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The effect of elastic compensation arms on the field and laboratory behavior of alpine skis

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Abstract

An elastic compensation arm hinged at the binding plate and preloaded via a screw was applied to the ski shovel: its effect was to redistribute the pressure applied by the skier on the shovel and to allow the full contact of the edges on the snow during a turn. This enhanced the edge pressure profile at the shovel tip as revealed during bench tests in the lab, thus improving the handling during the turn phase as perceived in the field by expert testers.
Results of the study showed that it is possible to modify the edge pressure profile of a ski by means of the application of elastic compensation arms of suitable stiffness, preload and length. The improvement in the field performance is correlated with the specific engineering parameters that can be evaluated in a laboratory setup.

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Keywords: ski, edge load profile, compensation arm, subjective evaluation

1. Introduction

The performance of modern skis is more and more related to the correct comprehension of the ski/snow interface behaviour, the effect of binding/plates/boots on the ski structural behaviour, the biomechanics of the skier, in the different types of skiing disciplines and environments [1-3]. Competition among manufacturers is not only based on marketing strategies but still involves the introduction of engineering or technological innovations that can enhance

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the properties of a product, create a new product segment or produce hybrid products that can bridge between different market segments by the introduction of superstructures or the tuning of adjustable components.

The use of elastic super-structures applied to the ski is not new, and almost all main manufacturers developed such solutions in the past or in their recent developments. On the other hand, among other properties, the Edge Load Profile of a carved ski on a flat surface has been studied extensively both by experimental, numerical or combined analysis [5-6]. This curves, at different edge angles, have been recognized as one of the engineering characteristics that can identify the ski properties: so far, the direct effect of an elastic super-structure on the edge load profile of a ski has not be presented, together with the quantification of the internal loads supported by the super-structure during skiing.

The description of the concept, the development and the field and bench evaluation of such a super-structure, covered by International Patents, is the aim of this work.

2. Methods

2.1. Elastic Compensator Arm and skis used

An Elastic Compensation Arm (ECA), as depicted in Figure 1, was applied to the ski shovel in order to enhance the edge pressure profile at the shovel tip. Its intended effect was to improve the edge catching and ski conduction during the turn phase: its function was to redistribute the load applied by the skier on the ski in order to produce a more intense pressure distribution to the shovel, to allow the full contact of the edges on the snow and to raise the anterior peak pressure (Patents EP 1641541 and US 7559571). It is composed by a cantilever arm (11) able to transfer the load to the shovel, hinged at (12) to an aluminium frame (15) to be fixed to the ski plates and preloaded by an adjustable screw (14). The tip of the arm can slide into a low friction slider (6) to transmit flexural and torsional loads (Figure 1).

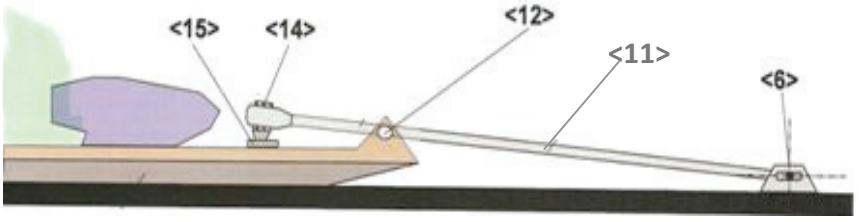

Fig. 1. The compensation arm concept and components. <11> arm, <12> hinge, <15> aluminium plate, <14> adjustable preload screw, <6> slider at the arm tip.

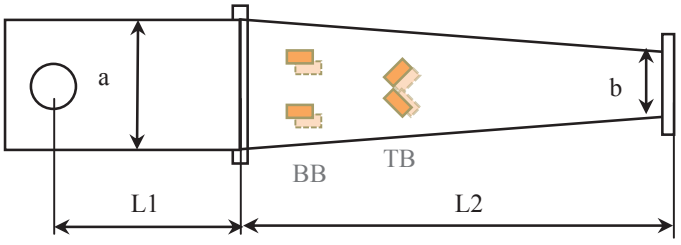

Fig. 2. Sketch of the compensation arm, with parametric dimensions and disposition of bending (BB) and torsion (TB) strain gauge bridges.

The effect of the arm length, thickness and number of preload rotation of the screw on the Edge Load Profile had been prior investigated by means of several laboratory tests [7], while keeping consistent the plate material. As a result, two versions of the elastic compensation arm were here examined: the difference among the two was only in the length of the portion connecting the hinge to the slider. Their effect on the shovel was different due to two reasons: the point of action of the slider (point <6> in Figure 1) and the resulting stiffness of the arm.