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Design and Fabrication of Manual Spring Rolling Machine

Kurian Seby*,Nikhil Chacko*,Nithin P Rajan*,Sony Thekkiniyath*,
Kapil Dev E J*, Christy V Vazhappilly**
**(UG Scholar, Department of Mechanical Engineering, Jyothi Engineering College, Thrissur, India)*
*** (Assistant Professor, Department of Mechanical Engineering, Jyothi Engineering College, Thrissur, India)*

ABSTRACT
This paper is to discuss to design and fabrication of a manual spring rolling machine by a simple mechanism arrangement for the production of closed and open coil helical springs. This machine is operated by manual method. This machine produces closed coil helical spring of different diameter and different length. Rolling is the process of bending metal wire to a curved form. The article in the shape of round is made by spring roller shaft. Rolling operation can be done on hand or power operated rolling machine. It can make a spring from a shaft. A shaft is a rotating machine element which is used to transmit power from one place to another. A bearing is machine element which supports another moving machine element. Guider is used to guide the raw material (spring wire). This guider moves on the shaft automatically. This self-movement is achieved by the lead of spring. Handle is used to operate the rolling machine manually, without electric power frame is carries an all parts of the machine, it is made up of mild steel. A work holding mechanism is used to hold the mandrel; it is attached to the main shaft of machine. Mandrel is fitting in the work holding mechanism, the mandrel's outer diameter is known as internal diameter of the spring.

Keywords: Spring rolling, Helical spring, Mandrel, Spring wire

I. INTRODUCTION

A spring is a device that changes its shape in response to an external force, returning to its original shape when the force is removed. The energy expended in deforming the spring is stored in it and can be recovered when the spring returns to its original shape. The amount of deformation is directly proportional to force exerted. Spring rolling industry is a large and growing industry. There are many special purpose machines used in this industry to-day. The proper selection of the machines depends upon the type of the work under –taken by the particular industry. There are many examples of spring rolling work include iron, copper, tin, aluminum, stainless and brass. This project the "SPRING ROLLING MACHINE" finds huge application in all spring rolling industry. Rolling is the process of bending metal wire to a curved form. The article in the shape of round is made by spring roller shaft. Rolling operation can be done on hand or power operated rolling machine. In forming round spring shapes a gradual curve is to be put in the metal rather than sharp bends. The gap between the springs can be regulated by proper arrangement. Spring is elastic bodies (generally metal) that can be twisted, pulled or stretched by some force. They can

Return to their original shape when the force is released. In other words it is also termed as a resilient member. A spring is defined as an elastic machine element, which deflects under the action of the load & returns to its original shape when the load is removed. Mechanical springs are used in machine designs to exert force, provide flexibility, and to store or absorb energy. Springs are manufactured for many different applications such as compression, extension, torsion, power, and constant force. Depending on the application, a spring may be in a static, cyclic or dynamic operating mode. A spring is usually considered to be static if a change in deflection or load occurs only a few times, such as less than 10,000 cycles during the expected life of the spring. A static spring may remain loaded for very long periods of time. The failure modes of interest for static springs include spring relaxation, set and creep.

II. PROBLEM STATEMENT

Rolling process for production of open and closed coil helical spring was difficult for different materials due to the variation in modulus of rigidity. And for the purpose of production of springs with different diameters usage of chuck made difficulty due to its unavailability and increased cost and also its maintenance. Which also abruptly increases the weight of the mechanism more than expected. So we had to replace the chuck by another holding mechanism which solved the difficulties that caused by chuck.

III. OBJECTIVE AND SCOPE

The goal of this project is to design and fabrication of a manual spring rolling machine by a

simple mechanism arrangement for the production of closed and open coil helical springs. The specific characteristics being variable spring diameters, variable spring coil diameters of various materials by manual rolling process. The scope of this project is the application of this "MANUAL SPRING ROLLING MACHINE" in small scale industries for the production of open and closed helical springs of varying spring coil diameters and varying spring diameter, without much expense in a small scale level.

The importance of this study was that to know about the different springs that are used in many automobile parts and other mechanisms, and the crucial role that they play in different mechanisms. The spring machine is made by a very simple arrangement. This machine is operated by manual method. This machine produces closed coil helical spring of different diameter and different length. In our project is the spring rolling machine. Rolling is the process of bending metal wire to a curved form.

IV. WORKING PRINCIPLE

When the hand wheel is rotated, the shaft will run. The main shaft is coupled to the bearing with the help of mild steel plate arrangement. The main shaft is rotated with help of hand wheel rotation. Before the hand wheel rotation, the spring wire locked to the lock nut in the spring mandrel. The spring wire is supplied by applying the load through a guide which is fixed in the frame stand. The guide will rotate freely according to the speed of the spring rolling shaft.

The main shafts one end is coupled to the chuck and other end is coupled to the hand wheel. A spindle shaft or mandrel (various diameters) is attached to the chuck and it rotates.

The spring rolling shaft is rotated when the hand wheel is rotates. The spring is rolled with the spring rolling shaft. The change in the length of spring due to the rotation of the spring is decided by the operator. After making the required length of the spring the hand wheel is rotation is stopped. After producing the finished product of spring, the procedure is repeated for mass production.

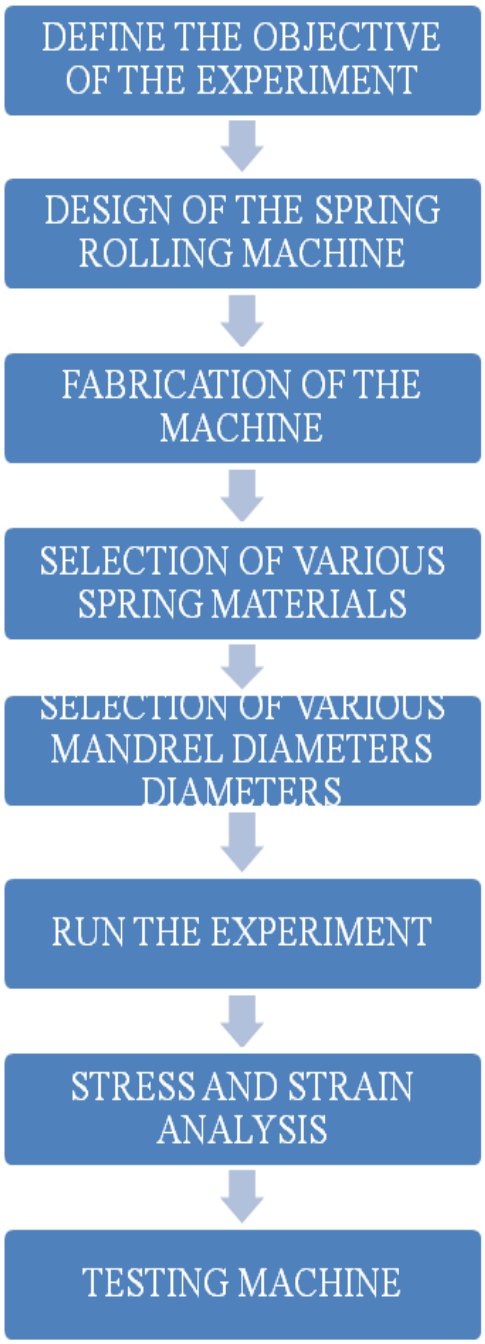

Figure 1 Flow Chart

Table 1 Components of spring rolling machine

SI. NO	COMPONENT	MATERIAL	DIMENSION
1.	FRAME	M.S	Length:650 cm
	(Square Hollow pipe)		Thickness:20 mm
			Guage:18
2.	MAIN SHAFT	M.S	Length:500mm
	(Cylindrical Hollow		Diameter:35mm
	pipe)		Thickness:1mm
3.	BEARING	M.S	Outer Diameter:60mm
			Inner Diameter:35mm
4.	BOLT	M.S	Diameter:10mm
5.	GUIDE SHAFT	GI	Diameter:16mm
			Length:1000mm

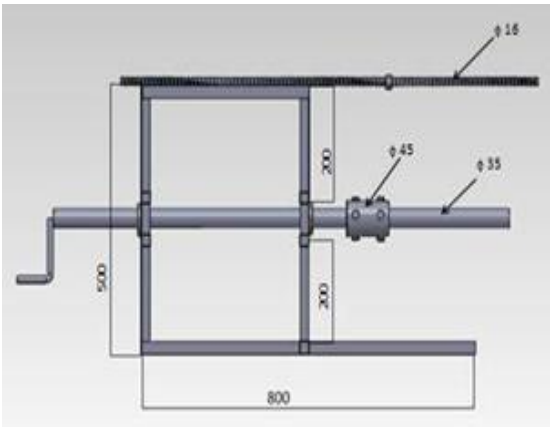

Figure 2 Spring rolling machine with dimension

V. DESIGN OF THE SPRING ROLLING MACHINE

The design part of our manual spring rolling machine was done in Solid Works software version 2011.

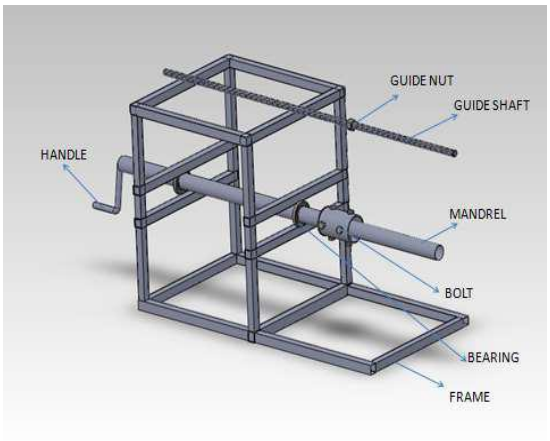

Figure 3 Spring rolling machine – Model

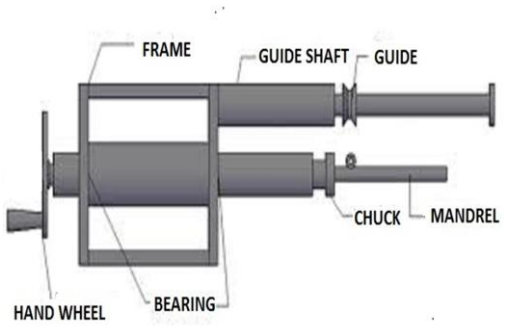

Figure 4 Components of Spring rolling machine

VI. CALCULATION

a. Torque On The Shaft

Torque (T) = Load x Distance between guide & mandrel
Where Spring diameter = 2mm (0.002m)

From P.S.G data book pg.no 7.105 for properties of spring steels
Tensile strength, (σu) = 1620 N/mm^2
Load = σu x area = 1620 x (π/ 4)x d^2 = 1620 x (π/ 4) x2^2 = 5089.38 N
Torque (T) = 5089.38 x 250
= 12.72 x 10^{5}N-mm

b. Bending Moment

M = W x L
= 5089.38x 150
M = 7.63 x 10^{5}Nmm
Teq = $\sqrt{T^2 + M^2}$ =$\sqrt{(12.723 \times 10^5)^2 + (7.63 \times 10^5)^2}$
= 14.841 x 10^{5}Nmm

c. Calculation Of Spring

Diameter of wire = d = 2mm
Mean diameter of spring D = 35mm
Radius of spring = R = 17.5mm
Load on the spring = P = 100N
Pitch of spring = P = 2mm
We consider No.of coil = n =10
Spring index C= $\frac{D}{d}$

Deflection y= $\frac{8PC3n}{Gd}$

Stiffness q= $\frac{Gd}{8C3n}$

Table 2 List of materials used for making spring and their G, Deflection, Stiffness

Si. No.	Material	Modulus of rigidity (G) (N/mm2)	Deflection (mm)	Stiffness (N/mm)
1	Music wire	79000	271.36	0.368
2	Oil tempered wire	79000	271.36	0.368
3	Copper	39000	549.64	0.18
4	AISI 302/304	69000	310.68	0.32
5	Steel C35	75000	285.83	0.34
6	Phosphor Bronze Grade A ASTM B159	43000	498.5	0.2
7	Beryllium Copper	48000	446.61	0.22
8	A 286 Alloy	71000	301.93	0.33
9	Aluminum	26000	824.51	0.12

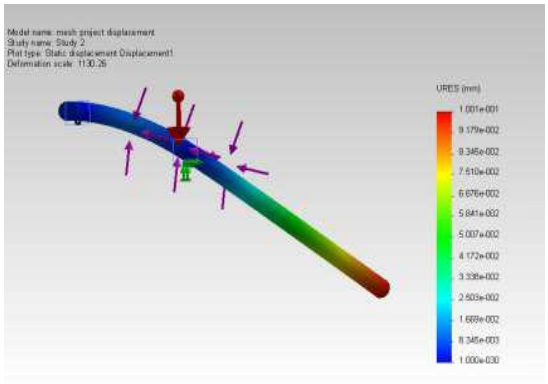

Figure 5 Displacement Analysis

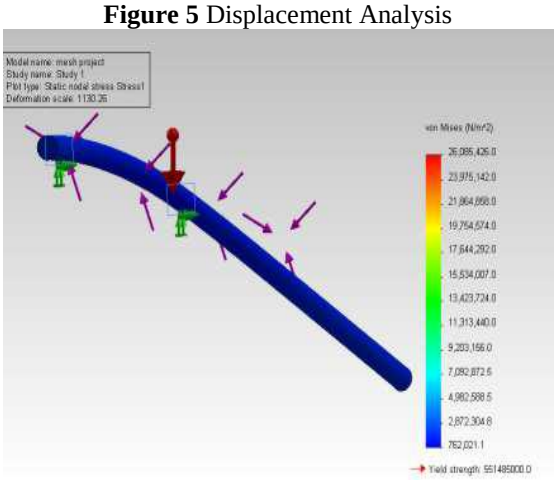

Figure 6 Stress Analysis

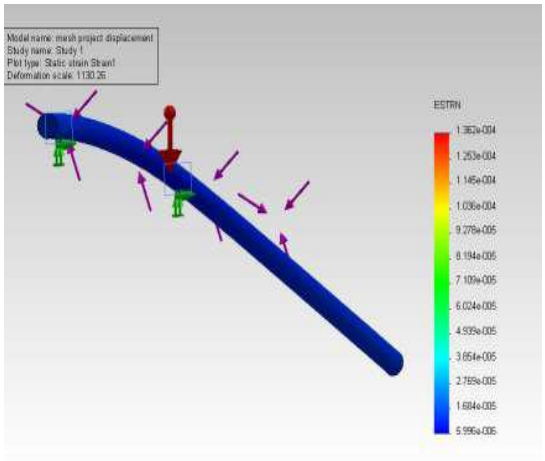

Figure 7 Strain Analysis

Springs are usually made from alloys of steel. The most common spring steels are music wire, oil tempered wire, chrome silicon, chrome vanadium, and 302 and 177 stainless. Other materials can also be formed into springs, depending on the characteristics needed. Some of the more common of these exotic metals include beryllium copper, phosphor bronze, Inconel, Monel, and titanium.

Figure 8 Fabricated manual spring rolling machine

VII. CONCLUSION

After completing the work, it is concluded that work is simple in construction and compact in size for use. Even in the absence of power supply it can be operated manually, and also manufacturing of machine is easy and cost of the machine is less .This machine can fabricate spring up to 3mm wire diameter of spring with less production time with ease by mass or batch production. This work can be implemented in small scale industries.

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