Large-Scale Dilatant Dynamics of Silly Putty

A Report by the Alfred University Chapter

Introduction

Dow-Corning 3179 Dilatant Compound™, or "Silly Putty™" as commonly known in less scientific circles, is a coral-pink silicone polymer with unique rheological properties. It exhibits dilatant behavior, meaning that as shear increases its viscosity increases. This property allows the compound to exhibit high elastic rebound in addition to ease of formation.

Patented in 1947 by McGregor and Warrick,[1] Dow-Corning 3179 has important uses as a therapeutic stress reliever, low gravity fastener (on the Apollo 8 Mission), and stabilizer of wobbly tables. In the novelty toy market, an offshoot of this technology accounts for annual sales of approximately 75 tons of this material.

Extensive informal research has investigated the effects of small, 13.3 g (egg-sized) samples striking a hard surface. Surprisingly little data, however, are available on the rebound behavior of larger samples (i.e. >45,000 g). The goal of the Alfred University Chapter's research is to spark interest in the new field of Large-Scale Dilatant Dynamics (LSDD).

Experimental Procedures

One hundred pounds (45.4 kg) of 3179 Dilatant Compound were obtained from Dow-Corning in two 50-lb lots. The two lots were joined together and kneaded to ensure homogeneity. The sample was formed to a near spherical shape by continuous rolling on a hard surface. The sample diameter measured 42 cm.

The spherical sample was accelerated by gravity from a height of 11.3 m onto a hard surface. The estimated velocity at impact was 14.9 m/s, with a travel time of 1.52 seconds. Height as a function of time was measured using a slow-motion video camera and mounted linear scale. Ambient temperature measured 7±2°C.

Results

The sample recoiled 2.0 m on impact. Even though the large pinkish mass remained intact, visible signs of fracture were observed on the lower surface at the point of impact.

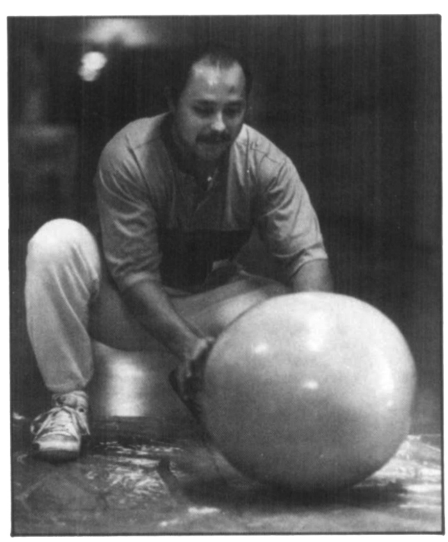
The second impact resulted in catastrophic failure of the sample. The sphere fractured into four large portions and numerous small fragments. Post-experimental fractography indicated that fracture initiated due to voids beneath the surface.

Discussion

The manufacturer specifies an 80% rebound for Dilatant Compound 3179. This would correspond to a recoil of 8.9 m after primary impact. The observed 2.0 m corresponds to a rebound value of only 17.9%. The deviance between the specified and observed values can be attributed to brittle fracture. It is hypothesized that the energy was dissipated in the creation of new surfaces, thus reducing energy available for rebound. Plastic deformation was not observed and was not considered to be a significant mechanism of energy dissipation.

The brittle failure can be attributed to localized regions of high stress intensified by subsurface flaws. The flaws were inherent due to the sample preparation techniques.

A smaller scale experiment performed with a 2.3 kg mass exhibited elastic behavior without fracture. Impact stresses were lower due to the reduced mass, and the rebound value was near the manufacturer's predicted value.



Before: Sample preparation of the 45.4 kg sphere of Dilatant Compound 3179™. The sphere had to be continuously rolled to maintain its shape.

During: Sample after primary impact. Some fissures are visible at the bottom of the sample.

Conclusions

It can be concluded that as the impact force is increased, brittle fracture becomes more probable. It can also be concluded that air voids in the sample provide fracture origins, which should be minimized for best elastic behavior. This clearly has ramifications in sample preparation techniques used for future research.

Infinitely more important than the scientific value of this experiment was the witnesses' general consensus that hurling a big wad of coral-pink Silly Putty off the tallest building in town was a fine way to spend a cold November afternoon in Alfred, New York.

References

1. R.R. McGregor and E.L. Warrick, "Treating Di-Methyl Silicone Polymer with Boric Oxide," U.S. Patent 2,431,878 (1943).

2. "Bouncing Putty: New Uses for an Old Idea," *Materials News*, May/June 1987, p. 3.

3. "Information About Silicone Compounds: DC 3179 Dilatant Compound", Dow-Corning Corporation, Midland, MI 1987.

https://doi.org/10.1557/S0883769400060541 Published online by Cambridge University Press

Stevens Institute of Technology Receives Charter at Fall Meeting

A Certificate of Charter officially recognizing the new MRS University Chapter at the Stevens Institute of Technology was presented to Stevens representatives at the 1989 MRS Fall Meeting in Boston. The New Chapter president and faculty advisers are ready to welcome inquiries about the Chapter and its upcoming activities.

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RPI Announces New Officers

The MRS University Chapter at Rensselaer Polytechnic Institute, Troy, New York has announced the results of elections for officers. Elected to serve in 1990 are:

Co-President, John Darab
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Co-President, Wayne Hasz
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Secretary/Treasurer, Sandra K. Woltermann
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Please contact any of these officers for information about the plans and activities of the RPI Chapter.

Penn State University Chapter members visit the Smithsonian Institution. (Bottom row, L-R): C-Y. Huang, J. Krause, C. Vaughan, A. Kazakos, H. Zhang. (Middle row, L-R): R. Sullivan, J. Perison, S. Hoyle, T. Guiton, C. Houser. (Top row, L-R): D. Snell (curator of the Penn State Mineral Museum), E. Plesko, G. Ruschau. Preview

Penn State Student Chapter Sponsors Smithsonian Trip

In August 1989, the Penn State University Chapter sponsored a trip to the Smithsonian Institution in Washington, DC. The day-long trip included visits to the Museum Support Center and the National Museum of Natural History.

The first stop was the Smithsonian Museum Support Center located in Suitland, Maryland. The purpose of the Support Center is to provide for the storage, preservation, and study of the Smithsonian's collections. During the tour Pamela B. Vandiver of the Support Center's Conservation Analytical Laboratory (CAL) described the facilities. Research at CAL centers primarily on archaeometry and conservation science. The conservation science group studies the physical and chemical processes that lead to the deterioration of museum objects and develops treatments to protect them from further damage.

During the visit to the National Museum of Natural History, Robert F. Fudali of the Department of Mineral Sciences, took the Penn State Chapter members on a behind-the-scenes tour of the department's collections and facilities. The tour included the meteorite and tektite collection, the extensive mineralogy and petrology reference collections, the exhibit-quality mineral collection, and the analytical laboratories. After the tour, the Chapter members spent the rest of the day viewing the museum's public exhibits.

In other activities, the Penn State University Chapter heard Kenneth Voss, manager of new business research at Engelhard Corporation, speak on "Working in Industry: An Engelhard Perspective" at the June meeting. After describing some of the areas of research at Engelhard, Voss discussed two possible career paths—that of the scientist/consultant and that of the manager—and outlined the challenges and opportunities of each. The July meeting combined a plant tour and summer picnic. Chapter members toured the Penn State Creamery, where they were shown various aspects of the production of cheese and ice cream. They were able to sample some of the ice cream during the picnic that followed.

Eric P. Plesko

MRS MATERIALS RESEARCH SOCIETY

https://doi.org/10.1557/S0883769400060541 Published online by Cambridge University Press

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