Enhancing Learning of Mechanics of Materials using Finite Element Simulation Models

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Abstract: Finite element (FE) simulation models are developed to enhance the learning of the Mechanics of Materials course taught in the joint Mechanical Engineering programme of Singapore Institute of Technology (SIT) and the University of Glasgow (UofG). The use of FE models in Mechanics of Materials allows the students to visualize deformation and stress distribution within a loaded structural member in a safe environment. This would also allow an early introduction of FE modelling and simulation practices to students for them to gradually develop their modelling and simulation skills and be ready for the workplace once they graduate from the engineering program. Similar learning strategy of integrating modelling and simulation can also be applied to other mechanical engineering courses, such as, dynamics, mechanics of solids, heat transfer, fluid mechanics and machine design.

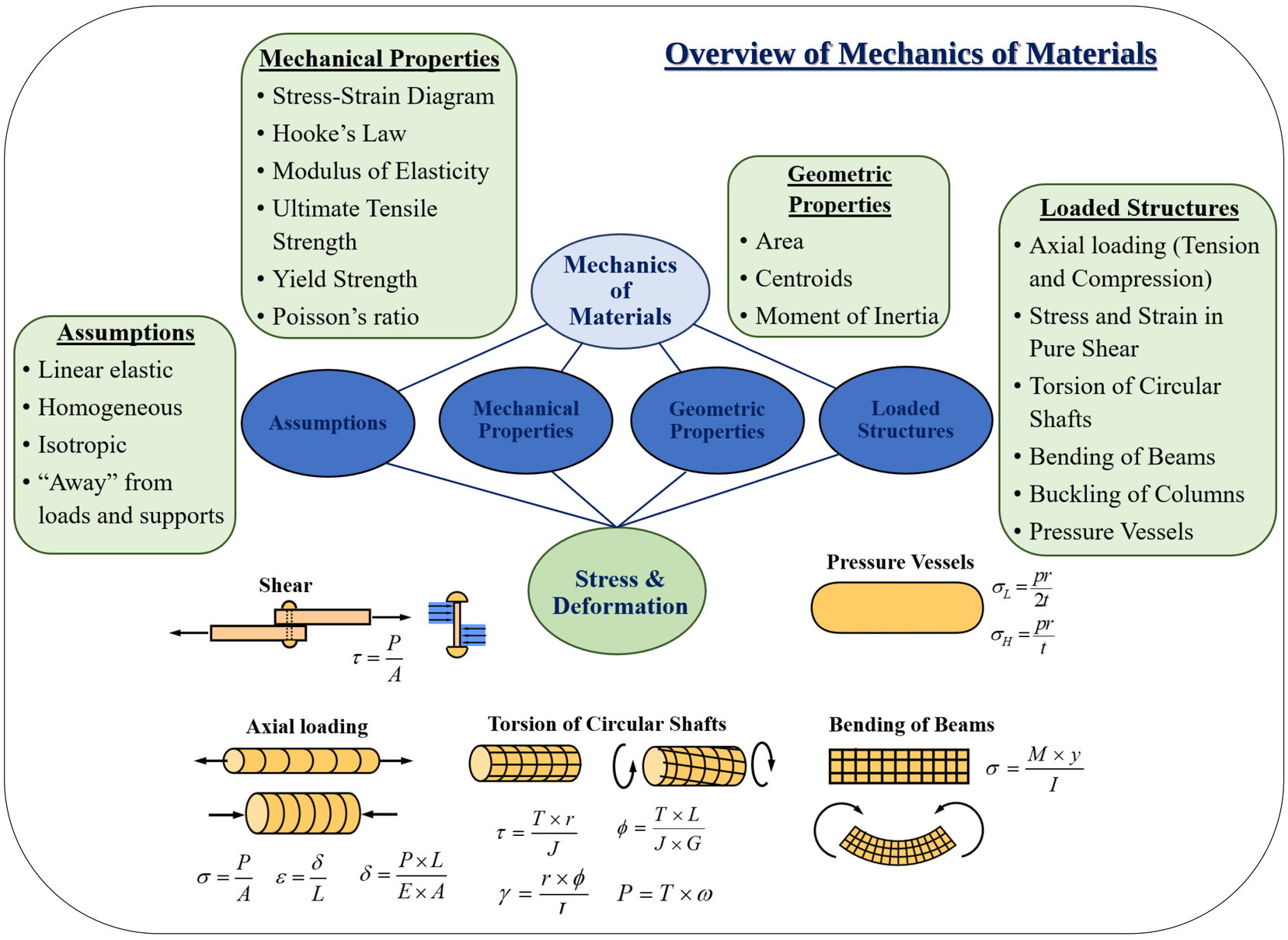
Introduction

- Modelling and simulation techniques have become common in modern engineering workplace [1].
- Modelling and simulation have been integrated in engineering courses for students to gradually develop their skills and competence in modelling and simulation and prepare them for the workplace.
- Modelling and simulation have been integrated in teaching mechanical and civil engineering courses, such as, basic mechanics [2-5].

Purpose

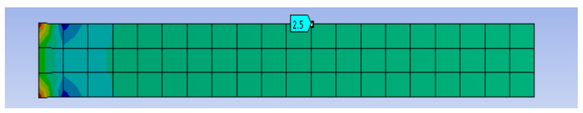
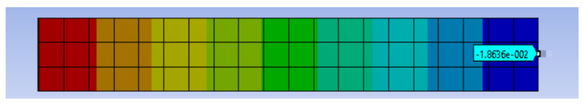
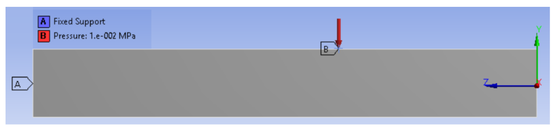
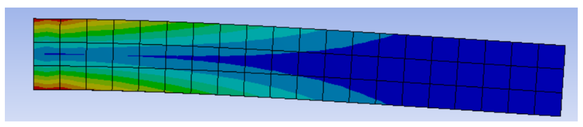
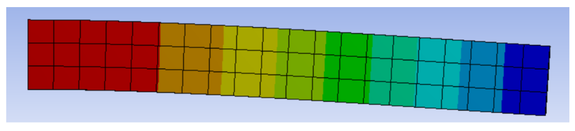
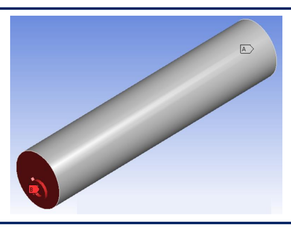
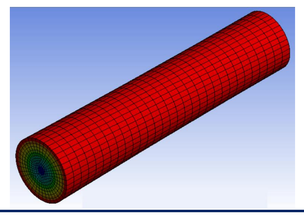
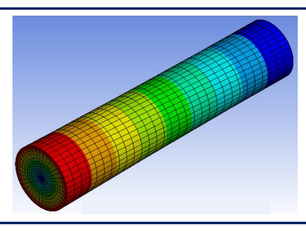
- Enhance the learning of Mechanics of Materials – through the use of FE models, the students can visualize the deformation and stress contours within the structural members.
- Early exposure of students on FE modelling and simulation practices to gradually develop their modelling and simulation skills and be ready for the workplace.
- Students can conduct "experiments" in a safe environment.
- Apply FE modelling and simulation to enhance learning of other courses, such as, dynamics, mechanical design, and heat transfer

Overview of Mechanics of Materials



Learning and Teaching Approach

- FE models are developed using a commercial FE software ANSYS, such as bar subjected axial load, bending of beam and torsion of circular shaft, and will be used by the students during the course:
- Students will verify the results of the FE model with the results of the analytical solutions;
- Students will conduct parametric studies using FE models to study the effects of materials and geometry on the behaviour of the structural member.

	Support and Load	Stress	Displacement	Analytical Solutions
Bar in Tension				$\sigma = \frac{P}{A}$ $\delta = \frac{P \times L}{E \times A}$
Cantilever Beam in Bending				$\sigma = \frac{M \times y}{I}$ $\delta_{max} = \frac{PL^3}{3EI}$
Shaft in Torsion				$\tau = \frac{T \times r}{J}$ $\phi = \frac{T \times L}{J \times G}$

References:

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