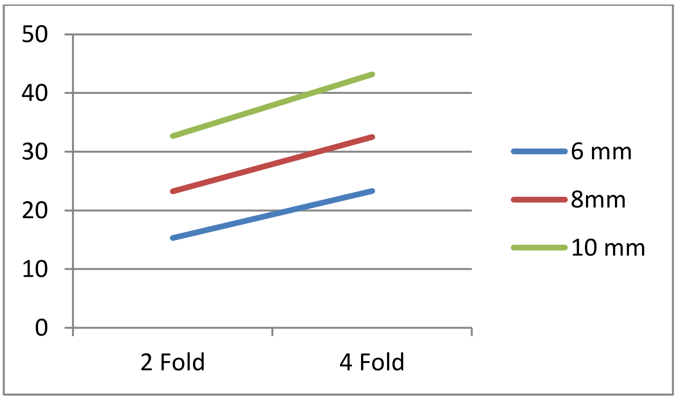


Chart -7: Chart between Different fold and square of radius of gyration (K^2_x) of 6,8,10 mm width of web

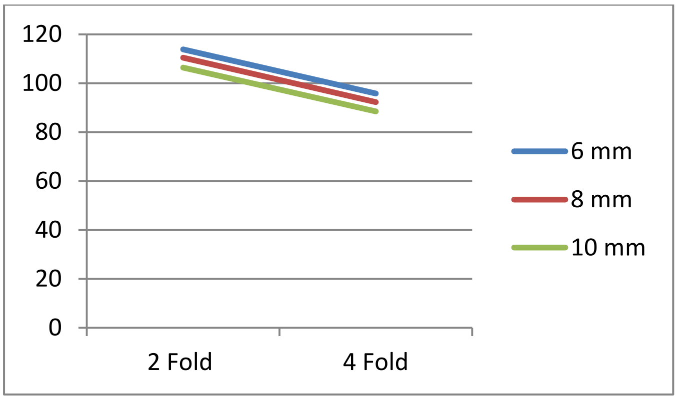


Chart -8: Chart between Different fold and square of radius of gyration (K^2_y) of 6,8,10 mm width of web

3. CONCLUSIONS

From the calculations and study we conclude that by increasing width of web the section modulus in X direction increases while in Y direction it reduces slightly. The radius of gyration also increases in X direction with width of web while in Y direction reduces slightly when number of folds are 2. When the number of folds increases from 2 to 4 the section modulus in X direction increases and in Y direction increases slightly . However radius of gyration in X direction increases while in Y direction decreases slightly. With increase in number of folds from 2 to 4 section modulus in X direction decreases while in Y direction increases. However radius of gyration in X direction increases and in Y direction decreases Rate of increment in Z increases with width of web from 6 to 10mm while the radius if gyration increases with number of fold in all the thickness at the same rate. Hence we conclude that by increasing the width of web the bending strength increases and by increasing the number of folds buckling strength increases.

REFERENCES

[1] Dr. R. K. Bansal, *"Strength of materials"*, Laxmi Publication (P) LTD, Page no. 519, India.

[2] K. Mahadevan, K. Balaveera Reddy, *"Design Data Handbook for Mechanical Engineers in SI and Metric Units"*, CBS Publishers and Distributors PVT LTD, India.

[3] S. Ramamrutham, R. Narayanan, *"Strength of matrial"*, Dhanpat Rai Publishing Company, India.

[4] http://wwwmdp.eng.cam.ac.uk/web/library/enginfo/textbooks_dvd_only/DAN/buckling/intro/intro.html

[5] https://shellbuckling.com/presentations/otherTopics/pages/page_24.html

BIOGRAPHIE

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