THE STUDY OF MATERIAL AND ACOUSTICS OF VIOLIN STRINGS

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ABSTRACT

This project is basically about acoustic physics. Now a days, violin string is made of different materials like Nylon and steel etc. But in ancient time strings were only made up "catguts". Due to invention of metal and synthetic string its very helpful for beginners .The main part of the project is to study the different physical parameters of violin string. While studying it is observed that the fundamental frequency of the resulting sound depends on the material properties of string, such as tension, length, mass, elasticity and damping factor. The more tension the higher frequency of vibration and therefore also the higher pitch. As the string is stretched it gives maximum frequency, therefore while studying it is observe that steel string can be stretched 3-4 times that of the gut ,silk, and nylon material strings.. Temperature also affects the material of violin strings. As the temperature is hotter the tension on the string is less, hence the violin note frequency decreases.

***Keywords :* Acoustic ,material, physical parameter , violin strings, Persistence of sound .**

I INTRODUCTION

1.1 The Acoustics of String Instruments

According to tradition, Pythagoras was first guided to the notation that mathematics held a key to understanding nature by observations of the relation between musical intervals and natural numbers. From this seminal position, musical acoustics remained a recognized part of scientific Endeavour until the early years of this century, with scientist of the caliber of Rayleigh and Helmholtz making major contribution.

A musical instrument is an instrument created or adopted to make musical sounds. Once humans moved from making sounds with their bodies for example by clapping to using object to create music from sounds, musical instruments were born. Musical instruments are constructed in broad array of styles and shapes, using many different materials. Early musical instruments were made from "found object" such as shells and plant parts. As instruments evolved, so did the selection and quality of materials. Virtually every material in nature has been used by at least one culture to make musical instruments. One play a musical instrument by interacting with it in some way for example by plucking the strings on a string instrument.

A Chordophone is a musical instrument that makes sound by way of vibrating string or strings stretches between two points. It is one of the four main divisions of instruments in the original hornbostel-sachs scheme of musical instrument classification. The chordophone is played, the string vibrate and interact with each other. There is usually something that makes the sound resonate, such as body of guitar or violin. The strings are set in the motion by their plucking (like a harp), strumming (like a guitar), by rubbing with a bow (like a violin, cello or double bass), or by striking (like a piano or berimbau). Common chordophones are the violin .The most general and broad classification is to divide all instruments as suggested above into three classes string, wind and percussions instruments, but of course there are other ways in which instruments can be distinguished from each other. [Physics Acoustic – TY.BS.C.]

[Physics Acoustic – TY.BS.C.]

Features of instrument	**Instruments**	**Characteristics**
Compass of instrument	1.Harmonium 2.Concertina	Large compass Small compass
Scale in use	1.Bugle 2.Cornet	Harmonic series Chromatic series
Power of sound	1.Trombon 2.Flute	Powerful sound Feeble sound
Nature of sound	1.Trumpet 2.Clarinet	Declamatory Smooth
Persistence of sound	1.Violin 2.Harp	Sounds are sustained Sounds quickly die away
Capacity for melody or harmony	1.Cello 2.Piano	Melody(generally) Harmony
Quality	1.Oboe 2.French horn	1.penetrating quality 2.muffled quality

Table - 1

II STUDY OF VIOLIN STRINGS

Fig - 1

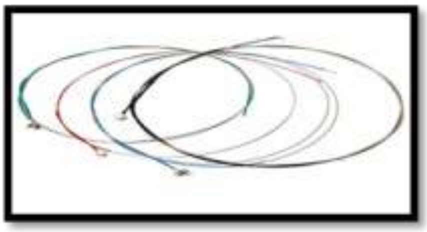
String were first made up of sheep's intestine (called catgut), Stretched, dried and twisted. Contrary to popular belief strings were never made of cat intersects

2.1 Types of Violin String :

Catgut violin string :

Catgut is type of cord that is prepared from natural fibers found in the wall of animal intestine Catgut makers usually use sheep or goat intestine, but occasionally use intesting of cattle, hogs, horses, mules or donkey, sometimes wrapped with silver or copper wire. This type of string is still available although its market niche is limited, due its cost and tuning sensitivity to humidity and temperature. Although gut string are not prevalent today, some classical violinist still prefer this type because of their warm , complex tone

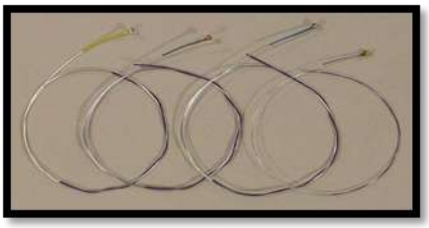
Fig - 2



Metal violin String

This is also called as steel core strings a very common choice for violinist as they produce a bright, full sound when played with proper technique metal string usually favored because of their volume capacity durability .

Fig -3



Synthetic string

It is made from high-tech nylon and other composite material other string offer the same warm tone found with gut strings, but don't require as much pickup.[Wikipedia]

Fig -4

2.2 LENGTH

[Useful Measurements For Violin Maker - Henry A. Strobel]

Area	Length (mm)	Length (inches)
4/4 violin	330	13
7/8 violin	317	12.5
3/4 violin	310	12.025
1/2 violin	285	11.025
1/4 violin	260	10.025
1/8 violin	235	9.025
1/16 violin	215	8.5

Table 2

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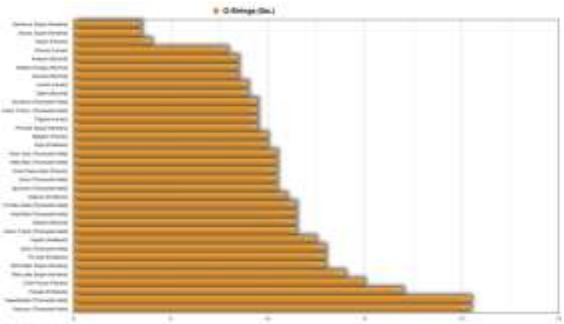
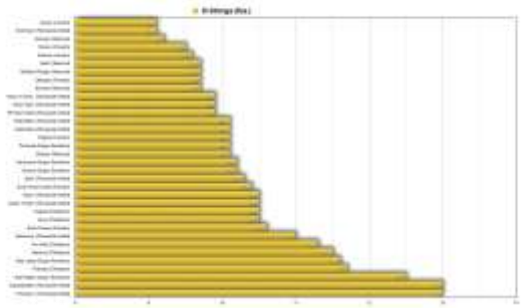
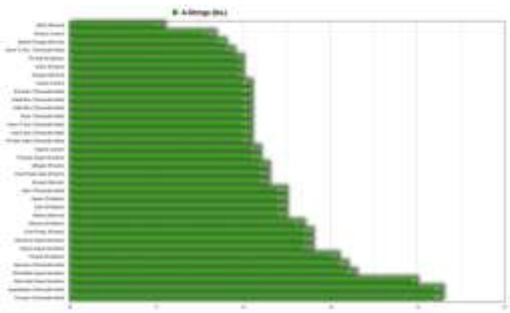
2.3 TENSION [Gathered data from different companies]



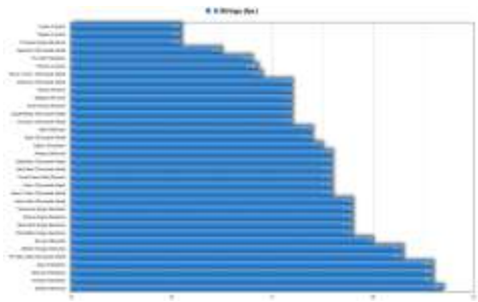
D String tension



G string tension



E string tension



A string tension

III EXPERIMENTAL WORK

3.1 Determination of Elasticity of Material

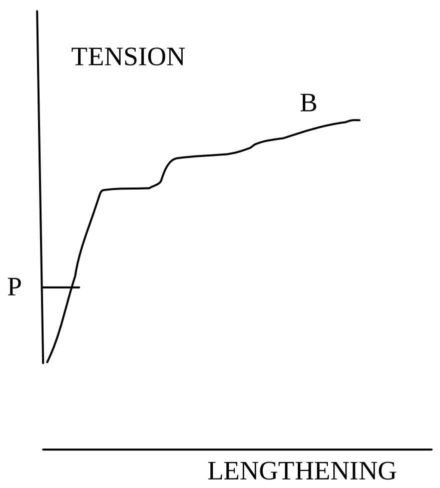
In the theoretical introduction we have already shown that the weight of the string is the most important and "automatically" determines the string tension. It is therefore interesting to know the density (weight per cubic meter) for materials, For string materials we are in the heavy range, for typical string material

Violin String Material Density [

String material	Density Kg/m3
Steel	7700
Gut 1	300
Nylon	1200

Table 3

The strength of a string is tested by tensile tests. In a measurement apparatus the string tension (load) is increased and the resulting lengthening (strain) is measured. The tension is increased until the string breaks. Thereby a load-strain diagram is obtained. The first part of the curve is a straight line. If the pulling force is disconnected within a certain range (up to the limit **P**) the string regains its original length. The strain within this range is elastic. At the limit **P** the elastic strain turns into a plastic strain and a remaining lengthening is left after the tension has been disconnected.If the string is stretched until it breaks, the fracture limit **B**, a measure is obtained of the maximum tension possible. Strings can not be stretched to any limit. First the string tension is increased, thereafter it is stretched and finally it breaks. The breaking limit **B** sets is the maximum frequency the string can be tuned up to but the elastic limit **P** should be the maximum useful limit. The breaking limit for some materials are given table



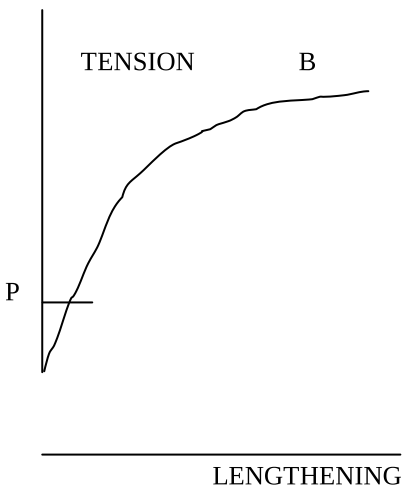


FIG 5 a) Typical lengthening **b)Plastic lengthening**

Fracture limit for typical string material (107 Pa = 1 "kg/mm2")

Material	**Elastic Limit**	**Material**	**Suitable tension in percent of the fracture limit**
Steel	2100-2600	Steel	40 – 75
Gut	320 - 460	Gut and fibres	35 – 70
Nylon	600 - 750		

Table 4

i.e. a steel string can be stretched 3 to 4 times that of the gut, silk and nylon materials. The string should not be stretched to the breaking limit. Suqitable limits are given for loading are given The table says that strings are loaded to 50 % of the breaking limit. Thus the steel string can still be tensioned 3 to 4 times more than the gut, silk and nylon strings.[Physics Acoustic –TY.BS.C.]

Suitable tension in percent of the fracture limit of string material

Elasticity modulus of E String

Material	Elasticity modulus E
Steel	220
Gut	5.5-6.5
Nylon	4.5-5.5

Table 5

APPLIED ON STRING TENSION

→

Fig 6

3.2 DETERMINATION FREQUENCY BY PHASE SHIFT METHOD

EXPERIMENTAL SETUP:

The experiment consists of measuring the phase velocity of sound waves through the use of simple tools .Amplifier and speaker are connected to the Cathod Ray oscilloscope so that they are working as receivers, while the third is connected to the signal generator and works as an emitter of sound. To trigger the CRO we use the function created by the generator, which is controlling the sound emitter. Oscilloscope and generator are shown in the Figure 1. The receivers are fixed on a suitable structure. Fuction generator outputting a sinusouidal signal. On the monitor of the oscilloscope, adjust a position of microphone such that we can obtain proper wave form.Note the position of microphone determine the time period and by taking inverse of time period we calculate frequency.

Fig 7 **Fig 8** **Fig 9**

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CRO SHOWING SINE WAVE OF GIVEN VIOLIN NOTE **POSITION AFTER ADJUSTING THE WAVE** **Wavefrom ON CRO**

FREQUENCY OF STRINGS

Strings	Time period	Frequency Calculated Hz	Frequency Theorotical Hz
G	0.0052	192.30	196
D	0.0035	285.714	293.66
A	0.00225	444.444	440
E	0.0015	666.666	659.25

Table 6

3.3 Effect of Temperature onViolin String:

Methods:

The musical instruments used included a quarter size violin with steel strings, a recorder. The procedure was to measure the "A" note on these instruments at a cold temperature, room temperature, and a hot temperature. The frequency measurements were done using a tuner.

Observation:

The violin note frequency decreased as the temperature got hotter due to less tension on the string. The recorder note frequency increased as the temperature got hotter due to the speed of sound increasing with temperature. The note frequency stayed fairly constant because the bass bar expanded and contracted little over temperature range which is given.

IV CONCLUSION

EXPERIMENT 1:

By using this experiment we can calculate elasticity of different material of violin string. From this experiment we conclude that, Steel string can be stretched 3 to 4 times that of the gut and nylon materials.

EXPERIMENT 2:

By using this experiment we can calculate time period of sound wave as well as frequency. From this experiment we conclude that frequency of G string is lowest. And frequency of E string has highest frequency.

EXPERIMENT 3:

Temperature does affect the frequency of a musical note.

The information shows that musical instruments need to be protected from extreme environmental factors like temperature in order to maintain their beautiful sound.

V FURTHER CONCLUSION FROM STUDY OF STRING:

From the study of material of string we observe different tonal quality of instrument i.e. if we use Gut's string we get soft and warm sound. And from metal strings we get bright and fuller sound. Also from synthetic strings we get soft as well as bright sound. Gut's string does not give quick response to pressure but Metal and Synthetic strings gives quick response to pressure.

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