College of Engineering Pune

F.Y M Tech Civil (Structures)

Subject CE 5102 Solid Mechanics (End sem)

Year 2011-12 | Term – First

Date -21/11/2011 | Time -4.00 pm to 7 .00 pm

Maximum marks 50

Instructions : *All questions are compulsory*

Use of non-programmable calculator is allowed.

Assume suitable data if required .

Q 1) Derive the expression for Cauchy ' s stress formula for the normal and shear stress on any arbitrary plane. (5)

Q 2) Using Saint-Venant's method derive the expression for the torsion of prismatic bars (7)

Q 3) Explain the phenomena of cubical dilation . (6)

Q 4) Derive the expression for Displacement equations of equilibrium . (5)

Q 5) The Displacement field for a body is given by $u = k (x^2 + y) I + k (y + z) j + k(x^2 + 2z^2) k$.

Where $k=10^{-3}$ at a point A(2, 2, 3) consider two line segments AB with the direction cosines

$n_x=n_y= n_z =1/\sqrt{3}$ and BC with the direction cosines $n_x= n_y= 1/\sqrt{2}$ and $n_z =0$. Determine the angle between the segments before and after deformation (6)

Q 6) What is an Ideally plastic solid. (3)

Q 7) What are yield surfaces of Tresca and von Mises. (8)

Q 8) If a is a constant and $\varepsilon_x = a(x^2+y^2)$, $\varepsilon_y = ay^2$, $\gamma = 2axy$, check whether it represents a possible state of strain or not. (6)

Q9)Compute Lame's coefficient μ and τ for steel having E =207 GPa and v= 0.3 and for concrete E =28 GPa and v= 0.2 (4)

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Wish you good luck

Civil Engineering Department
College of Engineering Pune
M.Tech. Civil (Structural Engineering): 2011-2013 Batch

End-Semester Examination

(SE 501) Structural Dynamics

Date: 19th November 2011
Duration: 3Hrs

Max. Marks: 50

Instructions:

1. Solve all questions.
2. Make necessary assumptions and assume suitable data wherever required and state it clearly.

Q.1 (a) Prove that the Dynamic Magnification Factor is maximum when the frequency ratio is $\sqrt{(1-2\xi^2)}$. For 5% damping, show that the dynamic response is ten times the static response. (05)

(b) A machine for manufacturing delicate electronic devices is to be mounted on a factory floor, using vibration isolation system. The vibration floor has predominant frequency of 10 Hz, with maximum amplitude of 20×10^{-4} mm. For reliable operations, the machine can tolerate maximum amplitude of 1×10^{-4} mm.

(i) For 2% damping, determine the natural frequency of vibration of the machine.

(ii) If the mass of the machine is 1500 kg, determine its static deflection. (05)

Q.2 Determine the first three natural frequencies of vibration and first three mode shapes of vibration of a fixed beam of span L and uniform flexural rigidity. Consider the beam as a system with uniform distribution of mass. Use following shape function:

$$\phi(x) = C_1.\sin(\beta x) + C_2.\cos(\beta x) + C_3.\sinh(\beta x) + C_4.\cosh(\beta x) \qquad (10)$$

Q.3 For the frame shown in Fig 1, the mode shapes and modal frequencies are given. (i) Determine the undamped response of the system, when it is subjected to a constant force of 100 kN, at all the floors, for duration of 10 sec.(ii) Determine the damping matrix of the structure if the damping ratio in the first and third mode is 5%. Also find the damping ratio in the third mode.

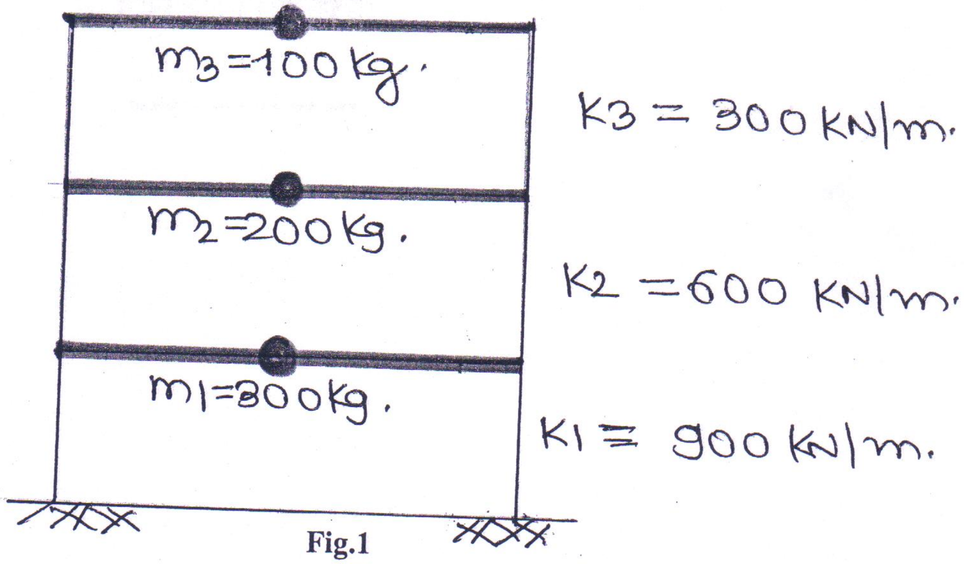


Fig.1

$$\phi_1 = \begin{Bmatrix} 1.00 \\ 0.701 \\ 0.342 \end{Bmatrix} \qquad \phi_2 = \begin{Bmatrix} 1.00 \\ -0.305 \\ -0.560 \end{Bmatrix} \qquad \phi_3 = \begin{Bmatrix} 1.00 \\ -1.565 \\ 1.164 \end{Bmatrix}$$

The natrual frequencies are $\omega_1 = 29.95$ rad /sec, $\omega_2 == 62.55$ rad /sec and $\omega_3 = 87.70$ rad/sec.

(10)

Q.4 A 150 m high RCC chimney of M40 concrete and with uniform cross section has outside diameter 10 m and inside diameter 9 m. It is to be clamped at the base. The chimney is idealized for dynamic analysis as a SDOF system , with the following lateral deflected shape :

$$\Psi(x) = 3/2\,(x/L)^2 - 1/2\,(x/L)^3$$

where L is the length of the chimney and *x* is measured from base. The unit weight of concrete is 2500 kg/ m^3. Consider exposed area of circular surface = 0.6 times the rectangular area. Calculate the shear force and bending moment at the base of the chimney due to ground acceleration of 0.25g. Also find the top deflection.

(10)

Q.5 The Fig. 2 shows a SDOF system with base isolation. The top RCC slab is supported on four columns. All columns are isolated at the base.

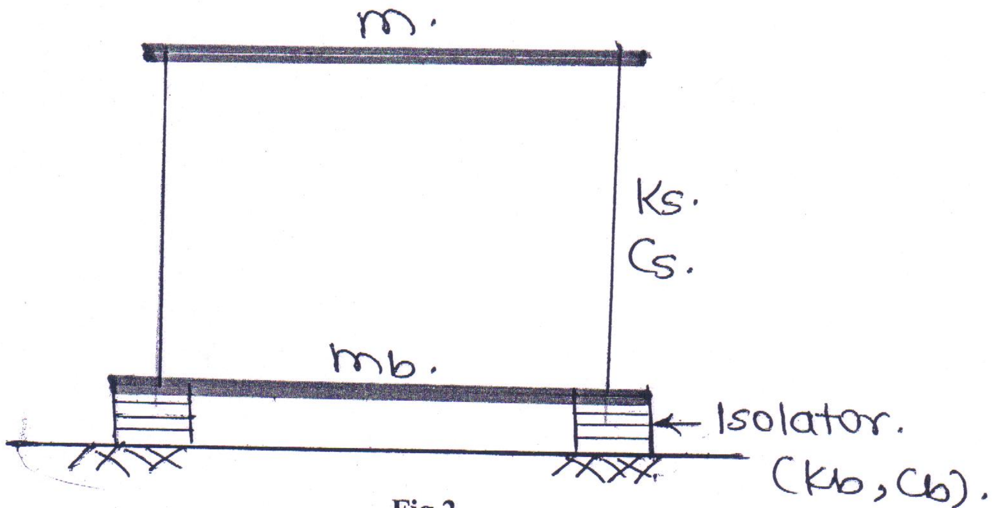


Fig.2

- Size of each column: 300 mm × 300 mm.
- Height of column = 3.2 m
- All columns are assumed to be fixed at the top and bottom.
- The top slab: Dimensions 5 m × 5 m and is 300 mm thick.
- The bottom slab: Dimensions 5 m × 5 m and is 500 mm thick.
- Grade of concrete: M25.
- The unit weight of concrete = 2500 kg/ m^3.
- Damping in the structure = 5%
- Damping of the isolation system= 25%.
- Stiffness of each isolator = 3×10^6 N/m.
- Assume 50% mass of columns lumped at the top and at the bottom level.

Find the natural fundamental frequency of vibration of the isolated system. Show that base isolation technique is effective in increasing the time period of the structure. (10)

Department of Civil Engineering
College of Engineering Pune
M. Tech. Civil (Structural Engineering)
(SE 505) Advanced Design of Structures
End-Semester Examination

Duration: 3 Hr.

Date: 23rd November 2011
Max. Marks: 50

Instructions:

1. Answer any **THREE** Questions.
2. Illustrate your answers with necessary sketches.
3. Assume suitable data if necessary.
4. Use LSM for design.
5. Use of non-programmable calculator and relevant Indian Codes is allowed.

Q.1 (a) Determine the collapse load in terms of M_P, for the portal frame shown in Fig.1, indicating structural configuration and loads with positions. The plastic moment capacity of a beam is twice that of a column. If factored load Wu = 72 kN and fy of steel = 250 MPa, select the sections required for the beam and columns. (4)

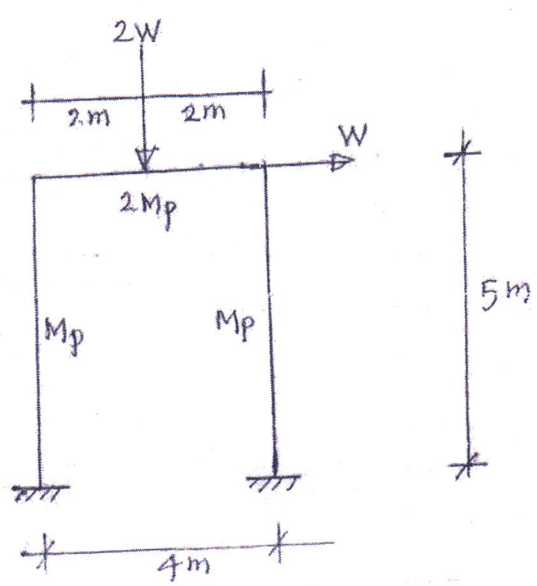


Fig.1

(b) A web of a plate girder consists of 1000 mm x 16 mm plate of grade Fe 410. The web plate is to be spliced to resist the factored shear of 1000 kN and the bending moment of 350 kNm. The flange plate thickness is 50 mm for each flange. Design a web splice, using double-V groove weld. (4)

(c) A cement silo has the following data:

- Diameter = 10 m, Height = 30 m, Unit weight of cement = 15.2 kN/m^3
- Ratio of horizontal to vertical pressure intensity = 0.54
- Coefficient of friction between concrete and material = 0.70.

Calculate the percentage of total weight of stored material transferred to the silo walls by friction. (4)

(d) A hyper shell of the inverted umbrella type roof covers plan area of 12m x 12m. The central dip of the roof is 1.2 m. The shell supports the total gravity load of 2.40 kN/m^2. Determine the maximum tension in the edge beams of the shell. (4)

Q.2 (a) A semi-infinite beam resting on an infinite elastic foundation is loaded at its end by a downward concentrated force P_0 and clockwise moment M_0. Derive the equations of deflections, slope, bending moment and shear force in the beam, in terms of P_0 and M_0 and conventionally defined symbols β, k, Aβx, Bβx, Cβx, Dβx. (10)

(b) A railroad, considered infinitely long, consists of steel rails having following properties:

- E = 200 GPa, Depth = 184 mm
- Distance from top of the rail to its centroid = 99.1 mm
- Moment of inertia = 37x106 mm4.

The rail is supported by ties, ballast and a road bed that together are assumed to act as an elastic foundation with spring constant k = 14.0 N/mm^2. For a single wheel load of 170 kN, sketch the diagrams of deflection, slope, bending moment and shear force in the beam, indicating the maximum values. Also determine the maximum flexure stress in the rail. (6)

Q.3 (a) State "Theorems of plastic collapse". (3)

(b) A gable frame is supported and subjected to six loads, as shown in Fig.2. The plastic moment capacity of column is M_P and that of rafter is $2M_P$. Obtain the degree of indeterminacy of the frame and decide the critical mechanism for the frame. Show that the collapse load, Wu = 4MP / 15L. (14)

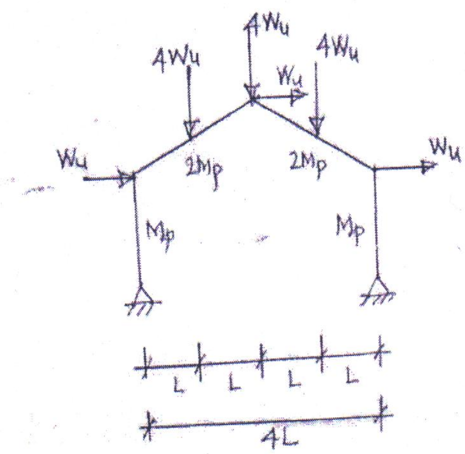


Fig.2

Q.4 Design an 18 m long simply supported welded plate girder including stiffeners, to support a uniformly distributed load of 50 kN/m excluding self weight, and two concentrated loads of 350 kN each, at quarter points of the span. Assume that the girder is laterally supported throughout. (17)

Q.5 (a) Describe briefly the behavior of a beam-column. (4)

(b) Design a column of a building frame for the following data:

- Height of column = 4 m
- Factored axial load = 500 kN
- Factored moment Mz :
  - at top of column = 27 kNm
  - at bottom of column=45 kNm
- Yield stress of steel = 250 MPa
- Take the effective length of the column as 0.8L along both the axes. Assume that there is no sway. (12)

Q.6 Design a gantry girder for the following data:

- Centre to centre distance between columns = 7.5 m
- Crane capacity = 200 kN
- Self weight of the crane girder excluding trolley = 200 kN
- Self weight of trolley = 40 kN
- Minimum clearance for hook = 1.2 m
- Distance between wheel centers = 3.5 m
- Centre to centre distance between gantry rails = 15 m
- Self weight of the rail section = 300 N/m
- Yield stress of steel = 250 MPa

Assume that the gantry girder is not laterally restrained along its span. Preferable section for a gantry girder is ISMB with a channel ISMC at the top. (16)

βx	$A_{\beta x}$	$B_{\beta x}$	$C_{\beta x}$	$D_{\beta x}$
0	1	0	1	1
0.02	0.9996	0.0196	0.9604	0.9800
0.04	0.9984	0.0384	0.9216	0.9600
0.10	0.9907	0.0903	0.8100	0.9003
0.20	0.9651	0.1627	0.6398	0.8024
0.30	0.9267	0.2189	0.4888	0.7077
0.40	0.8784	0.2610	0.3564	0.6174
0.50	0.8231	0.2908	0.2415	0.5323
0.60	0.7628	0.3099	0.1431	0.4530
0.70	0.6997	0.3199	0.0599	0.3798
$\pi/4$	0.6448	0.3224	0	0.3224
0.80	0.6354	0.3223	−0.0093	0.3131
0.90	0.5712	0.3185	−0.0657	0.2527
1.00	0.5083	0.3096	−0.1108	0.1988
1.10	0.4476	0.2967	−0.1457	0.1510
1.20	0.3899	0.2807	−0.1716	0.1091
1.30	0.3355	0.2626	−0.1897	0.0729
1.40	0.2849	0.2430	−0.2011	0.0419
1.50	0.2384	0.2226	−0.2068	0.0158
$\pi/2$	0.2079	0.2079	−0.2079	0
1.60	0.1959	0.2018	−0.2077	−0.0059
1.70	0.1576	0.1812	−0.2047	−0.0235
1.80	0.1234	0.1610	−0.1985	−0.0376
1.90	0.0932	0.1415	−0.1899	−0.0484
2.00	0.0667	0.1231	−0.1794	−0.0563
2.20	0.0244	0.0896	−0.1548	−0.0652
$3\pi/4$	0	0.0670	−0.1340	−0.0670
2.40	−0.0056	0.0613	−0.1282	−0.0669
2.60	−0.0254	0.0383	−0.1019	−0.0636
2.80	−0.0369	0.0204	−0.0777	−0.0573
3.00	−0.0423	0.0070	−0.0563	−0.0493
π	−0.0432	0	−0.0432	−0.0432
3.20	−0.0431	−0.0024	−0.0383	−0.0407
3.40	−0.0408	−0.0085	−0.0237	−0.0323
3.60	−0.0366	−0.0121	−0.0124	−0.0245
3.80	−0.0314	−0.0137	−0.0040	−0.0177
$5\pi/4$	−0.0279	−0.0139	0	−0.0139
4.00	−0.0258	−0.0139	0.0019	−0.0120
$3\pi/2$	−0.0090	−0.0090	0.0090	0
2π	0.0019	0	0.0019	0.0019

COLLEGE OF ENGINEERING, PUNE

F.Y.M. Tech. Civil (Structural) Engineering

(SE-507) Advanced Structural Analysis

End- Semester Examination

Year : 2011-12 **Semester : I**

Max. Marks: 50 Time: 3 Hrs

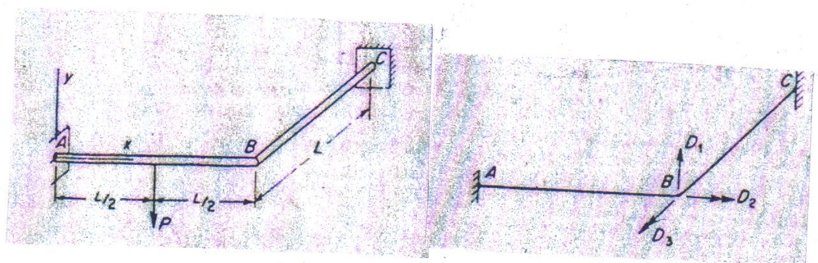
Instruction: ALL Questions are compulsory.

Q.1 The Grid shown in figure consists of two members (AB and BC) that are rigidly joined at B. Each member is assumed to have a constant flexural rigidity EI and torsional rigidity GJ. For the given loading the displacement at B can be derived as

$$D_1 = -\frac{PL^3}{96EI}\frac{5+2\eta}{1+\eta}$$

$$D_2 = \frac{PL^2}{16EI}\frac{5+2\eta}{(1+\eta)(4+\eta)}$$

$$D_3 = -\frac{3PL^2}{16EI}\frac{1}{(1+\eta)(4+\eta)}$$



where $\eta = \dfrac{GJ}{EI}$.

(a) Determine the reaction components at C for the given loading on the grid. [4]

(b) For member AB determine the member-end forces. [6]

(c) If the members AB and BC are found torsionally very weak, how will be the above displacements varied? [6]

Q.2 Why is it necessary to impose boundary conditions during structural analysis? With suitable example discuss various approaches used to model displacement boundary conditions in the stiffness analysis of structures. [8]

Q.3 Explain semi-bandwidth of stiffness matrix and its implementation in a typical computer program of Stiffness Analysis. [8]

Q.4 Starting from governing differential equation derive stiffness matrix for basic Bar-element using finite element formulation. [18]