PLASTIC MODULUS

Plastic section modulus

It is defined as the sum of moment of areas on each side of plastic neutral axis. An axis that divides the cross section in such a way that the tensile force from the area in the tension and compressive force from the area in compression are equal, is called plastic neutral axis.

It is used to find the maximum bending moment at a point when all the fibers in a cross section have yielded elastically. At this point, the entire section behaves plastically.

Plastic section modulus is only used in the problems for the design of steel structures.

It is denoted by the letter ‘Zp’.

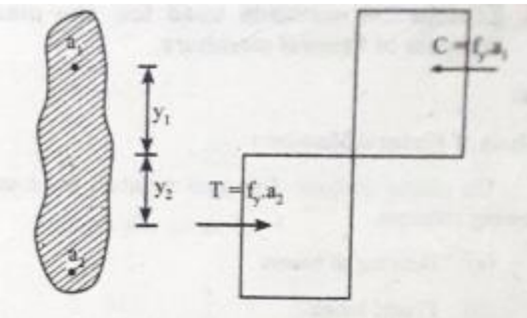
Fully plastic moment of a section

The maximum moment of resistance in a fully yielded cross section is termed as fully plastic moment. To determine the value of fully plastic moment, the following assumption are made,

The ultimate load is achieved without causing any instability to the structure.

The connections in the structure are assumed to give full continuity in order to transmit the fully plastic moment safety.

Each load increase in fixed proportion to the other i.e..loading is proportional.



The zone above the neutral axis is in compression and the zone below the neutral axis is in tension, such that the nature of the bending moment is sagging.

Force in compression

$$F_c=f_y.a_1$$

Force in tension

$$F_t=f_y.a_2$$

Consider the equilibrium condition where the force of compression is equal to force of tension

$$F_c=F_t.$$

$$f_y.a_1 =f_y.a_2$$

$$a1 = a2 = a/2$$

Where,

a1 -- Area of the section above N.A

a2 - Area of the section below N.A

a - Area of cross section of the beam

The "equal area axis" is the neutral axis of the plasticized section. The two forces tensile and compressive form a couple and resists the plastic moment.

$$M_p=f_y.a_1\ \bar{y}_1+f_y.a_2\ \bar{y}_2$$

$$M_p=f_y.a/2.\ \bar{y}_1+f_y.a/2.\ \bar{y}_2$$

$$M_p=f_y.a/2(\ \bar{y}_1+\ \bar{y}_2\ )$$

$$M_p=f_y.Z_p$$

Where

Z_p - Plastic section modulus

$= a/2(\bar{y}_1 + \bar{y}_2)$

$\bar{y}_1$= distance of centre of gravity above the neutral axis

$\bar{y}_2$ =distance of centre of gravity below the neutral axis