

Design and Manufacturing of Automobile Cushion Spring Manufacturing Machine

Sanket Prakash Deore¹

B.E., Dept. of Mechanical Engineering, MVP's KBT College of Engineering, Nashik, Maharashtra (India)

Abstract - Zigzag spring has to withstand the larger loads of humans while driving the car and they are act for very long-time duration continuously. So to overcome such high loads they are made with the spring steel which is too hard and have more rigidity than other materials. For manufacturing of spring metal wire with different diameter is use, diameter varying from 3mm to 4.5 mm. due high rigidity and the tensile strength the wire is very hard to deform in the required shape. In the press even large force up to 30 TN is not sufficient for deforming. Only the way remaining is the bending of wire by the automated lever and fixture arrangement, this is the easiest and convenient way for spring manufacturing. So we choose the bending technique for the manufacturing of spring. To acquire the bending action there are many ways but the most economic and easy way is by the electric motor and speed reduction gearbox to get the required speed for bending. Bending is plastic deformation technique use to deform the wire of metal in required shape and size according to application. In bending the metal flow is uniform along the bend axis with inner surface in compression and outer in tension. The most favorable conditions for bending exist when the axis of the bend is perpendicular to the direction of grains. In bending metal gets plastically within the bend area. Metal towards inner bend surface is under compression and metal towards outer is in tension.

Key Words: (Zigzag spring, Rigidity, Electric motor, Bending)

1.INTRODUCTION

Spring is a device which is use from long time for human comfort. A spring is device that changes its shape in response to an external force returning to its original shape when the force is removed. The energy used to distort the spring is stored in it and can be recovered when the spring returns to its original shape.. Generally, the degree of the shape change is directly connected to the amount of force exerted.. There are several types of springs such as coil spring, flat spring, torsional spring, leaf spring, zigzag spring. These all are uses for the cushioning of the automotive seats for human comfort. Zigzag spring is use at a wide range for the car seat cushioning and so required mass manufacturing

to complete the demand. The main aim to modify the process is reduce the human effort and to improve the production of the springs. One of the way to change the construction and make it more reliable is by using the zigzag spring. Zigzag spring is cushioning spring which when the force is applied is takes the curve shape and when forces removed is then regain its curvature shape according to the car seat arrangement.



Fig.1.The zigzag spring use in car seat construction

The load is distributed on all curves of spring so with less deformation larger loads can be bear by the spring. In the cars first coil springs are used which are easy to manufacture by conventional machines but their size and shape make difficulty. Construction of seat becomes so complicated and it required more space so now for this purpose they are absolute only some extent use. So to overcome the disadvantages the zigzag spring is introduced on large scale now. So to make the manufacturing easy newer techniques are developed for mass production. The sponsoring company manufactured the spring manually by the lever arm and the fixtures design according to spring design and its various parameters. So we decide to make the manufacturing easy by automating this process to make it more simple and fast than the prescribe method. fig 1.2

shows the use of zigzag spring in the automotive seat. The construction is more simple and easy than the coil spring.

2. Problem Statement

The companies were manufacturing the springs manually. So, it is needed to make an automated machine for manufacturing ease and mass production. These springs are more rigid than the coil spring due to its construction. These springs have rigidity due to its shape, size and the curvature. The load is distributed on all curves of spring so with less deformation larger loads can be bear by the spring. In the cars first coil springs are implemented which are easy to manufacture by conventional machines but their size and shape make the construction bulkier and heavier.

3. All about spring back action

In bending after the applied force is withdrawn the metal tries to resume its original position causing a decrease in bend angle. This type of metal movement is known as the spring back phenomenon.. It is caused by the residual elastic stresses in the bend area. After bending pressure on metal is released the elastic stresses are also released and cause metal movement spring back varies from 1/2 to 5 degree in steel.

Spring back depend on following factors

1. Material type
2. Thickness
3. Hardness
4. Bend radius

A larger bend radius causes greater spring back.

Spring back can be prevented by coining the metal slightly at the corners in order to relieve elastic stresses. This is sometime referred to as corner setting.

4. Existing stepwise procedure of manufacturing zigzag spring

1. First the wire comes in big roll with different wire diameter.
2. The wire is cut in the prescribe length require for whole spring making.
3. Then the worker takes one by one piece of wire and place on fixture.
4. The lever is placed at center in the bush for rotary motion and then the lever is rotated by arm force and the wire is get bend.

5. Here the one coil complete we have to make 8 turn
6. So the lever moves in opposite direction and the wire is turn for next coil.
7. After 1st coil every time the wire is turn and coiling is done.
8. And after 8th coil the coiling of spring complete and is proceed for next process.

During this process in practical the person actually doing the activity of bending is get tired after sometime. The man can apply up to 300N force for one stroke and is magnified by lever. So during day every time need of 300N force make the person thirsty and so rate of production is go on decreasing order. The spring specifications also not achieve at the required extent. So this method of bending by lever mechanism for zigzag spring is somewhat undesirable and unsuitable for production on mass scale.



Fig.2- Existing method for zigzag spring manufacturing

4.1. Need of implementing the new technique-

The need of changing the way of manufacturing arises from increasing the rate of production to complete the targets within time and production at high level to developed the company's image and become a leading manufacturer of a spring. There are some needs that have to complete by new techniques. The need of changing the way of manufacturing arises from the need to change or increase the rate of production to complete the targets within time and production at high level to developed the company's image and become a leading manufacturer of a spring. There are some needs that have to complete by new techniques reduce the manual work of worker to achieve high work efficiency of worker whole day. It reduces efforts of worker and hence his efficiency can be increase. It increases the accuracy. The overall productivity is also increased. Reduces scrap rate. Reduces manufacturing time per spring. Make the dies more simplified for simple fixture. Increase flexibility of machine for multi operation. Increase design load bearing capacity by

making spring more close to specified design. Fulfill market demand on the time and of required quality and quantity.

4.2. New design requirement-

According to the requirement A spring bending machine is designed. The new machine is basically there modification of the previous methodology. The aim was to design new methods that the lever which the operator operates manually should be rotate automatically.



Fig.3- 2 New implemented design of die

The new machine consists of:

1. 1.5 HP 3 phase induction motor
2. Reduction Gearbox with gear ratio 1:30
3. V-Belt (41-B)
4. Star coupling
5. Shaft
6. Rectangular Plate
7. Bush
8. Lever
9. Table (Base frame of L bar)
10. Allen Bolts
11. Hexagonal Bolts

5. Design procedure of DIE-

The design procedure of rectangular block as a die is as discuss below:

- The size of cuboid is $200 \times 200 \times 25$ mm. And it is made up of mild steel.
- First of all the center point of the cuboid is located from one face.
- A drill of 15 mm diameter is drilled at the center.

- Then a step bore of 25 mm was drilled in the hole of 15 mm diameter up to 15 mm depth as shown in figure 4.1.
- Such way a collar is obtained in the hole for mounting the cylindrical bush.
- A cylindrical bush of mild steel having 25 mm outer diameter and 5 mm thickness was inserted in that bore. The length of the bush is 25 mm. The bush is inserted in that hole with the interference fit.
- The bush remains 10 mm at external side, and hence it provides a collar for bending the wire.

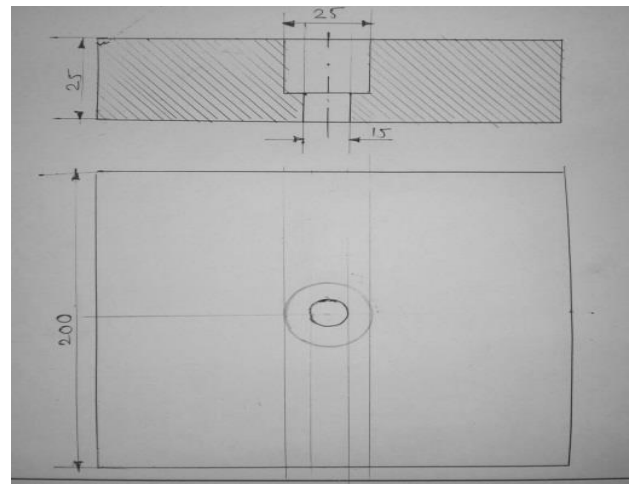


Fig.4- Sketch of DIE

6. Calculations-

The calculations are showing the increase in the production rate and also the labor cost decrease per day within the production.

Time required for manufacturing spring = 1 Min

No of spring manufacture in 1 hour = $60 \times 1 = 60$ springs

Total shift hours = 8

Total production of spring in one shift = $60 \times 8 = 480$ Springs

Existing production = 350 springs

Increase in production per shift = $480 - 350 = 130$ springs

Percentage increase rate in production per shift = $(130/480) \times 100 = 27.08\%$

Total shifts = 1

Annual Production = $480 \times 313 = 150240$ springs

Annual existing production = $350 \times 313 = 109550$ springs

Increase in annual production = $150240 - 109550 = 40690$ springs.

7. Results

1. The rate of production increases per shift is 27.08%
2. Time required for the manufacture spring = 1 Min.
3. Increase production per year = 40690 springs.

8. Conclusions

After successful implementation of cushion spring manufacturing machine it is concluded that ,

1. The semi automation leads to increasing production rate of cushion spring manufacturing per shift. For the organization it becomes very helpful for the mass production of cushion spring.
2. The efficiency of workman is increased by doubled than existing. This results in increase in production and maintaining proper human machine interface.
3. The dimensional accuracy of cushion spring increases at fine level and the strength of the spring is also increase by some percentage.
4. By the new technique rather than the existing technique gives good spring characteristics and stiffness.
5. The cost required by existing method per piece is greatly reduced by this technique including labor cost, machine cost and maintenance cost.
6. The power required for machine is low as compared to its production of cushion spring.
With the implementation of this new machine the mass production leads to complete the targets of company within prescribe time and with the greater accuracy

9. References

1. A textbook of Machine Design. K.S. Khurma & J.K. Gupta .Eurasia Publishing house pvt. ltd.
2. Paul, Akshoy; Roy, Pijush; Mukherjee, Sanchayan (2005). Mechanical sciences: engineering mechanics and strength of materials, Prentice Hall of India, p. 215.
3. Williams, Matt(2018). hooke's law from <https://phys.org/news/2015-02-law.html>