International Journal of Sports and Physical Education (IJSPE)
Volume 4, Issue 2, 2018, PP 8-12
ISSN 2454-6380
http://dx.doi.org/10.20431/2454-6380.0402002
www.arcjournals.org

Experimental Method to Determine the Volume of Cricket Bat Handle to Ensure 10% Volume of Non-wood Material

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Abstract: *As per the law 5 the-bat with appendix-B pertaining to the materials in handle, the researcher quantified the use of non-wood materials other than cane, wood or twin is only one-tenth part from the total volume of the handle. The experiment carried out on Grade 'A' handles, was short in size and round in shape, made up of finest quality of Singapore cane or Rattan Manau (Calamus Manan) four pieces of laminated with 3 rubber insertions. A referenced cricket bat handle was used that is constraint by its geometrical parameters. The aims of this study were to experimentally measure and numerically determine the 10% volume of Non-wood material from the total volume of the handle for making joint assembly & their parts for a detachable cricket bat handle. So, the experiment was conducted by using water displacement method and by using some mathematical formulas to find out the total volume of handle from which 10% of non-wood material is determined. And the preceding study revealed that (21.49 cm3) volume of non-wood material would be used, from which the joint assembly and their parts prepared finally.*

1. Introduction

Many inventions and technological development had been done in the game of cricket to improve the performance of cricket bat but most of them are detrimental to the sport that forces MCC to change Law and restrict the use non-wood material. So, once again in the light of new rules a cricket bat with detachable handle had been invented by (Ali, S. & Murtaza, S. T. 2014).

A cricket bat generally consists of two different parts Blade and Handle. These two are generally connected to each other through a *splice* (MCC, 2017). Here, this invention only related to the handles. So, the handle itself separate into two sections via joint assembly. Section 1 remains fixed with the blade of the cricket bat. Section 2 may be more than one having distinctive lengths and can either be detached or attached with section 1 and then only the handle length could be changed from short to long handle as per the requirement of the batsman (Ali, Murtaza, & Katiyar, 2016).

Cricket bat handles vary in size, shape and materials. So, by changing their overall profile and materialistic quantities within the limit as proposed by MCC, would be greatly affect the performance of the bat. This experiment is designed to test logistics and gather information prior to a larger study in order to improve the latter's quality and efficiency, reveal deficiencies, save fund, time and resources that would be expended on further research process, also identify adverse effects caused by the procedure, and the effectiveness of actions to reduce them for reliable and valid results. The total volume of the handle is determined by using water displacement method and mathematical calculations to determine 10% volume of non-wood material from which the joint assembly and their parts would be prepared for further research process.

2. Objective of the Present Method

To provide a simple and feasible method at very low cost and easy to determine the 10% material by volume as per Law 5-the bat (MCC, 2017) made restriction on the use of non-wood material in the cricket bat handle.

3. IMPLICATION OF THIS METHOD

This procedure is a part of an applied research which is going on to examine the performance & reliability of non-wood materiel used into cricket bat handle that mainly focuses on the use of 10% volume of non-wood material. From which the final joint assembly and their parts would be prepared. The ultimate goal of adopting this procedure is to relating the results to a particular situation on the above mentioned invention.

4. SIGNIFICANCE OF THE STUDY

A separate and reliable method for volume determination of non-wood material (i.e. joint assembly and their parts) for the detachable handle would be found for different type of cricket bat.

5. METHODOLOGY

5.1. Geometrical Parameters of Handle

The handle used in this experiment was short in size and round in shape used in the Grade A cricket bats, made up of finest quality of Singapore cane not less than 4 section of cane and 3 rubber insertions. The middle insertion was 270mm in length and two insertions on sides with minimum 260 mm in length. The constrained measurement of cricket bat handle (Katiyar, Murtaza, & Ali, 2018) of short length given below in Table No.1

Table1. *Constraint Measurement of Standard Value of Cricket Bat Handle of (Short Length)*

Handle Type	Handle Parameters			Symbol	Constraint Values (mm)
Modified Handle	**Full Handle**	Total Length of Handle		TLOH	430
	Handle Inside the Blade	Total Length of Handle Inside the Blade		TLHIB	195
		Length of Handle Inside Blade at Neck Point		LHIBN	130
		Thickness of handle at Middle of Neck Point		THMN	35
		Thickness of handle at Bottom Point		THME	50
		Breadth of handle at Middle of Neck Point		BHMN	25
		Breadth of handle at Bottom Point		BHME	5
	Length of Handle In Neck Region	Total Length of Handle in Neck Region		TLHN	65
		Tapered Angle and Length of Handle in Neck		T_ALH	3^o, 20
	Length of Handle Outside the Blade	Total Length of Handle Outside the Blade		TLOB	235
		Length of Top Part		LTP	30
		Length of Middle Part		LMP	205
	Handle Diameter	Diameter of Handle Top Part		DHTP	36.5
		Diameter of Handle Middle Part		DHMP	32.5
	Rubber Insertions (lxbxh)	Top Part	Middle Insertion of Rubber	MRI	30 x 36.50 x 0.5
			Side Insertion of Rubber	SRI	30 x 35.10 x 0.5
		Bottom Part	Middle Insertion of Rubber	MRI	240 x 32.50 x 0.5
			Side Insertion of Rubber	SRI	230 x 30.92 x 0.5

5.2. Material Used in Handle

Generally handles were made up of two types of material likewise wooden & non-wooden material. 90% material should be made up of cane, wood and rest of 10% of material would be anything e.g. rubber or composite material (MCC, 2008). For our purpose we took only 10% part of volume into consideration to determine the volume of non-wood material into cricket bat with detachable handle (Ali, S. & Murtaza, S. T. 2014).

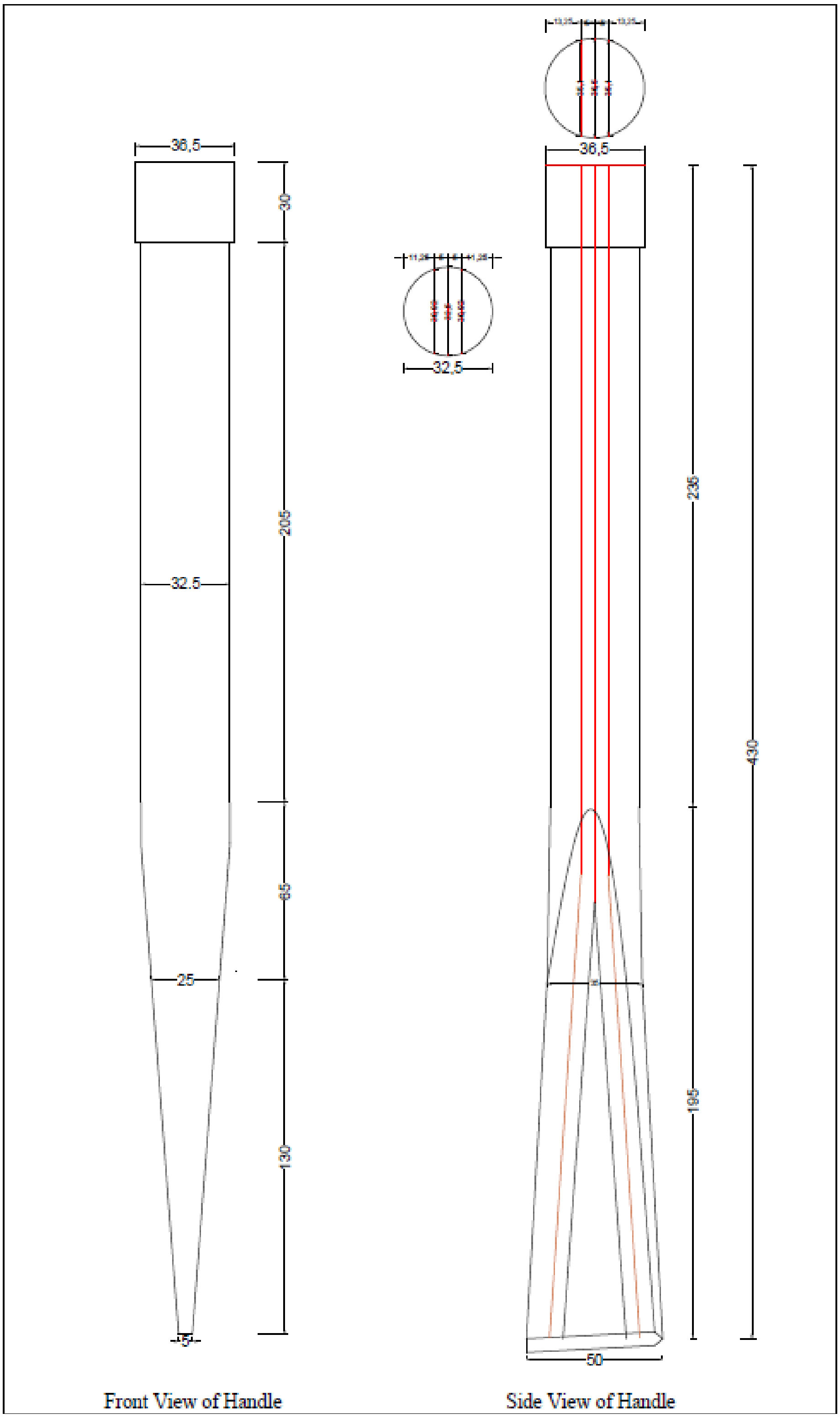

Figure1. *CAD Design of Standard Short Handle with all Measurement*

5.3. Experimental Procedure

The proposed procedure for this experiment was conducted in following different manners to find out 10% non-wood material.

5.3.1. To Find Out Total Volume of Handle

Experiments were conducted to measure the total volume of handle by using water displacement method because the handle of cricket bat is irregular shaped solid objects. So, using a known amount of water and submerging the handle into water filled gradated cylinder.

In this experiment total (n=10) handle were taken and measured in a water filled graduate cylinder to find the volume of handle. Each sample of handle was twice measured to reduce chance of error, and then the average of both reading (i.e. $\frac{(R_1+R_2)}{2}$ = V2 cm3) was calculated for all the samples. From the average values we subtract the initial reading of water level (i.e. V1 cm3).

Table2. *Observation Table for Determining the Volume of the Handles*

S.No	Type of Handle	Initial Level of Water	Raised Level of Water			Total Volume of Handle
		V_1	R_1	R_2	$\frac{(R_1+R_2)}{2} = V_2$	$V_2 - V_1$
1	Referenced Handle	2200	2538	2544	2541	341
2		2200	2539	2542	2540.5	340.5
3		2200	2538	2545	2541.5	341.5
4		2200	2540	2545	2542.5	342.5
5		2200	2540	2545	2542.5	342.5
6		2200	2538	2545	2541.5	341.5
7		2200	2538	2543	2540.5	340.5
8		2200	2538	2541	2539.5	339.5
9		2200	2538	2542	2540	340
10		2200	2540	2544	2542	342
	Average Volume of Handle $(cm)^3$ =					341.15

$$\textbf{Total Volume of Handle } (cm)^3 = \frac{\sum (V_1 - V_2)}{n} \qquad \text{.......... (1)}$$

Total Volume = **341.15 cm^3**

5.3.2. To Find Out 10% Volume

After finding the total volume of the handle we have to calculate the 10% of volume from the total amount of volume that was determined by using percentage formula.

$$= \frac{\sum (V2 - V1)}{n} \times \frac{10}{100} \qquad \text{.......... (2)}$$

So, 10% from the total volume of handle **= 34.11 cm^3**

5.3.3. To Find Out Volume of Rubber Insertions

There were 3 rubber insertion into the handle's top and bottom part. Into the top part, middle insertion was 30 mm in length, and 36.5 mm in breadth and 0.5 mm in thickness and other two side insertions were also of 30 mm in length, 35.1 mm in breadth and 0.5 mm in thickness and, in the bottom part of handle, middle insertion was 240 mm in length, 32.5 mm in breadth and 0.5 mm in thickness and other two side insertions were also of 230 mm in length, 30.92 mm in breadth and 0.5 mm in height. So, the measurement of rubber insertion is calculated by using formula for the volume of a rectangle.

$$\mathbf{V = l \times b \times d} \qquad \text{.......... (3)}$$

Where, l = length, b = breadth, d = depth

Volume of Middle Insertion = 4447.5 mm^3

Volume of Side Insertion = 8176.6 mm^3

Total volume of Rubber insertion = 12624.1 mm^3

= 12.62 cm^3

5.3.4. To Find the Remaining Percentage of Volume from 10% of Non-Wood Material

From 10% volume of handle is subtracted from the volume of rubber used into the handle. Then only we found the total percentage of volume from which the assembly is prepared finally i.e.

Eq. (2) - (3) = **34.11 cm^3 - 12.62 cm^3**

= 21.49 cm^3

6. Finding Of The Study

By conducting the experiment as described above in step by step, we found the volume for constrained measurement of handle in order to overcome the problem using non-wood material used into handle likewise rubber spring used for damping vibration and other material for making joint assembly & their parts used for attaching and detaching the handle from its distinct length (i.e. short to long) or vice versa.

Table3. *Results of the Experiment*

S. No		Type of Material	Name of Material	By Volume	By Percentage
1.	Constraint Handle	Wooden	Cane Wood	307.04 **cm^3**	90%
		Non-Wood	Rubber Insertion	12.62 **cm^3**	10%
			Joint Assembly and their parts	21.49 cm^3	
Numerical Value of Constraint Handle by Percentage and by Volume				341.15 **cm^3**	100%

7. Conclusion

The aim of conducting such type of experiment is to find out 10% volume of non-wood material (i.e. rubber spring and any other material for making joint assembly & their parts). This experiment give, support to a research work that is going on to examine the performance and reliability of non-wood material from which joint assembly and their parts would be prepared for attaching and detaching handle in different set of circumstances during play, so this experiment proves and provide, a reliable method to determine the volume of non-wood material as per the MCC's Law 6(the bat). In this experiment the handle had been constraint to find out non-wood material used into detachable handle. As per the handle constraint the total volume of handle was **(341.15 cm^3)** found and in light of our purpose, we are considering only 10% volume from total volume of handle. So, 10% volume of material is **34.11 cm^3**, out of that **(12.62 cm^3)** material used as rubber, and **(21.49 cm^3**) material would be used for Joint Assembly and their parts.

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Citation: *Ashish Kumar Katiyar, Syed Tariq Murtaza, Ph.D., Shamshad Ali. " Experimental Method to Determine the Volume of Cricket Bat Handle to Ensure 10% Volume of Non-wood Material" International Journal of Sports and Physical Education (IJSPE), vol 4, no. 2, 2018, pp. 8-12. doi:http://dx.doi.org/ 10.20431/2454-6380.0402002.*

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