Testing the performance characteristics of Modified handles with Referenced handle

Ashish Kumar Katiyar
Research Scholar, Department of Physical Education,
Aligarh Muslim University, Aligarh (U.P.), India
Email- akaty.rs@amu.ac.in

Syed Tariq Murtaza
Associate Professor, Department of Physical Education,
Aligarh Muslim University, Aligarh (U.P.), India
Email- abunarashans@yahoo.co.in

Shamshad Ali
Associate Professor, Mechanical Engg. Section, University Polytechnic,
Aligarh Muslim University, Aligarh (U.P.), India
Email- shamshadaliamu@rediffmail.com

Abstract- The study had been undertaken to investigate and, to develop an experimental & predictive techniques used for assessing the performances of different type of Modified Handles with a Referenced Handle. As per the defined methodology of the study, the results and the findings pertaining to all the key parameters associated with the performance characteristic of Referenced and Modified Handle had been accessed. Three tests were used, i.e. a bend test by using simple supported beam to assess Equivalent Bending Stiffness (EI), a tensile test for Modulus of Elasticity (E), a torsion test for Modulus of Rigidity (G) and Torsional Stiffness (k) were performed consecutively. From the experimental data key parameters (i.e. EI, G, E and k) associated to overall performance of a handle were calculated. Finally it was concluded that the performance of Modified Handles' violates overall performance characteristics of a cricket bat handle against a referenced handle and also reduces the player's comfort in terms of vibrational sensation due to the use of nonhomogeneous material in modified handles.

Keywords – Cricket bat handle, modified handle, referenced handle, joint assembly.

I. INTRODUCTION

Now a days, any equipment which comes out, and permitted to use into the games fairly, is often available after or with a lab test that simulate game conditions and incorporate the use of two objects; the object being evaluated and the object that it impacts in the course of its use.

Various modifications and designs have been developed using wood, aluminium and composite materials to improve the performance of baseball and cricket bats [1, 2, 3, 4 & 5]. An alternate approach had been carried out to modify the handle of the bat, and then to a prototype Modified Handle was developed by S. Ali, & S.T. Murtaza [6] in which a joint assembly was used for attaching and detaching the handle from its distinct length, made up of brass materials mounted on to bottom portion of the handle.

So, in this study same problem was sourced and selected from previously published one of the patent no. (993/DEL/2014 A, 2014), to further improve upon and modify into the invention; experimentally on cricket bat handle as per the recent advancement in technological development into materials that have motivated a number of changes in cricket bat design and its specification, that has may be guaranteed as some industrial application, and compilations of the same work with correct interpretation.

Recent advances in technology and materials have motivated a number of changes in cricket bat design. While some studies also suggest these advances have not affected performance, more work is needed to quantify their contribution [7]. Grant suggested that the handle offers the most scope for improvements in bat performance [8]. The handle should be regarded as a primary target for design and innovation [9]. The rules do not strictly restrict the handle design but, have left open an opportunity to alter the handle design, where there is no limitation to the innovative possibilities either in the form of improved structure, material composition, or additional instrument

incorporation in the handle [10]. But the opportunity may be used for innovative design and manufacture using high stiffness to weight ratio advanced fiber composites and material composites, there may be the possibility of significantly altering the dynamic characteristics of the bat by tailoring the design of the handle. This has left a door open for the possibility to design innovative Cricket bats [10]. However, the rules do not specify that modifications cannot be made but under the control of the MCC [11].

So, the sole intension of conducting this study is to test the invention technically and experimentally to make this invention industrially applicable that is novel and to ensure that the design and implementation should be in line with the international manufacturing standards of Cricket bats and it should conform to the rules of the sport. And, also to get affiliation form governing bodies i.e. MCC to fix this invention into the frames of Laws after successful conformity of this work, as to make this invention widely in usage as per the Law 5 the bat of MCC [11]. For the purpose, this work had been proposed and carried out for its concern cause; to provide a working framework.

In this study an approach was used to predict the performance of Modified Handles in respect to a Referenced Handle. In this study, two major types of specimens were tested, first was a Referenced Handle and other was Modified Handle in which joint assembly was installed on three locations. The specimens used in this study were made up of laminated cane wood of constraint measurements on selected geometrical parameters, which were more similar to a traditional design.

II. METHODOLOGY AND PROCEDURES

During the course of this study, various types of materials and methods were employed to make the required specimen i.e. Referenced Handle and Joint Assembly and Parts thereof for Modified Handle. Various methods of specimen testing have either been designed and/or purchased to meet the requirements of this study.

2.1 Handle models and Materials: A referenced handle of constraint measurements on selected geometrical parameters were used in this study, that was more similar to a traditional design made up of laminated cane wood[12].

The handles are often produced separately and without regarding their possible influence on the bat's performance. Each handle was constructed with Singapore cane, bonded together using PVA glue and without any extra bound as twine which provides extra strength to the splice. Each handle was 430 mm in length and approx 32.5 mm in diameter. The rubber inserts were made of 0.5 mm thick natural rubber. The inserts were cut into strips before being shaped to conform to the dimensions of the handle. These parameters were chosen as they matched many of the commercially available cricket bat handles.

2.2 Selection of Sample Size for each type of Handles : All together total thirty six (36) handles was used, out of that nine (09) were referenced handle in which a set of three (03) handles were used for each type of mechanical test. And, rest of twenty seven (27) were modified handles in which a set of three (03) handles each a joint assembly was installed on to three (03) different locations, were also tested on each type of mechanical test [12,13,14,15].

2.3 Preparation of Specimens: The dimensions of the specimens are to be put constraint before performing the test, allthe specimens is prepared in a manner that the procedure does not harm the specimen's characteristics and may not loose the originality of being, and act accordingly as it works and looks in the normal conditions.

In order to test the mechanical properties on laminated cane handle construction; four major types of handles were produced. Therefore, all the parameter quantified and assumptions were made that, all the materials (same type of cane wood, rubber, twine, adhesive and joint assembly) and manufacturing process are equivalent, or at least do confer any performance benefited, if altered.

a) Referenced Handle:

i) Handle 1 (a) has a more usual referenced handle, particularly used into cricket bat.

b) Modified Handle:

ii) In Handle 1 (b) the assembly was located on to top part of handle,
iii) In Handle 1 (c) the assembly was located on to middle part of handle and
iv) In Handle 1 (d) the assembly was located on to bottom part of handle part.

Figure 1.(a) Referenced Handle

Figure 1. (b, c, d) Modified Handle

The performance of handles is accessed by static test conducted by the means of dynamic machines, which are to be used for testing mechanical and physical properties of materials. All the tests were destructive in nature.

Three different experiments were performed to study the mechanical properties of Referenced and Modified Handles, for Equivalent Bending Stiffness (EI) a bend test was performed by using simple supported beam as shown in figure2 (a), for Modulus of Elasticity (E) a tensile test was performed as shown in figure 2(b), for Modulus of Rigidity (G) and Torsional Stiffness (k) torsion test as shown in figure 2(c),were performed consecutively, on the modified samples prepared for testing purpose as shown in figure 2(d), which are directly associated to the handle in relation to overall performance of cricket bat in terms of pick up weight, vibration imparted to the batsman & energy imparted to the ball.

Fig 2.(a) Bend test

Fig 2.(b) Tensile test

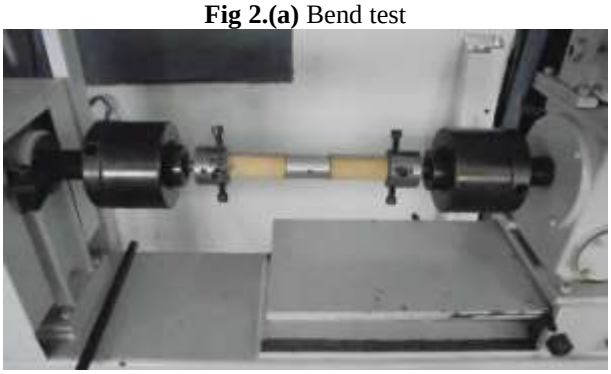

Fig 2.(c) Torsion test

Fig 2.(d) Modified Specimen used for testing

Only those Modified Handles were taken for further testing process, in which Joint Assembly were made-up of Metal Alloys materials i.e. Brass and Aluminium Alloy and rest of them were failed during the manufacturing process i.e. Polymer Mix Composite (PMC) and Fiber Reinforced Polymer (FRP), therefore they were put away from testing procedure.

Finally there were only six (06) different types of Modified Handles were tested against a set of Referenced Handle. The Referenced Handle was coded as H_1 Ref, and rest of Modified Handles were coded as H_2 Mod BT, H_3 Mod BM, H_4 Mod BL and H_5 Mod AT, H_6 Mod AM, H_7 Mod AL, Therefore, altogether in this study we measured and compared the performance of seven (07) different prototypes of cricket bat handles.

III. EXPERIMETAL RESULT OF MECHANICAL TESTING

The results and findings were presented on the basis of all those values which were recorded during testing specimens and were transformed as per the need to compute final results.

The result of tested specimens on to their selected key parameters were presented in the Table-1, determined by using the experimental values, which had been calculated separately for all the specimens by using simple conversation and following the procedures of elementary mechanics.

Table 1 for Results of Tested Specimens on Selected Key Parameter of Handles

S.No.	Type of Handle	Code	E (GPa)	G (GPa)	EI (Nm^2)	K (Nm/rad)
1	Referenced Handle	H_1 Ref	4.58	1.42	14.34	32.00
2	Modified Handle	H_2 Mod B_T	0.12	1.81	18.47	40.82
3		H_3 Mod B_M	0.14	3.39	31.32	76.12
4		H_4 Mod B_L	0.14	2.59	22.13	58.20
5		H_5 Mod A_T	1.52	2.84	16.80	63.76
6		H_6 Mod A_M	0.31	3.61	29.95	81.21
7		H_7 Mod A_L	0.85	2.91	20.94	65.32

Note: *E=Young's Modulus, G= Shear Modulus, EI= Bending Stiffness, k= Torsional Stiffness*

From the results which were presented in Table-1, the bar plot were shown in Figure 3 (a, b, c & d) drawn against each key parameter associated with the performance of handle separately and, then the results were compared in between Referenced and Modified Handle; the Referenced Handle's values (i.e. H_1 Ref) were used as a referenced value to make the comparison against Modified Handle values (i.e. H_2 Mod BT, H_3 Mod BM, H_4 Mod BL and H_5 Mod AT, H_6 Mod AM, H_7 Mod AL), from which the final result, discussion and conclusion were drawn out.

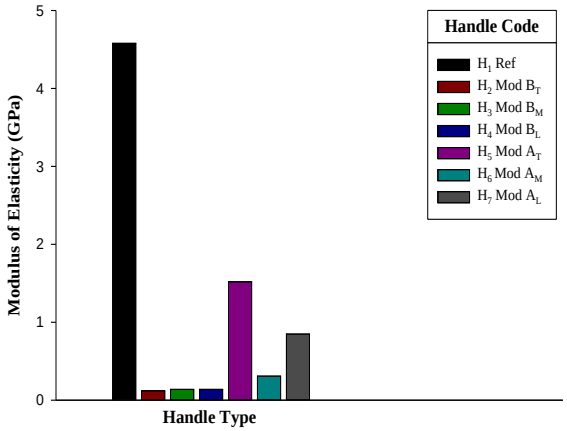

Fig 3.(a) Bar Plot for Modulus of Elasticity

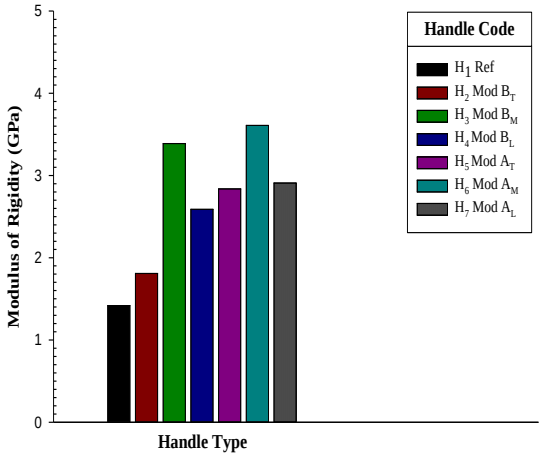

Fig 3.(b) Bar Plot for Modulus of Rigidity

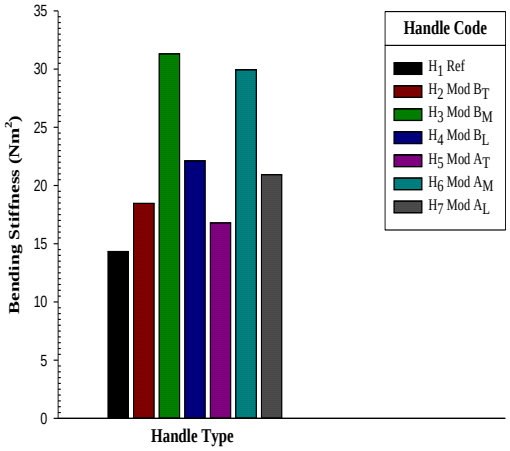

Fig 3.(c) Bar Plot for Bending Stiffness

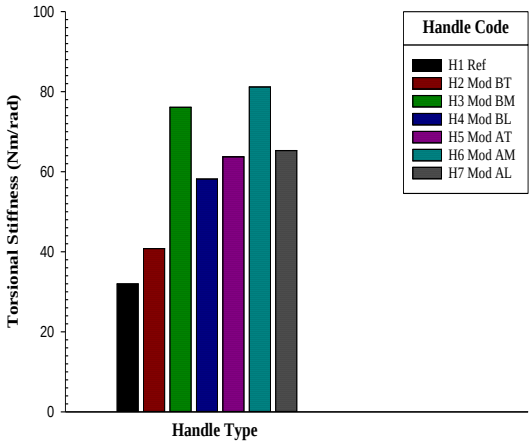

Fig 3.(d) Bar Plot for Torsional Stiffness

IV. DISCUSSIONS ON RESULTS

It was emphasized that these results may be different for the same or different type of cane wood/or materials other than wood, justifying the use of this methodology in each research developed. The mechanical properties which were reported in the above mentioned table were significantly different and affected by the specimens' material composition, in which non homogeneous material was used. Because the properties of wood i.e. the Modulus of Elasticity and Rigidity can vary widely within and especially between same species, due to the percent moisture content and density of material [15].

For an instance it was noted that the Shear Modulus (G) decreased with increasing in the Modulus of Elasticity (E) for Referenced Handle. And for Modified Handle, the Shear Modulus increased with decreasing Modulus of Elasticity. The Referenced Handle exhibited lower Shear Modulus, than those of Modified Handles and in particularly markedly higher Shear Modulus at lower Modulus of Elasticity than to Referenced Handle [15].

The Elastic Modulus dependent to a large extent on to the orientation and structure of the handle's cross-sectional properties, but also depending upon the use of different types of materials having different materialistic properties linking in between neighbouring materials. The torsional strength of Modified Handles was increased with decreasing tensile strength and that of in Referenced Handle, the torsional strength were increased as the tensile strength increases. Torsional Stiffness (k) shows the maximum deformation with maximum stress in Referenced Handles during twist load. That means the handle can hold only maximum twist load and still deformed elastically than to Modified Handles [15].

Well in the Equivalent Bending Stiffness (EI), the deformation is quite found significant that shows the maximum deflection in the Referenced Handle within the elastic limits and is in with safe state, than the Modified Handle which had minimal deflection at the same point of load. Due to that maximum deformation was showed at the different part of handles where the joint assembly was mounted. The joint assembly provided more strength to the whole component of the handle, which makes the handles more rigid due to that they get deformed plastically that to Referenced Handle [15].

Moreover, the results of vertical bending strength test in Referenced Handle showed minimum deformation with maximum stress within the safety factor, than to Modified Handle. Therefore the Referenced Handle is strong enough to resist the maximum load and have good flexural stiffness that can transmit more force to the batted ball, and also protect the batsman from painful vibration caused by the impact of high speed upcoming ball. So, Referenced Handle fulfilled all the qualities of being selected and worked as per the basic demands of play and also from mechanical perspective. So, Referenced Handle's material is most substantial to work with in playing condition than to Modified Handles [15].

V. CONCLUSION

Although this study has been an investigation regarding the analysis of cricket bat handle only, the main purpose of this study is to experimentally investigate the performance of materials used and fully document the responses of mechanical properties of cricket bat handle. As per the results and findings, this study was proved as non-developmental and less effective corroboration scheme to increase the performance of cricket bat handle and its durability. These modifications are likely to have a very less performance advantage without compromising

batsmen's comfort and too much cost effective equipment. All the Modified Handles were tested experimentally, the data was analysed to describe performance characteristics of Referenced and Modified Handles in order to meet out the demands of general playing properties. All the handles were tested experimentally; the results show the significant difference between the performances of all types of tested specimens. In modified handle different types of materials were used due to that mechanical properties of the modified handles were higher than the referenced one, the Modified Handles get rigid in which joint assembly was mounted on the top, bottom & middle locations, the transverse load bearing capacity i.e. Bending Stiffness (flexibility), Axial Deformation and Torsional Stiffness get effected and lost, and when the impact of high speed ball with blade at that time the ball produces more vibrational sensation (sting) in batters hand, due to that less energy is transferred to the ball; that reduces the maximum batted ball speed. By using the joint assembly made up of metallic materials, the weight of the handle get increased, that shifts the node of fundamental vibrational mode and Center of Mass (COM) of the bat, and due to that the balance of bat and Center of Percussion (COP) is disturbed. So, altogether the performance of Modified Handles was not so precise, feasible and fit for the purpose for that they were invented. The Referenced Handle is the only the reliable and performance oriented material which showed good agreement between the key parameters, associated to the overall performance of the handle and bat.

Finally it was concluded that the performance of Modified Handles' in which joint assemblies made up of different materials mounted on three different locations used for attaching and detaching the handle from its distinct length were analyzed to find out the most reliable material of joint assembly but none of the selected materials withstood with the durability and performance of Referenced Handle's materials. The process of manufacturing itself so tedious that blocks the way for any future research work regarding this invention, and the Modified Handles violate all the overall performance characteristics' of cricket bat and, also reduces the player's comfort in terms of vibrational sensation [15].

VI. SUGESSTIONS AND RECOMMENDATIONS

The research work carried out in this study was the initial trial to further improve upon and to carry forward this process into industrial and practical applicability within the Laws of MCC [11]. And, all the Modified Handles violates the overall performance characteristics of a cricket bat, and also reduces the player's comfort in terms of vibrational sensation. Moreover, the process of manufacturing itself so tedious that blocks the way for any future research work regarding this invention. Thus from this study, it can be deduced that the traditional cricket bat handle, which was termed as 'Referenced Handle', is the only viable options for the cricketers, until and unless the rules regarding the cricket bat in general do not change [15].

Conflicts of interest: There is no conflict of interest in between the author(s).

REFERENCES

[1] Eftaxiopoulou, T., Narayanan, A., Dear, J. P., & Bull, M. J, "A Performance Comparison between Cricket Bat Designs," Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology, 226, 16-23, 2011. doi:10.1177/1754337111425629

[2] Pang, T. Y., Subic, A., &Takla, M, "Finite Element Analysis of Impact Between Cricket Ball and Cantilever Beam," Procedia Engineering, 13, 258-264, 2011. doi.org/10.1016/j.proeng.2011.05.082

[3] Shenoy, M. M., Smith, L. V, & Axtell, J. T, "Performance Assessment of Wood, Metal and Composite Baseball Bats," Composite Structures, 52(3–4), 397–404, 2001. https://doi.org/10.1016/S0263-8223(01)00030-7

[4] Smith, L. V., Shenoy, M., & Axtell, J. T, "Simulated composite baseball bat impacts using numerical and experimental techniques," In society for Experimental Mechanics, Spring Conference, 2000. Retrieved from: https://ssl. wsu.edu/documents/2015/10/simulated-composite-baseball-bat-impacts-using-numerical-and-experimental-techniques.pdf

[5] Sridharan, S., Rao, J. S., &Omkar, S, "Finite element analysis of cricket ball impact on polycarbonate-EVA sandwich," Procedia Engineering, 112, 28-33, 2015. doi.org/10.1016/j.proeng.2015.07.171

[6] S.Ali, & S. T. Murtaza, "(Patent no.993/del/2013-14) Cricket Bat with Detachable Handle of Varying Length" 2014. Retrieved from: https://ipindiaonline. gov.in/patentsearch/search/index.aspx at (Accessed on April 04, 2015 at 8:00 am IST)

[7] Stretch, R.A., Brink, A., & Hugo, J, "A Comparison of the Ball Rebound Characteristics of Wooden and Composite Cricket Bats at Three Approach Speeds," Sports Biomechanics Vol. 4(1) pages 37-46, 2006.

[8] C. Grant, "Design of a Better Cricket Bat". Materials Research Society Bulletin Advanced Materials in Sports & Leisure Equipment 1998.

[9] Z. B. Li, "Vibration Suppression Analysis of Cricket Bats," MEng Thesis, Dept of Mech. & Manu. Eng, RMIT University, Melbourne, Australia, 2002.

[10] J. L. Cao, "Vibration Control in Cricket Bats using Piezoelectric-based Smart Materials", Doctor of Philosophy (PhD), Aerospace, Mechanical and Manufacturing Engineering, RMIT University, 2006. http://researchbank.rmit.edu. au/view/rmit:6139

[11] MCC, "Law-5 (The Bat), Laws of Cricket 2017 Code, 2017. Retrieved from:https://www.lords.org/mcc/laws-of-cricket/new-code-of-laws-october-2017/ (Accessed on 2 Oct 2017, 12:15 pm IST)

[12] A. K.. Katiyar, S. T. Murtaza & S. Ali, "Determining Geometrical Parameters for a Referenced Cricket Bat Handle," European Journal of Physical Education and Sport Science, 4(3), 158–164, 2018. https://doi.org/10.5281/zenodo.1218138

[13] A. K.. Katiyar, S. T. Murtaza & S. Ali, "Utilization, Processing, Grading And Manufacturing Process Of Laminated Cane Handles (Calamus Manan)," IOSR Journal of Sports and Physical Education, 5(3), 5–8, 2018. https://doi.org/10.9790/6737-05030508

[14] A. K.. Katiyar, S. T. Murtaza & S. Ali, "Improved Design of Joint Assembly and their Parts for Cricket Bat with Detachable Handle. International Journal of Mechanical Engineering and Technology, 9(96), 178–181, 2018. Retrieved from http://www.iaeme.com/IJMET/index.asp

[15] A. K.. Katiyar, S. T. Murtaza & S. Ali, "Analysis of the performance and reliability of materials to be used in cricket Bat Handle," (Un-published Doctoral Thesis) Department of Physical Education Aligarh Muslim University, Aligarh, India, 2018. URL: http://hdl.handle.net/10603/251448