EFFECTS OF GRAIN ANGULARITY AND SHAPE ON BEACH MORPHOLOGY

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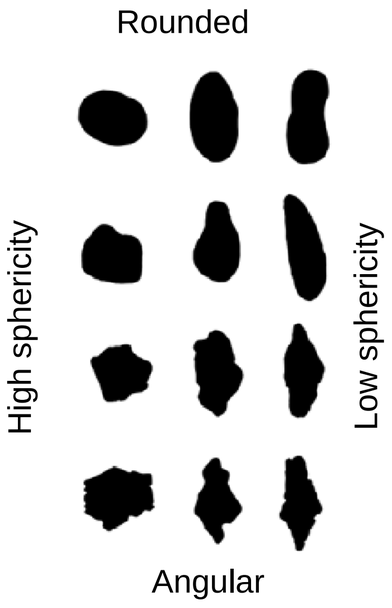
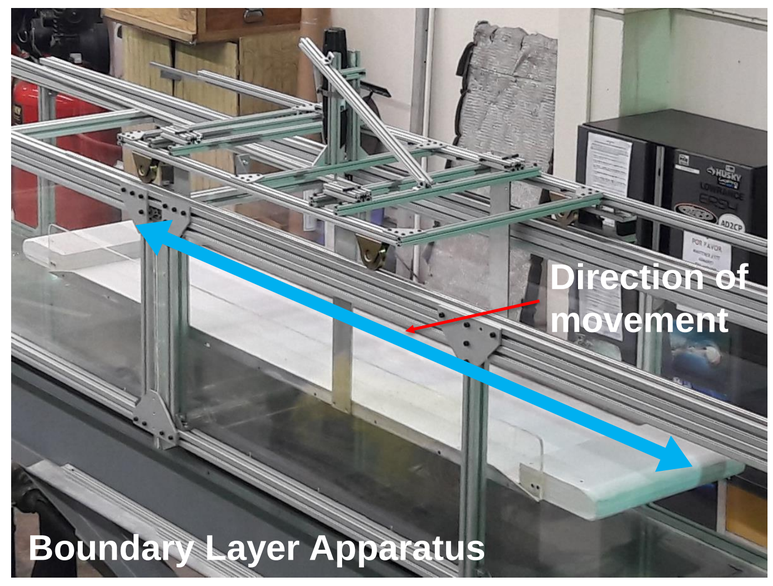
Introduction

This research began with the objective of finding alternatives for beach nourishment with a recyclable material such as recycled glass. To achieve this purpose, glass particles were studied to quantitatively characterize their shape angularity and subsequently evaluate their relationship tp angle of repose, settling velocity, bed state, friction, and sediment transport potential.



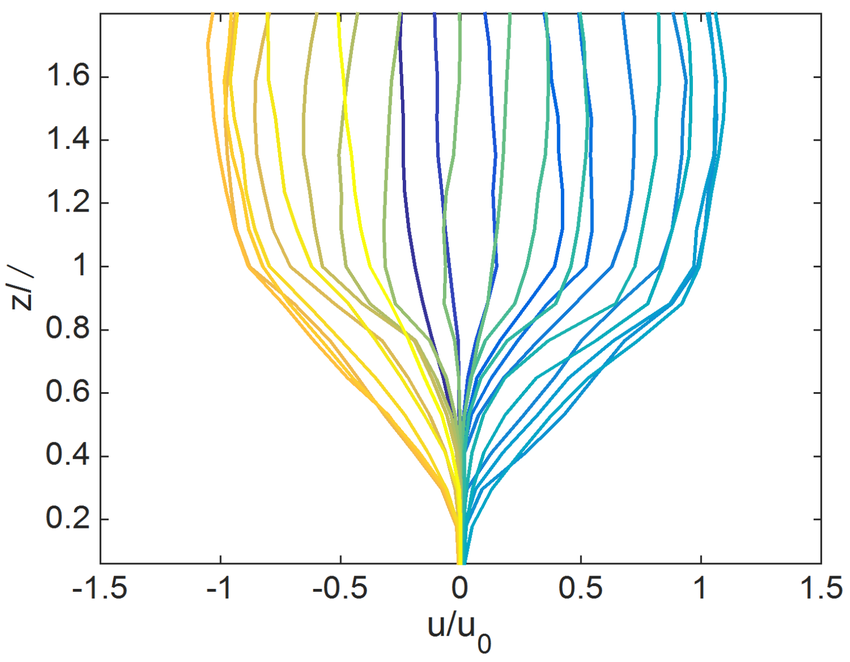
Methodology

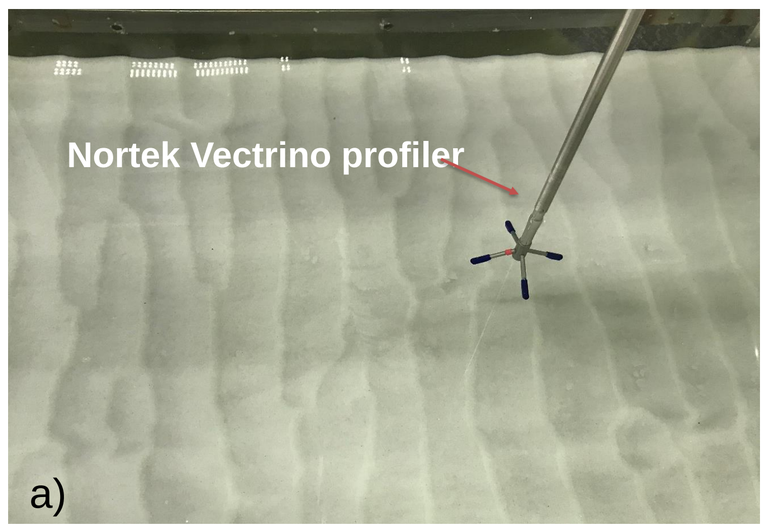
- Individual particles were characterized through image analysis in Matlab.
- Settling velocities and the angle of repose were measured according to ASTM standards.
- A boundary layer apparatus was fabricated at UPRM's CAOSE laboratory.
- Nearbed fluid velocities were obtained with an Acoustic Doppler Profiling Velocimeter, while bedform geometry was resolved with high-speed cameras all oscillating with the moving frame.

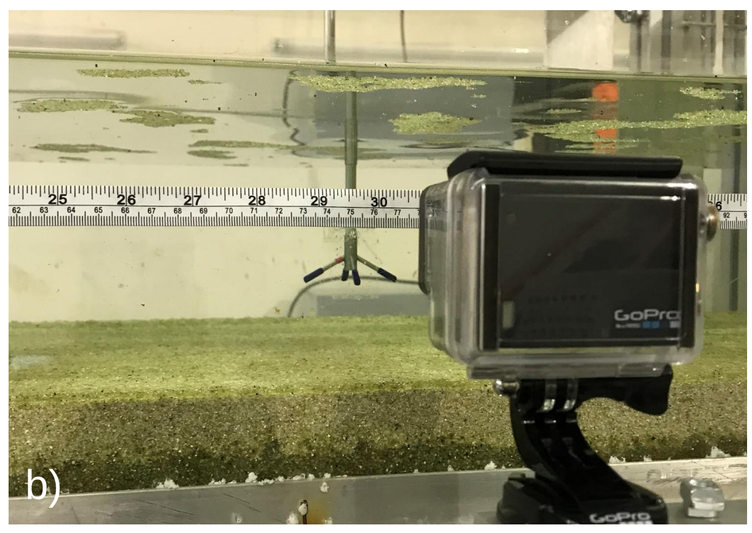


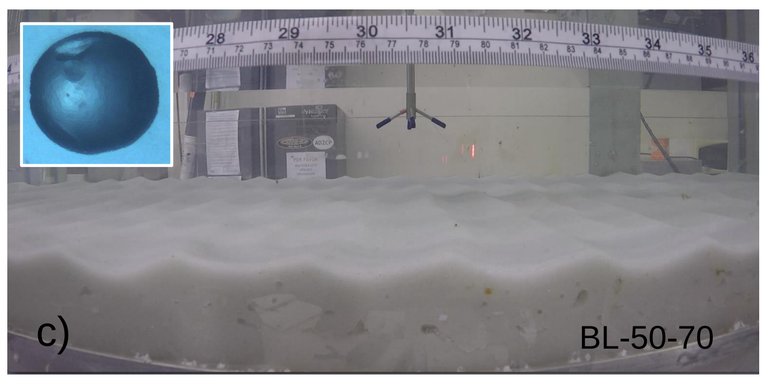
Boundary Layer Apparatus and Bed Morphology

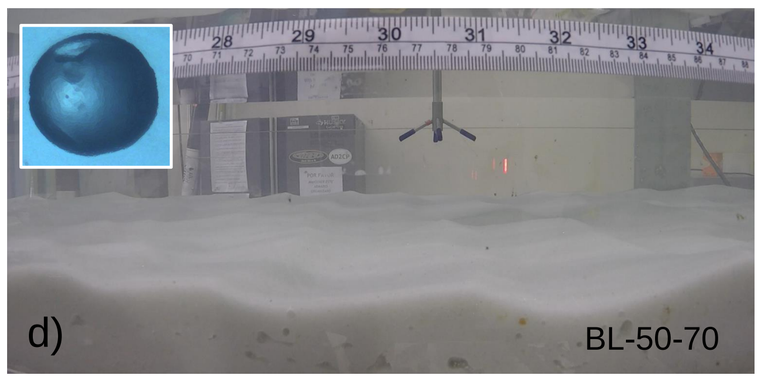
The UPRM Boundary Layer Apparatus is a 2-m long tray suspended from a cart oscillating atop a 8m x 0.7m x 0.7m acrylic tank, similar to that of Hay et al. (2012) and Sleath (1990). The design incorporates full control of the frequency and extent of the oscillations in order to achieve maximum velocities of ~50 cm/s, periods (T) of 10-20 s, and semi-excursions (A) of up to 75 cm. A Nortek Vectrino profiler (oscillating with the frame of reference) provides for high-resolution nearbed fluid velocities (below). Bed morphology was characterized in terms of it ripple height and wavelength using a GoPro camera.







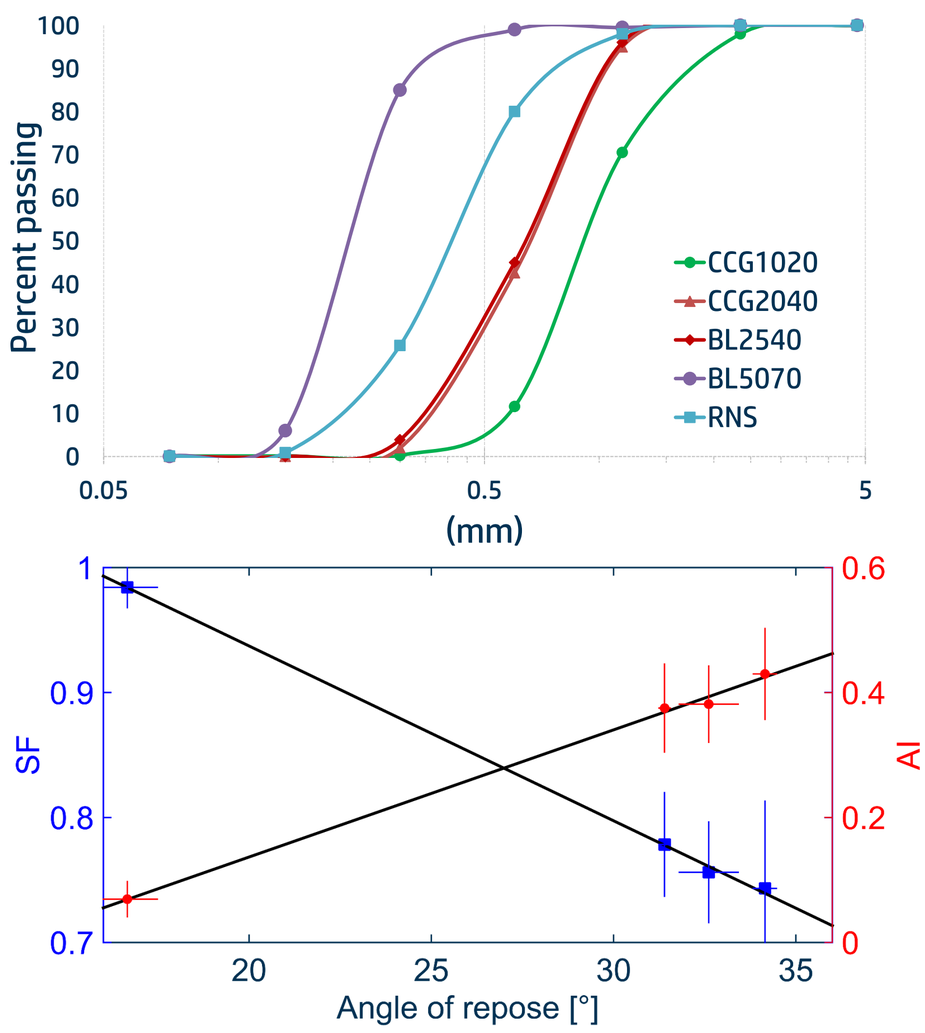




a) Example of ripples developed during the trials.
b) GoPro setup.
c) Ripples formed by an oscillating motion of with T=20s and amplitude A=65cm. The separation between crest (λ) is 4cm.
d) Same as c) with T=15s, A=75cm, and λ=8cm.
e) For self-similar conditions ripples did not develop for CCG-20-40 particles, due to their high angularity.

Grain Characteristics and Effects on Angle of Repose

Designation	CCG-10-20	CCG-20-40	BL-25-40	BL-50-70	RNS
Appearance					
D50 (mm)	0.98	0.68	0.64	0.24	0.44
Angle of repose (°)					
	32.6±0.81	34.2±0.32	31.4±0.15	16.7±0.83	30.4±0.86
W-settling (mm/s)	128.6±18.87	116.8±19.32	60.4±10.2	34.1±1.78	61.4±16.8
Angularity Index	0.386±0.12	0.421±0.21	0.375±0.14	0.070±0.06	0.367±0.17
Shape Factor	0.75±0.07	0.77±0.13	0.78±0.08	0.98±0.03	0.72±0.13
RMS roughness (μm)	1.50±0.03	1.67±0.10	1.07±0.03	1.06±0.02	1.11±0.04
Specific gravity (g/cm^3)	2.50±0.04	2.51±0.06	2.44±0.03	2.37±0.10	2.65±0.07



It is clear that grain angularity and shape are directly related to angle of repose. That is, spherical particles with rounded edges tend to form less steep beaches.

Puerto Rico Science, Technology & Research Trust

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