INTRODUCTION TO STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING

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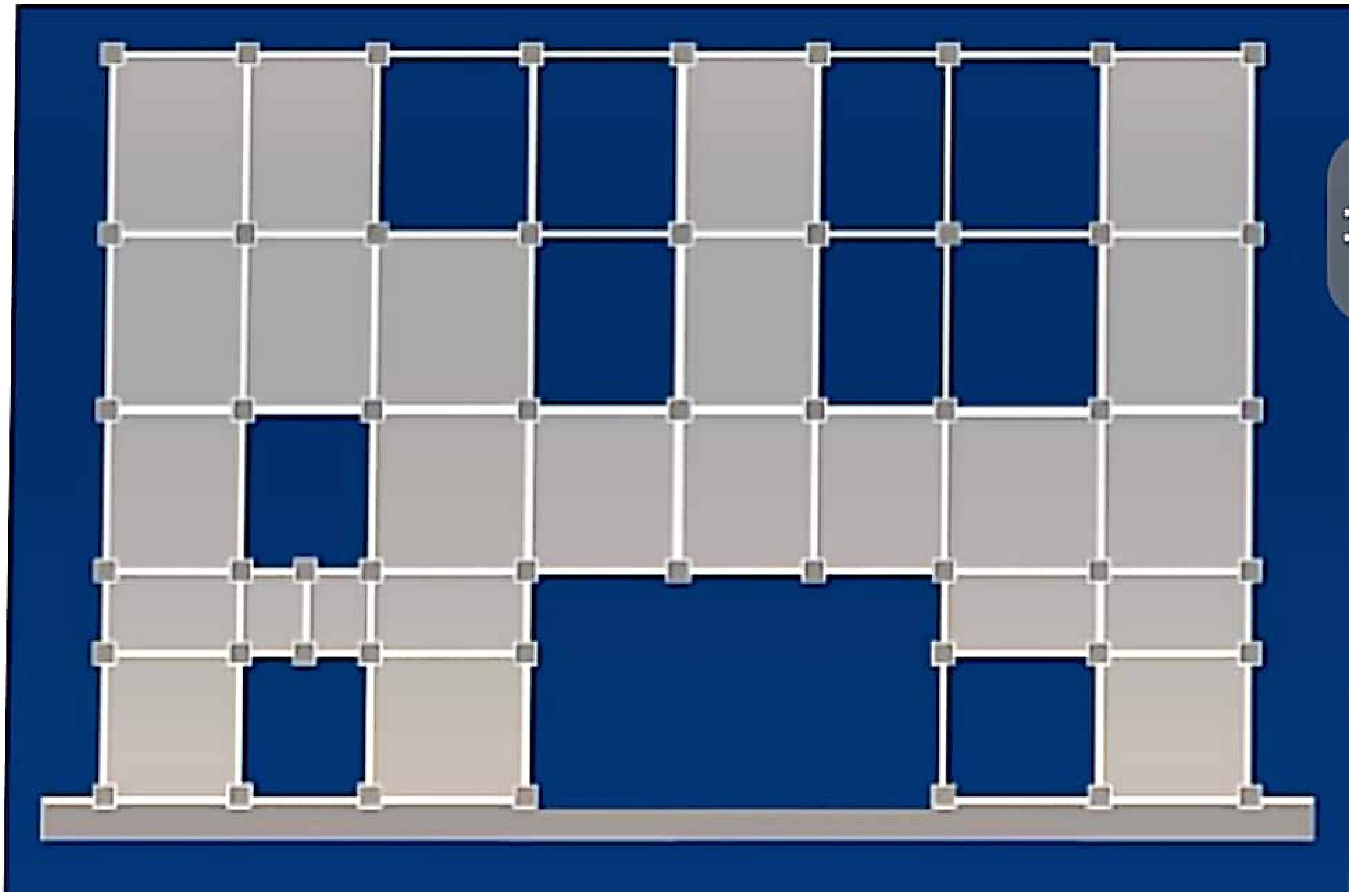
Figure 1



Configuration Condition Type

The type of serious configuration condition as mentioned in the figure is "Discontinuous Shear Walls"

Purpose Of Shear Wall

The purpose of shear wall is to collect the diaphragm loads at each floor and transmit them directly and efficiently to the foundation.

Effects

When there is discontinuity in shear walls, so the lateral forces which are caused by earthquake, produces powerful torsion and hence the chances of collapse increases.

When all the stories of the building doesnot contain the shear wall. This means discontinuity in shear walls, so it indicates that there is no continuious load pattern from roof to the foundation because of the absence of shear wall and the result of this can be so serious at point of discontinuity during an earthquake and can create damages.

Possible Solutions

1. Eliminate Shear Wall

One of the possible solution to this type of configuration condition is to eliminate the shear walls so as to avoid the sesmic affects due to discontinuity of shear walls.

2. Provide Shear Walls In All Stories

Another solution to this problem is to provide the shear walls in all stories of the building, so that there is no discontinuity in shear walls and there is a continuous load path from roof to foundation

3. Architectural And Engineering Consideration

If the decision is made to use the shear walls, then their presence must be recognized from the begining of schematic design and their size and location made the subject of careful architectural and engineering coordination in early stages of design.

4. Prevent Rotation At Joints

Another possible solution is to reinforce the frame by attanching or placing a rigid wall inside the frame maintains the shape of the frame and thus prevent rotation at the joints and eliminates seismic effects.

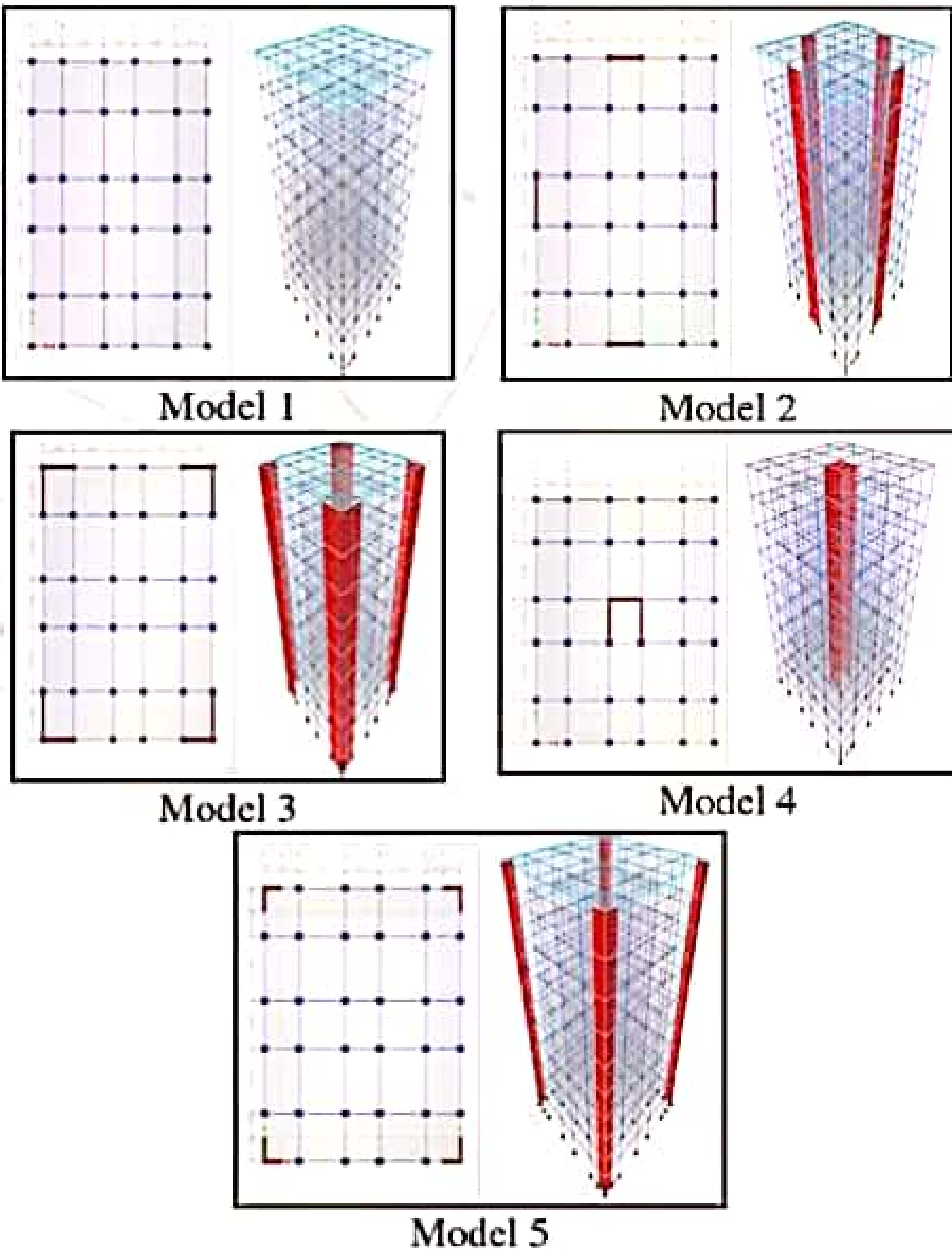


Figure 3: Models with Different locations of Shear Wall

Figure 2

Configuration Type

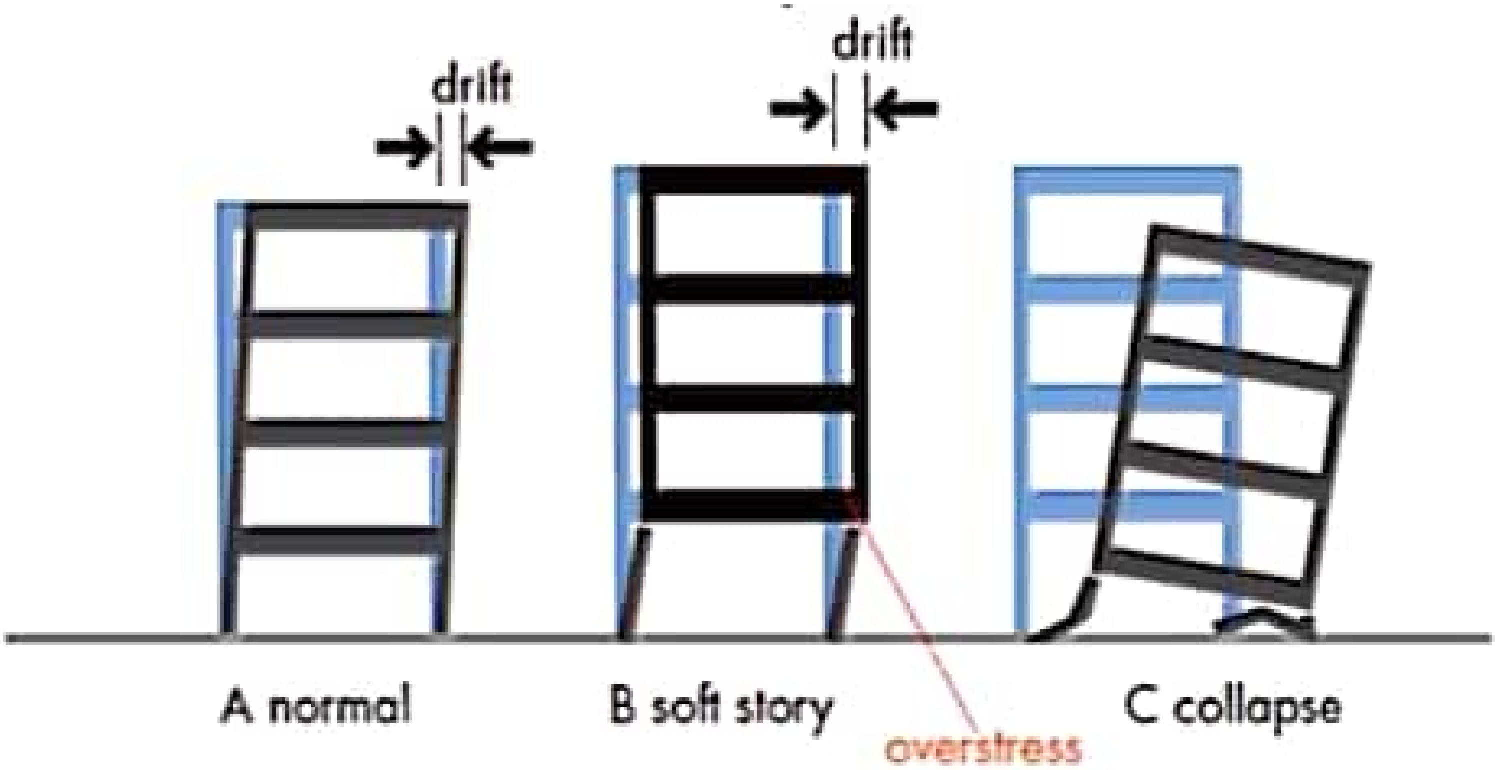
The type of serious configuration condition which is shown in figure is "soft and weak story."

Soft And Weak Storey

The buidings in which the stiffness and strength of the lower story is less as compare to all the above stories. Such type of phenomenon is soft and weak story condition.

Effect

The presence of walls in the upper storey make it much stiffer than the lower story. Thus the upper stories moves almost as a single block and lower soft storey moves seperate during an earthquake and as a result the soft storey will collapse.



The soft first story failure mechanism.

Possible Solutions

Some of the possible solutions to minimize the effect of earthquake on soft story are mentioned below

1) Add Columns

One of the solution is to provide more columns in Order to achieve the required strength and to increase the stiffness to overcome the soft storey configuration condition

2) Add Bracing

Add bracing to the soft sotorey of the building.

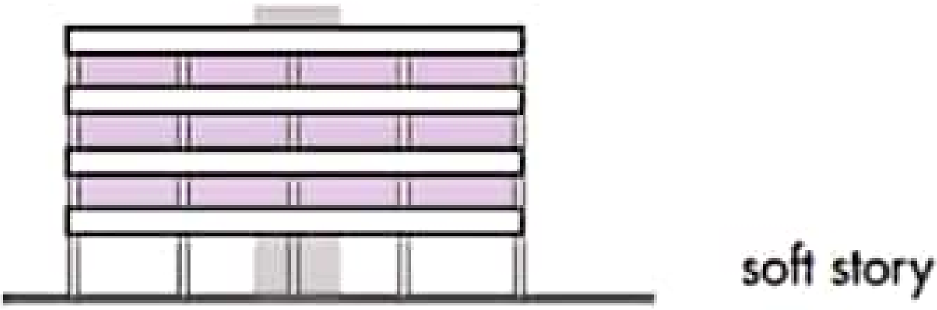
3) Add External Buttresses

In order to overcome soft storey configuration condition we usually provide external buttresses to the building.

4. Design Consideration

Another possible solution is to specifically design the first/lower storey for much larger loads and smaller induced displacements then the rest of the structure.

Solutions


soft story

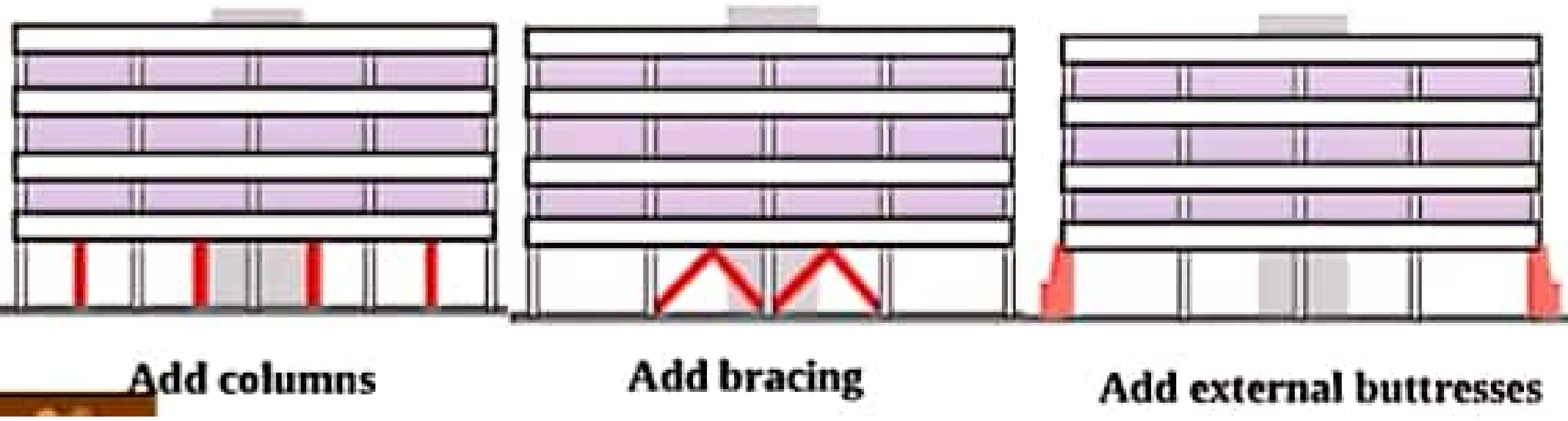

Add columns
Add bracing
Add external buttresses

Figure 3

Configuration Type

The type of serious configuration condition as mentioned in figure is "Re-entrant Corners"

Re-entrant Corners

The re-entrant corner is a common building characteristic that in plan assumes the shape of an L, T, H etc or a combination of these shapes

Re-entrant corner plan forms.

Effects

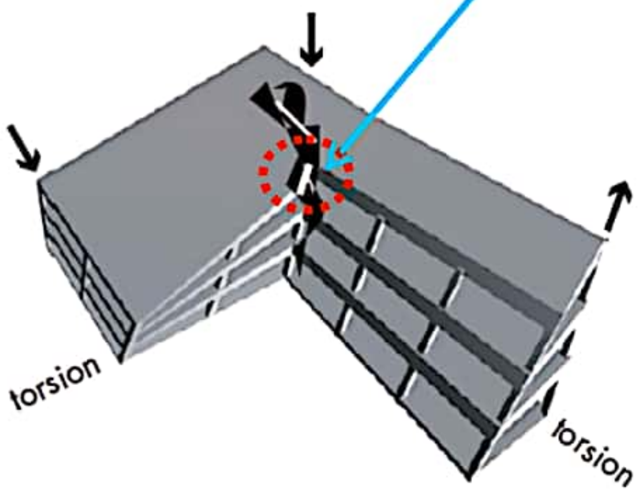
1) Torsion

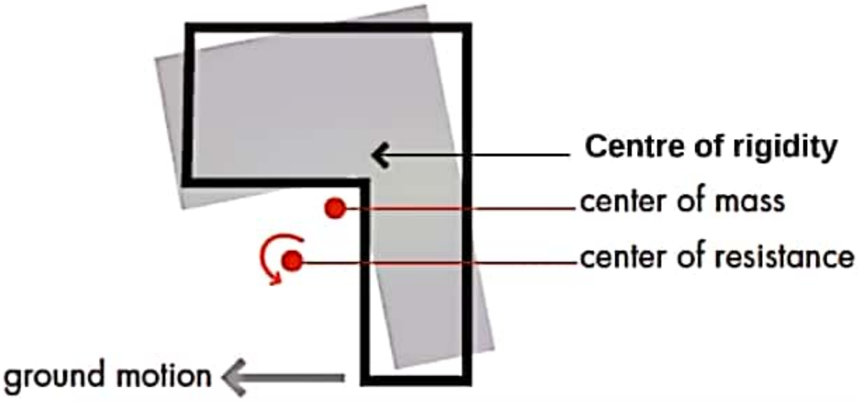
Torsion is one of the effects of reentrant corners. Torsion is caused because the centre of mass and centre of rigidity in this form cannot geometrically concide for all possible seismic waves directions. The result is torsion. The resulting force is difficult to analyze and predict.

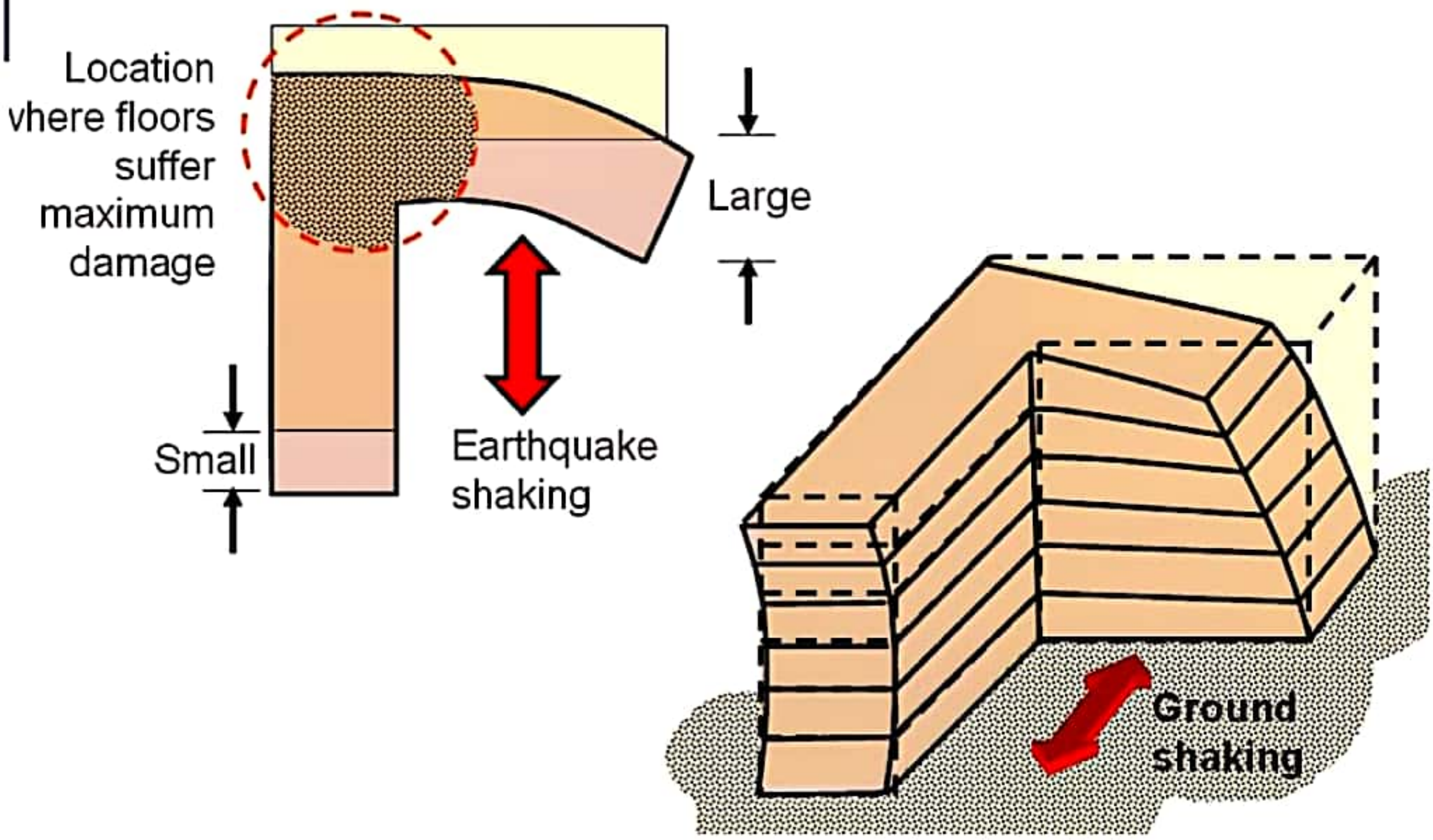
2) Differential Motion

Structures consisting of re-entrant corners tends to produce differential motions between different wings of the building. Because of stiff elements that tends to be located in this region, result in local stress concentration at re-entrant corners.

Re-entrant Corners







Differential deformation at the junction of two wings

Possible Solutions

1) Seperate the building

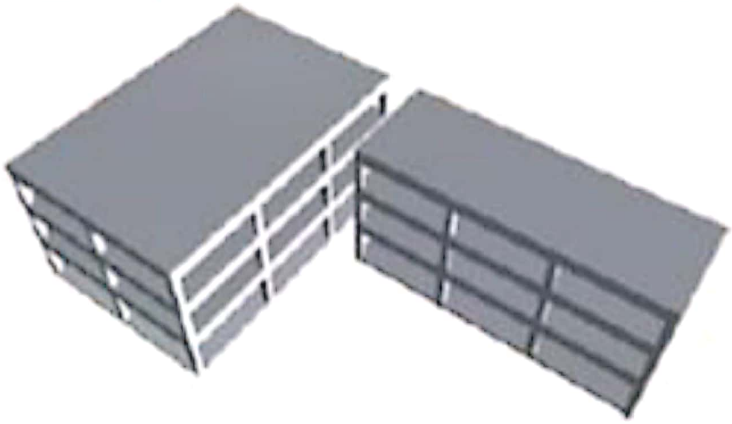
Solution to this type of configuration condition is to structurally seperate the building into simpler shape, in order to avoid stress concentration at corners and also to avoid the formation of cracks, so to reduce the torsional effect. In case of seperation of building, it must be ensured that they are sufficiently away from each other and they do not pound together so that the buildings/structure does not damage each other during sesmic waves.

2) Tie the building

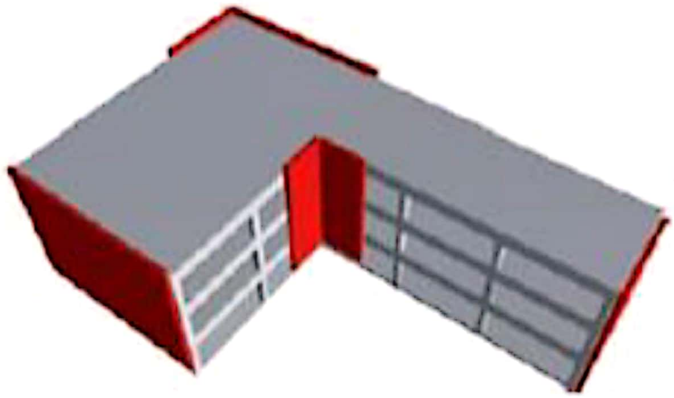
Another solution may be to tie the building together more strongly with element positioned to provide a more balanced resistance. But this type of solution applies only to smaller structures.

3) Use of Splayed

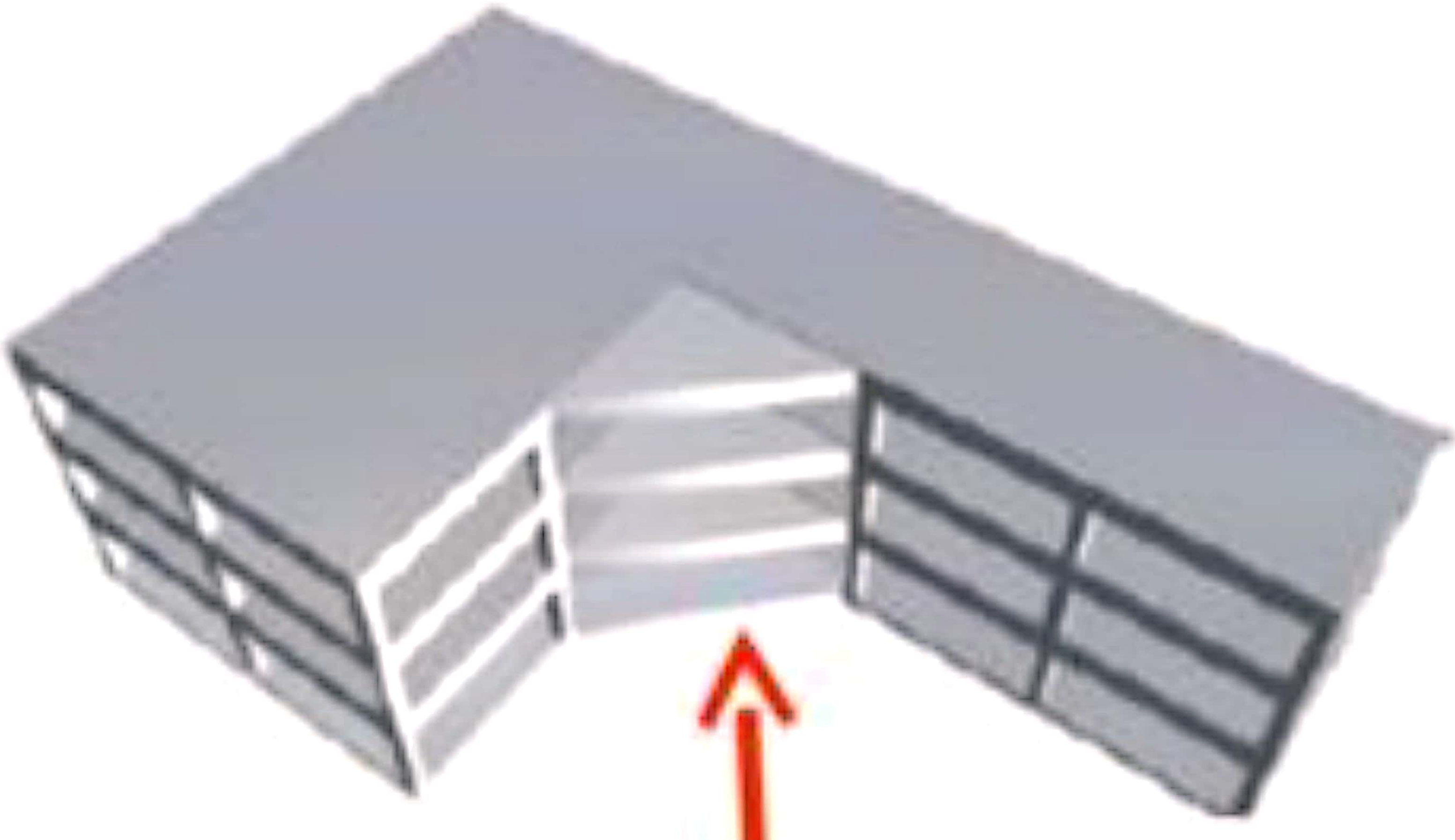
Another solution may be to use splayed instead of right angle re-entrant corners lessens the stress concentration.



Seperation

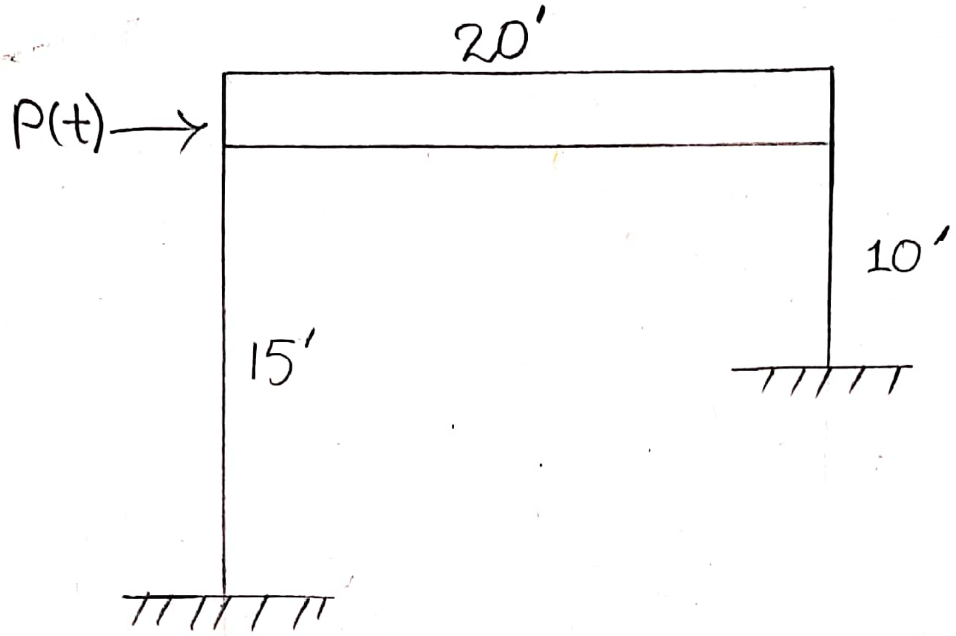


Stiff resistant elements



Splayed re-entrant corners

Question #02



Given Data

Modulus of elasticity, E = 29,000 ksi
Moment of inertia, I = 1200 in^4
Uniformly distributed gravity load = 7733 lb/ft

Required Data

Develope equation of motion, (pt) = ?

Solution

As,

$$k_{eq} = k_1 + k_2$$

$$k = 12EI\left[\frac{1}{h_1^3} + \frac{1}{h_2^3}\right]$$

$$k = 12 \times 29000 \times 1200 \left[\frac{1}{(15\times12)^3} + \frac{1}{(10\times12)^3}\right]$$

$$k = 313.29 \text{ k/in}$$

$$\boxed{k = 3759 \text{ k/ft}}$$

Also

$$m = \frac{W}{g}$$

$$= \frac{7.733 \times 20}{32.2 \text{ ft/sec}^2}$$

$$m = 4.803 \text{ k.sec}^2/\text{ft}$$

$$\boxed{m = 4803 \text{ lb.sec}^2/\text{ft}}$$

Now

Using D-Alembert's Principle of dynamic equilibrium

$$P(t) = ku + m\ddot{u} \quad \text{---} \quad (1)$$

As,

$$k = 3759 \text{ k/ft} = 3.759 \times 10^6 \text{ lb/ft}$$

put the values in eq (1)

$$\boxed{p(t) = 3.759\times10^6 u + 4803 \ddot{u}}$$

Where u and p(t) are in lb & ft respectively