MUSICAL SAW AND FREQUENCY

Kakogawa Higashi High School Group OTONOKO

CONTENTS

1.Key Words

What is a MUSICAL SAW?

http://s3.amazonaws.com/production.mediajoint.prx.org/public/piece_images/186083/musicsaw_small.jpg

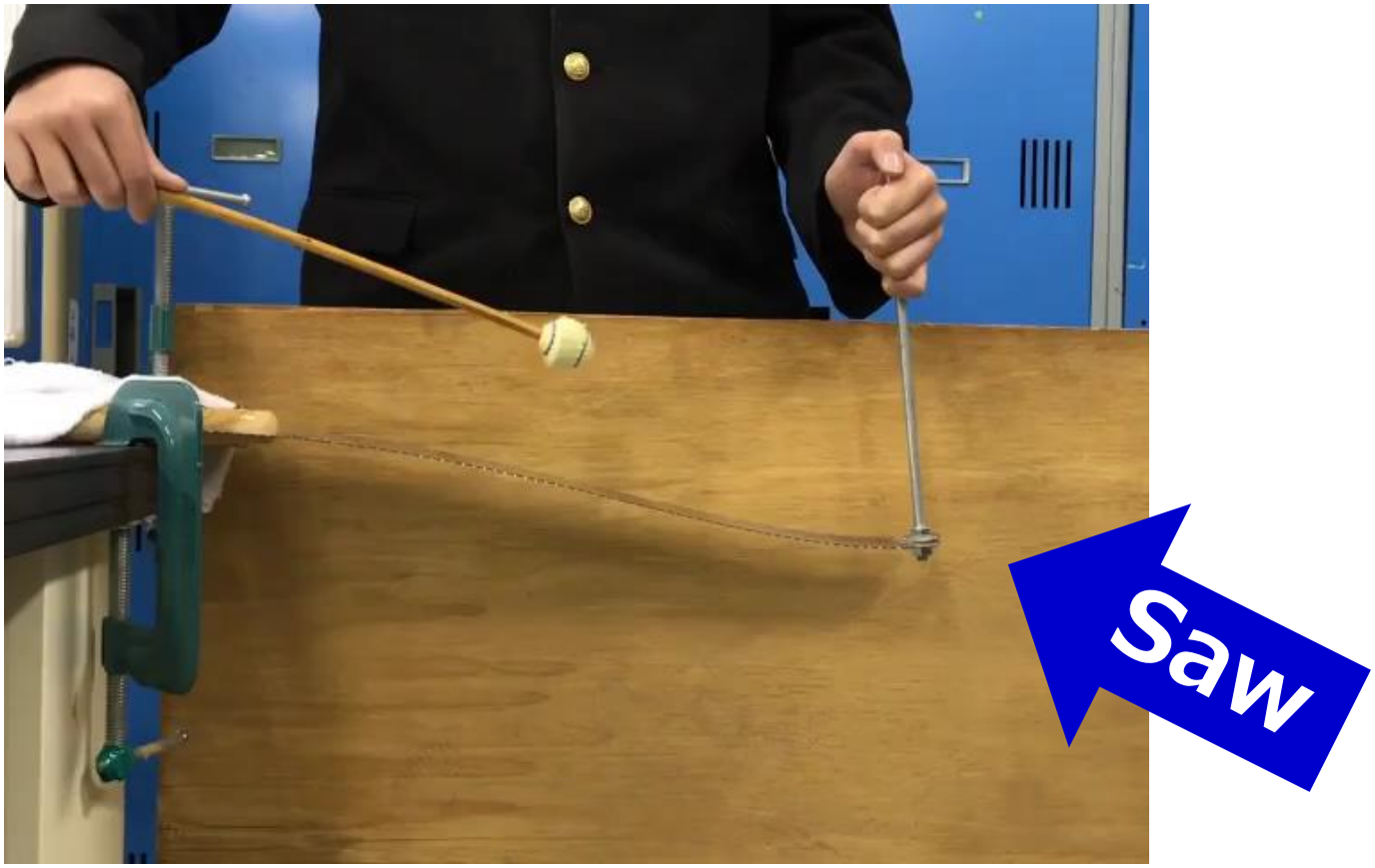
Bend the saw

Into a S-shape

Bow or mallet

CONTENTS

2.Purpose



The frequency of sound can be changed

2.Purpose

The relationship between frequency and saw shape

A player must find it

only by "try and error"!!

2.Purpose

THE FINAL PURPOSE OF OUR EXPERIMENT

Clarifying the relationship
&
Creating a tuning guide for this musical saw

It could be played more easily.

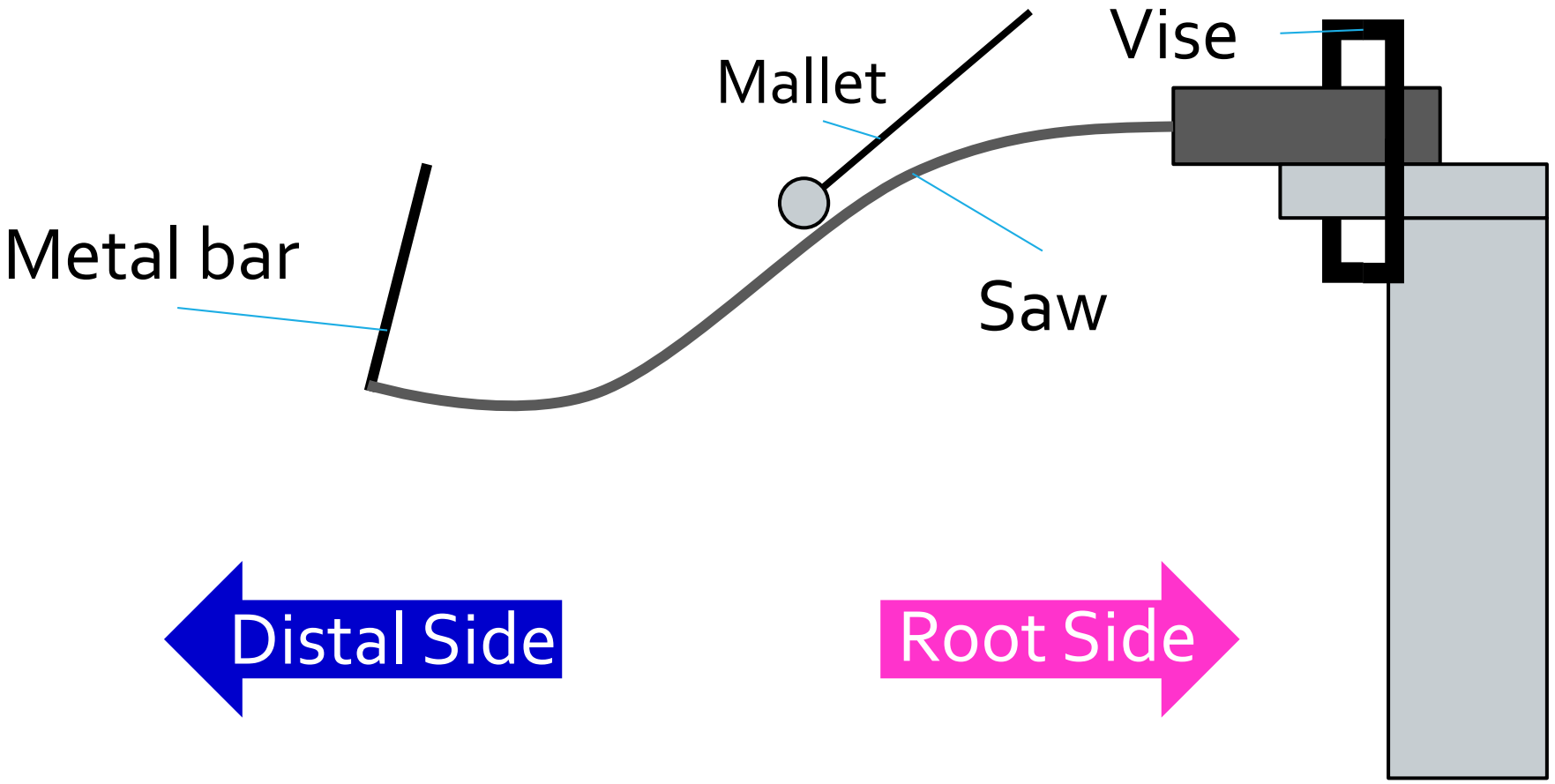
CONTENTS

3.a Method

Our device

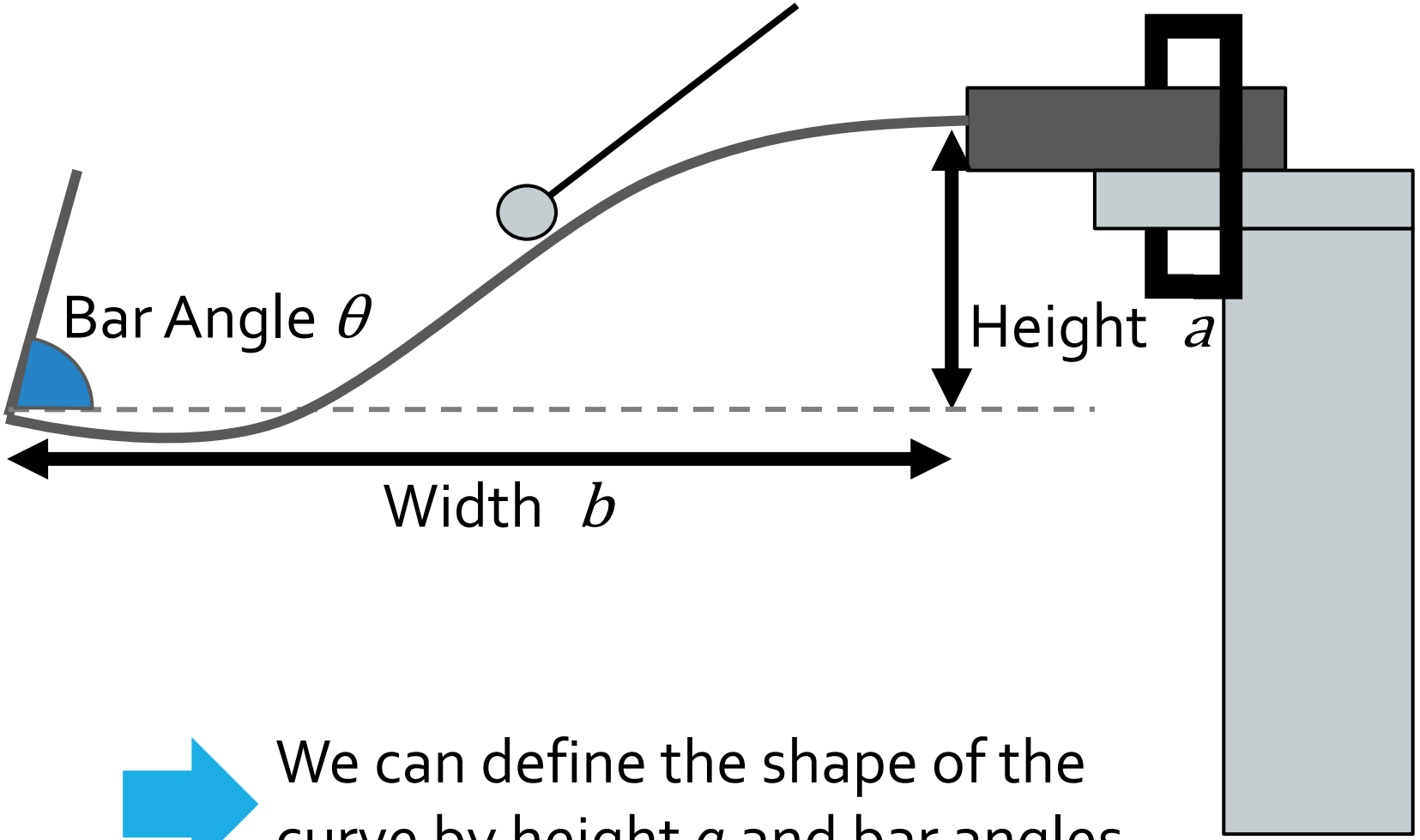
3.a Method

【Experimental Device】



3.a Method

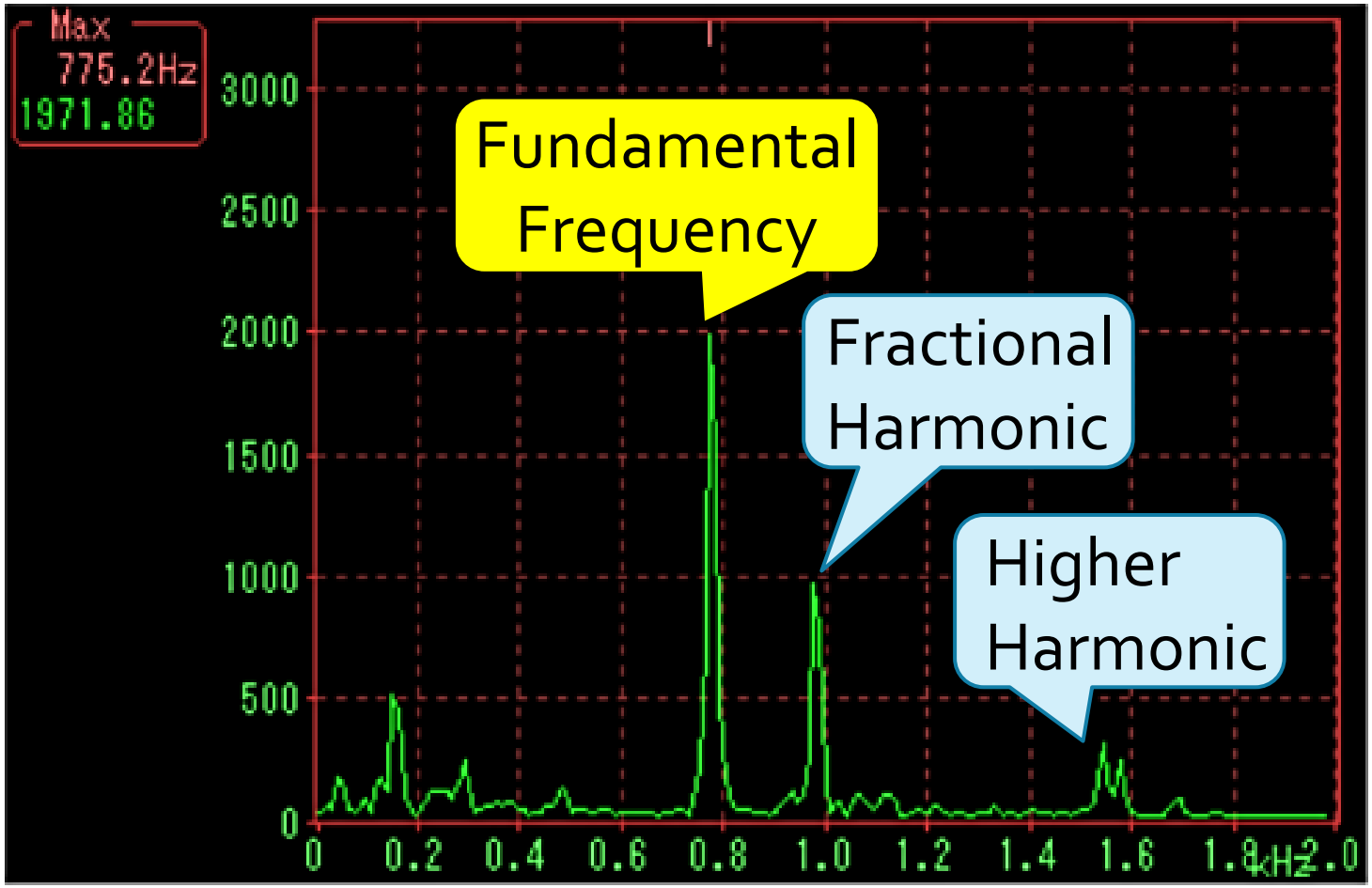
【Index of Curvature】



We can define the shape of the curve by height a and bar angles.

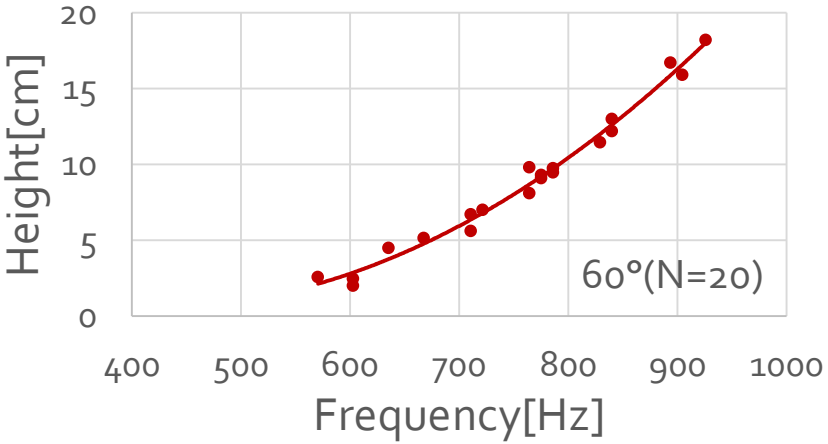
3.b Results

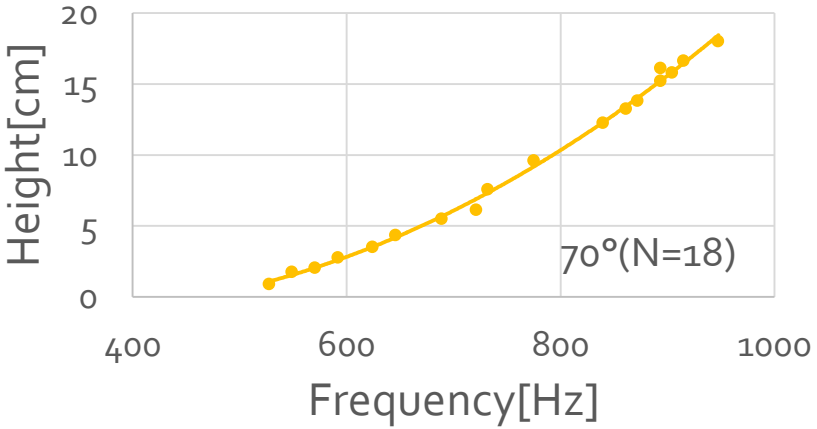
【Saw Frequency Spectra】

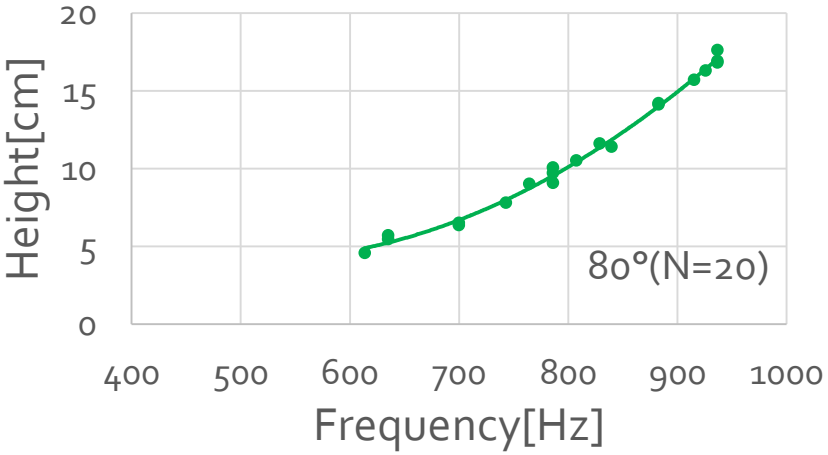


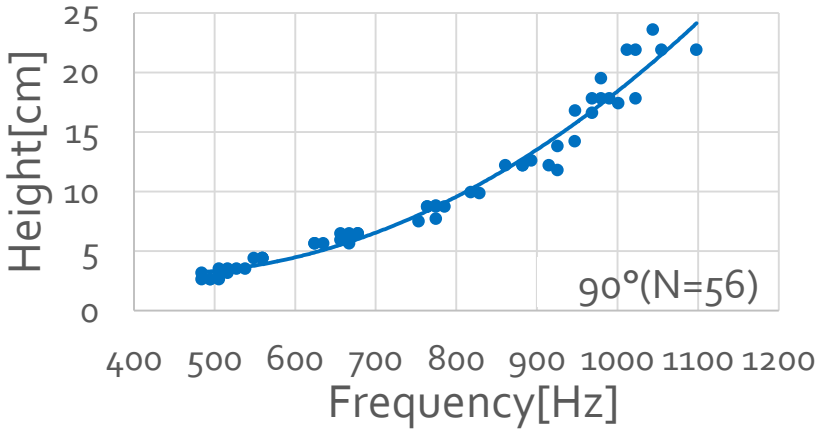
3.b Results

【Relationship between Fundamental Frequency and Height】



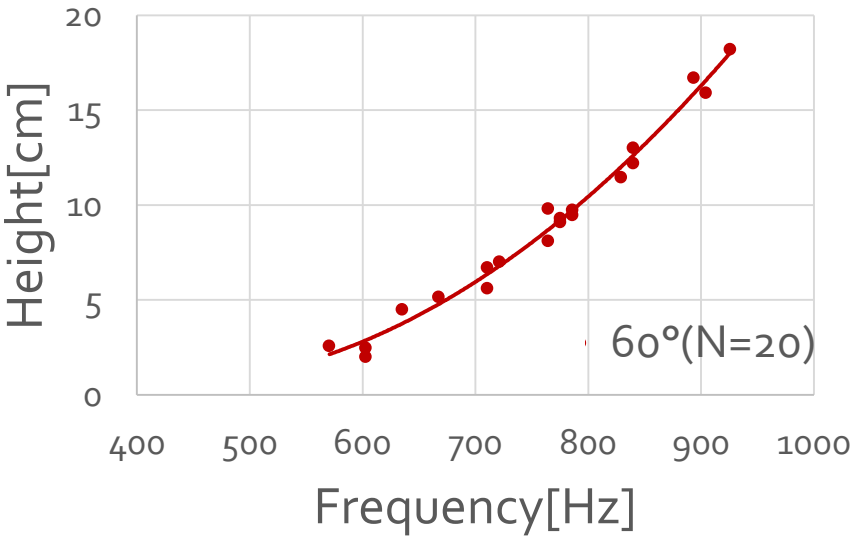


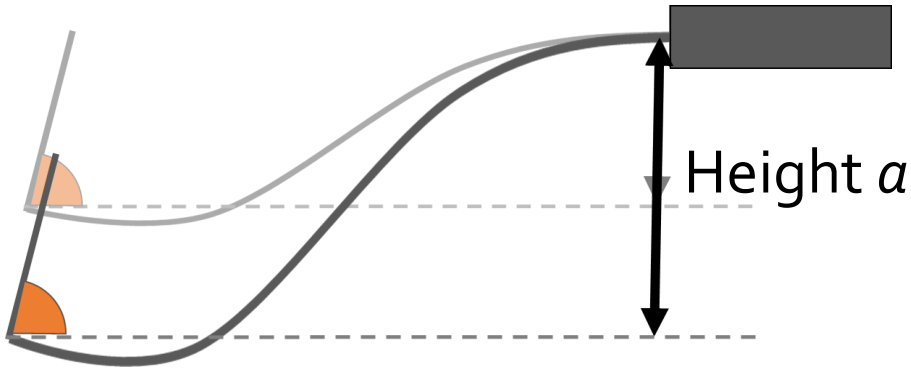




3.b Results

【Analysis】

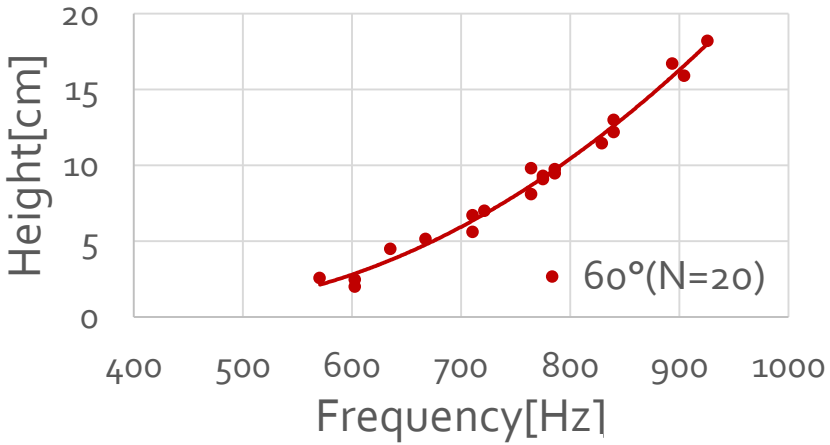


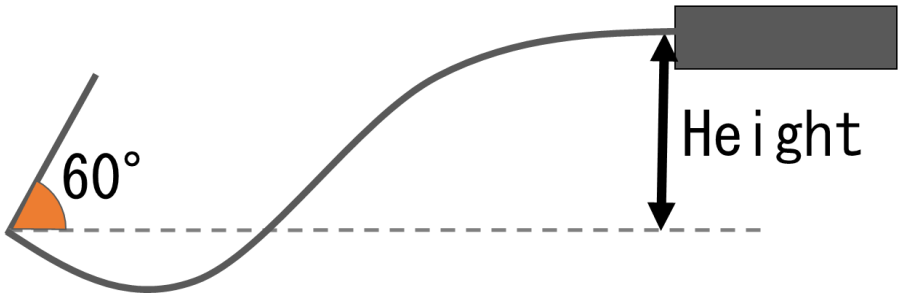


Height *a* is proportional to the square of the fundamental frequency.

CONTENTS

4 .Tuning Guide【 Equation of Frequency and Height 】





θ=60°

$$y = 0.0000675371\,x^2 - 0.0563386\,x + 12.2942$$

(x[Hz]:Frequency of Sound, y[cm]:Height)

4 .Tuning Guide

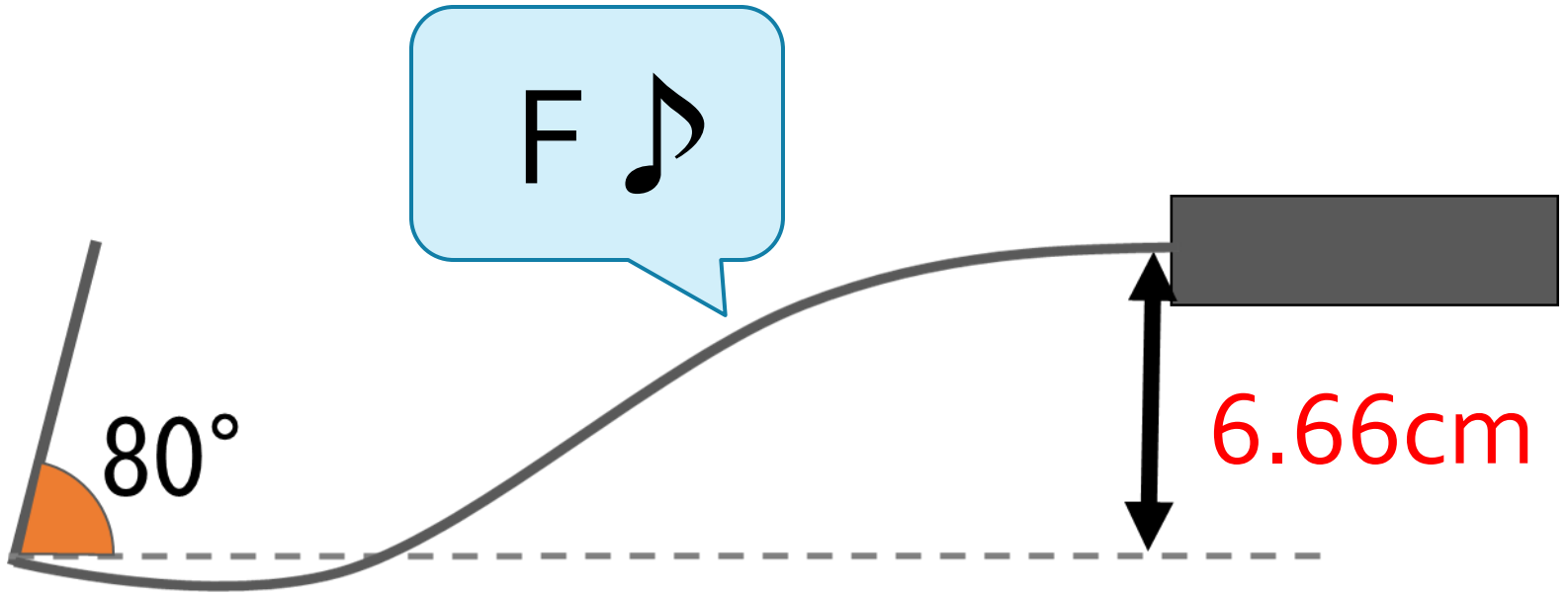
【Tuning Guide for each Bar Angle】

Relationship between the Musical Note Pitch and the Height

Pitch Name		C	D	E	F	G	A	B	C
Frequency[Hz]		523.25	587.33	659.26	698.46	783.99	880.00	987.77	1046.50
Height[cm]	$\theta = 60°$	1.31	2.50	4.51	5.89	9.64	15.02		
	$\theta = 70°$	1.00	2.48	4.63	6.02	9.59	14.46		
	$\theta = 80°$	4.13	4.55	5.71	6.66	9.47	13.86		
	$\theta = 90°$	3.52	4.28	5.59	6.51	9.02	12.66	17.77	21.02

4 .Tuning Guide

【Tuning Guide for each Bar Angle】



Conclusion

- Devised the new indexes to determine the shape of the saw
- Discovered that height is proportional to the square of the fundamental frequency
- Made a tuning guide to play the musical saw

CONTENTS

5. Future Tasks

- Do a theoretical study or physical analysis into why height is proportional to the square of frequency
- Check the precision of the tuning guide

Acknowledgment

KANSAI SAW MFG. CO., LTD.
Mr. Ashihara（president, CEO）

We express our thanks to Mr. Ashihara who gave us a saw which we use for our experiment.

References

1) Georg Essl, Stefania Serafin, Perry R. Cook, and Julius O. Smith: Musical Applications of Banded Waveguides, Computer Music Journal,28:1, pp.51-63, Spring 2004

2) Neville H. Fletcher, Thomas D. Rossing, (Translated by Kenji Kishi, Hidemi Kubota, Shigeru Yoshikawa) "THE PHYSICS OF MUSICAL INSTRUMENTS", Maruzen Pabulishing, 2012

2012

3) Erin Else Stuckenbruck: The Singing Blade: The History, Acoustics, and Techniques of the Musical Saw, Senior Projects Spring 2016, Paper 383, 2016

Thank you for listening

http://www.scribnerfamilies.org/Images6.htm

Q. and A.

1. KEY WORDS

2. PURPOSE

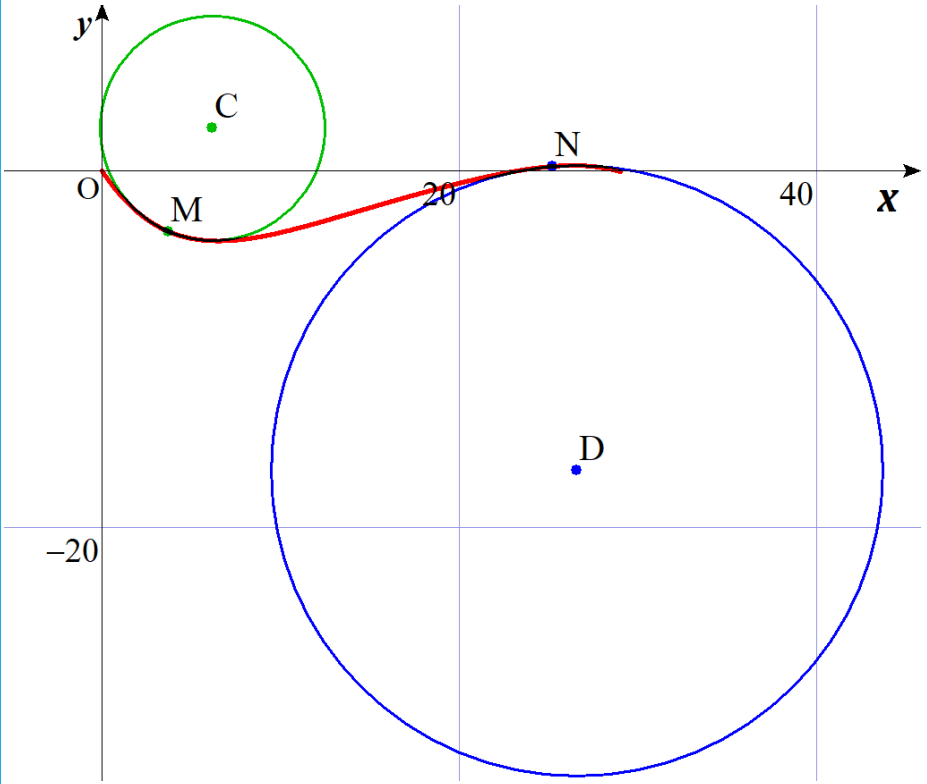
3. EXPERIMENT
   a. METHOD
   b. RESULTS

4. TUNING GUIDE

5. FUTURE TASKS

1.Key Words

【Curvature】



The amount that something is curved

Radius of Curvature

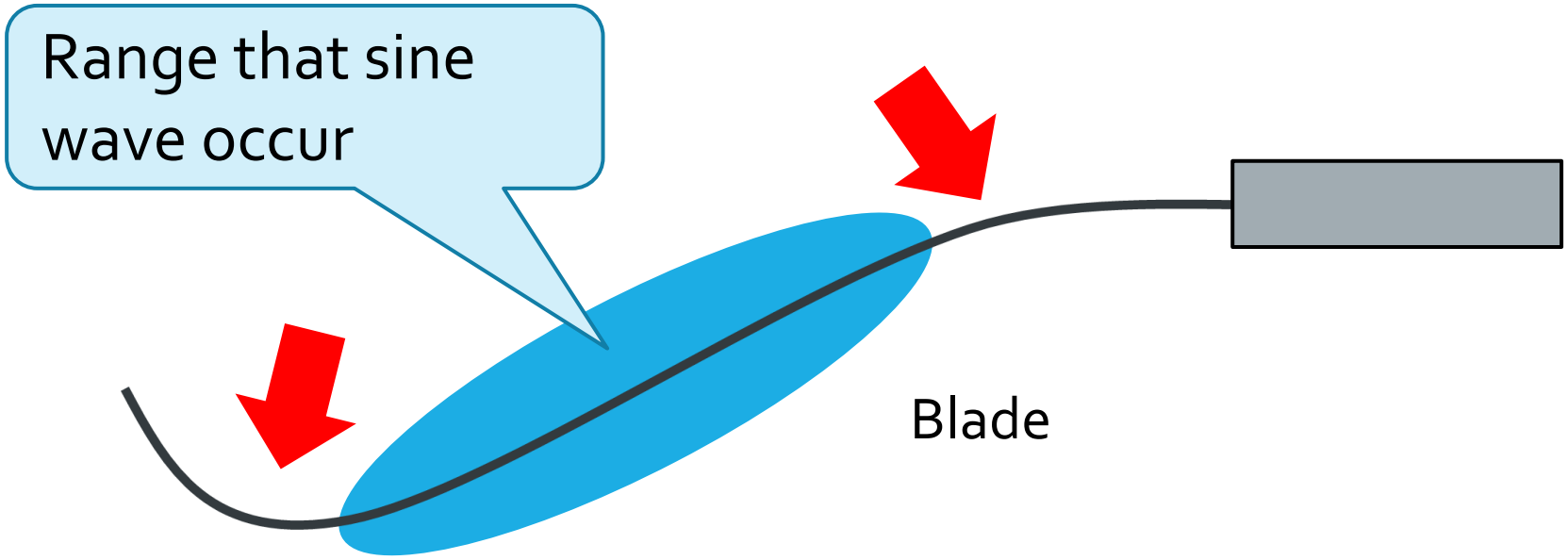
Radius of circle that was approximated curve to circle

$$(\text{Curvature}) = \frac{1}{(\text{Radius of Curvature})}$$

2.Purpose

【Previous Research】

2 Point of Bigger Curvature → Role of Fixed End



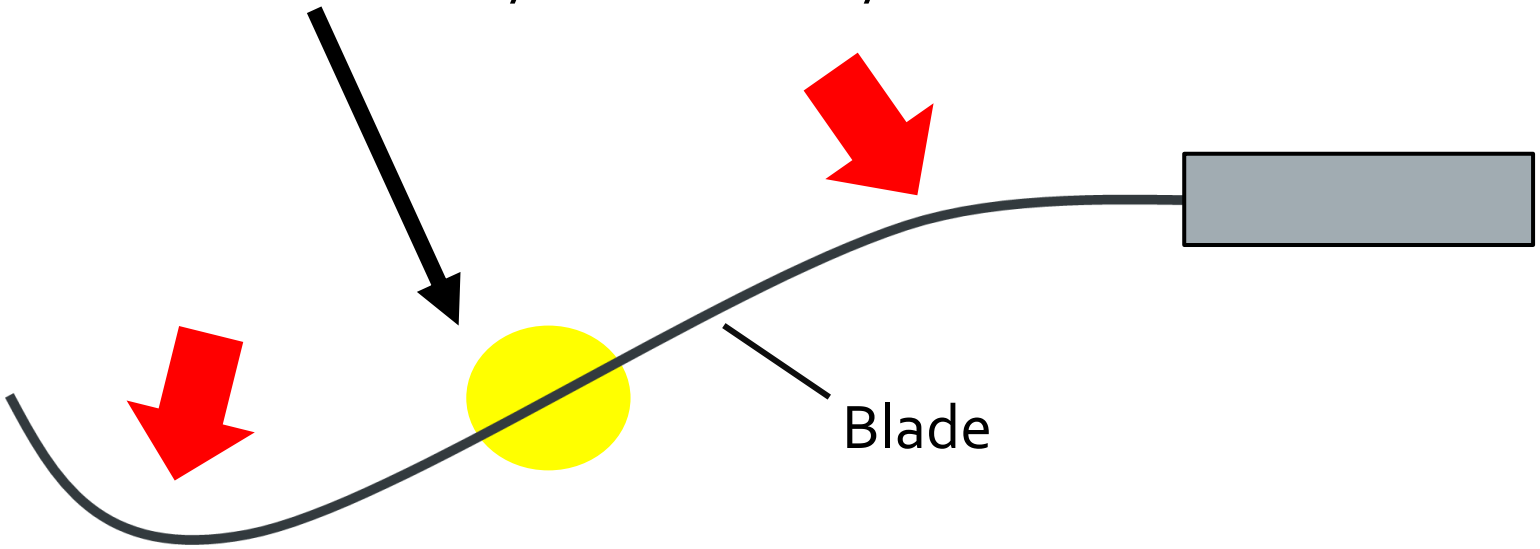
Sectional view of S shape musical saw

3.a Method

【 Position to Knock on 】

Sweet Spot

…The place where a sound sounds through more than ten seconds (by former study)



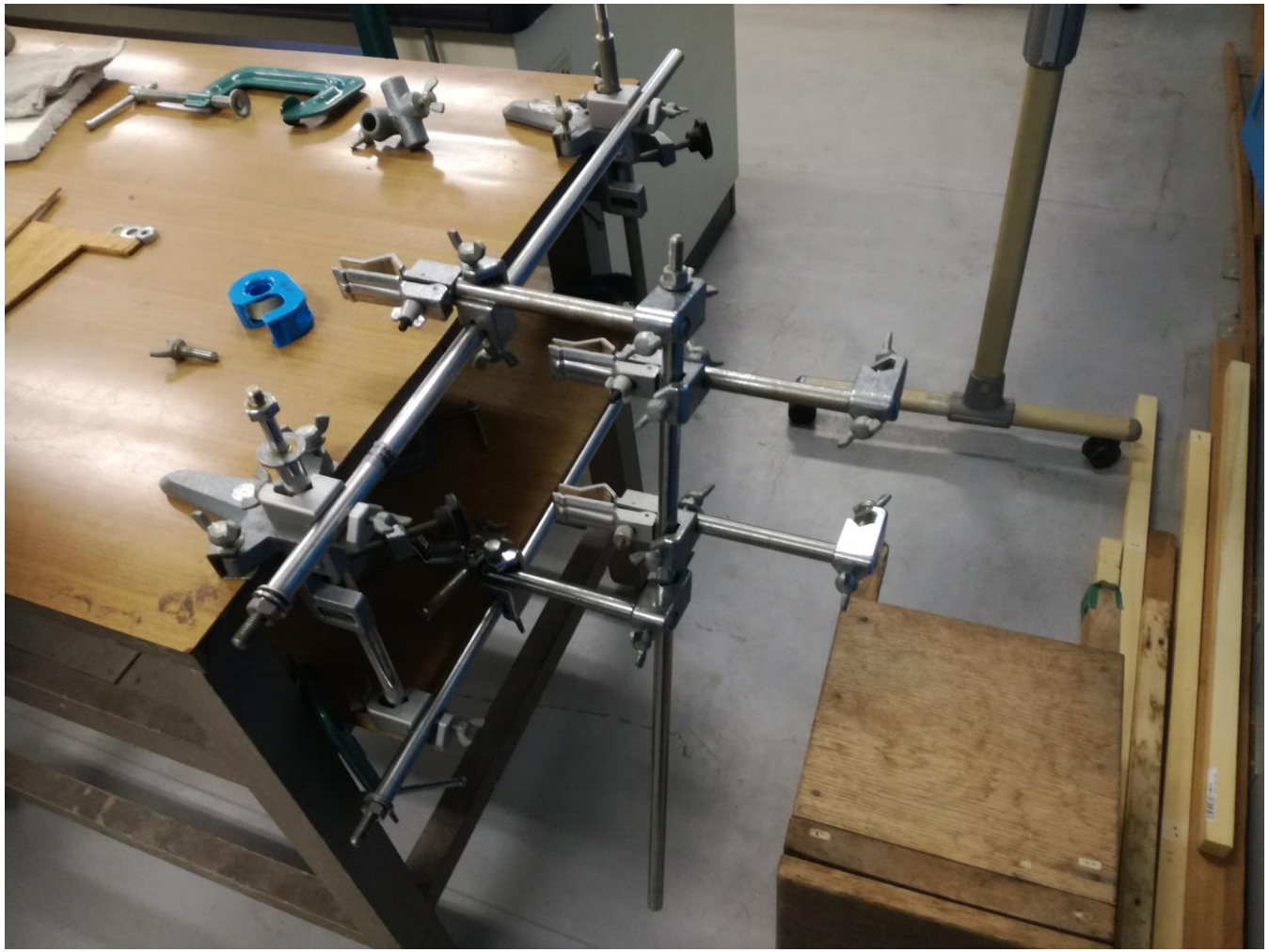
Cross section of the sigmoid musical saw

3.a Method

【Experimental Device】

3.a Method

【 Experimental Device 】



3.a Method 【Saw】

SAWMASTER

- Steel
- Blade length
  56cm
- Thickness
  0.8mm

3.a Method 【Saw】

SAWMASTER

- Steel
- Blade length 56cm
- Thickness 0.8mm

3.a Method 【Tools to Play】

Musical Tools	Sound
Bow	Variable Frequency
Mallet	Constant Frequency

3.a Method

【The Curvature of the Blade】

1. Copy the shape of the blade to paper

2. Import the shape of blade with a scanner

3. Calculate the coordinate of one hundred points in the section of the blade by using the fitting software "Fig Date"

4. Calculate a radius of circle to go along three points next to each other, calculate a radius of curvature, take the reciprocal number

3.a Method

【The Curvature of the Blade】

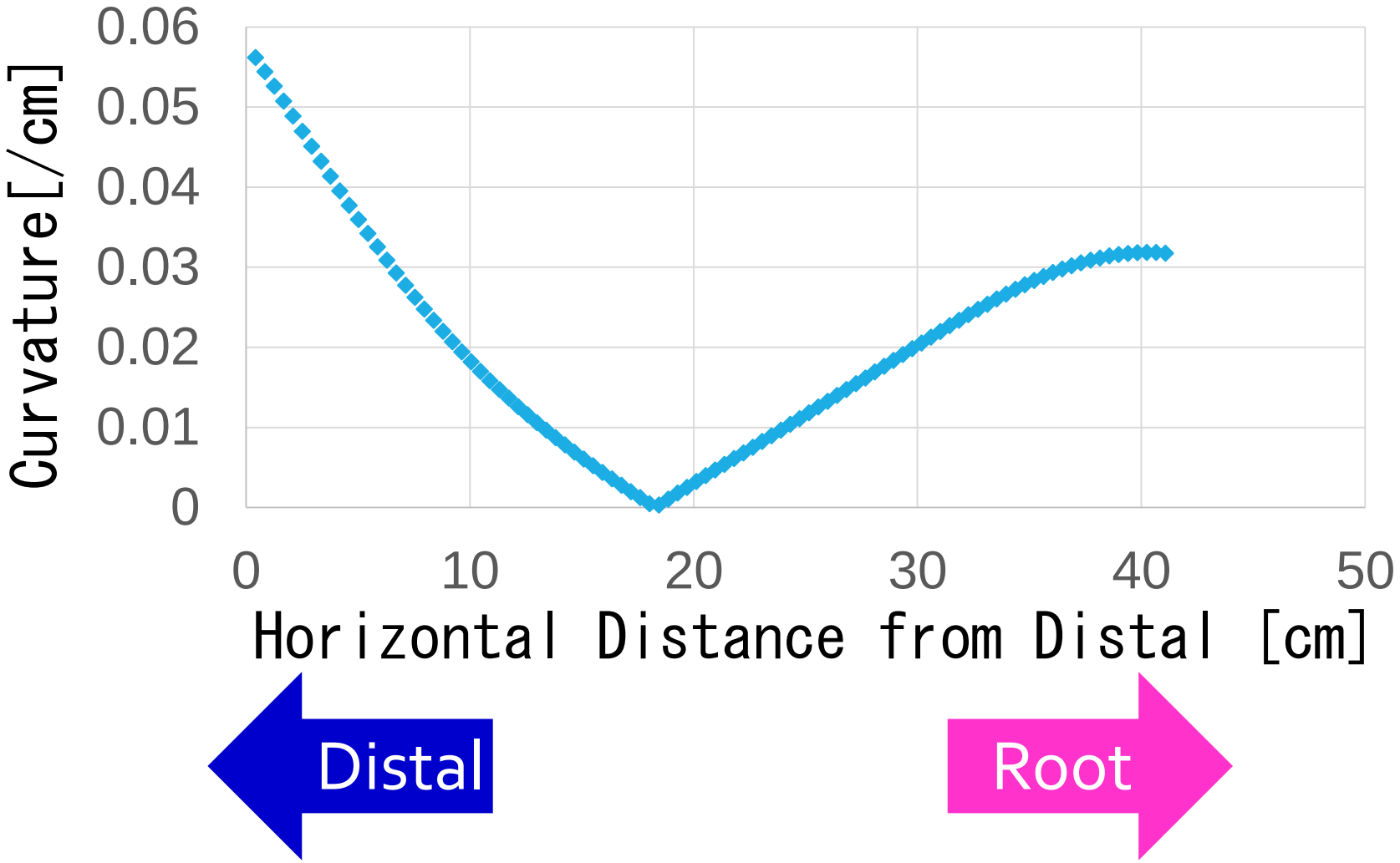
Formula for the radius of curvature

$$\frac{(1+f'(x)^2)^{\frac{3}{2}}}{|f''(x)|}$$

※$f(x)$ is the approximate curve of the saw.

3.a Method

【Curvature at Each Point of Blade】



3.a Method

【Curvature at each Point of Blade】

Going from the center of blade to the outside, the curvature becomes bigger

Correspond with previous research

3.b Result

【Basic Sound】

Fundamental Frequency

- The sound whose amplitude is bigger and attenuation is smaller
- When there are 2 sound whose attenuation is smaller, we treat the sound whose frequency is smaller as fundamental frequency

3.b Result

Higher Harmonic

The sine wave that are integer multiply of the fundamental frequency

Fractional Harmonic

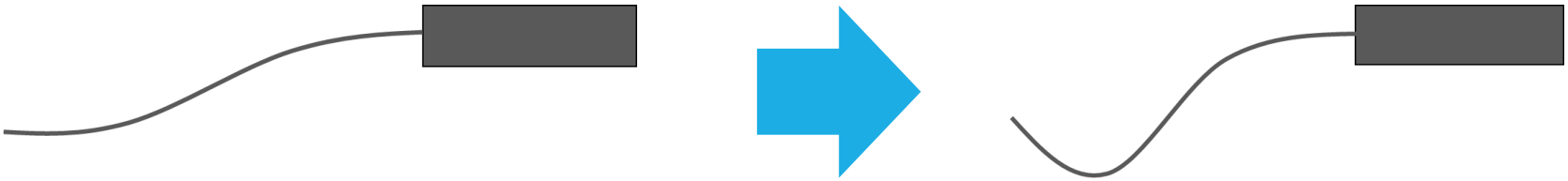
The sine wave that are fraction multiply of the fundamental frequency

3.b Result

【Analysis】

From
Previous Research

The more the blade is bent, the bigger frequency is

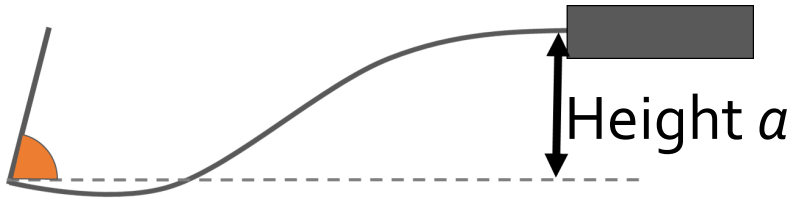


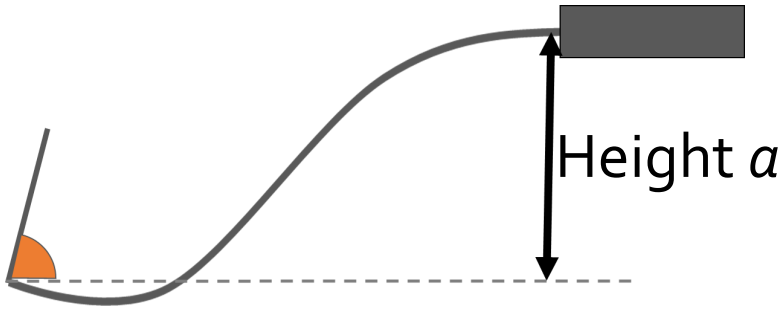
3.b Result

【Analysis】

From Result

The bigger height *a* is,
the bigger frequency is





More bent?

4.Tunig Guide

【Relationship between Frequency of Basic Sound and Height】

x[Hz]:Frequency of Basic Sound y[cm]:Height

Relationship of θ=70°

$$y = 0.0000498954\,x^2 - 0.0322746\,x + 4.22469$$

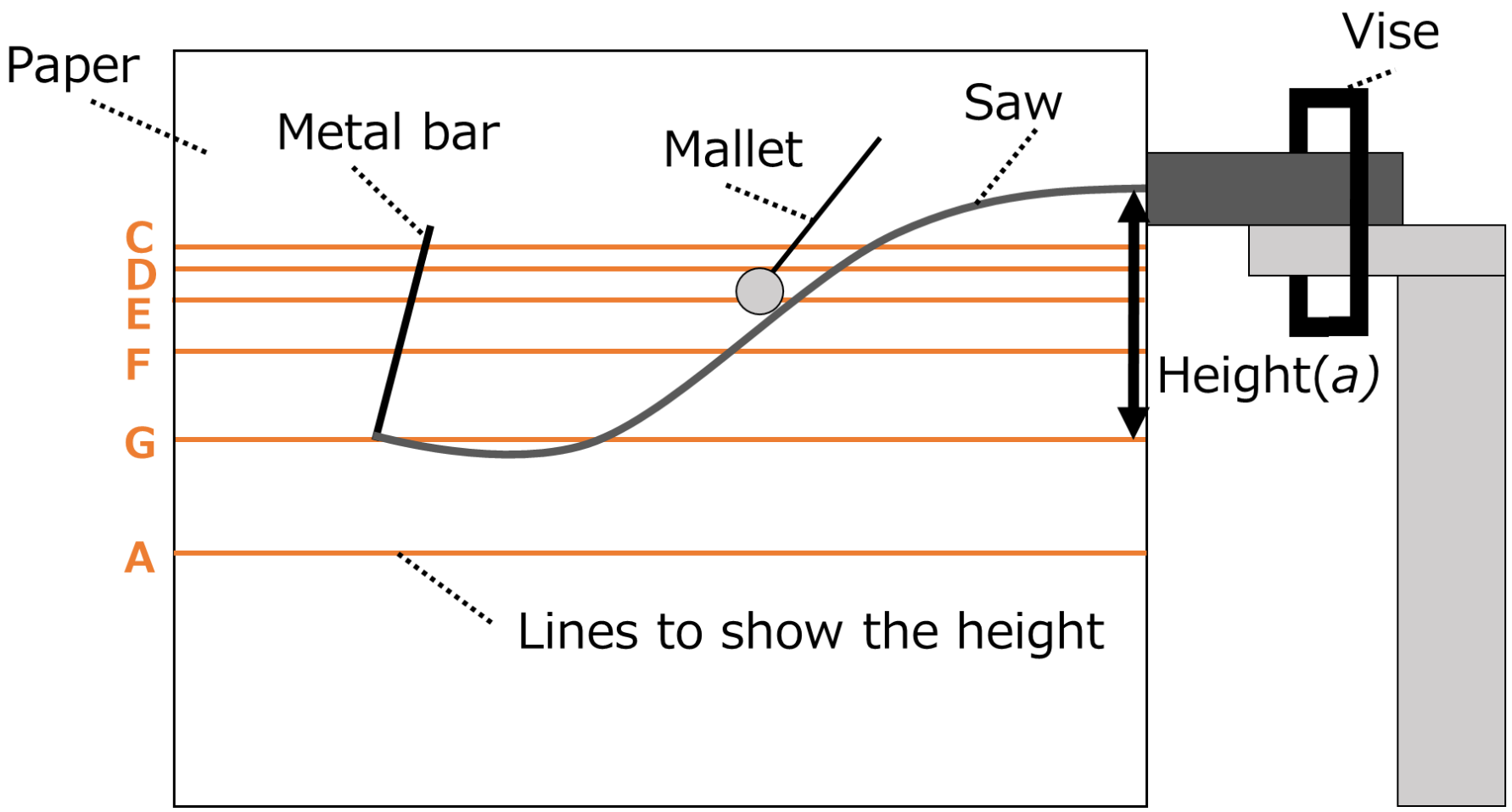
Relationship of θ=80°

$$y = 0.0000709198\,x^2 - 0.0722376\,x + 22.5130$$

Relationship of θ=90°

$$y = 0.0000469768\,x^2 - 0.0403005\,x + 11.7424$$

Additional Experiment 【Experimental Device】



Additional Experiment 【Results】