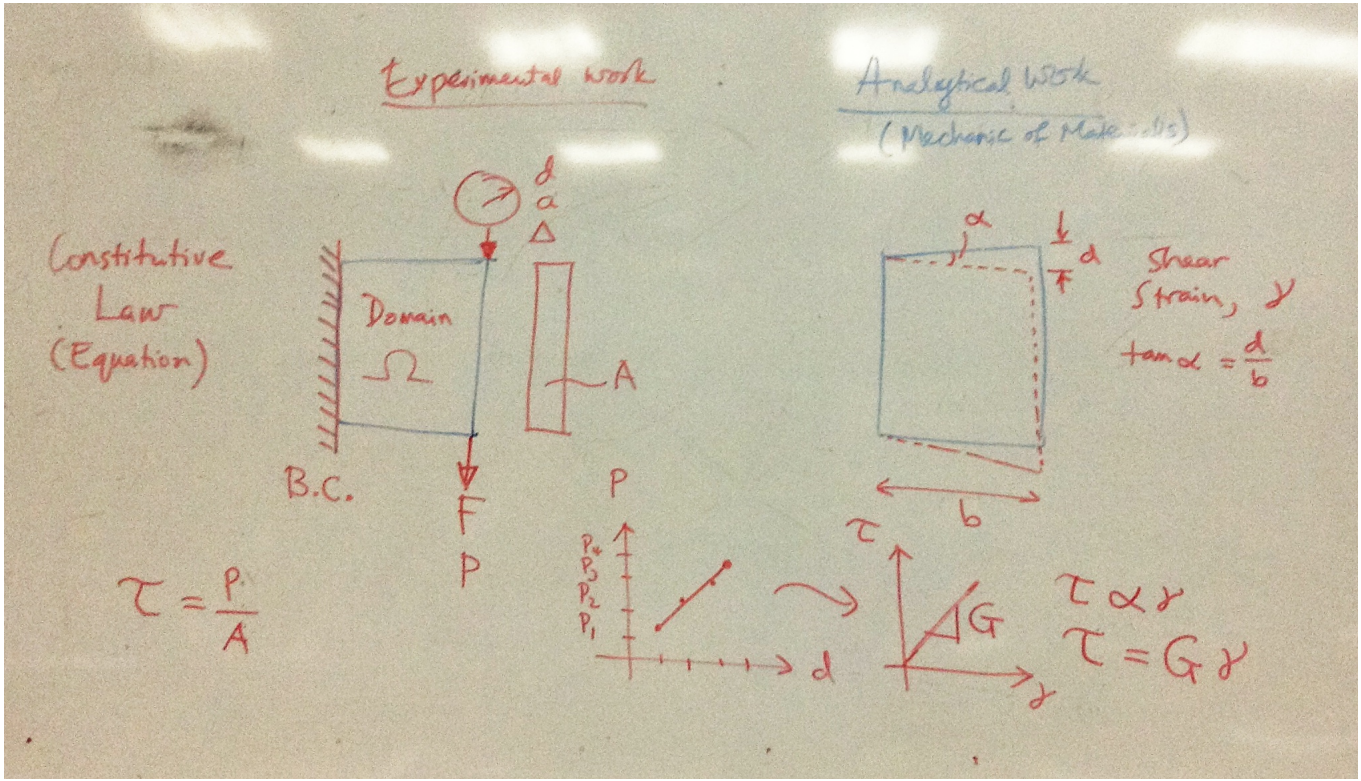
Assignment

A simple shear test is 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 the one 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, **D** and strain-displacement matrix, **B**.
- Outline the global stiffness matrix **K** and global force vector **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)
Domain
Ω
A
B.C.
F
P
d
a
Δ
α
d
Shear Strain, γ
tan α = d/b
b
τ = P/A
P
d
τ
G
γ
τ α γ
τ = G γ

Finite Element Method

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

Simulation

→ hand calculation

→ excel

→ COMSOL

MRT 2nd Penang Bridge


HI-TECH
SCIENTIFIC

Pre processor → Engine → Post processor

www.ukm.my/kamal3/fem

| excel | new

Enable / Disable

1.46 MPa → $G = \frac{E}{2(1+\nu)}$

4.06 MPa MN/m² 4.06 N/mm² RM12K

ABACUS RM50K

Excel RM ⊖

~~0.45~~ 0.5 0.39

Material properties (M) E G

CST

$y = ax + c$

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

$\sigma = E\varepsilon$

$\tau = G\gamma$ } Contitutive Equation

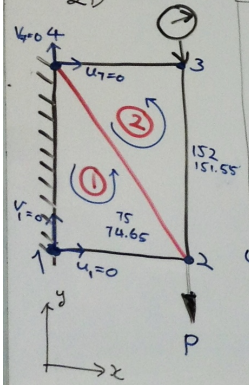
$y = ax^2 + cx + b$

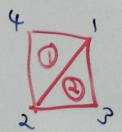
$X = \sqrt{X_x^2 + X_y^2}$

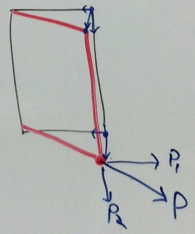
Rubber Damper

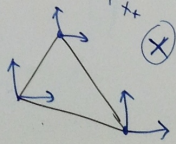
2D

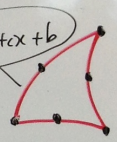
Shear (P) Force, N	Deflaction (mm) D			
	Δl_1	Δl_2	Δl_3	Δl_{ave}
2	3.5	3.5	3.0	3.33
4	7.5	6.5	6.0	6.67
6	11.5	10.5	10.0	10.67
8	15.5	14.5	14.0	14.67
10	20.0	19.0	18.0	19.0

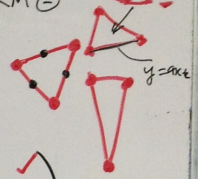












Force (N)	$\Delta l_1(mm)$	$\Delta l_2(mm)$	$\Delta l_3(mm)$	$\Delta l_{1average}(mm)$
0.0000	0.0000	0.0000	0.0000	0.0000
1.0000	0.0200	0.0180	0.0190	0.0190
2.0000	0.0300	0.0300	0.0310	0.0303
3.0000	0.0500	0.0500	0.0510	0.0503
4.0000	0.0800	0.0790	0.0800	0.0797
5.0000	0.1020	0.1020	0.1010	0.1017
6.0000	0.1210	0.1210	0.1210	0.1210
7.0000	0.1420	0.1410	0.1420	0.1417
8.0000	0.1690	0.1690	0.1710	0.1697
9.0000	0.1940	0.1980	0.1960	0.1960
10.0000	0.2190	0.2180	0.2190	0.2187
11.0000	0.2490	0.2450	0.2450	0.2463
12.0000	0.2620	0.2680	0.2630	0.2643
13.0000	0.2990	0.2960	0.2980	0.2977
14.0000	0.3200	0.3220	0.3200	0.3207
15.0000	0.3420	0.3490	0.3420	0.3443

Table 1. The rubber block shear experiment results

causes

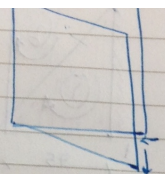
→ human error

→ apparatus error instrumental error

→ ~~environment~~ factor

→ surface roughness (systematic error)

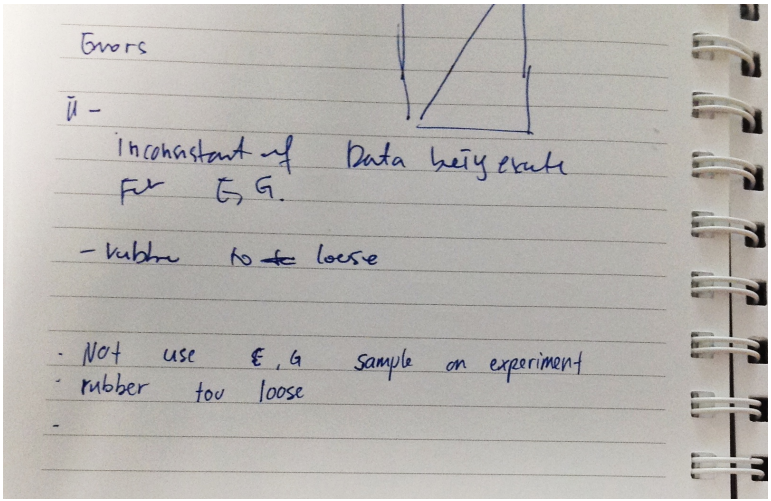
→

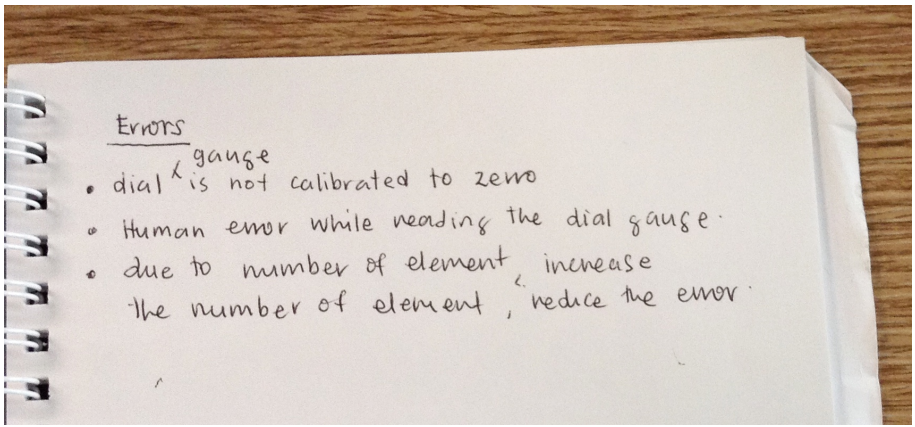


Results are mines due to changing in their direction.

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

~~N = Kg x 9.81 =~~


Errors
Inconsistant of Data being create
For E.G.
- rubber too 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.