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The ROSETTA PHILAE Lander damping mechanism as probe for the Comet soil strength.

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Abstract

The ROSETTA Lander is equipped with an one axis damping mechanism to dissipate kinetic energy during the touch down. This damping is necessary to avoid damages to the Lander by a hard landing shock and more important to avoid re-bouncing from ground with high velocity. The damping mechanism works best for perpendicular impact, which means the velocity vector is parallel to the damper axis and all three feet touch the ground at the same time. That is usually not the case. Part of the impact energy can be transferred into rotational energy at ground contact if the impact is not perpendicular. This energy will lift up the Lander from the ground if the harpoons and the hold down thruster fail, as happen in mission.

The damping mechanism itself is an electrical generator, driven by a spindle inside a telescopic tube. This tube was extended in mission for landing by 200mm. A maximum damping length of 140mm would be usually required to compensate a landing velocity of 1m/s, if the impact happens perpendicular on hard ground.

After landing the potentiometer of the telescopic tube reading shows a total damping length of only 42,5mm.

The damping mechanism and the overall mechanical behavior of the Lander at touch down are well tested and characterized and transferred to a multi-body computer model. The incoming and outgoing flightpath of PHILAE allow via computer-simulation the reconstruction of the touch down. It turns out, that the outgoing flight direction is dominated by the local ground slope and that the damping length is strongly dependent on the soil strength. Damping of soft comet ground must be included to fit the damping length measured. Scenario variations of the various feet contact with different local surface features (stone or regolith) and of different soil models finally lead to a restricted range for the soil strength at the touch down area.