5.4 Design Of Eccentric Shear And Moment Resisting Connections Girders

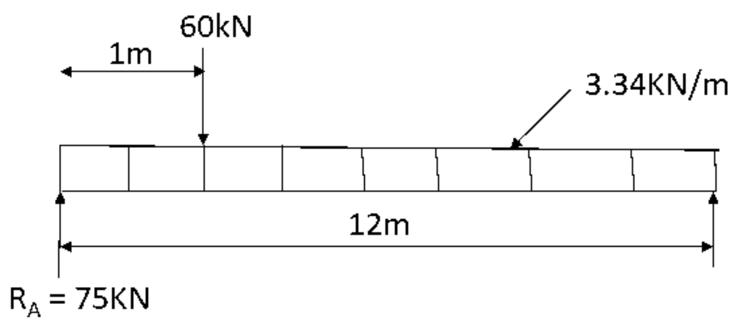
Example 4

Design a hand operated overhead crane, which is provided in a shed, whose details are

Capacity of crane	= 50kN
Longitudinal spacing of column	= 6m
Center to center distance of gantry girder	= 12m
wheel spacing	= 3m
Edge distance	= 1m
Weight of crane girder	= 40kN
Weight of trolley car	= 10kN

Solution:

Step 1 Find wheel load



To find support reaction,

Weight of crane girder per meter span

= 40/12

= 3.34 kN/m

Weight of crane and trolley added together and placed at 1m

= 50+10

=60kN

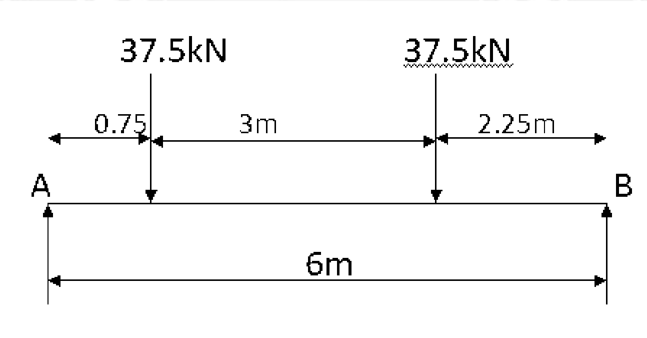
R_Ax12 = 60x11 + 3.34x12^2/2

R_A = 75kN

Wheel load = R_A/2

= 37.5KN

Step 2 Find max BM in gantry girder



R_A = 46.88KN

R_B = 28.12KN

Max BM = 28.12x2.25

= 63.27 kNm (at trailing wheel)

Adding 10% for impact,

M1 = 1.1x63.27

= 69.60kNm

Max BM due to self weight of girder and rail taking total weight as 1.2kN/m

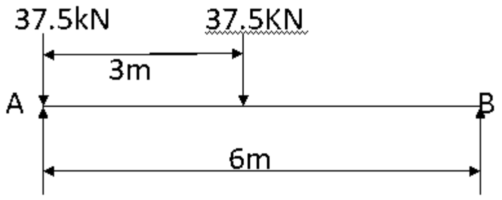
M2 =wl^2/8

= 1.2x6^2/8

= 5.4kNm

Total BM, M = 75KNm

Step 3 Find max shear



S_F = R_A

=(37.5x6 + 37.5x3)/6

= 56.25KN

Step 4 Find lateral loads

25% of lateral load/num of wheel

= 0.025x60/2

= 0.75KN

Max BM due to lateral load ,

ML =(36.37/37.5) X0.75

= 1.27KNm

Step 5 Selection of section

Economic depth of section

= L/15

= 6000/15

= 400mm

Let us try ISMB 450@710.2N/m

IS Code 800;2007, pg138,

Flange criteria, b/t_f = 75/17.4

= 4.31 <9.4Є

web criteria, d/t_w = 415.4/9.4

= 44.19<83.9Є

∴ section is plastic

Step 6 Shear capacity

F_{vd} = fy x A/√(3 xγ_{mo})

= 250x450x9.4/√(3x1.10)

= 555043 N

=555KN

F_v/F_{vd} = 56.25x1.5/555

= 0.152<0.6

Check for torsional buckling,

$t_f/t_w \leq$ 17.4/9.4 =1.85 <2

β_{LT} = 1.2 for plastic section

M_{cr} = elastic critical moment

M_{cr} = β_{LT}π^2EI.h/2(KL)^2 [1+1/20[(KL/r_y)/(h/tf)]^2]^0.5

KL = 1.0x6000

= 6000mm

M_{cr} =1.2π^2x2x10^5x834x10^4x450 /

2x6000^2{1+1/20[(6000/30.1)/(450/17.4)]^2}^0.5

= 246x10^6 Nmm

Factored longitudinal moment,

M_f = 75x1.5

= 112.5kNm

Factored lateral moment ,

M_{fL} = 1.27x1.5

= 1.91kNm

Lateral BM capacity,

M_{dL} = $Z_{py}.f_y/1.10$

=[Z_{ey}/2 x shape factor x fy]/1.10

= [(111.2x10^3)/2 x 1.15x250]/1.10

= 14.53x10^6 Nmm

=14.53 kNm

For safety,

M_f/M_d[longitudinal + M_f/M_d]lateral ≤ 1.0

= 112.5/174.34 + 1.91/14.53

= 0.78 <1.0

Hence, section selected is adequate and safe.