THE FINITE-ELEMENT MODELLING OF COMPRESSION SPORTSWEAR

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ABSTRACT

Compression clothing (CO) for sports purpose is widely used as a way to stimulate blood flow, maintain the main muscles of the human body [1-3], accelerate the restoration of their efficiency, and the reduction of traumatic risk of ligaments and joints [4]. The advantage of compression clothing is a significant impact on the physical, physiological and psychological state of a person [5-6], which predetermines the relevance of its usage in sports activities.

Among the most topical and perspective methods of compressional pressure studying is mathematical modelling of the effects of compressional pressure on an athlete's body with the use of finite element analysis (FEA) [7–8]. The finite element method is based on the division (decomposition) of the investigated object into a grid consisting of small sections - finite elements. Elements can have both a flat geometric (triangle, parallelogram), and three-dimensional shape (tetrahedron, cube, parallelepiped).

In the nodes of the formed grid, the whole range of necessary conditions is set: the properties of the material of the stress-deformable body (most often is set for the whole object), the operational forces (gravitational acceleration, pressure, various loads and fixings), as well as boundary conditions, after which the numerical solution is performed in a variational formulation or in the form of a system of partial differential equations. As a result of the simulation of the physical process in the "athlete-clothes-environment" environment, we obtained the values of the soft tissues of the body deformations under the influence of compression clothing, as well as the mechanical stress caused by the product.

It should be mentioned that this method allows to explore the effect of the pressure on the athlete's body not only in a static position but also in a dynamic one. Thus, the results of FEA allow to obtain an additional set of data about the actual effect of compression clothing on the athlete's body.

Thus, the goal of the work is to conduct a study of the effect of compression pressure on the athlete's body by means of FEA to develop optimal structural and technological solutions of CO.

For this purpose, we should solve the following tasks:

- to conduct a three-dimensional scan of the figures of the athletes;
- to develop a database of deformation characteristics of human soft tissues and textile materials;
- to investigate the pressure of CO on the athlete's body in static and dynamic conditions to obtain boundary conditions;
- to develop a mathematical model of FEA;
- to investigate the change in thermal balance in the space under the clothes in a static and dynamic state;
- to calculate and simulate the obtained model in the ANSYS environment;
- to develop recommendations for the development of optimal-constructive CO solutions.

References

[1] Tyurin, I.N., Getmantseva, V.V. & Andreeva, E.G. Fibre Chem (2018). https://doi.org/10.1007/s10692-018-9918-y

[2] Tyurin I.N., Getmantseva V.V. The analysis of the features of the constructive solution of sportswear. In the collection of materials of the international scientific and technical conference: Design, technology and innovation in the textile and light industry (Innovations 2016). 2016. p. 242-245.

[3] Born D.-P., Sperlich B., Holmberg H.-C. Bringing Light into the Dark: Effects of Compression Clothing on Performance and Recovery// International Journal of Sports Physiology and Performance.- 2013, Vol.8, Is.1.- P.4-18.

[4] Tyurin I.N., Getmantseva V.V., Andreeva E.G., Belgorodskiy V.S. Research of design features of compression sportswear In Proceedings of AUTEX 2018 conference proceedings. 2018. C. 1019-1022.

[5] Tyurin I.N., Getmantseva V.V., Andreeva E.G. Application of QFD method for determining performance properties of tight-fitting and compression sportswear In Proceedings of AUTEX 2018 conference proceedings. 2018. C. 1041-1044.

[6] Driller M.W., Halson S.L. The Effects of Wearing Lower Body Compression Garments During a Cycling Performance Test International Journal of Sports Physiology and Performance.- 2013, Vol.8, Is.3.- P.300-306.

[7] McRae B.A., Cotter J.D., Laing R.M. Compression Garments and Exercise: Garment Considerations, Physiology and Performance Sports Medicine. - 2011, Vol.41, No.10.- P.815-843.

[8] Kuzmichev V.E., Tislenko I.V., Adolphe D.C. Virtual design of knitted compression garments based on bodyscanning technology and the three-dimensional-to-two-dimensional approach Textile Research Journal. 2018.