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Slick or Stick: Investigating μk (Mu) of Sandboarding

The Great Sand Dunes National Park allows visitors to use sandboards and sand-sleds (essentially snowboards for sand) to slide down the dunes. This project designed and constructed a Sand Dune Simulation System (SDSS) to isolate and quantify the coefficient of kinetic friction (μk) of various materials sliding across sand.

The SDSS consisted of an elevated sand-box and pulley system with a hanging drop mass which, when released, would drag a material sled across the sand-bed. Material sleds consisted of flat sheets of experimental material (aluminum, steel, fiberglass reinforced plastic (FRP), polyethylene (P-tex), Formica, cardboard, and butyl rubber) bonded to a 1-sqft plywood deck. A flag mounted to the material sled passed through a Photogate timer at the beginning and end of the track, to measure the total time required for the sled to traverse the sand-bed.

The formula $\mu k = Md \times G - (Md + Ms) \times A / (Ms \times G)$ was used to determine the coefficient of kinetic friction (drop mass = Md, sled mass = Ms, sled acceleration = A, gravity = G). Two validation tests verified material sled acceleration across the sand-bed was linear, and indicated adding 10 lbs. created a 5.4% difference in μk.

The initial prediction was the harder and smoother materials would yield a lower coefficient of friction, yet the data showed the metals (steel and aluminum) were within 1.6% μk of the plastics (FRP and Formica). The data clearly shows the P-tex material-sled has the lowest μk (0.425) while the other material-sleds ranged between 0.571 and 0.615 μk.

The SDSS performed well; with standard deviations between 0.6% and 8.8% (mean 2.2%) over 180 runs, supporting further investigation of different sand temperatures, moisture content, material types, waxes, etc.