Indian Institute of Technology, Palakkad

Report OELP
Mechanical characterization of dried calabash material

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1. Introduction

The calabash, a unique gourd like fruit of the Lagenaria siceraria plant, has garnered attention not only for its traditional uses in crafting utensils and containers but also for its potential as a material with distinct mechanical properties. This report delves into the mechanical characterization of calabash material, seeking to unravel the structural intricacies and performance metrics that define its mechanical behavior. Calabash has been employed by various cultures for centuries, showcasing its durability and adaptability in crafting utensils, musical instruments, and decorative items. As we embark on this mechanical characterization journey, our objective is to systematically investigate the material's physical and mechanical attributes. By doing so, we aim to not only comprehend the fundamental properties that govern calabash material but also to evaluate its viability in contemporary engineering applications. This report will undertake a comprehensive examination of calabash material, encompassing methodologies, compression testing, Impact testing and Bending test. Through these analyses, we will summarize the material's strength , resistance to deformation as well as bending ,mechanical response to external forces. The main aim of this project is to find the mechanical properties of dried calabash material by performing bending , compressive , impact test(charpy).After finding mechanical properties, it will compare with other engineering materials to highlight its strengths and weakness.

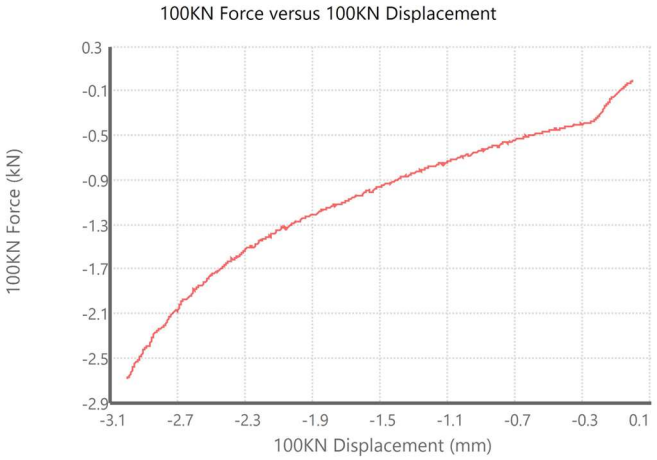
2. COMPRESSION TEST

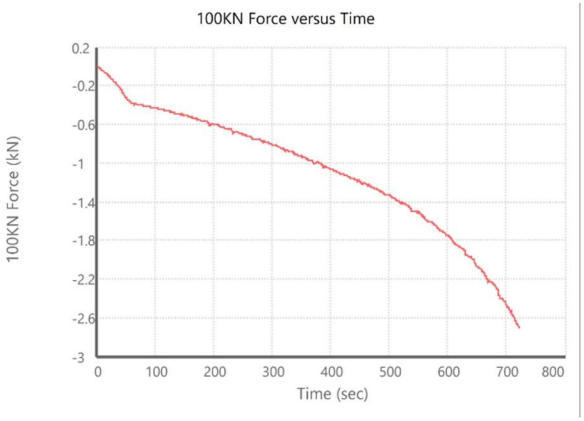
A compression test conducted on an MTS (Materials Testing System) machine is a fundamental and widely employed method in materials science and engineering to evaluate the mechanical behavior of materials under compressive loading. MTS machines are robust testing systems designed to apply controlled forces and measure corresponding displacements, enabling precise determination of a material's response to compression.

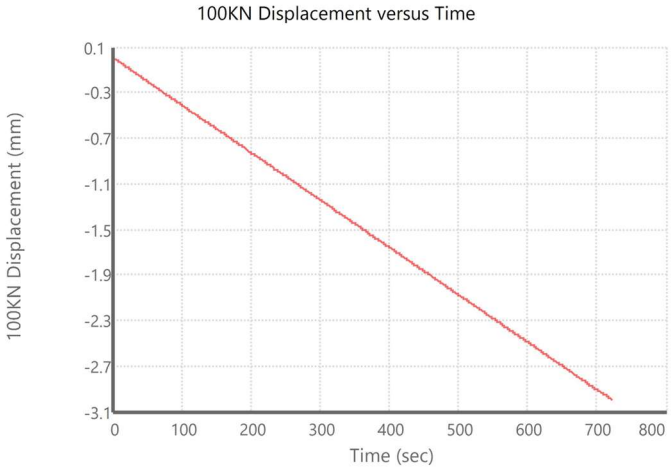
We have cut specimen in cuboid shape total no of specimen are 3 and dimensions are 10mm x 10mm x5mm ,area is 100mm^2.

We have give a displacement rate of 0.25mm/min and sets a limit at 3mm(maximum displacement).

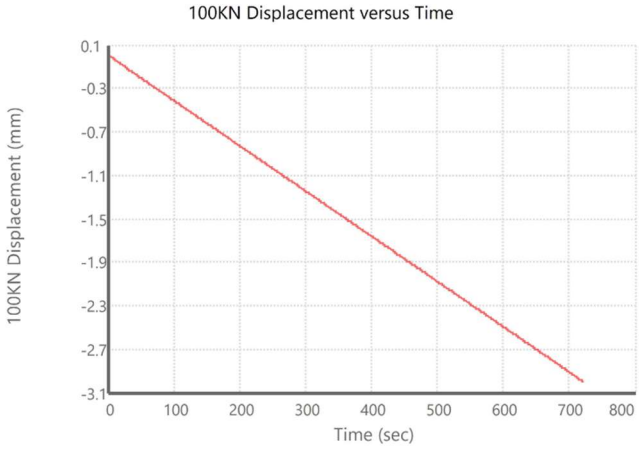
TEST 1

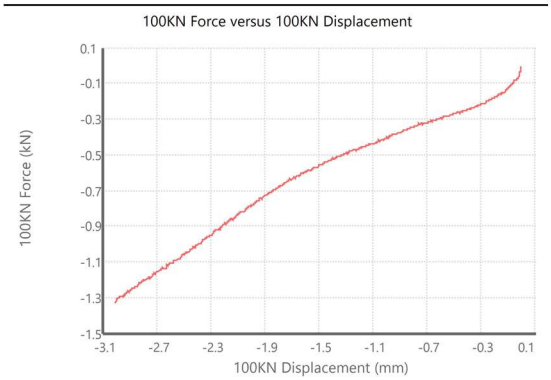

100KN Force versus 100KN Displacement
100KN Force (kN)
0.3
-0.1
-0.5
-0.9
-1.3
-1.7
-2.1
-2.5
-2.9
-3.1
-2.7
-2.3
-1.9
-1.5
-1.1
-0.7
-0.3
0.1
100KN Displacement (mm)

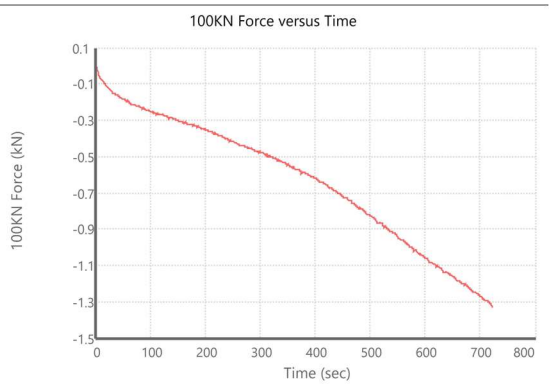

100KN Force versus Time
100KN Force (kN)
0.2
-0.2
-0.6
-1
-1.4
-1.8
-2.2
-2.6
-3
0
100
200
300
400
500
600
700
800
Time (sec)


100KN Displacement versus Time
100KN Displacement (mm)
0.1
-0.3
-0.7
-1.1
-1.5
-1.9
-2.3
-2.7
-3.1
0
100
200
300
400
500
600
700
800
Time (sec)

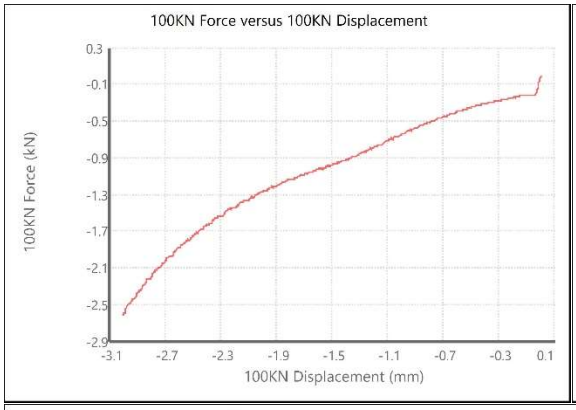
TEST2

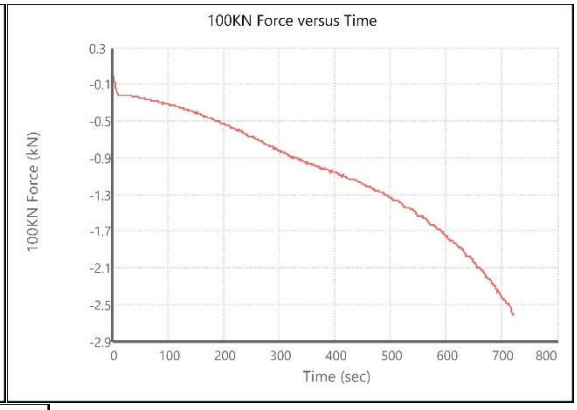

100KN Displacement versus Time
100KN Displacement (mm)
0.1
-0.3
-0.7
-1.1
-1.5
-1.9
-2.3
-2.7
-3.1
0
100
200
300
400
500
600
700
800
Time (sec)

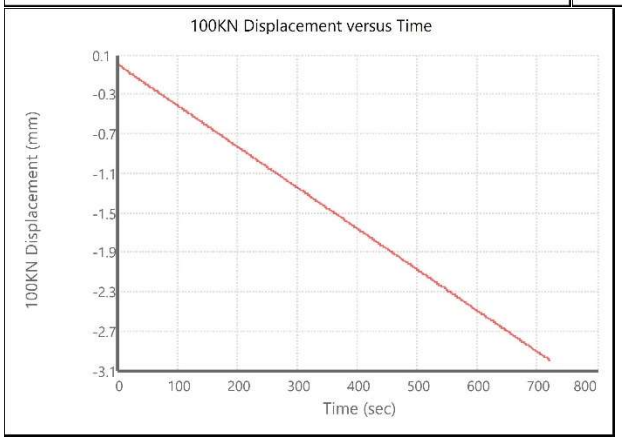




TEST3







RESULTS

1. MAXIMUM COMPRESSIVE STRESS IN TEST 1 IS 27MPa.
2. MAXIMUM COMPRESSIVE STRESS IN TEST 2 IS 13.1MPa.
3. MAXIMUM COMPRESSIVE STRESS IN TEST 3 IS 26MPa.

INFRENCES and CONCLUSION

For test 1 and test 3 maximum stress is almost same values but is test 2 there is a significant differences because Inherent variations in the material itself, such as differences in composition, density, and structural defects, can lead to variations in the compression test results. Natural materials like in this case, especially, can

exhibit significant heterogeneity. Also there can be factor of sample preparation also that causes significant differences.

3.IMPACT TEST

The Charpy impact test is a widely used method to measure the toughness or impact resistance of materials, especially metals assessing the ability of a material to absorb energy and resist fracture under sudden, high-stress loading conditions.

The test involves striking a notched specimen of the material with a pendulum hammer, causing it to fracture. The amount of energy absorbed by the material during the fracture is measured. The specimen is typically a standardized shape, such as a V-notch, to create a stress concentration and induce controlled fracture.

The results of Charpy impact tests are often represented by the energy absorbed at the point of fracture, measured in joules. The impact energy value is then used to assess the material's notch toughness and its ability to resist brittle fracture.

Machine used for performing charpy impact test is WP 400 impact testing unit.

In this three tests are performed, specimen dimensions are length of 55mm,width is 15mm.Notch dimensions are 2mm deep.

RESULTS

For all three tests performed readings are almost same for all specimens and readings are 1.5 N-m(newton meter).Also there is zero error of 0.8N-m due to frictional losses in pendulum and air drag.

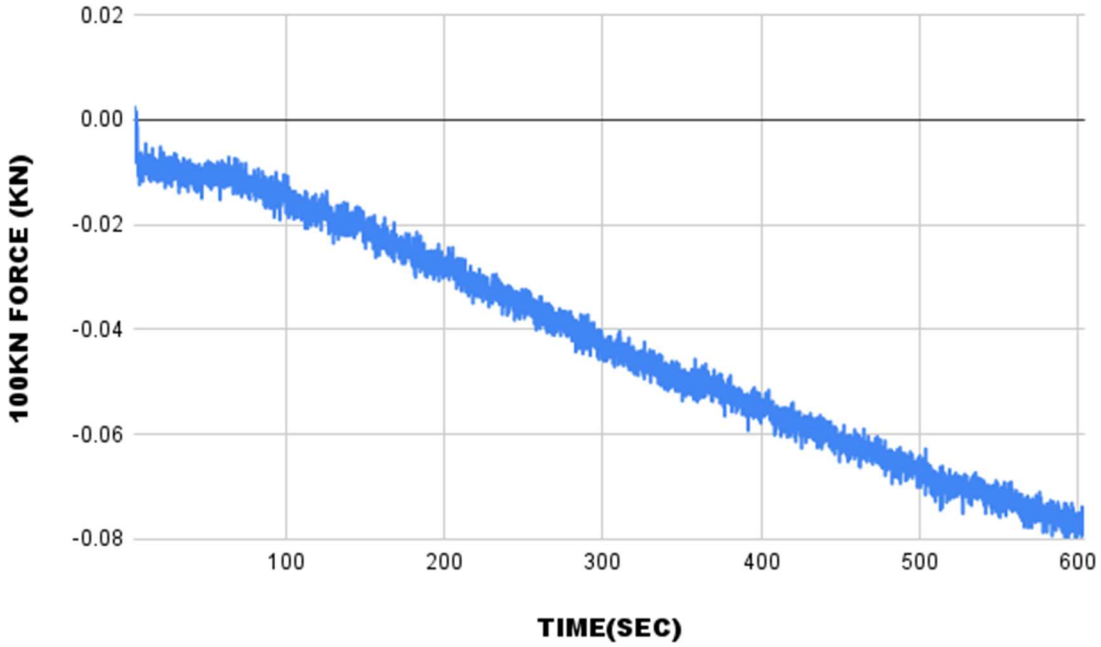
So our final Impact energy
= 1.5-0.8 = **0.7N-m**.

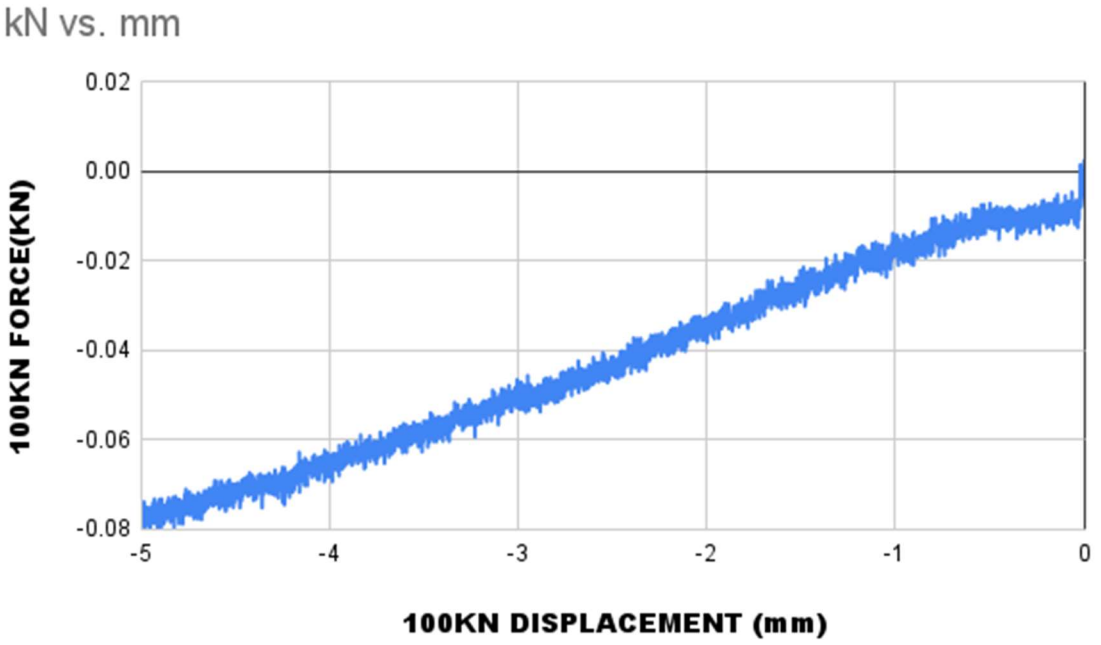
4. BENDING TEST

A four-point bending test is a mechanical test commonly conducted on materials using a testing machine, such as a Materials Testing System (MTS). This type of test is designed to evaluate the flexural strength and behavior of a material when subjected to bending forces.

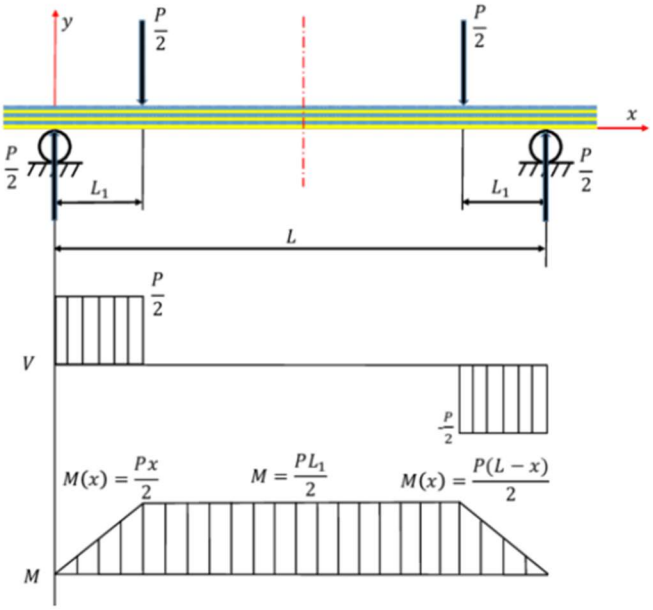
In a four-point bending test, a specimen is supported at two points on either end, creating two spans. The load is then applied at two points, typically equidistant between the supports. This configuration differs from a three-point bending test, where the load is applied at a single point between the supports. The four-point bending test provides a more uniform stress distribution across the central region of the specimen, making it particularly useful for materials with brittle behavior or complex structures.

Dimension of specimen length 150mm, width 25mm.
Distance b/w end points or span 100mm
4 Points loading with 33.33mm space
Loading Rate 0.5mm/min
Absolute end level
Max 5 mm displacement control load
Percentage change 50





CALCULATIONS



Bending moment (M) and shear force (V) diagrams of a four-point bending beam

Maximum bending moment = P*L/2
In this case; P=80N; L=0.033m; Maximum bending moment = 1.32N-m;
Moment of area (I) = 260.42 mm^4;
Distance of outermost point from neutral axis = 2.5mm;
Flexural Strength (Mf) = 12.67 MPa

RESULTS

Flexural strength is equal to 12.67MPa.

5 APPLICATIONS

SOME COMMON APPLICATIONS

Calabash, a type of gourd, has various applications across different cultures and regions. Here are some common applications of calabash material:

1. Containers and Utensils

Calabashes are often hollowed out and used as containers for storing liquids, grains, or other items.

In some cultures, calabashes are used as bowls or cups for serving food and beverages.

2. Musical Instrument Calabashes are used to create traditional musical instruments such as rattles, shakers, and drums. The dried and hollowed gourd can produce unique sounds when filled with seeds or beads and shaken.

3. Art and Crafts:
Calabashes are utilized in various artistic and craft applications. Artists carve intricate designs on the surface, creating decorative pieces like bowls, vases, and masks.

4 Lamps and Lanterns
The dried and hollowed calabashes are sometimes used as lampshades or lanterns. When lit from within, they create a warm and diffused light.

5.Water Storage
Calabashes are often used for carrying and storing water, especially in rural areas where access to modern containers may be limited.

6.Home Decor:
Dried and decorated calabashes can be used as decorative items in homes, adding a touch of traditional and natural aesthetics.

SOME ENGINEERING APPLICATIONS

While calabash material is not a conventional engineering material like metals or polymers, there are some creative and niche engineering applications where it has been utilized. These applications often leverage the unique properties of calabash, such as its lightweight nature

1. Bioengineering and Medical Devices
Calabash material has been explored for creating biodegradable containers for medical implants or drug delivery devices. Its natural properties may make it suitable for certain bioengineering applications.

2.Agricultural Engineering In some agricultural practices, calabashes have been used as natural and biodegradable containers for seedlings. They can serve as protective casings during the early stages of plant growth.

3.Sustainable Packaging

Given its organic and biodegradable nature, calabash material can be explored as an alternative to traditional packaging materials. It may be suitable for packaging certain types of goods in an environmentally friendly manner.

4. Acoustic Engineering

Calabashes have been used to create resonant chambers for musical instruments, and this concept could be extended to engineering applications where controlled acoustic properties are desired.

END OF REPORT