UNIVERSITI TEKNIKAL MALAYSIA MELAKA	No Dokumen: SB/MMSB2/BMCS2333/2	No Isu./Tarikh 1/28-3-2013
SOLID MECHANICS 2 **Curved Bars And Davits Test**	No Semakan/Tarikh 4/02-04-2013	Jumlah Mukasurat 3

OBJECTIVE

To apply strain energy concept to define the deformation of a structure in terms of its horizontal and vertical deflections for the four test structures; quarter circle, semicircle, curved davit and angled davit structures.

LEARNING OUTCOMES

At the end of this laboratory session the students should be able to

1. Apply strain energy method to determine horizontal and vertical deflections of curved beams or structures subjected to concentrated load
2. Validate the experimental result based on its theoretical prediction.
3. Determine the maximum horizontal and vertical deflections of the test structures.
4. Write a clear and well presented laboratory report that describes the deflection behaviour of test structures under applied load.

THEORETICAL BACKGROUND

Energy method is a method of determining the stresses and deformations in structures subjected to both static and impact loadings. For example, a beam such as shown in Figure 1 that subjected to transverse loads, the strain energy associated with the normal stress is given by;

$$U = \int_0^L \frac{M^2}{2EI} dx \tag{1}$$

where, M = bending moment
EI = flexural rigidity of the beam
L = beam length

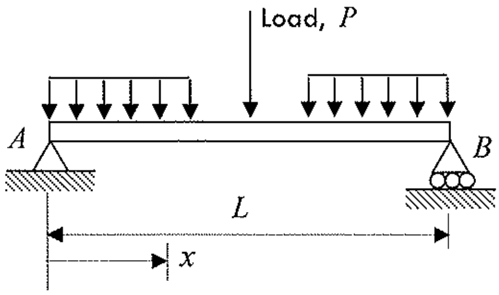


Figure 1 A simply supported beam

Castigliano's theorem states that the deflection x_j , of the point of application of a load P_j measured along the line of action of P_j is equal to the partial derivative of the strain energy of the structure with the respect to the load P_j. It can be show as

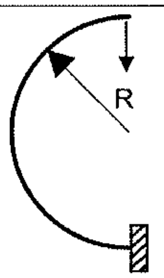
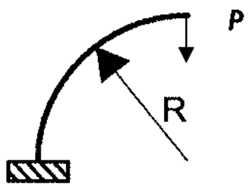
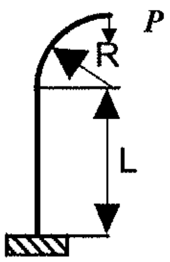
$$x_j = \frac{\partial U}{\partial P_j} \qquad (2)$$

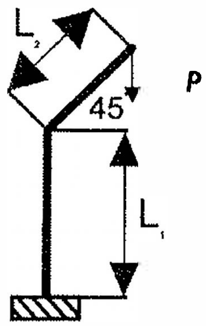
Hence, the theorem can be applied to determine deflections and slopes at various points of a given structure. The use of "dummy" loads enabled us to include points where no actual load was applied. The calculation of a deflection x_j can be simplified if the differentiation with the respect to the load P_j was carried out before the integration. In the case of a beam, referring to equation (1) and (2), the deflection of a beam can be written as

$$x_j = \frac{\partial U}{\partial P_j} = \int_0^L \frac{M}{EI}\frac{\partial M}{\partial P_j}dx \qquad (3)$$

Table 1 Shows formula of horizontal and vertical deflection for few types of beam.

Note: For the FORMAL report, students <u>must prove</u> the equations of ΔH and ΔV as part of their theoretical development or explanation.

Shape	Dimensions	Δ H	Δ V
 a) Semi circle	R = 150 mm	$\frac{2PR^3}{EI}$	$\frac{\pi PR^3}{2EI}$
 b) Quarter circle	R = 150 mm	$\frac{PR^3}{2EI}$	$\frac{\pi PR^3}{4EI}$
 c) Curved davit	R = 75 mm L = 150 mm	$\frac{PRL}{2EI}(2R+L)$	$\frac{PR^2}{4EI}(4L+\pi R)$

 d) Angle davit	L_1 = 150 mm L_2 = 105 mm	$\frac{PL_1L_2(0.707L_1+L_2)}{2EI}+\frac{PL_2^{\,3}}{6EI}$	$\frac{PL_2^{\,2}}{6EI}(3L_1+L_2)$

where, Young's Modulus for aluminium alloy, E_{al} = 69 GN/m^2 , P = load, R = radius, I = second moment of area and L = length.

APPARATUS

a) Test Frame
b) Back plate
c) A pair of dial indicators
d) Four test structures
e) Weight set
f) Vernier caliper

TASK

i.The student must design and perform the experiment in order to analyse and compare the experimental and theoretical results

ii.All related data must be recorded