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Frictional Effects on the Dynamics of a Truncated Double-Cone Gravitational Motor

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Abstract : In this work, effects of the friction and truncation on the dynamics of a double-cone gravitational motor, self-propelled on a straight V-shaped horizontal rail, are evaluated. Such mechanism has a variable radius of contact, and, on one hand, it is similar to a pulley mechanism that changes the potential energy into the kinetic energy of rotation, but on the other hand, it is similar to a pendulum mechanism that converts the potential energy of the suspended body into the kinetic energy of translation along a circular path. Movies of the self- propelled double-cones, made of S45C carbon steel and wood, along rails made of aluminum alloy, were shot for various opening angles of the rails. Kinematical features of the double-cones were estimated through the slow-motion processing of the recorded movies. Then, a kinematical model is derived under assumption that the distance traveled by the contact points on the rectilinear rails is identical with the distance traveled by the contact points on the truncated conical surface. Additionally, a dynamic model, for this particular contact problem, was proposed and validated against the experimental results. Based on such model, the traction force and the traction torque acting on the double-cone are identified. One proved that the rolling traction force is always smaller than the sliding friction force; i.e., the double-cone is rolling without slipping. Results obtained in this work can be used to achieve the proper design of such gravitational motor.

Keywords : Truncated double-cone, friction, rolling and sliding, dynamic model, gravitational motor
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