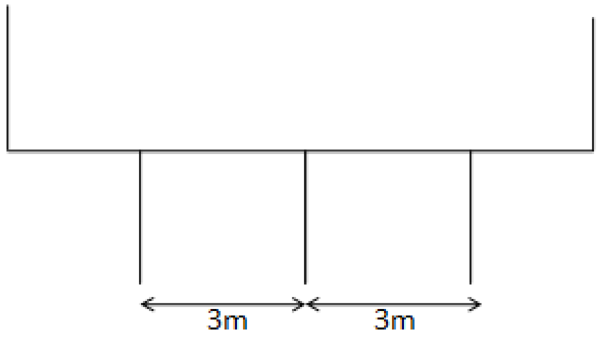
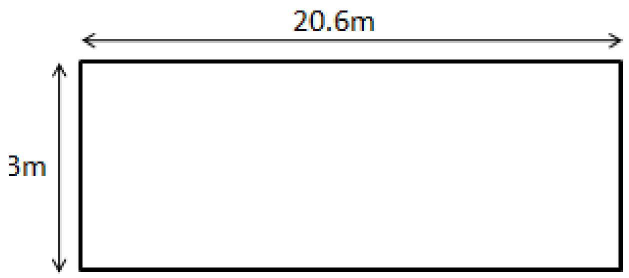
# Design of X- Beam




| | | |
|---|---|---|
| Depth of beam | = | 1.4 m |
| Thickness of beam | = | 0.4 m |
| Density of concrete, $\gamma_c$ | = | 25 kN/m |
| Thickness of slab | = | 0.25 m |
| Thickness of W.C. | = | 0.1 m |
| Density of W.C. | = | 22 kN/m |
| Spacing of X – beam | = | 20.6 m |

Step1:- Dead Load:

| | | |
|---|---|---|
| Spacing of Main girder ( Span of X - beam, $l_{x)}$ | = | 3 m |
| Weight of rib of x- beam | = | 1.4 x 0.4 x 25 |
| | = | 14 kN/m |
| Weight of ( Slab + W.C.) | = | 0.25x25+0.1x22 |
| | = | 8.45 kN/mm² |
| Total load of deck slab | = | 8.45x 2x 0.5x 3x 3/2 |
| | = | 38.025 kN |

This load is assumed uniformly distributed along ?

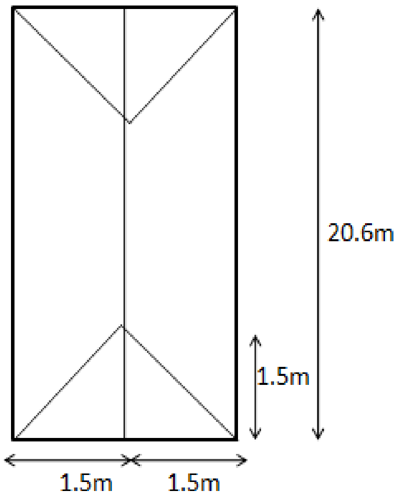
~~3 meter length~~

Load per meter run due to deck slab

| | | |
|---|---|---|
| | = | 38.025/3 |
| | = | 12.7 kN/m |
| Total dead load per meter run | = | 14+12.7 |
| | = | 26.7 kN/m |

This load is assumed uniformly distributed along

This cross – girder is assumed to be rigid.




The reaction on each longitudinal girder

= 26.7*2*3/3

= 53.4 kN ?

Step2:- Live Load:

B.M. due to dead load at a distance from support ? = 1.975 m

Class AA (tracked) vehicle produce maximum B.M. and S.F. in x- girder.

This position of loading longitudinal direction gives maximum reaction to x – girder.

Magnitude of reaction = 700*19.7/20.6

670 kN

No. of long. Beam 3

Because x-girder is rigid,reaction on each longitudinal girder

= 700/3

233.33 kN

Maximum bending moment occurs under track load,

= 700*1.975/3

460.83 kN/m

Impact factor = 1.1

Including, Impact factor for B.M. due to live load

= 460.83*1.1

= 507 kN/m

B.M. due to dead load at a distance of 1.975 from support ?

= 53.4*1.975-(26.675(1.975/2)^2)

= 80 kN/m

Total Bending Moment = 507+80

= 587 kN/m

Step3:- Live Load shear including Impact = 700*1.1/3

= 257 kN

Dead Load shear = 53.35 kN

Total shear for depth = 53.35+257

= 310.35 kN

| | | | | | |
|---|---|---|---|---|---|
| | Clear cover | = | 40 | m | ? Take on tmp |
| | Diameter | = | 25 | m | ? |
| Step4:- | Effective depth | = | 1650-(40+25/2) | | |
| | | = | 1597.5 | mm | |
| | | = | 0.1598 | m | |
| Step5:- | Check for shear: | | | | |
| | b | = | 400 | mm | |
| | $\tau_v$ | = | 310.35*1000/400*1597.5 | | |
| | | = | 0.486 | $N/mm^2$ | |
| | Spacing of 2 – legged stirrups | | | | |
| | Diameter of bar used | = | 12 | mm | |
| | Asv | = | 2*0.785*12^2 | | |
| | | = | 226 | $mm^2$ | |
| | $\sigma_{sv}$ | = | 200 | | |
| | Spacing of stirrups Sv | = | 200*226*1597.5/310.35*1000 | | |
| | | | 232.7 | $mm^2$ | |
| | Area of steel required :- | | | | |
| | Ast | = | 587*10^6/0.9*1597.5*200 | | |
| | | = | 2041.4 | $mm^2$ | |
| | Minimum shear reinforcement | = | 226/400*.0015 | | |
| | | = | 377 | $mm^2$ | |

sketch?

/ other sheet

Design of Bearing Pad

Given

| | | | |
|---|---|---|---|
| Max. Dead Load | = | 1025 | kN |
| $f_{ck}$ | = | 30 | |
| Thickness | = | 75 | mm |
| Live load | = | 365+75 | |
| | = | 440 | kN |
| Horizontal force due to live load | = | 80 | kN |
| Assumed Size of bearing pad | | | |
| Breadth of pad(bp) | = | 550 | mm |
| Length of pad(Lp) | = | 950 | mm |
| Side cover(Sc) | = | 6 | mm |
| Thickness of steel | = | 10 | mm |

Step 1-

Thickness should be between Breadth of pad(bp)/10 to Length of pad(Lp)/5

55 to 110

O.K

Step 2-

| | | | |
|---|---|---|---|
| Live load | = | 400 | kN |
| Loaded area | = | (bp*Lp)-(2(bp+Lp)*Sc) | |
| | | 504500 | $mm^2$ |
| Total load (Nmax) | = | DL+LL | |
| | = | 1465 | kN |
| Approx. | ~ | 1500 | kN |
| Nmin | = | 1025 | kN |
| A1 | = | 4 | |
| A2 | = | 2 | |
| A1/A2 | = | 2 | |

Step 3- Grade Provided M30 :-

| | | | |
|---|---|---|---|
| Allowable contact pressure | = | $0.25 \times fck \times \sqrt{\frac{A1}{A2}}$ | |
| | | 10.61 | Mpa |
| Effective area of bearing required | = | 1500*1000/10.61 | |
| | = | 14.1376 | $mm^2$ |
| $\sigma_m$ | = | total load/loaded area | |
| | = | 2.973 | Mpa |

Step 4- Thickness of individual Elastomer layer

| | | | |
|---|---|---|---|
| hi | = | 15 | mm |
| No. | = | 5 | |
| Thickness of steel Laminates | = | 10 | mm |
| Overall thickness of bearing | = | 75 | mm |
| Side cover | = | 6 | mm |
| Total thickness of elastomer(t) | = | 55 | mm |
| Shear modules assumed , d | = | 1 | $N/mm^2$ |
| Shear strain due to creep, shrinkage ,temprature(L) | = | 0.0005 | |
| From temp. sheet(K) | = | 41000 | |
| Shear strain per bearing due to creep, shrinkage ,temprature | = | (L*K)/2t | |
| | = | 0.186 | |
| Shear strain due to longitudinal force | = | 80*1000/504500 | |
| | | 0.159 | |
| Shear strain due to translation | = | B/loaded area | |

| | | | | | |
|---|---|---|---|---|---|
| | | = | 0.345 | | Safe |
| Step 5- | Calculation of rotation, | | | | |
| | $\sigma_{min}$ | = | 0.5*σm*hi/b*s^2 | | |
| | N | = | 538 | | |
| | O | = | 938 | | |
| | s | = | 15 | | |
| (I) | Shape factor (s) | = | Loaded area/(2(N+O)$h_i$) | | |
| | | = | 11.393 | | safe |
| (ii) | Assume, $\sigma_m$,max. | = | 10 | MPa | |
| | $\alpha b_i$ , max. | = | 0.5*σm*hi/b*s^2 | | |
| | | = | 0.00107 | radians | |
| | P | = | 2.973 | | |
| | β | = | P/10 | | |
| | | = | 0.2973 | MPa | |
| | Permissible rotation | = | β*N*αbi , max. | | |
| | | = | 0.00159 | MPa | |
| Step 6- | Friction | | | | |
| | Shear strain(Z) | = | 0.345 | MPa | |
| | Check:- | | | | |
| | | = | 0.2+0.1*$\sigma_m$ | | |
| | | = | 0.4973 | | safe |
| | where, $\sigma_m$ | = | 2.973 | | |
| | Check:- | | 2MPa<σm<10MPa | | satisified |
| | Total Shear Stress | | | | |
| Step 7- | Shear stress due to compression(X) | = | (1.5*σm)/s | | |
| | | = | 0.3914 | MPa | |
| | Shear Stess due to Horizonal deformation(Y) | = | 0.5*b/hi^2*αbi | | |
| | | = | 0.688 | MPa | |
| | Shear Stess due to Horizonal rotation | = | X+Y+Z | | |
| | | = | 1.4244 | MPa | safe |

| | | |
|---|---|---|
| | Bearing pad | beam |
| A | 365 | |
| | 75 | 700 |
| B | 80*1000 | 19.7 |
| | | 20.6 |
| | | 1.975 |
| | | 26.675 |
| | | 40 |
| | | 25 |
| | | 1650 |
| | | 200 |
| | | 0.9 |
| | | 0.0015 |