THE TOW-SKIER-SYSTEM-ANALYSIS

Andrij Lavytskyj, Ihor Zanevskyy,
Lvivsky Derzhavny Instytut Fizychnoyi Kultury, Lviv, Russia

KEY WORDS: skier, ski lift, towing, modeling, accelerometry

INTRODUCTION: The towing of skiers along the route of the surface ski lift is a complicated and crucial process. It is complicated, because the skier and tow together represent a distinctive man-machine system with special processes: physical and mechanical, physiological, biomechanical, etc. It is a crucial process, because the surface ski lift is objectively a potentially dangerous object for a skier. Falling on the ski lift route, unsuccessful starts and finishes are potentially trauma-dangerous phenomena. An aim of the studies was to determine comfort and safety criteria for the towing process of skiers by a surface ski lift.

METHODS: The investigation included the mechanical and mathematical modeling of the skier and towing device interaction, biomechanical analysis and accelerometry of the skier's movements, statistical processing of the experimental data. The anatomy and biomechanical studies of a skier on a ski lift route were carried out taking into account special features of the system 'tow-man-track'; the model assumptions have been substantiated. The geometry and inertial characterization of a skier’s body links were considered within the framework of the five-link approach. The six-channel accelerometry system has been developed to study the biomechanical parameters of a skier’s movements on a ski lift route.

RESULTS: On the ski lift's route the skier's body interacts with the track and through the tow - with the towing device. This results in vibrational and impact loadings. In particular, when starting to move, the skier is subjected to the jerk from the towing bar; its intensity depends both on the skier's experience and on the design and operation state of the ski lift. It has been established experimentally that the amplitude values of the common mass center when sitting on a tow are within the limits 1.9-3.3 m/s2. The top limit of this range is over the permissible value for comfortable transportation. Statistical analysis using the methods and techniques of the hypothesis theory enables us to demonstrate conclusively ($a = 0.05$) the efficiency of the polyspast towing device developed by the 'Horizont AL' firm, Lviv. This device allows one to reduce start accelerations by 1.7-1.8 times.

CONCLUSIONS: The analysis of accelerograms enables us to reveal two kinds of mechanical effects on a skier during towing by a ski lift. The first are vibrations not threatening to the skier's health and general state as judged by accepted standards. The second effects are the impulse inertial influences which should be taken into account when designing towing devices and setting acceptable towing velocities.