

Training on NBC Com[plaint Computer Aided Design of Buildings for Engineers/ Designers of Kathmandu Valley

Building Configuration

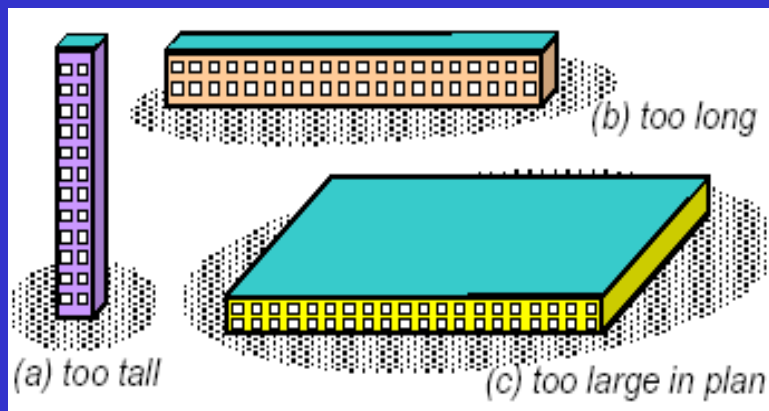
Er. Himal K.C.

August 22, 2014

Building Shape and Configuration

- We can see different Shapes of Buildings such as rectangular, Square , L , Y , H , C , Circular etc.
- Regular Buildings are those which has Low height to base ratio, Equal floor heights, symmetrical plans, uniform section and elevation ,direct load path
- Buildings with different Shapes behave differently in an Earthquake.
- Irregular Shapes (C,L,T,Y) buildings behave with more complexity and suffer more damage than of the regular shape (Rectangular , Square and Circular)

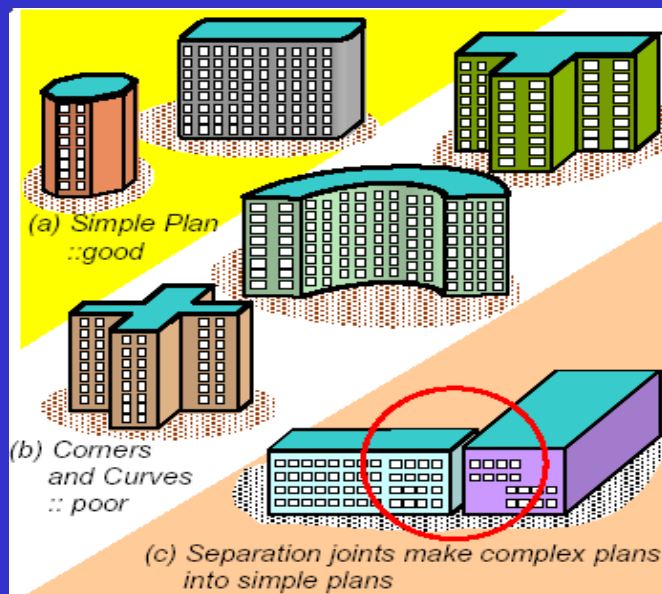
Building Shape and Configuration



Buildings with one of their overall sizes much larger or much smaller than the other two, do not perform well during earthquakes.

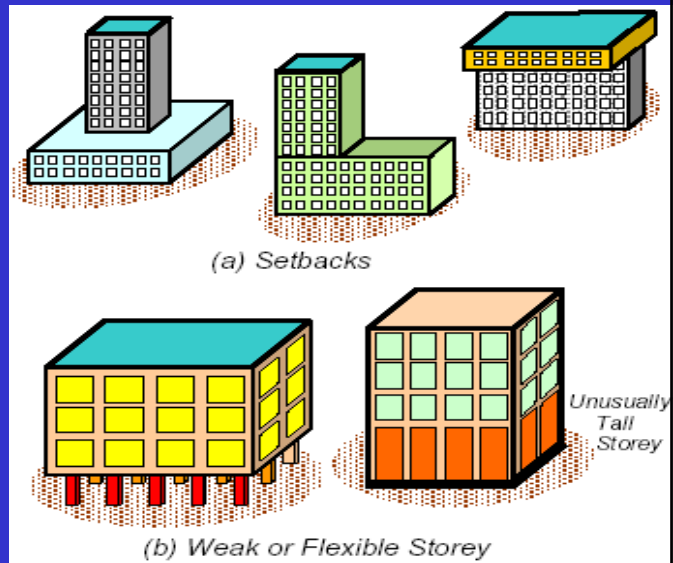
Building Shape and Configuration

Simple plan shape buildings do well during earthquakes.



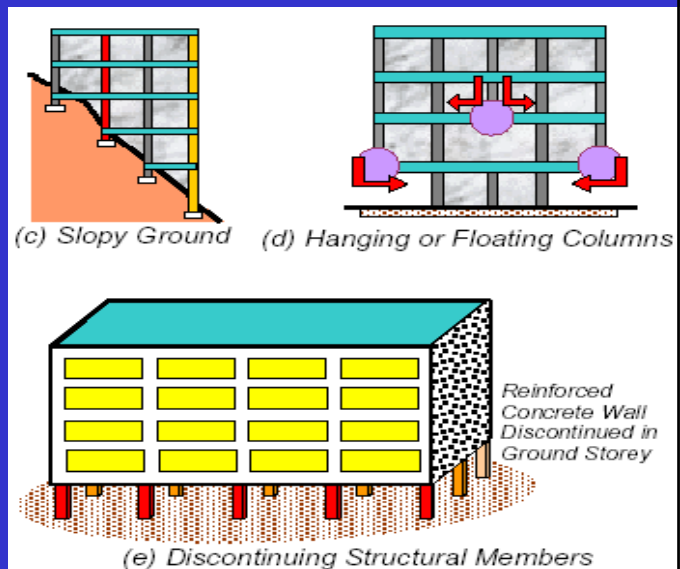
Building Shape and Configuration

Sudden deviations in load transfer path along the height lead to poor performance of buildings.



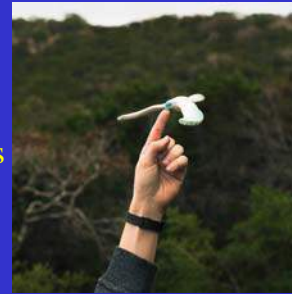
Building Shape and Configuration

Sudden deviations in load transfer path along the height lead to poor performance of buildings.



Center of Mass (CM)

The center of mass is the unique point at the center of a distribution of mass in space that has the property that the weighted position vectors relative to this point sum to zero



Center of Rigidity (CR)

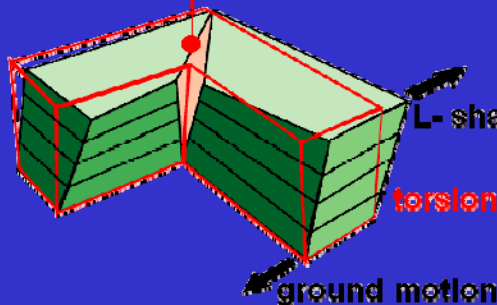
A point (Stiffness Centroid) through which a horizontal force is applied resulting in translation of the floor without any rotation.

Eccentricity creates Torsion

Irregular Shape

TORSIONAL FORCES and STRESS CONCENTRATION

stress concentration

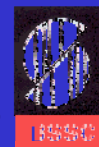


L-shaped building

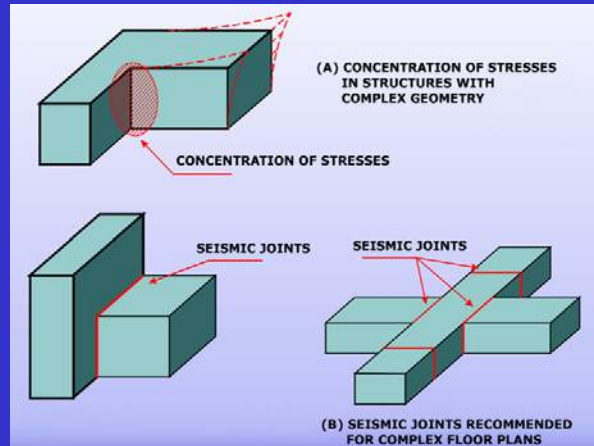
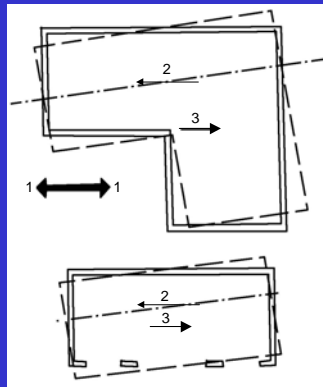
torsion

ground motion

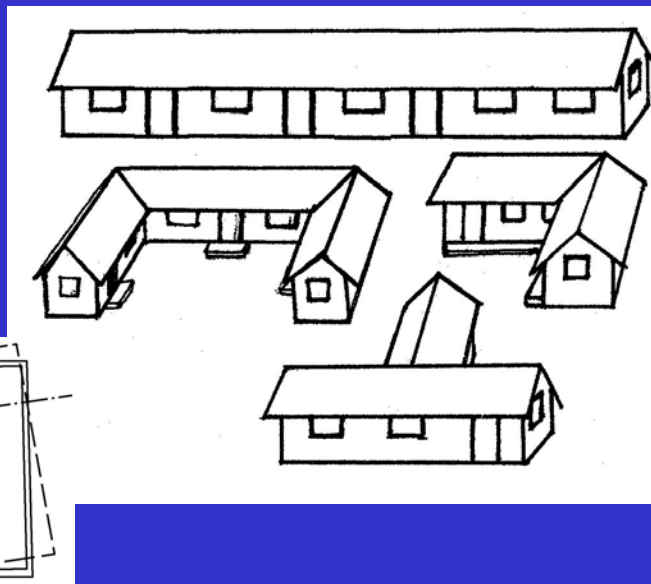
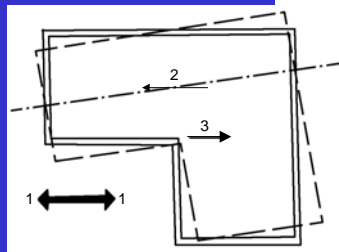
PRINCIPLES OF SEISMICITY AND SEISMIC DESIGN



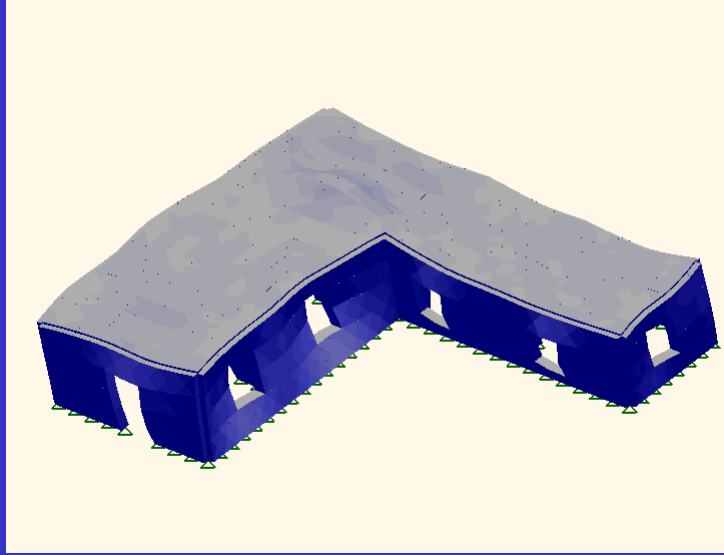
Irregular Shape



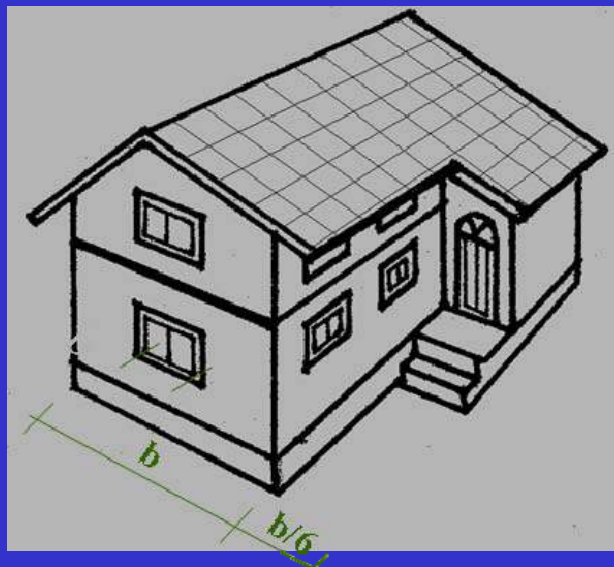
Irregular Shape



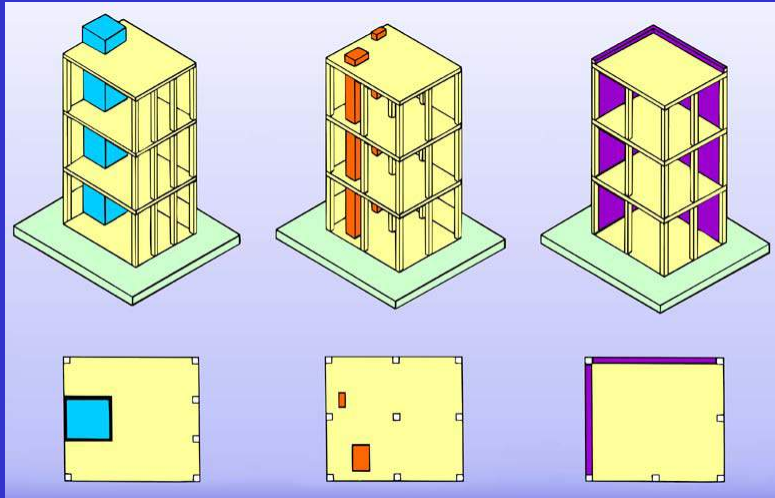
Irregular Shape During Earthquake



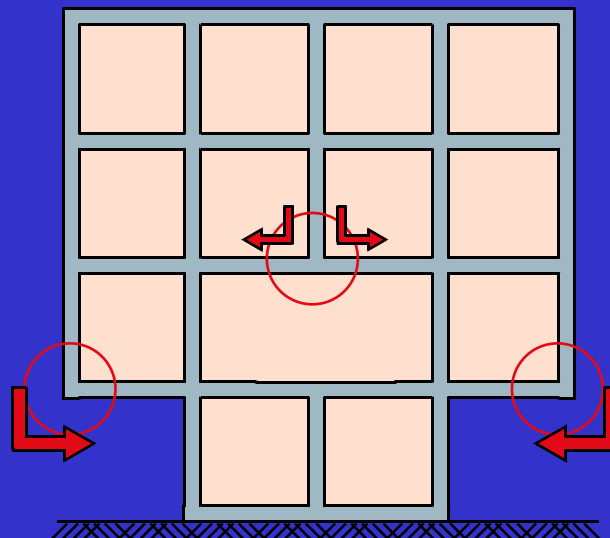
Acceptable Offset in building



Asymmetry(false symmetry) due to the location of structural elements



Undefined Vertical Load Path



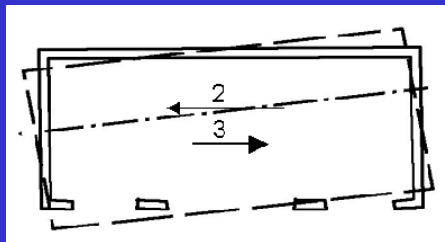
Undefined Vertical Load Path



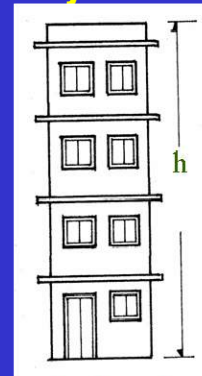
Undefined Load Path



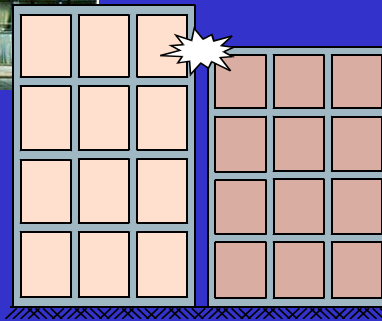
Unbalanced Openings



Tall Buildings with no Redundancy



Hammering Effects



Soft storey Effects



Long Narrow Buildings



Long narrow building

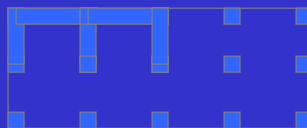


Long narrow buildings are also weak because the long side of the building can easily be damaged.

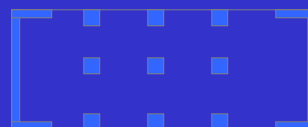
Regular and irregular arrangement



Significant difference between walls in x and y



Irregular arrangement of vertical element



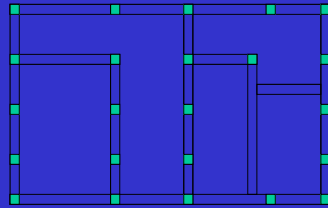
Balanced walls in x and y



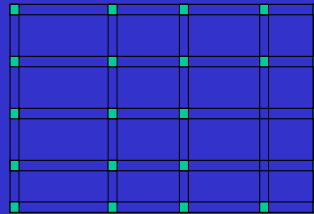
Regular arrangement of Vertical element



Regular and irregular arrangement



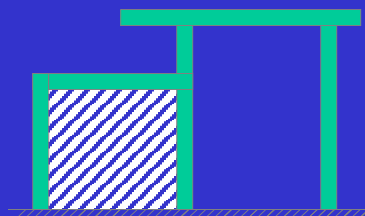
Unclear Frame Behavior



Good Frame Behavior in x and y

Regular and irregular arrangement

No

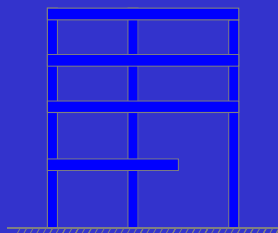


No Seismic Joint

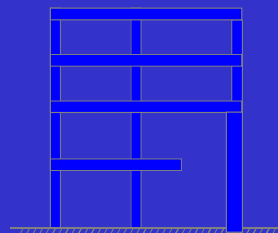
Yes



Seismic Joint at appropriate location

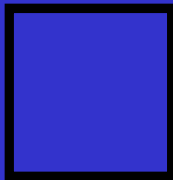
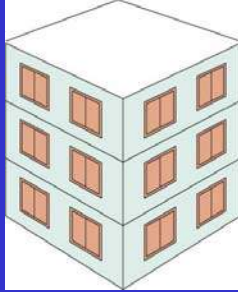


Interaction of Structural Elements of Different Stiffness

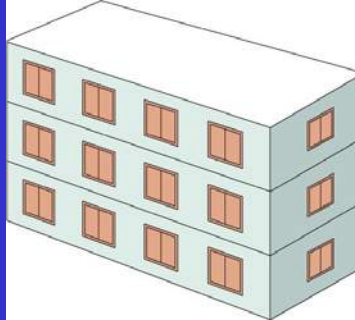


Proper Design or Strengthening of Flexible Elements

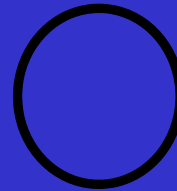
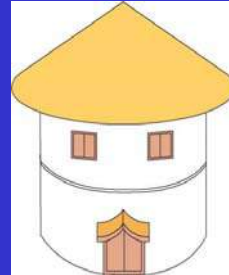
Some Appropriate Shapes



Square



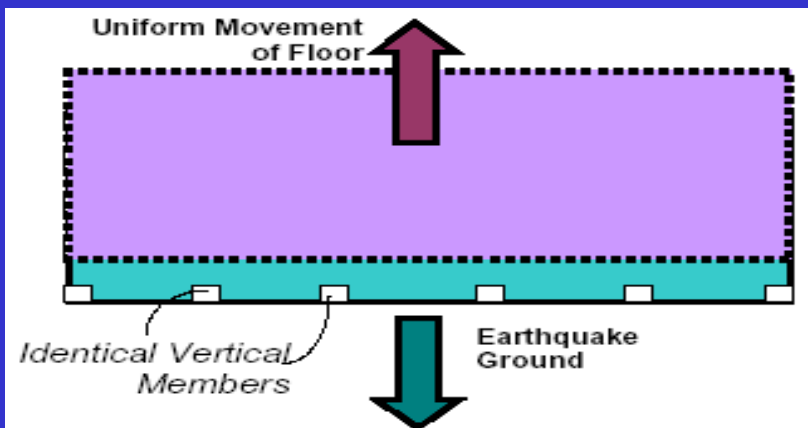
Rectangular



Circular

Building Shape and Configuration

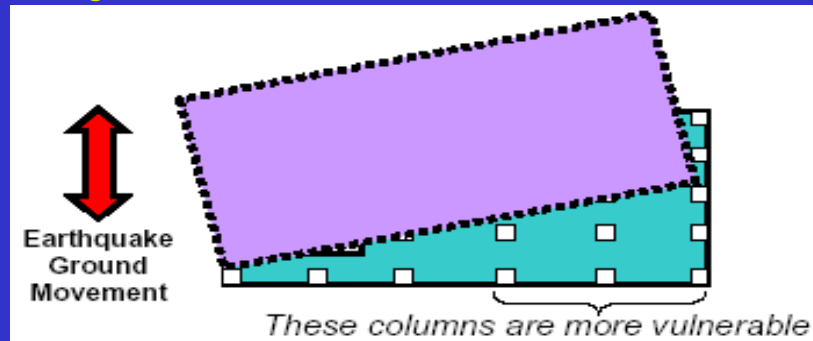
When the Building is Hit by an Earthquake, it is Subjected to the horizontal force at the Floor levels and the whole Building is deflected. If the Building is regular shaped the deflection is uniform in all parts of the building.



Identical vertical members placed uniformly in plan of building cause all points on the floor to move by same amount.

Building Shape and Configuration

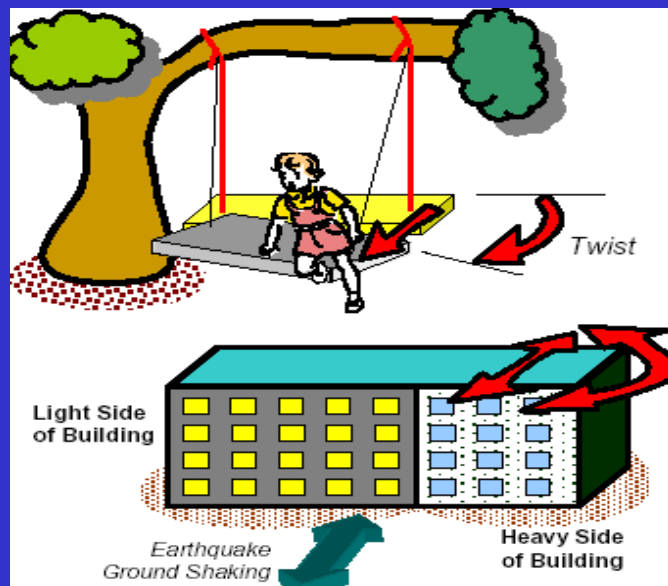
If the Building is irregular shaped then deflection is not uniform , some parts deflect much and some parts less. Due to this difference in deflection the building as a whole tends to rotate leaving the Corner and ends at more stress. This rotation of the building is called the torsion.



Vertical members of buildings that move more horizontally sustain more damage.

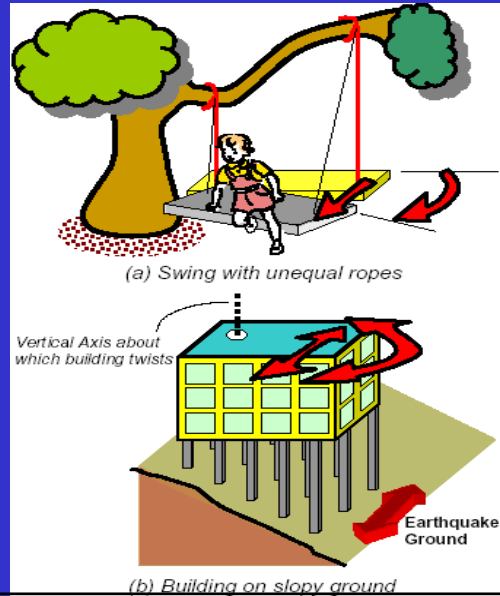
Torsion During Earthquake

Even if vertical members are placed uniformly in plan of building, more mass on one side causes the floors to twist.



Torsion During Earthquake

Buildings have unequal vertical members; they cause the building to twist about a vertical axis.



7.1 Regular and Irregular Configuration

7.1 To perform well in an earthquake, a building should possess four main attributes, namely **simple and regular configuration**, and adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation, suffer much less damage than buildings with irregular configurations.

Source: IS 1893 (Part 1) : 2002

7.1 Regular and Irregular Configuration

1. *Torsion Irregularity*
2. *Diaphragm Discontinuity*
3. *Stiffness Irregularity —Soft Storey*
4. *Mass Irregularity*
5. *Vertical Geometric Irregularity*

Things to Remember

- *“If we have a poor configuration to start with, all the engineer can do is to provide a band-aid - improve a basically poor solution as best as he can. Conversely, if we start off with a good configuration and reasonable framing system, even a poor engineer cannot harm its ultimate performance too much.”*

Henry Degenkolb

Key Words to remember regarding Building Configuration

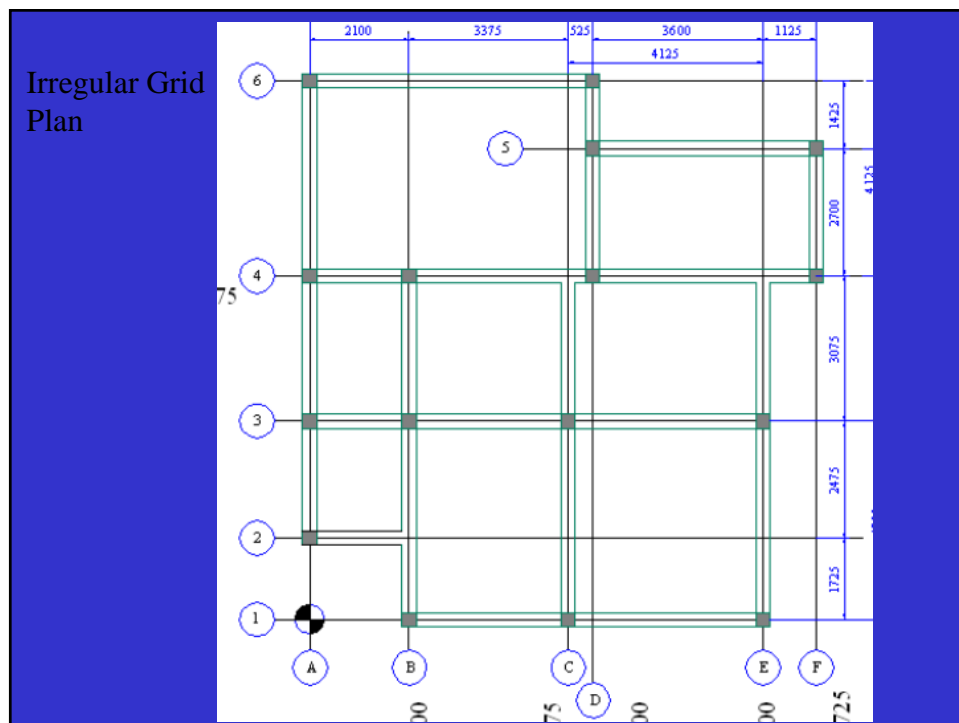
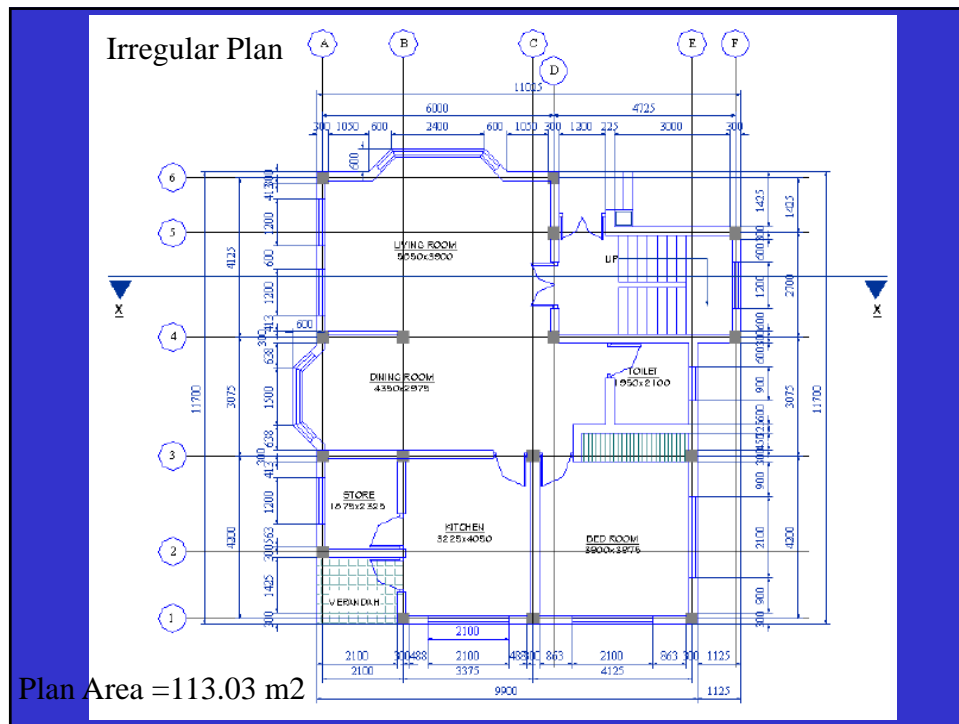
- 1. Direct Load Path*
- 2. Balanced Lateral Resistance*
- 3. Low Height to Base Ratio*
- 4. Less Mass Irregularity*
- 5. Less Geometric Irregularity*
- 6. Less Stiffness Irregularity*
- 7. Less Eccentricity*
- 8. Good Frame Behavior in two Orthogonal directions (X & Y Grid)*
- 9. Uniform Sections.*
- 10. Redundancy*

Reference:

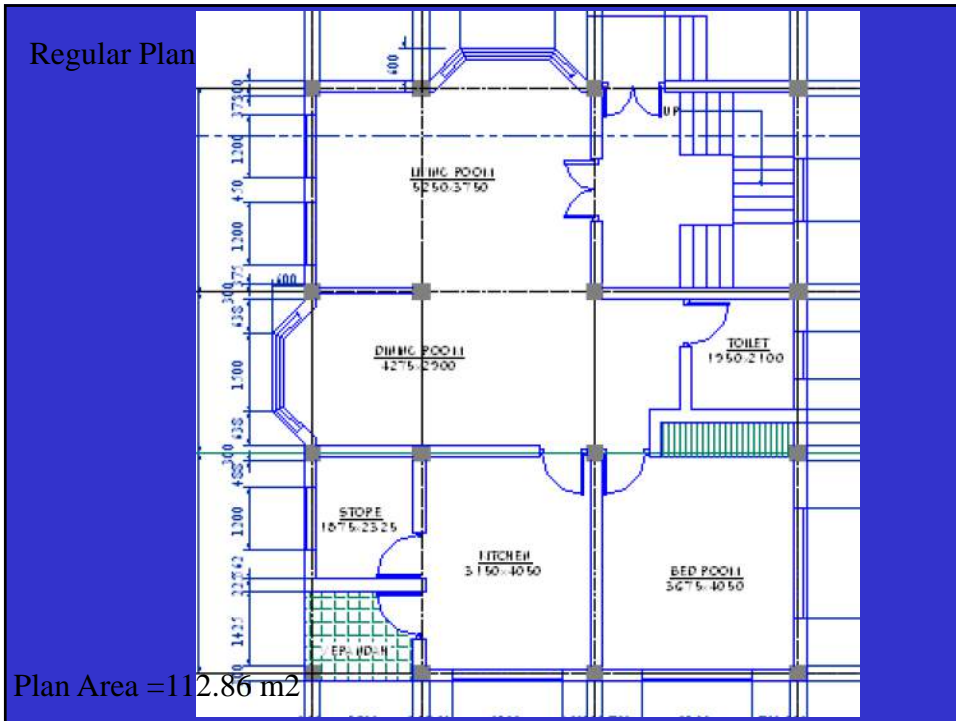
- Training manual on Earthquake resistant construction of Buildings,
Government of Nepal
Ministry of Physical Planning and Works
Department of Urban Development and Building Construction
Earthquake Risk Reduction and Recovery Preparedness
Program for Nepal
- EQ Tips

Lets see some examples Through SAP models

Practice



Regular Plan



Regular Grid

