ABSTRACT

No artificial limb can replace what is lost. However, intensive rehabilitation and appropriate prosthetic provision will enhance the ability of injured individuals to pursue athletic activities once again. The aim of this work is to design and manufacture an Athletic Prosthetic Foot (APF) that can perform at the level of professional athletes. These objectives have been achieved experimentally and numerically. The experimental work was achieved by selecting the material to be used in manufacturing the APF , glass fiber and carbon fiber with the use of three different types of epoxies,QuickMast-105, Unsaturated polyester and Epolam-2017. In order to test the suitability of the manufactured samples of the APF, three testers were designed and manufactured for the first time in Iraq, the fatigue foot tester, impact foot tester and static load-deflection tester.

Each sample must pass some tests: force-deflection test to calculate the stiffness, dorsiflexion angle, stored and returned energy and the efficiency of the foot to store energy that found to be 96% for the sample using glass / Epolam-2017 and 95% for the sample of carbon / Epolam-2017.

Impact test simulates the response of the foot during running and calculating the peak force. Fatigue test describes the life time of the foot that exposed to a cyclic load which is three times the body weight to simulate the load during sprint. The life of the sample using glass fiber with Epolam-2017 was about 4×10^5 cycles.

NI (National Instruments) DAQ system was used for the interfacing the sensors, load cells … etc., with the PC and all the data were collected via LabVIEW (Laboratory Virtual Instrument Engineering Work bench).

The high cost of the commercially available (APF), about $22500, restricts importing these types of feet to Iraq. In present work, these feet were designed, manufactured and tested locally with a total cost of about 10-15% with respect to the commercial type. The final foot sample was made from carbon fiber with Epolam-2017 epoxy.

To get the best result, the amputee must be prepared and well-trained. In this work, a multi-disciplinary team have assisted amputees to be success. The basic team involves the doctor/orthopedic surgeon, physiotherapist, prosthetist, and psychologist.

Electromyography (EMG) is performed using an instrument called electromyograph to produce a record called electromyogram that detects the electrical potential generated by muscle cells, when these cells are electrically or neurologically activated. In present work, volunteer that have one amputated limb, the electrmyographic activities of the rectus fermoris and semitendinosus of the intact and amputated limbs were achieved, and the results were compared between the two limbs.

In numerical method, the finite element was used by employing ANSYS 14.5 package to simulate the layup of the fibers ply and draw the final structure of the foot to specify the stress distribution, Y-displacement; Von Mises stress and shear elastic strain in different loads.

Finally, the new prosthetic foot was compared with the one by Össur by tracking selected points during running on treadmill on the two feet and drawing the paths of these points, which seem to be identical.