CE : GATE 2020

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I. 27-39

1) A continuous function $f(x)$ is defined. If the third derivative at x_i is to be computed by using the fourth order central finite-divided-difference scheme (with step length = h), the correct formula is

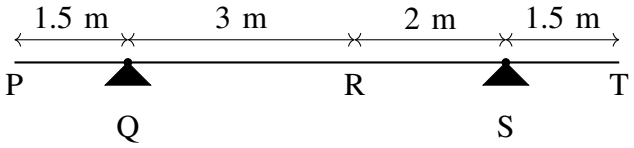
   a) $f'''(x_i) = \frac{-f(x_{i+3})+8f(x_{i+2})-13f(x_{i+1})+13f(x_{i-1})-8f(x_{i-2})+f(x_{i-3})}{8h^3}$

   b) $f'''(x_i) = \frac{f(x_{i+3})-8f(x_{i+2})-13f(x_{i+1})+13f(x_{i-1})+8f(x_{i-2})+f(x_{i-3})}{8h^3}$

   c) $f'''(x_i) = \frac{-f(x_{i+3})-8f(x_{i+2})-13f(x_{i+1})+13f(x_{i-1})+8f(x_{i-2})-f(x_{i-3})}{8h^3}$

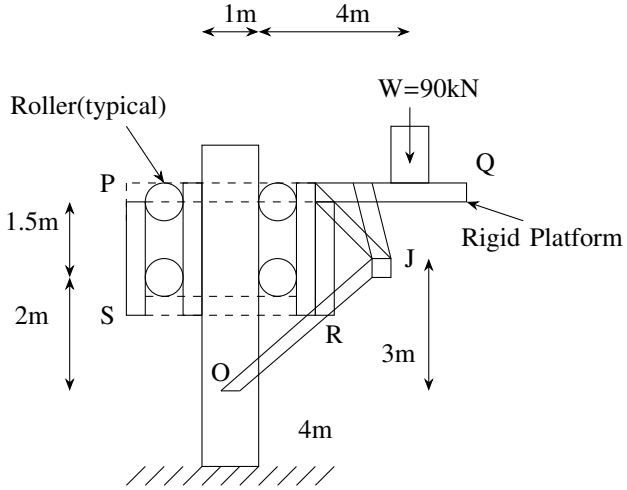
   d) $f'''(x_i) = \frac{f(x_{i+3})-8f(x_{i+2})+13f(x_{i+1})+13f(x_{i-1})-8f(x_{i-2})-f(x_{i-3})}{8h^3}$

2) Distributed load(s) 0f $50kN/m$ may occupy any position(s) (either continuously or in patches) on the grider **PQRST** as shown in the figure (not drawn to the scale) The maximum negative negative (hogging) bending moment (in $kN.m$) that occurs at point R, is



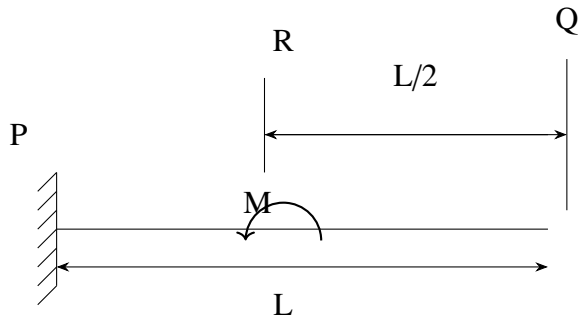
   a) 22.50 b) 56.25 c) 93.75 d) 150.00

3) A rigid weightless platform **PQRS** shown in the figure (not drawn to the scale) can slide freely in the vertical direction. The platform is held in position by the weightless member **OJ** and four weightless, frictionless rollers. Points **O** and **J** are pin connections. A block of $90kN$ rests on the platform as shown in the figure The magnitude of horizontal componenet of the reaction (in kN) at pin **O**, is



a) 90 b) 120 c) 150 d) 180

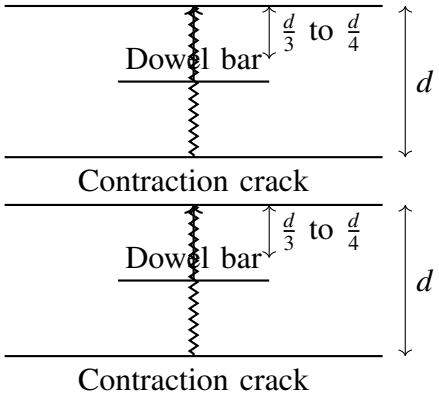
4) A cantilever beam **PQ** of uniform flexural rigidity (EI) is subjected to a concentrated moment M at **R** as shown in the figure

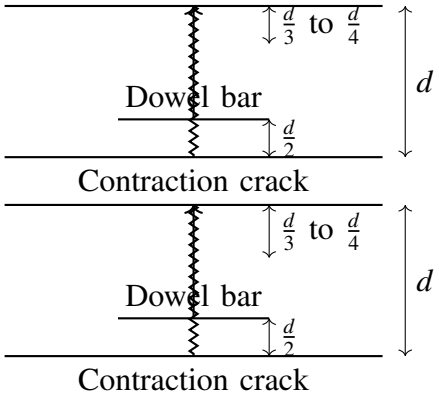


The deflection at the free end **Q** is

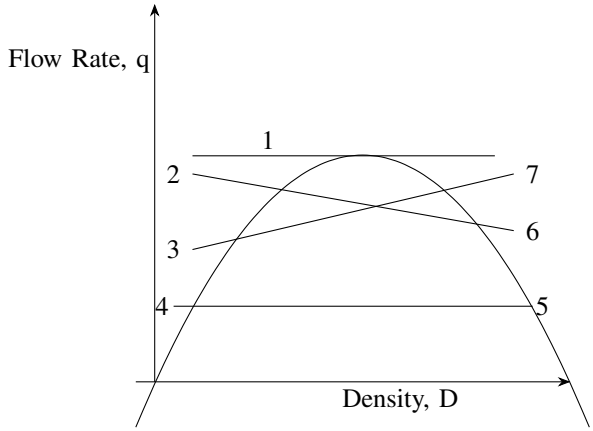
a) $\frac{ML^2}{6EI}$ b) $\frac{ML^2}{4EI}$ c) $\frac{3ML^2}{8EI}$ d) $\frac{3ML^2}{4EI}$

5) A dowel bar is placed at a contraction joint. When contraction occurs, the concrete slab cracks at predetermined location(s). Identify the arrangement, which shows the correct placement of dowel bar and the place of occurence of the contraction crack(s).





6) The relationship between traffic flow rate (q) and density (D) is shown in the figure

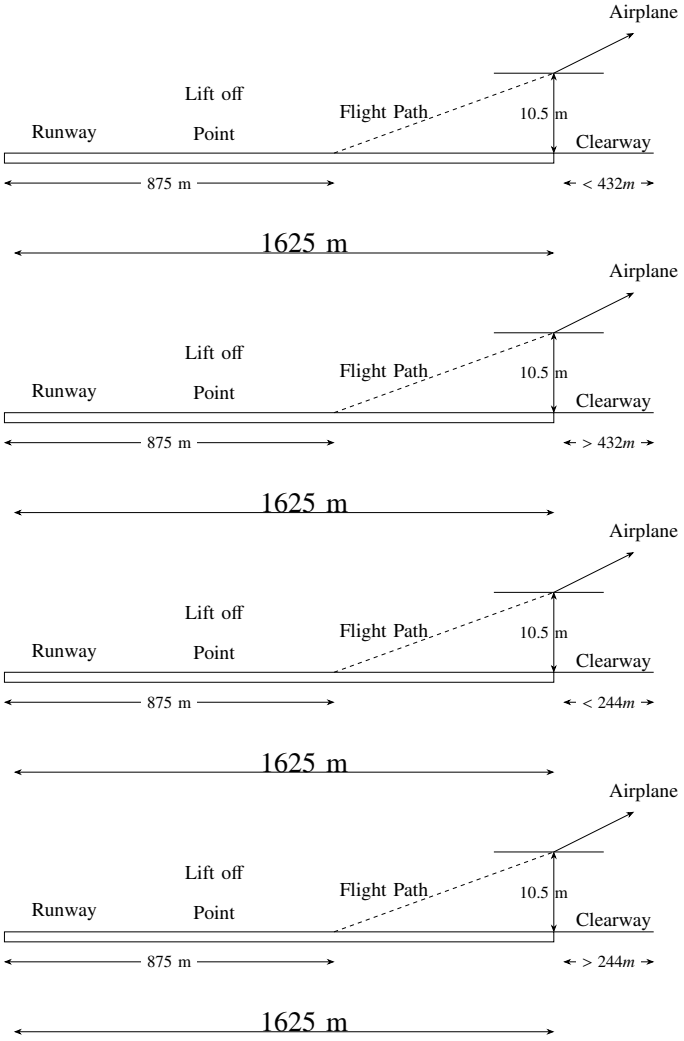


The shock wave condition is depicted by

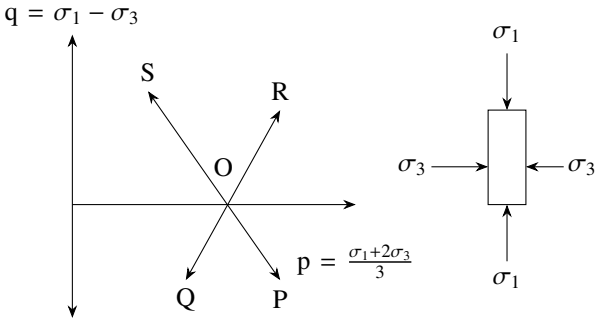
a) flow with respect to point 1 ($q_1 = q_{max}$)
b) flow changing from point 2 to point 6 ($q_2 > q_6$)
c) flow changing from point 3 to point 7 ($q_3 < q_7$)

d) flow with respect to point 4 and point 5 ($q_4 = q_5$)

7) The appropriate design length of a clearway is calculated on the basis of 'Normal Take-off' condition. Which one of the following options correctly depicts the length of the clearway? (Note: None of the options are drawn to scale)



8) The total stress paths corresponding to different loading conditions, for a soil specimen under the isotropically consolidated stress state(O), are shown below

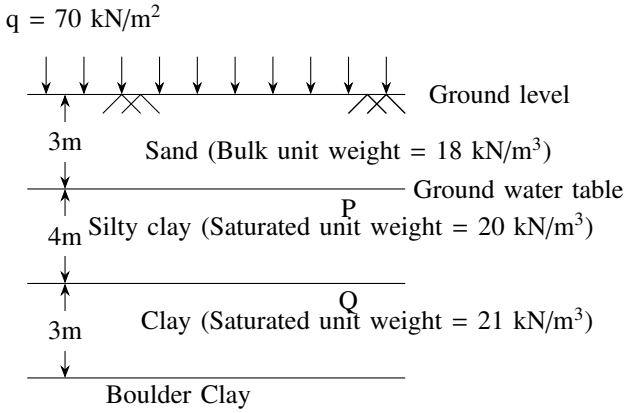


Stress Path	Loading Condition
OP	I-Compression loading (σ_1 - increasing ; σ_3-constant)
OQ	II-Compression unloading (σ_1 - constant ; σ_3-decreasing)
OR	III-Extsion loading (σ_1 - decreasing ; σ_3-constant)
OS	IV-Extension loading (σ_1 - constant ; σ_3-increasing)

The correct match between the stress paths and the listed loading conditions, is

a) OP-I, OQ-II, OR-1V, OS-III
b) OP-IV, OQ-III, OR-I, OS-II
c) OP-III, OQ-II, OR-I, OS-IV
d) OP-I, OQ-III, OR-II, OS-IV

9) The soil profile at a site up to a depth of $10m$ is shown in the figure (not drawn to the scale). The soil is preloaded with a uniform subcharge (q) of $70kN/m^2$ at the ground level. The water table is at a depth of $3m$, below ground level. The soil unit weight of the respective layers is shown in the figure. Consider unit weight of water as $9.81kN/m^3$ and assume that the surcharge (q) is applied instantaneously. Immediately after preloading, the effective stresses (in kPa) at points P an Q, respectively, are



a) 124 and 204 b) 36 and 90 c) 36 and 126 d) 54 and 95

10) Water flow at the rate of $12m^3/s$ in a $6m$ wide rectangular channel. A hydraulic jump is formed in the channel at a point where the upstream depth is $30cm$ (just before the jump). Considering acceleration due to gravity as $9.81m/s^2$ and density of water as $1000kg/m^3$, the energy loss in the jump is

a) $114.2kW$ b) $114.2MW$ c) $141.2h.p.$ d) $141.2J/s$

11) A water supply scheme transports scheme transports $10MLD$ (Million Litres per Day) water through a $450mm$ diameter pipeline for a distance of $2.5km$. A chlorine dosee of $3.50mg/litre$ is applied at the starting point of the pipeline to attain a certain level of disinfection at the downstream end. It is decided to increase the flow rate from $10MLD$ to $13MLD$ in the pipeline. Assume exponent for concentration, $n = 0.86$. With this increased flow, in oreder to attain the same level of disinfection, the chlorine dose (in mg/litre) to be applied at the starting point should be

a) 3.95 b) 4.40 c) 4.75 d) 5.55

12) An open traverse $PQRST$ is surveyed using theodolite and the consecutive coordinates obtained are given in the table

Line	Northing (m)	Southing (m)	Easting (m)	Westing (m)
PQ	110.2	-	45.5	-
QR	80.6	-	-	60.1
RS	-	90.7	-	70.8
ST	-	105.4	55.5	-

TABLE 12: Consecutive Coordinates

If the independent coordinates (Northing, Easting) of station P are $(400m, 200m)$, the independent coordinates (in m) of station T, are

a) $194.7, 370.1$ b) $205.3, 429.9$ c) $394.7, 170.1$ d) $405.3, 229.9$

13) If C represents a line segment between $(0, 0, 0)$ and $(1, 1, 1)$ in Cartesian coordinate system, the value (expresssed as integer) of the line integral

$$\int_C [(y + z)\, dx + (x + z)\, dy + (x + y)\, dz] \tag{1}$$

is _____.