# Optimal Conditions for Mechanical Pencil ✏ Lead not to Break

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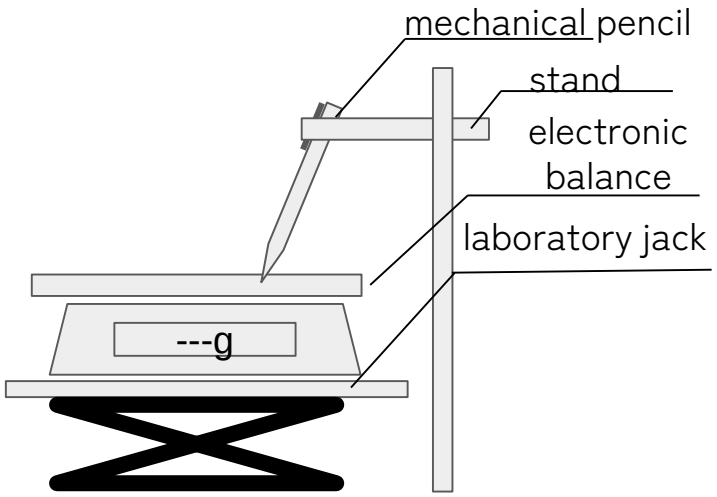
## Introduction

Many people are dissatisfied with the breakage of mechanical pencil leads. Therefore, we researched the differences in how easily leads break. The length and angle at which a lead is likely to break have already been calculated numerically as a formula for the pressure applied to the lead. Therefore, we graphed the relationship between the pressure applied to the lead from different perspectives, such as darkness and thickness, and then found the optimal conditions for the lead to be less likely to break.

## Survey Contents

〈 Conditions 〉

Used Lead α and Lead β H, HB, and 2B lead
15 times each/4 clicks/
Angle 60° (based on the average angle of a human hand)




< Method >

Apply a force vertically upwards from underneath the shear core with a lab jack until the shear core breaks. Compare the numerical values (mass) when the shear core breaks.

## Conclusion

Figure 1
Lead α

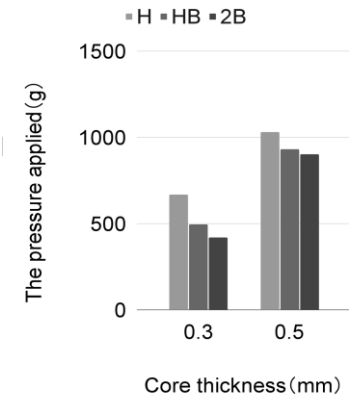



Figure 1 shows the experimental results for Lead α,
The graph shows that the pressure endured by the 0.5 mm type is greater than that of the 0.3 mm type, and that the pressure endured by the H, HB, and 2B types is greater than that of the 0.3 mm type, in order of thinnest density and greatest hardness.

Figure 2
Lead β

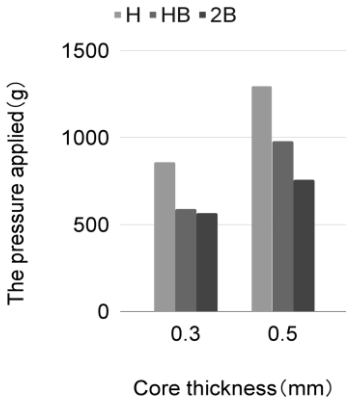



Figure 2 shows the result for Lead β.The tendency of Lead β's mechanical lead to break is almost the same as that of Lead α. It can be seen that the pressure endured by Lead β is greater than that of Lead α.

## Consideration

(1) Comparison of density: The relationship between the resistance of mechanical pencils to breakage and density was found to be H, HB and 2B, in that order, regardless of whether the pencil lead was Lead α or Lead β. The higher the density, the more difficult the mechanical pencil lead is to break.

(2) Comparison of thickness: The relationship between the difficulty of a mechanical pencil lead to breakage and its thickness was found to be more difficult for a 0.5 mm pencil lead to break than for a 0.3 mm pencil lead, regardless of whether it was a Lead α or Lead β. This is thought to be because the greater the area (S), the smaller the pressure (P) for the same force (F), based on the formula P=F/S.

(3) Comparison of manufacturers: The same tendency can be seen in all manufacturers.

## References and Citations

https://tinyurl.com/yc224yds What types of lead are there in mechanical pencils? | FAQ | PILOT