

COMPARISON OF WOOD, STEEL, AND CONCRETE STRUCTURES

Material differences, advantages, & disadvantages

WOOD

- MATERIAL DIFFERENCE: ORGANIC, IT CAN BE USED TO BUILD A STRUCTURE PURELY MADE OUT OF WOOD
- ADVANTAGES: THERMAL PROPERTIES, ACOUSTICS, AESTHETICS, AND WORKING PROPERTIES
- DISADVANTAGES: DESIGN CHALLENGES, FLAMMABLE, SHRINKING AND SWELLING, DETERIORATION OF WOOD, AND INSECTS

STEEL

- MATERIAL DIFFERENCE: OFTEN USED AS A STRUCTURAL DESIGN MATERIAL
- ADVANTAGES: HIGH STRENGTH/WEIGHT RATIO, SPEED OF ERECTION, QUALITY OF CONSTRUCTION, EASE OF REPAIR, ADAPTATION TO PREFABRICATION, FATIGUE STRENGTH, AND REPETITIVE USE
- DISADVANTAGES: FIREPROOFING, MAINTENANCE, COST, AND SUSTAINABILITY TO BUCKLING

CONCRETE (REINFORCED)

- MATERIAL DIFFERENCE: REINFORCED CONCRETE BUILDING SYSTEMS ARE MORE DURABLE THAN ANY OTHER BUILDING SYSTEMS
- ADVANTAGES: HIGH COMPRESSIVE STRENGTH, FIRE AND WEATHER RESISTANT, DURABILITY, RIGIDITY, CAN BE MOLDED TO ANY SHAPE REQUIRED, LOW MAINTENANCE COST.
- DISADVANTAGES: TENSILE STRENGTH IS 1/10TH OF ITS COMPRESSIVE STRENGTH, CRACK DEVELOPMENT FROM SHRINKAGE CAUSES LOSS OF STRENGTH, THE MIXING, CASTING, AND CURING OF REINFORCED CONCRETE AFFECTS THE FINAL STRENGTH.

Cost/Availability

WOOD

- COST: Low cost of wood structures due to the material being used for low loads, strength, and span.
- AVAILABILITY: Very accessible as an organic and renewable material.

STEEL

- COST: Initially greater than reinforced concrete structures, but is balanced out by the durability of a structure and increasing the longevity of building structure.
- AVAILABILITY: Steel is mainly available in large wealthy cities where it can usually be due to a construction site, but isn't as accessible at different locations.

CONCRETE

- COST: Due to the properties of ready-mix concrete, the cost remains relatively stable despite an increase in steel on reinforced concrete building structures.
- AVAILABILITY: Concrete is much more accessible in comparison to steel. Its ingredients are easily available in any native area as compared to steel.

Schedule (Construction Speed)

WOOD

- Wood is typically used for shorter spans and lower loads in comparison to steel and concrete, so the construction time tends to be a lot shorter as well in comparison.

STEEL

- Construction for steel tends to be faster than wood and concrete because steel members are required to fasten their position, which takes less time and can be done easily with skilled workers or faster machines.

CONCRETE

- Construction for reinforced concrete does take some time due to the mixing process involved and building the framework to be placed is done. Once placing has been cured for a certain period of time, making the construction time slower than steel and wood.


Design Possibilities/Influences

WOOD: ...


STEEL: ...

CONCRETE: ...

BUILDINGS USING PREDOMINATELY STEEL OR WOOD IN STRUCTURE AND DESIGN



Centre Georges Pompidou by Richard Rogers and Renzo Piano, along with Gianfranco Franchini



Jean-Marie Tjibaou Cultural Center inspired by native Architecture by Renzo Piano

WEIGHT OF EACH STRUCTURE

Material	Weight (kN/m³)	Volume (m³)	Weight (kN)
Steel	78.5	100	7850
Concrete	24	100	2400
Wood	5	100	500

Safety

WOOD: ...

STEEL: ...

CONCRETE: ...

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Design Possibilities/Influences

WOOD: The natural grain of wood provides a unique aesthetic and structural character. It allows for curved forms and intricate details that are difficult to achieve with steel or concrete. Wood structures often have a warm, organic feel and can be easily integrated with natural surroundings.


STEEL: Steel offers a high degree of flexibility in design, allowing for long spans and complex geometries. It is often used in modern, industrial-style buildings and is well-suited for high-rise structures. Steel's strength and ductility make it a popular choice for seismic zones.

CONCRETE: Concrete provides a solid, monolithic appearance and is highly resistant to fire and weather. It is often used in traditional, classical architecture and is well-suited for large, open spaces. Concrete structures can be easily finished with a variety of textures and colors.

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Safety

WOOD: Wood is a natural material that is highly flammable. It requires fireproofing treatments to be used in high-rise buildings or in areas with high fire risk. Wood structures are also susceptible to insect damage and rot.

STEEL: Steel is highly resistant to fire and is often used in high-rise buildings. However, steel can lose its strength at high temperatures, so fireproofing is still required. Steel structures are also susceptible to corrosion.

CONCRETE: Concrete is highly resistant to fire and is often used in high-rise buildings. However, concrete can crack and spall over time, so regular maintenance is required. Concrete structures are also susceptible to acid rain and other environmental factors.

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Reinforced concrete building structures:

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Design Possibilities/ Influences

WOOD: Wood's organic properties are demonstrated in the flexibility of the material which makes it much easier to work and design with, thus making it less expensive in comparison to steel and concrete. Since wood is used often in residential areas, it is common to see high-pitched roofs with interesting roof lines, overhangs, dormers, offsets, etc. on wood-frame buildings and dwellings.

STEEL: Steel has the highest strength-to-weight ratio of any construction material. With new construction methods, steel buildings remain a popular choice for office and multifamily developers. Use of girder slab, staggered truss, and castellated beam construction enables lower floor-to-floor heights than typically expected in structural steel buildings. With the use of steel, extremely long spans in structures can be accomplished, including very open-bay footprints without intermediate columns. Steel is a very flexible material in terms of different ways to address design requirements.

CONCRETE: Concrete builds are taking many different shapes. As well as to the unique aesthetics achieved with concrete construction, these buildings offer some very real space advantages. Public and private developers should also realize that using cast-in-place reinforced concrete to frame a high-rise office building would yield a more rentable space because of lower floor-to-heights. With proper engineering, a concrete building can also offer uninterrupted floor plates.

REFERENCES:

1. [Steel Buildings: The Best of Both Worlds](#)
2. [The Benefits of Steel Buildings](#)
3. [Concrete Buildings: The Best of Both Worlds](#)

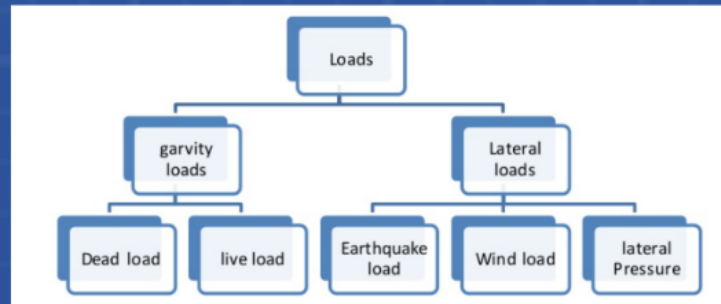
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WEIGHT OF EACH STRUCTURE



Materials	Dead load lb/ft ³	Dead load KN/m ³
Aluminum	170	26.7
Plain concrete	144	22.6
Reinforced concrete	150	23.6
Steel	490	77
Brick	120	18.9
plywood	36	5.7

Occupancy or use	Live Load lb/ft ²	Live Load kN/m
Assembly areas and theaters		
a) Fixed seats	60	2.87
b) Movable	100	4.97
c) Garages	50	2.40
Office buildings		
a) Lobbies	100	4.79
b) offices	50	2.40
Storage Ware Houses		
a) Light	125	6
b) Heavy	250	11.97
Residential		
a) Dwellings	40	1.92
b) Public rooms	100	4.79

Safety

WOOD: Although wood is a flammable material, dense wood does offer good resistance to fire and acts as a better thermal insulator.

STEEL: With exposure to extremely high temperatures, steel can soften and melt. Spray-on fireproofing buildings that are built on a steel structure can sustain greater temperatures.

CONCRETE: Concrete is the safest in comparison to steel and wood. It can endure very high temperatures from fire for a long period of time without losing its structural integrity. Performs well during both natural and manmade disasters.