Improvement of a Helmet Test Rig for Endlessly Textile Secure Riot Helmets

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Abstract

This paper is a portion of research carried out for the industrial and evaluation of riot police helmet having constant textile reinforcement. Successful procedure was developed for the manufacturing on single-piece constantly textile reinforced riot helmet shells. In order to fulfil the impartial of in-house impact testing on the developed continuously textile reinforced helmets, a helmet test rig was made. The Academy of Manchester's drop weight impact testing device was used and successfully changed for helmet testing.The importance of the developed test rig was the adequate abilities to carry out impact testing at dissimilar impact position at the helmet shell, force blocking effectiveness at diverse locations can be designed and the behavior of the communicated force at dissimilar impact locations can be understood. Furthermore, energy absorption at different impact location can also be studied.

Keywords *- Helmet, Continuous Textile Reinforcement, Impact Testing, Test Rig, Drop Weight Impact Testing Instrument.*

I. INTRODUCTION

This paper is a portion of research accepted out for the industrial and estimation of riot police helmet having continual textile reinforcement. Successful procedure was established for the manufacturing on single-piece always textile reinforced riot helmet shells. In order to fulfil the detached of in-house impact testing on the developed continuously textile reinforced helmets, a helmet test rig was made. The Academy of Manchester's drop weight impact testing device was used and effectively changed for helmet testing. The reputation of the developed test rig was the adequate abilities to carry out impact testing at different impact position at the helmet shell, force blocking usefulness at diverse locations can be designed and the behavior of the transferred force at dissimilar impact locations can be understood. Furthermore, energy absorption at different impact location can also be studied.

II. LITERATURE REVIEW

A. The Drop Weight Impact:

Impact testing on composite structures can be carried out in number of ways as discussed by Abrate, but the major three categories are: Gas gun, Drop weight and Pendulum. In this research as discussed that Drop weight method was chosen due to the instrument availability. In drop weight testers, a large mass impactor is guided by rails in a free fall motion from a given height. Sensors can detect the velocity and load at the time of impact. Impact energy and velocity are calculated from the following equations.

$$E = \frac{1}{2}\ m v^2$$
$$v = \sqrt{2gh}$$

In the drop weight system the potential energy of the system is converted into kinetic energy during an impact onto the specimen. Friction in the mechanism is supposed to be zero due to the free fall motion of the impactor.

B. Instron Dynatup 8200 Drop Weight Tester - Impact Testing Instrument:

The Instron Dynatup 8200 drop weight impact tester is skilled of testing constituents at a velocity of up to 4.4 m/sec with a maximum drop height of maximum 1.2 meters. Figure1shows the sketch of the Instron Dynatup 8200 impact tester. The main assemblies of 8200 drop weight impact testing instruments have been described as follows.

1) The Drop Weight Assembly:

It is the core of the Dynatup impact instrument. This assembly involves of three parts, which are the drop weight, tup and flag bracket. Brief explanations of the machine used are as follows.The drop weight consists of the mass for the impact testing. The drop weight assemblage is a framework of weights and plates attached together. The empty mass of the drop weight is approximately 3 kg. The drop weight has an ability to hold more mass; ten extra weights, each weighing roughly 1.1 kg, to give a total test mass of 13.6 kg. These ten weights can be stacked within the drop weight and are reserved by a negotiated rod and securing hand-knob. Protection plates bolt onto the front and back of the drop weight surround to retain the weights.The impact force applied on the specimen is measured by the tup of the drop weight assembly. It involves of two parts, the tup: which is a load cell for measuring force,

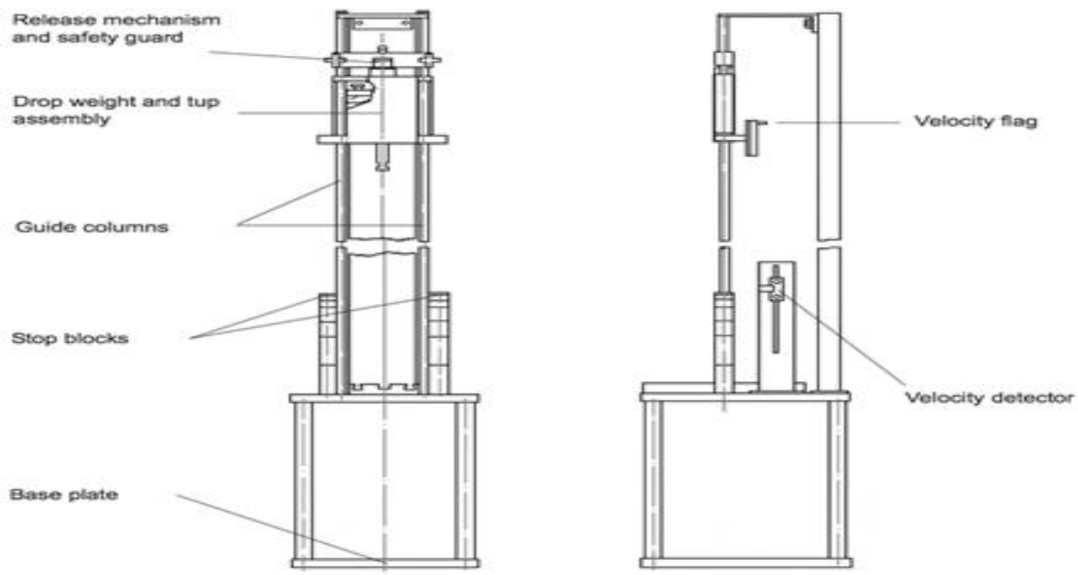


Figure 1. Sketch of the Instron Dynatup 8200 Impact Tester

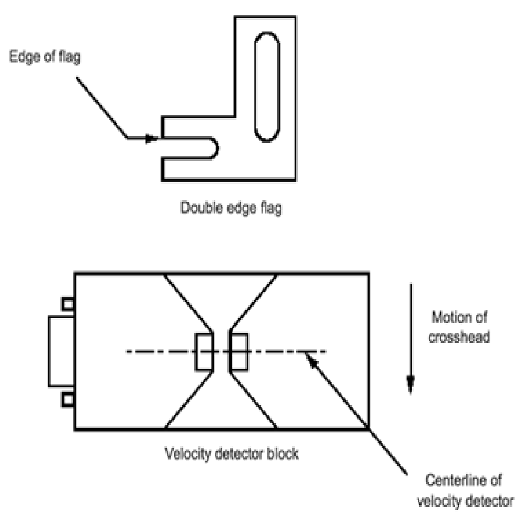


Figure 2. Velocity Detector and Flag

2) ***The Drop Weight Release Mechanism:***

A mechanical lever is providing to physically release the drop weight assembly from a pre-selected drop position. The situation, based on the required impact energy, can be accustomed by moving the clamp frame up and down and compressing it to the guide columns using the clamp knobs. The speed of the drop weight can be adjusted from the drop height by using the equation.

3) ***The Drop Tower Framework:***

The impactor was released precisely onto the specimen with the help of a guiding mechanism. This guiding mechanism comprises of two vertical bars, base plate, back and top weldment and table. The drop weight gathering drops free fall on the guide columns via holes in its upper and lower guide blocks. The two controller columns bolted to the base plate and the top weldment. The back weldment offers rigidity and vertical solidity to the drop tower.

4) ***2.2.4. The Anvils:***

Itstuffs that hold specimens throughout testing. Diverse styles of anvil are available to quarter various test specifications and techniques. The drop weight mechanism also be contingent on several factors for instance impactor mass, impactor shape, height of the drop weight and also the boundary conditions property the variety to be tested.

III. REQUIREMENTSOF HELMET TEST RIG

The impact testing instrument at the University of Manchester can be seen in Figure 3. This device is used for low velocity and low energy impact testing.

There was no anvil available to hold the helmets on the drop weight impact instrument as can be seen in Figure 3. Additionally, there was a need to regulate the transmitted force underneath the helmet. For that purpose force sensors had to be entrenched. In other words, a test rig was mandatory which could be used as an anvil in the drop weight impact testing instrument. In order to develop the test rig for helmet testing, there was ample space accessible at the bottom portion of the Instron Dynatup 8200 drop weight impact tester as can be seen in Figure 3. Utilization of this bottom portion as the working space was aimed for the helmet holding assembly.

Figure 3. Dynatup 8200 Drop Weight Impact Testing Instrument

The test rig for the helmet testing should have certain necessities.

- there was a need of a head form for field the helmet during an impact.
- Secondly, helmet should be believed firmly during the impact, so there was a need to develop a head form holding assembly.
- Impact testing has to be approved out on the back, top and side of the helmet. So, there was a need to develop a mechanism by which helmet could be switched with the head formdepressed of resetting the whole setup.
- Instron Dynatup 8200 drop weight impact tester can give the impact data from the top of the specimen. In order to discovery the force communicated through the helmet, a force sensor was compulsory for the evaluation of force blocking effectiveness.

IV. DEVELOPMENT OF TEST RIG

Established on the requirements discussed above, the test rig was industrial in three steps namely,

A. Head form Manufacturing

In order to hold the helmet, there was a need for a head formwhich could serve the purpose of helmet a holding. An ideal head form is the one which should be able to stay firm at low velocity impacts and also force sensors can be mounted on the head form for determining the spread force. In this study, spherical headform synchronizes with 525 mm circumference from the British headform standard 'Headform for use in the testing of protective helmets' selected due subsequently it seems suitable for the developed helmets. A polypropylene made headform which has a circumference of 525 mm was as a mould and casted from aluminum as shown in Figure 4. Head forms made of aluminum are commonly used by several authors.

Figure 4. Aluminumhead form

B. Headform Holding Assembly:

There were three basic objects while manipulative the helmet holding assembly. Firstly, impact testing has to be carried out on at least three sides of the helmet that is top, side and back of helmet. Secondly, the whole helmet holding assembly should be able to rotate for dissimilar impact locations without resetting the whole setup. Thirdly, a force sensor should be connected on the headform at the exact position of impact. Based on the prerequisite it was planned that the headform was drilled and steel rods were fixed in the drilled portions at the bottom and the front. The purpose of these steel rods was to hold the headform and can be rotated to the required impact location.

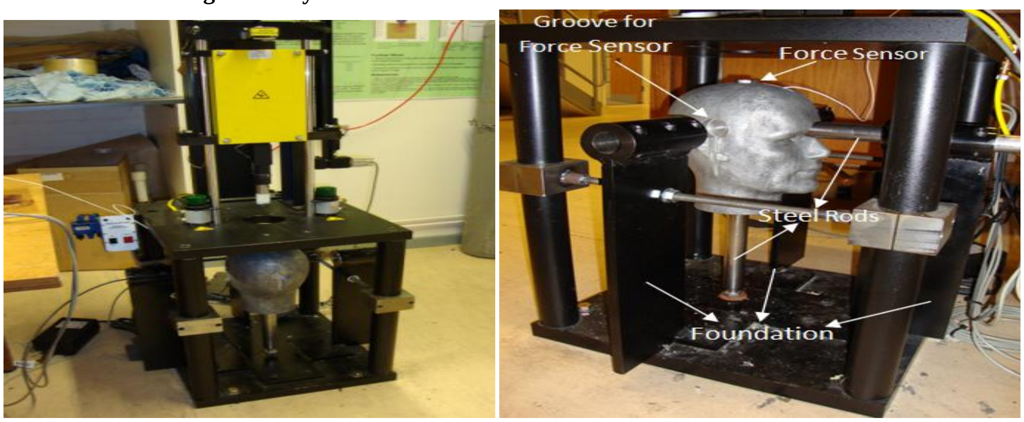
The drilled headform with steel rods can be seen in Figure 5(a). The purpose of these steel rods was to hold the headform on a specially designed foundation which can be seen in Figure 5(b). In this way the headform along withhelmet on it can be swing simply to the required direction without removing and resetting the whole helmet holding assembly. The helmet holding assembly foundation was bolted to the main base foundation of the Dynatup 8200 Impact testing instrument. The steel rods were bolted on to the upper part of the helmet holding assembly. Anti-vibration pads were also used in the bottom of the steel rod connecting to the foundation to reduce vibration caused by the reaction on the impact.

(a) (b)

Figure 5. (a) Headform holding rods(b) Foundation for helmet holding assembly

C. *Force Sensors and Mounting at Headform:*

The Dynatup 8200 impact testing apparatus has the capacity to provide the impact force, but in order to estimate the force received underneath the helmet, a force sensor has to be installed at the headform. A Dytran ring type model series 1203V5 force sensor was selected due to its inherent form of thin ring with through hole and also having high compression range. This sensor is considered to measure dynamic forces in machines.



(a) (b)

Figure 6. Different Views of the Helmet Test Rig (A) Front View (B) Side View

V. EXPERIMENTAL RESULTS FROM THE MANUFACTURED TEST RIG

The investigational results will be published in the future papers. Though, in order to give a glimpse for the test rig working status some of the results are discoursed. The developed helmet shells were impacted with impact energy of 5.6 Joules at the top, back and side impact locations on the helmet shell.

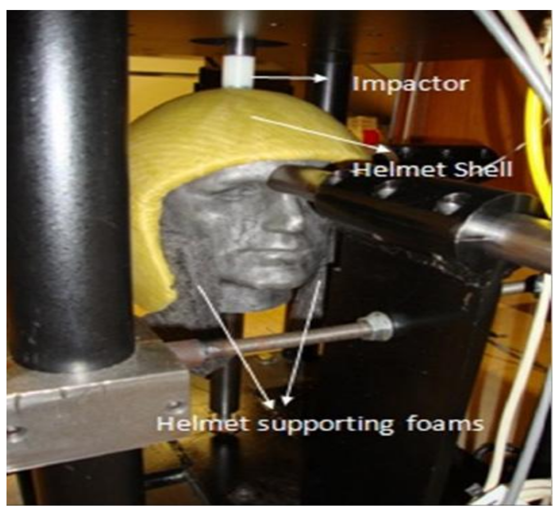


Figure 7. Impact on Top Location at Riot Helmet Shell

The energy rapt was calculated from the method discussed. Also, the force reduction factor was calculated from the method discussed in section.HS characterizes the impact at helmet side location, HB epitomizes the impact at the helmet back location and HT represents the impact at the helmet top location. The results show that the helmet top impact location is fascinating more impact energy than the helmet side location and helmet back location for impact energy of 5.6 Joule. Additional, force reduction factor for helmet top location is also much higher than the other two impact location for 5.6 Joule impact. Energy fascination results and the force attenuation results show that the helmet top location has better properties as compared to the helmet side and helmet back location against impact energy of 5.6 Joules.

VI. CONCLUSIONS

In this paper a detailed procedure for industrial a test rig for helmet testing has been designated. Successful manufacturing of a test rig provides sufficient competence for the impact testing of the developed uninterruptedly reinforced helmets. Furthermore, a procedure for conducting impact testing using IDAS and LIVMS instantaneously has been established. With the developed test rig helmet, impact testing can be carried out on the side, back and top locations of the helmets. Preliminary impact testing on the developed test rig results shows that for an impact having impact energy of 5.6 joules the helmet shells behaves better impact belongings at the top helmet shell location. Riot helmets have double curving surfaces. Due to appropriate abilities of testing helmets at dissimilar impact position with the developed test rig, force blocking effectiveness at diverse helmet locations can be calculated and the behavior of the communicated force at altered impact locations can be understood. Furthermore, energy absorption at different impact location can also be studied.

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