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EFFECT OF PLATE THICKNESS AND ROLL GAP ON THE GEOMETRIC QUALITY OF ROLLING PRODUCTS

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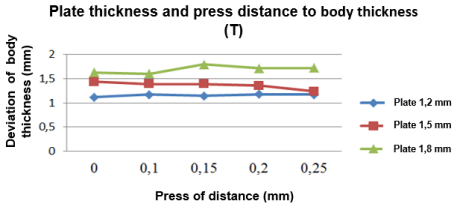
Graphical abstract



Abstract

The folding gate is a middle frame flanked by cross bars on the back of the shop door which has a higher level of strength than the body of the door and has better security. The U folding profile is made by a plastic deformation rolling process in which the plate is passed between the pressing roll and the sliding roll. Flat plates are used from the base material of metal plates with varying plate thickness where the metal forming process uses a cold working process. Factors that affect the results of rolling are roll dimensions, machine capacity, roll pressure lever settings and others. The thickness of the plate that can be rolled by the machine, the amount of force exerted on the roll gap, the evenness of the roll surface both vertically and horizontally and the alignment of the roll gap. The thicker the material with a large pressure spacing can affect the forming process so that it enlarges the largest angular deviation of 0.761 mm at a pressure spacing of 0.0 mm. A thicker material with a large pitch can enlarge the wing opening so that both wings bend imperfectly making the height deviation increase by 18.58 mm at a pitch of 0.0 mm. Thinner material with a large press distance at the start of the roll affects the flange width so that the rolling force exerted on the contact gap between the roll and the workpiece side is unbalanced. Get the largest size b- (8.030 mm) 0.0 mm pressure distance and b+ (7.843) 0.15 mm pressure distance.

Keywords: Folding gate; roll plate; thickness; roll gap; quality of product

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Abstrak

Pintu lipat merupakan rangka tengah yang diapit oleh palang palang di bagian belakang pintu ruko yang memiliki tingkat kekuatan lebih tinggi dari badan pintu serta memiliki keamanan yang lebih baik. Profil lipat U dibuat dengan proses penggulungan deformasi plastik di mana pelat dilewatkan di antara gulungan penekan dan gulungan geser. Pelat datar digunakan dari bahan dasar pelat logam dengan ketebalan pelat yang bervariasi dimana proses pembentukan logam menggunakan proses pengerjaan dingin. Faktor yang mempengaruhi hasil rolling adalah dimensi roll, kapasitas mesin, setting tuas tekanan roll dan lain-lain. Ketebalan pelat yang dapat digulung oleh mesin, besarnya gaya yang diberikan pada celah rol, kerataan permukaan rol baik secara vertikal maupun horizontal dan keselarasan celah rol. Semakin

tebal material dengan press distance yang besar dapat mempengaruhi proses pembentukan sehingga memperbesar deviasi sudut terbesar sebesar 0,761 mm pada press distance 0,0 mm. Material yang lebih tebal dengan pitch yang besar dapat memperbesar bukaan sayap sehingga kedua sayap membengkok tidak sempurna membuat deviasi tinggi bertambah 18,58 mm pada pitch 0,0 mm. Material yang lebih tipis dengan jarak tekan yang besar pada awal roll mempengaruhi lebar flensa sehingga gaya rolling yang diberikan pada celah kontak antara roll dan sisi benda kerja tidak seimbang. Dapatkan ukuran terbesar jarak tekanan b- (8,030 mm) 0,0 mm dan jarak tekanan b+ (7,843) 0,15 mm.

Kata kunci: Folding gate; Roll pelat; Tebal; Roll Gap; kualitas produk

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1.0 INTRODUCTION

The folding gate is part of an iron door which is located on the middle frame flanked by an iron cross on the back. The folding gate must have higher strength than the door body and have better safety. The folding gate is made of U-profile steel [1], where the manufacturing process is carried out by a plastic deformation rolling process where the plate is passed between the pressing roll and the sliding roll.

Industries that produce iron doors use roll machines to produce products on a large scale and form plates into profiles. The roll machine used also varies according to the desired thickness and profile shape. The profile shapes that can be produced are U-profile plates, S-profiles and leaf plates so that they become a complete door.

One of the roll machines used is a U profile roll machine with an electric drive. This machine is used to print flat plates into a U shape with an embossing system on rolling media. Flat plates are used from the base material of metal plates with varying plate thickness where the metal forming process uses a cold working process [2-10].

In this paper the focus is on the thickness of the plate that the machine can roll, the amount of pressure on the roll gap, the flatness of the roll surface both vertically and horizontally and the alignment of the roll gap [11]. Through variations in plate thickness and variations in roll press distance, a U roll profile is obtained which has deviations in dimensions or cross sectional shape due to variations in thickness and active roll press distance in the profile roll process. Roll plate procession can be seen in the Fig. 1

2.0 METHODOLOGY

2.1 Tools and Materials

The tools and materials are used in this research consist:

1. Tools

A roll forming machine is used for forming plate to made folding gate product. Roll plate machine consisting of 8 pairs of active rolls and 3 pairs of parallel passive rolls which are widely used in producing various kinds of steel profiles. Roll plate machine can be seen in Fig. 2 and specification of roll plate forming machine as shown in the Table 1

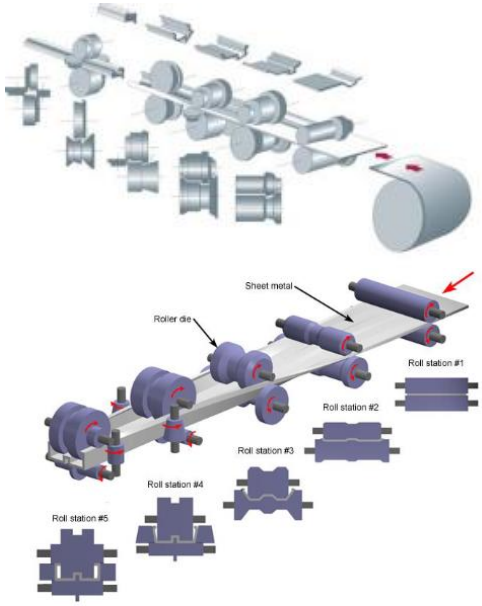


Figure 1. Roll Plate Processing [1]

Figure 2 Roll Forming Machine

Table 1 Specification of roll forming machine

Part of Machine	Capacity
Roll	11
Cutting System	Automatic sharing cutting
Rotation	1440 rpm
Dimension of machine	450 x 1000x 4000
Electric control inverter	4.0 Kw
Power of motor	5.5 HP
AMB	40°C
Pole of motor	4
IP motor	55

2. Material

The material used is black plate iron (base plate) in the rolling process with plate thickness of 1.5 mm, 1.5 mm and 1.8 mm as shown in Fig. 2 and specification of material in Table 2.

Figure 3 iron sheet

Table 2 Specification of iron sheet

Classification	Specification	Grade	Chemical Composition					Tensile Test					Bend Test	
			C	Mn	Si	P	S	Tensile Strength	Yield Strength	Elongation			Bending Angle	Bending Radius
			Max.	Max.	Max.	Max.	Max							
			%	%	%	%	%	N/mm²	N/mm²	Test Po	Thickness	%		
Hot Rolled Steel Plates and Sheets	JIS G 3131	SPHC	0,15	0,60	-	0,05	0,05	270 min	-	N0.5	1,2 mm & over, up to 1,6 mm & over	27 min	180°	Flat on it self
											1,6 mm & over, up to 3.2	29 min		
											3,2 mm & over	31 min		0,5t

2.2 BJP Quality Standard U Channel

In testing a U-profile product, namely by referring to the quality standards of U-canal BJ P according to BSN (National Standardization Agency) may include the following [12]:

1. U Profile Plate Dimensions

The dimensions that must be met from the resulting U-profile product are according to the cross-sectional size limitations in Table 3.

Table 3. Size minimum of cross section of profile U

Profile	Size minimum (mm)
Body Heigth (H)	16 ≤ H ≤ 18
Wing wide (B)	5 ≤ B ≤ 10
Body Thickness (t_1)	t_1 ≤ T

The results of a profile product have a cross-sectional measurement testing stage, namely testing on the magnitude of the deviation T in the maximum figure of the results of the U profile product is 0.5% of the flange width as shown in Fig.4.

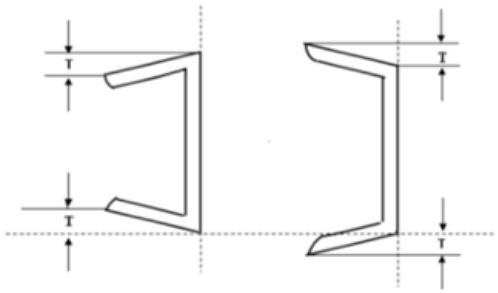


Figure 4. Cross Section of elbow plate [7]

The size of the cross-section according to the name used on a U-profile product produced by PT. X Folding Gate as follows in Table 4.

Table 4 Dimension of cross section profile U Product

Size cross section (mm)	
Type Profile U	**H × B × T**
U 1,8	18 × 10 × 1,70
U 1,5	18 × 10 × 1,45
U 50	50 × 35 × 5
U 65	65 × 4 × 5,5
U 75	75 × 40 × 5
U 80	80 × 40 × 6

2.3 Data collection procedures

The data collection procedures carried out include the following (see Figs. 5-6):

1. Make an active roll by technical drawing as an illustration of the work scheme for data collection.
2. Observing the process of the incoming plate passing through the first active roll forming the plate profile up to the eighth roll.
3. Measure the initial gap of the active roll against the plate before being given a variation of the press distance with a variation of the press distance of 0.10 mm, 0.15 mm, 0.0 mm and 0.5 mm.
4. Measure the active roll gap against the plate after being given a variation of the roll press distance.
5. Roll out the flat plate 3 times by taking data by giving a measuring distance of 5 cm.

6. Measure the cross-sectional dimensions of the product.
7. Compare the data for each thickness that has been rolled and measured.

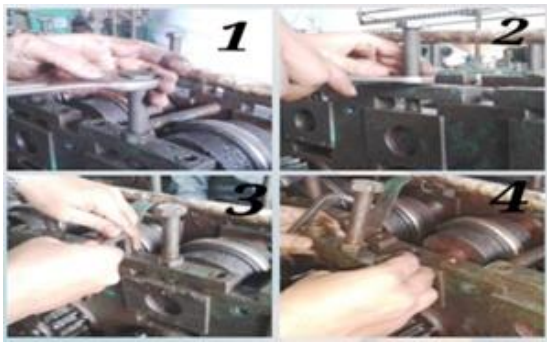


Figure 5 Gap roll variation process

Figure 6 Measurement of Roll Gap

3.0 RESULTS AND DISCUSSION

3.1. Results of setting the distance of the press

From the test results of setting the pressure distance to the gap distance shown in Table 1. In Table 1 it can be seen that at a distance of 0 mm the largest roll distance is obtained in roll 4 of 1.50 mm and the smallest with a size of 0.10 mm in roll 2. For a press distance of 0.10 mm with the largest roll distance in roll 4 of 1.5 mm and the smallest in roll 2 with a size of 0.05 mm. The same results at a press distance of 0.10 mm with 0.15 mm obtained rolls 4 and 2 giving the largest and smallest results of 1.0 mm and 0.05 mm. The press distance is 0.20 mm with the largest gap distance of 1.15 mm and the smallest is 0.05 mm on rolls 4 and 5. The press distance of 0.25 mm has the largest gap distance on rolls 4 and 5 of 1.10 mm and the gap distance the smallest on rolls 1 and 2 is 0.30 mm.

Variations in the roll press distance will cause the gap between rolls to become large or small. The roll gap distance will affect the flat plate forming process to become a U profile. The yield of the U profile product is also affected by the thickness of the plate to be rolled. The thinner the U profile material and the smaller the pressure gap, the smaller the pressure generated on the roll.

Table 5 Distance of gap roll and press

Distance of roll press	Distance of roll gap active (mm)							
	Roll 1	Roll 2	Roll 3	Roll 4	Roll 1	Roll 2	Roll 3	Roll 4
0	0,40	0,10	0,60	1,50	1,30	1,30	1,40	1,40
0,10	0,40	0,05	0,60	1,25	1,20	1,20	1,15	1,05
0,15	0,40	0,05	0,60	1,20	1,20	1,15	1,10	1,00
0,20	0,35	0,05	0,55	1,15	1,15	1,10	1,05	0,95
0,25	0,30	0,30	0,50	1,10	1,10	1,05	1,00	0,90

Table 6 Measurement of plate profile U with thickness 1 mm

No.	Distance of roll press	Dimension of cross section (mm)					
		Height of body (H)	Wide of wing (B)		Thickness of body (T_1)	Thickness of wing (T_2)	Elbow
			b-	b+			
1	0	18,193	7,060	7,228	1,119	1,314	2,260
2	0,10	18,230	7,255	6,930	1,168	1,291	2,454
3	0,15	18,090	7,336	6,994	1,141	1,301	2,219
4	0,20	18,226	7,292	6,833	1,176	1,334	2,415
5	0,25	18,276	7,132	7,156	1,169	1,290	2,521

From the results of variations in the pressure distance on each roll, it can be seen that the gap rolls 1 to 8 have different distances because each roll has a different shape and role. The forming process that occurs in each roll is by pressing and then bending the plate to form a U profile. If the gap distance for each roll is made the same, then the results of rolling the U profile will experience many deviations from the U profile and during the rolling process causes the material to bend up or down roll area.

3.2 Measurement results of the U profile section

From the results of the measurements that have been carried out, the results of the dimensions of the U-profile cross-section can be seen in Table 6-8. Where these dimensions are body thickness, wing thickness, wing width, body height and elbow.

The rolling process that is carried out consists of pressing and then bending with constant roll rotation which has a tendency to get different cross-section size deviation values. Deviations arise due to the influence of plate thickness and press distance which are varied and can be seen in Figs. 7, 9,11-12.

The roll gap factor also has an effect because the smaller the gap, the better the angle, but it has a big effect on the working process of the machine as shown in Fig. 8, the

life of the bearing and the strength of the material being rolled.

Table 7 Measurement of plate profile U with thickness 1.5 mm

No	Distance of roll press	Dimension of cross section (mm)					
		Height of body (H)	Wide of wing (B)		Thickness of body (T_1)	Thickness of wing (T_2)	Elbow
			b-	b+			
1	0	18,285	7,201	7,250	1,437	1,535	2,680
2	0,10	18,350	7,301	7,295	1,388	1,647	2,644
3	0,15	18,411	6,738	7,565	1,389	1,612	2,648
4	0,20	18,365	7,263	7,220	1,358	1,561	2,586
5	0,25	18,176	7,223	7,112	1,237	1,556	2,444

Table 8 Measurement of plate profile U with thickness 1.8 mm

No	Distance of roll press	Dimension of cross section (mm)					
		Height of body (H)	Wide of wing (B)		Thickness of body (T_1)	Thickness of wing (T_2)	Elbow
			b-	b+			
1	0	18,306	7,547	7,601	1,629	1,767	2,530
2	0,10	18,125	7,530	7,135	1,601	1,768	2,382
3	0,15	18,390	7,669	7,843	1,791	1,815	2,739
4	0,20	18,582	8,030	7,806	1,712	1,728	2,761
5	0,25	18,492	7,747	7,801	1,721	1,719	2,550

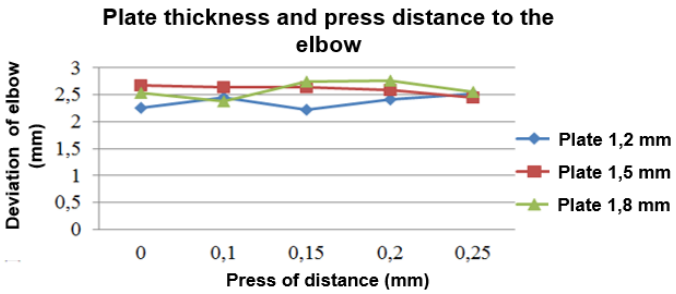
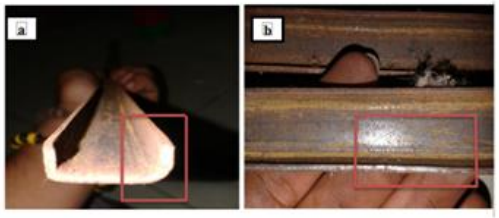


Figure 7 Relationship between plate thickness and press distance to the elbow



a. Minor Aberrations. b. Slightly Stretched Wings.

Figure 8 Deviation of elbow

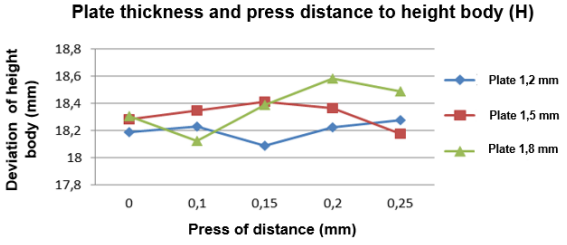
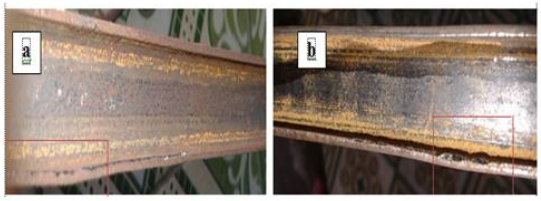


Figure 9 Relationship between plate thickness and pressure distance to the height body (H)

The deviation of the body height for each plate thickness is not only from pressing the lever and the material but also the power of the driving motor in adjusting the roll rotation speed when pressing thicker material, one of which can be seen in Figure 10.



(a). Wings are not Perfectly Bent. (b). Material Damage.

Figure 10 Deviation of height body

The difference between the left and right flange widths is from the difference in the contact gap between the roll and the work piece so that the bending of the flange is unbalanced, the flange is worn out and the plate position setting on the chuck, the flange data is still within the permissible size limit, namely $5 \leq B \leq 10$ but between the two sides still look wide next door (see Fig. 11).

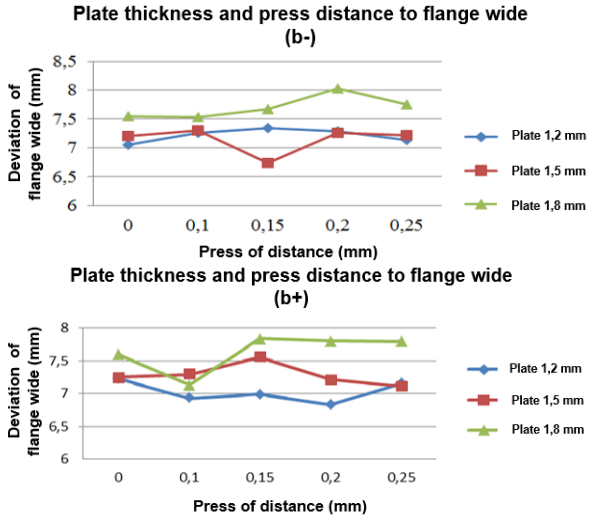


Figure 11 Relationship between plate thickness and pressure distance to flange wide (B- and B+)

The difference in final thickness between the three materials is due to the thickness of the material and the variation in pressure where the greater the pressure variation given, the smaller the roll gap causes the body thickness to decrease but the smaller the pressure variation, the larger roll gap causes the material to receive a little emphasis so that there is a difference in the dimensions of the thickness of the body on each material (see Fig. 12).

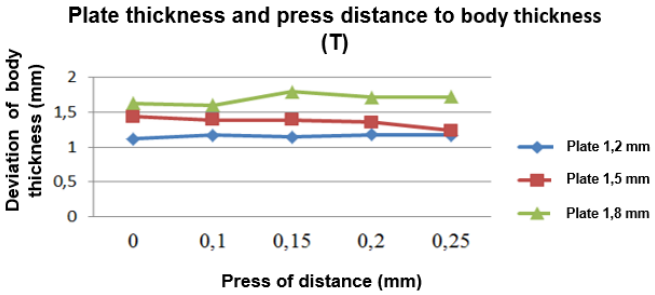


Figure 12 Relationship between plate thickness and pressure distance to body thickness (T)

4.0 CONCLUSION

The conclusions from the results of the tests and measurements that have been carried out so that the following conclusions are obtained: the thicker the material with a large pressure distance can affect the forming process so that it enlarges the largest angular deviation of 0.761 mm at a pressure distance of 0.0 mm. A thicker material with a large press distance can enlarge the wing opening so that both wings bend imperfectly making the height deviation enlarge 18.58 mm at a pitch of 0.0 mm. Thinner material with a large pressure distance at the start of the roll affects the width of the flange so that the rolling force exerted on the contact gap between the roll and the side of the work piece is unbalanced. Get the largest size b- (8.030 mm) 0.0 mm pressure distance and b+ (7.843) 0.15 mm pressure distance.

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