Assignment

A shear test is used to measure the shear deformation of a rubber block as shown below. Establish the shear modulus and Young modulus of the rubber block. Determine the deformations of the rubber block using analytical and finite element analysis, and compare these deformations with measurement obtained from the test. Discuss the results of deformation using testing, analytical and finite element calculations.

For the finite element model;

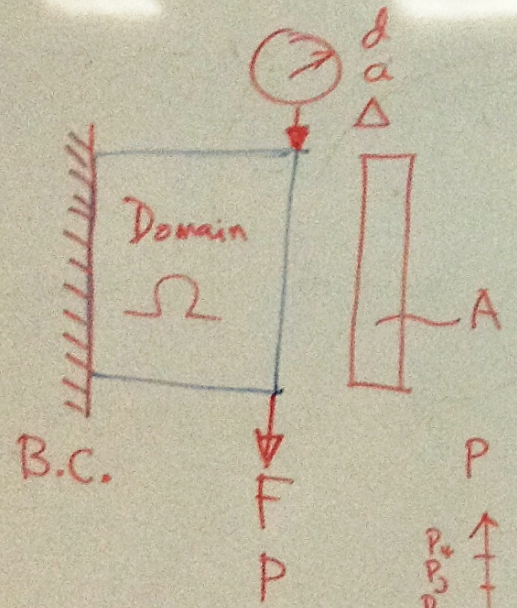
- Model the problem with two constant strain triangle finite elements.
- Establish the material matrix, $\mathbf{D}$ and strain-displacement matrix, $\mathbf{B}$.
- Outline the global stiffness matrix $\mathbf{K}$ and global force vector $\mathbf{F}$.
- Determine a suitable approach, solve the displacement of all nodes,
- Compare the stress in each element.
- Validate with the von-Mises stress.
- Conclude your results.
- What is the optimum number of elements using excel finite element simulation.
- Produce the deformation contour using **COMSOL** finite element software. Plot the profile graph.

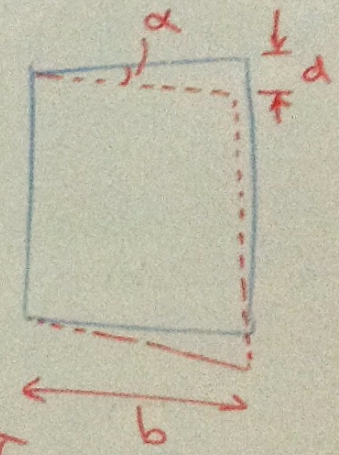
Produce a complete report individually. If possible using LaTeX as in www.ukm.my/cem/latex

Experimental work

Analytical work
(Mechanic of Materials)

Constitutive Law (Equation)

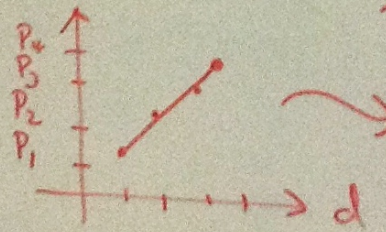


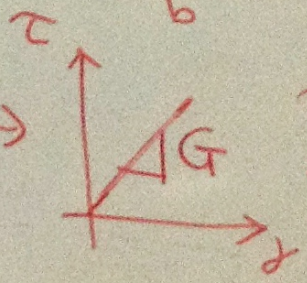


Shear Strain, γ

$\tan\alpha = \frac{d}{b}$

$\tau = \frac{P}{A}$





$\tau \propto \gamma$

$\tau = G\gamma$

Finite Element Method

Analysis — Ansys, ABACUS, PERMAS, ..., COMSOL

Simulation

→ hand calculation

→ excel

→ COMSOL

MRT 2nd Penang Bridge


HI-TECH
SCIENTIFIC

Preprocessor → Engine → Post processor

www.ukm.my/kamal3/fem

| excel | new

Enable / Disable

4.06 MPa MN/m² 4.06 N/mm²

ABACUS < RM12K, RM50K, RM ∞

Excel

1.46 MPa → $G = \frac{E}{2(1+\nu)}$

~~0.48~~ ~~0.5~~ 0.39

Material properties (M) — E, G

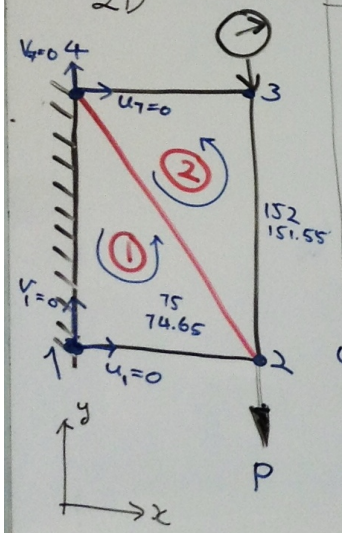
CST

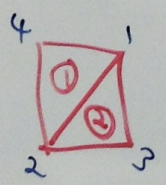
$y = ax^2$

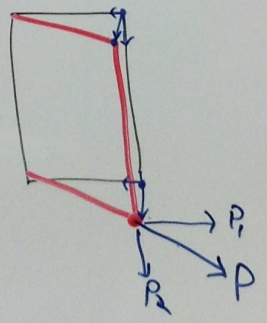
Rubber Damper

2D

Shear (P) Force, N	Deflection (mm) D			
	Δl_1	Δl_2	Δl_3	Δl_{ave}
(2)	3.5	3.5	3.0	3.33
4	7.5	6.5	6.0	6.67
6	11.5	10.5	10.0	10.67
8	15.5	14.5	14.0	14.67
10	20.0	19.0	18.0	19.0





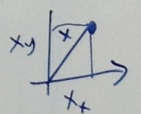


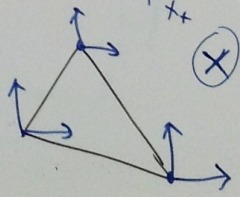
$D = f(P, M, g)$

$\sigma = E\varepsilon$

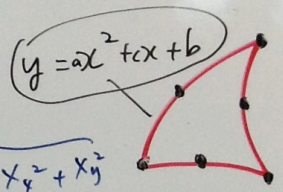
$\tau = G\gamma$

} Constitutive Equation





$(x) = \sqrt{x_x^2 + x_y^2}$



causes

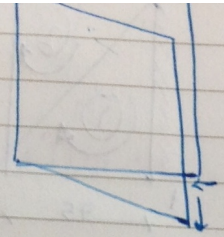
→ human error

→ aparatus error instrumental error

→ environment ~~=~~ factor

→ surface roughness (systematic error)

→

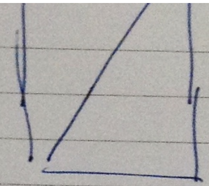


Results are mines due to changing in their direction.

1) The scale is having problem.
2) E may be wrong
3) The load is too small.
4) ~~human~~ mistake withtaking reading.

~~N = Kg X 9.81 =~~

Errors



ii –

inconstant of Data being erratic
For E, G.

– rubber to ~~to~~ loose

- Not use E, G sample on experiment
- rubber too loose
-

Errors

- dial gauge is not calibrated to zero
- Human error while reading the dial gauge.
- due to number of element, increase the number of element, reduce the error.

A sample of a report might include, but not limited to, the following contents:

Introduction.
Background theory & formulation.
Analysis & Simulation
Results
Discussion
- comment on accuracy / error
- comparison with other established results
- limitation of the FEM formulation

Conclusion
Reference
Appendix (if necessary)