Beam Column

4.3 Design a Beam column

Example 3

A beam column is to be designed to support a factored axial load of 500KN(tension). Factored moments Mx acting at top and bottom of the column are 30KNm and 50KNm respectively. Effective length of the column may be taken as 3.2m. Assuming fy = 250N/mm^2, Design the beam column section and check the same to conform to the specifications of the Indian standard code IS 800 - 2007

Given data

Factored axial load ‘P’ = 600 KN

Bending moment at top = 30KNm

Bending moment at bottom = 50KNm

Effective length ‘fy’ = 3.2m

Step 1 : Selection of beam column section

Assuming the same ISHB 250 rolled steel section

Sp 6(1) 1964 page. No. 4, code book

A = 64.96cm^2

= 6496mm^2

h = 250mm

B = 250mm

Tf = 9.7mm

Ry = rmin

= 5.49cm

= 54.9mm

Tw = 6.9mm

Slenderness ratio

KL/rmin = 1 x 3200 / 54.9

= 58.3

Pe = P + 2M bot / h

= 600 + 2 x 50 / 0.25

= 800KN

Compressive stress

IS 800 - 2007 page. No. 42, code book

Fcd = 170 N/mm^2

Design strength of beam column

= fcd x A / 1000

= 170 x 6496 / 1000

= 1104 KN > 800KN

Hence the selected section is safe

Step 2 : Section properties

Ixx = 7736cm^4

= 7736 x 10^4mm^4

Iyy = 1961cm^4

= 1961 x 10^4mm^4

Rx = 10.9cm

= 109mm

Zx = 618.9cm^3

$= 618.9 \times 10^3 \ mm^3$

$Z_y = 156.9 cm^3$

$= 156.9 \times 10^3 \ mm^3$

$R_1 = 10mm$

Check the section

IS 800 - 2007 page. No. 18, code book

$b/t_f = 250/9.7$

$= 25$

This section is semi compact

Moment

IS 800 - 2007 page. No. 30, code book

$M_{dx} = Z_x \times f_y / \gamma_{mo}$

$= 618.9 \times 10^3 \times 250 / 1.1$

$=140.7 \times 10^6 \ Nmm$

$= 140.7 \ KNm$

(a) Design shear strength due to yielding

IS 800 - 2007 page. No. 32, code book

$T_{dg} = f_y \times A_g / \gamma_{mo}$

$= 250 \times 6496 / 1.1$

$= 1476.3 \times 10^3 \ N$

$= 1476.3KN$

(b) Design shear strength due to rupture

$T_{dn} = 0.9 \times f_u \times A_n / \gamma_{m1}$

= 0.9 x 410 x 6496 / 1.25

= 1916 x 10^3 N

= 1916 KN

Take least value

The design strength Td = 1476.3 KN

Step 3 : Check for resistance of cross section to combined effects

IS 800 - 2007 page. No. 70, code book

[N / Nd + Mx / Mdx + My / Mdy] < 1

Nd = Ag x fy / γmo

= 6496 x 250 / 1.1

= 1476.3 10^3

= 1476.3 KN

Mx = 50KNm

Mdx = 140.7KNm

[N / Nd + Mx / Mdx]

= 600/1476.3 + 50/ 140.7

= 0.756 <

Hence safe

Step 4 : Check for resistance of cross section to combined effects

Meff = [M – ψ x T x Ze / A]

= 50 x 10^6 – 0.8 x 600 x 10^3 x 618.9 x 10^3 / 6496

= 4.3 KNm < 140

Hence safe

Step 5 : Check for overall buckling strength

[P / Pdx + Meff / Mdx]

= 600/1476.3 + 4.3/ 140.7

= 0.433 < 1

Hence safe

Example 4

A beam column is to be designed to support a factored axial load of 500KN(tension). Factored moment Mx Acting at top and bottom of the column are 30 KNm and 50KNm respectively. Effective length of column may be Taken as 3.2m. Assuming fy=250N/mm^2, design the beam column section and check the same to conform the Specification of the Indian standard code IS 800:2007.

Solution:

Given data:

Factored axial load	= 600KN (tension)
Bending moment at top	= 30KNm
Bending moment at bottom	= 50KNm
Yield stress of steel	= 250N/mm^2

Step 1 Selection of beam column section

Mdx $= Z_0$ fy/ γmo

= (62x10^4x250)/(1.1x10^6)

= 140.7KNm

Tdg = fy Ag/γmo

= 250x6500/1.10x1000

= 1477.3KN

Desgin strength due to rupture of critical section,

Tdn =0.9 fy An/γmi

= (0.9x415x6500)/ (1.25x1000)

= 1942.2 KN

The design strength Td = 1477.3 KN

Step 2 Check for resistance of cross section to combined effects

Using the interaction equation ,

[N/Nd + Mx/Mdx + My/Mdy] ≤ 1.0

Nd = Ag fy /γmo

= 6500x250 / 1.1x1000

= 1477.3 KN

Mx = 50KNm and

Mdx = 140.7 KNm

∴ [600/1477.3 + 50/140.7] = 0.756 <1

Hence safe

Step 3 : Check for lateral torsional buckling resistance

Reduced effective moment is computed as,

Meff = [M –Ψt Zec /A] ≤ Md

= [(50x10^6)-(0.8x600x10^3x619x10^3)/6500]

= 4.3x10^6 Nmm

= 4.3 KNm < 127.3KNm

Step 4 Check for overall buckling strength

$$[\ P/P_{dx} + M_{eff}/M_{dx}\ ] \leq 1.0$$

$$[\ 600/1477.3 + 4.3/127.3] = 0.439 < 1.0$$

Hence safe