Durability: Structures that can withstand natural disasters

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Dome House (Pensacola, Florida)

- This house is a white, almost shell-like, concrete structure that sticks out of the ground like half a sphere.
- It has withstood four catastrophic hurricanes, thanks to its one-piece concrete construction embedded with five miles of steel.
- It is able to withstand 300 mile per hour winds.

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Sticky Mortar Building (China)

- Structures built 1,500 years ago in China have survived multiple earthquakes.
- Scientists have discovered that a combination of sticky rice soup with limestone that has been heated to a high temperature and then exposed to water creates a substance that is nearly indestructible.
- Buildings made with this substance have even resisted demolition by modern construction equipment including bulldozers.

Cheyenne Mountain Complex (Colorado Springs, Colorado)

- Enter the North Portal of this military installation at the foot of Cheyenne Mountain and you'll walk through a nuclear bunker.
- The 25-ton blast doors and blast valves in the air intakes and outlets allow the bunker to withstand a 30-megaton explosion from as little as two feet away.

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Sky Dome

- Blizzard-ready Sky Dome homes can withstand 700 kilograms of snow per square meter.
- These dome homes are designed for the comfort and safety of people who battle extreme winter weather.
- Sky Dome constructs these houses using natural materials such as pinewood, seaweed, flax, and cork – all environmentally-friendly and sustainable materials.

Tsunami House

- The main living area of this home is nine feet above grade.
- The foundation was built to counter high velocity waves.
- Strong materials like steel and concrete bolster the exterior of the home and indoors the industrial feel is tempered with western red cedar ceilings.

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Superabode Houses

- Built with sandbags, barbed wire, and earth, these structures are resistant to natural disasters.
- They can be erected as a replacement for unstable slum shanties or to solve housing needs for refugees.
- Anyone interested in building their own sustainable home can learn the process through the organization Khalili founded in California

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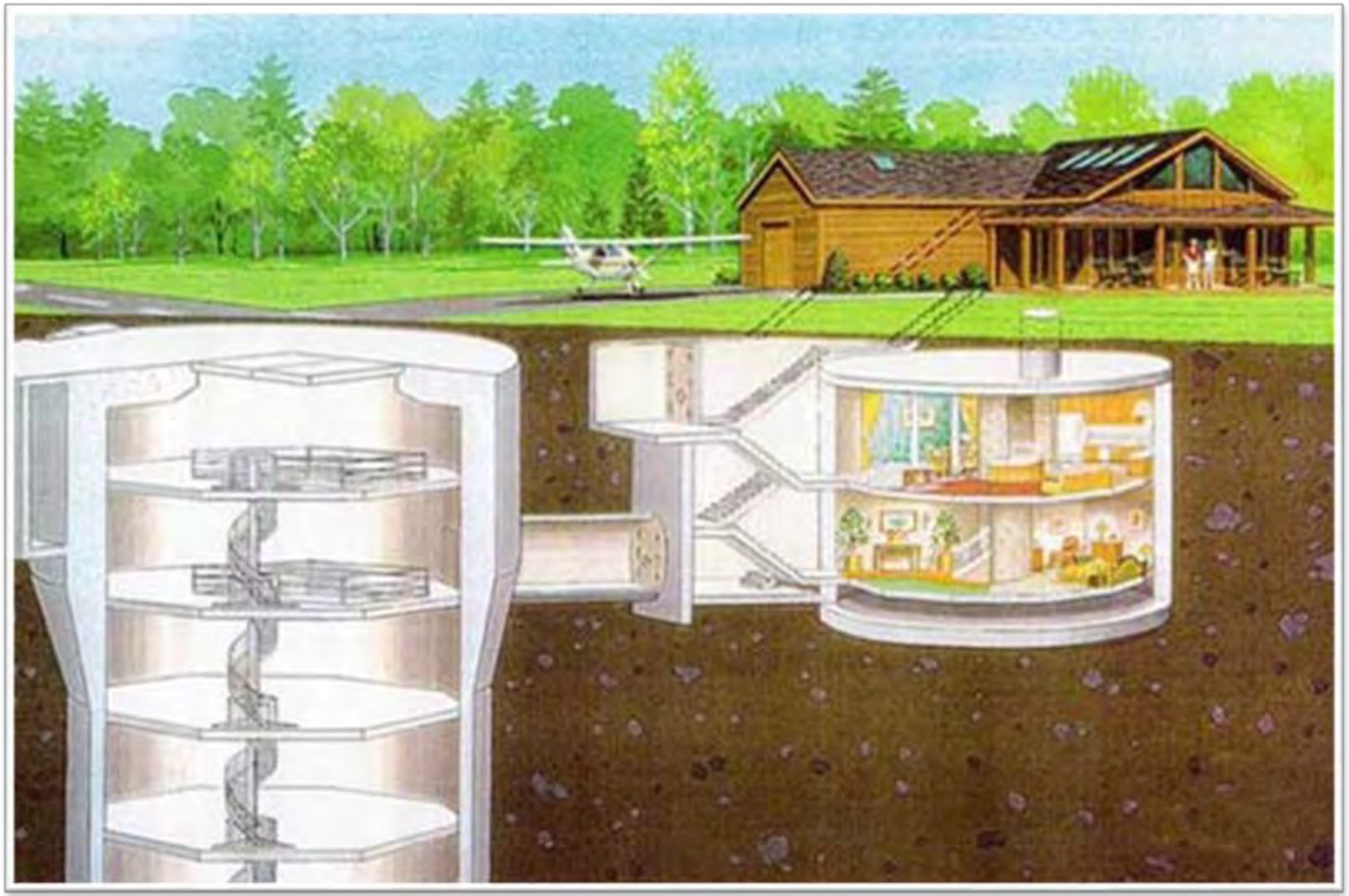
Underground Homes

- Underground home plans will help with ideas about what type of house design you may want to consider.
- The plan or design you choose will depend on the area where you are building and any building codes that have to be considered.

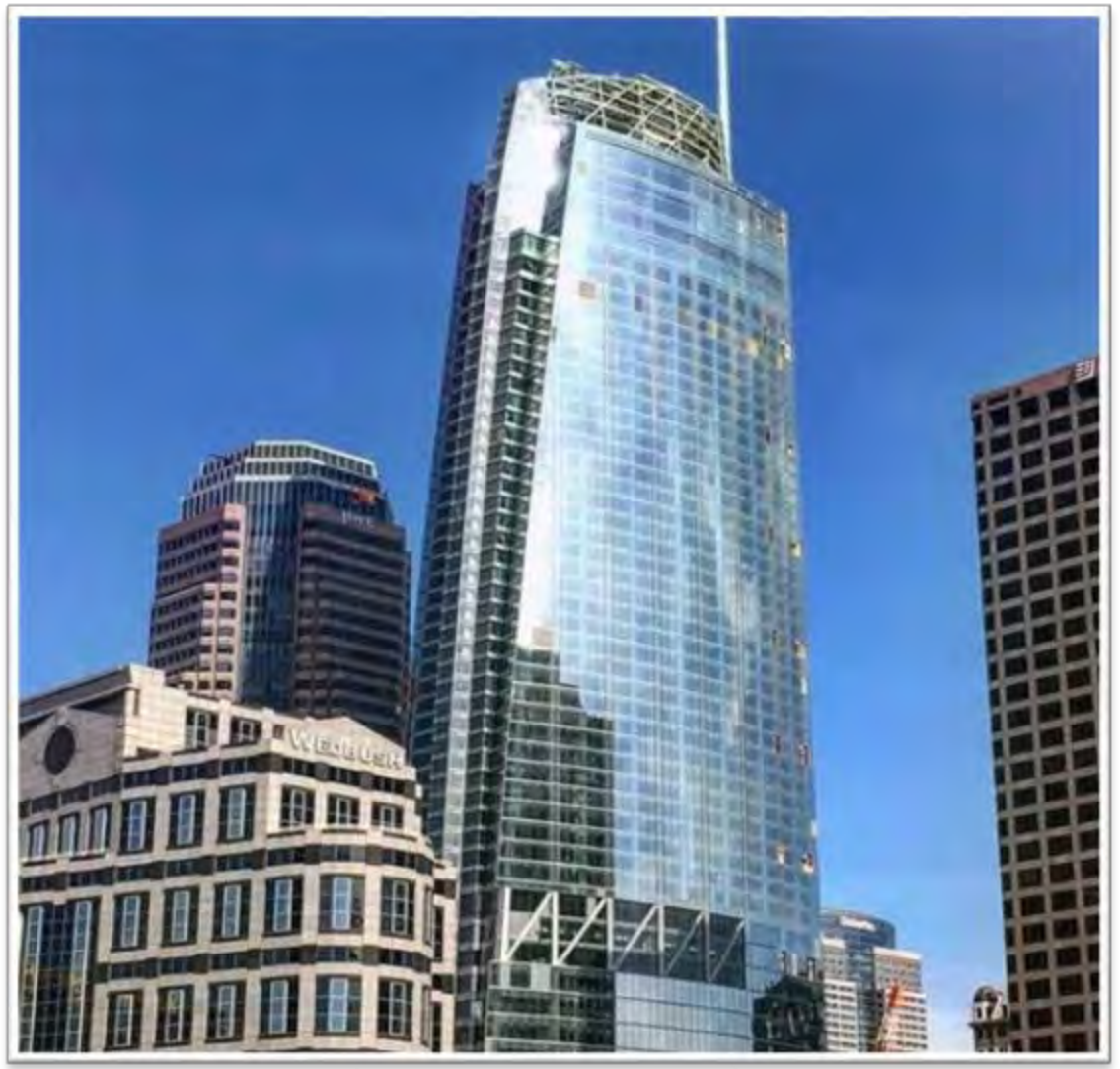


AT&T Building (New York)

- Not all nuclear fallout shelters are hidden in secluded trenches or buried deep underground.
- Located in plain sight on Thomas Street in New York City is the 550-foot AT&T Long Lines Building. It was built in 1974 and was designed to protect inhabitants from nuclear fallout for up to two weeks.
- The floors are above average in height but also in strength—they can shoulder 200 to 300 pounds per square foot of impact load.

Wilshire Grand Center (Los Angeles, California)

- Although you'd never guess it by the elegant exterior reminiscent of a cigarette lighter, the Wilshire Grand Center was cleverly engineered to survive a major earthquake.
- The 1,100-foot-high building, the tallest on the West Coast, features a concrete core reinforced by buckling-restraining braces that enable it to withstand an earthquake as great as 7.4 in magnitude.



Spaulding Rehabilitation Center (Charlestown, MA)

- Vulnerable to flooding due to its proximity to the Boston Navy Yard, this hospital's first floor sits behind an extensive network of berms and is built 30 inches above the 500-year flood elevation.
- Even if the water does get through, the entire first floor may be flooded butthe upper levels would still be able to operate freely.

Kansai International Airport (Osaka Bay, Japan)

- Typhoons, earthquakes, and storm surges aside, the biggest threat to this hulking complex is gravity.
- To prevent uneven sinking that could destroy the buildings, a concrete foundation was laid directly on the seabed, and a "jack-up system" installs iron plates where and when needed to keep things level.

Shanghai Tower, (China)

- The tallest structure of any kind in China stands at 2,073 feet.
- The Shanghai Tower is exposed to the region's typhoon-level wind loads but the twisting design of the exterior reduces those loads by 24 percent, which keeps this tower steadfastly upright. This is amazing since it is constructed with 25 percent *less* structural steel than comparable skyscrapers.

One World Trade (New York)

- The tallest building in the Western Hemisphere is the 1,776-foot-tall One World Trade Center.
- It needed to be built to resist powerful winds; it also uses fortress-like reinforced concrete so the structure is extremely solid.
- It sits atop a 185-foot tall, windowless, concrete base that's designed to withstand blasts and other ground-level attacks.

Torre Mayor (Mexico City, Mexico)

- This was the tallest building in Latin America when it was completed in 2003. This 738-foot-tall office tower can withstand an earthquake of 8.5 on the Richter Scale, making it one of the most quake-resistant buildings on Earth.
- In fact, when a 7.6 earthquake hit in 2003, its 96 diamond-shaped dampers were so effective that it not only survived undamaged but workers inside didn't even feel the tremors.

Taipei 101

- Once the world's tallest buildings, this 1,667-foot tower sits just 660 feet from a major fault line in typhoon-prone Taiwan.
- Luckily, a 730-ton mass damper that's 18 feet in diameter and supported by hydraulic cylinders sits near the top of the structure to counteract sudden and violent movement by the earth.

CCTV Building (Beijing, China)

- It can resist an earthquake of up to 8.0 on the Richtor Scale.
- The CCTV building however has a unique design that presents some challenges to the engineers.
- Its "cantilevered shape" puts enormous pressure on the building from gravity and other forces.
- The outside framework, the "exoskeleton," distributes these loads across the surface of the building to keep it standing in all weather conditions.

Engineering Activity

Design and build a structure that will withstand a natural disaster of your choosing. See the next slide for more details.

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Project

- Using what you have learned from viewing these slides, design and build a structure that will withstand a natural or man-made disaster.

- You may choose any of the weather events below or one of your own choosing:

Blizzard
Explosion
Fire
Flood
Hurricane
Mudslide
Tornado

- Describe how you designed your building and how the materials and shape would withstand a disaster.