28/Sep/18

Unit - 3 Railway Bridges

① A Deck type railway bridge Girder has effective span of 24 mts it is subjected to bor. Broad guage loading EUDL for Bending Moment is 22500 kN for track and EUDL for shear force is 2503 kN/per track and the impact factor is $\frac{20}{14+L}$, Design Girder for flexural fixed of the dimensions of grider. and check for Bending stress and shear, stress Draw neat sketchs showing c/s and longitudinal section of the grider.

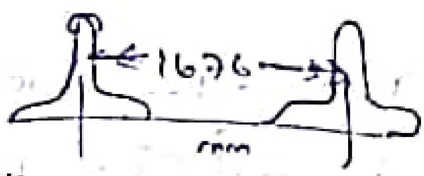
Sol^n:- **Step- I :-**

Span of the railway bridge grider = 24 mts

The Bridge is Broad guage

EDUL for Bending moment

= 2280 kN/track



EDUL for shear force

= 2503 kN/track.

Impact factor calculated $\frac{20}{14+L}$

$= \frac{20}{14+24} = 0.526$

Step-II :- Assume suitable data

weight of stock rails = 0.6 kN/m

weight of Guard rail = 0.4 kN/m

weight of fastenings = 0.2 kN/m

Type of sleepers = wooden sleepers

unit weight of Timber = 7.5 kN/m³

~~length~~ Dimensions of sleeper

B.G → 2.8m × 0.25m × 0.25m.

Optimum spacing between the sleeper = 400mm

The main girder of plate girder are spaced at 2m c/c

Step-III :-

Calculation of Dead loads and live loads

The various loads acting on the bridge are

1. Dead load = (a) weight of stock rails per track per metre

= 2 × 0.6 = 1.2 kN/m

(b) weight of guard rails per track per metre

= 2 × 0.4 = 0.8 kN/m

(c) weight of sleeper/track/m

$= \frac{7.5 \times 2.8 \times 0.25 \times 0.25}{0.4}$

= 3.281

(d) weight of fastenings

= 0.2 kN/m

Total superimposed dead load/track on both plate girders = (1.2 + 0.8 + 3.28) × 24
(stock rails) (guard rails)

= 131.54 kN/track

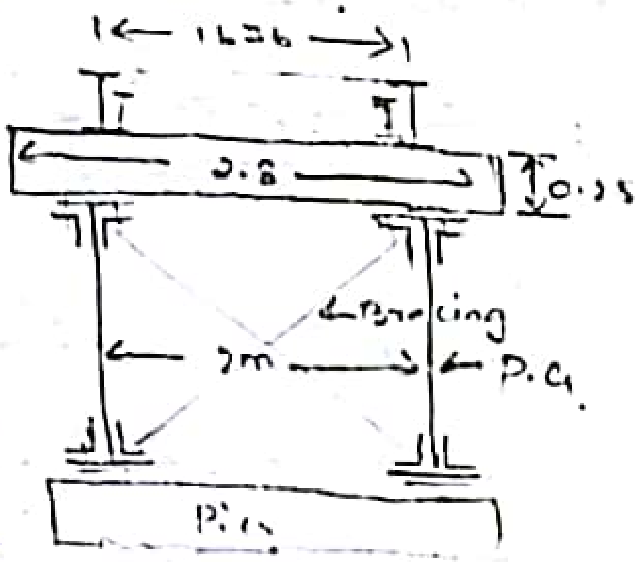
Scanned by CamScanner

Impactor factor

= 0.526

Impact load

= EDUL for Bending Mx × Impact factor



Deck type P.G Bridge for Broad gauge train loading.

= 0.526 × 2250

= 1199.28 kN/track

total Super imposed load on both plate girders = D.L + EDUL for BM + Impact load

= 131.54 + 2250 + 1199.28

= 3610 kN/track

Assume

Self weight of both plate girder $= \frac{WL}{300}$

where W = Total Super imposed load

= 3610.8 kN/track

$\Rightarrow \frac{3610 \times 8 \times 24}{300} = 288.64$ kN/track

Self weight of both plate girder / Meter

$= 27.8 \; \frac{288.64}{24} = 12.036$ kN/m/track

$\therefore$ Overall dead load/track/meter =

$1.2 + 0.8 + 0.2 + 3.28 + 12.036$

$= 17.516$ kN/m/track

$\therefore$ Total Dead load $= 17.516 \times 24$

$= 420.384$ kN/m/track

Now, total dead load + live load + Impact load for bending moment on both plate girder

$\Rightarrow 420.384 + 1199.26 + 2280$

$= 3899.644$ kN/m/~~track~~

Now, Total dead load + live load + Impact on each plate girder is equal to

$= \frac{3899.644 \; ~~+ 2280~~}{2}$

$=$ ~~4480.044~~ $= \frac{4980.044}{2}$

$= 1949.832$

$= \ldots$

Similarly, total D.L + L.L + I.L for shear

= 420.84 + 2503 + (0.526 × 2503)

= 4239.926 kN/track

Now, Total D.L + L.L + I.L for S.F on one Plate Girder

$$= \frac{4239.962}{2}$$

= 2119.98 kN/track

Loads	for BM	for S.F
D.L	420.384 kN/track	420.384 kN/track
L.L	2280 kN/track	2503 kN/track
I.L = i×LL, i = 0.526	1199.28 kN/track	1316.58 kN/track
	2899.664	4239.962

Step-4:

Maximum Bending at Mid Span

$$= \frac{wL}{8}^2$$

$$= \frac{1949.832 \times 24}{5}$$

$$= 5.349 \times 10^3 \text{ KN.}$$

Step- 5 :- Economical depth of plate girder

$$d = 1.1\sqrt{\left(\frac{M}{\sigma_b \cdot t_w}\right)}$$

where σ_b = allowable bending stress

= ~~165~~ 165 N/mm²   0.66×250 = 165.

Let us Assume t_w (thickness of web) as 12mm for the web plate.

∴ Depth of web plate $d = 1.1\sqrt{\frac{5.349 \times 10^9}{165 \times 12}}$

$\Rightarrow$ 1.31 N/m. = 1359 N/mm

Let us adopt depth of web plate = 2000

Dimensions of web plate = 2000×1

Net Area of tension flange

$$A_f \text{ Net} = \frac{M}{\sigma_b \times d}$$

Adopt (two) ↗ compression zone flange plates of 550×16 mm on top and 2 plates in tension area.

Also provide 2 Angle sections of ISA: 200×150×15

Use 22mm diameter rivets for the connection of flange Angles and flange plates and with web plate.

Hole diameter = 22 + 1.5   1.5 → clearance

= 23.5

Description	Gross Area mm^2	deduction of Rivet holes	Net area (mm^2)
1) flange angle 2 ISA 200	2×502.5 = 10050	4×23.5×15 = 1410	10050−1410 = 8640
2) flange plate 2× 550×16	2×550×16 = 17600	4×23.5×16 = 1504	17600−1504 = 16096
web area (Aw)	$\frac{1}{6}$ Aw = $\frac{1}{6}$ ×2000 ×12 = 4000	—	$\frac{1}{8}$ Aw = 3000
	= 31650		27736

Gross Area of Tension flange = 31650 mm^2

Net area of tention flange = 27736 mm^2

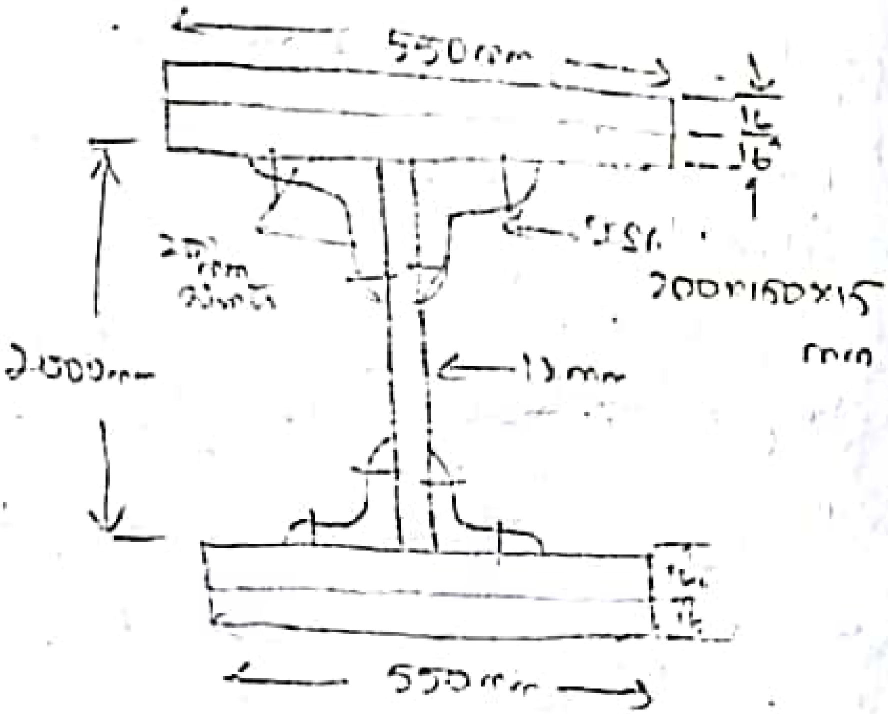
But Required Net area from the formulae.

177.25 mm^2

∴ provided area is greater than required area

27736 > 177.25

Hence the plate girder is safe



Maximum section of plate girder for Railway Bridge.

Step-17:
Check for stress from IS Hand book number "1".

Moment of inertia of 1 flange angle about its own axis

$I_{xx} = 969.9 \times 10^4$ mm^4

Area = 5025 mm^2

Centre of Gravity = 32.2 mm

Let us Assume the Neutral axis is located at the centre of plate girder

Now, I_{xx}, gross = $\frac{12 \times 2000^3}{12}$ (web) + $(4 \times 969.9 \times 10^4)$ (Angle)

(Angle) + $(4 \times 5025 \times (\frac{2000}{2} - 32)^2)$ +

$(\frac{2 \times 550 \times 32^3}{12}) + (2 \times 550 \times 32 \times (\frac{2000}{2} + 16)^2)$

Flange plate section

$= 6.3 \times 10^{10}$ mm^4

(i) Bending stress in Compression flange

$\sigma_{cbc, Net} = \frac{M_{Max} \times y}{I_{xx}} = \frac{5849.49 \times 10^6 (1000 + 32)}{6.3 \times 10^{10}}$

$= 92.84$ N/mm^2 < 165 N/mm^2 Hence safe

2) Bending stress in tension flange:-

$\sigma_{bt,cal} = \sigma_{cbc} \left(\frac{\text{Gross area of Compression flange}}{\text{Net area of tension flange}} \right)$

$= 92.34 \left(\frac{31650}{27736} \right) = 105.94 \ N/mm^2$
$< 142 \ N/mm^2$
(Hence safe)

3) Shear stress:

$\tau_{v,cal} = \frac{1059.95 \times 10^3}{2000 \times 12} = 44.164 \ N/mm^2$
$< 0.4(250) = 100 \ N/mm^2$

4) If $\frac{d_1}{t_w}$ of pg > 85, then Intermediate stiffners are needed

$d_1 = 2000 - 2(150) = 1700 \ mm$

$t_w = 12 mm$

$\frac{d_1}{t_w} = \frac{1700}{12} = 141.66 > 85$

∴ provide Intermediate stiffner of 170×10mm

Step- 5:-

Check for Dead load.

Gross area of flanges = 2(31650) = 63300 mm²

Area of remaining portion of web not included in flange.

$= 2000 \times 12 \times 4/6 = 16000\ mm^2$

total area of P.G = 63300 + 16000

$= 79,300\ mm^2$

weight of P.G/m $= \frac{79300 \times 78.5}{10.6}$ ← unit weight steel $= 587268.867$ kN/m

weight of P.G assumed $= \frac{1}{2} \times 12.036$

$= 6.0186$ kN/m.

Hence safe.

05/oct/18

① The effective span of a plate girder deck type bridge for a single meter gauge track is 24 mts. The dead load, live load, and impact load, reaction is 750 KN. The vertical reaction due to overturning effect of a wind at the each of the girder is 115 KN. Design a suitable bearing

Soln:- Let us design a plate bearing

Step - I :- Given, dead load + live load + impact load

= 750 KN

Step - II :- Log longitudinal force per girder

It has two components - they are
~~Tractive~~ tractive effort and breaking force
tractive

for given span, these forces are obtained from table - 2.10 2.10 - A :

for 24mt span tractive effort = $\frac{248}{2}$

= 124

Breaking force = $\frac{255}{2}$ = 127.5

The allowable stress in concrete = 4 mt N/mm²

Area of bed plate required = $\frac{750 \text{ kN}}{4 \text{ N/mm}^2}$

= 187500 mm²

Assume
provide atleast 550 mm broad bed plate.

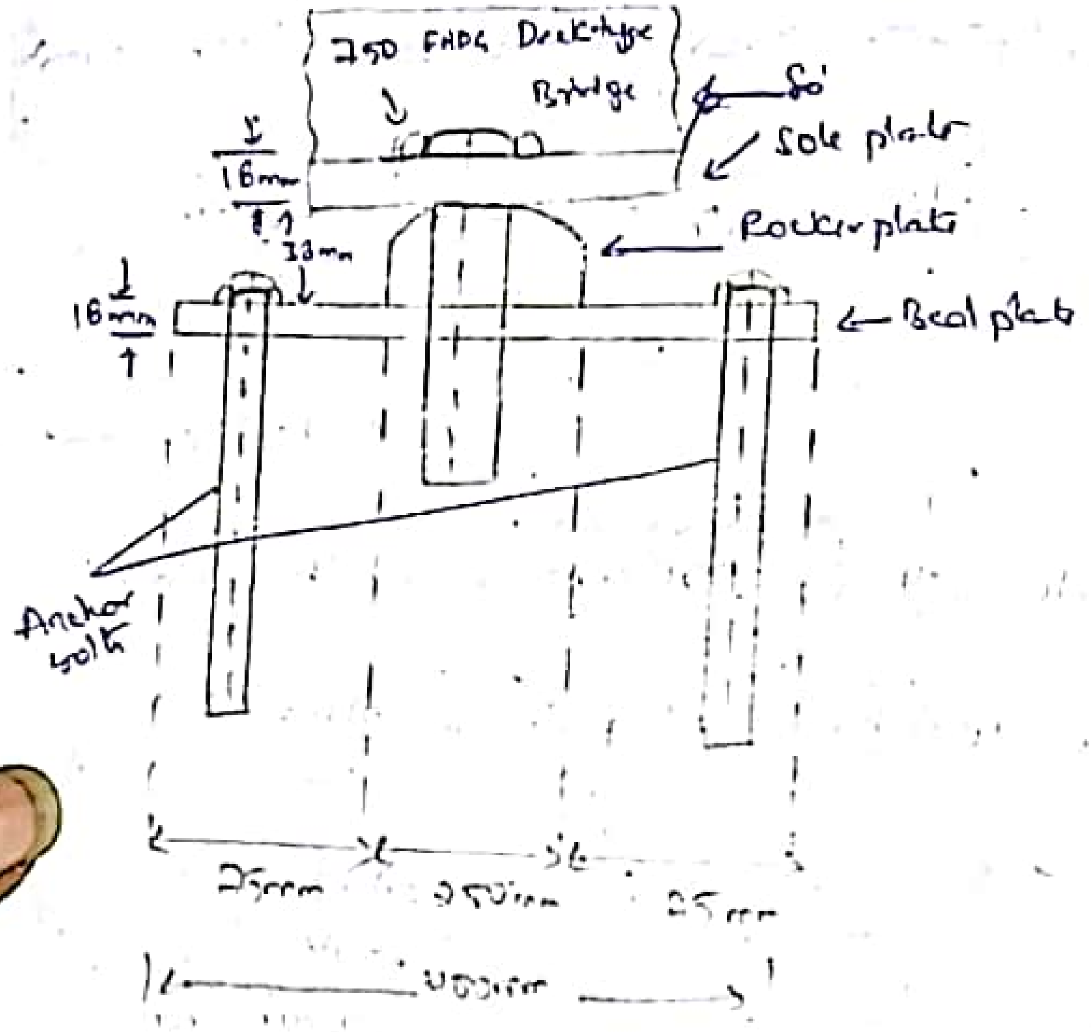
∴ width of bed plate = $\frac{\text{Area}}{550}$

= $\frac{187500}{550}$

= 340.909 mm

≃ 400 mm

There fore provide 550 × 400 mm bedplate
and 550 × 250 mm rocker plate



Step-(ii) Design of Rocker plate

maximum bending moment is $\frac{wL^2}{2}$ (considering the half width of Rocker plate as span of cantilever)

But here, we have ~~Wl~~ W = 750 kN

~~BM = $\frac{Wl}{2}$~~ = 750

Converting into UDL $= \frac{750}{0.25} = 3\times10^3$ kN/m.

$\therefore \frac{wl^2}{2} = \frac{3\times10^3\times0.125^2}{2}$

$= 23.4375$ kNM

Let ~~t~~ t_1 - be the thickness of Rocker plate.

from design principles we have

$\frac{1}{6}\times550\times t_1^2\times165$ ← Allowable stress / ~~in~~ unit length

$= 37.15$ mm

$t_1 = 35$ mm

Step-IV:

Design of Anchor bolts.

It is assumed that longitudinal force is taken equally by bearing at both ends.

Longitudinal force for one-bearing at each end. $= \frac{1}{2}\times$ breaking force

$= \frac{1}{2}\times197.5 = 63.75$

Provide two - Anchor bolts in 1-bearing. allowable shear equal to 100 N/mm²

Area of each bolt (2 bolts in each bearing) =

$$\frac{63.75 \times 10^3}{100 \times 2}$$

$= 318.75$

∴ provide 22mm diameter bolts

Step - V :-

Design of base plate or bed plate

Bearing pressure.

Actual Bearing pressure $= \frac{750 \times 10^3}{550 \times 400} = 3.40$

Let us take a projection of 75 mm on both sides of Rocker plate.

∴ Maximum Bending moment $= \frac{wl^2}{2}$

$$= \frac{3.41 \times 75^2}{2} = 9590.62 \text{ Nm}$$

$= 9.59$ kN/m

let t_2 be the thickness of bed plate and considering to one 1mm wide strip. from design principle

$$\frac{1}{6} \times 1 \times t_2^2 \times 185 = 9590.625$$

$$t_2 = 17.63\ mm \simeq 18mm$$

∴ provide 550 × ~~18~~ 400 × 18mm bed plate and rocker plate 550 × 250 × 36 ~~bed~~ rocker plate. Also provide sole plate of 18mm thickness

Assignment :-

1. Design a Rocker bearing for the following data. Reaction due to dead load, live load, impact load = 750 KN. lateral load due to wind 75 KN. Longitudinal force may be taken as per the bridge

2. Bridge Girder is subjected to vertical loads due to live load, dead load, and impact load equal to 1000 KN, and due to wind load a vertical load of 200 KN, and lateral load on pin due to