

# DEVELOPMENT OF LIGHT WEIGHT CRICKET LEG GUARD USING BORON CARBIDE PLATE

S.Praveena<sup>1</sup>, Dr.S.Kavitha<sup>2</sup>

<sup>1</sup>PG Scholar

<sup>2</sup>Assistant Professor III

<sup>1,2</sup>Department of Fashion Technology, Kumaraguru College of Technology, Coimbatore, India

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**Abstract** - Cricket leg guard is a personal protective equipment, which is used by the cricket batsmen while playing cricket to cover the legs of cricketer while batting. Boron carbide is proposed as one of the hardest known materials, behind cubic boron nitride and diamond. Boron carbide is known as a robust material having high hardness with less density. Boron carbides are used as a plate in the ballistic vests due to its lesser density and high hardness. In this research project, the cricket leg guard is to be created with light weight using boron carbide plate. The weight of making cricket leg guard will be between 600grams-800grams where the weight gets reduced by 300-500grams from the existing cricket leg guards. The light weight cricket leg guard will help the cricket players play comfortably without any hindrance. Boron carbide plate is sandwiched in between the layers of EVA (Ethylene Vinyl Acetate) foam sheets.

**Key Words:** Boron Carbide Plate, Light weight, Cricket Leg Guard, EVA Foam.

## 1. INTRODUCTION

Cricket is one of a global sports traditionally most popular in commonwealth nations but now it's being played in 105 member countries of International Cricket Council. Even though cricket is a kind of noncontact sport, the impact injuries are highly familiar because players involved in a wide range of physical activities, including batting, bowling, running, throwing, catching, diving and jumping. Furthermore, projectile injuries may occur in spite of protection, as 5.5-ounce hard cricket ball is bowled against the batsman at the speed ranges from 140km/h to 160 km/h, can bounce off the pitch in an eccentric form. The cricket batsman's must play with the protective equipment's to safeguard themselves from the hard hitting cricket balls. Hence, to safeguard cricketer's from injuries they need to wear the cricket kit which includes cricket bat, a leg guard, a thigh pad, a set of batting gloves, an elbow guard, an arm guard, and a kit pad while playing. Then the main complication for cricketers while playing cricket is to balance both the weight of cricket kits they worn and to play, run is a challenging one. With the help of light weight cricket leg guards batsman's can easily be able to run without any hindrance. These light weight cricket leg guards are made by using the boron carbide plate and EVA foam. EVA foam with light weight and boron carbide plate with high hardness, light weight properties both can be used for the cricket leg guard- a sports personal protective equipment for sport person. Here the EVA Foam can be used along with the boron carbide plate as the EVA foam has characteristics of good impact absorbing and finds lot of applications in recreational activities, then in mouth-guards for sports.

## 2. PROBLEM DEFINITION:

Personal protective equipment (PPE) has become increasingly important in professional sport, due to the high intensities of both training and competition, and with increasing expense associated with injury. Traditionally, PPE has been uncomfortable, bulky, cumbersome and ill-fitting, which can inhibit the performance of the user.

The major problems faced by the cricket Batsman are,

1. The leg and knee injuries for batsman are occurred due to the fast hitting balls against their legs.
2. The weight of the existing leg guard ranges from 1300 grams to 1500 grams.
3. Existing leg guards are made of using PVC foam, which has less impact resistant force than EVA foam.
4. As weight increases on legs, which increases hindrance to the cricketer's while taking runs.

### 3. OBJECTIVE:

The main objectives of this project is to develop

- Cricket leg guard to protect cricketers from knee and leg injuries with the ergonomic sportswear design.
- Cricket leg guard with lesser weight ranges from 500grams-600grams by placing the boron carbide plate inside the pad with the EVA (Ethylene Vinyl Acetate) foams.
- To create a cost efficient light weight leg guard while comparing the existing leg guards in the market.

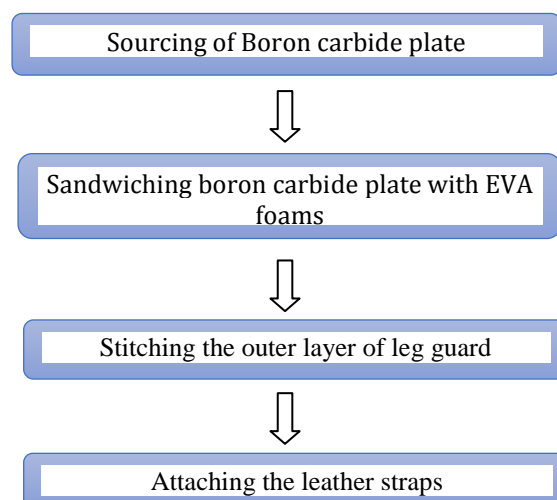
### 4. PARTS OF CRICKET LEG GUARD:

- The cricket leg guard includes different parts that protects the wearer from the hard hitting balls.
- Different parts are Top Hat, Knee Roll, Wings, Face and Straps.
- The parts of the leg guard are clearly shown in the fig.3.



**Fig.1** Parts of Cricket Leg Guard.

### 5. METHODOLOGY:

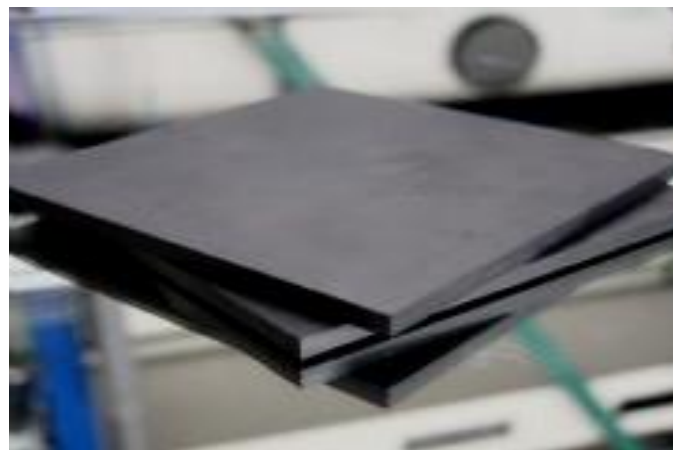


## 6. MATERIALS:

### 6.1 Boron Carbide Plate:

Boron Carbide is well known for its hardness and stiffness. The boron carbide plate is made with the boron carbide rhombohedral crystal structure. Boron Carbide has the third place in the hardest material list after diamond and cubic boron nitride. Boron Carbide was first discovered in 19<sup>th</sup> century from the metal borides byproduct reaction. There are eight different methods by which the boron carbide can be synthesized. The boron carbide plates has immense applications in the personal protective clothing and equipment's. Boron carbide plates are used in the bulletproof vests that are worn by the military, police Special Forces. These bulletproof must be of lightweight and should protect wearer from projectiles that are coming against them. M.CEGLA et al in his paper done an experimental research on bullet proof vests with the boron carbide plates are used as inserts for body armors and tested against the different kinds of fast emerging projectiles [1]. Hence as the results, the body armors with boron carbide plates placed as hard front layers gives good weight reduction and also good protection with the polyethylene foam as backing layer.

Aghajanian et al in his research found that the reaction bonded boron carbides has high specific stiffness than the silicon carbides [2]. The high specific stiffness is a kind of substantial properties which find its applications in place requiring precise motion, large loads or higher accelerations and control of motion involved. These boron carbide possesses remarkable hardness and stiffness with low specific gravity and comparatively high flexural rigidity.



**Fig.2** Boron Carbide Plate

### 6.2 EVA Foam:

Ethylene vinyl acetate (EVA) foams are represented as a specific kind of cross-linked closed cell polyethylene foam. The appearance of EVA Foam are soft with rubber-like texture then with the characteristics of good shape recovery after the deformation. Generally EVA foam is considered to be a nontoxic material which can be used in the sports equipment making. These EVA foam are used as inserts in the face guards and other protective equipment. EVA foam has applications in midsoles used for running shoes. Verdejo et al in his research to measure the pressure distribution at heel pad-midsole interface performed the experimental tests and numerical simulations. The midsole made of EVA foam by the shock absorbing characteristics it reduces the peak impact force of the heel pad. Davey et al in his work chosen the foam sandwich consisting of three layers in which the two layers are of polycarbonate and one layer of EVA foam to analyze the impact absorbing characteristics [5]. The polycarbonate and EVA foam has been chosen as a protective material is imputed to its excellent impact resistant properties and its light weight. The main aim of this research is to use finite element analysis method to examine the performance characteristics of EVA foam and other new materials for use as protective gears in sports like cricket.



**Fig 3.** EVA Foam Sheet

### 6.3 Materials Used:

The existing cricket leg guard is made of high density poly vinyl chloride (PVC) foams. Its weight ranges from 1300 grams - 1500 grams and above. Face of the leg guards are made from cane - a light wooden material filled with cotton. In order to reduce the weight of the leg guard and further to make it tenacious boron carbide plate is placed in the middle of ethylene vinyl acetate foams in the leg guard. The outer cover of leg guard shaped with synthetic sheet. Materials specifications are listed below:

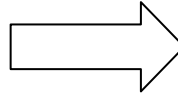
- Boron Carbide Plate thickness – 2 mm
- Ethylene Vinyl Acetate foam thickness – 4 mm
- Leather straps – 2 straps
- Rexine sheet for outer layer

### 7. STITCHED LIGHT WEIGHT CRICKET LEG GUARD:

The existing traditional leg guard construction, comprising of PVC foams, reused fabrics stuffing and pieces of cane for added support which increases the weight of the leg guard. The mobility of cricketer's getting reduced due to material thickness, weight, protection level and design of the cricket leg guards. Hence the design of stitched light weight leg guard is changed from the existing leg guard, the knee roll part isn't included in the newly stitched light weight leg guard. The image of the stitched light weight cricket leg guard is in the fig.4.



**Fig.4** Stitched Light Weight Cricket Leg Guard.



PVC Foam is replaced with the EVA Foam i.e instead of PVC foam strips, the EVA foam sheets are placed as three layers up and down in the light weight leg guard, in between the EVA foam Sheet layers a light weight Boron Carbide Plate of thickness 2mm is Inserted.

**Fig.5** Image of PVC Foam insertion in existing leg guard making.



Replacement of EVA foam sheet instead of PVC Foam inside the leg guard



**Fig.6** PVC Foam

**Fig.7** EVA Foam Sheet

The leg guard of weight 565 grams (single piece) is constructed by

- Placing the light weight EVA foam sheet of thickness 4 mm as three layers on top and bottom inside the leg guard.
- Between the layers of EVA foam sheets the boron carbide plate of thickness 2 mm and of length 20 cm with the weight 106 grams are sandwiched between the EVA foam sheet layers.
- Then the leather straps are attached to the leg guard which is used to tie the leg guard around the leg to protect the leg and knee parts.

Hence the leg guard is designed with reduced weight of 565 grams by placing the boron carbide plate which is sandwiched by the EVA foams sheets inside the leg guard. The EVA foam sheets are placed inside the leg guard which has light weight, good impact resistance and resilience. Thus the leg guard is with reduced weight, the running velocity of cricketers will be increased. Hence the impact testing and the field trails (by making the cricketers to wear the light weight cricket leg guard and ask them to run, to find the running velocity of the cricketer's on the cricket ground) has to be done for the produced light weight cricket leg guard.

**8. COMPARISON OF EXISTING LEG GUARD WITH STITCHED THE LIGHT WEIGHT CRICKET LEG GUARD:**



**Fig.8** Existing Leg Guard(PUMA EVO 2 Men's)



**Fig.9** Stitched Light Weight Cricket Leg Guard

**Table 1.** Comparison of Existing Leg Guard with Stitched the Light Weight Cricket Leg Guard.

S.No	Features	Existing Leg Guard (PUMA EVO 2 Men's Leg Guard )	Stitched Light Weight Leg Guard
1	Weight	1500 g (one set)	1130 g (one set)
2	Length	66 cm	61 cm
3	Width	8 cm	7 cm
4	No Of Straps	3	2
5	Filling Material	PVC Foam	EVA Foam
6	Cost	Rs.4,499	Rs.1,860
7	Face Material	PVC Facing	Rexine Sheet
8	Color	White	Black
9	Cane Sticks	Available	Unavailable

- Hence the light weight cricket leg guard is made by the light weight boron carbide plate and EVA foam with the good resilient properties.
- The cost of the stitched leg guard is reduced to half of the existing leg guard is due to the usage of EVA foam sheets instead of PVC foams.
- The placement of boron carbide plate gives the resistance against the cricket balls which replaces the need of denser PVC foam layers so that three layers of EVA foam sheets are much more enough inside the light weight cricket leg guard.

**9. CONCLUSION:**

Boron Carbide plate has the good properties of high hardness, light weight and flexural rigidity. Then EVA Foam has soft structure, with the good impact resistant properties. To make personal protective sports equipment like cricket leg guard the raw materials must be with light weight, soft, with good impact resistant properties. Thus the combination of Boron Carbide Plate with EVA foam sheets makes the light weight cricket leg guard with good impact resistance, so that batsman can run fast to take runs and also protects the batsman from the hard hitting cricket balls at the speed of 45m/s. While comparing with the

existing leg guard(PUMA EVO 2 men's) with the stitched leg guard, the stitched leg guard shows lighter in weight, then the cost of making the light weight leg guard is reduced than the existing one. Hence the stitched light weight leg guard is cost efficient and user friendly for the cricket batsman's comparing to the existing leg guards in the market.

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