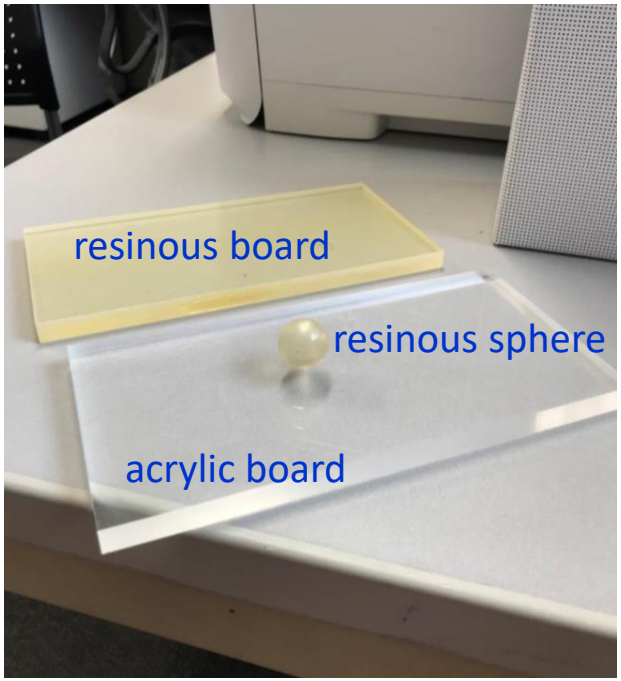
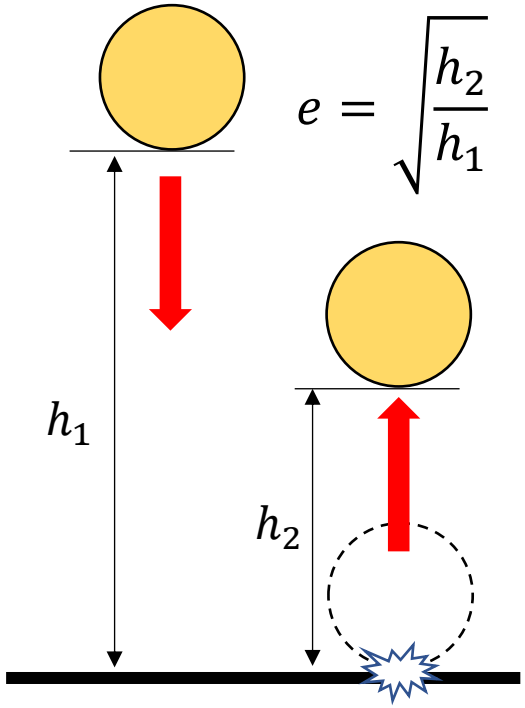
Experiments to measure the coefficient of restitution, the static friction angle, and the dynamic friction angle.

Photos and images of the experiments carried out to measure the coefficient of restitution, the static friction angle, and the dynamic friction angle are presented in this document. For each experiment 100 repetitions were carried out. The experimental devices comprise acrylic boards and the clumps were made of resin, and so parameter values for the cases of “acrylic vs resin” and “resin vs resin” were measured. The average, the standard deviation, and histogram of each parameter are summarized in this document. If original experimental data are needed, they can be obtained in the EXCEL file that can be downloaded from the verification website http://geotech.civil.yamaguchi-u.ac.jp/tc105/tests.html (filename: results of coefficient of restitution and friction angles.xlsx).

Experiment to measure the coefficient of restitution





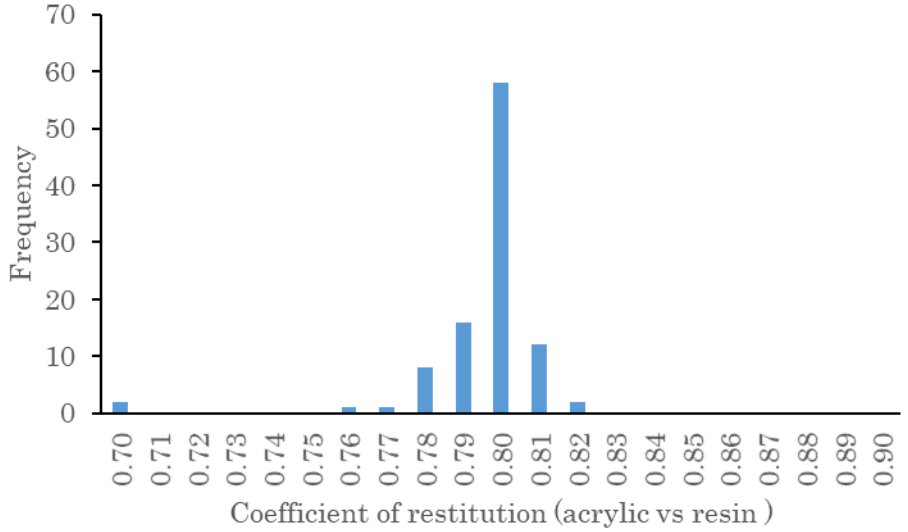
A resinous sphere and an acrylic board or a resinous board were used in this experiment. The sphere was held in its initial position 50cm above the board by applying suction through a vacuum cleaner. The sphere fell down on the board after switching off the vacuum cleaner, then the height to which it rebounded was measured. A video was taken to measure the rebound height.

Results of coefficient of restitution tests

acrylic vs resin

Average: 0.790

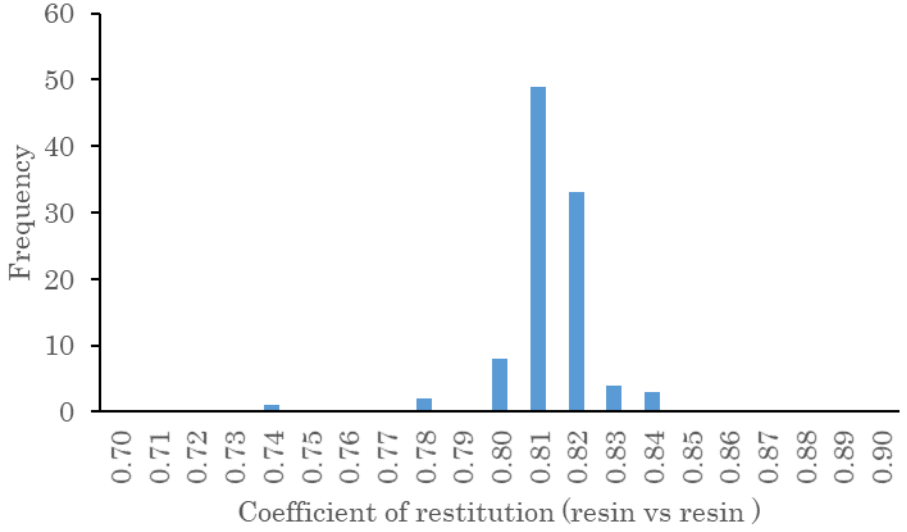
Standard deviation: 0.0280



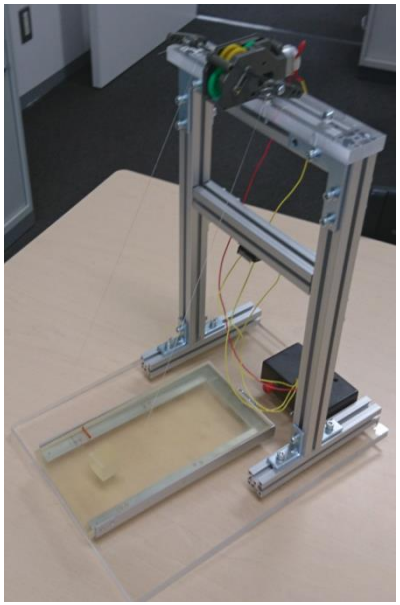
resin vs resin

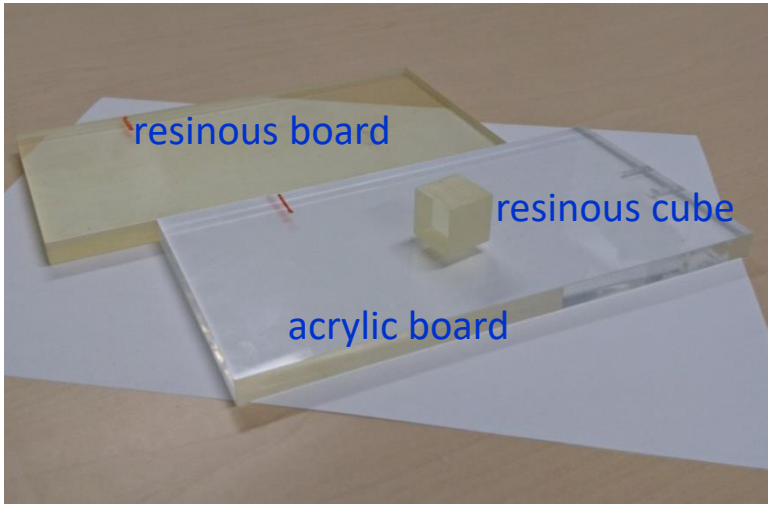
Average: 0.809

Standard deviation: 0.0115

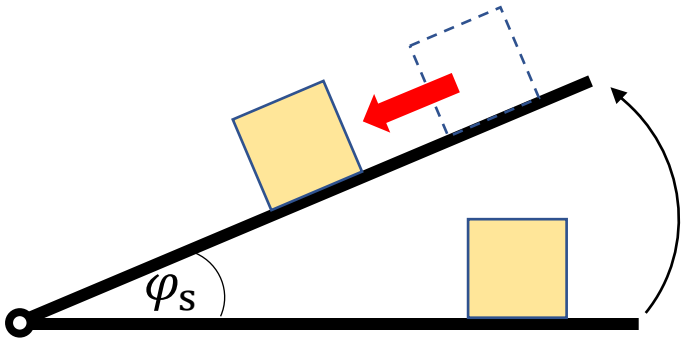


Experiments to measure the static friction angle





φ_s: static friction angle



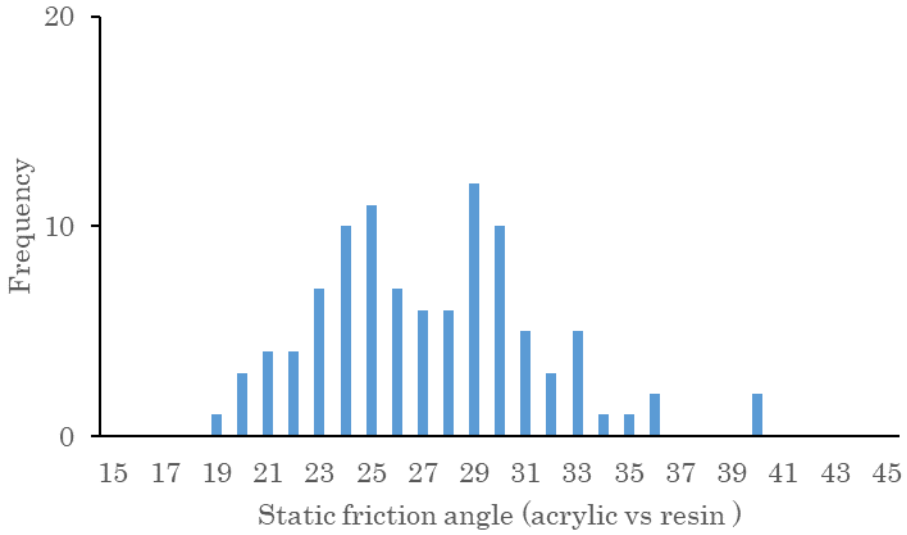
A resinous cube and an acrylic board or a resinous board were used in this experiment. The cube was initially placed on the surface of the board, then the board was inclined gradually. The static friction angle was measured as the angle of inclination when the cube just started to move.

Results of the static friction angle tests

acrylic vs resin

Average: 27.2 (deg)

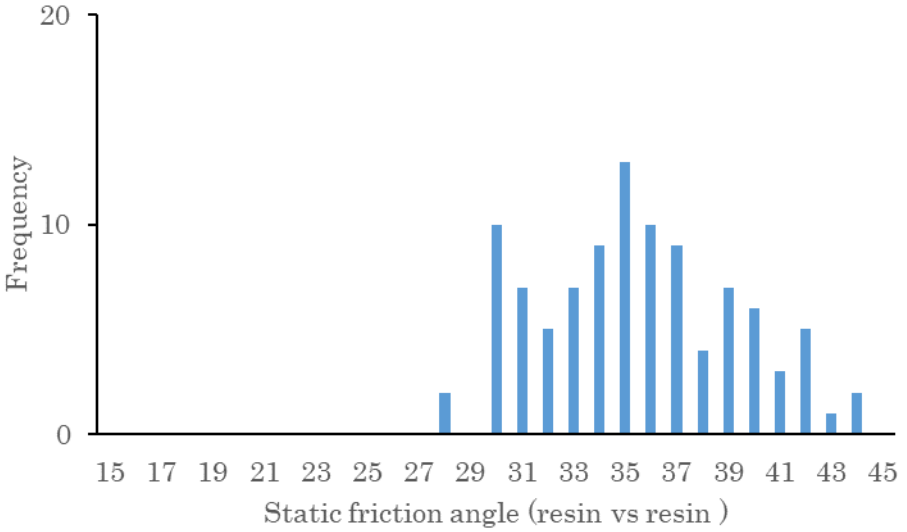
Standard deviation: 4.26 (deg)



resin vs resin

Average: 35.5 (deg)

Standard deviation: 3.82 (deg)



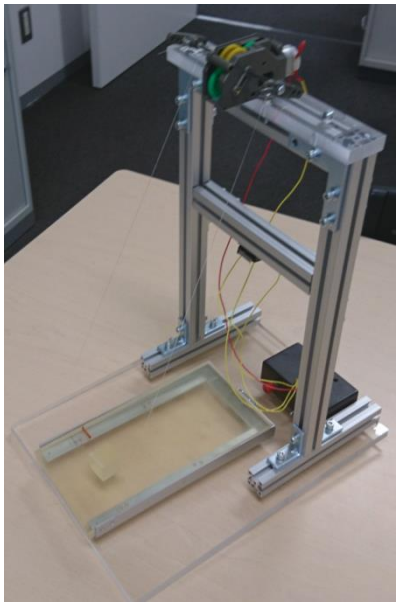
Experiment to measure the dynamic friction angle

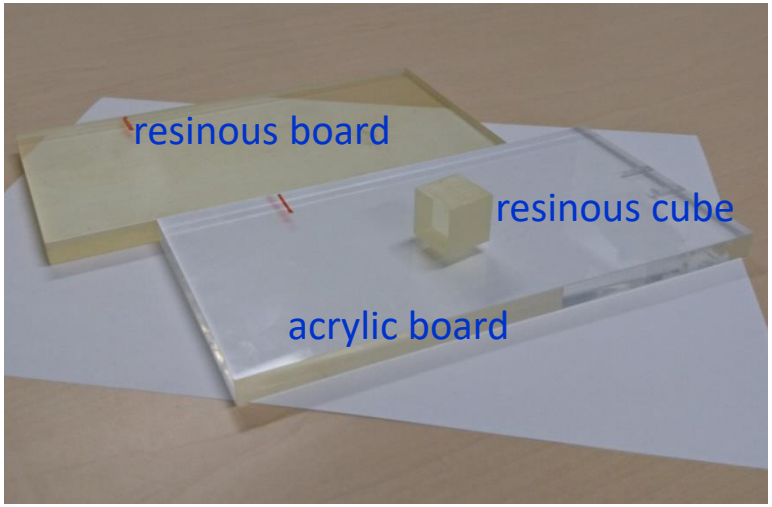
$$\varphi_d = arctan\left\{tan\theta - \frac{2l}{gt^2 cos\theta}\right\}$$

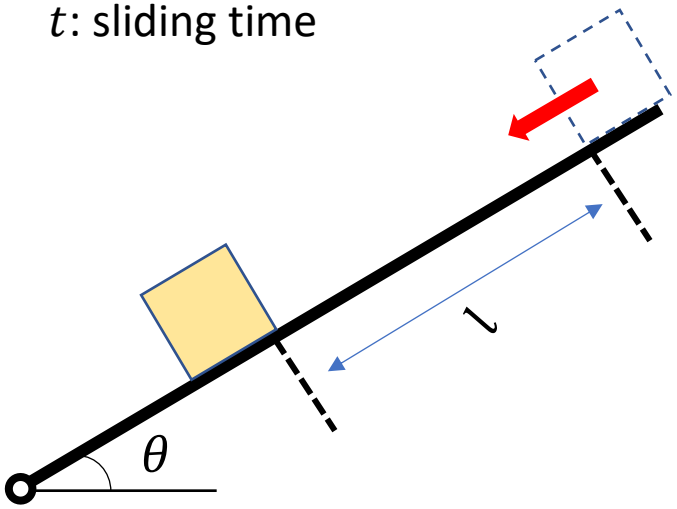
φ_d: dynamic friction angle

g: gravitational acceleration

t: sliding time







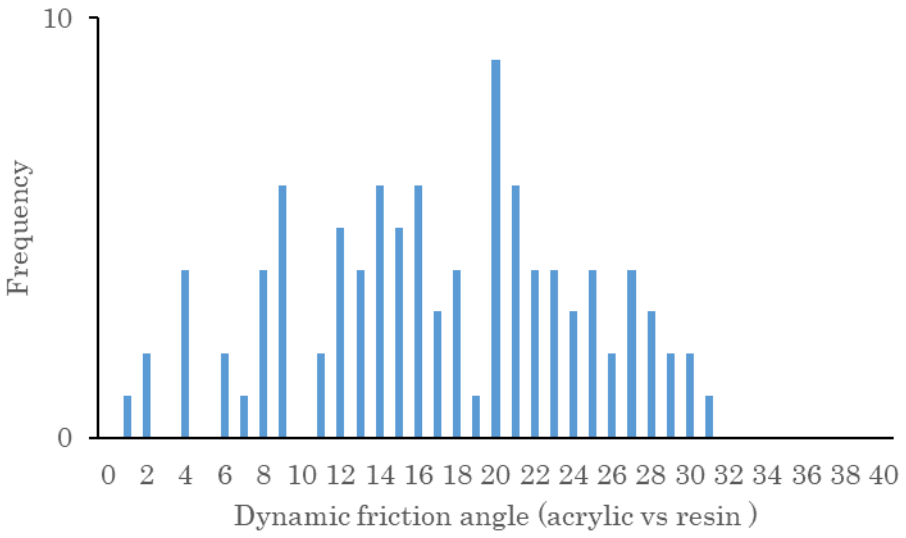
A resinous cube and an acrylic board or a resinous board were used in this experiment. The cube was initially placed on the surface of the board. The slope angle was fixed with 45 degrees. The time taken to for the cube to move 18 cm was measured using a video.

Results of the dynamic friction angle tests

acrylic vs resin

Average: 16.5 (deg)

Standard deviation: 7.35 (deg)



resin vs resin

Average: 29.6 (deg)

Standard deviation: 2.42 (deg)