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The Experimental Design of a Spring Coil Compressor Remover for Automobile

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Abstract. This study examined various types of coil spring compressors in the automobile industry. A coil spring compressor for compressing a coil spring during the assembly of subassemblies of automotive suspension systems, having a head jaw positioned above a base and movable concerning the base. The coil spring compressor is provided with a pair of guide bars suspended from the head plate and on which a slidable carriage is mounted. The carriage carries a pair of compressing assemblies facing each other in vertical positions and positioned at both the upper and lower parts of the coil spring. Each assembly comprises a pair of compressor arms interconnected with each other. Each compressor arm is provided with a jaw mount to which a compressing hook is adjustably attached. The jaws are introduced between a few successive turns of the coil spring by operating handles provided on the compressor arms. The purpose of this design is to be used on various types of suspension disassembly and assembly of vehicles, the tool includes the upper and the lower jaw which by the smooth turning of the screw lowers to compress the coil spring or turns to release the compressed coil spring. The new design was made from mild steel and the tools used for the construction were an electric arc welding machine, power, and hand hacksaws, the bench vice, assorted hammers, vice, etc. The findings indicated that the new design is more efficient than the existing one. It was also recommended that car owners who visit the workshop should insist on the use of the right compression tool in the disassembly and assembly of their suspension systems.

Keywords: Trunnion, Steer, Elevation, Slidable

Introduction

Background to the Study

Coil springs are widely used in the motor vehicle industry as one of the primary elastic members of the vehicle suspension system. They are used as a connection between the wheel and the body of the vehicle; they tone down the shocks that would otherwise be transmitted from the uneven surface of the road to the body of the vehicle. Nowadays, coil springs are subjected to significantly larger stresses compared to ones used in previous generations of vehicles, and they due to fail which may need replacement or repair hence the analysis of the coil compressor remover. A coil spring is an integral part of an automobile suspension system, it is used to store energy and subsequently release it when needed (Kong et al., 2018). A coil spring is used in vehicles to absorb shocks and maintain the force between two contacting surfaces, it also maintains the weight of the vehicle together with a shock absorber usually called a strut (Trzesniowski, 2023). Owing to their benefits in weight, durability, space, and easiness of manufacture, the majority of car manufacturers choose coil springs rather than balloons. Steel alloys are the most commonly used materials for springs but other metals like beryllium copper alloy, phosphor bronze, and titanium rubber urethane may be used for cylindrical non-coil springs (Chen, 2011). Due to the high compressive force required to compress coil springs, a lot of components and devices have been designed in the past to serve the purpose (Kobelev, 2018). Coil springs usually fail due to many factors which include unprofessional installation and violation of the use of the system. The failed system will have to be installed to normalcy and without the use of one form of spring coil compressor or the other, there is no way the system will be installed correctly. Apart from the belt spring coil compressor, the others consist of two jaws, one of which is fixed and the other movable. They must be capable of resisting large forces, in particular, axial forces such as those that the coils of an automobile vehicle suspension spring are capable of exerting. Examples of some of the existing coil spring compressors are The Branick 7600 professional coil spring compressor which is used for the heaviest coil over shocks on light cars and SUV's without the need for additional adapters, as it also handles extra torque. Its multi-position upper spring hooks are adjustable up to 4 inches. It was made out of Branick's manufacturing facility in Fargo. This compressor is at times dangerous especially when it is not properly mounted on the walls and this type of compressors is so designed that they can be mobile and can be use everywhere. Another type of a coil compressor is the hydraulic coil spring compressor which is a foot operated coil spring compressor designed for car and van suspension system strut (Goodarzi, Lu, & Khajepour, 2023). It has adjustable spring retainers and is used on spring diameter of up to 507mm and 550mm, it has a maximum compression of 1000 kg/1 tone. The weight of this device is usually 31.5kg, and this equipment is made to be safe to the user by allowing for safe removal of the spring from the system, though quick and easy but putting them up again to put the top mounting plate on most of the time prove difficult.

Furthermore Shankly coil spring compressor is used for compressing strut and other coil spring for passenger and light vehicles providing the user a versatile compressor solution. It has an operating capacity of 300mm and overall length of 300mm. the problem with this type of compressor is that the thread inside of the compressor can strip out to cause the spring violently decompress which can cause an injury to the operator or the environment. An important is this belt coil spring compressor which is an improvised tool made from a cargo belt (CLB) and an adjuster. It is recognized tool for the removal or compressing of spring coils, it is almost used in all workshops and by the Mechanics and the Technicians of the various workshops. Though it is in use, this tool or method of coil spring removal is one of the dangerous method ever existed, per the energy built up in springs when compressed the adjust does fail or at times when the pressure build up exceed that which the built can contain the belt fail without any given signal. The most common and versatile is the Owatana tools company an (OTC) coil spring compressor which is convenient and affordable, and it fits a wide range of struts and requires no special adapter shoe. Safety locking pins holds the compressor jaws in place. This tool compresses springs of 101.6 to 228.6 mm with wire diameter of 177.8/406.4 mm to 177.8/406.4 mm built to use with an impact wrench. This tool cannot be operated by one technician, it need two or more persons to be able to operate smoothly and safely. The dangers associated with a coil spring compressor cannot be overstated and therefore there is the need to conduct research on them and design a safe compressor. It has been found out from almost all coil spring compressor users that, the operation of the entire coil spring compressor has some problems and they are at times very difficult to operate (Bhandari, 2020). That is, it is not easily to be operated and cannot be easily operated by one person. It causes a lot of inconvenience and sometimes causes injuries to the operator(s), it also requires a lot of time to operate. The reason for the inconvenience in operation is attributed to the design and construction of these tools, and the belt type of coil spring compressor has the same demerits as the other compressors. It sometimes traps the user or one's finger when the release mechanism is delayed (Narayanamurthy, 2017). In some cases, the coil spring flies to the face of the operator when the mechanism fails (Zhang, 2017). It is therefore important to improve the design of the existing coil spring to provide easy and safety operation.

The aim of this study is to redesign and construct a coil spring compressor device that will be easily accessible to the local workshops and Mechanics in order to ensure their safety and that of those who visit their workshops and surroundings.

The study will go a long way to eliminate the problems that are most of the time associated with use of some of the existing coil spring compressors in use, in most of the mechanical workshops and also to eliminate almost all the accidents related to the use of other compressors.

As introduced initially, that, there are a lot of spring coil compressors in use, simple structure, low cost, effectiveness and compact design which have led all of them to become popular compressor type in use. The main disadvantage of all of these is that almost all of them does not have a supporting stand hence difficult to be operated by one person. In order to have full understanding of this work, a practical review on the various works and types of coil spring compressors in use shall be considered. This chapter discussed thoroughly a number of coil spring compressors in use in the field of the Automobile industry and one will clearly see that a lot of work has been done to improve upon the design and operation of the various coil spring compressors over time. The research done by other persons which are related with this research were discussed. The facts from their research were used to guide this research in correct way. The source came from the journals wrote by the previous researchers. Their theory and results help this research as they can be a comparison between this research and theirs.

Suspension System

A car suspension system is the mechanism that physically separates the car body from the wheels of the car (Goodarzi, Lu, & Khajepour, 2023). Basically, this system consists of two main parts. They are the suspension spring and the shock absorber. A suspension must be able to minimize the vertical force exerted to the passengers in the car. Muhammed (2022) also said that to achieve minimum vertical force, the vertical car body acceleration must be minimized. The suspension system can be categorized into passive, semi-active and active suspension system according to external power input to the system and/or a control bandwidth (Pan, 2017). For the semi-active suspension, it has the same elements as the passive suspension system but the damper has two or more selectable damping rate.

Passive Suspension System

Passive suspension system is used widely by commercial vehicles nowadays to control the dynamics of a vehicle's vertical motion as well as pitch and roll. The word passive is used to explain that the suspension elements cannot supply energy to the suspension system. This system controls the motion of the body and wheel by limiting their relative velocities to a rate that gives the desired characteristics. Some type of damping element need to be used and be placed between the body and the wheels of the vehicle. The damping element can be like a hydraulic shock absorber. An early design for automobile suspension system focused on unconstrained optimizations for passive suspension system which indicate the desirability of low suspension stiffness, reduced unsprung mass, and an optimum damping ratio for the best controllability (Hajidavalloo, 2022). Thus the passive suspension systems, which approach optimal characteristics, had offered an attractive choice for a vehicle suspension system and had been widely used for car. However, as mentioned before, the suspension spring and damper do not provide energy to the suspension system and control only the motion of the car body and wheel by limiting the suspension velocity according to the rate determined by the designer (Goodarzi, Lu, & Khajepour, 2023). This gives a meaning that the performance of a passive suspension system is variable subject to the road profiles.

Spring and Strut

Generally, a mechanical spring is defined as an elastic body whose mechanical function is to store energy when deflected by a force and to return the equivalent amount of energy on being released. This spring need to have the mechanical properties which are required by a suspension spring. Springs are crucial suspension elements in cars, necessary to minimize the vertical vibrations, impacts and bumps due to road irregularities (Aboazoum, 2022). The function of the suspension spring is to maintain good control stability and to improve riding comfort (Sharma, 2018). Types of springs are Tension/extension spring, compression spring, torsion spring, constant spring, variable spring, and variable stiffness spring. Springs are storage devices for mechanical energy, think of them as analogous to batteries (Rimpel, 2021). The earliest spring driven clocks appeared in the 1400s, fast forward some 600 years one still have to charge the watch every day and it's not nearly as fast as winding a clock. The main function of a spring is to store energy and release it when necessary and function under the right load (Guo, 2023). The most common types of springs are coil springs. These are made of round wire and include compression, extension, and torsion springs. Spring wire forms are spring wires formed in a bracket-like manner. They can assist in storing energy and release it due to their shape. These are not coiled nor have a cylindrical shape, rather they are curved and/or have concave shapes that allow them to be attached to a load and absorb energy or force (Turner, 2016). Spring leafs are one type of wire form that has been around for ages. Spring leaves where made out of flat wire that was curved to form an arc and was used in a suspension like manner for carriages and other heavy loads.

A strut is a structural component commonly found in engineering, aeronautics, architecture and anatomy (Chua, 2023). Struts generally work by resisting longitudinal compression, but they may also serve in tension (Wang, 2021). The strut is a common damper type used on many of today's independent suspension, front wheel drive vehicles as well as some rear wheel drive vehicles.

A strut is a major structural part of a suspension. It takes the place of the upper control arm and upper ball joint used in conventional suspensions, because of its design, a strut is lighter and takes up less space than the shock absorbers in conventional suspension systems. Struts perform two main jobs. First, struts perform a damping function like shock absorbers (Chen et al., 2020). Internally, a strut is similar to a shock absorber. A piston is attached to the end of the piston rod and works against hydraulic fluid to control spring and suspension movement. Just like shock absorbers, the valving generates resistance to forces created by the up and down motion of the suspension (Franczyk, 2023). Also like shock absorbers, a strut is velocity sensitive, meaning that it is valves so that the amount of resistance can increase or decrease depending on how fast the suspension moves (Piwowarczyk, 2019). Struts also perform a second job. Unlike shock absorbers, struts provide structural support for the vehicle suspension, support the spring, and hold the tire in an aligned position. Additionally, they bear much of the side load placed on the vehicle's suspension. As a result, struts affect riding comfort and handling as well as vehicle control, braking, steering, wheel alignment and wear on other suspension.

Spring Dimension

In producing spring, there are 3 main dimensions that need to be focused on. These dimensions are the parameters that affect the behavior of spring (Pratomo, 2022). Usually, for each country, it will set the standard dimension for the spring that will be installed in the vehicle produced inside the country. The 3 dimensions are the wire diameter (d), loop diameter (D) and the distance between two consecutive loops or known as pitch (P). For better understanding, the dimension is illustrated as in the Figure 1.

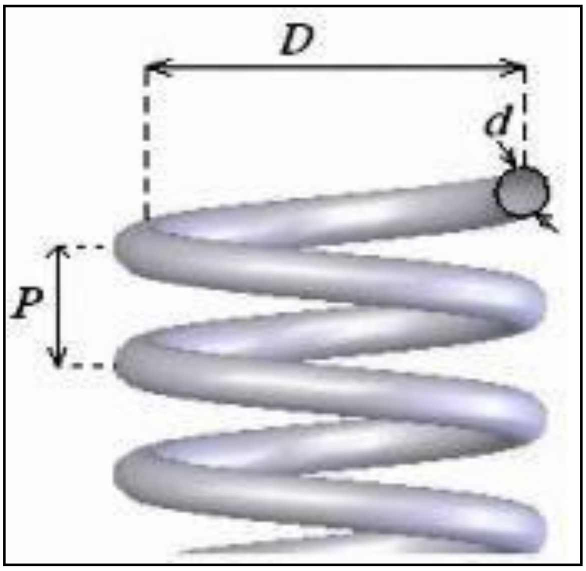

Figure 1. Parameter of helical spring

Bakhshesh (2012) used the dimension listed in Table 1 for his research which he claimed as the standardize dimension. The wire diameter for suspension spring is 13 mm and it is proved by Bakhshesh statement and also from the dimension of the suspension spring measured in the laboratory. The sample used was a suspension spring from PROTON car.

Table 1. Spring specifications

Parameter	Value
Wire diameter (d)	13 mm
Mid diameter (D)	145 mm
Spring height	440 mm
Maximum force	3000 N

Table 2. PROTON car spring specifications

Parameter	Value
Wire diameter (d)	13 mm
Mid diameter (D)	145 mm
Spring height	400 mm

From the above tables, the wire diameter (*d*) and coil diameter (*D*) are the same. It shows that these dimensions are already used in automotive industry in our century. The dimensions above can be classified as the optimum dimensions because they are used in manufacturing the suspension springs. The dimensions in Table 1 and Table 2 were then compared with (Tokuriki, 2009) proposed dimension. (Tokuriki, 2009) also chose the dimension as close as Baksheih et al. (2012). The coil diameter (*D*) that was use was 150 mm while the wire diameter was varied from 13 to 20 mm. The other dimension for wire diameter chosen was 12 mm which was chose by (Tse, 1994) uses 10 mm of wire diameter in his study of steel spring. Another research done before chose the wire diameter to be 11 mm was used by (Michalczyk, 2009), (Gopinath, 2012) select the wire diameter to be 10 mm. From the research done by (Mihai, 2009) the optimum wire diameter that he obtained was 14.81 mm. Other than that, (Mallick, 1987) chose 4 inches or equal to 10.16 mm as the wire diameter. 14.62 mm wire diameter was selected by (Yong, 1998). In the laboratory, the suspension spring provided was from PROTON car. The suspension spring was examined and measured. The wire diameter of the spring was 13 mm. Thus, for this research, the wire diameter (*d*) will be manipulated.

In this research, the dimension parameters will be the main factor that will be discussed. From the literature by previous researchers, many of them manipulate the dimension of the wire diameter (*d*). This is because the coil diameter cannot be adjusted without changing the socket at the wheel and the car body. Basically, the suspension spring is located between the wheel and car body. If the diameter of the coil being manipulated, it can cause the suspension spring not to be installed into the vehicle. Every vehicle that used suspension spring will have a socket at the wheel where the suspension spring will be attached. The socket will be in constant size so the diameter cannot be easily changed without considering the size of the socket at the wheel and also of the body of the car. *(Dai, 2020)* mentioned that the design parameters of a coil spring are the rod diameter, spring diameter and the number of coiled in the form of helix.

Spring Material

From history, the gasoline-powered automobile can be traced back to 1870, when the first car was made in Austria; the mass production of cars did not start until the early 1900s both in Germany and in the United States. The first automotive coil spring was installed on the Model-T Ford in 1910, where the suspension combined the leaf spring and the coil spring. The earliest coil spring material had approximately a 500 MPa design stress level (Kobelev, 2018). Nowadays, it is common to have a coil spring with a design stress of around 1200 MPa. Ilyas (2022) said that, in making the suspension part, fiber-reinforced polymers have been vigorously developed for many applications, mainly because of the potential for weight savings. Fiber-reinforced polymers have many advantages compared to steel such as (a) the possibility of reducing noise, vibrations and ride harshness due to their damping factors; (b) the absence of corrosion problems, which means lower maintenance costs; and (c) lower tooling costs, which has favorable impact on the manufacturing costs. If a steel part is replaced with a composite-based part, it will yield a significant weight savings (Singh, 2021). However, the manufacturing of composite material is complicated and yet to be achieved in successful result. This is why many engineers take the opportunity attempting to design a composite spring or suspension.

Various types of coil spring compressors in existence

Figure 2. (a) Coil spring (b) Strut (c) Pre-assembled unit

(a) (b)

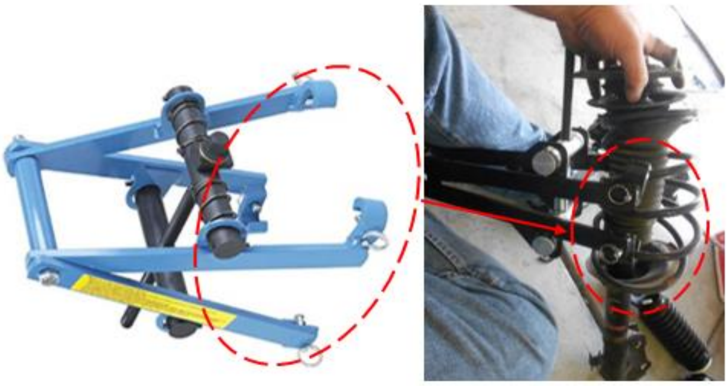

Figure 3. (a) OTC spring compressor. (b) Fitted with a coil spring

(a) (b)

Figure 4. (a) Branick 7600 professional compressor. (b) Compressor in operation

(a) (b)

Figure 5. (a) Hydraulic coil spring compressor. (b) Tool in operation

(a) (b)

Figure 6. (a) Shankly spring compressor. (b) Fitted with a coil spring

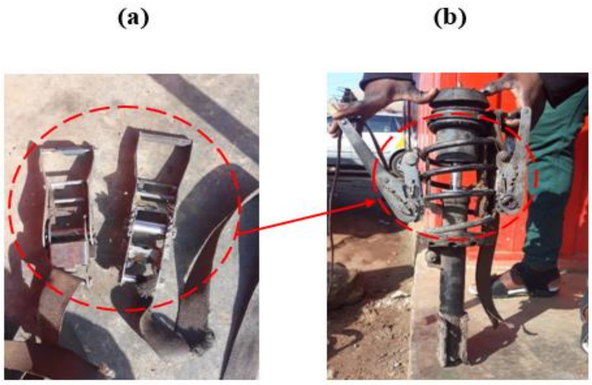

Figure 7. (a) Belt coil spring compressor. (b) Fitted with a coil spring

Methods and Materials

This is to presents the methodology used in the design of the modified coil spring compressor as well as material used.

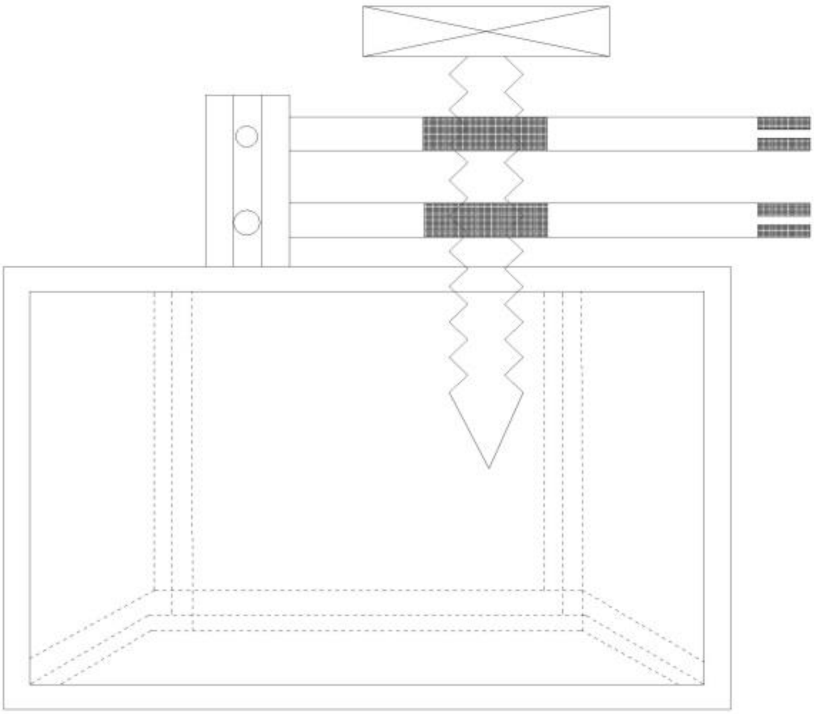

Figure 8. (a) TU coil spring compressor

Detail View of the design

The drawing below shows the details of the design labelling.

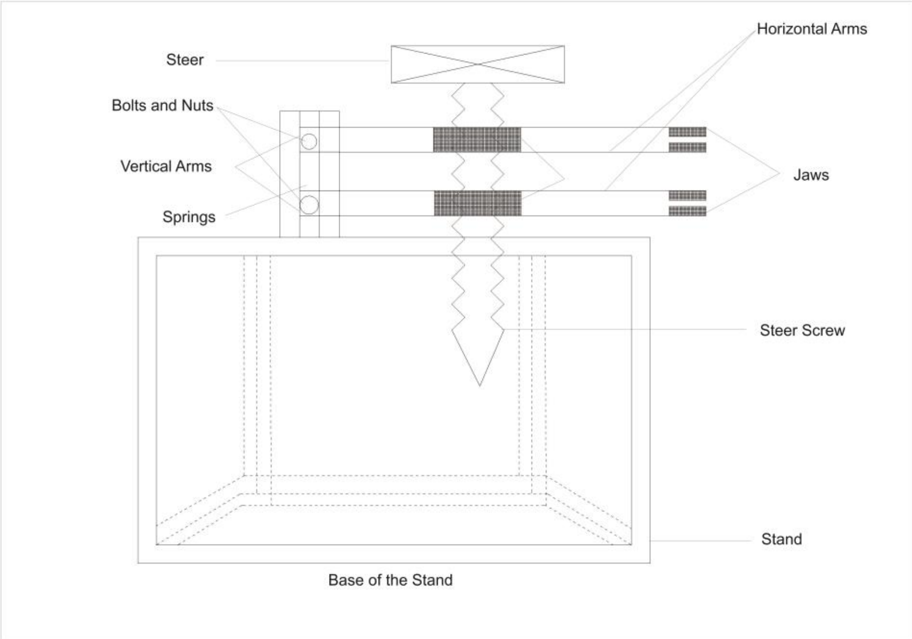

Figure 9. Detail drawing of the design

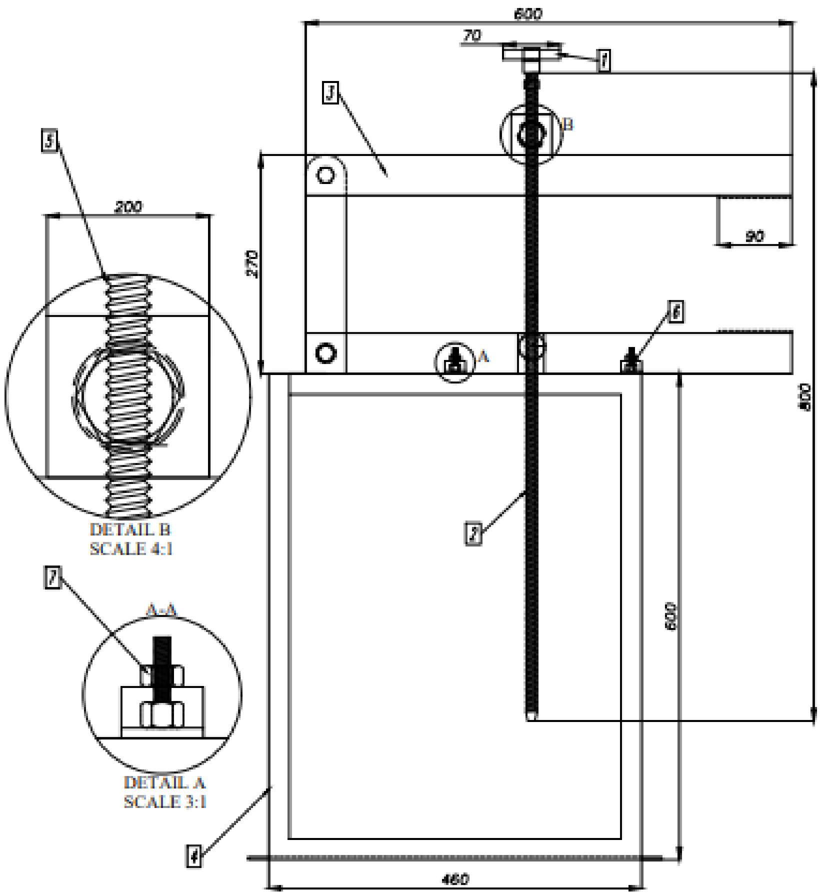

Figure 10. Dimensional details front elevation

Table 3. Parts list and material of component

Parts	Number	Dimension	Materials
Jaw	4	90mm	Galvanized
Flat bars	4	600mm	Carbon steel Carbon steel
Flat bars (vertical arm) Stand	2 1	270mm 600 x 460mm	Carbon steel Carbon Steel
Plain Trunnion	3	70 x 50mm	Carbon Steel
Steering Screw Bolts and nuts Bolts and nuts	1 4 2	800mm 22mm 32mm	Carbon steel Carbon steel Carbon steel

Functions of the parts of the design

Stand: is a piece of rectangular shaped, which is also the base of the whole design use to support the equipment arrangements.

Steer screw: is a smooth fine screw long enough to hold both the upper and lower horizontal arms of the equipment and unlike other steering system of components, which has linkages, etc. which allows any vehicle, car, motorcycle, bicycle to follow the desired course, the steer screw allows the movement of the arms only in the up and down direction.

Jaw: The jaws are a pair of hinged or sliding components designed to grip a work piece or the spring coil compressor in position so that compression can be done easily

Horizontal arm: with similar functions to a human arm, the arm help the equipment to be able to hold the spring coil, and compression and decompression is done on the arm

Trunnion: it is one part of a rotating joint where a shaft (the trunnion) is inserted into (and turns inside) a full or partial cylinder.

Bolts and nuts: A bolt is a form of threaded fastener with an external male thread requiring a matching pre-formed female thread such as a nut.

Springs: is an elastic object that stores mechanical energy and this is fitted between the horizontal and the vertical arms at one end to keep the distance between them constant

Material Used

In constructing the device, the main material used is carbon steel. As it has the mechanical properties, knowing the properties of Carbon content. It is used in the construction of the coil spring due to its high tensile strength and low cost, it is a major component used in building infrastructure, tools, ships, automobile, machines, appliances and weapons. Carbon steel is a steel that has some percentage of carbon in its base element, is has carbon content of between 0.05 to 0.25% by weight. Steel is considered to be carbon steel when no minimum content is specified or required for chromium, cobalt, molybdenum nickel, niobium, titanium, tungsten, vanadium or zirconium or any other element to add to obtain a designed alloying effect. The specified minimum for copper does not exceed 0.04%, or the maximum content specified for any of the following elements does not exceed the percentages needed; manganese 1.65, silicon 0.6, copper 0.60. As carbon percentage content rises, steel has the ability to become harder and stronger through heat treating, however it becomes less ductile. Examples of carbon steel is mild or low carbon steel and high tensile steel. Many considerations have to be addressed during this design, but it begins with material selection. Other things that were also considered were to be sure as much as possible about the device's intended operating environment and the space available for spring installation. Once the materials were selected, careful consider on how wire diameter and volume of coil springs can help determine the compressor spring's load handling capabilities, tolerances and manufacturability.

Operating capacity of the design

The new design of the tool compressor which may possess most the features of the original tool which are that, **it** is convenient and affordable; it fits a wide range of struts and requires no special adapter shoe. Safety locking pins holds the compressor jaws in place. This tool compresses springs of 100 to 230mm with wire diameter of 80/410 to 280/410 mm built to use with an impact wrench. The new design will possess all the qualities of the old design with little changes with respect to the following; it will be able to compress 260 to 710 mm long compressor with a diameter of 130 to 410 mm coil spring.

Helical Coil Springs Design procedure

The helical coils springs are made up of a wire coiled in the form of a helix and are intended for compressive or tensile loads. The cross-section of the wire of the spring is generally circular and the two main types of helical coil springs are compression and tension helical springs. Only the compression springs will be of interest in this study because of coil spring compressor design and will help in measuring the characteristics when the compressor is used. A typical compression coil spring can be seen in Figure 11.

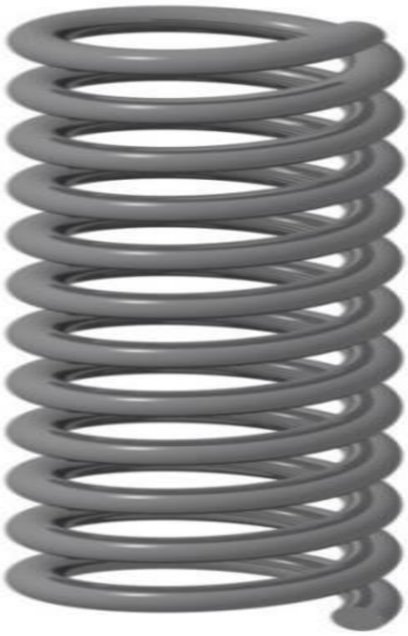

Figure 11. Compression Helical Coil Spring

Definitions of the Some Terms Used in Compression Coil Springs

Solid Length: That is the length when the spring is compressed until the coils come in contact with each other.

$$L_S = n'.d \tag{1}$$

Where
Ls = solid length
n= is the number of active coils and
d= internal diameter of the coil

Free length: It is the length of the spring in the free or unloaded condition.

$$L_F = n'.d + \delta_{max} + 0.15\,\delta_{max} \tag{2}$$

Where Lf = the free length of the coil

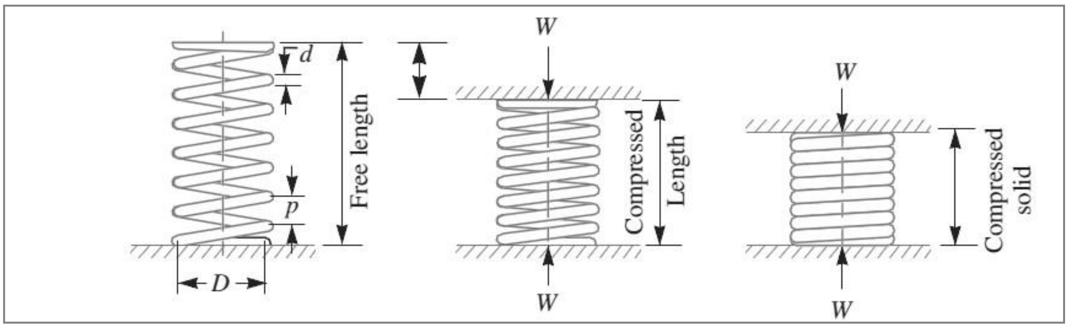

Figure 12. Free and Solid Length of the Helical Coil Spring

Spring index: The ratio of the mean diameter of the coil to the diameter of the wire.

$$C = \frac{D}{d} \tag{3}$$

Spring rate (stiffness): The load required per unit deflection of the spring.

$$k = \frac{W}{\delta} \tag{4}$$

Pitch: The axial distance between adjacent coils in uncompressed state.

$$p = \frac{Free\ length - Solid\ Lenth}{n' - 1}\ or\ p = \frac{L_F - L_S}{n'} + d \tag{5}$$

The maximum shear stress equation has importance, because, while doing the static analysis validation of the analysis model in ANSYS, the results will be checked according to maximum shear stress value and deformation according to applied load.

Deflection of Helical Springs of Circular Wire

The total active length of the coil spring;

$$l = Length\ of\ one\ coil \cdot number\ of\ active\ coils = \pi D \cdot n \tag{6}$$

This seeks to analyses the results and also discusses the redesign and construction of the spring coil compressor, based on the operational principle of the original coil compressors currently in use in the automobile industry and comment by some key players in the use of coil spring compressor.

Experimental Results of the Modify Coil Spring Compressor

After the design and construction of the compressor, and in order to make sure the equipment meets standard it required to meet that is per the operation of other compressor. A particular helical coil spring which have the below parameters was used in testing the equipment. The coil spring used for the testing have the following information as per its design. Free length of spring 345mm, Pitch 70mm, Mean diameter 150mm,Wire diameter 125mm, Number of active coils 6, Music diameter 13mm. Using scale hanged over the TU compressor and the experiment performed three different times the following results were obtain per the following, load, deflection, and angles, coil spring seat type, and the average results were picked. Below is the outcome of the results from the test. Measurement of load and deflection represented on the graph

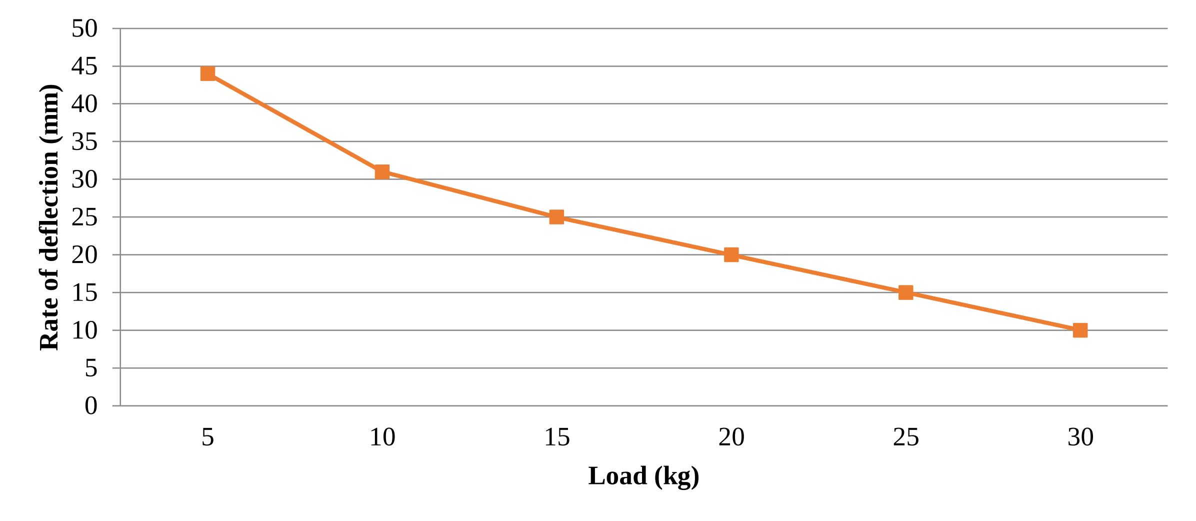

Figure 13. Rate of deflection in (mm) against load in (kg)

It is now clear from the graph that when the coil spring was not loaded (free length) the total length was 345mm when the compressor placed a load of 5kg on the spring at the initial stage the length was reduce from 345 to 301mm which means that at the load of 5kg the compressor was able to reduce the length by 44mm and that means that at that point there was no any resistance from the coil spring so from the graph at load 5kg deflection was 44mm. When the compressor placed a load 10kg deflection was from 301 to 270mm this time unlike the initial load of 5kg which gave a deflection of 44mm this time the deflection was 40mm which shows that resistance have started setting in, at 15kg of load from the compressor deflection was 25mm, and at 20kg deflection was 20mm, at 25kg deflection was 15mm and at 30kg deflection was 10mm this goes on to show that though there some form of resistance pursed by the coil still the new designed compressor was still able to place a load and some rate of deflection were achieved. This means that at load 15kg and deflection 100mm any loaded coil spring can unloaded and be loaded this new design, by this assessment one can say that new the design has performed its functions just like the original spring coil compressor. The test that was conducted is on the angle, load, and deflection.

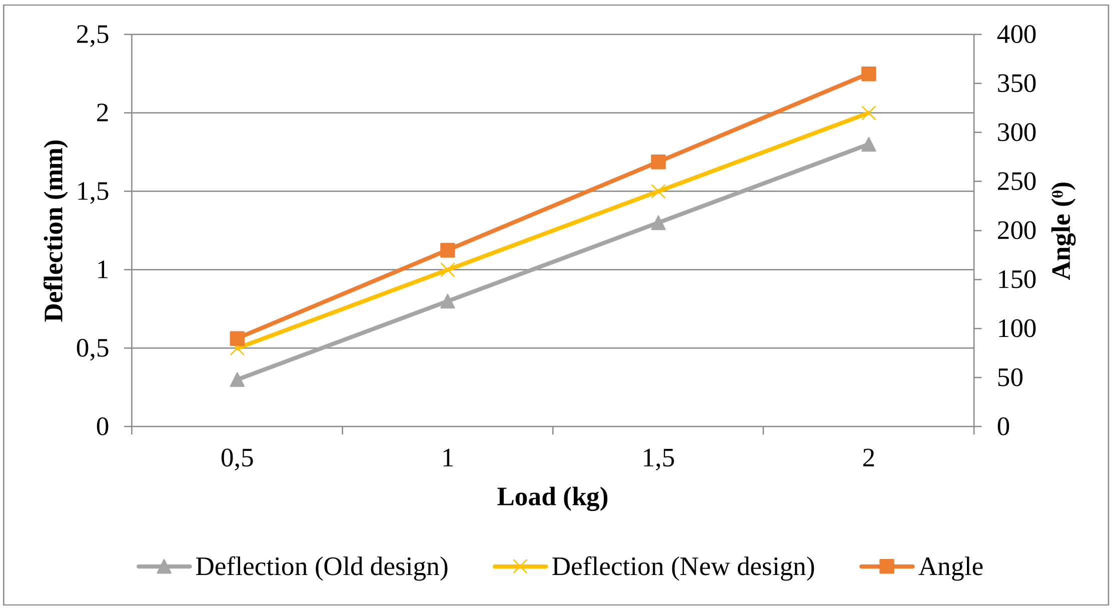

Figure 14. Rate of deflection in (mm) load in (kg), and angle in (degree) for both new and the existing design

From the above graph which was plot with rate of deflection in (mm), load in (kg) and angle in ($^{\theta}$) for both the new and the existing design, it is clear that at angle 90^{θ} and load of 0.5kg for the new design deflection was 0.5mm, at 180^{θ} and load of 1kg, deflection moved from 0.5mm to 1mm, at 270^{θ} load and deflection also move by 0.5 that is from 1kg and 1mm to 1.5kg and 1.5mm respectively and at 360 load and deflection gets 2 kg and 2 mm exactly so this shows that at any increase in the angle and load, deflection will change in respect to the angle. Comparing the modified design to the existing design from the above graph with the same applied load and angle the rate the following results were obtained, when the new design achieved 0.5mm at 90^{θ} the old design obtain 0.3mm, at 180^{θ} the deflection in the existing design was 0.8mm, at 270^{θ} the rate of deflection was 1.3mm and at 360^{θ} the rate of deflection was 1.8mm so from the above analysis deflection was lagging in the old design one could conclude that the modified or the new design is efficient than the old design.

Mode of Operation

This spring compressor allows the spring to be compressed with its upper spring arm against the lower spring arm with a very firm griping jaws so that the spring shape or the spring coils pitch are no longer an issue. The variable set arms spring compressing assembly, adjustable horizontal and vertical arms assembly and strut holding clamp with single hand operation widen the field of application this compressor to almost any strut or shock absorber while, at the same time satisfying the highest health and safety standard.

When the coil spring is inserted into the device, the lower part of the spring gets seated on the two jaws at the bottom whilst the two upper jaws hold the coil spring from the top part. The load (coil spring) is positioned properly so that there is minimal movement, The steering screw is then rotated clockwise to compress the upper trunnion and compel it to move the coil towards the lower trunnion, this action causes the upper long hook frame to also move towards the lower long hook frame. Since the jaws are fixed on the various hook frames, the movement of the hook frames will automatically cause the coil spring to be compressed. When the coil spring with the strut is at the compressed state or position, bolts on the absorber can then be removed with ease with a wrench and the strut be pulled out easily from the bottom. Same procedure can be followed to fix a new strut into the complete absorber.

Specific improvement of the TU coil spring compressor

The newly constructed coil spring compressor has been enforced with an additional trunnion to give it a square shape, its square shape allows the coil spring to be compressed axially and hence eliminate the possibility of the spring being pushed away as it is peculiar with other coil spring compressor. This new design has made the used of safety pins on other coil compressors unnecessary yet safer to use. With the introduction of the stand, this tool can be set to a fixed position and yet be able to accommodate a wide range of coil springs without being dismantled, adjustment may be necessary only when there is the need. The introduction of the steering screw has eliminated the need to use a spanner for turning the screw to compress the spring as in the case of other coil spring; this feature has reduced the operation time and has made the use of this design more enjoyable, safer to both operators and the environment.

Performance

No additional accessories are needed, the T U design of the spring compressing assembly, respectively the jaws, as well as of the radial and driving bar enables all designed spring coils suspensions and damper strut designs to be compressed and repaired, no additional jaws needed as shown in the complete assembly of the compressor. The jaws are able to withstand the forces exerted by the load (coil spring), the steering screw does not require so much force to be turned during operation. Also the steering screw is able to hold the spring in the compressed position without returning on its own.

The jaws in collaboration with the locking pins are able to hold the load (coil spring) in a stable position to stop it from moving freely. The plain trunnions are not fixed to any part of the body and that they have the ability to move slightly towards the direction of the jaws when in operation. Mobility of the compressor, though it can be fixed on the workshop floor permanently, it as well can be made mobile by moving it with the workshop trolley. The workshop trolley is ideal for use in garages and workshops allowing the user to carry out repairs conveniently next to the vehicle. It allows for one person operation unlike other compressors discussed in the literature as well as other original design when one will need the support of the other in order to be able to operate the new design which is termed the T U design has the procedure that can be carried out by just one person, the strut holding clamp is equipped with a quick clamping and comfortable seating seat for the strut and a hand operation device to allow for ease of use. No damage to the strut, the special tube holding clamp can quickly be adjusted to the corresponding strut diameter and the height of the spring coils and the clamping jaws feature protect most plastic coatings.

With the redesigning of the compressor it is safe to operate compared to other original designs, but remember any piece of equipment can be dangerous if not operated properly. The operator is always responsible for the safe operation of this equipment. The operator must be well vest in the operation of this equipment before putting it into use. A compressed coil spring is very dangerous, be extremely careful, never stick fingers, hands, or other body parts anywhere that they may be pinched or smashed. This tool has and creates multiple pinch points. It may come lose with extreme force. There is a chance of parts being shot at high speeds, this could cause serious injury or death to the operator or by standers, keep hands, feet and all other body parts clear at all times. Never operate equipment of any kind if tired or under the influence of alcohol, drugs, medication or any substances that could affect your ability or judgment.

Using this tool requires dissemble of some components of the suspension, if the operator is not confident that the work could be completed safely, then have work performed by a certified technician or person who is familiar with the front suspension of the vehicle. Failure to reassemble the suspension properly can lead to serious injury or death.

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