ENGINEERING TECHNOLOGY TOP UP

Civil engineering is the mother of all engineering. The best part about civil engineering is that it has many fields, such as structural, geotechnical, water, construction, transportation. You can choose any field you like after you graduate with a degree in civil engineering. If you like efficient transportation systems, safe drinking water, safe and stable buildings, thank a civil engineer.

Civil Construction Materials

What is a construction material?

A construction material is any material used in the construction industry. Examples: concrete, cement, soil, stones, aggregates, plastics and asphalt.

The basic materials used in civil engineering applications or in construction projects are:

- Wood
- Cement and concrete
- Bitumen and bituminous materials
- Structural clay and concrete units
- Reinforcing and structural steels

Most civil materials have a purpose of bearing loads. So for these purposes wood, cement, stone, brick and steel are preferred.

For keeping out the elements, tar, stone, glass, brick and aluminum are preferred.

For surfaces and fixtures within a building, Sheetrock (gypsum), particle board, brass, stainless steel, and similar alloys are used.

Beyond this, many engineered systems sit within a building and use their own specialized materials for each task.

Distinctions in soil are used in assessing the soils that are to have structures built on them. Soils when wet retain water, and some expand in volume. The amount of expansion is related to the ability of the soil to take in water and its structural make-up (the type of atoms present). These tests are mainly used on clayey or silty soils since these are the soils that expand and shrink due to moisture content. Clays and silts react with the water and thus change sizes and have varying shear strengths. Thus these tests are used widely in the preliminary stages of designing any structure to ensure that the soil will have the correct amount of shear strength and not too much change in volume as it expands and shrinks with different moisture contents.

The **Atterberg limits** are a basic measure of the critical water contents of a fine-grained soil: its **shrinkage limits, plastic limit**, and **liquid limit.**

Depending on its water content, a soil may appear in one of four states: solid, semi-solid, plastic and liquid. In each state, the consistency and behavior of a soil is different and consequently so are its engineering properties. Thus, the boundary between each state can be defined based on a change in the soil behavior. The Atterberg limits can be used to distinguish between silt and clay, and to distinguish between different types of silts and clays. The water content at which the soils changes from one state to the other are known as consistency limits or Atterberg limit.

These limits were created by Albert Atterberg, a Swedish agriculturist in 1911. They were later refined by Arthur Casagrande.

ROLE OF WATER

Some keys ones are:

1. Water as a raw material to make any kind of cementitious paste (be it plain cement concrete/ reinforced/ or with additives/ simple mortar paste). It is what helps initiate the hydrogen reaction of the cement to turn that slurry of the mix to act as a binder between all its constituents (bulk matter).
2. Water in soil preparation in carious structures. Be it to help compact soil to its densest underneath a road, or on the back side of a retaining wall, foundations etc.
3. Water as a curing compound.
4. Water as a raw material during manufacture of various civil materials. Say during quenching in TMT process of the reinforcements, etc. or in standardized testing (as various test are performed under some or the other water requirements.
5. Water as a weathering action (opposing) force needs to be considered as well. Say to estimate the damage to a steel structure in heavy rainfall areas, so we can better judge the structures durability and take counter-measures. Or to say ground water table rising up and compromising the strength of soil base and others (you get the idea)
6. Water as a parameter that civil engineers need to plan for while designing a dam/river-diversion structure/irrigation-channels to fields/etc.
7. Water as a to-be-treated output from a water treatment facility (Yes, civil engineers here again).
8. And finally, some water to drink when all of the hard work is done!

FACTOR OF SAFETY

A Factor of Safety (also known as Safety Factor) is the load carrying capacity of a system beyond what the system actually supports. It is **how much stronger a system is than required**. In the planning phase of all structures and safety equipment, engineers determine required overload from any object to remain safe in the event of an emergency.

Factor of safety is a term describing the structural capacity of a system beyond the expected loads or actual loads. It is how much stronger the system is than it usually needs to be for an intended load.

For reliability, structures are typically built stronger than necessary. This is in case a structure experiences a heavier-than-expected load. This is a factor of safety.

Determining the factor of safety:

Factor of safety: It is defined as ratio of Maximum stress to the working stress

(permissible /design stress

Mathematically, $$\text{Factor of safety} = \frac{\text{Maximum stress}}{\text{working stress / Designstress}}$$

By this definition, a structure with an FoS of exactly 1 will support only the design load and no more. Any additional load will cause the structure to fail. A structure with an FoS of 2 will fail at twice the design load.

Engineers perform strength tests to determine how much weight a material can handle. Certain materials are more ductile than others, meaning they deform to pressure before breaking more so than others, like brittle materials. Brittle materials simply break once they meet the maximum force.

Ductile materials use the **yield strength** to determine the safety factor. Brittle materials use the **ultimate strength**.

Yield strength: Determines the safety factor until the start of deformation.

Ultimate strength: Determines the safety factor until failure.

Ductile materials often test the factor of safety against yield and ultimate strengths while brittle materials usually only calculate the ultimate safety factor since the yield and ultimate values are often so close.

Why is the safety factor important?

A factor of safety increases the safety of people and reduces the risk of failure of a product. When it comes to safety equipment and fall protection, the factor of safety is extremely important. The safety factor is usually higher when there is a possibility that a failure will result in injury and death as well as a company's financial loss.