LECTURE # 2

In this lecture you will learn about:

- Risk
- Seismic Risk
- Seismic Hazard
- Seismic Vulnerability
- Basic Considerations for seismic design

Course Name:

"Introduction To Earthquake Engineering"

Course Code: CT-634

Credit Hours: 3

Semester: 6TH

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RISK

Earthquake scientists and engineers make an important concept about risk. They defined risk as

Risk is the probability of loss of life, injury, or damage.

Risk = Hazard x Vulnerability x Exposure

RISK CONTD……….

- A hazard is an agent that can cause harm or damage to humans, property, or the environment.

- Vulnerability measures the likelihood that something like a building will be damaged.

- Exposure is the number of people, buildings, structures that are exposed to the hazard. This is called an inventory.

SEISMIC RISK

Seismic risk directly depends upon

- Seismic Hazard.
- Seismic Vulnerability.
- Exposure of Elements at Risk.

For the purpose of simplicity we will discuss the first two parameters.

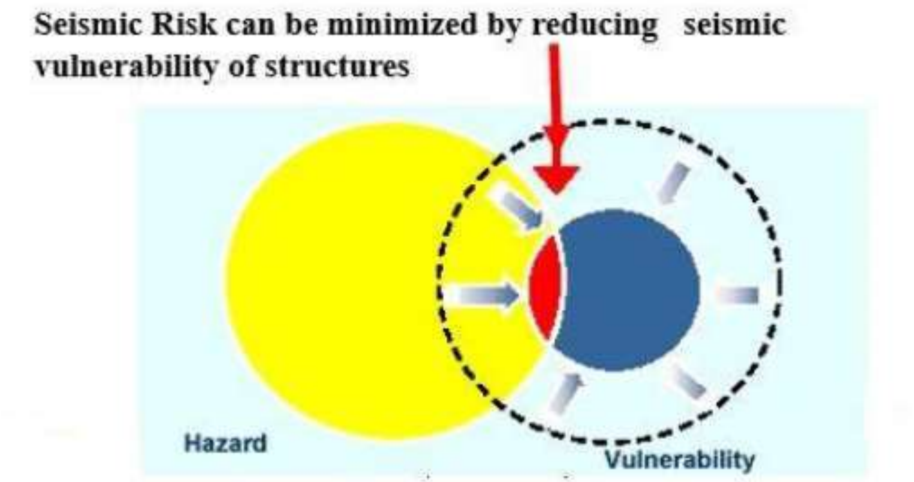
SEISMIC HAZARD & SEISMIC VULNERABILITY

SEISMIC HAZARD

- Depends upon the geology of site and therefore cannot be controlled.

SEISMIC VULNERABILITY

- Belong to structures and can therefore be reduced by appropriate design and construction.



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THE SEISMIC RISK KEEP ON INCREASING

- The current building stock is enlarged by the addition of new buildings, many with significant or even excessive, earthquake vulnerability. This above all due to the fact that for new buildings, the basic principles of earthquake resistant design and also the earthquake specifications of the building codes, are often not followed.
- The reason is either **unawareness, convenience or intentional ignorance**
- As a result the, the earthquake risk continues to increase unnecessarily.

URGENT ACTIONS NEEDED

- The preceding remarks clearly illustrate that there is a large deficit in the structural measures for seismic protection in many parts of the world.
- New buildings must be designed to be reasonably earthquake resistant to prevent the constant addition of new vulnerable structures to a building stock that is already seriously threatened.
- Your course “Introduction To Earthquake Engineering” aims at conveying the fundamental knowledge to the Civil Engineers regarding seismic resistant design and construction of structures.

SOME OF THE BASIC CONSIDERATIONS FOR SEISMIC DESIGN

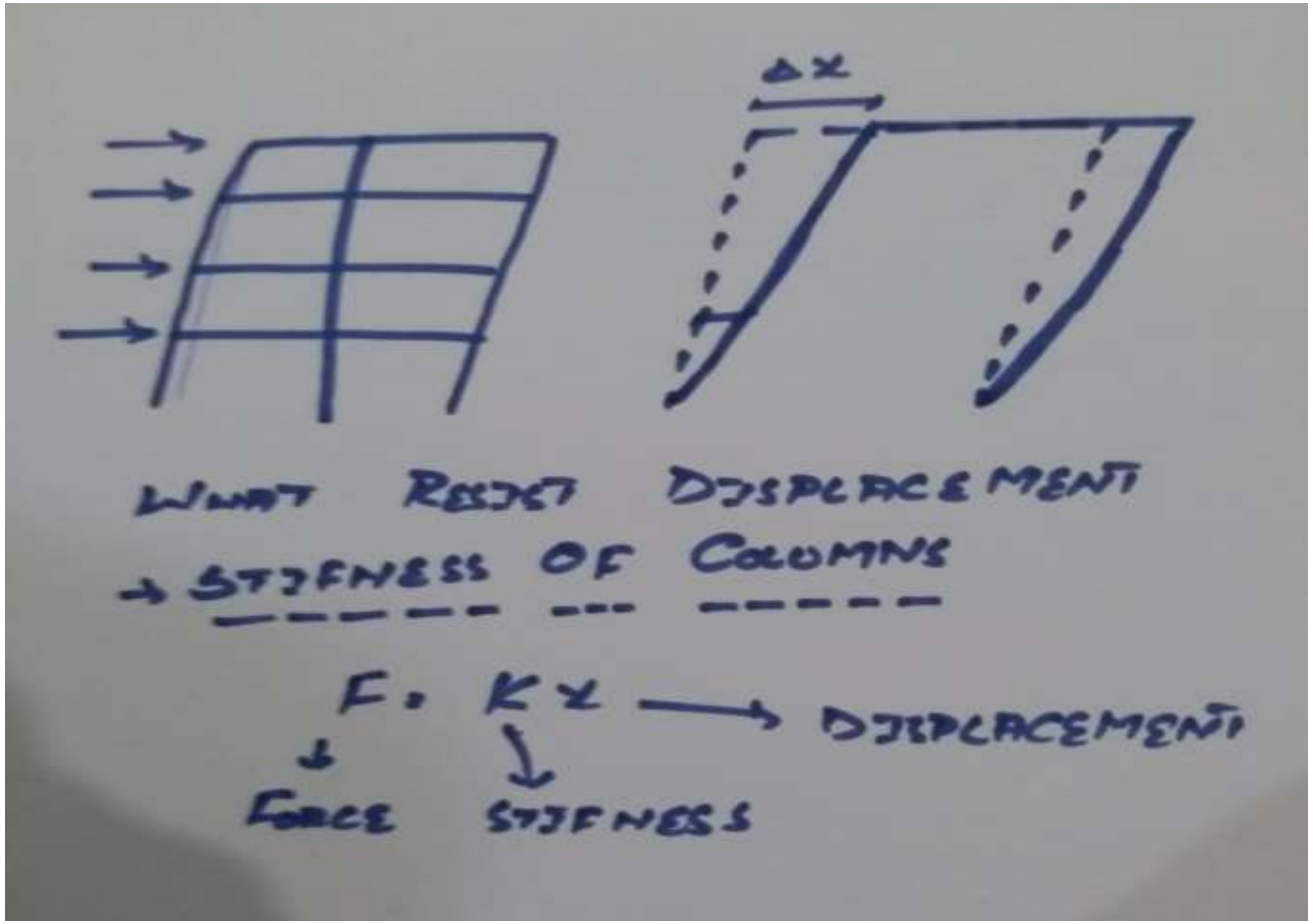
Basic considerations for seismic design are:

- Effect of Relative Stiffness.
- Torsional Forces.
- Effect of Shear Wall arrangement on the torsional resistance of building.

RELATIVE STIFFNESS

- The lateral force is distributed (at a particular story level) in proportion to the relative stiffness of the resisting members.
- The applied forces are "attracted to" and concentrated at the stiffer elements of the building.
- Thus the engineer must calculate the stiffness of the resisting elements to ascertain the forces that they must accommodate. - If two elements (two frames, walls, braces, or any combination) are forced to deflect the same amount, and if one is stiffer, that one will take more of the load.

STIFFNESS



Δx
WHAT RESIST DISPLACEMENT
→ STIFNESS OF COLUMNS
F = Kx → DISPLACEMENT
FORCE
STIFNESS

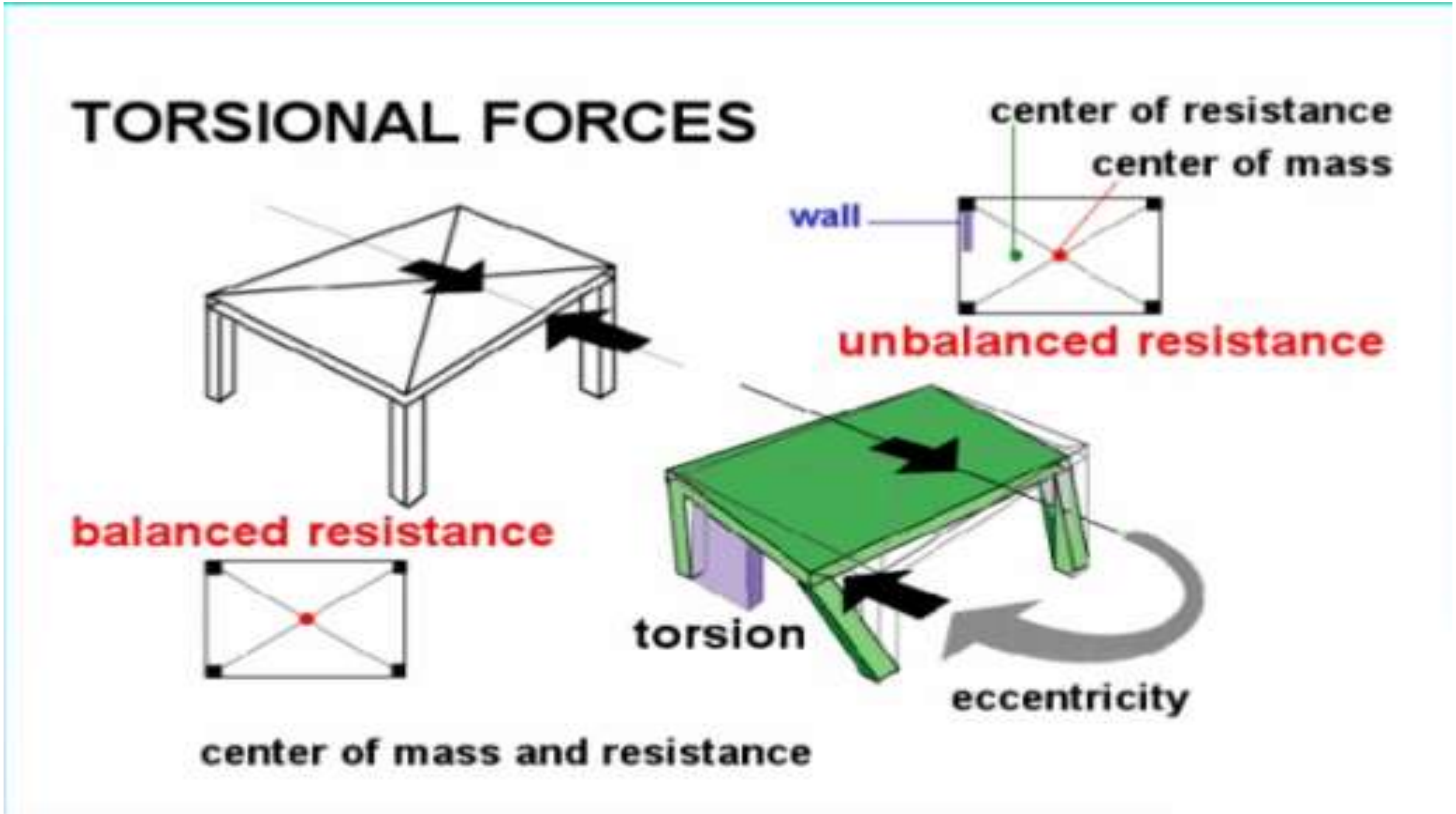
CENTER OF MASS AND RIGIDITY

- The **center of mass, or center of gravity**, of an object is the point at which it could be exactly balanced without any rotation resulting.
- If the mass (or weight) of a building is uniformly distributed in plan), the result is that the plan's geometric center (centroid) will coincide with the center of mass.
- In a building, the main lateral force is contributed by the weight of the floors, walls, and roof, and this force is exerted through the center of mass, usually the geometric center of the floor (in plan). - If the mass within a floor is uniformly distributed, then the resultant force of the horizontal acceleration of all its particles is exerted through the floor's geometric center.
- **Center of rigidity** is the point where whole body of have fully resistance against rotation. The stiffness is majorly contributed by the columns and shear walls of the building.

TORSIONAL FORCES

"Torsional forces are created in a building by a lack of balance between the location of the resisting elements and the arrangement of the building mass."

Engineers refer to this as eccentricity between the center of mass and the center of rigidity, C.R. (or center of stiffness), which makes a building subjected to ground motion rotate around its center of rigidity, creating torsion - a twisting action in plan, which results in undesirable and possibly dangerous concentrations of stress.



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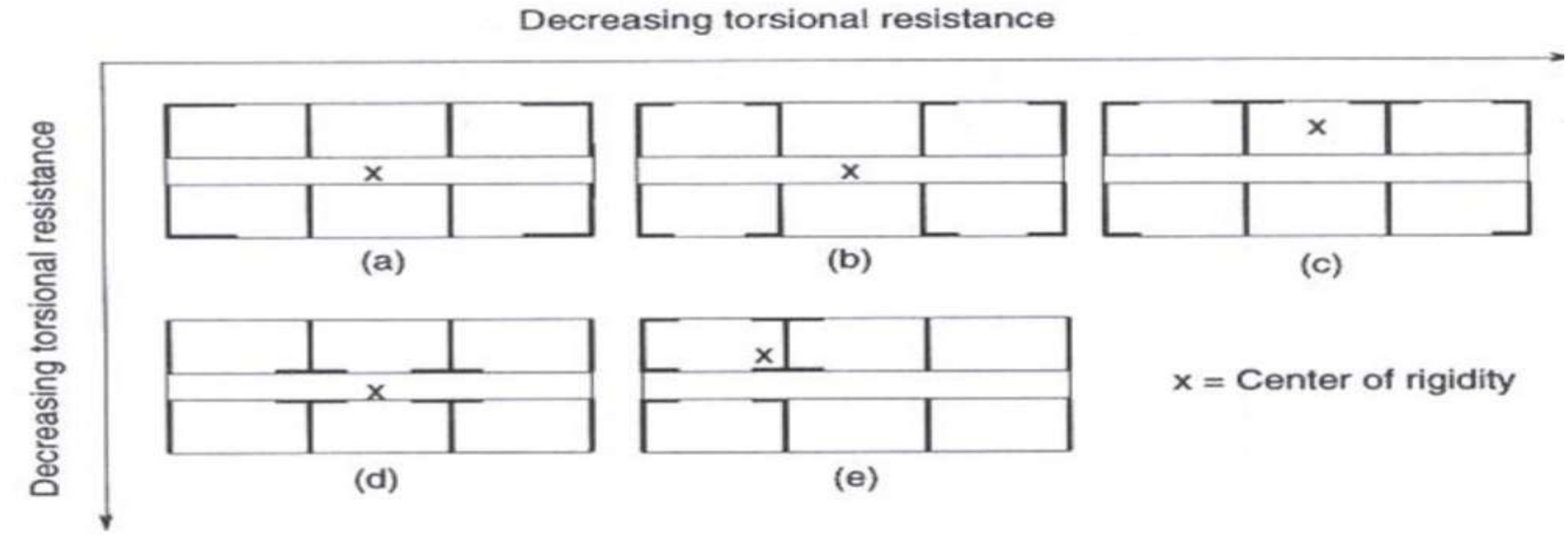
EFFECT OF SHEAR WALL ARRANGEMENT ON THE TORSIONAL RESISTANCE OF BUILDING



Effect of shear walls arrangement on torsional resistance (*the same total length of longitudinal wall is distributed in a different way for each layout.*

EFFECT OF SHEAR WALL ARRANGEMENT ON THE TORSIONAL RESISTANCE OF BUILDING

- Greatest torsional resistance is obtained by concentrating the longitudinal walls at the comers of the building, as in Fig. **a**. The center of rigidity is at the center of the plan (from symmetry) and the longitudinal walls, being placed as distant as possible from this center, produce the greatest torsional resistance.
- Although the position of the center of rigidity of the symmetrical arrangement in Fig. **b** remains at the center of the plan, the longitudinal walls are not entirely placed at the extremities thus resulting in a reduced torsional resistance

EFFECT OF SHEAR WALL ARRANGEMENT ON THE TORSIONAL RESISTANCE OF BUILDING

- Because of lack of symmetry about one axis in Fig. **c**, the center of rigidity will move slightly off centroidal axis and lateral forces will have an increased torsional effect due to this offset of the center of rigidity. Also the distances from the center of rigidity of the flanged sections created with longitudinal walls have been reduced, thus reducing the torsional resistance.
- Although the arrangement of walls in Fig. **d** is symmetrical, the longitudinal walls have been moved close to the center of rigidity and the sections produced have a greatly reduced influence on the torsional resistance of the total arrangement.

EFFECT OF SHEAR WALL ARRANGEMENT ON THE TORSIONAL RESISTANCE OF BUILDING

- A very poor arrangement of longitudinal walls is shown in Fig. **e**. Here they are clustered toward one comer, displacing the center of rigidity a large distance from the center of the plan and greatly increasing the torsional effects of the lateral loads. In addition, the longitudinal walls are at a short distance from the center of rigidity and therefore contribute less to the overall torsional resistance.

Thank You