COMPUTATIONAL MECHANICS 2019
35th conference with international participation
Srní
November 4 - 6, 2019

Utilization of virtual human body model Virthuman in the mountaineering safety

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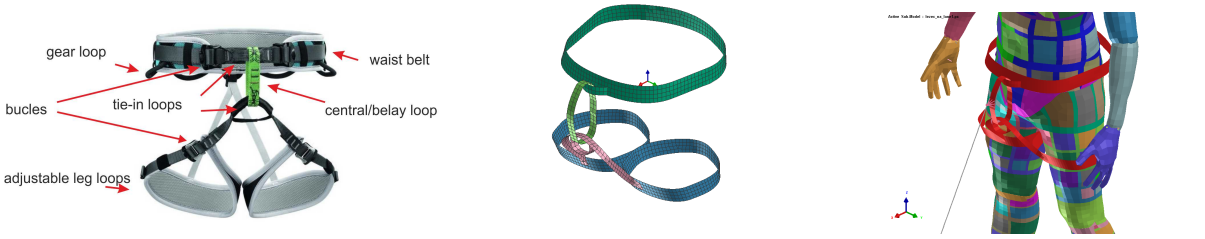
1. Introduction

Human safety and security are currently main topics of the research in many fields. The primarily area is an automotive safety, followed by other way of transport industry (trains, trams, aircraft etc). Currently, there is a big effort of the human safety in the sports, mainly in contact sports. There is a massive investment in the american football research, since there is a high risk of the injury and there is a very strong economical background beyond this sport. However, the biomechanical research focused on human safety starts to play a role in more and more different kind of sports (ice hockey, cycling, martial arts, etc.).

This work is a preliminary research of a student's project utilizing a very new field of the safety focused on the rock climber/mountaineers. Nowadays, the rock climbing become very popular between the people of all ages, especially in Europe. The number of climbers, the number of new climbing routes as well as number of climbing gyms dramatically increased in last few years. Moreover, the professional climbers are still pushing the limits of human skills further and further. Such effort is followed by higher number of falls. However, the numbers of athletes death because of the fall is very low, the loading which human body have to sustained is significant. The climbing gear is still enhancing, to be more safe but also to be more user friendly. In this case, to be light enough to minimize the disturbance of the athlete. The climbing rope become thinner (from 20 mm in the past, to 8 mm nowadays) with even better dynamics behavior. Similarly the harness, slings and so on dramatically decrease their diameter and mass. Decreasing of the mass results in the lower lifetime of the gear and it can lead up to decreasing of the comfort or even the safety of the athletes.

Purpose of this work is to use Virthuman (validated human body model successfully used in the traffic safety purposes [3, 6, 7, 8]) and utilized it in the rock climbing fall scenario. The main aim is to understand the mechanism of the fall, to build an appropriate numerical model of the climbing harness and the rope and to simulate the athlete fall in the rope-harness protection chain. The model developed here can be further used as a tool to predict the loading of the human body (mainly the head, neck, abdomen and the spine) and can be used in the development of the new protection gear. There are several published papers focused on the climbing fall [4, 5] or modeling of the rope, harness and belaying devices [1, 2]. However, the evaluation of the athlete's injury risk and level of the dynamic loading of the body has not been accessed.

This work firstly deals with the modeling of the harness and the rope and together with the model of the athlete prepare some falling configurations in order to understand the mechanism



(a) Rock climber harness (b) FEM model of the harness (c) Virthuman with the harness

Fig. 1. Climbing harness and its FEM model

of all fall stages and to understand how to body reacts with the harness. Fig. 1a, 1b and 1c show the climbing harness, model of the harness and athlete (Virthuman) wearing the harness, respectively.

2. Results and future work

Since this is an ongoing student's project, the authors present only a preliminary results, consisting basic athlete's fall into the harness-rope. Free fall of the athlete into the protection devices (harness and rope) from the initial height and laterally shifted, are used for testing robustness and capability of the model in such scenarios. The material models used here are standard materials used in car seat belt (flat slings and rope). Due to the lack of the material data and experimental tests, the further work includes also material testing and material model fitting.

Acknowledgement

The result was financially supported with internal research project of University of West Bohemia SGS-2019-002: Computer modelling and monitoring of human body used for medicine.

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