CONCEPT OF ALLOWABLE STRESS METHOD

The allowable stress or allowable strength is the maximum stress (tensile, compressive or bending) that is allowed to be applied on a structural material. The allowable stresses are generally defined by building codes, and for steel, and aluminum is a fraction of their yield stress (strength)

$$F_{\alpha} = \frac{F_y}{F.S.}$$

In the above equation, Fa is the allowable stress, Fy is the yield stress, and F.S is the factor of safety or safety factor. This factor is generally defined by the building codes based on particular condition under consideration. Since tension members do not generally buckle, they can resist larger loads (larger Fa) due to small F.S value.

- Allowable Stress Design (ASD) also known as Working Stress Design (WSD) method is based on the principle that stresses developed in the structural members should not exceed a certain fraction of elastic limit.
- This is old method of design which only considers elastic strength of material and hence limits the allowable stresses to a fraction of this limit (e.g. 40-50%).
- All loads are taken as service loads and no factor is applied to increase these services loads.
- The major drawback of this method is that it does not take into account the Plastic and Strain Hardening stages of material, hence, it becomes overly conservative in certain situations, while due to considering loads

at service load values only, it produces unsafe results in other situations.

- Further serviceability limits are also not considered in ASD method, which may result in structures which although safe, do not fulfill their intended purpose.
- The main drawback of this method is that it results in an uneconomical section.

The concept of introducing a factor of safety is to make the structure safe to account for the following:

1. The analysis methods are based on assumptions and do not give the exact stresses.
2. Structural members may be temporarily overloaded under certain circumstances.
3. The stresses due to fabrication and erection are not considered in the design of ordinary structures.
4. The secondary stresses may be appreciable.
5. Underestimation of the future live loads.
6. Stress concentrations.
7. Unpredictable natural calamities.

Design of steel beam (ASD, Allowable Stress design)-IS:800-2000

Design requirements

1. Maximum bending stress, f_b must not exceed allowable stress, F_b.
2. Deflection should not exceed allowable limit.
3. Maximum shear stress, f_v shall not exceed allowable shear stress.

Design procedure:

1. Calculate design load.
2. Calculate design moment, M and bending stress, f_b.

3. Select a trial beam size and calculate allowable bending stress, F_b

4. Calculate deflection and check with allowable deflection ratio.

5. Calculate design shear and shear stress, f_v.

6. Calculate allowable shear stress, F_v.

Design of laterally supported beams

1. Calculate the factored load and the maximum bending moment and shear force
2. Obtain the plastic section modulus required

$$Z_{req} = \frac{(M \times \gamma_{mo})}{fy}$$

Select a suitable section for the beam-ISLB, ISMB, ISWB or suitable built up sections (doubly symmetric only). (Doubly symmetric, singly symmetric and asymmetric- procedures are different)

3. Check for section classification such as plastic, compact, semi-compact or slender. Most of the sections are either plastic or compact. Flange and web criteria.

$$\frac{d}{t_w} \ , \frac{b}{t_f}, \ \varepsilon = \sqrt{\frac{250}{fy}} = 1$$

4. Calculate the design shear for the web and is given by

$$V_{dp} = \frac{(Av \times fy)}{\sqrt{3} \times \gamma_{mo}} > V_d \ and, V < 0.6 V_d$$

5. Calculate the design bending moment or moment resisted by the section (for
plastic and compact)

$$M_d = \beta_p \ x \ Z_p \ x \ f_y \ / \ \gamma_{mo}$$

6. Check for buckling

7. Check for crippling or bearing

8. Check for deflection