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Performance Testing and Preventive Maintenance of Roller Bending Machine Using the ISMO Method

Adhan Efendi[1], Angga Prasetyawan[2], Yohanes Sinung Nugroho[3]

[1,2]Department of Maintenance and Repair Mechanical Engineering, Politeknik Negeri Subang, Indonesia
Brigjen Katamso Street No. 37 (Belakang RSUD), Dangdeur, Subang, Jawa Barat 41211 3
[3]Department of Mechanical Engineering, Politeknik Negeri Bandung, Indonesia
Gegerkalong Hilir Street Ds. Ciwaruga, Bandung, Jawa Barat 40012

Corresponding author: adhan@polsub.ac.id

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ABSTRACT

This study aimed to perform performance testing and make a preventive maintenance plan on the roller bending machine with inspection, small-repair, medium repair, and overhaul (ISMO) methods. The preventive maintenance time of the roller bending machine run with daily and monthly types of maintenance. The data collection method starts from reading design drawings and manufacturing results, conducting observational trials and identifying roller bending machine components, making preventive maintenance schedules, conducting expert validation, and implementing a preventive list. Data collection uses field observations during the testing process and the implementation of preventive maintenance schedules. The data obtained were then analysed descriptively quantitatively. The sample used is a roll bending machine that has gone through the assembly process. All series of testing and data collection processes are carried out at the Subang state polytechnic machine shop. The results showed that the performance and calculations to determine the radius of the rolling results with the digital calculation method through the machine test application worked optimally. Monthly and daily routine preventive maintenance was accomplished using the ISMO method. The total time required for the roller bending machine prevention machine maintenance is 800 minutes per month. The breakdown includes 180 minutes for inspection, 80 minutes for minor repair, and 540 minutes for moderate repair.

Keywords: Performance testing, Preventive maintenance, Roller bending machine, ISMO method

INTRODUCTION

In industry and manufacturing, the Research [1] investigated a three-roller bending process for two steel plates used in the naval industry. This study provides a recommendation in the form of compatibility of deformations in the plate joint area of the upper tangent roller area considered to estimate the curvature radius of the flexural plate using an analytical formulation. Furthermore, several patented roll bending devices, such as patents of [2]US 5 218 850 A about a roller bending machine for bending sheet metal or plate consist of a roller bending machine for bending iron sheets or plates consisting of an upper roller for plate dragging, a middle roll gripping the roller, and lateral bending rollers under the upper roller. The bending of each roller of the bending machine is detained longitudinal beam and several roller members located between each pair of rollers and are directional. There is also a patent from [3] with patent number EP 0 879 655 A2. This patent claims a roller bending machine equipped with a position detection device to detect the alignment of the axes in the metal bending process.

Large-scale or small-scale industrial machines need periodic maintenance to maintain optimal machine conditions [4]. Added by [5], this preventive maintenance type is required on a newly used engine to keep the engine condition in the best performance. Routine maintenance can avoid machine downtime due to sudden damage. It can also maximize the life of a machine component [6]. A similar study from [7] stated that maintenance scheduling on machines could be due to the use of equipment degradation predicted using genetic algorithms. In the patent of [8] with the number US 8 473 089 B2 concerning the method and application of scheduling prevention of machine breakdowns stating that the suitability of data collection on machine conditions can help companies prevent downtime. In the author's research, the process of designing and manufacturing the roller bending machine has passed, currently entering the testing, manufacturing, and implementation stages of a maintenance schedule. One of the essential thing required is bending and rolling. Rolling is the bending process of a material used according to the needs of the industry [9]. Human limitation in bending the perfect metal is a strong reason for the need for the machine [10]. In general, the need for rolling is functioned to roll metal materials into a U-shape, V-shape, or other shapes for the needs of trellis doors, trellis windows, railings, canopies as well as for the manufacture of roof parts from tricycle frames, and so on [10][11][12].

Added by [13], roll bending is a process in which the metal can be deformed by plastically deforming the material and changing its shape. An industrial-scale bending machine is an expensive machine. In the small-scale industry, a roller bending machine is an appropriate machine [14] The example of a study on the manufacture of roller bending machines is on the thesis research [15], namely the initial stage of machine manufacture run by designing the roll forming process to optimize procedures. The use of a lower number of tracks may be able to maintain the quality of the final product within an acceptable level so that a machine design analysis is needed that can optimize the results. Research [16] on the design and development of hydraulically powered roller bending machines (for the construction, aerospace, automobile, and industrial fields) states that the manufacture of a roller bending machine must be consistent with the machine's purpose. Purposes of making this roller bending machine is to bend the pipe that will be used to form the main frame of the Sula Evolution electric car of Subang State Polytechnic which is being prepared for the national level competition.

RESEARCH METHOD

This research is a type of research and development. Researchers obtained data from observation and documentation, then analyzed the data descriptively and qualitatively. The stages of this research include reading design drawings and manufacturing results, conducting observational trials and identifying roller bending machine components, making preventive maintenance schedules, conducting expert validation, and implementing a preventive list.

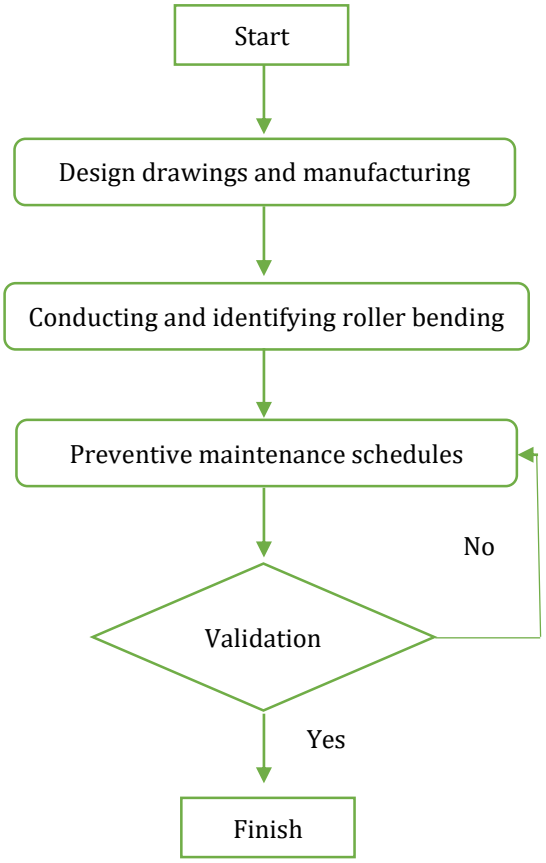
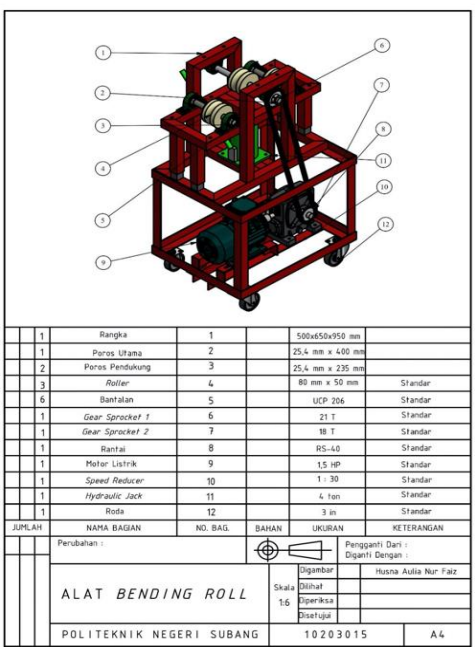


Figure 1. Research flowchart

RESULT AND DISCUSSION

Design and Manufacture

The manufacture of the roller bending machine begins with the machine design carried out by the research team using the Autodesk inventor application. Researchers carried out the manufacturing process of a roller bending machine includes measuring, cutting, joining, and painting. This roller bending machine is made with an automatic mechanism using a drive. The driving force is an electric motor with a damper. This machine uses three rollers as the area for bending the pipe (maximum 1 inch and the total weight of the entire frame of the roller bending machine is 29.16 Kg).



JUMLAH	NAMA BAGIAN	NO. BAG.	BAHAN	UKURAN	KETERANGAN
1	Rangka	1		500x650x950 mm	
1	Poros Utama	2		25,4 mm x 400 mm	
2	Poros Pendukung	3		25,4 mm x 235 mm	
3	*Roller*	4		80 mm x 50 mm	Standar
6	Bantalan	5		UCP 206	Standar
1	*Gear Sprocket 1*	6		21 T	Standar
1	*Gear Sprocket 2*	7		18 T	Standar
1	Rantai	8		RS-40	Standar
1	Motor Listrik	9		1,5 HP	Standar
1	*Speed Reducer*	10		1 : 30	Standar
1	*Hydraulic Jack*	11		4 ton	Standar
1	Roda	12		3 in	Standar

Perubahan : | Pengganti Dari : Diganti Dengan :

ALAT *BENDING ROLL* | Skala 1:6 | Digambar: Husna Aulia Nur Faiz | Dilihat | Diperiksa | Disetujui

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a. Design b. Roller Bending Machine

Figure 2. Design and manufacture of roller bending machine

Performance Testing

This test aims to check the performance of the developed roller bending machine. There are two stages in the performance test. The first experiment used stainless pipes, while the second one used iron from the Subang State Polytechnic laboratory. Pipe bending begins with preparing the object by marking which part to bend is. Next is inserting the iron part into the chisel by paying attention to its position on forming part. The bending process takes place by changing the direction of rotation of the motor using a switch and putting pressure on the object by raising the jack when it is one turn until two turns to the left/right.

Figure 3. Roller bending testing process

Figure 2 above is the testing process of the roller bending tool. The object bending process is going well. The calculation results are applied to determine the radius of the bending results by using a digital calculation method through the curvature calculator application.

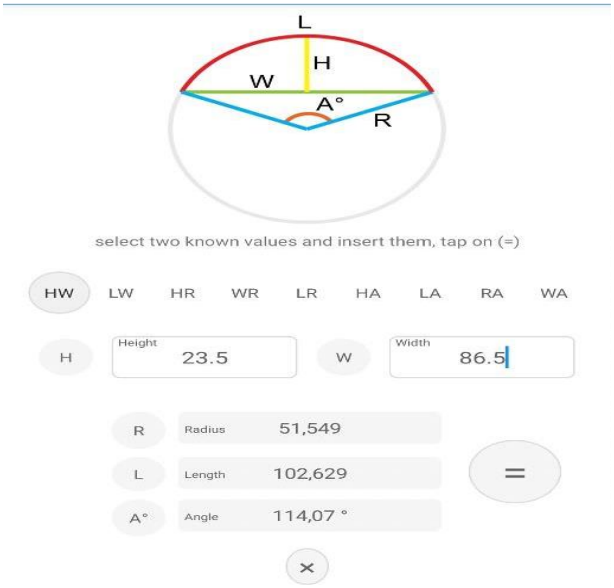

Figure 4. Digital calculation through arch calculator application

Observation and Identification

Making a routine schedule for the roller bending machine begins with observing and identifying the roller bending tool. Observation aims to classify the components that need to be maintained regularly. Then, the researcher identified the compiling process of which material tools were used in carrying out the preventive maintenance schedule. Table 1 shows the results of observation and identification.

Table 1. Observation and identification

No	Machine Parts	Maintenance Schedule Plan	Risk Information
1	Power Transfer System (Shaft, chain and sprocket)	Weekly Maintenance (Inspection, small repair, medium repair, overhaul)	
2	Manufacture System (Roller and bearing)	Weekly Maintenance (Inspection, small repair and medium repair)	
3	Power System (Electric Motor and Reducer)	Monthly Maintenance (Inspection)	
4	Electricity System (Push Button and Cable)	Monthly Maintenance (Inspection)	

Table 1 explains that preventive maintenance is applied using the inspection, small-repair, medium repair, and overhaul (ISMO) method. This method consists of four categories of roller bending machine systems. Power transfer systems and manufacturing systems marked in red inform the high risk. On the other hand, the power system and electricity system sections are marked with a green color inform the low risk. Added by [17] that effective routine maintenance can increase the profits of large and small-scale industries. The concept of preventive maintenance can prevent the failure of a machine. It is explained by [18] that the highest rating of a machine's failure rate can lead to high repair costs or a threat to operator safety.

Schedule Maintenance and Expert Validation

Maintenance on the roller bending machine is a preventive maintenance type. Added by [19] that preventive maintenance aims to keep the engine in optimal condition. A frequently used method for this type of treatment is the inspection, small repair, medium repair, and overhaul (ISMO) method. Moreover, [20] states that the implementation of preventive maintenance can be done with a longer period with consideration of efficiency and reliability. Besides, the preventive maintenance schedule plan was made by the research team based on the results of observations and identification of the roller bending machine. The schedule plan was then validated by two expert judgments. The equipment maintenance schedule that has been approved by the experts can be seen in table 2.

Table 2. Roller bending machine schedule maintenance

No	Machine Parts	Monthly Maintenance				Weekly Maintenance			
		I	S	M	O	I	S	M	O
1	Shaft	20’				5’			
2	Chain	20’	20’	60’		5’	5’	15’	
3	Sprocket	20’		240’		5’		60’	
4	Reducer	20’				5’			
5	Electric Motor	20’				5’			
6	Bearing	40’	40’			10’	10’		
7	Roller	20’	20’	240’		5’	5’	60’	
8	Cable	20’				5’			
	Total	180’	80’	540’		45’	20’	135’	
		800’/Month							

Based on table 2 above, the researcher concludes that the total time required for preventive maintenance with the ISMO method on the roller bending machine is 800 minutes per month. The details are 180 minutes for inspection, 80 minutes for small repair, and 540 minutes for medium repair. An additional note from the validator is that the inspection level is continued to the Overhaul level if at the minor repair stage and the engine condition is still damaged.

Gear sprocket and Chain Maintenance Schedule Implementation

The application of maintenance for the bending roller is implemented on the gear sprocket and chain components with the aim that the drive system can operate properly. The following steps need to be taken care of:

1. Visual inspection and checking of the condition of the sprocket components. The gear sprocket inspection is done for 20 minutes per month. This is to prevent the sprocket from wearing out which causes the chain to break easily.

Figure 5. Sprocket inspection

2. Lubrication of the chain is done by using oil. The purpose of this lubrication is so that the chain is not prone to corrosion and wear (dry).

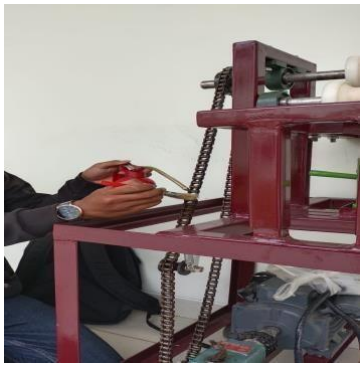

Figure 6. Lubrication on the chain

3. The chain tension check is carried out by adjusting the chain tensioner. The purpose of adjusting the tensioner is so that the chain does not loosen. If a problem is found, it is recommended to do a small repair for 20 minutes according to the schedule agreed upon by the experts.

Figure 7. Tensioner adjustment

Figure 7 describes the chain test, the test is intended to see whether the chain tension is good enough or not. Because if it is too tight it can cause the chain to break, if it is too loose it can cause the chain to catch.

CONCLUSION

The results showed that the performance and calculations to determine the radius of the rolling results with the digital calculation method through the machine test application worked optimally. Monthly and daily routine preventive maintenance settle using the ISMO method. The total time required for the roller bending machine prevention machine maintenance is 800 minutes per month. The breakdown includes 180 minutes for inspection, 80 minutes for minor repair, and 540 minutes for moderate repair.

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