PROPER REQUIREMENTS OF SPRING DESIGN

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When approaching an engineering challenge such as the designing of a custom spring, you may ask yourself, ***"What parameters would be paramount in the manufacturing of this particular item?"*** In this article, we aim to educate the designer on the key spring design and manufacturing factors that are required to precisely evaluate and engineer a custom spring that will meet and exceed all of the designer's expectations.

The first question a designer must take into consideration is the environment in which this custom spring will be required to perform within. Will this spring be required to perform in excessive heat or cold? This answer will be vital in the material selection of this part. For instance, if this part will see heat factors exceeding 650 degrees (F), the designer will need to begin engineering this spring using a high temperature material such as Inconel. Whereas, if the design requires the spring to work in an ambient temperature environment, perhaps a less costly material such as Oil Tempered, can be introduced.

Keeping with the theme of environment and material selection, it must be established early in the design process, whether the designer's spring were to be in contact with any form of moisture, or chemicals such as chlorine or bleach. This is also imperative in the design process. An example of this would be any spring that would necessitate an application outdoors exposed to salt water. In this environment, the majority of professional spring designer's would initiate their project using T-316 Stainless Steel. Though there are other, more costly materials on the market, T-316 Stainless is highly used in these applications. If the spring were simply subjected to a high moisture source such as tap water, conceivably a design using T-302 can be implemented?

The next requirement in material selection that should be addressed is cycle life. This simply means the amount of cycles that this spring was to encounter over its life time. For instance, if the designer is engineering a spring that works in an engine and the spring were to be cycled several million times over its lifetime, a material such as Chrome Silicon Valve or Chrome Vanadium Valve should be the material of choice. If the application calls for minimum cycle life, say a safety switch that may only be implemented around 1,000 cycles over its lifetime, perhaps the most efficient material to implement would be Music wire?

The next question the designer would need to ask would be ***"Where is the spring going to be installed in its application?"*** This is also very significant in the proper designing of springs. The designer will need to establish what the spring will be working over, such as a pin or a mandrel? Next, will this spring be asked to work inside any form of cylinder or bore? The designer will need to leave a "Safety Margin" within any design that requires these limitations, keeping into effect that all springs are "Coiled" when they are manufactured; springs are not "Machined" products! Therefore, the tolerances that a spring maker requires are much more substantial than those of machinists. For example, a machinist may be asked to hold a one inch block to +/- .0001" (in). On an average, a spring maker would hold a one inch OD spring to +/- .030" (in). So when designing as spring that fits into a 1" inch bore, the designer would be requested to build in a safety factor of +/- .040" (in). So a spring with an OD of .960" (in) +/-.030" (in) would be recommended.

Moving forward, to achieve the peak performance from your custom design, the 20/80 rule should be implemented. What this rule involves, is that a spring should be installed no less than 20% of its total deflection and no more than 80% of its total deflection.

In order to calculate the total amount of deflection within a compression spring, the designer needs to take three (3) aspects of the design into consideration. First, the wire size being used in the spring. Second, the relaxed free length of the spring. Third, the solid height of the spring.

In order to calculate the solid height of a spring, the engineer will determine the wire size employed in the design and multiply that number by the total coils within the spring. Once the solid height of the design is established, this figure is then subtracted from the relaxed free length of the spring. For example, using a design that comprises .250” material, with 4 total coils and a relaxed free length of 3.00” (in)

.250” (wire) X 4 (Total Coils) =1.00” Solid Height

Next, in determining the total travel contained within the spring, the designer will then take the calculated relaxed free length of the spring and subtract the solid height of the spring. Using our example above:

3.00” (Free Length) - 1.00” (Solid Height) = 2.00” total travel.

Now that the total travel has been calculated by the designer, the 20/80 rule needs to be applied. In this instance, the designer would take the total travel of 2.00” (in) and multiply that travel by 20%. This calculates out to .400” (in). The designer would then subtract this sum from the relaxed free length of their design (In this case 3.00” (in)). Step two, would be for the spring engineer to add the sum of .400â€ (in) to the solid height of the spring (In this case 1.00â€ (in)). For example:

3.00” (Free Length) - .400” (20% of Total Travel) = 2.60” (in) (20%)

1.00” (Solid Height) + .400” (20% of Total Travel) = 1.40” (in) (80%)

Therefore, in order for this design to work within its optimum range, the load heights required by this spring should be applied within the installed heights of 2.60” and 1.40” inches. By applying this 20/80 rule, it will insure that there is ample amount of travel to engage the inactive coils initially within the design and that the spring is not engaged too closely to the solid height of the spring at its final deflection. Exceeding these parameters, could potentially cause failures within the spring's required application.

Other key factors in proper spring design include direction of wind, particularly when engineering a torsion spring. This will dictate the way energy is directed through the spring. This is established by the terms: ***Right Hand (Clockwise) or Left Hand (Counter Clockwise)*** wound.

It is also essential to understand the method in which the springs are to be assembled in conjunction to their mating part(s). When designing torsion and extensions springs, an enormous assortment of end configurations can be shaped, using CNC technology, to precisely aid in the assembly process. By recognizing the springs complete installation requirements, the spring maker can insure accurate assembly for crucial form and function.

Finally, when the final design is complete, the manufacturer will need access to any specific style of coating, plating or packaging that is required by the end user. For instance, any form of Powder Coating, Zinc Plating, E-Coating or any bag and tag requests. This enables the spring maker, to offer an accurate, complete price at time of RFQ.

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