Structural Concepts Simplified

Unless you have a background in structural or mechanical engineering, you are unlikely to be familiar with the key structural concepts:

Loads

These are the input data for structural, involving a range of loads to allow structural engineers to complete their design, such as:

- Dead loads (self-weight of the equipment/module itself with its contents).
- Live loads (installation lifting loads).
- Environmental (including wind and wave).
- Thermal loads.
- Blast overpressure loads.

Structural philosophy

In the design of any structure, it is important to be clear about the design philosophy and keeping the solutions simple. However, there are many types of solutions to most problems and the structural engineers will consider several methods:

- Braced Structure.
- Cantilevered Structure.
- Propped Cantilevers.
- Moment Frames.
- Trussed Frames.

Design codes and design verification

There are a range of design codes for offshore structures, the common ones being:

- AISC.
- Eurocodes.
- API.

There are a number of types of codes from Working Stress Design (WSD) to Limit State Design (LSD). The WSD applies simple factors reducing the allowable stress within an element being designed while LSD applies factors to the applied loads depending on the type and application of the loads to define a maximum member capacity. Codes are regularly updated and most recently codes have started to move to Load Resistance Factor Design (LRFD), which utilises separate factors for applied loads and material resistance factors. The development of these codes is largely as a result of better definitions regarding the application and use of the materials in order to ensure greater efficiencies of design.

Utilisation

You will often hear your structural colleagues talking about utilisation of a structural member, which is often quoted as a percentage or a figure between 0 and 1 or 0% and 100%. A 100% utilised section can be considered to be loaded to the maximum allowable stress level for that particular material and application per the appropriate design code.

Due to either physical failure of existing structures a design issue on a proposed structure, a member can have a reported utilisation greater than 100% after initial analysis .However, further refinement of the calculations or alternatively strengthening the elements can be undertaken to allow a project to continue or resolve concerns over individual elements.

Allowable stresses

The engineers then complete calculations, usually using a mixture of software and manual methods to calculate the stresses in a particular design. Stress results when a material is loaded with a force. Depending on the design code, the proposed material will have a maximum allowable stress. If the calculated stress is too high, the engineer might increase the area of the section of material used or change the design geometry. The symbol for stress is σ, (sigma), and is measured in N/mm^2.

Allowable strains

Strain is a term used to measure the deformation or extension of a body subjected to a force or set of forces. The symbol for strain is Ɛ, (epsilon), and is dimensionless as it is the ratio of the original unloaded dimension over the loaded dimension. Strain is used to determine deflections in loaded structures. Some equipment, such as gas turbine generators and pumps, are critical to the amount of deflection in their foundation supports which may cause alignment and vibration problems if of a high value.

There is always a trade-off in structures as increasing section thickness may reduce stresses and strains but will cost more and will increase the overall weight of the topsides.