Design of Tool Elasticity of Compressed Springs Tester with the Variable Value of the Force and Spring Constant Through a Load Cell and a Millimeter Scale Reading Method

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Abstract: This study aims to design a tool for testing the elasticity of compression spring that often used in strippers in press tool design. The elasticity spring is the ability of the spring to return to its original shape when the external force is removed. The process of loading and unloading compressed springs uses a hydraulic system. The method for reading the value of spring elasticity at the time of measurement on the tool is by using a load cell measuring instrument and a millimeter scale. Design of tools from being a tool for reading the spring elasticity value it can also be used as a tool to install and ensure that the spring is attached to the stripper. The design method refers to VDI 2222 which consists of planning, concept, design process, and finishing. The results obtained are the tester design of the test equipment with a maximum capacity for four springs, with a total load that can be accommodated 180 kg. The results of calculations and simulations using Solidworks software show that the frame and base are safe because they can withstand a pressure with a safety factor value of 2.

1 INTRODUCTION

One part of the press tool construction is the stripper plate. The stripper plate is a part that can moves freely up and down along with a spring attached to the bolt holder. This plate functions as a material clamping plate during the process and so as to avoid the occurrence of defects in the formation of the workpiece surface such as wrinkles and folds, as well as a punch guide. One of the components to help the movement of the stripper plate is the stripper spring. The stripper spring serves to maintain the position of the stripper, return the punch position to its initial position, and provide a compressive force on the stripper so that it does not shift when subjected to cutting and shaping forces.

Springs are objects that have elastic properties to a certain extent. The elasticity's spring is the ability of the spring to return to its original shape when the external force was removed. However, several obstacles that still encountered in the determination and selection of springs, one of which is the absence of tools to ensure and test the condition of the spring and its elasticity properties, especially the compressed spring for the stripper on the press tool. The problem of testing the compressive elasticity of the stripper for the press tool is still not widely studied and researched, especially on the education scale. It can also be used as practicum material for students to test the elastic properties of springs.

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According to (Yakin, et al., 2020) in their research stated that the results of the spring constant analysis using the conventional method showed that the horizontal and vertical soil spring constant values for

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clay soils were the same as those for sandy soils with the same N-SPT value. Budi research, et al., (2020), only discusses the nature of the spring constant and the modulus of elasticity with the conclusion that two identical springs have different spring constant values. While the value of the spring constant is directly proportional to the value of the modulus of elasticity but inversely proportional to the length of the material. The results of the design and simulation of the spring constant test equipment for a capacity of 50N/mm, able to withstand a maximum static load of 2000N or 203.94 kgf with a safety factor of 1.1 (Pratama and Fitri, 2021). Research by (Djaja and Hatuwe, 2015), states that there is a decrease in the spring caused by cyclic loads, minimum loads (preload) the number of revolutions caused by diesel motors. However, this decrease in spring force is still in the safe category from several parameters.

Several studies have discussed the design of spring constant test equipment. The design of the spring constant test tool that has been carried out by Chaudhary (2018) states that the tool in the form of a spring rolling machine is very simple in operation using a microcontroller with a digital display. Meanwhile, (Jadhav., et al, 2015) in a hydraulic spring stiffness testing machine made a tool using two cylinders with different diameters connected by the same fluid. Rahat, et al., (2015) performed spring compression on a spring constant testing machine using a combination of direct shear loads and torsional loads. Saha, et al., (2018) for a spring stiffness measuring apparatus tool using a pneumatic system the air cylinder is clamped perfectly to the equipment frame. So, this machine uses wind power from the compressor. While the spiral spring deflection test tool Martias's (2018) research uses a mass placed on top of the spring to be tested.

Based on the exposure of several studies above, several tests of spring constants and spring elasticity properties have been carried out, as well as several forms of test equipment that have been made for certain needs with several methods. It is still difficult to find research that discusses how to check and test springs that have been installed and have been used in the production process several times, especially for stripper springs used in press tools. The purpose of this research is to design and manufacture a tool for testing the elasticity properties of the compressed spring with the method of reading the value of the variable force and spring constant through a load cell and a millimeter scale for tools that install springs on a stripper for press tools with a hydraulic system in previous studies.

2 METHOD

2.1 Design Method

The design method will follow the VDI 2222 method to design tools according to several types of springs with different press tool shapes. The VDI 2221 method is a “Systematic Approach to Design for Engineering Systems and Engineering Products” described by (Pahl, et al., 2007) in his book, Systematic Approach to The Design of Technical Systems and Products. This method is very suitable for designing the test equipment because there are problems faced also systematic in the steps of the process. Tools designed, able to adjust the shape of the press tool. The experimental method is carried out by performing the Finite Element Method (FEM) using supporting analysis software that can analyze well to analyze the shape of the tool design. The design stages for this tool which refers to the VDI 2222 method are:

1. Planning
   At this stage, identification of the requirements required for testing aids carried out. A spring tester is needed to test the spring deflection and the maximum spring load on the existing component catalogue with actual readings. In addition, a spring tester can be used to check the quality of springs that are old but still fit for use. Because there is a need, a solution is made that will later meet that need.
2. Concept
   At the conceptualizing stage, a list of requirements is made as a reference in making the design. Based on this list of requirements, the most optimal design concept for the assessment of technical aspects will be made. In addition, the search for data and information about the test equipment that will be made starts from the shape of the frame to the sensors that will be used.
3. Design
   This stage can be done when it’s have determined the chosen alternative design, which alternative has met the design requirements for the customer. The design made is in the form of a 3D modeling design using Solidworks software.
4. Finalization
   At the final stage in the design process, it produces a complete working drawing of the part drawing, but in the design of this spring

tester, it has only arrived at the stage of making the 3D modeling design.

2.2 Product Analysis

The requirements for a spring tester can be seen in Table 1. This tool is designed for testing the elasticity of a compressed spring with a force that reaches 180 kg Regarding the page layout, authors should set the Section Start to Continuous with the vertical alignment to the top and the following header and footer:

Table 1: Design List Demand.

	Requirements	Quantity (Unit)
Press Type	Hidraulic Hand Pump	1
Load Cell Type	Compression Load Cell	1
Display Type	Digital	1
Spring Type	Spring Coil	4

3 THE RESULT

3.1 Design Alternative

Based on the stages in the design, the obtained two alternative designs of tools for testing the elasticity properties of the compressed spring with the method of reading the value of the force variable and spring constant through a load cell and a millimeter scale. The form of 3D models for these two alternatives can be seen in Figure 1 and Figure 2. These two alternatives can accommodate the integrity or requirements must be as a spring elasticity testing tool. Each alternative has advantages and disadvantages.

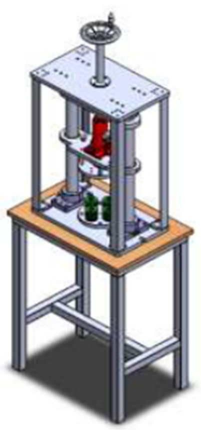

Figure 1: 3D Alternative Model 1.

The advantage of the first alternative design is that the tool operating system is easier. Because the moving side process can be adjusted by adjusting the height (adjustable). The operation process is also facilitated by the presence of a handle wheel. Another advantage is the relatively smaller dimensions of the tool. However, the first alternative has a drawback, namely, the number of components used is more.

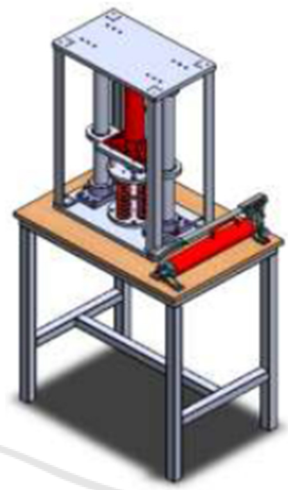

Figure 2: 3D Alternative Model 2.

The second alternative design is the opposite of the first alternative design. These two alternative designs can accommodate the needs and requirements as a tool for testing the elasticity of the compressed spring.

Based on the consideration of the two alternative designs for testing the elasticity properties of the compressed spring using the method of reading the value of the force variable and spring constant through a load cell and a millimeter scale, the design chosen is the first alternative design because of the ease of operation and smaller dimensions of the tool. The framework used in the first alternative is the L profile and is used as a reference in calculation and simulation analysis using Solidworks software.

3.2 Design Calculation

The calculation was carried out on the chosen alternative design, namely the first alternative which can be seen in Figure 1. The critical parts that need to be analyzed and simulated are the frame and upper plate because they get greater pressure during operation. The safety factor used in the calculation is 2. This is because this tool was included in the category of dynamic loading, known materials, and environmental conditions of fixed and easily determined loads and stresses. The simulation results using Solidworks can be seen in Figures 3 and Figure 4.

Table 2: Pressure Calculation Results

Plane	Pressure Value	Unit
Frame	0.02	N/mm^2
Upper Plate	2.67	N/mm^2

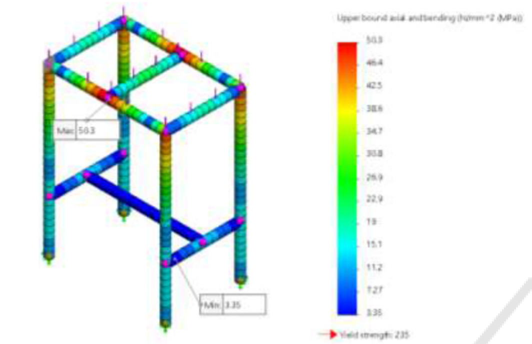

Figure 3: Frame Simulation Results.

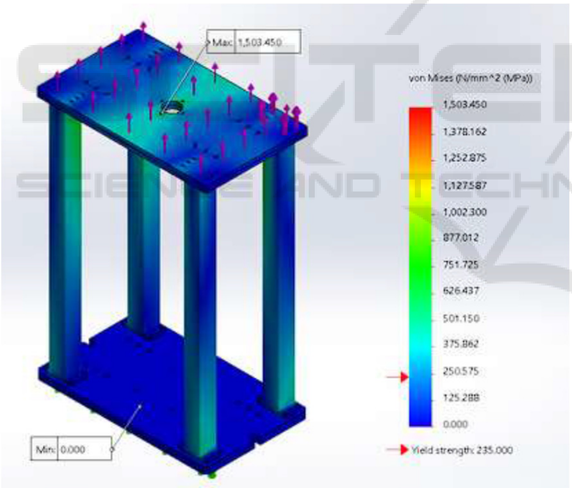

Figure 4: Upper Plate Simulation Results.

From the results of calculations and analysis, the frame used is recommended to be replaced the minimize damage that occurs. The recommended frame profile is using a square tube profile. Based on the calculation results and recommendations, the finalization of the design was carried out by changing the L profile to a square tube profile which can be seen in Figure 5. While the working drawing without a framework that will be used as a reference in making the product can be seen in Figure 6. The part descriptions can be seen in Table 3.

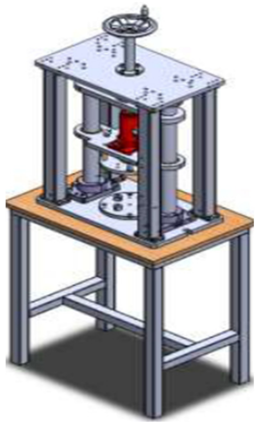

Figure 5: 3D Final Model.

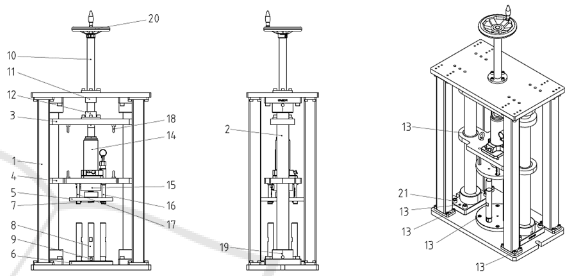

Figure 6: Final Drawing.

Table 3: Drawing Part.

No.	Part Name
1	Frame
2	Guide Shaft
3	Indexing Plate
4	Hydraulic Base Plate
5	Base Spring Upper
6	Base Spring Lower
7	Sring Holder Upper
8	Spring Holder Lower
9	Extension Shaft
10	Adjuster Shaft
11	Screw Bush Adjuster Shaft
12	Adjuster Shaft Holder
13	Insert Bush Hydraulic Base
14	Hydraulic
15	Load Cell
16	Guide Pin
17	Stripper Bolt
18	Lifting Eye Bolt
19	Guide Shaft Holder
20	Handle Wheel
21	L-Bolt M12x40
22	L-Bolt M8x25
23	L-Bolt M6x16
24	Pin Bolt M8x10
25	Silinder Pin dia 10x35
26	Silinder Pin dia 6x20

4 CONCLUSIONS

A tool for testing the elastic properties of compressed springs using the method of reading the value of the force variable and spring constant through a load cell and a millimeter scale, consisting of the frame and base, and the system. The use of a hydraulic jack as a spring press. When the spring is pressed, the length of the spring will change. This process continues until the maximum working condition of the spring. Changes in the length of the spring will be read on the millimeter scale measuring instrument. Meanwhile, elasticity is measured with a load cell. Tests were carried out for a maximum of four springs, with a total load that can be accommodated 180 kg.

The results of calculations and simulations using Solidworks software show that the frame and base are safe because they can withstand a safety factor of 2. However, it is recommended to use square tube profile steel. However, this still needs further research to compare in terms of costs.Words like “is”, “or”, “then”, etc. should not be capitalized unless they are the first word of the subtitle.

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