Design and Application of a Portable Launching Catapult for Crash Test Simulations

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INTRODUCTION. In speed disciplines performed in natural ambient such as downhill skiing, racing and downhill cycling, safety of athletes is related to the possibility of correct design of the course trajectory and competition artifacts (i.e. jumps & walls in cycling) as well as to the correct installation of safety barriers when dangerous elements cannot be removed from the course background (rocks, trees, drops). Not only the intrinsic properties of structures and barriers but also their installation determine the real behaviour of such elements in the field [1]. Crash/functional in-situ evaluation of crashworthiness or correct dynamic design of such structures gives to course safety managers and athletes a final tool for the engineering assessment of such installations [2].

METHODS. A launching catapult for bicycle and skiing crash test simulations was designed following given requirements of portability and energy release. The system was designed to accelerate an instrumented Hybrid III 50th male dummy and a 25 kg downhill bicycle up to an exit speed of 50 km/h in a total wooden base length of 4.0 m. In principle, two main guide beams (5.6 m) sustain a carriage (15kg) that can be accelerated by a set of 4 elastic bands (L=1m, K=210 N/m each) each side: the bicycle/dummy assembly is guided at the floor, pulled at the handlebars and pushed at the dummy back by the carriage. The catapult can be preloaded by a wrench and released by a remote mechanical trigger: the carriage is stopped by two car shock absorbers. The catapult was used to test downhill bicycle jumps with different take off angle (-4°, 0°, +4°) of the jump board and recording landing events.

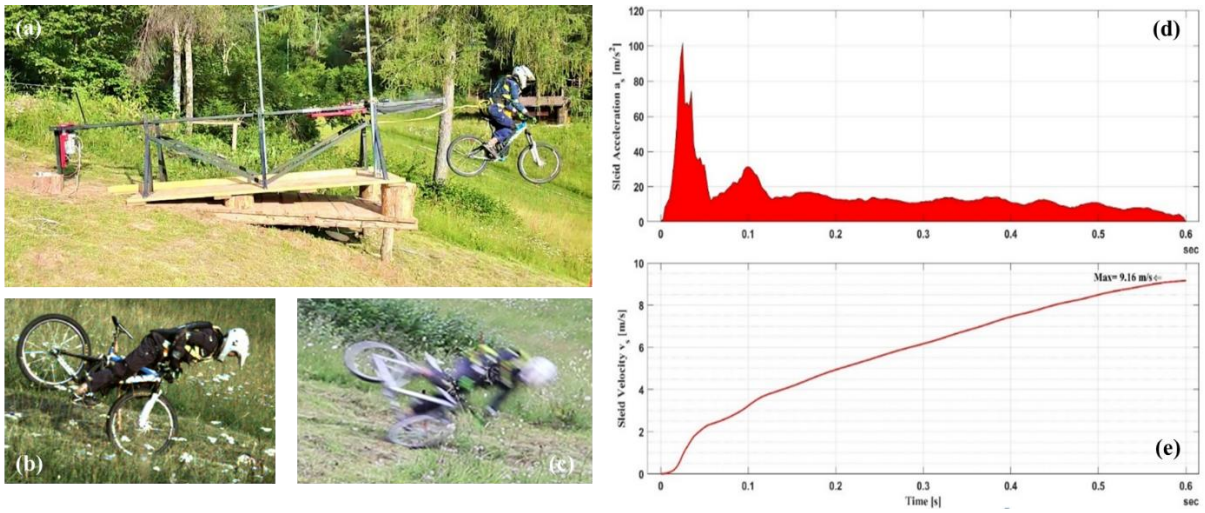

Figure 1. *(a) Side view of catapult installation at bike jumps; (b,c) dummy landing photograms of two tests; (d,e) take off acceleration and speed curves of the HIII dummy chest in the catapult, with 3 elastic bands per side.*

RESULTS. The catapult allowed to successfully launch the dummy/bike up to 48km/h for a total number of 14 jumps. Speed can be modulated by the number of elastic bands. Dummy/bike stabilities were satisfactory and improvement were made to prevent hand/handlebar release or dummy backflips due to the high accelerations (max 11g). Crash impacts on the downhill slope allowed recording Peak Head Resultant accelerations up to 375 g.

DISCUSSION AND CONCLUSIONS. The catapult is being adapted to other sports such as ski barriers testing by lowering of the guide beams, introducing low friction guide for the skis, and adapting the carriage to a skiing posture. It will be used against A-nets, B-nets and Mattresses along a racecourse after installation on the snow.

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