ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 10| October 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

WEB-BASED TOOL FOR CALCULATING MECHANICAL PROPERTIES OF FIBRE–RESIN COMPOSITES

Jobitha Jacob, Aaron George
International Centre for Technological Innovations, Kerala, India

ABSTRACT
Fibre–resin composites are widely used for their excellent strength-to-weight ratio. Predicting their mechanical properties is crucial but often involves laborious calculations. This study introduces a web-based tool that automates the calculation of composite modulus and density using the Rule of Mixtures for parallel loading conditions. Developed with HTML and JavaScript, the tool allows users to input fibre and resin properties along with fibre volume fraction to obtain real-time results. This simplifies the design process and aids both educational and industrial applications.

1 INTRODUCTION

Fibre–resin composites are renowned for their superior strength-to-weight ratios and are extensively used in industries such as aerospace, automotive, and construction (Jayan et al., 2021). The mechanical properties of these composites depend on factors like fibre type, resin properties, and fibre orientation (Laranjeira et al., 2006). Accurate prediction of these properties is essential for effective design and optimisation.

Methods like the Rule of Mixtures are commonly used to estimate composite properties but often require manual calculations (Tam et al., 2012). These calculations can be time-consuming and prone to errors, especially when dealing with multiple scenarios or large datasets. Therefore, there is a need for tools that automate this process to enhance efficiency and reliability.

2 OBJECTIVE

This study aims to develop a web-based application that automates the calculation of mechanical properties of fibre–resin composites under parallel loading using the Rule of Mixtures. The tool seeks to:

- Simplify the calculation process.
- Provide an intuitive interface for inputting parameters.
- Offer real-time results for modulus and density.
- Support educational and industrial use.

3 METHODOLOGY

3.1 Tool Development

The tool is built using HTML and JavaScript for accessibility in web browsers without additional software.

3.2 Functionality

Users select fibre and resin types and input the fibre volume fraction (V_f). The tool calculates:

$$E_c = V_f E_f + (1 - V_f) E_m$$

$$\rho_c = V_f \rho_f + (1 - V_f) \rho_m$$

where E is modulus and ρ is density.

3.3 Implementation

Key code snippets:

```
<!-- HTML elements for user input -->
<label for="fiberSelect">Choose Fibre:</label>
<select id="fiberSelect">
  <option value="pineapple">Pineapple Fibre</option>
  <option value="carbon">Carbon Fibre</option>
</select>

<!-- JavaScript function for calculations -->
<script>
function calculateProperties() {
  const Vf = parseFloat(document.getElementById('fiberVolume').value);
  if (isNaN(Vf) || Vf < 0 || Vf > 1) {
    alert('Enter a valid fibre volume fraction between 0 and 1.');
    return;
  }
  const Ec = Vf * fiber.modulus + (1 - Vf) * resin.modulus;
  const density = Vf * fiber.density + (1 - Vf) * resin.density;
  // Display results
}
</script>
```

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 10| October 2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

4 Results

The tool was tested with pineapple and carbon fibres, and epoxy and polyester resins.

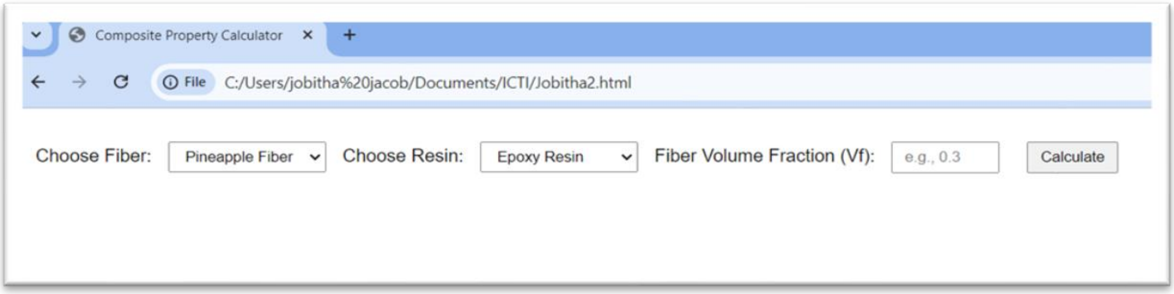

Fig 1 Indicates Basic Interface of the Web-Tool Developed

Example Calculation:

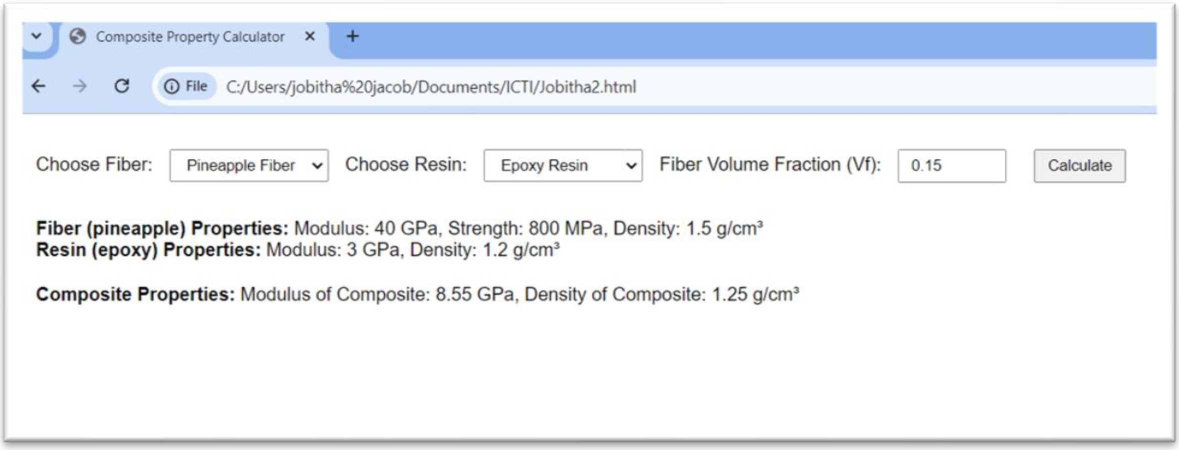

Fig 2 Showcases the result of the Pineapple Fibre-Reinforced Epoxy Resin Composite's Modulus which has a 0.15 volume fraction of fibre (Vf).

For a pineapple fibre–epoxy resin composite with V_f=0.15

- Modulus of Composite (E_c): Calculated using the provided moduli.
- Density of Composite (ρ_c): Computed based on fibre and resin densities.

5 CONCLUSION

The web-based tool effectively automates the calculation of mechanical properties for fibre–resin composites, enhancing efficiency and reducing errors. It is user-friendly and provides immediate results, aiding in material selection and composite design.

Future Work

- Expand material database.
- Allow custom material inputs.
- Include different loading conditions.
- Host on an open-access platform for wider accessibility.

6 REFERENCES

1. *Jayan, J.S., Appukuttan, S., Wilson, R., Joseph, K., George, G. and Oksman, K., 2021. An introduction to fiber reinforced composite materials. Fiber Reinforced Composites, https://doi.org/10.1016/b978-0-12-821090-1.00025-9.*
2. *Laranjeira, E., Boisse, P., & Advani, S.G. (2006). Influence of fiber orientation on mechanical properties of polyester/jute composites. Journal of Reinforced Plastics and Composites, 25(12), 1269–1278. https://doi.org/10.1177/0731684406060577*
3. *Tam, D.K.Y., Chen, J.K., & Lee, Y.D. (2012). High-performance ballistic protection using polymer nanocomposites. Advances in Polymer Nanocomposites (pp. 213–237). Elsevier. https://doi.org/10.1533/9780857095572.2.213*