Design and Analysis of Spring Compression Tool in Tow Hook

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Abstract

This paper is implemented based on labours issue and describe about the design and analysis of spring compression tool in tow hook. A tool is used to compress the spring compressing inside the hollow cylinder where the force is applied with the thrust ball bearing through the deformation occurs in spring to settle in it. The thrust ball bearing helps to reduce to time for inserting the spring in tow hook cylinder and it also helps to minimize the deviations whereas while using the hydraulic jack.

Keywords: *Thrust ball bearing, open coil spring, bolts& nuts and clamp.*

1. Introduction

Compression tool is defined as rod. It can be operated by the person or labour without direct contact dealing with large links for heavy weight components. It has ability to move towards rotational motion. Tool can easily place the job in particular mechanical industries. Industries are growing up makes easier the mechanism It is a working methodology for pick& place mechanism at many direction is achieved by a series of mounting the job.

Tool is divided into three parts.

They are

- Screw rod,
- Ball bearing and
- Mounting.

Compression tool is operated by using man power to hold the mounting clamp together. The aligning pipe is nothing but it is similar to support by human hand, helps to does the operation at certain incline angles.

2. Material selection for Bellow

The different materials under comparison include

- EN19
- Thrust ball bearing

- Open coil helical spring

2.1 EN19

EN19 is a quality alloy steel having more tensile strength. EN19 steel is having combined good ductility and its shock resistance, it is suitable for very high loading applications such as engine gear boxes. For having very high surface hardness as well as excellent wear resistance to a carbon steel grade, it is flame or induction hardened.

2.2 Thrust ball bearing

A particular type of rotary bearing is a Thrust ball bearing. Thrust ball bearings are specially designed to support a predominantly axial load, in similar to other bearings they also permit rotation between parts. Hence, thrust ball bearing can withstand linear load. Thrust bearing absorbs axial load from rotating shafts into stationary housings or mounts in which bearings are turning.

2.3 Open coil helical springs

Coil springs are designed to absorb energy. The applied pressure to a coils spring causes the energy, that pressure energy is to be transferred into the compressed coils. As that same amount of pressure is alleviated, the energy within the spring is too. In other words, coil springs stores energy.

3. Comparison of properties of materials

The heat flux values calculated do not present a stark difference among the materials. The ANSYS results reveal the same too. Hence, these are not sufficient enough to arrive at any conclusion. So it is advisable to understand the composition of each material and their respective properties in order to suggest a suitable alternate.

Table 1. Chemical composition of different material carbon

Element	Min	Max
Carbon	0.35%	0.45%
Manganese	0.50	0.80%
Silicon	0.10	0.35%
Nickel	-	-
Molybdenum	0.20	0.40%
Chromium	0.90	1.50%
Sulfur	-	0.05%
Phosphorous	-	0.05%

3.1 Carbon

Lower carbon content leads to higher wear resistant. Hence, a low carbon content material is preferred in order to reduce wear.

3.2 Manganese

It improves the hot workability of the material by preventing the formation of iron sulphide. It also improves the melting point, strength and toughness.

3.3 Silicon

Improves properties such as freezing point, boiling point, density and hardness.

3.4 Phosphorus

Lowers boiling and freezing point.

3.5 Sulphur

Lowers density, boiling point and freezing point.

3.6 Molybdenum

Increases hardenability, weld ability, toughness, high temperature creep deformation and corrosion resistance.

3.7 Nickel

Increases toughness, resistance to fracture due to high temperature, elastic limit and abrasive resistance.

Other factors such as erosion resistance, temperature resistance and hardness also influence the life of a material. The comparison of these properties for the four material under consideration.

Table 2 Comparison of erosion resistance, temperature resistance and hardness for materials

Material	Erosion resistance	Temperature resistance	Hardness (Brinell Hardness HB)
EN8	Medium	High	201
EN12	High	High	217
EN19	High	High	217

4. Working methodology

An open-coil helical spring is a compression spring that offers resistance by means of axially applied compressive force. They are coiled usually with a constant diameter, even though they can be coiled in the needed forms such as conical, convex (hourglass), concave (barrel), or of their combinations. First the heavy duty spring is inserted in the cylinder. Open-coil helical compression springs are wound or constructed to resist compression along the axis of wind. When a load is applied on a compression coil spring, making it shorter and pushes back against the load, which tries to get back to its original length. Thus compress the spring by means of an external force to be applied. compression spring tool can be used to deform the spring. Spring to be adjusted and fixed in the mounted cylindrical pipe. Tool is inserted in the spring with clamp. When the force is applied from one end screwing with ratchet on the other end stud is fixed to proper position to align correctly. It helps to fix the position between studs in which thrust ball bearing material are used, so rotation takes place easier and reversible is not taken place.

Figure 1. Cross section of handling wheel

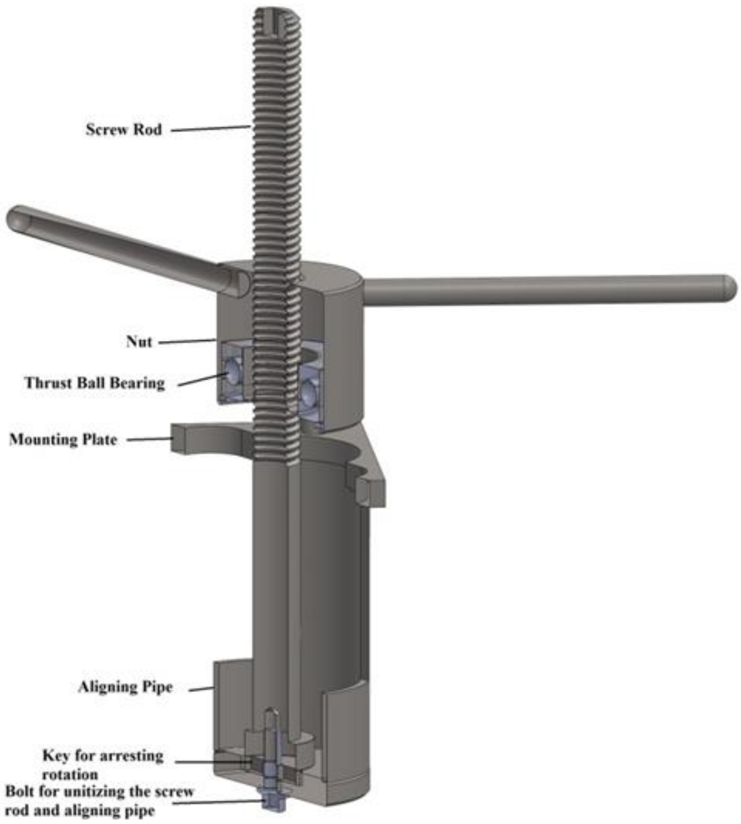

Figure 2. Spring compression tool

5. Calculation

Spring material: Hardened steel

Capacity: 10 tons; Pitch: 3.5 cm

Outer diameter: 12.5 mm; Inner diameter: 11 mm

Mean diameter = (outer dia + inner dia)/2

= (12.5+11)/2 = 11.75 mm

Mean radius = R/2 = 11.75/2 = 5.8 mm

Length = 20 cm ; No. of coils = 10

Shear modulus of hardened steel = 78 x 103 (8x103)

No. of coils (n1) = 12; Active no. of coils = 10

Mean diameter (D) = D1 – d

= 25 – 15 = 10 mm

Outside diameter of spring (D1) = 25 mm

FOS = 2

Weight of spring = 3 kg

Axial load of spring = total weight x FOS x 9.81 = 3x2x9.81 = 58.86 N

Modulus of rigidity spring index (C) = D/d = 25/15 = 1.66

Stress factor (k) = 4c – 1 (4c – 4 + 0.515 k)

= 4(1.66) – 1 (4x1.66 – 4 +0.515/1.66)

= 5.64/2.64 + 0.310 = 2.446

Shear stress in spring (τ) = ksx 8x Fx D/πd3

= 2.44x8x58.86x15/πx153

= 18.56 N/mm2

Deflection(Y) = 8x f xc3 x n / Gx d

= 8x58.86x1.663x10/78x103x15

= 41.42 mm

Stiffness (q) = G x d/8 x c^3 x n

= 78x103x15/8x1.66x1.66x1.66x10

= 6.6 x 106 N/m

Length of spring (Ls) = d x n +2d

= (15x10) + 2x15

= 150 +30 = 180 mm

Free length of the spring (Lf) = solid length +deflection

= 180 + 41.12

=221.42 mm

Pitch (P) = Lf - Ls/n1 + d

= 221.42 – (180/12) + 15

= 221.42 mm

Helix angle (α) = 1/ tan ($p\pi d$)

= 1 / tan(221.42x πx15)

= 1/0.102

= 9.80 °

Table 3 Comparison of Traditional and suggested method

S.No	Traditional method	Suggested method
1	Accuracy is less	Accuracy is more
2	Man power requirement is more	Man power requirement is less
3	Time consumption is more	Time consumption is less
4	In traditional method the tool used is hydraulic jack.	In suggested method the tool used is thrust ball bearing

6. Analysis using ANSYS Software

ANSYS software was used to analyze the spring compression tool of the total deformation, directional deformation, equivalent stress, strain energy, safety factor.

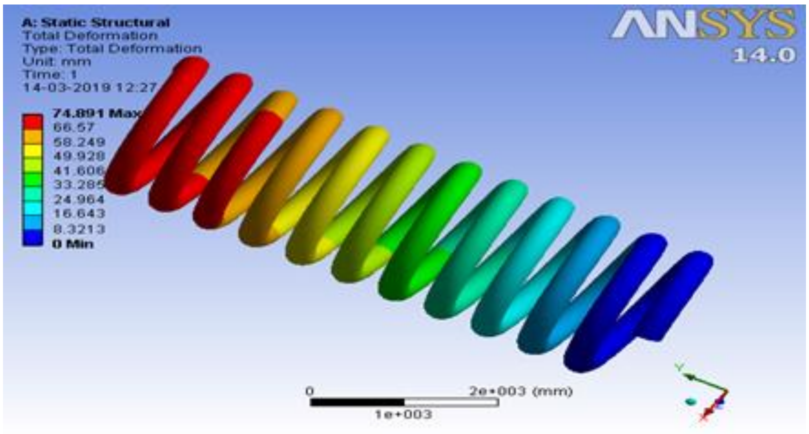

Figure 3. Analyze the Total deformation

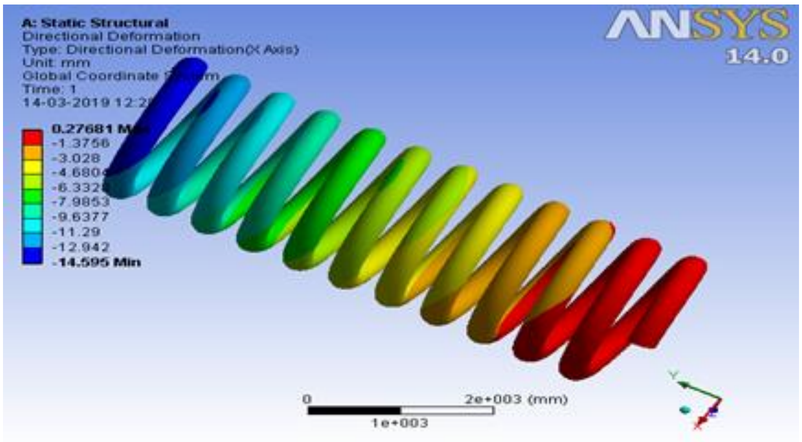

Figure 4. Analyze the directional deformation

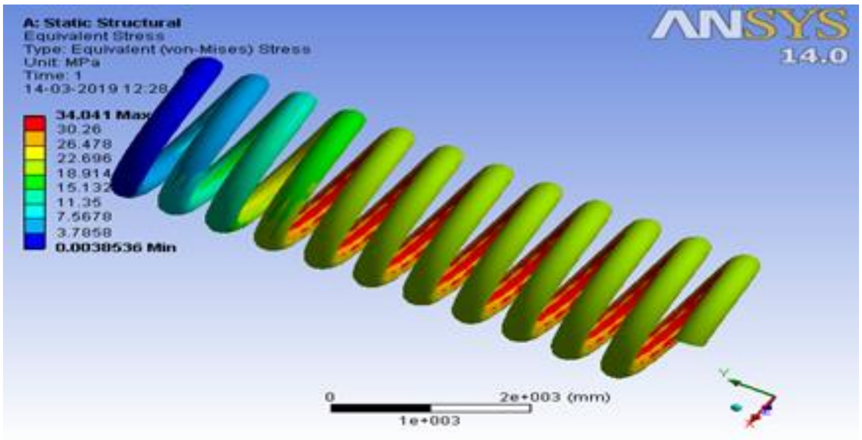

Figure 5. Analyze the equivalent stress

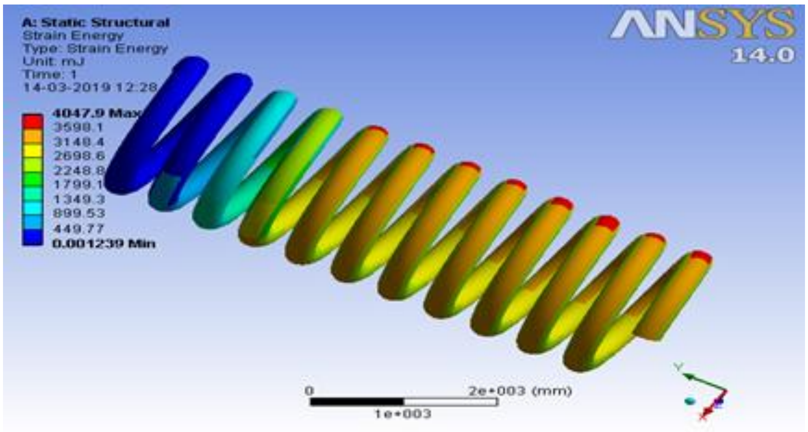

Figure 6. Analyze the strain energy

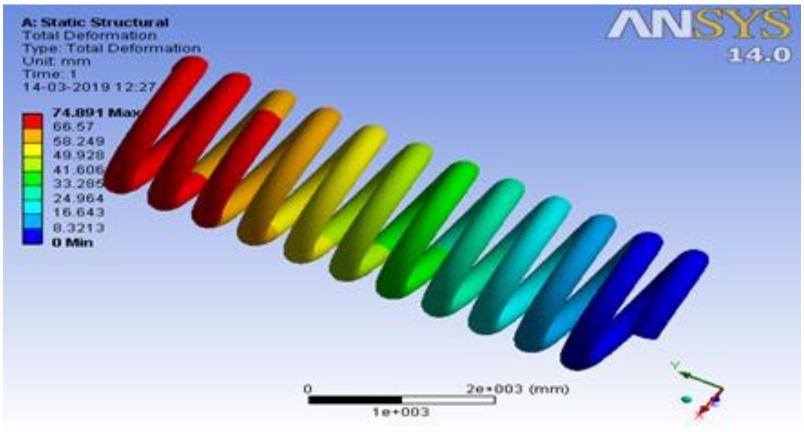

Figure 7. Analyze the safety factor

7. Conclusion

Thus, the tool designed helps in overcoming the difficulties faced in the traditional method. The thrust ball bearing helps to overcome the difficulties of hydraulic jack, which is used to insert the spring in the tow hook. The thrust ball bearing helps to reduce to time for inserting the spring in tow hook cylinder and it also helps to minimize the deviations whereas while using the hydraulic jack there is a lot of deviation occurs and requires more time for correcting the deviations and for inserting the spring in tow hook cylinder. The tow hook helps to pull the vehicle which was in repair. The traditional method requires two hours to assemble. But in this method, as suggested it takes only thirty minutes. Thus time can be saved up to one and half hours and also reduce the labor work. The traditional method requires more work and input. Hence, the suggested method requires less work input is needed and also reduces the time.

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