Automatic Pneumatic Sheet Metal Cutting Machine

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Abstract :The recent advancements in technology have now enabled us to make low-cost machines for Real time applications. This paper presents a simple way of designing and implementing an automatic sheet metal cutting machine using easily available low-cost pneumatic, sensor & micro-controllers. A pressure from the pneumatic cylinder is enough for operating the shearing machine unit. The pressurized air from the compressor, actuates the pneumatic cylinder, power from the piston is transmitted to the shear cutting blades. Sheet metal is fed through the roller and the sensor fixed at a particular position senses the sheet and sends command to the blades to cut the sheet metal. This entirely eliminates the human intervention.

IndexTerms - Automatic Sheet cutting Machine, Sheet metal, Pneumatic, Microcontroller.

I. INTRODUCTION

Today's high competitiveness of the industries demanding delivering high quality and more precise products with a reasonable price. To address this, industries are developing new technologies ie, automation which yield to savings in material, labour savings, improvement in quality and accuracy. Automation is the use of various electro mechanical devices for processing wide variety of operations with minimal human intervention. In order to achieve complete automation various devices and computer or combination is used. The task of sheet metal cutting is accomplished using manual or Hydraulic machines. These machines are guided manually by hand using levers and require very skilled workers. In order to avoid laborious process manual cutting is replaced by Hydraulic, pneumatic and automatic machines. Keeping these things in mind, locally developed, completely automatic and cost-effective machine for the cutting of metal sheets is the need of the hour. AnAutomatic machine would enable in increase the production capacity and produce high quality products at much cheaper rates, helping the small and medium scale industries to survive in competitive global market. Hence in the present paper discusses in detailed process of fabricating and implementation of a novel low cost automatic sheet metal cutting machine which can be used for cutting sheet metal of varied thickness.

II. LITERATURE SURVEY:

Manual method makes use of lever operated HSS blade to part the sheets. Sheets are wasted if the operator makes error because of laborious process and takes more time for a simple operation. Hydraulic cylinders are also available for sheet metal cutting. AvinashJathar et al., carried out an experiment to cut different thickness metal sheets using Hydraulic cylinders which can easily replace the manual lever method. The power required to cut the sheet of given dimension was found to be higher in case of machines using hydraulic cylinders. The drawback is its cost is very high and requires a lot of maintenance [1]. Pankaj Kumar Pandey et al., conducted experiment to bend rods, bars, plates and sheet metal utilizing a hydraulic power [2]. ThokaleManoj et al., designed and implemented a rod bending machine working using pneumatic cylinders which is simpler and less cost compared to conventional rod bending machine in the construction sites [3]. K.Krantikumar et al., developed an semi-automatic mechanism leading to more structured and quicker operation resulting in cleaner environment and less maintenance [4]. Dinesh Lamseet al., developed a unit for bending and departing wide range of sheet by allowing air into cylinders which actuates the tool [5]. ThoraveRohit V et al., conducted experiments involving pipe rolling operation using three phase stepper motor which is used to bend 19 mm diameter pipe [6]. Madhu Kumar V et al.,developed a semi-automatic apparatus which is mobile and compact in size. This apparatus used control timing unit for automation which resulted in repeatability and increase in the yield [7]. Swapnil Laxman Gaikwad et al., illustrated the different varieties of material and thickness of materials that can cut by the shearing machine [8]. Satish G. Bahaleyet al., explained the designing and optimization of elemental analysis of shear cutting unit [9]. Rahul Ranjan et al.,carried out to cut sheet metal by using an image stored in computer memory. Performance of this machine found to be higher than the conventional machines and with high technology content [10]. The aim of the research work was therefore to develop a low cost fully automatic machine using microcontrollers and obstacle sensors.

III. MATERIAL & METHODS:

The development of thePneumatic driven sheet metal cutting system was proceeded following stages, such as Conceptualization followed by Design and Drafting of the various parts and then assembling these parts in order to obtain novel sheet metal cutting machine. The process of sheet metal cutting has to go through many stages which generally requires human intervention in order to perform the operation. Hence, it is planned to develop a novel sheet metal cutting unit which can eliminate manpower requirement, hence a detailed novel sheet metal cutting unit drawing is prepared and the same is shown in Figure 1.

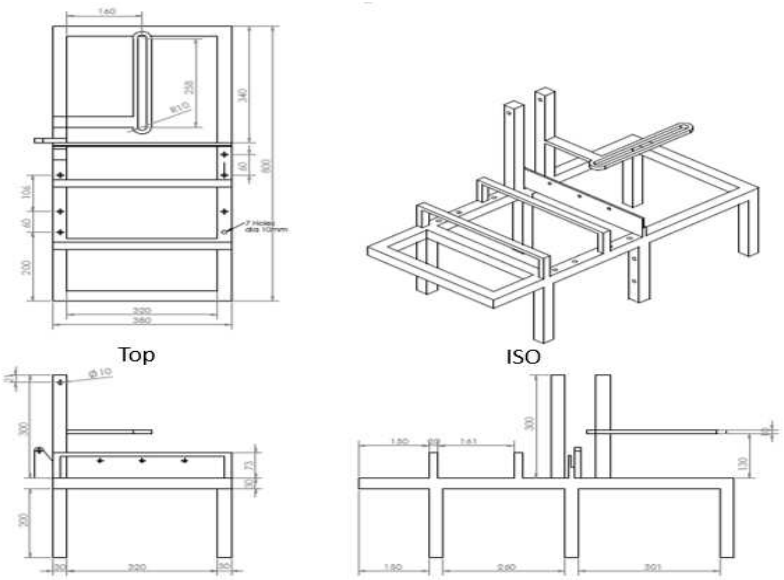

Figure 1: Model of sheet metal cutting unit drawing

Material Used to evaluate novel sheet metal cutting unit was Galvanized sheets of gauge number 23 to 28. From the gauge 23 that is 0.78 mm sheet thickness to that of gauge 28 measured 0.47 mm was the materials used for the evaluation of the newly developednovel sheet metal cutting machine. Number of sheets can be cut for various gauges of the sheets per minute were evaluated through cutting process and the accuracy of the cutting as well as edge condition was the bench mark considered to evaluate the newly developed novel sheet metal cutting machine in comparison with the conventional sheet metal cutting machine. It was found that the force required for cutting the sheets was directly proportional to the thickness of the sheet and width of the sheet required to be cut. Figure 2 and 3 shows the conventional sheet metal cutting machine and the newly developed novel sheet metal cutting machine respectively.

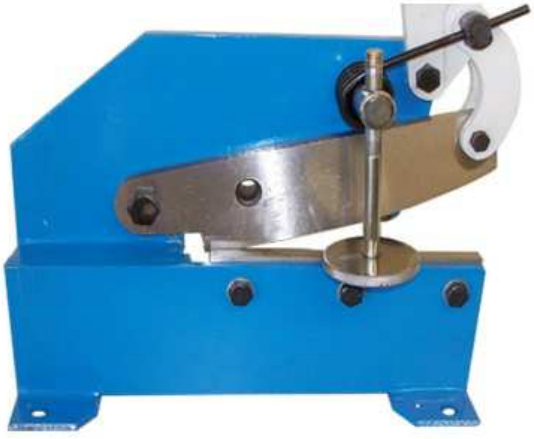

Figure 2: Conventional sheet metal Cutting machine

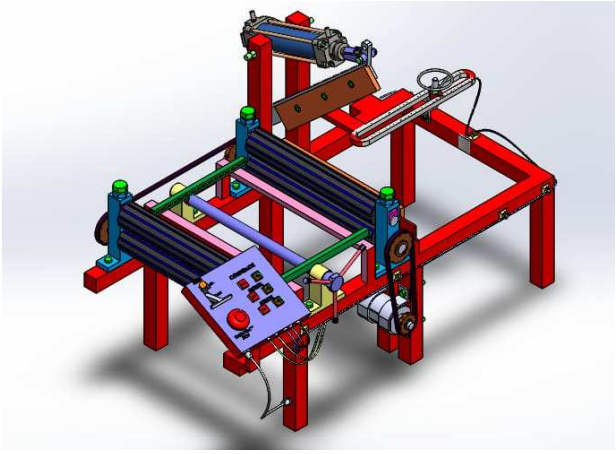

Figure 3: Automatic sheet metal cutting machine

Electronic Circuit Components: Electronic circuit components consists of Arduino UNO (Microcontroller), L298N Motor controller, 12V Single Channel relay, Feedback Diode, DC Motor, IR obstacle Sensor. Electronic Circuit to control the Automated Shearing Machine is show in the Figure 4.

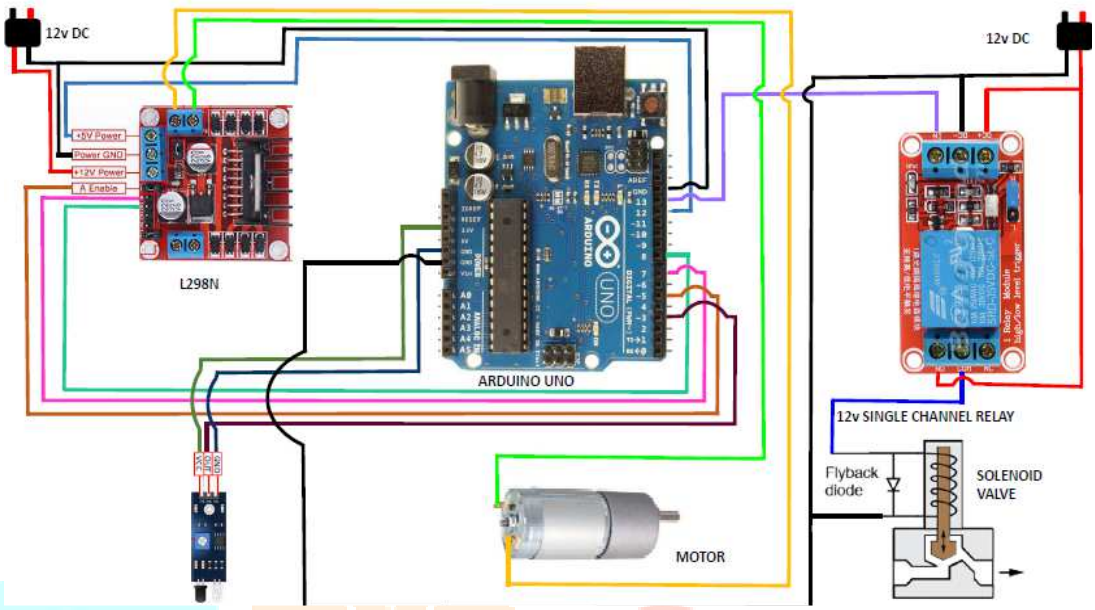

Figure 4: Electronic circuit to control for the Shearing Machine

The Arduino UNO is a user friendly, programmable, cheapest widely used microcontroller. Microcontroller consists of sets of digital and analog input/output (I/O) pins that may be interfaced to various circuits. The microcontroller has 14 Digital pins and 6 Analog pins. Programming can be done with the Arduino IDE via a type B USB cable. It is powered by a USB cable or by an external 9 volt battery.

IV. WORKING OF SHEARING MACHINE

The Shearing machine consists of different parts along with the frame such as pneumatic cylinder, shear blade, roller driven by DC motor through chain sprocket, and compressor. In operation, once the machine is Switched ON the sheet metal is fed to the roller through guide way. The roller is driven by 12V Dc motor running at 30 rpm connected with chain sprocket. The IR sensor is attached to the stopper and scale arrangement and it is fixed at the predefined length. When the sheet metal passing through the roller enters the IR sensor sensing range, the sensor senses the obstacle presence and sends the signal to the arduino board which in turn actuates the L298N motor controller to stop the DC motor, further the arduino also sends the signal to 12V DC single channel relay (electromechanical switch), it is connected to solenoid valve, when the power is supplied to the relay which in turn actuates the solenoid valve by energizing the coil. The pressurized air from compressor enters the solenoid valve inlet port, the outlet ports of solenoid valve are connected to the pneumatic cylinder. When the solenoid valve is actuated the cylinder's piston connected to shear blade cuts sheet metal and now there is no obstacle present in sensors sensing range, the arduino will stop the supply to relay connected to the solenoid valve which now actuates the cylinder in retract stroke, also the signal from the arduino is sent to the L298N motor controller which starts the motor again and the cycle repeats.

V. RESULTS AND DISCUSSION:

The sheet metal cutting experiments on novel sheet metal cutting machine carried out using 28, 25 and 23 Gauge Galvanized iron sheets of varied width and length were carried out and the results of the experiments are tabulated in Table 1 to Table 3. Influence of sheet metal dimension on shearing time while shearing 0.47mm, 0.63 mm and 0.78 mm thickness sheet is as shown in the Figure 5.1 - Figure 5.3.

Table 5.1: Time taken to shear 0.47 mm thickness

Gauge No.	Thickness in mm	Width of Cut (mm)	Length of Cut(mm)	Number of Pieces	Time taken (Seconds)
28	0.47 mm	45	45	10	36
			55	10	38
			65	10	41
			80	10	43
		90	45	10	40
			55	10	43
			65	10	45
			80	10	48
		135	45	10	44
			55	10	47
			65	10	49
			80	10	52
		180	45	10	46
			55	10	49
			65	10	51
			80	10	53

From the table 5.1, it can be observed that higher the width and length of cut longer will be the shearing time. For 28 Gauge, least shearing time is obtained for 45 mm width and 45 mm length of cut and longest shearing time was obtained for 180 mm width and 80 mm length of cut which is as shown in the Figure 5.1.

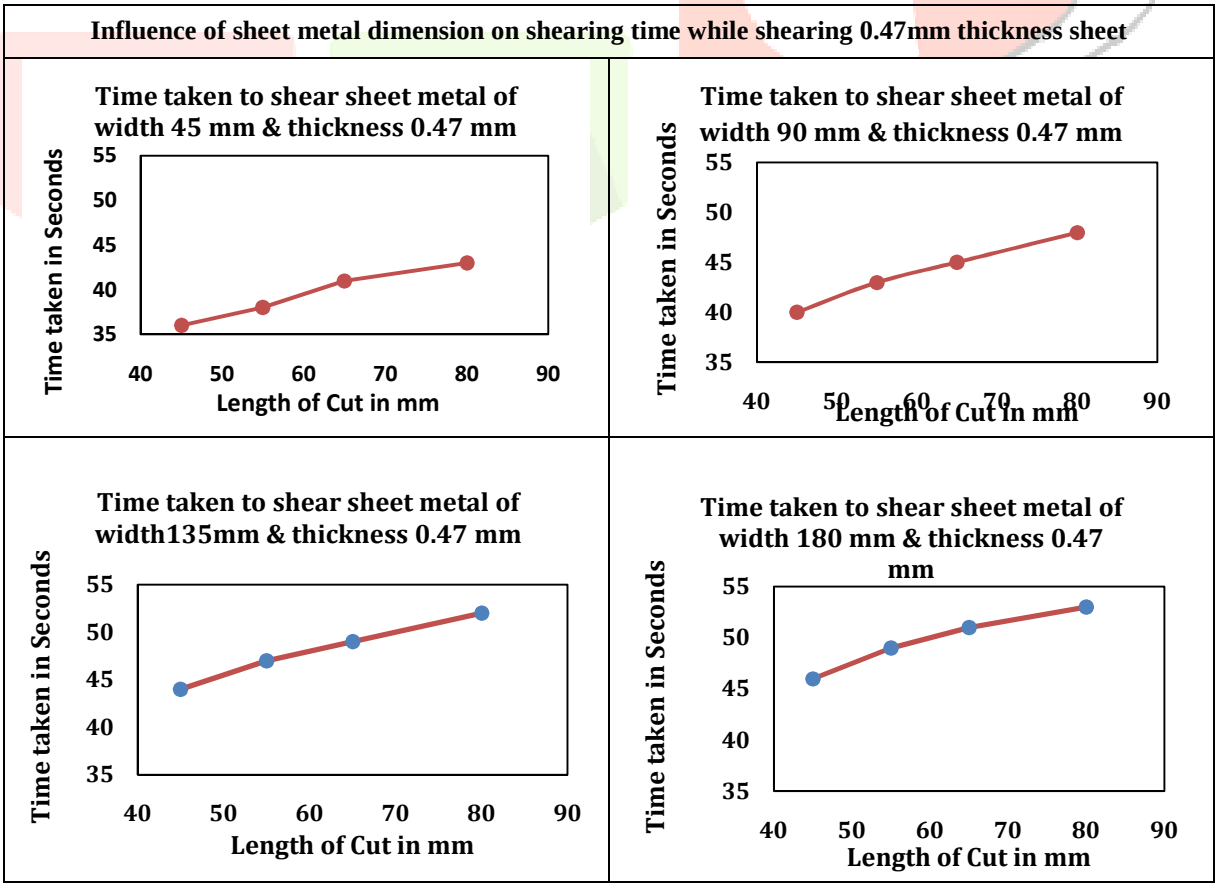

Figure 5.1: Influence of sheet metal dimension on shearing time for 28 Gauge sheet

Table 5.2: Time taken to shear 0.63 mm thickness

Gauge No.	Thickness in mm	Width of Cut (mm)	Length of Cut(mm)	Number of Pieces	Time taken (Seconds)
25	0.63 mm	45	45	10	49
			55	10	54
			65	10	56
			80	10	60
		90	45	10	54
			55	10	59
			65	10	61
			80	10	63
		135	45	10	59
			55	10	64
			65	10	67
			80	10	71
		180	45	10	63
			55	10	66
			65	10	70
			80	10	74

From the table 5.2, it can be observed that higher the width and length of cut longer will be the shearing time. For 25Gauge, least shearing time is obtained for 45 mm width and 45 mm length of cut and longest shearing time was obtained for 180 mm width and 80 mm length of cut which is as shown in the Figure 5.2.

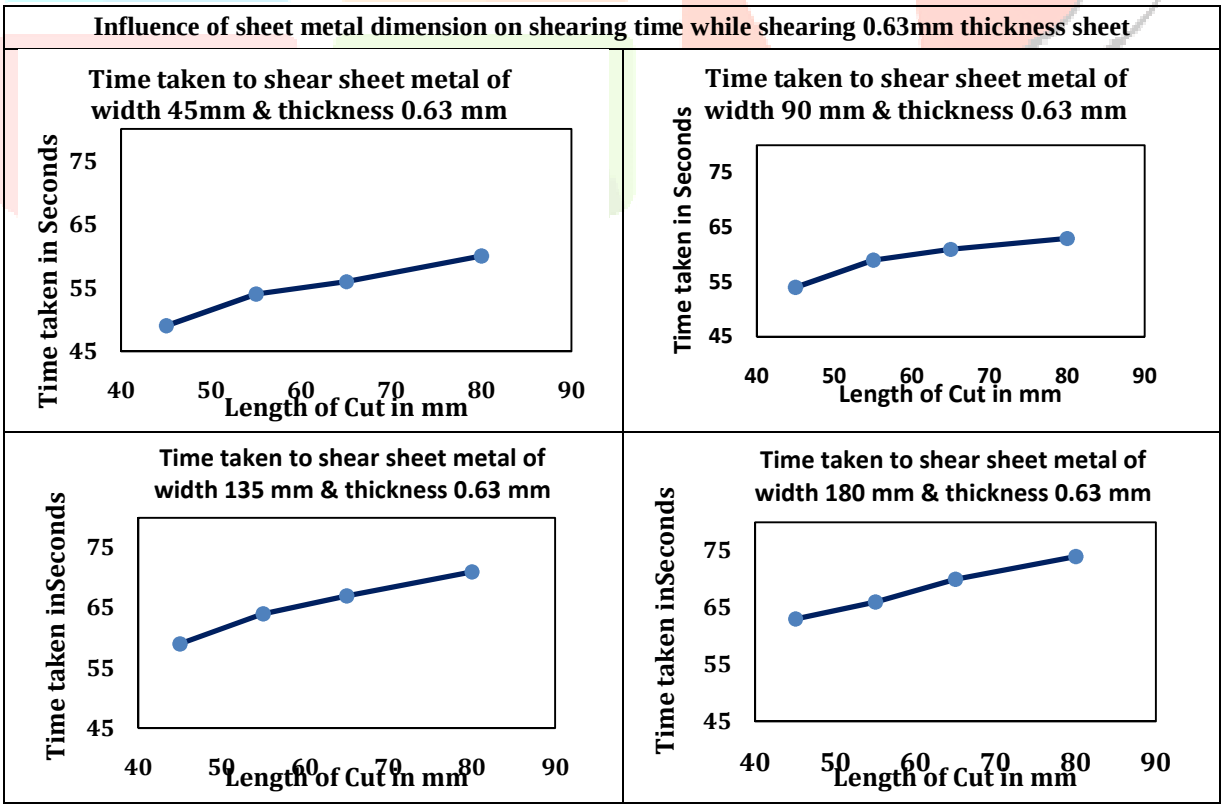

Figure 5.2: Influence of sheet metal dimension on shearing time for 25 Gauge sheet

Table 5.3: Time taken to shear 0.78 mm thickness

Gauge No.	Thickness in mm	Width of Cut (mm)	Length of Cut(mm)	Number of Pieces	Time taken (Seconds)
23	0.78 mm	45	45	10	64
			55	10	68
			65	10	71
			80	10	76
		90	45	10	70
			55	10	75
			65	10	78
			80	10	83
		135	45	10	76
			55	10	82
			65	10	86
			80	10	90
		180	45	10	80
			55	10	85
			65	10	89
			80	10	93

From the table 5.3, it can be observed that higher the width and length of cut longer will be the shearing time. For 23 Gauge, least shearing time is obtained for 45 mm width and 45 mm length of cut and longest shearing time was obtained for 180 mm width and 80 mm length of cut which is as shown in the Figure 5.3.

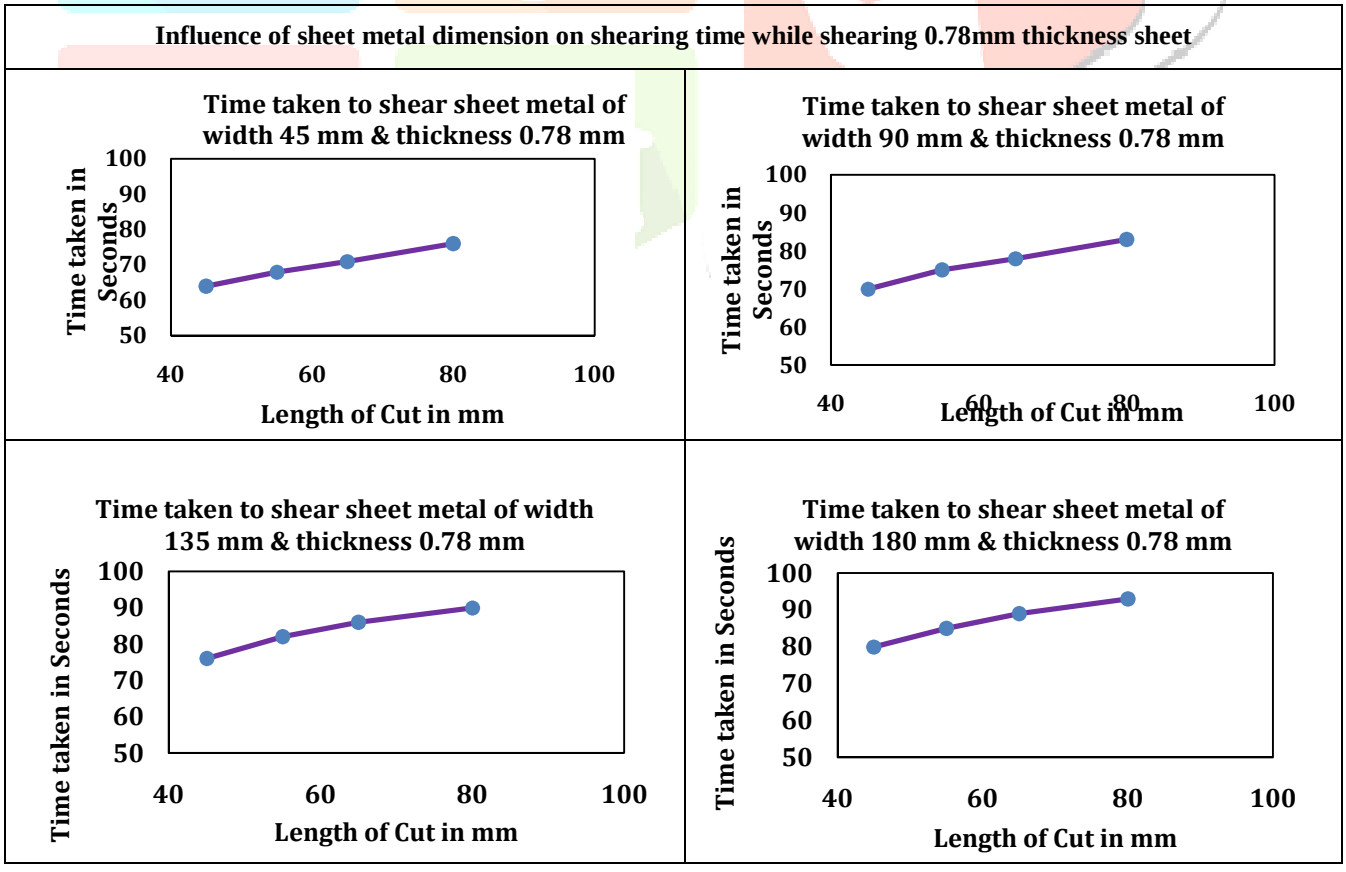

Figure 5.3: Influence of sheet metal dimension on shearing time for 23 Gauge sheet

CONCLUSIONS:

1. It can be inferred that as the length of cut increases, shearing time also increases.
2. The width of cut has major impact on shearing time. As the width of cut increases shear time also increases.
3. While shearing 25 and 23 Gauge GI sheet similar trend of increased shearing time was observed with the increased length and width of the specimen.
4. Increase in shearing time was observed as sheet thickness increases.
5. Least shearing time was consumed while shearing 28 Gauge sheet with 45 mm width and 45mm length.
6. Longest cycle time was observed while shearing 23 gauge sheet having 180 mm width of cut and 80 mm length of cut.
7. The sheets cut from the newly designed automatic shearing machine was precise in dimension.

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