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Electrical Installation and Calculation Analysist of Roll Bending Machine Drive System

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ABSTRACT

Bending and rolling service providers in Subang Regency are still minimal, based on observation data in five workshops, there is only one workshop that provides bending and rolling services, in addition, in the manufacture of the bending roll machine, it is necessary to have an electrical installation as the power that drives the drive system and analysis of the calculation of the drive system as planning to determine and install the drive system to be used. This final project is a qualitative descriptive study with the stage of data collection, wiring diagrams and calculations, installation, testing, and analysis. The results of the study can be concluded that: (1) the electrical installation uses two main components including a 1 phase 1.5 HP electric motor and a 15 A cam starter 3, (2) the analysis of the calculation of the drive system includes the calculation of the power of the motor drive with the results: driving torque = 269 , 66 Nm, Driven torque = 210.66 Nm, calculation of the final rotation ratio of the roller with the results: the final rotation ratio n3 = 39.94 rpm, chain calculation ratio with chain speed results: v = 0.15 m / s, the amount of chain workload = 88 kg, comparison of theoretical calculations with technical calculations (measured tests) which include electric motors: (1400 rpm): (1403 rpm) difference = 3 rpm, speed reducer = (46.6 rpm): (59.93 rpm) difference = 13.33 rpm, main shaft sprocket = (39.94 rpm):(32, 83) difference = 7.11 rpm.

Keywords: Workshop, Analysis, Calculation, Drive System

INTRODUCTION

Subang City is one of the districts that has quite a lot of industry, both large and small scale industries. One of the small-scale industries is rolling workshops. In Subang City, there are still few workshops that provide rolling services. Based on observations in five fabrication workshops in Subang, only one workshop provides rolling services. Rolling or rolling is a process of reducing the thickness or forming process on a long workpiece. The rolling process is carried out with a set of rollers that rotate and press the workpiece so that its shape changes. Generally, rolling work is carried out on pipe material which is often used for making trellis fences, windows, bicycles, rickshaws, canopies and so on. The application of the work function of the roll tool that is made, of course, requires a driving component to rotate the roller shaft in order to move the object of the material to be rolled. In addition, electrical components are also very important as a source of power to start and support the automatic work mechanism of the pipe roller [1].

The electrical installation on the bending roll tool has a function to transform electrical energy which will later be converted into kinetic energy to drive the drive system and support the automatic working mechanism of the tool. While the drive system is a set of components that drive the tool to rotate the roller shaft in order to move the object of the material to be rolled [2],[3], this drive system requires calculations from the electric motor, chain and sprocket, gearbox (speed reducer) which will be used to determine the final rotation required [4].

RESEARCH METHODS

This research is a qualitative descriptive research. The time and place of the research was from February to July 2020 which took place in the Subang State Polytechnic Machine Maintenance laboratory and the Karya Mandiri Group Subang welding workshop.

The research method used in this research is carried out in the following steps:

Data Collection

Data collection was carried out by means of interviews, literature studies and observations regarding relevant data required for this research. Reference literature studies used include: the journal Design and Build Roll Bending Machine with Hydraulic Assist, the journal of Calculation of the Transmission System of a 1¼ inch Galvanized Pipe Curved Roll Machine and General Requirements for Electrical Installation (PUIL) 2000. Interviews and observations were conducted by visiting several manufacturing workshops in the region. Subang Regency to see the availability of bending roll tools.

Figure 1. Observation

The results of interviews and observations at 5 manufacturing workshops in the Subang Regency area include:

1. Las Sinar Jaya Dangdeur Workshop - Subang.
   Availability of tools: none
   Drive type: none.
2. Las Aceng Karanganyar Workshop - Subang.
   Availability of tools: none
   Drive type: none.
3. Las Mekar Jaya Workshop, Cigadung - Subang.
   Availability of tools: none
   Drive type: none.
4. Welding & TB Patent 313 - Subang.
   Availability of tools: available
   Drive type: electric motor.
5. Las Raka Mandiri Soklat Workshop - Subang.
   Availability of tools: none
   Drive type: none.

Making Wiring Diagrams and Calculations

Making wiring diagrams and calculations is a step that includes the manufacture of electrical circuits and detailed explanations and calculations that focus on the components of the drive system that drives the engine, namely, electric motors, speed reducers (gearboxes), sprockets and chains.

Installation

Installation is an advanced stage of research which includes a process that includes the steps to assemble the engine's electrical components.

Testing

Testing is a further research step that focuses on testing the work of electrical components and the engine drive system, ensuring the performance of each component is functioning properly and in accordance with initial planning. If at the time the machine performance test has been running optimally, the research has been completed, but if you experience a failure or there are problems, it is necessary to identify the constraints / problems and find a solution for them [5].

Analysis

The analysis is the final step of research which includes a description of the analysis of the performance of the electrical components and the drive system with a comparison of technical measurements with the measurement of the initial planning theory.

RESULTS AND DISCUSSION

Wiring Installation Diagram

Wiring diagrams have an important role in an installation process, with the appropriate wiring diagrams, the installation process will be directed and can find out the flow of electricity flowing between the components connected to the wiring. The following is a wiring diagram for the electrical installation of a bending roll [6],[7] with the symbols according to PUIL 2000:

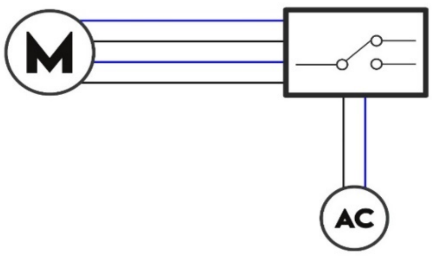

Figure 2. Wiring Diagram Bending Roll

Wiring Diagram Of Detailed Connections Between Components

The detailed wiring diagram of the connection between components aims to determine the wiring path which includes details of the connection (jumper) of the cables between the main components connected; electric motor with cam starter and connection (jumper) cable in one component; starter cam.

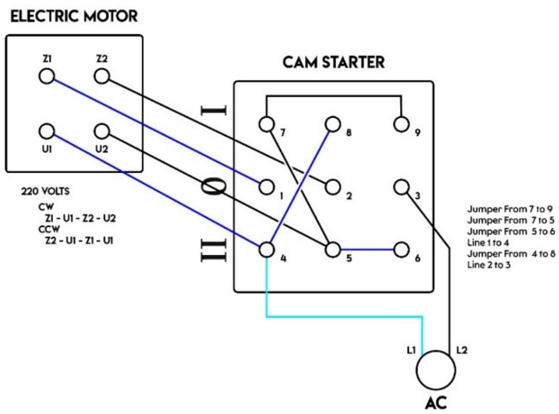

Figure 3. Component Wiring Diagram

Roll Bending Tool Installation Detailed explanations for the wiring diagram between these components include:

1. Phase 1 cable (blue) on the electric motor port wiring port z1 is connected to the starter cam port wiring (port 1). The connection of the blue phase 1 cable is combined with the phase 2 cable, neutral wire 1 and neutral cable 2 which are adheredly wrapped using electrical insulation.
2. Neutral wire 1 (black) on the electric motor port wiring (port z2) is connected to the starter cam port wiring (port 2). The connection of the neutral 1 black wire is combined with the phase 1 cable, the phase 2 cable and the neutral 2 cable which is securely wrapped using electrical insulation.
3. Neutral wire 2 (black) on the electric motor port wiring (port U2) is connected to the starter cam port wiring (port 5). The connection of the neutral 2 black wire is combined with the phase 1 cable, the phase 1 cable and the neutral 2 cable

which is securely wrapped using electrical insulation.

4. Jumper wire 1 (blue) on the starter cam port wiring (port 5) is connected to the starter cam port wiring (port 6).
5. Jumper wire 2 (black) on the starter cam port wiring (port 7) is connected to the starter cam port wiring (port 5).
6. Jumper wire 3 (black) on the starter cam port wiring (port 7) is connected to the starter cam port wiring port 9.
7. Jumper wire 4 (blue) on the starter cam port wiring (port 4) is connected to the starter cam port wiring (port 8).
8. Neutral contact wire (black) on the starter cam wiring port: (port 4) with L1 (connecting line 1) to the socket (AC). So, the neutral contact cable from (port 4) is joined to the cam starter phase contact cable (port 3) which is coated with a coating cable with a plug connected at the end as a connection cable to the socket (AC) when the engine wants to be turned on.
9. Neutral contact wire (black) on the wiring of the starter cam port (port 3) with L2 (connecting line 2) to the socket (AC). So, the neutral contact wire from (port 3) is joined to the cam starter phase contact cable (port 4) which is coated with a coating cable with a plug connected at the end connecting the plug wire to the socket (AC) when the engine wants to be turned on.

Motor Drive Calculations

Based on the calculation of the planned torsional moment on the design of this bending roll tool, above it can be determined the power usage of the driving motor that meets the requirements. It is known that the motor power is 1.5 HP and the amount of rotation of the motor is 1400 rpm which is reduced through the gearbox (speed reducer) and the chain becomes the final rotation specified. Then calculate the amount of driving torque:

Calculation of the drive motor (Planned torque (T)):

$$T = 9{,}74 \times 10^5 \frac{Pd}{n}$$

$$T = 9{,}74 \times 10^5 \frac{0{,}88}{39{,}9}$$

= 21418,704 kg.mm

= 210, 66 Nm

Information:

T = moment of torsion (Nm)

Pd = planned power (kW)

n3 = Speed of rotation at the shaft (rpm)

$$T = \frac{P}{\omega}$$

Information:

P = motor power used

ω = angular velocity (rad / s)

Known:

The motor power used (P), = 1.5 HP = 11.1 Kw = 1100 watts

$$T = \frac{P}{\omega} \,.,\, \omega = \left(\frac{(2)(\pi)(n)}{60}\right)$$

$$= \frac{1100}{\left(\frac{(2)(\pi)(n)}{60}\right)}$$

$$= \frac{1100}{\left(\frac{(2)(3{,}14)(39{,}9)}{60}\right)}$$

= 269,47 Nm

So T drive = 269.47 Nm> Ttot driven = 210, Nm. In accordance with the results of the above calculations, it can be concluded that the electric motor driving the bending roll tool used by 1.5 HP meets the workability requirements.

Final Turn Ratio Calculation

To find out the final rotation to be used, a calculation must be done by multiplying the initial rotation source with the gearbox ratio (speed reducer) which is then multiplied again by the ratio of the sprocket used [8]. The motor speed is 1400 rpm, it is too fast to turn the rolling roller [9]. The gearbox (speed reducer) used has a ratio of 1:30, and the chain used has a ratio of 1: 1.2 so that the resulting motor rotation after reduction will be:

n1 = rasio electric motor (rpm)

n1 = 1400 *rpm*

n2 = n1 x rasio gearbox (speed reducer) (rpm)

$n2 = 1400 \times \frac{1}{30}$

n2 = 46,6 *rpm*

n3 = n2 x rasio sproket *(rpm)*

$n3 = 46{,}6 \times \frac{18}{21}$

n3 = 39,94 *rpm*

Where:

(n1) = initial round,

(n2) = after being reduced by the gearbox (speed reducer),

(n3) = after being reduced by the chain.

So from these calculations it can be found that the final result of the planned rotation ratio to operate this bending roll tool is 39.94 rpm.

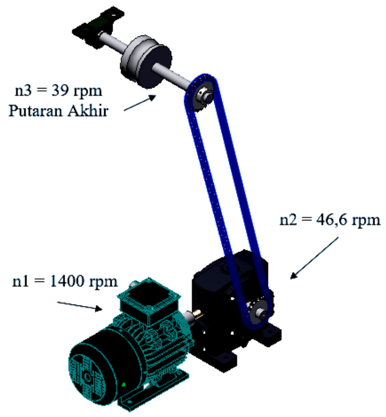

Figure 4. Final Round Calculation Schematic of Bending Roll Drive System

Chain Speed Calculation

The type of chain used for the transmission of this bending roll tool is a roller chain with a chain type number RS-40 with a single circuit. The first gear sprocket used has a ratio of Z1: Z2 or 18:21 which is used to reduce the rotation of the gearbox (speed reducer) to the main shaft to 39.9 rpm 40 rpm.

Chain speed calculation:

$$v = \frac{(p)(z1)(n3)}{60}$$

$$v = \frac{(0{,}0127)(18)(39{,}9)}{60} m/s$$

v = 0,152019 m/s ≈ 0,15 m/s

Information:

v = linear velocity

p = distance for the chain (m), for the RS-40 chain is 12.70 mm = 0.0127 m.

Z1 = number of teeth of the small sprocket, in terms of rotation reduction

n3 = Rotation of the shaft (rpm)

So the linear velocity on the chain is 0.15 m / s. The chain speed does not exceed the allowable chain speed, the allowable chain speed is 4-10 m / s, it can be said that the speed is safe.

Calculation of Load Working on the Chain

To calculate the load acting on a chain, you must first know the design power transmitted on the chain. To calculate the power plan can use the formula equation:

$$P_d = f_C \times P, (Kw)$$

The calculation of the power plan has been obtained from the previous calculation, (Pd) = 1.1 kW. After that, the amount of load acting on a chain can be calculated using the formula equation:

$$F = \frac{(102)(Pd)}{v} kg$$

$$F = \frac{(102)(1{,}1)}{0{,}15} kg$$

= 88 kg

So the amount of load that occurs in chain 1 is 88 kg. The amount of load on the chain is smaller than the allowable load (88 kg <520 kg), so it can be stated that the chain used is safe / good.

Analysis of Electrical Installations and Drive Systems

Table 1. Tabel Analisis Instalasi Electrical and Drive Systems

Component	Test Result	Description
A. Electrical Installation 1. Electric motor	The electric motor is capable of rotating clockwise and counter clock wise	Appropriate
2. Cam Starter	*cam starter is able to adjust the rotation of the electric motor which rotates clockwise counterclockwise and the off*	Appropriate
B. Drive System 1. Electric motor	Spinning at speed 1403 rpm	Difference with theoretical calculation (final rotation ratio (n1)) = 3 rpm
2. *Gearbox (speed reducer)*	Spinning at speed of 59.93 rpm	Difference with theoretical calculations (final rotation ratio (n2)) = 13.93

Component	Test Result	Description
3. Main shaft sprocket	Spinning at speed of 32.83 rpm	Difference with theoretical calculation (final rotation ratio (n3)) = 7,11 rpm

Based on the analysis table of the components of the electrical installation and drive system above, it can be described as follows:

The electrical installation consists of 2 main components that are connected, namely the electric motor and the starter cam. The result of the installation of the electrical component of the bending roll tool can be said to be "in accordance" with the desired working method which refers to the installation wiring diagram, where when the electrical installation component is connected to a current source, the electric power is able to drive the motor [10],[11] whose rotation is regulated by the cam starter with 2 turns. The different ones are clockwise and counterclockwise (clockwise and counter-clockwise) and the neutral position (off).

The results obtained from testing the components of the drive system are 1) testing the electric motor is carried out with three tests with an average result per minute of 1403 rpm, while the theoretical calculation per minute is 1400 rpm so that the difference is 3 rpm, thus it can be concluded that the electric motor can rotate. well; 2) testing the gearbox (speed reducer) is carried out by three times with an average result per minute of 59.93 rpm, while the theoretical calculation per minute is 46.6 rpm so that the difference is 13.93 rpm, thus it can be concluded that the gearbox (speed reducer) can rotate well; 3) testing of the main shaft sprocket is carried out by three tests with an average result per minute of 32.83 rpm, while the theoretical calculation per minute is 39.94 rpm so that the difference is 7.11 rpm, thus it can be concluded that the main shaft sprocket can rotate with good.

CONCLUSION

Installation of the electrical system on the bending roll tool uses 2 main components, namely: 1 phase 1.5 HP electric motor and 3 15 cam starter. The electric motor can rotate in 2 directions: clockwise (direction of the lever in position I) and counter-clockwise (direction of the lever in position II) and off / neutral in position 0.

The calculation analysis of the drive system includes the calculation of the power of the motor drive with the results: 1) driving torque = 269.66 Nm; 2) actuated torque = 210.66 Nm; 3) calculation of the final rotation ratio of the roller with the result n3 = 39.94 rpm.

Chain calculation with the result 1) Chain speed: v = 0.152019 m / s ≈ 0.15 m / s; 2) the amount of chain workload = 88kg.

Comparison of theoretical calculations with technical calculations (testing) which includes 1) electric motor: (1400 rpm) (1403 rpm) difference = 3 rpm, the rotation of the electric motor works in good condition; 2) Gearbox (speed reducer): (46.6 rpm) (59.93 rpm) difference = 13.33 rpm, the gearbox rotation (speed reducer) works in good condition; 3) Main shaft sprocket: (39.94 rpm) (32.83 rpm) difference = 7.11 rpm, the main shaft sprocket rotation works in good condition.

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