Lab #8

Drop Test

The City College of New York

Department of Mechanical Engineering

ME 37100 Computer Aided Design

Section 1EF

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18 November 2024

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Abstract

In this lab, impact of a ceramic ring will be observed at different drop heights. Such testing looks at the stress wave propagations, the stress wave propagation within the ring through using a direct time integration solution. Mesh control is applied at the area of impact for further accuracy in looking for the principal stresses.

Introduction

Impact testing can be used to determine mechanical properties of materials such as toughness. Through impact, ductile materials generally absorb more energy upon impact. Ceramic materials display low toughness overall during an impact test. Varying heights can change the impact observed during the event of the testing.

The use of ceramic materials is due to its ability to maintain its mechanical properties under extreme temperature and corrosion resistance, thus making it a suitable material in applications involving the use of glass, pottery and porcelain as such ceramics are used to resist extreme conditions.

Theoretical Background

Principle stresses look at the normal stresses experienced by the material under impact. In designing for impact criterions of fracture directions and locations becomes more important than that of plastic deformation experienced. Various drop heights can impact the resulting principal stress by the buildup of energy and therefore the total energy absorbed by the material. Other factors involved in a drop test include parameters such as geometric configurations, surface impact and the drop conditions.

Graphical Demonstrations of SolidWorks Results

This lab looked to use various drop height and vibration in the ring caused by the drop impact

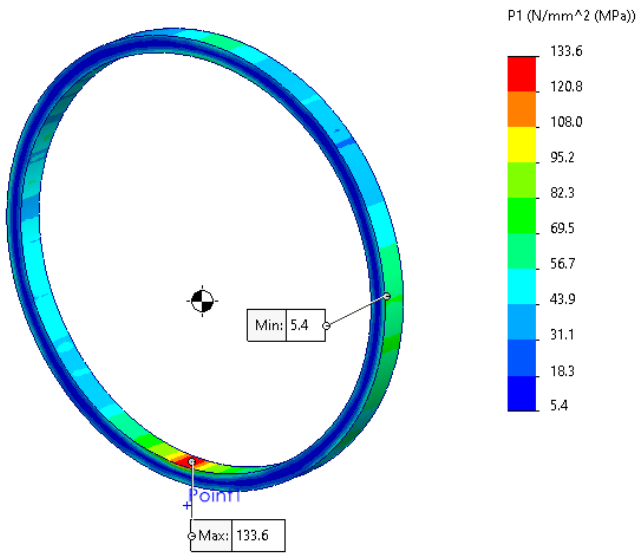

Figure 1: Resulting drop test principal stress graph for a ceramic ring dropped from a height of 100 mm for 600 microseconds.

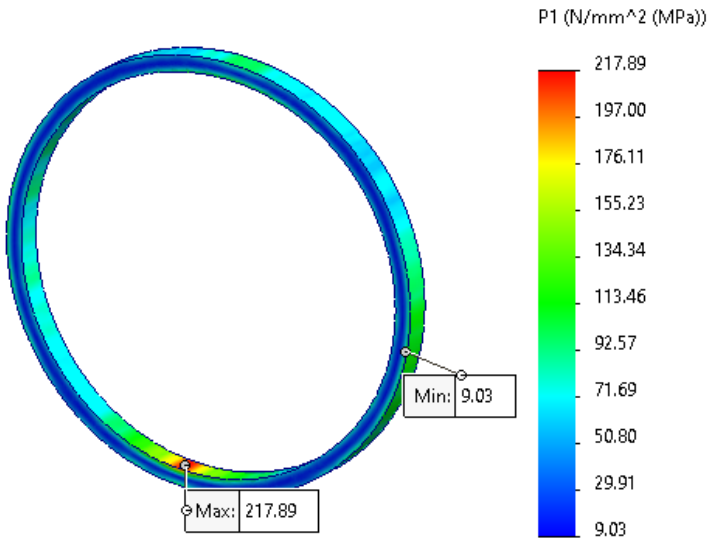

Figure 2: Resulting drop test principal stress graph for a ceramic ring dropped from a height of 200 mm for 600 microseconds.

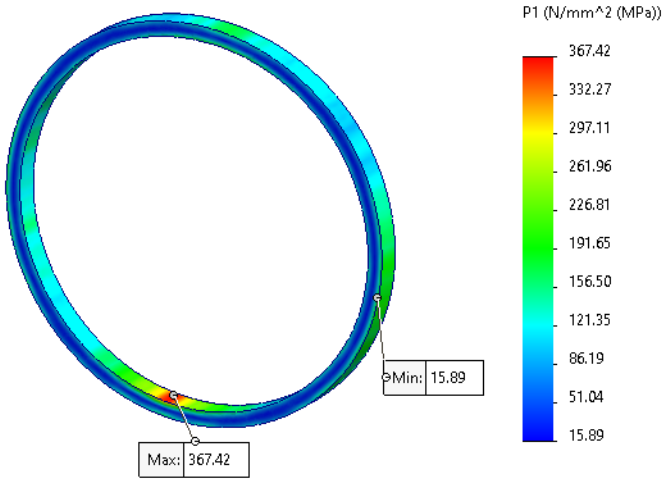

Figure 3: Resulting drop test principal stress graph for a ceramic ring dropped from a height of 500 mm for 600 microseconds.

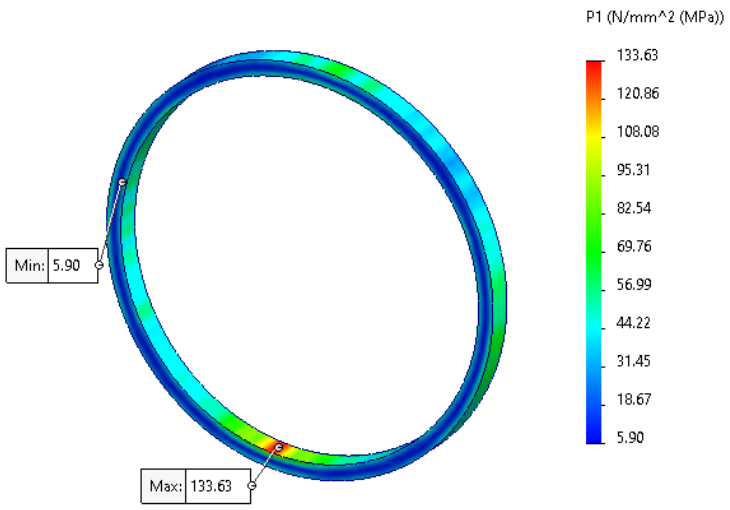

Figure 4: Resulting drop test principal stress graph for a ceramic ring dropped from a height of 100 mm for 1800 microseconds.

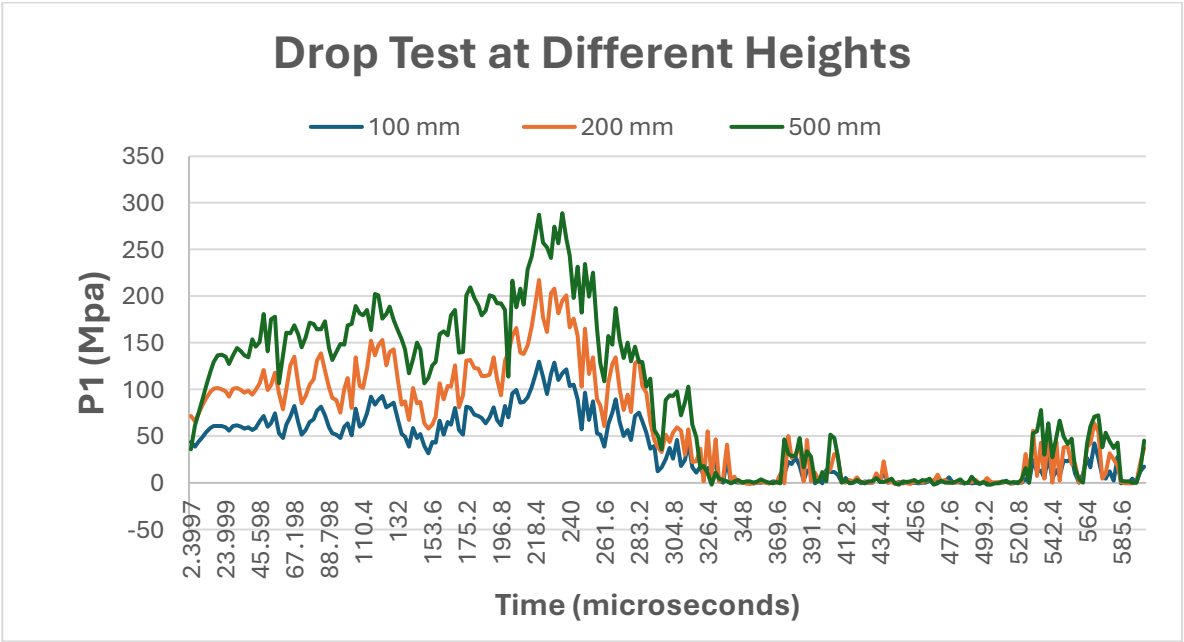

Figure 5: Principal Stress Plot of Ring dropped at 100, 200 and 500 mm over 600 microseconds.

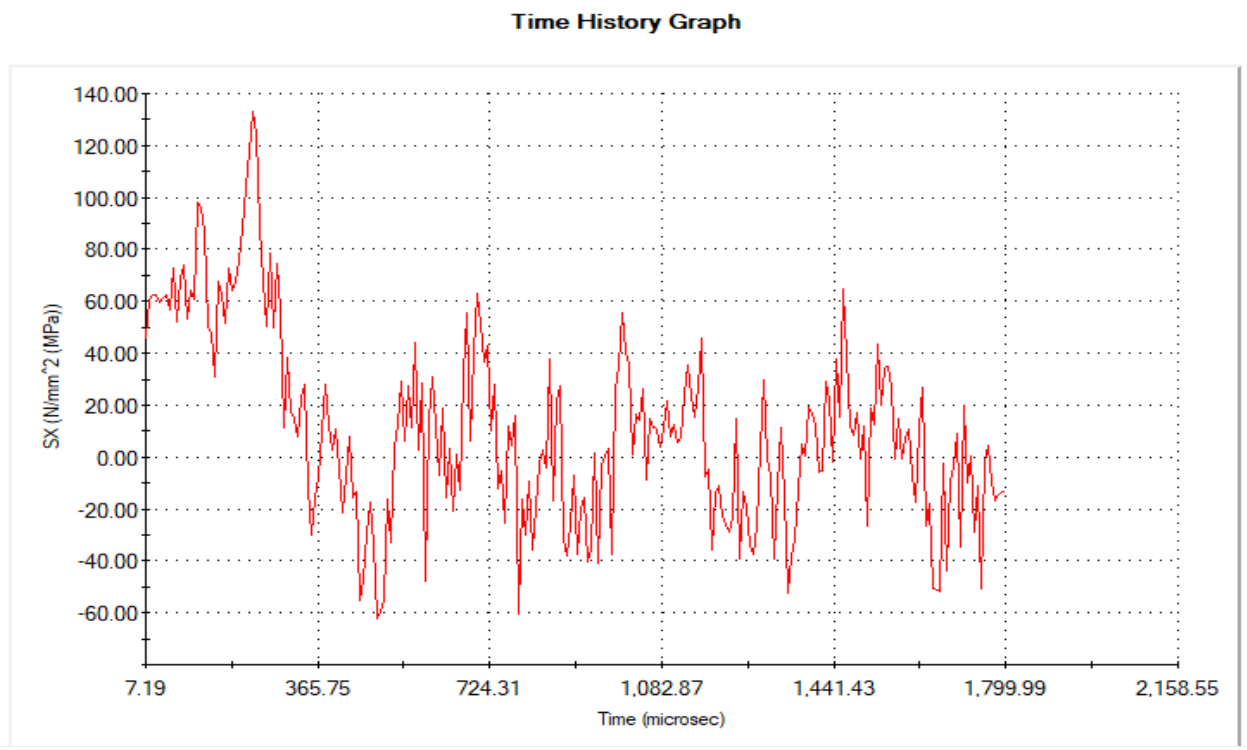

Figure 6: Vibration caused by impact plot of Ring dropped at 100mm over 1800 microseconds.

Discussion and Interpretation of Results

Ceramics were used as the material for the drop test. From various heights, the largest principal stress was seen to have increased (Figure 1-4) and experience the maximum stress at the point of contact between the surface. For the ceramics, ultimate strength is 172 MPa, thus showing the ring will survive at a 100 mm drop. However, a drop test is not conclusive in deciding whether the ring will fail as the severity of impact must be considered.

Due to the lack of energy dissipation, it can also be seen that the upon impact, the rings will experience bouncing that lasts forever. From figures 6, vibration of the ring can be seen to be cyclical, increasing and decreasing in similar frequency after the first 400 microseconds, from the first drop. Such plot is representative of the periodic tension and compression experienced by the ring during the simulations.

Conclusions

Drop tests are not able to directly conclude whether a part will fail or pass upon impact, however, they may be able to provide onsite on the periodic stresses and principal stresses observed. Such testing can be used to improve design through a realization of the dissipation of energy that may occur due to the material and vibrations caused by the impact. Different drop heights can be seen to affect the performance and can also be an important parameter that can be found through the use of a drop test.

References

[1] Engineering Analysis with SolidWorks Simulation 2024, by Paul Kurowski (2024), ISBN-10: 1630576298.
[2] A First Course in the Finite Element Method, Enhanced Edition, 6th Ed., by Daryl Logan (2022), ISBN-10: 0357884140.