DISASTER RESISTANT BUILDINGS

Tackling Disasters...

in a Civil Engineer's way...

DISASTERS THAT AFFECT BUILDINGS

Natural Disasters

- Earthquakes
- Floods
- Cyclones
- Tsunamis etc

Man-made/ Anthropogenic Disasters

- Nuclear Blasting
- Bomb Blasting
- Fire
- Structural Collapse etc

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EARTHQUAKE RESISTANT BUILDINGS

INTRODUCTION TO EARTHQUAKE

An earthquake is the result of a sudden release of energy in the Earth's crust, creating a series of seismic waves

Richter scales are used to measure their magnitude and Mercalli's scale for their intensity. The shallower an earthquake, the more damage to structures it causes

Causes:

Tectonic plates movement are the primary causes

Effects:

Shaking, ground rupture, landslide, tsunami, loss of life, property damage etc

STRUCTURAL FEATURES OF AN EARTHQUAKE RESISTANT BUILDING

As earthquake force is a function of mass, the building s
as possible, consistent with structural safety and functio
requirements. Roofs and upper storeys of buildings shou
be made of light weight type.

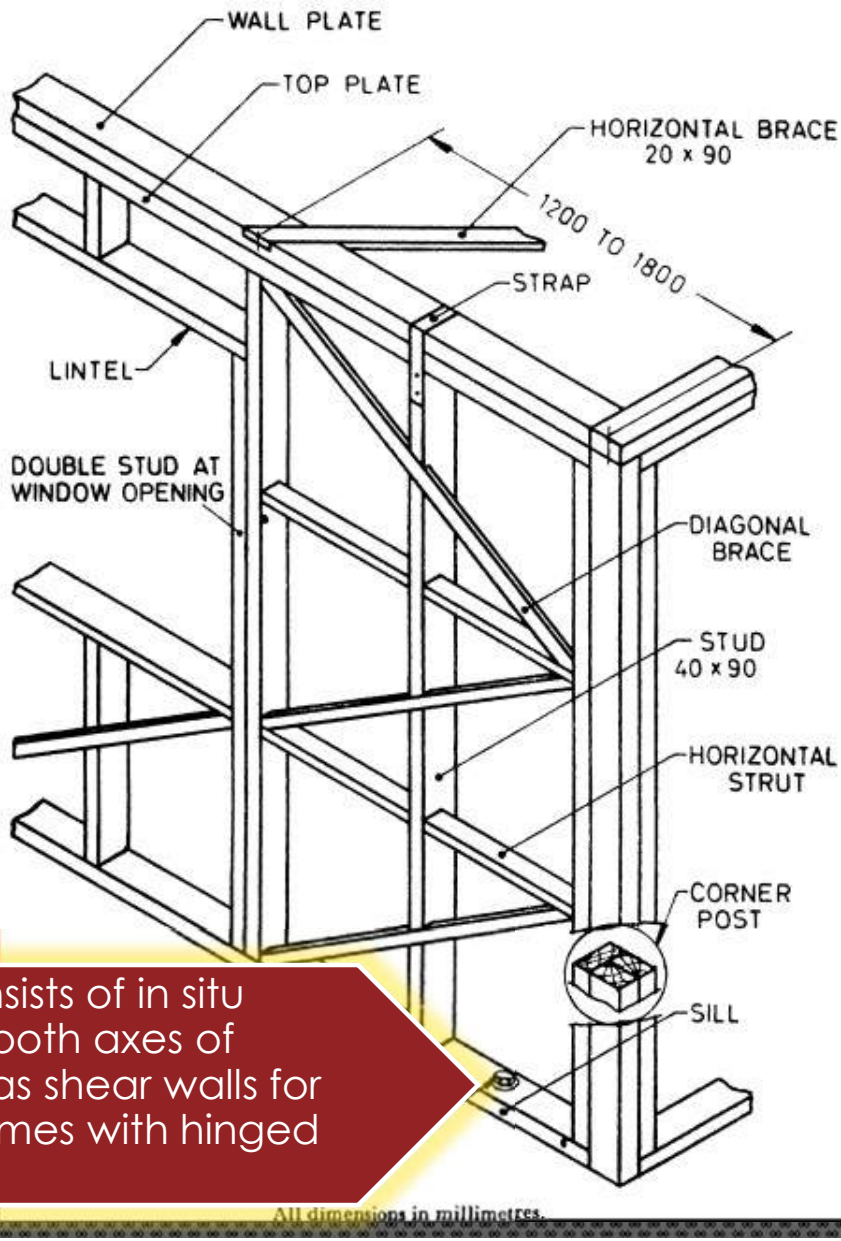
The building should have a simple rectangular plan and
as far as possible about both the axes instead of having
giving rise to L, T, E or Y shape plans.

Loose fine sand, soft silt and expansive clays should be a
building foundations. All the individual footings or pile ca
soils shall be connected by reinforced concrete ties at le
directions approximately at right angles to each other.

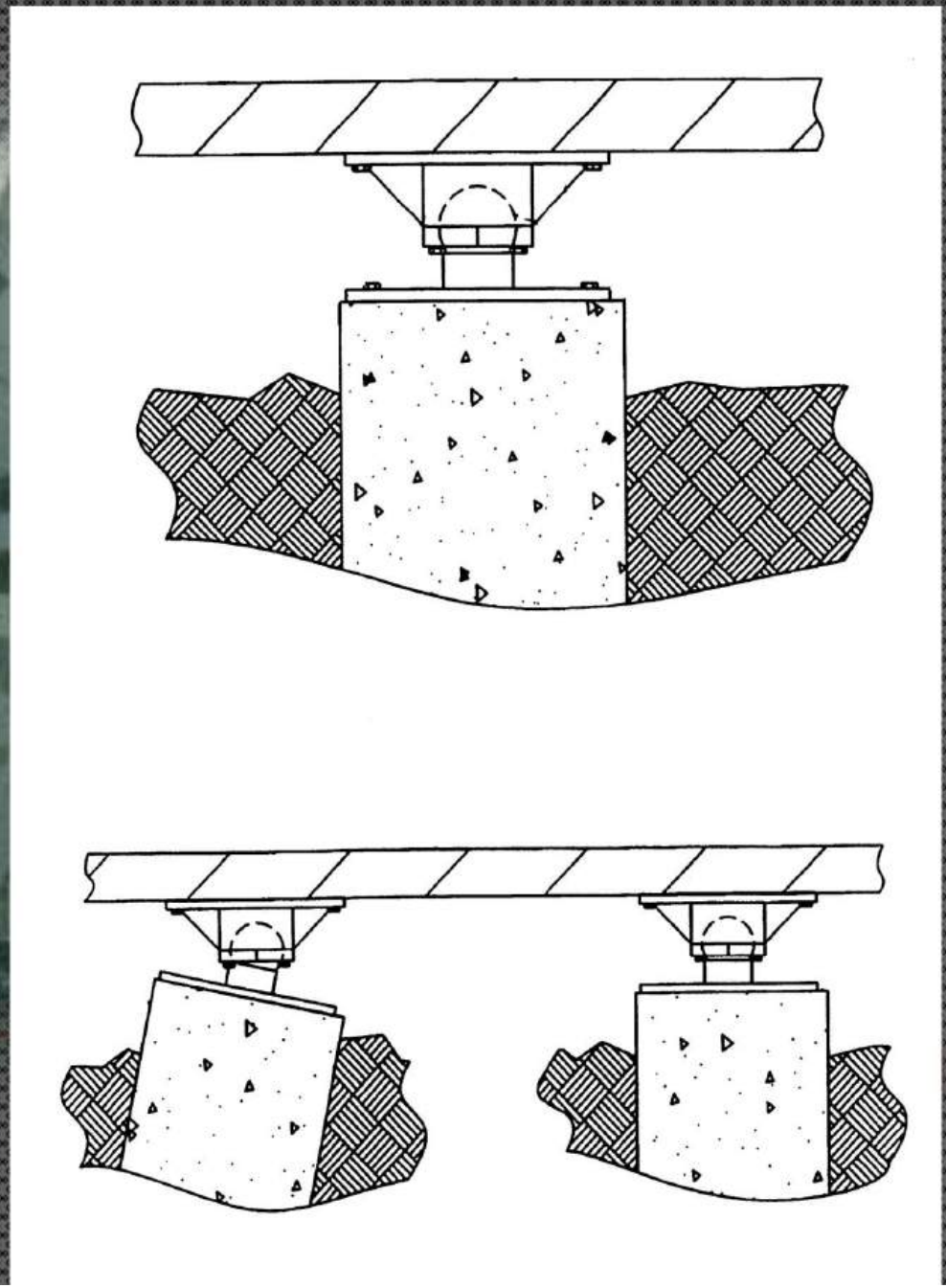
Where ties are used, their sections shall be designed to c
well as in compression, an axial load not less than the ea
acting on the heavier of the columns connected.

The thickness of reinforced concrete slab shall not be le
the clear distance between footings, but not less than
be reinforced in each direction at top and bottom. Hip
to gable ended roofs.

Two modes are adopted: 1.Box Type Construction-consists of in situ masonry, concrete or reinforced concrete wall along both axes of building. The walls support vertical loads and also act as shear walls for horizontal loads. 2. Framed Construction-consists of frames with hinged joints and bracing members.

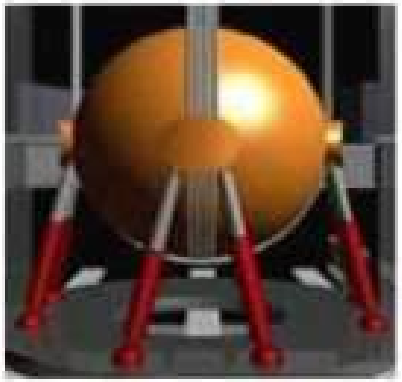


EMERGING TECHNOLOGIES

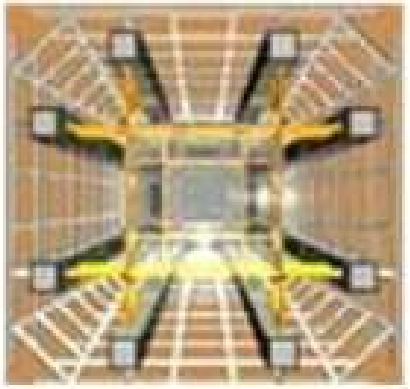


CASE STUDY: TAIPEI 101, CHINA

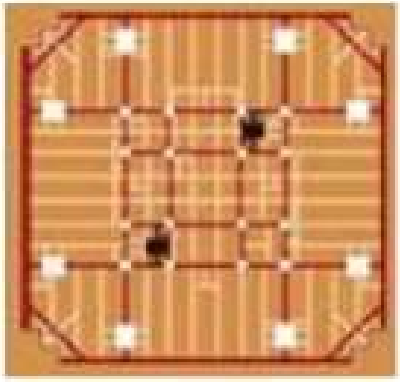
The world's largest passive tuned mass wind damper, suspended from level 92 down to level 88, helps to ensure stability and comfort.



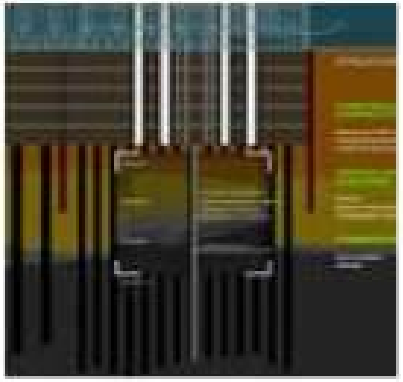
36 columns provide vertical support, including eight mega columns around the perimeter.



The structure is reinforced by a Moment Frame System linking the columns on all floors



The Tower is built on 380 concrete piles, sunk 80 meters into the ground



FLOOD RESISTANT BUILDINGS

INTRODUCTION TO FLOOD

A flood is an overflow of water that submerges land which is usually dry

Principal types of flooding: Areal (rainfall related), Riverine, Estuarine and Coastal, Urban and Catastrophic flooding

Causes:

Heavy rainfall, River overflow, Cyclones, Sea tidal surges, Collapse of Dam, etc

Effects:

Loss of life, Damage to buildings and other structures, Damage to transport infrastructure, Economic hardship, etc

STRUCTURAL FEATURES OF A FLOOD RESISTANT BUILDING

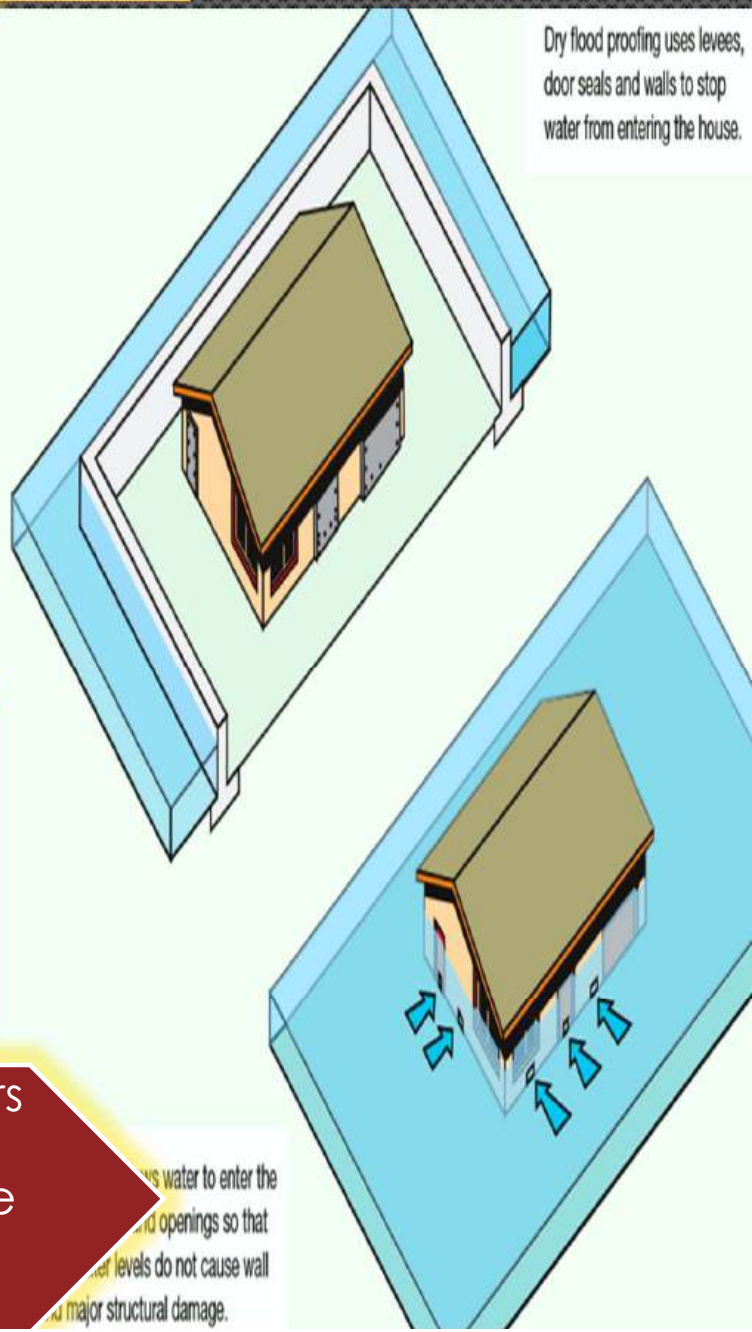
Compact buildings offer less resistance to flowing water and are structurally more robust. Long walls of houses should not face the direction of the flowing flood water

Hip roofs are preferred to Gable. Foundation walls must be designed to withstand any unbalanced soil/hydrostatic load. Cripple walls, where used, should be firmly attached and braced. Masonry and concrete should be reinforced

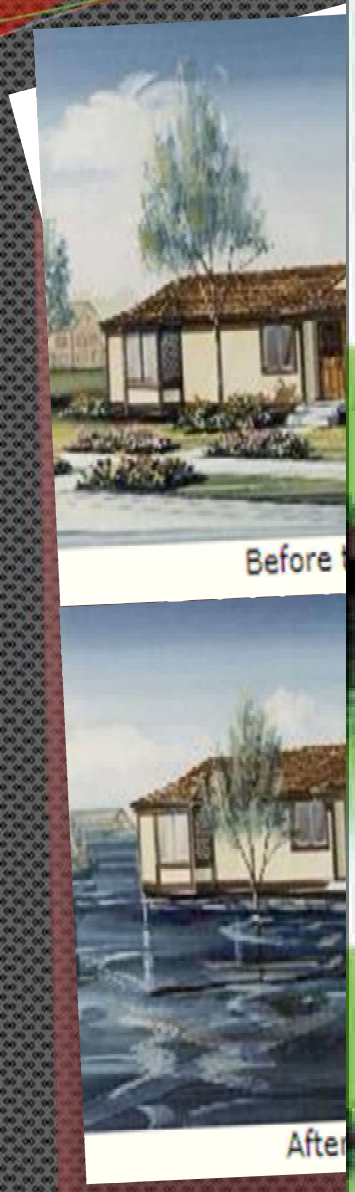
Where flowing water can cause erosion to embankments, retaining walls can be built to protect the site from undercutting

Houses can be protected from overland flows by having their ground floors elevated above the Base Flood Elevation level, hence creating an extra floor (for storage purpose only). Electrical outlets, sewage pipes and domestic machines have to be situated at higher levels.

Levees or walls can also be built to keep flood waters off the property. Or membranes, one-way valves, sealants, coatings etc may be used to watertight the house. Windows and doors should be made especially watertight by shields or panel closures



EMERGING TECHNOLOGIES:



Flood protection: Floating home

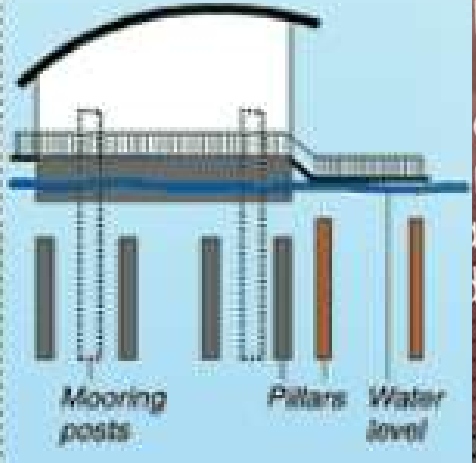
Besides structural measures such as dikes and levees, the Netherlands has developed a new concept in flood protection: houses that float.

Normal water level → House and concrete body rest on pillars

High water level → House floats; hollow concrete body acts like a ship's hull

Amsterdam
Maasbommel
BELG.

Side view



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CASE STUDY: THE LIFT HOUSE, DHAKA, BANGLADESH

CYCLONE RESISTANT BUILDINGS

INTRODUCTION TO CYCLONE

Cyclones are huge revolving storms caused by winds blowing around a central area of low atmospheric pressure

Characterised by an intense large-scale cyclic circulation of air, producing sustained gale force winds

Causes:

- Along with favorable wind regime, the sea-surface temperature generally needs to be above 26.5°C
- There has been a rise in frequency of cyclone owing to the increasing sea temperature, an indirect effect of global warming

Effects:

Heavy Rainfall, Destructive winds, floods and coastal inundation

STRUCTURAL FEATURES OF A CYCLONE RESISTANT BUILDING

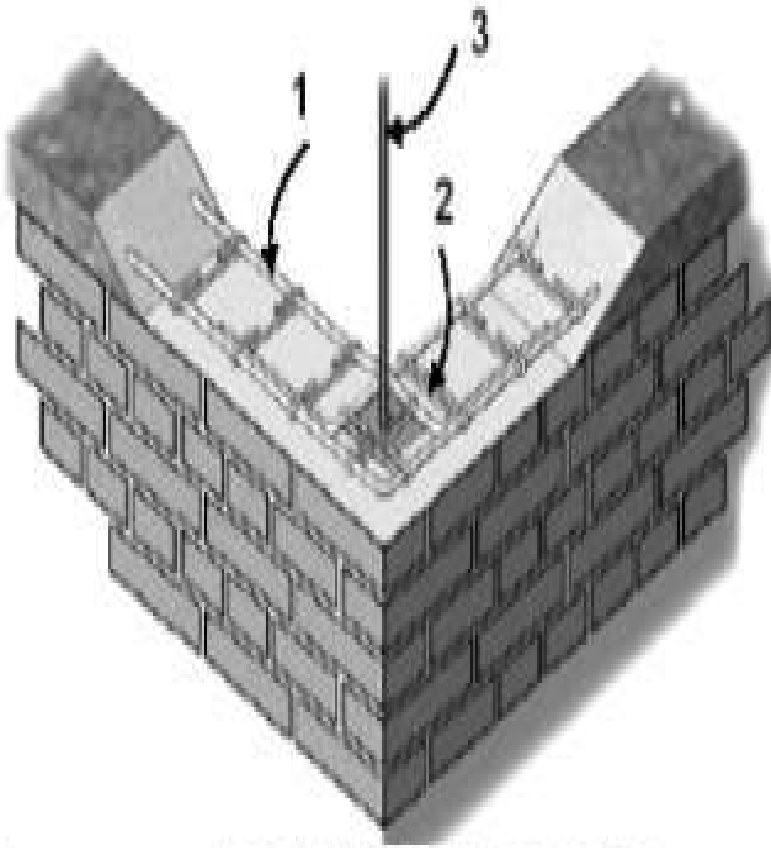
Simple, compact, symmetrical shapes are best. The square plan is better than the rectangle since it allows high winds to go around them. The rectangle is better than the L-shaped plan.

The lighter the building the larger (or heavier) the foundation needs to be in cyclone resistant design. Also factors like type of underlying soil, whether the region is prone to cyclone-induced-flood, scouring etc is taken into consideration.

To lessen the effect of the uplifting forces on the roof, the roof Pitch should not be less than 22°. Hip roofs are best, they have been found to be more cyclone resistant than gable roofs.

Overhangs, if any, should be braced by ties, openings with cyclone shutters and cyclone resistant connections having U-bolts and J-bolts are recommended

The walls should be strengthened by means of reinforced concrete bands and vertical reinforcing bars.



1. Longitudinal reinforcements
2. Lateral Ties
3. Vertical reinforcement at corners

iew showing the connection between the vertical reinforcement and the seismic band at lintel level

CASE STUDY: VILLA 921, JAPAN

NUCLEAR BLAST RESISTANT BUILDINGS

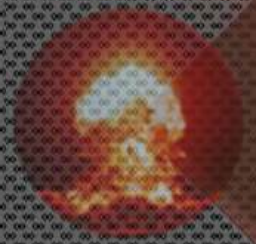
INTRODUCTION TO NUCLEAR BLAST

A nuclear blast is an explosion that occurs as a result of the rapid release of energy from a high-speed nuclear reaction

Usually characterised by a huge mushroom cloud

Causes :

- Detonation as a part of testing
- Detonation as a weapon

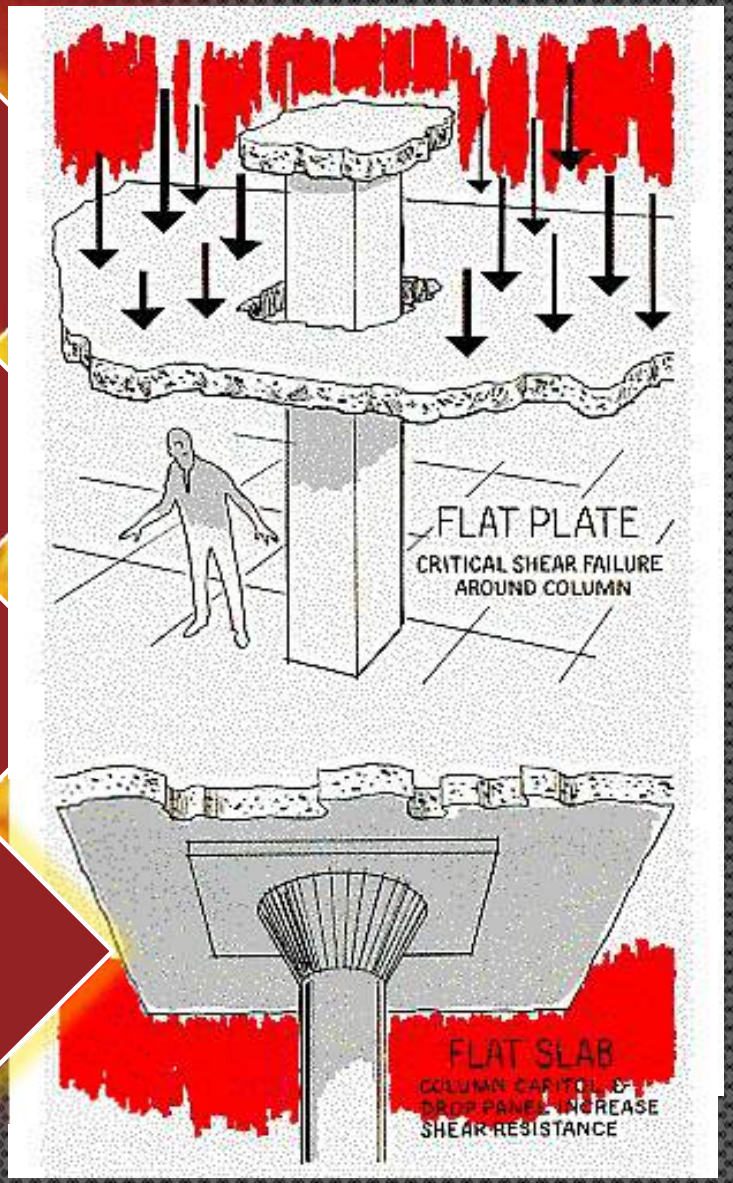


Effects:

Initial blast (like other conventional explosions), Thermal and Nuclear radiation, Atmosphere displacing shockwave, Ionizing rays, EM Pulse, Earthquake, etc

STRUCTURAL FEATURES OF A NUCLEAR BLAST RESISTANT BUILDING

- Use of frangible upper-story walls and partitions to prevent complete demolition by blast, as stronger the exterior wall, more the blast load imparted, more the damage
- Basement(shelter rooms) are to be wholly below ground to protect the basement walls from reflected pressure, nuclear fallout, gamma radiation etc.
- Under-reinforced flexural members with adequate shear, bond and diagonal tension resistance should be provided to insure ductile response to blast loads
- Spirally reinforced columns should be provided as they are more ductile than tied columns, hence can resist blast load better. Flat-slab floors over the shelter area should have either a column capital or drop panel or both



OTHER FEATURES

Thermal radiation protection :Thick, solid, opaque, light-coloured walls in the shelter room; and light coloured metallic blinds/glass fibre draperies on windows with solar glass

Non-combustible roof, exterior walls etc for fire protection; Provision of airtight exhaust system and emergency ventilation system to keep the poisonous gases from spreading;

The Nuclear blast resistant shelter room must be located either underground or at the centre of the middle floor. More interior is the location more is the protection factor against thermal and nuclear radiation

To prevent the radiation from penetrating the shelter space, openings should be located near the corners of the building & they should be thick and blast-proof

Most economic materials to build a nuclear radiation resistant shelter are: Steel, Concrete and packed soil

CASE STUDY: ATLAS F MISSILE BASE, NEW YORK

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THANK YOU