6.5. Technology and Equipment

6900 Th, 16:00-16:15 (P45)

Effects of ski and snow properties on the turning of Alpine skis – a computer simulation

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Geometry, bending and torsional stiffness, and damping are the main ski properties that affect carving and skidding of the ski. The aim of this paper was to present the effects of ski geometry, bending and torsional stiffness as well as snow conditions on the turn radius and the pressure distribution along the running surface of a ski using a validated computer simulation model.
The skier was replaced by a sledge on two skis. The sledge and the skis were modeled in the multi-body system software LMS Virtual.Lab. Flexural and torsional properties of the skis were implemented by dividing the ski into 19 rigid segments connected by revolute joints. Stiffness and damping constants of the joints were adjusted by measurements of real skis. The penetration force of the ski in the snow was modeled using a hypoplastic constitutive equation. For the shearing force a limiting value based on snow measurements was introduced. Ski and snow properties as well as the edging angle were varied in the simulation.
The results showed that small turn radii were achieved when large bending deformation of the skis and little amount of skidding occurred. Especially large side cuts and/or large edging angles caused high ski bending and thus small turn radii. The pressure distribution along the running surface was shifted from the center of the skis to the shovel and the tail of the skis by increasing side cut, bending stiffness and edging angle. Shearing was observed primarily in the frontal half of the skis. Overall the simulation shows that the effects of ski properties on turning depend strongly on snow conditions, edging angle and loading of the ski. Loading and edging angle are mainly influenced by the kind of skiing.

6349 Th, 16:15-16:30 (P45)

Kinetics of the skateboarding kick flip

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We aimed to construct a kick flip simulator using biomechanical information that mimics a common jumping maneuver used by skateboarders to hop onto, off of, and over obstacles. Seven male amateur skateboarders (mass = 75.1±11.4 kg) performed kick flips from a standing position on a large force plate. Vertical ground reaction force data were measured using an AMTI force plate, while RSscan pressure insoles in both shoes measured the distribution of the forces under the plantar surface of each foot. Three Halm piezoceramic transducers were also used to measure the local pressures between foot and shoe in the toe area. Sensors were place on the dorsal surface of the 3ʳ4 and 5th distal phalanges and the lateral aspect of the 5th metatarsal. High speed digital video was used to aid in the analysis of these rapid movements. Peak vertical ground reaction forces were found to be 2.05±0.17 bodyweights (BW's) at takeoff and 4.61±1.19 BW's during landings due to the intentional spike landings the subjects induced to stabilize themselves on top of their skateboards. In-shoe plantar pressure data revealed that most of the force occurred across the hallux and the first through fifth metatarsal heads at the time of takeoff and landing. Pressure across the 3ʳ4 phalange, 5th phalange, and 5th metatarsal head was found to be 147±80 kPa, 190±107 kPa, and 138±51 kPa respectively during the duration of the flicking motion of the shoe on the skateboard. The duration of the flicking movement was found to be approximately 140 ms. Using these data a kick flip simulator was constructed to closely match the biomechanics of real life skateboarding kick flips.

5099 Th, 16:30-16:45 (P45)

Soccer ball trajectory simulation

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As the performance of athletes and their equipment is pushed to new limits, the importance of understanding the behaviour of sports balls is becoming increasingly apparent. Athletes may try to maximise the distance travelled by a ball (e.g. golf, rugby) or unexpectedly swerve a ball to deceive the opposition (e.g. soccer, cricket, baseball). Equipment manufacturers can help to achieve this through improved understanding of their products.
In this study, computational simulation techniques have been used to investigate the aerodynamics of soccer balls. A tool has been developed to simulate the flight of free-kicks taken with various different balls, to predict the likely success of a particular kicking strategy. This involves using Computational Fluid Dynamics (CFD) to calculate the aerodynamic properties of each ball and then using this data along with details of the kick to predict the path of the ball. The tool has been used to examine the effects of different ball manufacturing techniques, such as thermal bonding, and different surface finishes, such as embossed patterns. The effects of different kicking techniques, such as different foot impact location and foot speed, have also been examined.
Various soccer balls from a number of different manufacturers were scanned using a 3D laser scanner, and the airflow around them at game-relevant velocities was simulated using the CFD software, Fluent v6.2. The drag and lift coefficients were obtained at a number of different velocities. The launch conditions were measured by recording different types of kicks with a high speed video camera. This data can be entered into the prediction programme to simulate the flight of the ball.
The prediction tool allows the user to enter the kick type, initial velocity, ball type and starting position, and simulates the resulting path of the ball. There is potential to use this as a training tool and for interactive TV, and to combine it with details of a particular player's kicking technique.

7715 Th, 16:45-17:00 (P45)

Decoupling of the tennis racket frame decreases grip vibrations

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Introduction: Lateral epicondylitis or tennis elbow is often associated with vibrations initiated by the racket (Hach and Renstroem 2001). To decrease the risk to develop lateral epicondylitis racket design is focussed on damping the vibration of the grip and consequently the vibration transmitted to the player's arm. The purpose of this study was to investigate the effect of a damping element (DE) in a racket on the transition of vibrations from the frame (FR) to the grip (GR).
Materials and Methods: To quantify the vibrations at the different locations (FR, GR) and the effect of the DE, two accelerometers (3000 Hz) were fixed on FR and GR. Six male and six female players returned a ball shot from tennis ball cannon. Speed of the ball and the point of ball-racket contact were optically controlled. Ten valid repetitions for each of four conditions were performed: (1) TR (test racket with DE), (2) R1 and R2 (two conventional rackets without DE) and (3) MR (modified test racket with stiffened DE). Mean power frequency (MPF) and the normalised (to FR acceleration) maximum acceleration of GR were quantified. An ANOVA was performed to identify differences between the racket conditions.
Results: Maximum acceleration at FR up to 90 g was recorded. The ANOVA shows at GR significant ($p < 0.001$) lower MPF and normalized acceleration values between TR (79.4 Hz, 0.81) and the three remaining rackets (93.4–99.7 Hz, 0.88–0.92). The DE provides the capacity to dampen the vibrations caused by the ball-racket collision regarding MPF and peak acceleration at GR.
Discussion: The DE is an effective design element to dampen racket vibration. It provides the pre-requisite for injury prevention due to a significant reduction of MPF and peak acceleration at GR. However, the transition of vibrations from GR to the wrist and along the forearm is not yet well understood.

References

Hach, T., Renstroem, P. (2001). Tennis elbow – insertional tendinopathy of the elbow. Deutsche Zeitschrift fuer Sportmedizin, 52: 154–161.

6562 Th, 17:00-17:15 (P45)

Functionality of playing surfaces

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The biomechanical study of sports playing surfaces has generally focussed on running. To increase our understanding of the functionality of playing surfaces, it is necessary to additionally consider the influence of the surface on participants' ability to safely perform typical sports movements such as accelerating, stopping and turning. This presentation describes the ongoing biomechanical study of both synthetic and natural sports surfaces within a laboratory environment, with the inclusion of movements such as running, accelerating, stopping and turning. The aim of the work is to identify effects of playing surface characteristics on the ability of participants to successfully perform typical sports movements. A series of studies have been performed where groups of subjects have executed sports movements under controlled laboratory conditions. Data collected have included ground reaction force, in-shoe pressure and lower limb kinematics. A particularly novel aspect of the work is the inclusion of natural turf surfaces, which have rarely been studied biomechanically. This has allowed the comparison of biomechanical data for varying natural turf conditions, and comparison with typical data collected on synthetic surfaces. The general pattern of force application has been found to be comparable for different surface conditions, with the highest vertical forces occurring in running and the highest horizontal forces during the braking