Developing an Innovative System for Skates

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Abstract: - In time, there were developed various systems enabling mounting on the same boot, of both rollers and blades. This paper presents an orientation and fastening innovative system that enables roller skates and ice skates to be easily and safely in use. Design, modelling and simulation of the component elements, as well as of their loadings and strain states are essential in an appropiate and correct system's developing.

Key-words:- innovative system, modelling, simulation, roller skates, ice skates.

1. Introduction

Roller skating is a form of recreation as well as a sport, and can also be a form of transportation. Skates generally come in two basic varieties: quad roller skates and inline skates or blades, though some have experimented with a single-wheeled "quintessence skate" [2].

First recorded use of roller skates, in a London stage performance was in 1743, the inventor of this skate being „lost" to history - see figure 1 [3]. First patented roller skate design, was in 1819, in France by M. Petitbled. These early skates were similar to today's inline skates, but they were not very maneuverable. It was very difficult to do anything but move in a straight line and perhaps make wide sweeping turns.

In 1876 William Brown in Birmingham, England patented a design for the wheels of roller skates. Brown's design embodied his effort to keep the two bearing surfaces of an axle, fixed and moving, apart. Bown worked closely with Joseph Henry Hughes, who drew up the patent for a ball or roller bearing race for bicycle and carriage wheels in 1877. Hughes' patent included all the elements of an adjustable system. These two men are thus responsible for modern day roller skate and skateboard wheels, as well as the ball bearing race inclusion in velocipedes - later to become motorbikes and automobiles [2].

Ice skating is moving on ice by using ice skates. Ice skating occurs both on specially prepared indoor and outdoor tracks, as well as on naturally occurring bodies of frozen water such as lakes and rivers.

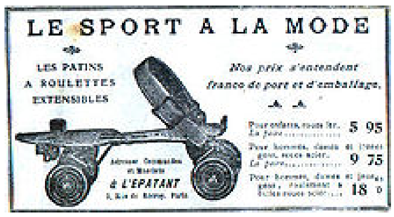


Fig. 1. Rollers skates advertising [3]

A study by Federico Formenti (Oxford University) suggests that the earliest ice skating happened in Finland about 4,000 years ago. Originally, skates were merely sharpened, flattened bone strapped to the bottom of the foot. Adding edges to ice skates was invented by the Dutch in the 14th century [3, 4].. There where many attempts to improve the basic rollers design, even attempting to design a system that allow a mounting on the same boot of both rolls and skates. Some of the approved patents are presented below – see figure 2 and figure 3.

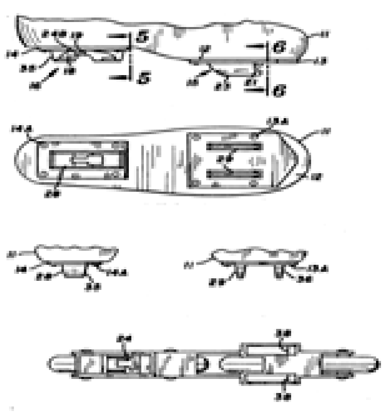


Fig. 2. Skates patent 1 [4]

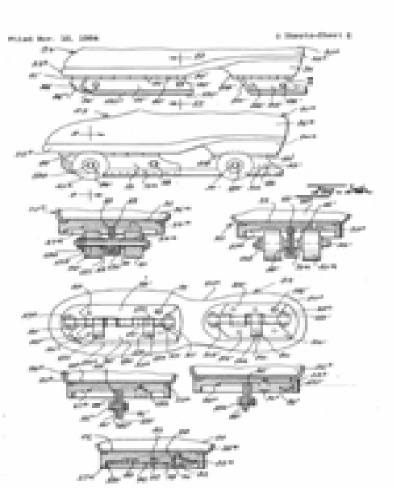


Fig. 3. Skates patent 2 [4]

In figure 2 there is presented a joint system with jaws and a fixation screw, which allows the user to attach on the same boot both rolls and skates. Figure 3 there shows a 1966 patent for converting ice skates into rollers skate, the rollers being attacehd directly on the blade.

2. Proposed innovative system

2.1 Modeling System

After the analysis of patents and market offers [1, 8, 5, 7], we found that there were many user's complaints, some of them being:

- the high weight, that reduces the speed;
- the low precision of blade and rollers orientation;
- the difficulty of joints between the boot and the running system.
- the long time of transformation from ice skates to roller skates.

The new proposed system was designed with Autodesk Inventor 2010 software - see figures 4, 5 and 6. It can be noticed the possibility to attach on the same boot both rolls and skates.

Fig. 4. Innovative system – for roller skates

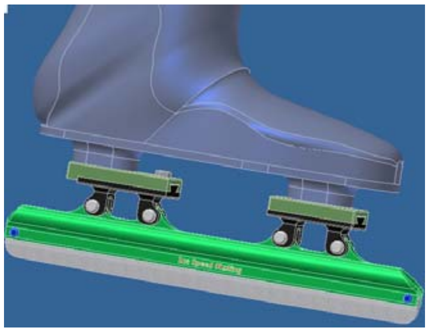
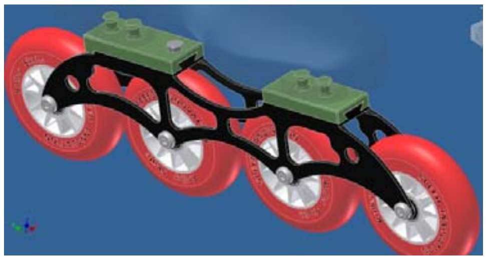


Fig. 5. Innovative system – for ice skates



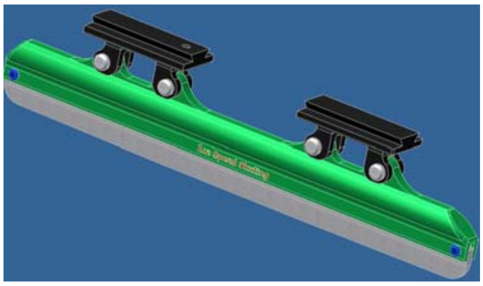


Fig. 5. The innovative joint system

It can be observed – in figure 7 - the dovetail guidance (3-guide, 5-rail), the bollard (2), the fastening system screw (4) and nut (6) type.

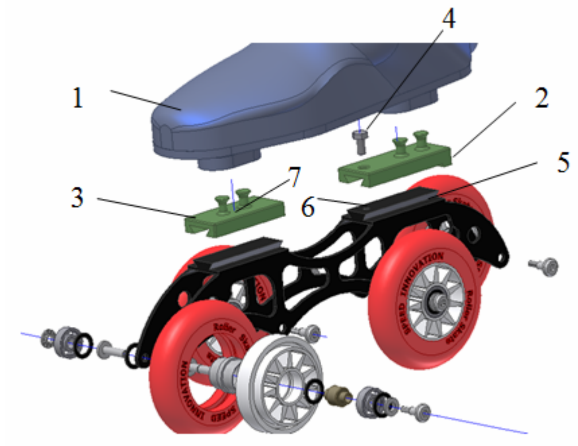


Fig. 7. Innovative system's components

The transition from rollers to ice skates can be made by unscrewing, detaching rollers assembly from the guide(3), assembling the blade and ensure fixation by screwing(4).

The rollers assembly (5) and the guidance system are made of mechanical shock resistance aluminum alloys, with „the sum" Zn+Mg+Cu > 10%.

The joint between the boot and the mounting support it's made with taper head pins (7). While jointing, the mounting supports are positioned and oriented with the aid of a special device to keep them in the same plane.

2.2 Design and simulation of the new system

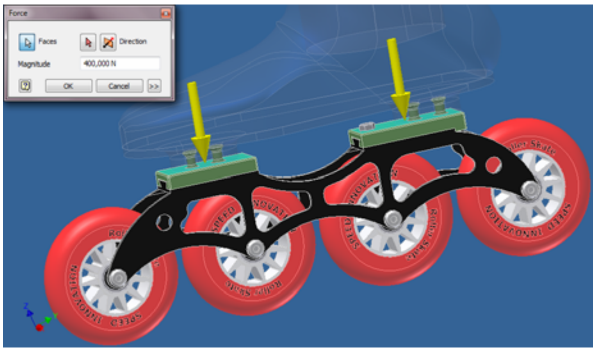
In order to complete the system's components design, simulation of different loading types, was carried out with *Autodesk Inventor 2010* software. There have been considered situations occurring while using the skates and, thus both stress and strain states were generated.

The simulations were made for a 80 kg weight person, and the analyzed cases refer to: *steady position*, *starting the motion*, in *motion* (rolling/sliding) and *braking*.

A. Roller skates

◙ *Steady position* – rollers' support compression analysis

The results are presented in figure 8, and it can be observed that the strain in the most affected areas is an elastic one, about 0.0014 mm (very low).



- rollers' support compression simulation -

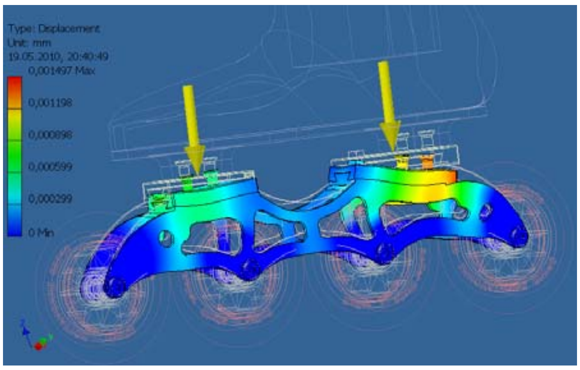
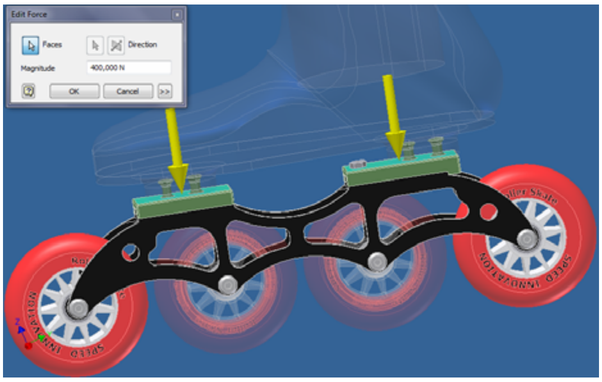


Fig. 8. Generated strain simulation

→ *Roller support and spokes* compressing analysis, for a structure using two rollers (because of available software. restriction) – see figure 9.

It can be noticed that the most maximum strain value is about 0.05 mm. Thus, it is estimates that for a four rollers structure, the strain will be even lower.



- two rolls structure's compression simulation -

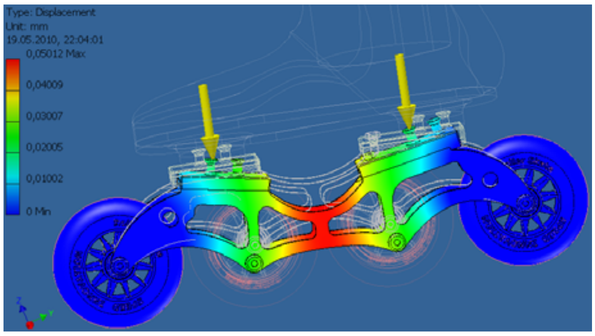
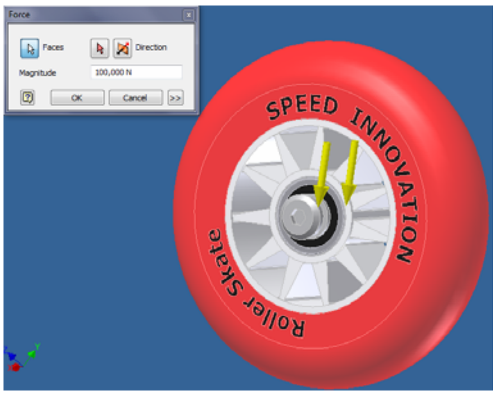


Fig. 9. Generated strain simulation

→ *Roller strain* analysis – see figure 10.

The hypotheses were that: the force was acting on the two screws and the silicone section was fixed.

It can be seen that highest spokes deformation is of 0.0013 mm. So, it can resist to the their loading stresses.



- roller's loading simulation -

Fig. 10. Spokes displacement simulation

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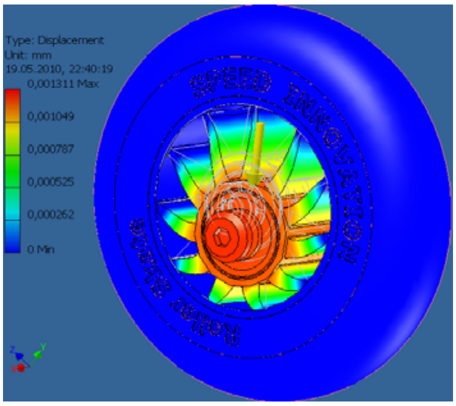


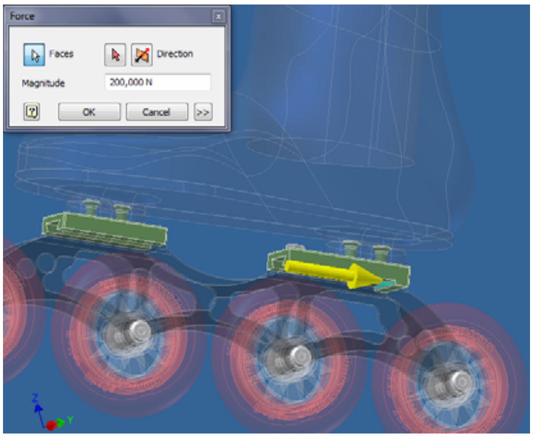
Fig. 10. Spokes' displacement simulation - continuing

◙ *Starting the motion* - see figure 11

When studying the bollard, the guide (3) is fixed on the boot (1) through the taper head pins and the rollers assembly is acting on it with F force – see figure 11.

It is noticed the very low the displacement's value.

◙ *When rolling (in motion)* - see figure 12, there can be noticed the same low deformation values.



-. bollard's behaviour simulation –

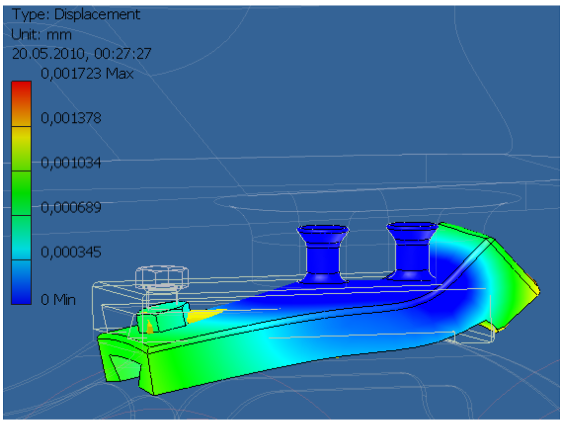
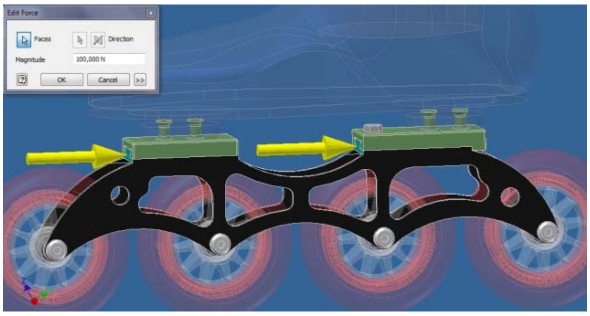


Fig. 11. Generated displacement simulation



- in motion behaviour simulatrion -

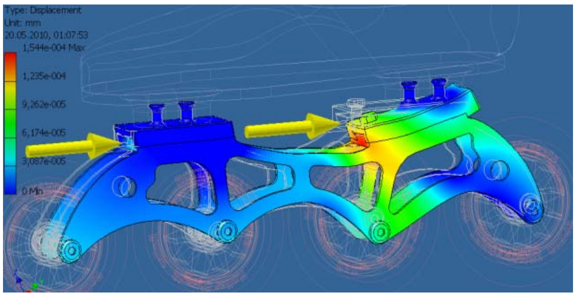
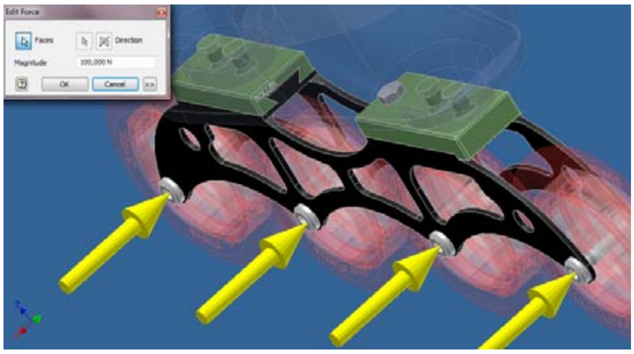


Fig. 12. Generated strain simulation

◙ *Braking*

Roller assembly and roller's behaviour while braking, perpendicular to the direction of advance have been simulated - see figure 13 and 14. There are noticed the very low strain values.

The two green guide supports are attached to the boot by bolts, and the friction force that appears during the brake is acting on the side.



- rollers assembly behaviour while braking -

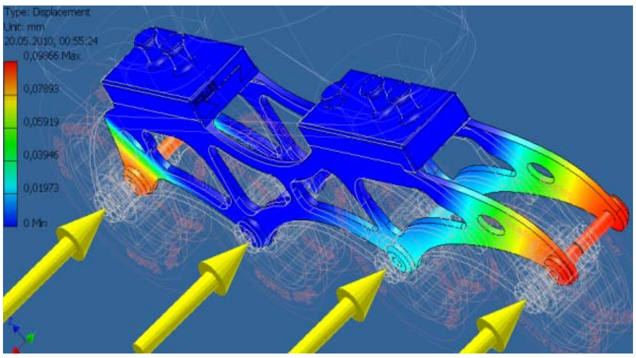


Fig. 13. Generated displacement simulation

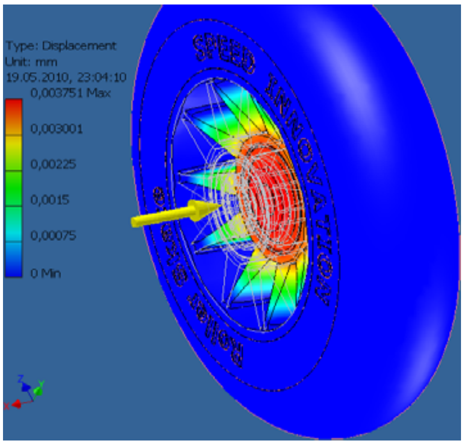
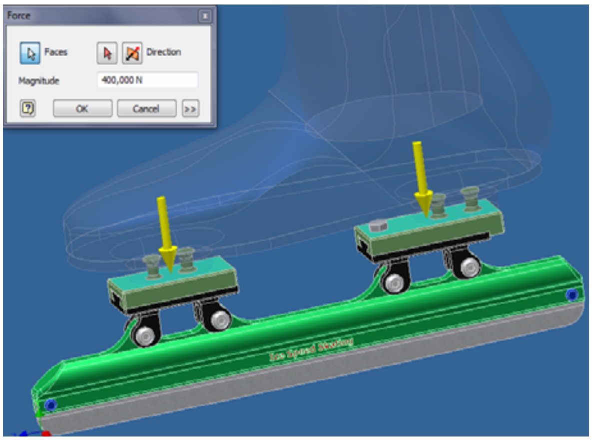


Fig. 14. Generated strain simulation - of spokes

B. Ice skates

◙ *Steady position* - there has been simulated a compression test for blade, when loading with two forces F = 400 N (equivalent to 80 kg weight person loading) – see figure 15..

Same low values of deformation can be noticed.



- ice skate ompression analysis -

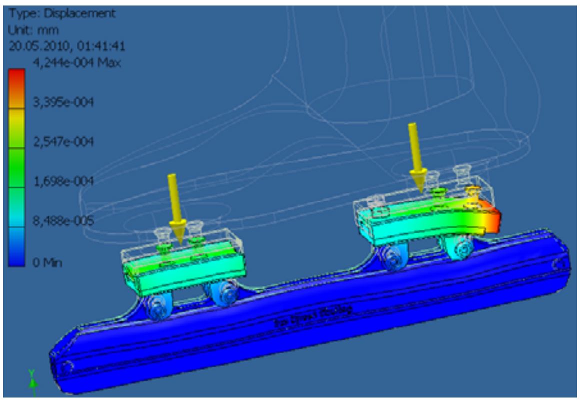
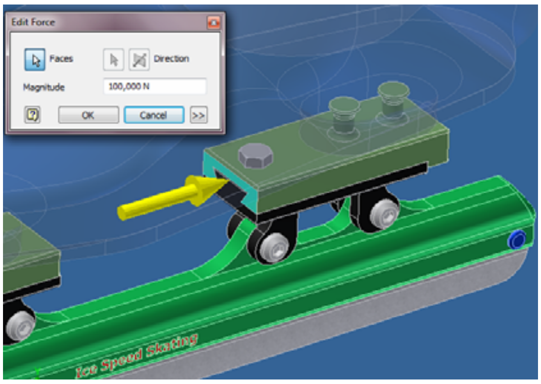


Fig. 15. Generated displacement simulation



- ice blade behaviour when motion starts -

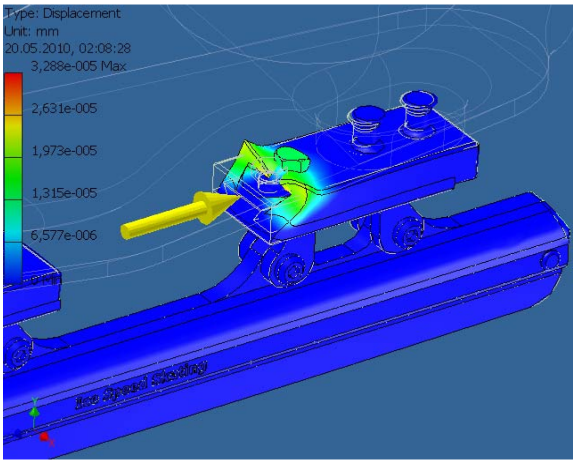
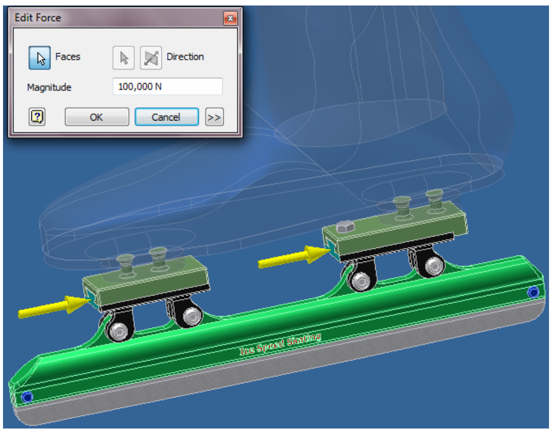


Fig. 16 Generated strain simulation

◙ *Starting the motion* - there has been checked the screw shear state (the black guide is fixed, the green one is pushed by the N force) – see figure 16..

It can be noticed that the screw “stands” for the loading, without failing.

◙ *When skating (in motion)* - see figure 17, there can be seen low elastic deformation values.



- the two guide supports loading simulation, when skating –

Fig. 17. Resulting strain simulation

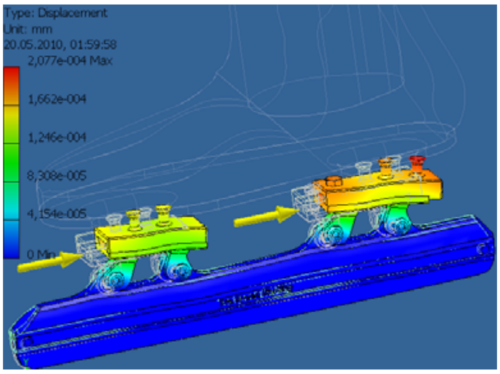
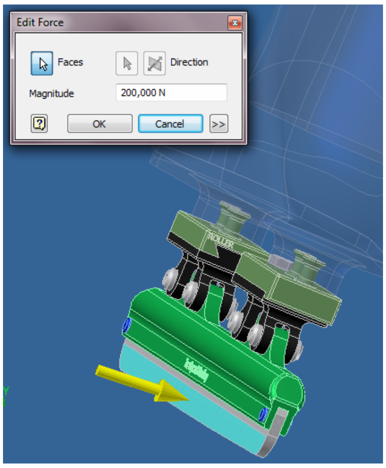


Fig. 17. Resulting strain simulation – continuing

◙ *Braking*

The simulation of assembly behaviour while braking is shown in figure 18 . The assembly is attached to the boot and the force F is acting on the blade.

It can be observed that the highest displacement values are lower than 0.009 mm, meaning they are very low and the blade resists the loading forces.



- blade behaviour simulation in braking -

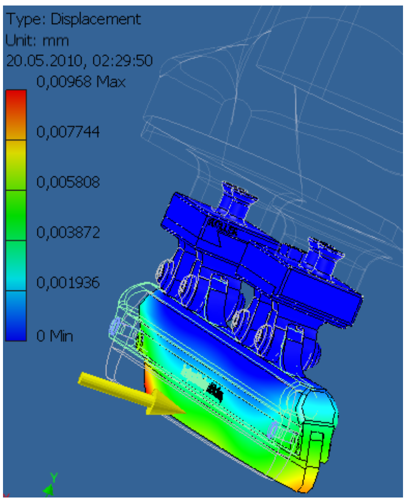


Fig. 27. Generated displacement simulation

The blade is made of stainless steel, with 59HRC (Rockwell) hardness.

The blade support is made of heat-treated aluminium alloy.

The blade is designed with 12 m radius and length of 325 mm.

The rollers diameter is 100 mm.

3. CONCLUSIONS

This paper presents an innovative system to diversify the use of skates. It must meet both customer needs, and improve previous models both in terms of accuracy, ease of assembly, as well as the design.

Due to the small number of elements, the innovative system (for multi-purpose skates) has a high reliability.

According to simulation results, the system components withstand all types of loadings which are estimated to be while its operation, so the safety of users is high.

The product (proposed system) is lightweight due to materials and design.

Model provides good accuracy and a minimum gap.

Both rollers and ice skates can be used in high speed rolling.

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