CBCS SCHEME

USN | | | | | | | | | | | 18CV741

Seventh Semester B.E. Degree Examination, Feb./Mar. 2022
Earthquake Engineering

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of IS-1893-2016, 13920-2016 is permitted.

Module-1

1 a. What is an earthquake? Explain the characteristics of different body waves and surface waves with neat sketches. **(10 Marks)**
b. Explain the plate tectonic theory and its mechanism. **(05 Marks)**
c. Explain clearly causes of earthquake and effects of earthquakes on structures. **(05 Marks)**

OR

2 a. Explain the concept of elastic rebound theory. **(06 Marks)**
b. How earthquakes are classified? Explain. **(07 Marks)**
c. Differentiate between Magnitude and Intensity of earthquake. **(07 Marks)**

Module-2

3 a. Derive an expression for motion of undamped single degree of freedom system subjected to free vibration. **(10 Marks)**
b. Derive an expression for effective stiffness of springs connected in series. **(04 Marks)**
c. Evaluate the natural frequency of and natural period for the structural system shown in Fig.Q3(c), when L = 3.6m, E = 22000 MPa, I = 1.2×10^{-4} m^4, k = 40 kN/m, m = 10 kN.

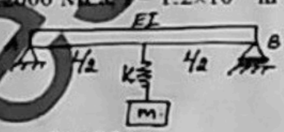


Fig.Q3(c) **(06 Marks)**

OR

4 a. Define response spectrum and design response spectrum. **(04 Marks)**
b. Explain the method of construction of earthquake response spectrum. **(06 Marks)**
c. A single degree of freedom system consists of mass 6 kN, and spring with stiffness 5 N/mm. The system has damping force of 200N with a velocity of 250 mm/s. Find damping ratio, damping frequency, logarithmic decrement and ratio of two consecutive amplitudes. **(10 Marks)**

Module-3

5 a. Explain the types of damages to buildings observed during past earthquakes. **(10 Marks)**
b. Briefly explain the irregularities in plan as per IS 1893 code. **(10 Marks)**

OR

6 a. Explain the influence of building configuration on seismic response. **(07 Marks)**
b. Explain the architectural aspects of earthquake resistant buildings. **(07 Marks)**
c. A building having non-uniform distribution of mass is shown in Fig.Q6(c). Locate its Centre of mass. **(06 Marks)**

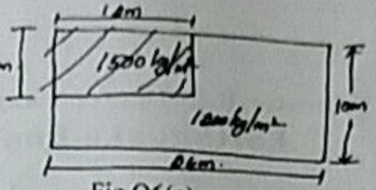


Fig.Q6(c)

Module-4

7 For the residential RCC, special moment resisting frame shown in Fig.Q7. Compute the seismic forces by equivalent static procedure. Building is founded on hard soil (rock) and situated in Zone-IV. Given w_1 = 294.3 kN, w_2 = 1863.9 kN and w_3 = 1079.1 kN.

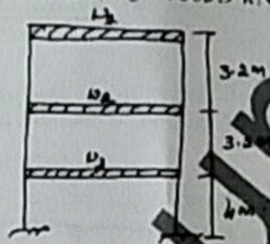


Fig.Q7

(20 Marks)

OR

8 The plan and elevation of a three storey building (RCC) is shown in Fig.Q8. The building is located in Zone-V. The type of soil encountered is medium stiff and it is proposed to design the building a special moment resisting. Given w_1 = 640 kN, w_2 = 688 kN, w_3 = 688 kN.

Storey level	Natural period	Mode 1	Mode 2	Mode 3
3	0.134	1.00	1.00	1.00
2	0.191	-2.038	-0.489	0.81
1	0.533	1.611	-1.223	0.45

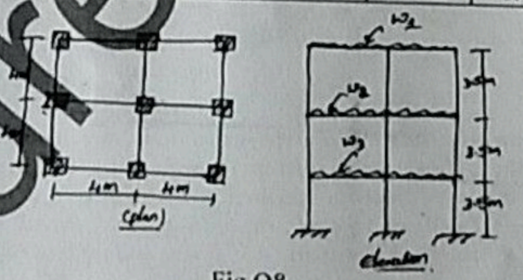


Fig.Q8

Determine the design seismic forces and show the distribution of lateral forces with building height using dynamic analysis. **(20 Marks)**

Module-5

9 a. What are the ductile - detailing provisions for beams (for flexure and shear) as per IS code? Explain with neat sketches. **(10 Marks)**

b. Write a note on retro fitting of masonry and RCC buildings in earth quake prone areas. **(10 Marks)**

OR

10 a. Explain various modes of failure of masonry buildings with neat sketches. **(10 Marks)**

b. What is ductility? Discuss different factors which influences ductility in RC structures. **(10 Marks)**

* * * * *

Module - 1

1 a. An Earthquake is the sudden release of strain energy in the Earth's crust, resulting in waves of shaking that radiate outwards from the Earthquake Source. — 2

Characteristics of Body waves.

1) They travel through Interior of Earth
2) These waves are High frequency, short wavelength
3) These are Less distructive in Nature. — 4
4) Two Types - P waves & S waves. P waves speed 5-15 km/s. & 1.7 times faster then S waves.
5) P waves travel in all medium, S waves travel only in solids.

Characteristics of Surface waves

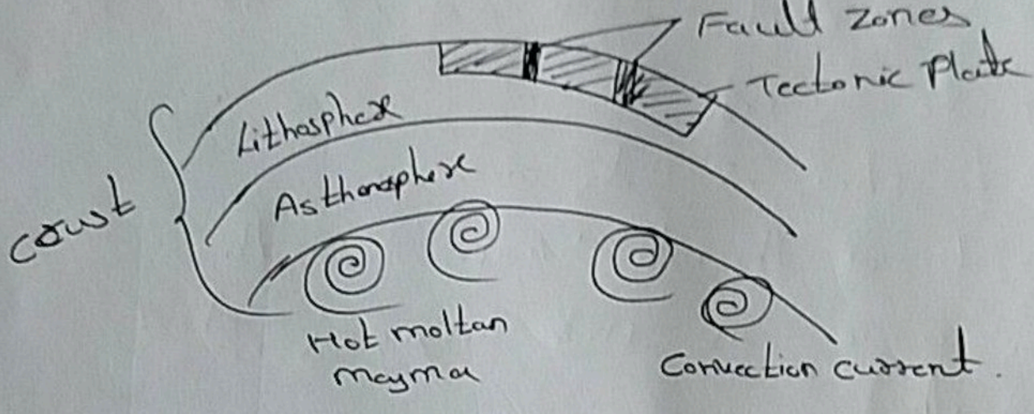
1) They travel along Earth's Surface
2) Two Types Love waves & Rayleigh waves
3) Speed is slow, amplitude decreses as distance Increses. — 4
4) Low frequency, Long wavelength
5) Travel with Rotary movement, speed 3-5 km/s
6) They are more distructive in Nature.

10

1 b Plate Tectonic Theory.

According to this theory earth's crust is Broken up into Number of Plates called crustal Plates.

Epi-center of Earthquakes are not evenly distributed on Earths surface, But occur predominently in well-defined narrow seismic zones which further divide Lithosphere into Tectonic plates.



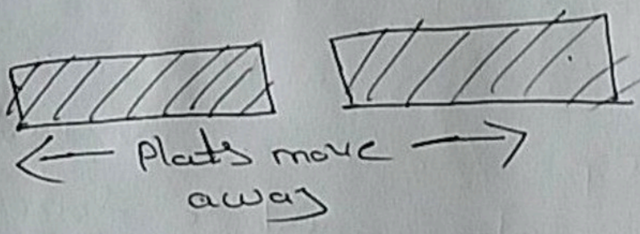
-3

The convection current in magma are responsible for plate movements. Plates move in different direction with different speed.

Plate Boundaries are classified as.

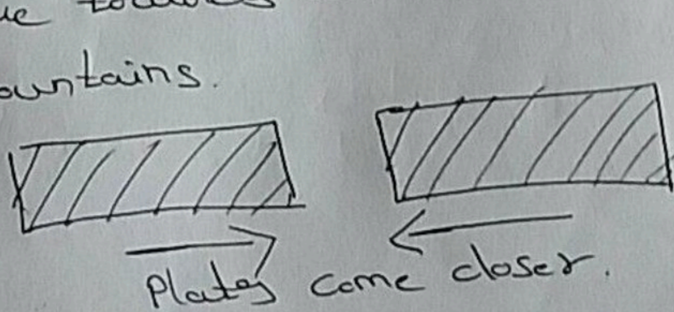
1) Divergent Boundaries

Plates moves away from Each other forming new crust.



2) Convergent Boundaries. -2

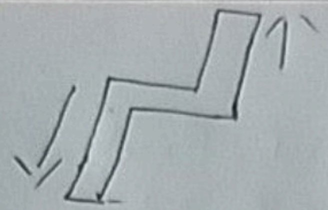
Plates move towards each other & collide to form mountains.



3) Transform Boundaries

Plates slide Past Each other & Large Build up of strains occur due to friction ~~are~~ released.

(3)



5

1c **Causes of Earthquake.**

Earthquake are vibrations or oscillations of the ground surface caused by disturbance in Equilibrium of rock at or beneath surface of Earth. This disturbance give rise to shock waves.

Natural Earthquake are classified as — 2.5

1) Tectonic Earthquake [Movement of plates]
2) Plutonic Earthquake [Deep seated changes] or Volcanic.
3) Other Causes of Earthquake are.
   → Underground Explosions.
   → Induced Quaking (Human activities)
     ↳ mining
     ↳ Construction Large Building & Dams.

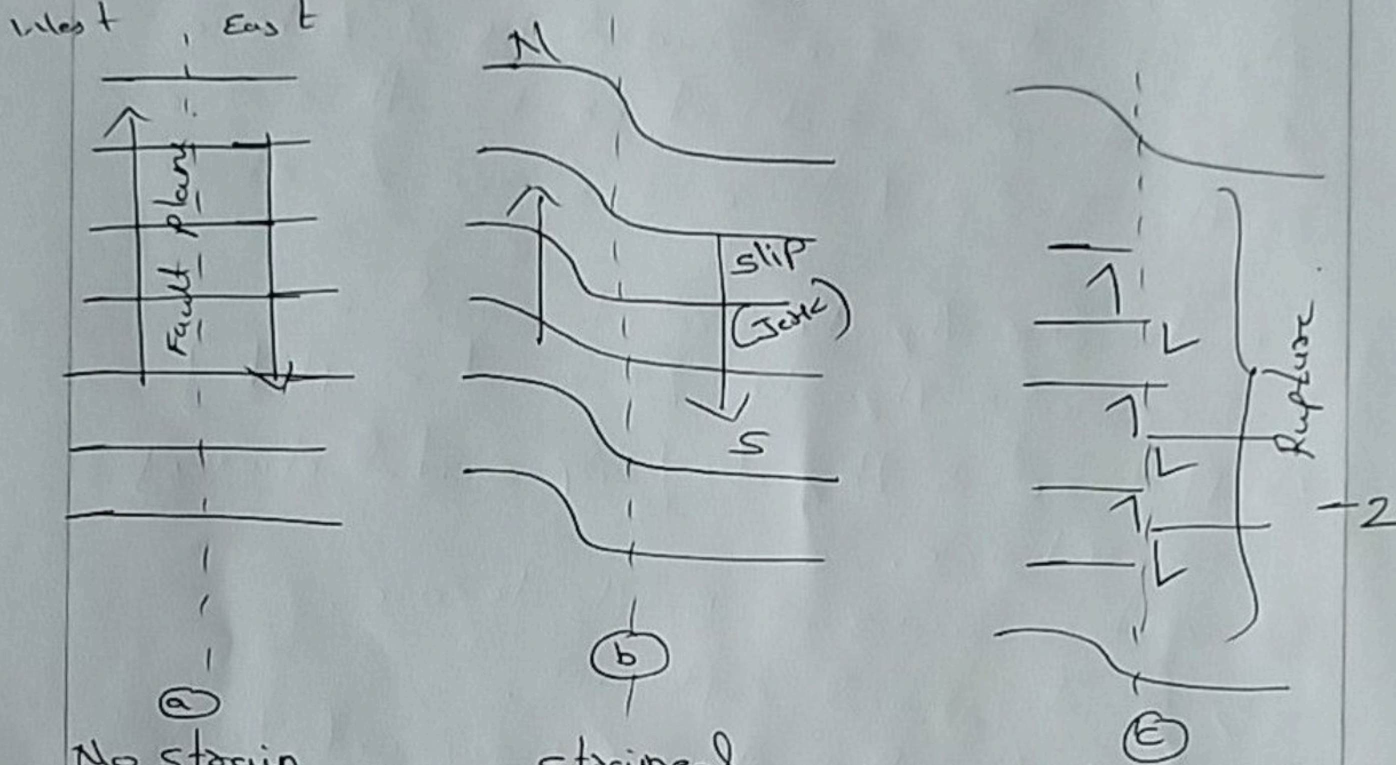
Effects of Earthquake.

1) Land shaking
2) Land slides
3) Tsunami
4) Destruction of Properties.
5) Environmental Destruction. — 2.5
   Loss of valuable Ecosystem & habitats.
   & Can Cause Pollution & Contamination of water source.
6) Human Life & Poverty.
   Loss of Human Life & Because of Heavy distruction leads to Poverty.

5

2a **Elastic Rebound Theory.**

Theory was proposed by M.F. Reid in 1906.
The gradual accumulation & release of stress & strain is referred as "Elastic Rebound theory" of Earthquakes. —1



No strain (Pre seismic phase) | strained (seismic phase) | Just after Earthquake (Post Seismic phase).

(a) Pre seismic phase.

Continuous Increase in shear force are acting on Two Blocks which are unstrained in an Existing fault.

(b) Strained - Seismic phase. —3

Resulting stress are trying to move western Block towards North & Eastern Block towards South. Later Blocks are distorted & straight Line has Become oblique. & it is strained Condition.

(c) Post Seismic Phase.

weakest Part of fault slips suddenly when strain Becomes more than what the

fault can support. This makes Blocks on either side to Jerk. Half arrow Indicates Sudden Jerk. or displacement.
Accumulated Energy is suddenly released in the form of Seismic waves. 6

2b Classification of Earthquake.

I Based on Location.

① Interplate Earthquake.
Earthquake which occur along the active boundaries of tectonic plates are called Interplate Earthquake.

② Intraplate Earthquake.
These Earthquake occur within the Tectonic plates.

II Based on Focal Depth

① shallow Depth → Focal Depth Less than 70km, cover small area & Severely distructive.

② Intermidiate Depth → occur at focal depth 71 - 300km. Cover Large area & are very distructive.

③ Very Deep → occur at a focal depth greater than 300km. Cover Large area & Less distructive.

III Based on Epicentral Distance.

① Local shock - shaking with Epicenter within 4km.

(2) Near shock - shaking with the Epicenter in 4-10km.

(3) Distant shock - shaking with the Epicenter in 10-20km.

(4) Telescopic shock - shaking with Epicenter beyound 20km range.

IV Based on Magnitude.

(1) Micro Earthquake. → Magnitude M<3
(2) Intermidiate Earthquake → M - 3-4.9
(3) Moderate → M → 5-5.9
(4) Strong → M - 6-6.9
(5) Major → M - 7-7.9 — 7M
(6) Great → M > 8.

2c

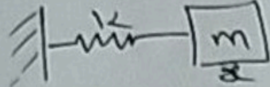
Magnitude.	Intensity.
1) It is the Quantitative Measure of Earthquake.	*) It is the qualitative measure of Earthquake.
2) Size of Earthquake is measured by amount of strain Energy released by fault Rupture.	*) It Indicates the saviarity of shaking generated at the Location.
3) It is related to characteristic of fault Extent of Relative displacement Between Two sides by fault	*) It depends on observed Effect of Landscape (slope, failure, cracks etc) Loss of Life.
4) It is single value for a given Earthquake.	*) For a Particular Earthquake It varies from place to place, Geological area.
5) Assigned in Numbers.	*) Assigned as Roman capital Numbers.

Module-2

3a Free Undamped Single Degree freedom system

$F(t) = 0$

Equation : $x'' + \omega_n^2 x = 0$ — 2



$\omega_n = \sqrt{k/m}$

General Equation

$x = A\cos\omega_n t + B\sin\omega_n t$ — 2

Initial condition

$t = 0$, $x = x_0$, $x' = x_0'$

1) At $t = 0$, $x = x_0$, $x_0 = A$

2) At $t = 0$, $x' = x_0'$ — 3

$x' = -A\omega_n \sin\omega_n t + B\omega_n \cos\omega_n t$

$x_0' = B\omega_n$, $B = \left(\frac{x_0'}{\omega_n}\right)$

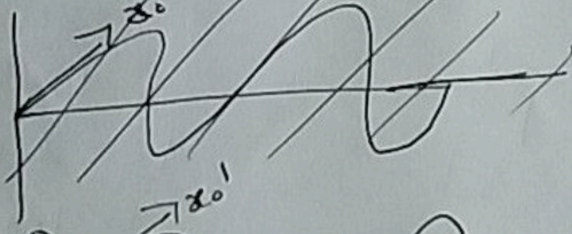
Substitute A & B

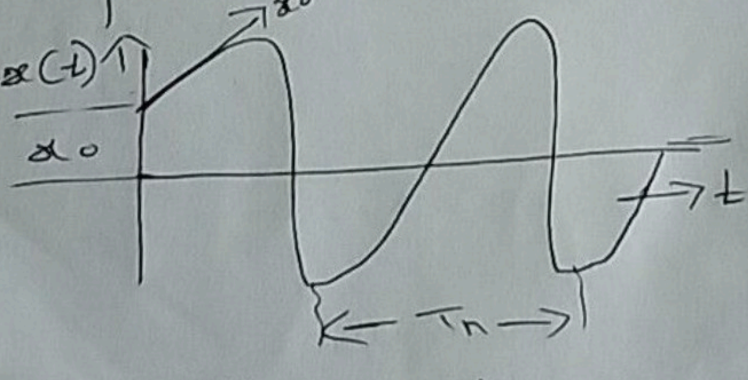
$x = x_0 \cos\omega_n t + \left(\frac{x_0'}{\omega_n}\right)\sin\omega_n t$ — 3

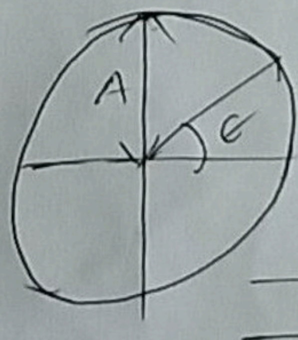
$\omega_n = \sqrt{\frac{k}{m}} = \frac{2\pi}{T}$

$A = \sqrt{x_0^2 + \left(\frac{x_0'}{\omega_n}\right)^2}$

$\tan\theta = \frac{(x_0'/\omega)}{x_0}$



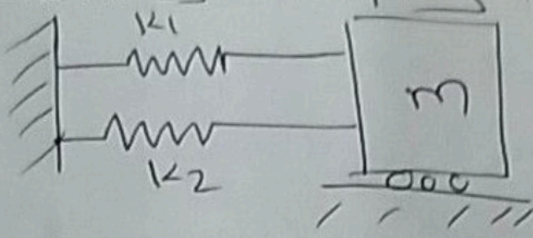




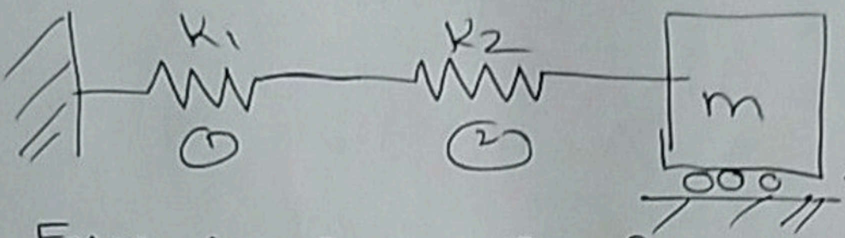
10

Harmonic motion.

3b Effective stiffness of spring in Series.



Spring in Parallel



Spring in Series — 2

Force in Spring ① = P_1

Force in Spring ② = P_2

Displacement in spring ① = x_1

Displacement in spring ② = x_2

$P_1 = P_2 = P$

$x_1 \neq x_2$ — 1

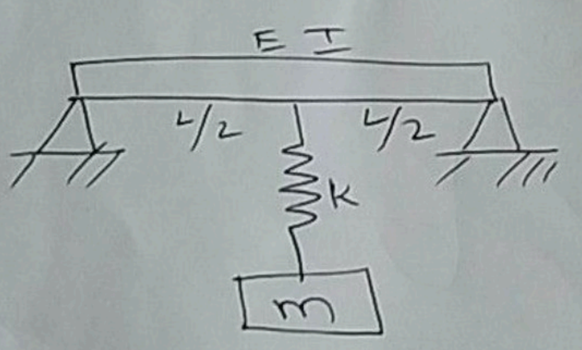
$x_1 + x_2 = x$

$\frac{P_1}{K_1} + \frac{P_2}{K_2} = \frac{P}{K_{Eq}}$

$$\boxed{\frac{1}{K_1} + \frac{1}{K_2} = \frac{1}{K_{Eq}}}$$

— 9/4

3c



$L = 3.6 m$

$E = 22000 MPa$

$I = 1.2 \times 10^{-4} m^4$

$K = 40 kN/m$

$m = 10 kN$

$m = \frac{10 \times 10^3}{9.81} = 1019 kg$

$K_b = \frac{48EI}{L^3}$

$K_b = \frac{48 \times 22000 \times 10^6 \times 1.2 \times 10^{-4}}{3.6^3}$

$K_b = 2716.04 \times 10^3 N/m$ — 2

$K_s = 40 \times 10^3 N/m$

$$\frac{1}{K_{Eq}} = \frac{1}{K_b} + \frac{1}{K_s}$$

$$K_{Eq} = 39.419 \times 10^3 \, N/m$$

$$\omega = \sqrt{K/m} = \sqrt{\frac{39.419 \times 10^3}{1019}}$$

$\omega = 6.2196$ rad/sec — 2

$T = 1.010$ sec. — 2

6

4a **Response spectrum**

It is a plot of peak response of all Possible SDOF system. Such as displacement, velocity or acceleration response. for the same Base vibration or shock. — 2

Design Response spectrum

Design Response spectrum is smooth & is the Envelop of the different Elastic design spectra. — 2

4

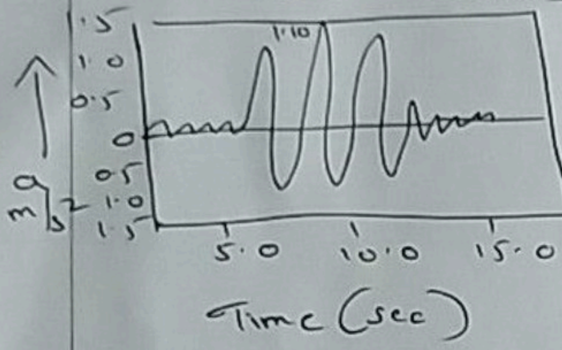
4b **Earquake Response spectrum**

1) The Response History is the ground motion record that is plot of the acceleration, velocity & displacement of a Point on ground surface as a function of time. as in Fig a, b, c

2) Peak Responses are considered from these Response History. i.e Peak velocity, Peak acceleration & Peak displacement.

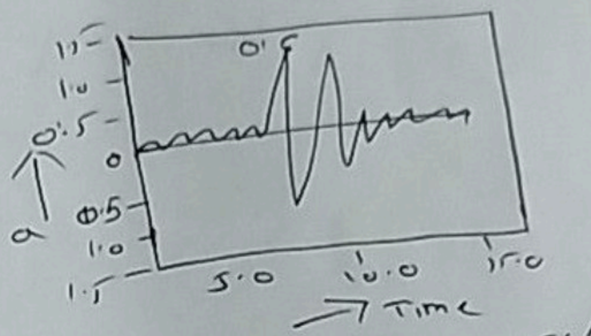
3) Also Peak ground Responses values of different Natural Period are different

4) Response Parameters Include -
Absolute acceleration
Pseudo displacement
Pseudo velocity



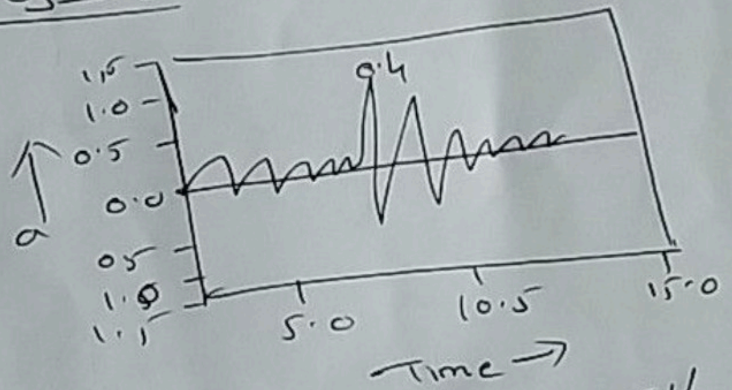
$T_n = 0.5\,sec,\ \xi = 0.5\%$

Fig 1 a



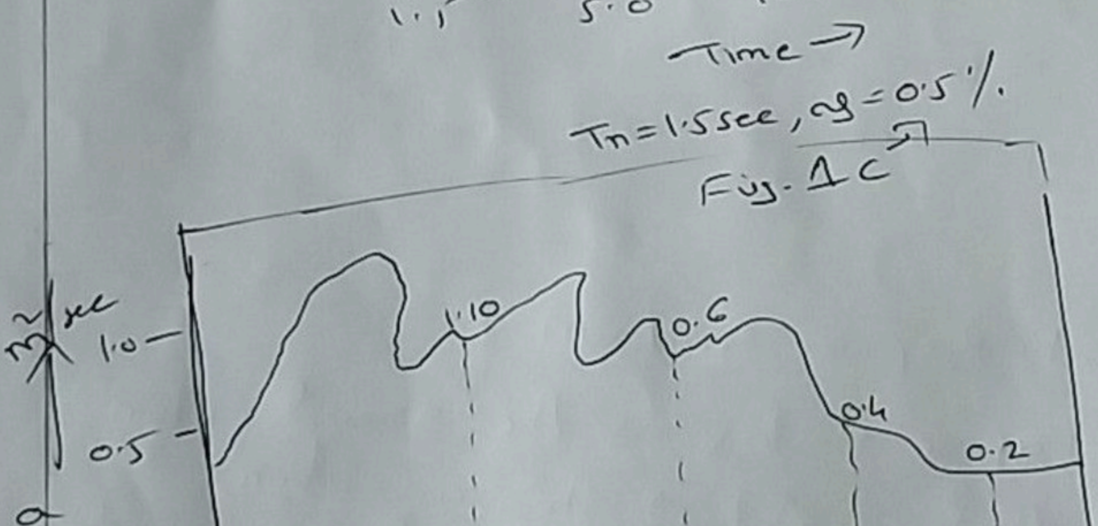
$T_n = 1.0\,sec,\ \xi = 0.5\%$

Fig 1 b



$T_n = 1.5\,sec,\ \xi = 0.5\%$

Fig. 1 c



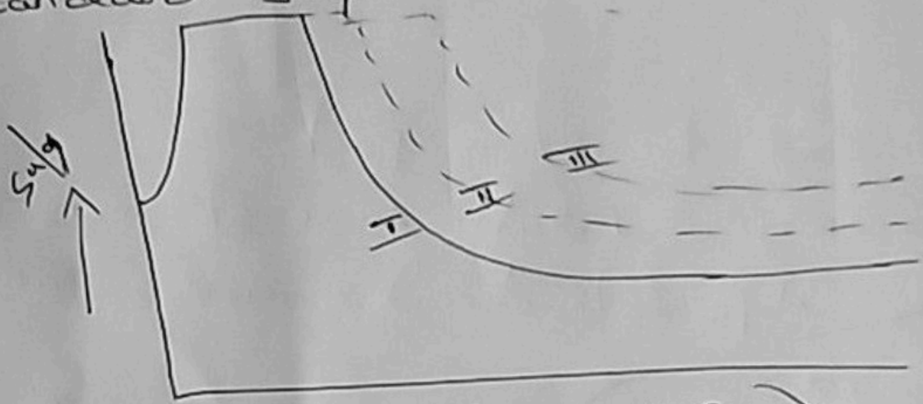
Acceleration Response Spectrum Fig. 2

⑤ Maximum Response parameters obtained by Response History for different Natural Period are clubbed ie Graph of maximum Response for given Damping to Verses Natural Period for Spectrum as in Fig. 2 form Response Spectrum

(11)

6) Individual spectrum can be used for Analysis of Particular Earthquake.

7) This Response spectrum is Normalised & uses $\frac{Sa}{g}$ values & is smoothed to get Design Response spectrum which is a standard graph as shown in Fig. 3



Natural Period (Tn)

Design Response spectrum.

6

4C $\omega = 6KN$, $K = 5N/mm$, $C\dot{x} = 200N$

$\dot{x} = 250 mm/sec$,

$\omega n = \sqrt{\frac{K}{m}} = \sqrt{\frac{5}{6\times10^3/9810}} = 2.859 \, rad/sec$.

$\xi = \frac{c}{2m\omega n} = \frac{1.25}{2\times 6\times 0.8} = 0.23$

$\delta = 2\pi\xi$

$= 2\pi \times 0.23$

$\delta = 1.45$

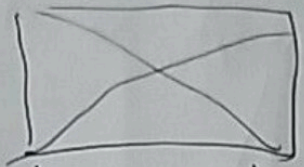
$\delta = \ln\left(\frac{x_1}{x_2}\right)$

$\frac{x_1}{x_2} = e^{\delta} = 4.2$ ||

Module - 3

5a Damages observed During Past Earthquake.

1) Shear failure in walls caused by Excess Principal Tensile stress in masonry structures. This leads to 'X' shape cracks

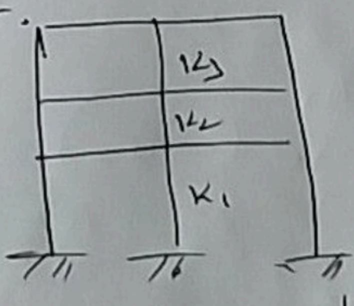


2) Damage to stair part.
Because of Relative Large stiffness of the slope structural members, Damage is severe.

3) Damages caused by structural Irregularity, 'L' shaped Building with unequal height or severe damage in staggered elevation.

4) Damage caused by out of plane Bending Failure of masonry wall

5) Damage caused by stiffness Irregularity in storey. collapse of Parking or Basement floor.

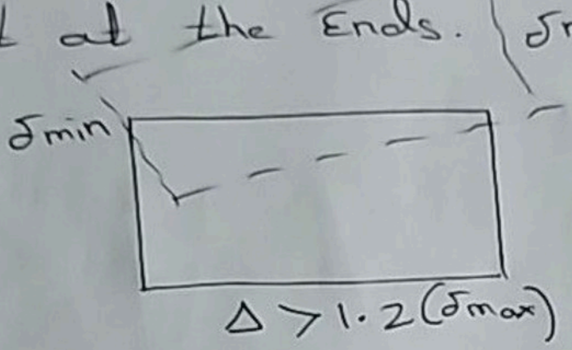


$K_1 < K_1 + K_2$

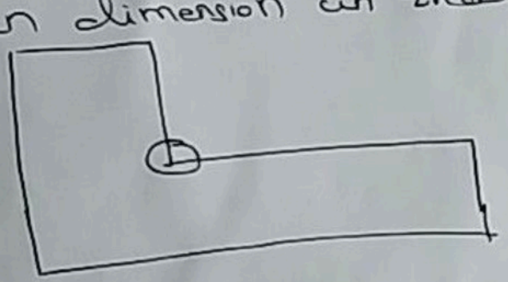
6) Seperation of walls at Junction
7) Corner Seperation — 10
8) Buckling of wythes
9) Seperation of walls at Junction
10) Failure of masonry Piers etc.

5b **Plan Irregularities**

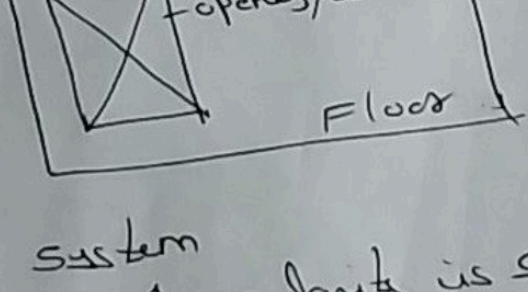
1) Torsional Irregularity
If Lateral drift at one end is more than 1.2 times avg Lateral drift at the Ends.



2] Re entrant corners.
If Projection of Lateral load resisting structural system is greater than 15% of Lateral plan dimension in that direction.



3) Diaphragm discontinuity.
Variation in lateral stiffness of diaphragm due to openings, cut outs, adjacent floors at different level.



4) Non Parallel system
Plan Irregularity is said to exist if vertical structural elements of Lateral load resisting system are not orthogonal as shown.

—10

Non - Parallel system

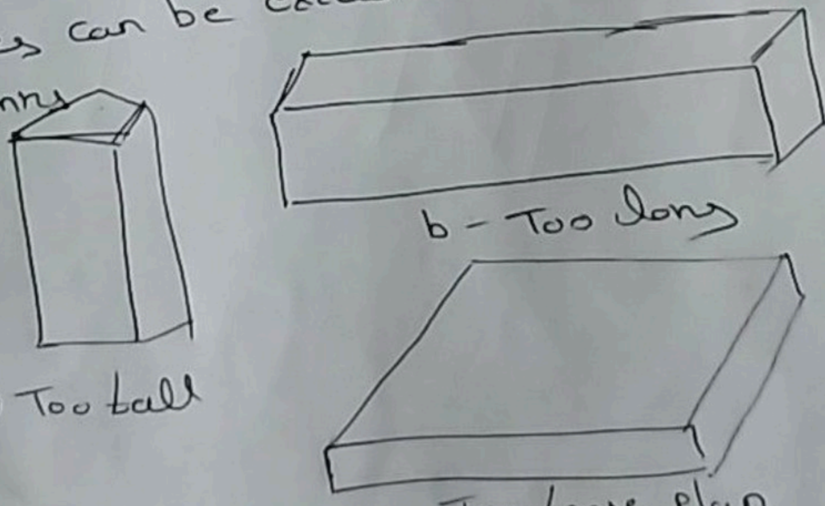
6a **Building Configuration**

→ Behaviour of Building during Earthquake depends critically on its overall shape, size & geometry.

→ Hence at the Initial planning stage selecting proper Building configuration is Important.

→ Building size

Tall Building with large height
to Base size, Horizal movement of floor
is large In short but very long
Building effects during shaking are many.
Also In Building with large plan are
like warehouse, the horizontal seismic
forces can be excessive carried by walls &
columns



b - Too long

a) Too tall

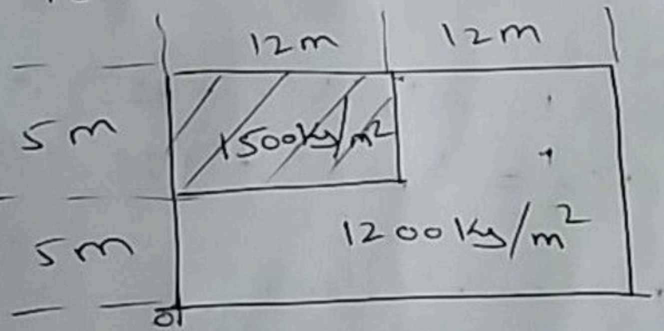
c - Too Large plan

→ Horizontal Layout of Building
Building with re-entrant corners like U, V, H, & + shaped plan have undergone significant Damage.

→ Vertical Layout of Building
Building with vertical set backs causes sudden jump in Earthquake forces at level of discontinuity.

→ Hanging or floating columns effects lot in transfer of all Earthquake force to ground. Hence stress accumulation occurs at particular junction leading to failure. 7

6c



Total mass = $(1500 \times 12 \times 5) + (1200 \times 12 \times 5) + (1200 \times 5 \times 24)$
= 306000 kg

Moment of all mass about Point 'O'.

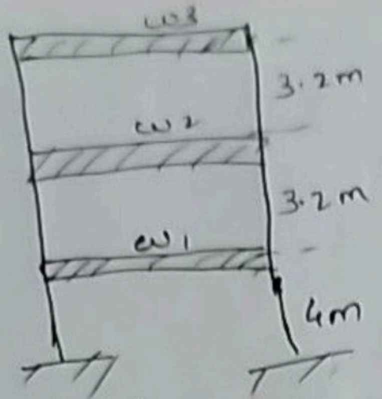
$[(1500 \times 12 \times 5)6] + [(1200 \times 12 \times 5) \times 6] + [(1200 \times 5 \times 24) \times 12]$
$= 306000 \times \bar{x}$

$\Rightarrow \bar{x} = 8.823m$ — 3M

$[(1500 \times 12 \times 5)]7.5 + [(1200 \times 12 \times 5) \times 7.5 + [(1200 \times 5 \times 24) \times 2.5]$
$= 306000 \times \bar{y}$

$\Rightarrow \bar{y} = 5.1470m$ — 3M

7a



Natural Period $T_n = 0.075 h^{0.75} = 0.434$

S_a/g for Hard soil $= 1/T_n = 2.302$

$Z = \overline{IV} = 0.24$

Importance factor $I = 1$

$R = 5$ — 4

$A_h = \frac{Z}{2} \times \frac{I}{R} \times \frac{S_a}{g} = \left(\frac{0.24}{2}\right) \times \left(\frac{1}{5}\right) \times 2.302$

$= 0.05525$ — 3

Total seismic wt

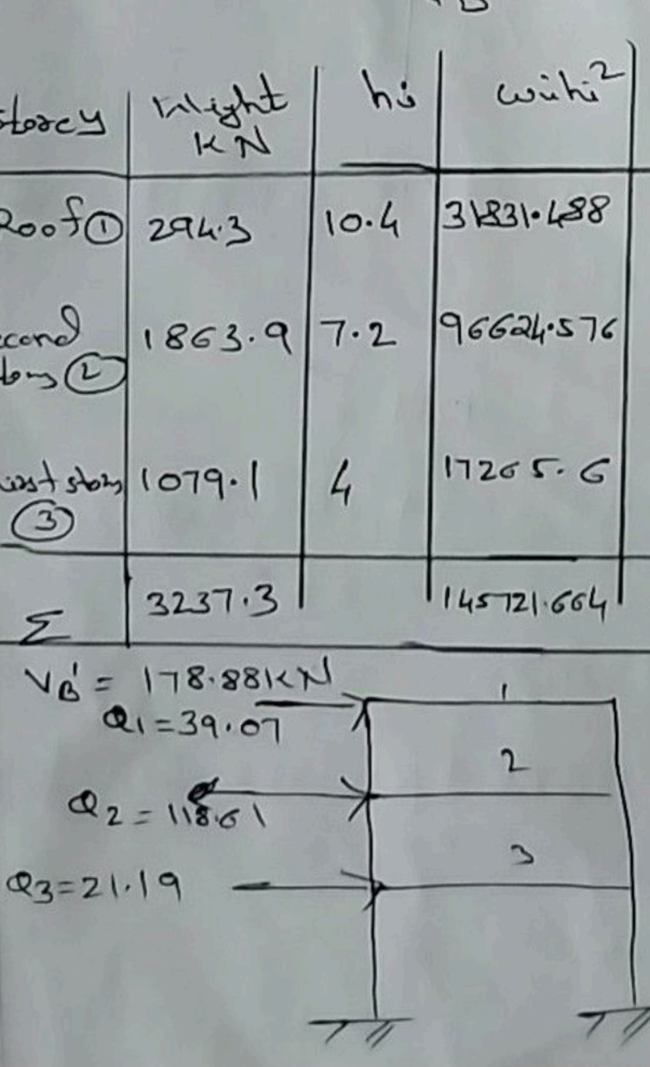
$W = W_1 + W_2 + W_3 = 3237.300 \text{ kN}$

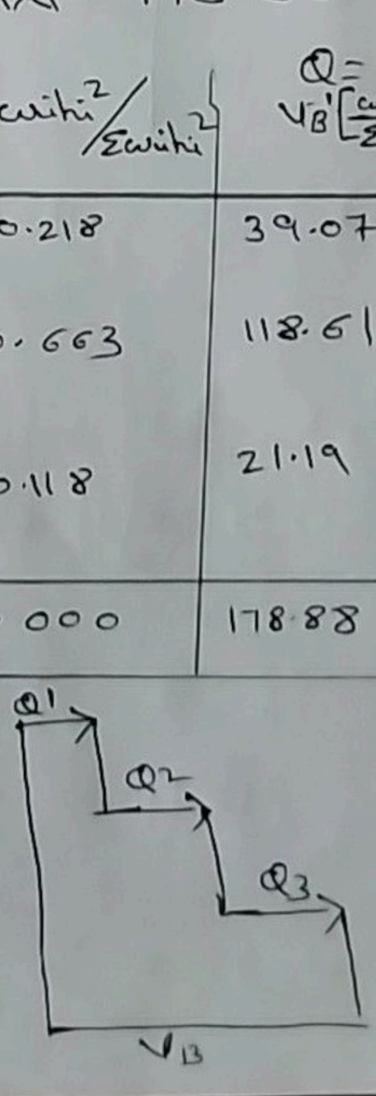
$V_B' = A_h \times W = 178.88 \text{ kN}$ — 3

Storey	Weight kN	h_i	$w_i h_i^2$	$w_i h_i^2 / \Sigma w_i h_i^2$	$Q = V_B' \left[\frac{w_i h_i^2}{\Sigma w_i h_i^2}\right]$
Roof (1)	294.3	10.4	31831.488	0.218	39.07
Second Story (2)	1863.9	7.2	96624.576	0.663	118.61
First story (3)	1079.1	4	17265.6	0.118	21.19
Σ	3237.3		145721.664	1.000	178.88

— 6

$V_B' = 178.88 \text{ kN}$





— 2

20

Hence only 3rd Mode is considered

$T_n = 0.533 \text{ sec}$

$S_a/g = \frac{1.36}{T} = 2.5515$

$Z = \underline{V} = 0.36$

$I = \underline{I} = 1$

$R = 5$

$A_h = \frac{Z}{2} \times \frac{I}{R} \times \frac{S_a}{g}$

$= \frac{0.36}{2} \times \frac{1}{5} \times 2.5515$

$A_h = 0.0918$ 5

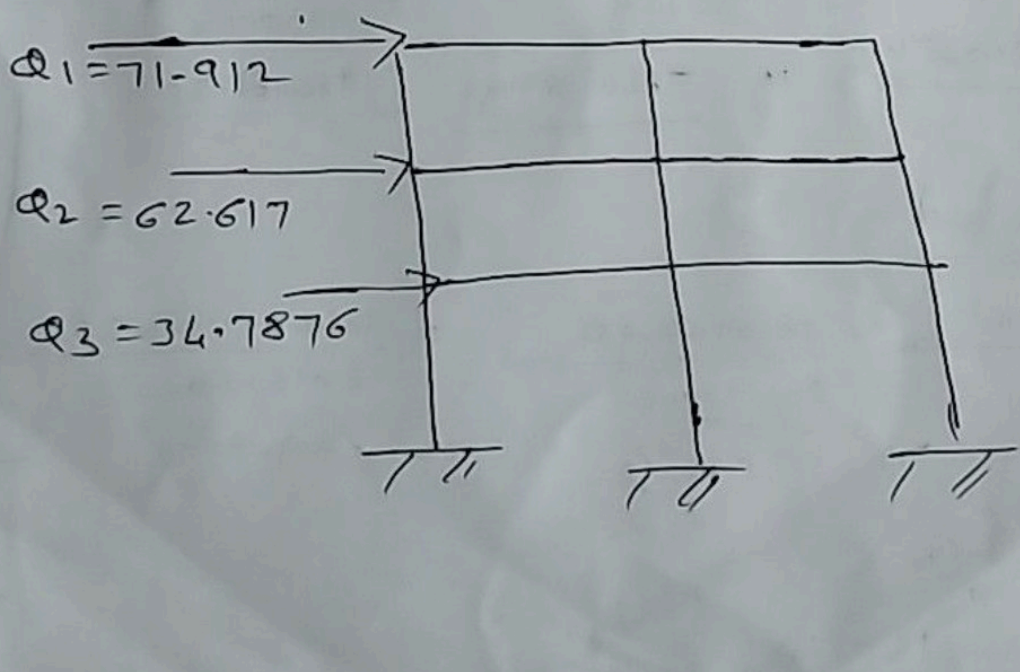
Mode-3

$Q = A_{hk} \times \phi_{ik} \times P_{k} \times W_i$

$Q_3 = 0.0918 \times 1.224 \times 1 \times 640 = 71.912 \text{ KN}$

$Q_2 = 0.0918 \times 1.224 \times 688 \times 0.81 = 62.617 \text{ KN}$

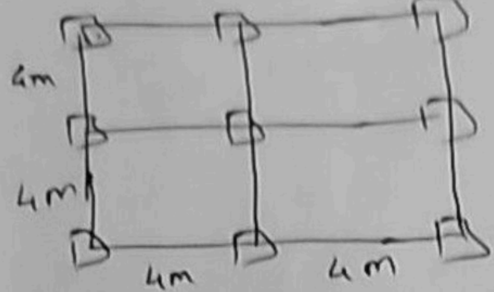
$Q_1 = 0.0918 \times 1.224 \times 688 \times 0.45 = 34.7876 \text{ KN}$

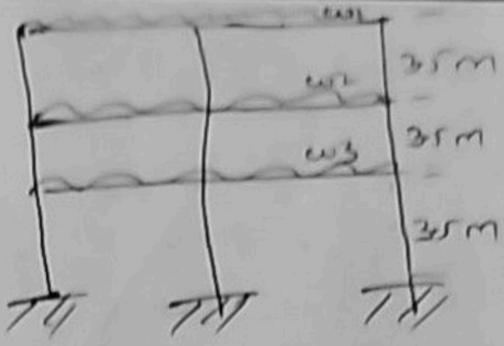


5

20

5.





computation of modal mass & modal Participation factor.

story	weight	K=1 ϕ_1	$w_i\phi_1$	$w_i\phi_1^2$	K=2 ϕ_2	$w_i\phi_2$	$w_i\phi_2^2$	K=3 ϕ_3	$w_i\phi_3$	$w_i\phi_3^2$
Roof	640	1	640	640	1	640	640	1	640	640
2	688	2.038	-1402.14	2857.56	-0.489	-336.43	164.515	0.81	557.28	451.396
1	688	1.611	1108.3	1785.58	1.611	1108.36	1785.58	0.45	309.6	139.32
Σ	2016		346.16	5283.14		1411.93	2590.0		1506.8	1230.716

$M_{K_1} = \left(\frac{346.16^2}{5283.14 \times 9} \times 1000\right)$ $\quad M_{K_2} = \left(\frac{1411.93^2}{2590 \, g} \times 1000\right)$ $\quad M_3 = \frac{1506.8^2 \times 1000}{1230.716}$ — 5

$M = 2312.025 \, kg$ $\quad M_2 = 78461.67 \, kg$ $\quad = 1844817.35$

% Total weight

$= \frac{2312.025 \times 9.81}{2016 \times 1000} \times 100 = 1.125\%$

$= \frac{78461.67 \times 9.81}{2016 \times 1000} \times 100 = 38.18\%$

$= \frac{1844817.35 \times 9.81}{2016 \times 1000} \times 100 = 89.77\%$ — 3

P_K calculate

$$P_{K_3} = \frac{1506.8}{1230.716} = 1.224$$ — 2

$$M_K = \frac{\Sigma (w_i \phi_{ik})^2}{g \, \Sigma (w_i \phi_{ik}^2)}$$

$$P_K = \frac{\Sigma (w_i \phi_{ik})}{\Sigma (w_i \phi_{ik}^2)}$$

Module- 5

9a Ductile detailing provision for Beams.

1) Factored axile stress on member shall not Exceed 0.1 fck

2) concrete grade M_{20} to be used

3) High strength deformed steel Bars to be used Fe500 Fe550 having elongation 14.5%.

4) width to Depth ratio of more than 0.3 to Ensure adequate stability.

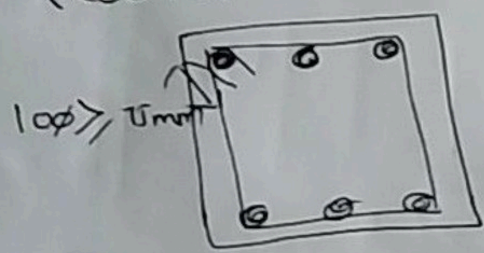
5) B ≮ 200mm — 3

6) D ≯ $\frac{1}{4}$th of Clear span.

7) Shear Reinforcement.

→ Contribution of Bent up Bar & Inclined Hoops not considered

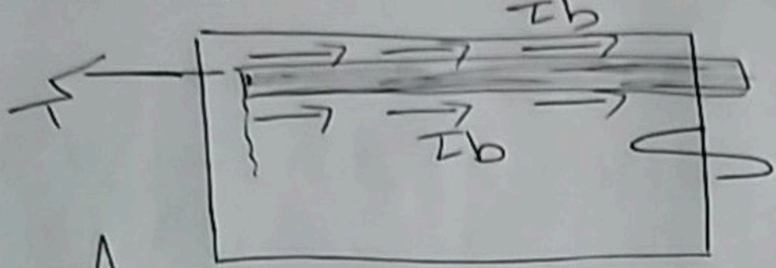
→ consist of vertical stirups (Hoops) of 135° Hook. Mini diameter of stirup 6mm

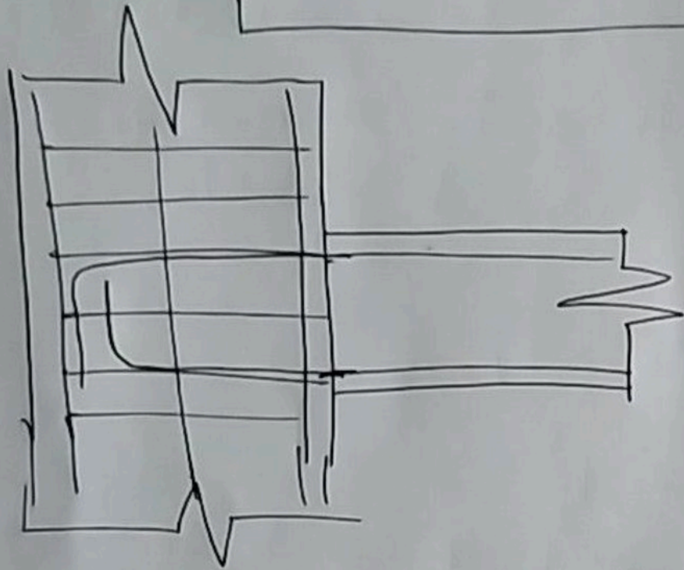


8) Anchorage of Reinforcement & concept of Development Length

→ Bond strength of concrete can be Improved by use of higher grade concrete, Ribbed Reinforcing Bars, provision of Hooks, Bends for Rebars — 3

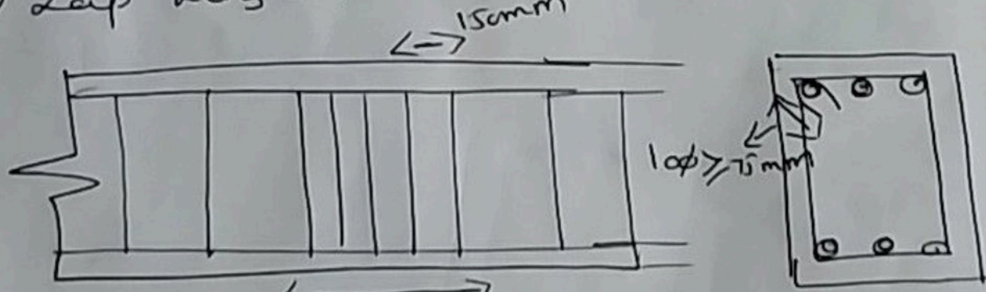
→ Development length is minimum embedment length of Bar required on either side of section in order to develop full design stress



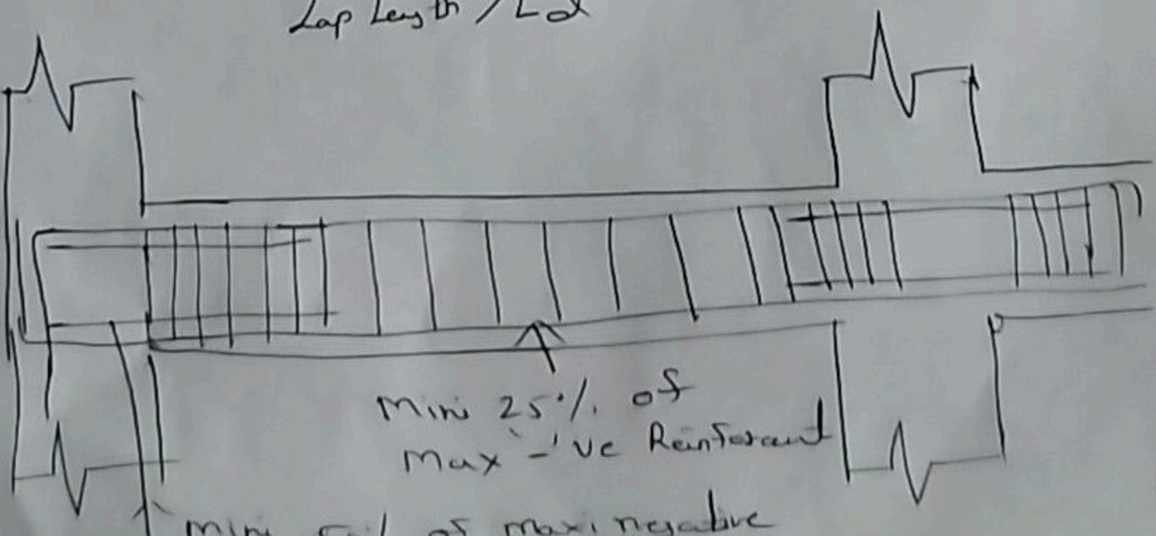


Provision of Proper lap splices

→ Lap Length



Lap Length > Ld



– 4

10

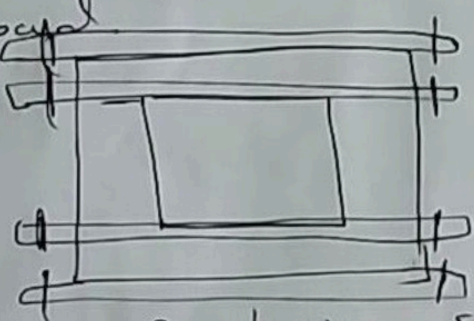
9b Retrofitting of Masonry Building

→ Grouting

For cracks with small crack width of less than 6mm the original Tensile strength of cracked element may be restored by Pressure injection of epoxy or cement mortar known as Grouting.

→ Pre stressing

Strengthening of old walls this Technique is used. Here Internal stress of suitable magnitude & distribution are Introduced so that it counteracts the stress from External load.



Prestressing of walls.

→ External Binding

opposite Parallel walls can be held to Internal cross walls by Prestressing Bars as shown. Anchorage is done against Horizontal steel channels instead of steel plates

→ Inserting New wall

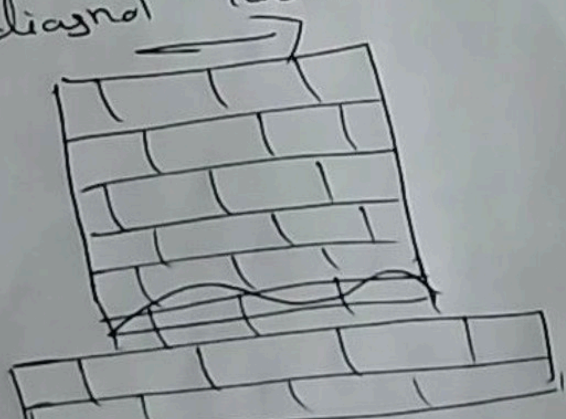
In case of Existing Building shown any type of dissymetry which may produce dangerous Torsional effects during Earthquake, Center of mass should be made coincident with center of stiffness

— 2×4 = 8
Diagram = 2
10

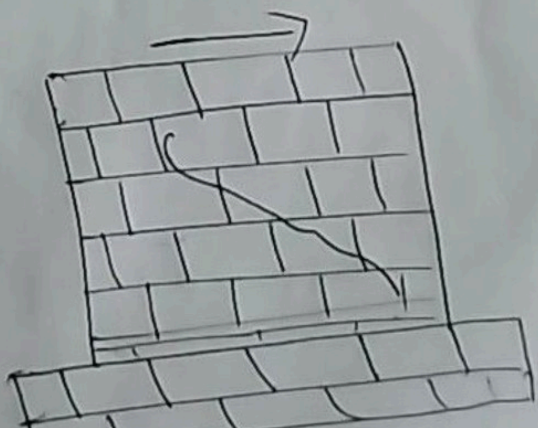
10a Failure modes of Masonry

→ If Length to Height ratio is small, the wall fails by developing Horizontal crack due to sliding failure. such sliding Failure may occur under roof slab depending on area of opening.

→ If Length to Height ratio is Large, wall fails by developing diagnol cracks due to diagnol Tension failure.



(a)



$\frac{L}{H}$ Large (b)

It is ability of a structure to undergo larger deformation without callapsing.

Factors affecting Ductility in RC structures

* Tension steel Ratio – P_t
  - → Ductility of Beam cross section Increases as the steel ratio P decreses. If the Excessive reinforcement is provided the concrete will crush before steel yields. Beam should be designed under reinforced.
  - → Ductility is directly affected by values P_a, f_{ck}, f_y.
  - → Ductility Increases with Increase in strength characteristic of of concrete, decrease in characteristic of steel.

* Compression steel ratio A_c
  Ductility Increases with decrease in $(P-P_c)$ value, that is ductility increases with Increase in compression steel.

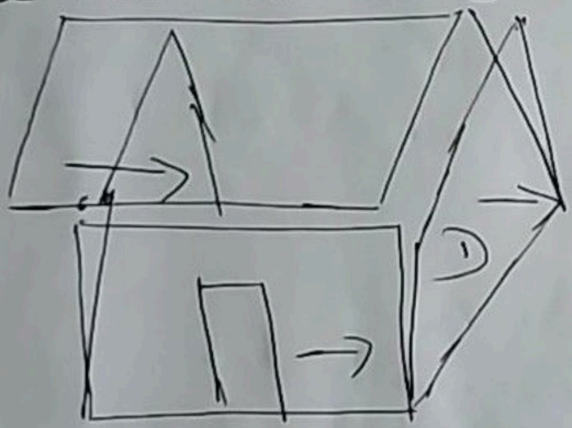
* Shape of cross section.
  The presence of enlarged compression flange in a T-Beam reduces depth of compression zone at callapse & thus Increases Ductility

* Lateral Reinforcement
  Lateral Reinforcement tends to Improve ductility by preventing premature

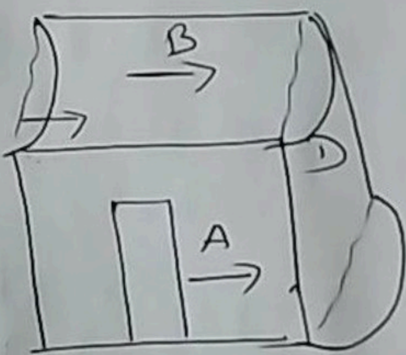
Failure modes of unreinforced masonry under Lateral loading depends on fixity to adjacent Perpendicular walls

1) If wall subjected to Lateral loading has considerable fixity with adjacent Perpendicular wall, the wall fails by Two-way Bending.

2) If wall subjected to Lateral loading does not have a fixity with adjacent Perpendicular wall. Such walls get seperated at corners & fall outwards



Toppling of walls. C&D



Bending of wall
C & D

3×3 = 9
Neat Diagram = 1
10

10b Ductility: The capacity of components & Structures to bend elastically without deteriorating their strength or rigidity Excessively is referred as ductility.

shear failure & by confining the compression zone, thus increasing deformation capability of a reinforced concrete Beam.

It can be increased by

- → Decrease in Percentage Tension Steel
- → Increase in Percentage Comp steel
- → Decrease in Tensile st of Steel
- → Increase in compressive strength of concrete
- → Increase in compressive flanges area in flanged Beams.
- → Increase in transverse (shear) Reinforcement.

Faculty:
Laxmi G H

HOD

HEAD
Dept. of Civil Engg.
KLS V.D.I.T., Haliyal

Dean, Academics
KLS VDIT, HALIYAL

KLS's V.D. Institute Of Technology * HALIYAL * Dept Of Civil Engg