

Investigating the Relationship Between Rubber Band Number and Breaking Force

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Abstract

Rubber bands are used for a wide variety of things in our everyday life. The uses of a rubber band are endless, from tying flash cards together, to keeping trash bags secure, and everything else in between. Despite its incredible versatility, many people don’t realize the true relationship between the number of rubber bands and the resulting tensile strength that comes with it. Our study aims to find whether more rubber bands increases the tensile strength of the system linearly or exponentially. We hypothesized that a greater number of rubber bands would increase the tensile strength linearly rather than exponentially. After testing, we were able to find that as we increased the number of rubber bands, the force required to snap them did in fact increase linearly, strengthening our hypothesis. Additionally, we were able to take this data from our experiments and create a graph, displaying a strong linear relationship between the number of rubber bands and the force required to break them, strengthening our hypothesis even further.

Introduction

Many people, especially YouTubers, experiment with how many rubber bands it would take to hold a heavy object. While these experiments could be entertaining and demonstrate the strength of rubber bands, they lack the necessary control to produce scientifically reliable results. Many of these experiments don’t control variables such as the weight or force being applied. Due to these inconsistencies, the results can vary significantly between experiments and may not accurately represent the true relationship between tensile strength and rubber bands. A controlled experiment is therefore necessary to determine the relationship between rubber bands and tensile strength, to produce reliable and measurable results. This experiment will discover the true relationship between the number of rubber bands using a controlled experiment. We hypothesize that as the number of rubber bands increases incrementally, the breaking force required to snap them will increase linearly.

Methods

This study used a quantitative approach to identify the relationship between the number of rubber bands and the force that is required to break them. A Mxmoon free ZMF-500N digital force gauge and manual force test stand were used for testing. The samples consisted of four different rubber band types and sizes, including AIWOQI Size 16, AIWOQI Size 10, AMUU Size 18, and Foshine small rubber bands. Before testing, the AIWOQI Size 16 rubber bands were cut to 1.58 inches, which was ⅓ of their original length so they could break in the available space of the test stand. The rubber bands were placed in between the clamps (Figure 2), and the force gauge was set to newtons and Peak mode to record the maximum force. The hand wheel was turned until the rubber bands broke apart, and the breaking force was recorded. The number of rubber bands was increased between different trials, and the values that were recorded were graphed to determine if the relationship between the number of rubber bands and the breaking force was linear or exponential.

Results

As we predicted, the results showed a linear relationship between the number of rubber bands and peak force required to stretch them. The line of best fit for the data points was $y = 8.33885x + 4.07244$ (Figure 1), mirroring Hooke’s Law ($F=kx$). In this context, the positive slope of 8.33885 represents the spring constant (k) of the rubber bands.

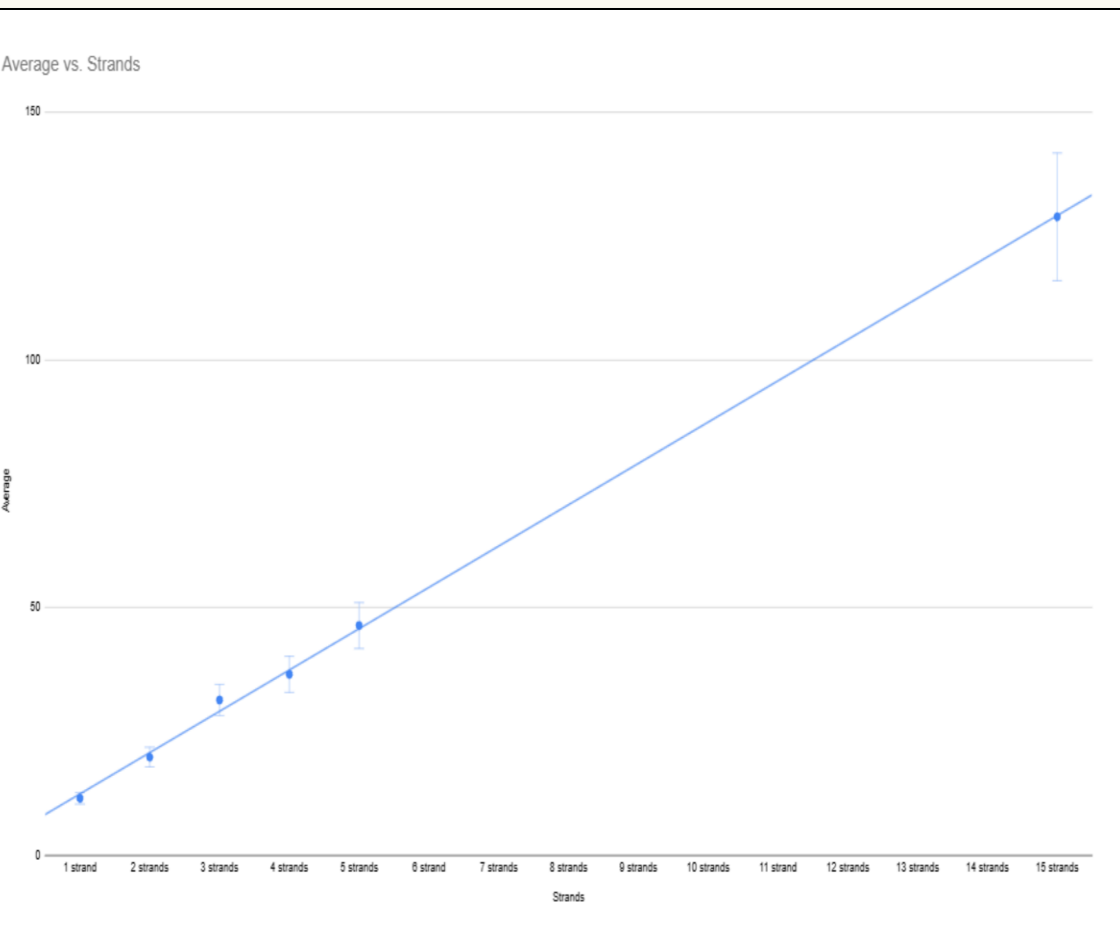


Figure 1: Graph displaying increase in breaking force as more rubber bands are added

Discussion

In order to obtain a more reliable measurement of this relationship, we expanded the experiment to include up to 8 rubber bands. When reaching 6 strands, however, they began slipping out of the clamps In response to this issue, we reached out to a Rice University Grad student for help. By manufacturing resin blocks to securely grip the strands during expansion, we were able to further expand the number of strands we can test, reaching all the way up to 15 strands. The graph of these data points is shown (Figure 1). The newly recorded data presented consistent results with our predicted linear expression.

Conclusion

This experiment explored the relationship between the peak force generated when stretching rubber strands to their snapping point. The results demonstrated a linear relationship: As the number of rubber strands increased incrementally, the generated force also increased proportionally. These resulting figures confirmed our hypothesis: the force output has a linear relationship with the amount of rubber strands present. These findings can provide additional information on the development of prosthetic devices and robotics. Due to its elastic properties, rubber bands can mimic the functionality of muscles. So, the relationship between the strands and their resulting force can provide an estimate for the desired force in future.

References

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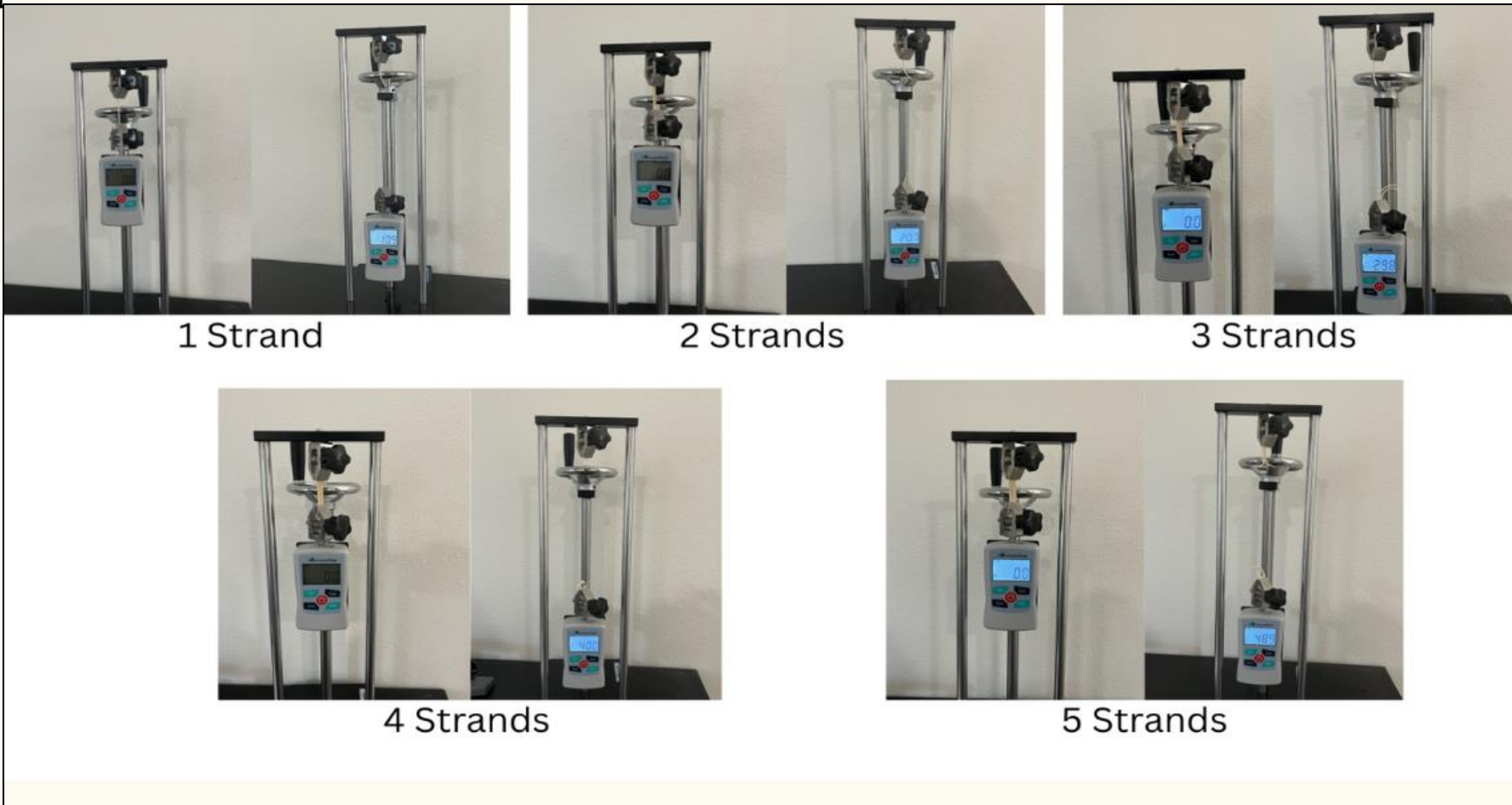


Figure 2: Setup of force gauge stand and rubber bands