Steel Bridges

- Steel bridges are opted where speed in construction is crucial.
- Advantageous for urban flyover/elevated road projects as these cause less disturbance to traffic.
- Light weight construction and prefabrication of component parts done away from site.

Classification of steel bridges :-

a) Beam bridges :— Culverts
b) Plate girder bridges } Simply supported span less than 50m
c) Box girder bridges } Continuous spans up to 260m.
d) Truss bridges ⟶ Span 40 to 375m
e) Arch bridges — 200 to 500m span
f) Cantilever bridges — Main spans of 320 to 549m
g) Cable stayed bridges — Economical span 200 to 800m
h) Suspension bridges. — Economical span above 800m.

Beam bridges :- Railway Culvert:

Q. To design a steel beam culvert with a clear span of 5m to carry a broad gauge single track on main line.

Sol :- I: Dead load effects :-

Assume 2 R.S. joists placed at 2m c/c as shown in fig. The dead load due to track can be assumed as 7.5 kN/m and equally shared by both the joists.

Self wt. of the joist may be estimated as $(0.2L + 1.0)$ kN/m, where L is the clear span in m

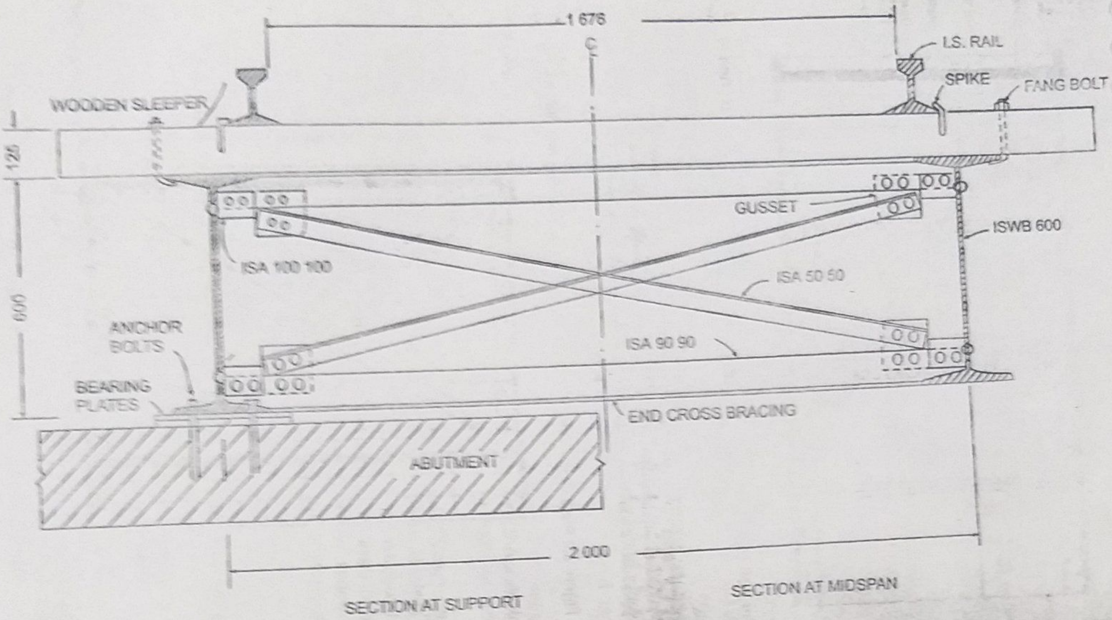


Figure 9.1 Cross Section of a Railway Culvert of Clear Span of 5.0 m.

$$\text{Total dead load} = \frac{7.5}{2} + (0.2 \times 5 + 1.0) = 5.75 \text{ kN/m}$$

$$\text{Max. B.M} = \frac{wL^2}{8} = \frac{5.75 \times 5^2}{8} = 18 \text{ kNm}$$

$$\text{Max. Shear} = \frac{wL}{2} = \frac{5.75 \times 5}{2} = 14.4 \text{ kN}$$

II : Live load effects :-

Span, L = 5 m.

Using Table 4.1, corresponding to L = 5m, & B.G. loading

Equivalent uniform load due to L.L for B.M (WL) = 741 kN

Equivalent udl for shear (WL) = 888 kN

Coefficient of dynamic augment (CDA) = 0.877.

Impact factor = 1.877.

Table 4.1 EUDL, CDA and Longitudinal Loads for Modified BG Loading-1987 and Modified MG Loading - 1988.

L	CDA for Bending Moment and Shear	Modified BG Loading – 1987				Modified MG Loading – 1988			
		EUDL (Total) for B.M.	EUDL (Total) for Shear	Tractive Effort	Braking Force	EUDL (Total) for B.M.	EUDL (Total) for Shear	Tractive Effort	Braking Force
m		kN	kN	kN	kN	kN	kN	kN	kN
1	1.000	490	490	81	62	314	314	89	57
2	1.000	490	519	164	123	314	365	118	78
3	1.000	490	662	164	123	326	452	118	78
4	0.950	596	778	245	184	429	536	157	118
5	0.877	741	888	245	184	501	616	157	118
6	0.817	838	985	245	185	581	685	157	124
7	0.765	911	1068	327	221	644	755	176	135
8	0.721	981	1154	409	276	714	819	209	157
9	0.683	1040	1265	409	276	774	871	262	196
10	0.650	1101	1377	490	331	828	934	262	198
12	0.594	1377	1589	490	331	953	1061	314	235
15	0.531	1631	1801	490	368	1138	1252	353	253
20	0.458	1964	2168	735	496	1421	1532	471	353
25	0.408	2356	2586	735	565	1677	1833	523	401
30	0.372	2727	2997	981	662	1991	2144	628	486
40	0.324	3498	3815	981	816	2589	2748	628	594
50	0.293	4253	4630	981	978	3099	3269	628	702
60	0.271	5051	5442	981	1140	3625	3818	628	810
70	0.255	5831	6254	981	1301	4178	4372	628	918
80	0.243	6603	7065	981	1463	4727	4922	628	1026
90	0.233	7391	7876	981	1625	5274	5470	628	1134
100	0.225	8201	8686	981	1787	5822	6017	628	1242
110	0.219	9011	9496	981	1949	6365	6562	628	1349
120	0.213	9820	10306	981	2110	6908	7106	628	1457
130	0.209	10630	11115	981	2272	7451	7649	628	1565

B.M due to L.L including impact $= \left(\frac{wL}{2}\right) \times \frac{L}{8} \times 1.877 = 435$ KNm

Shear due to L.L including impact $= \left(\frac{wL}{2}\right) \cdot \frac{1}{2} \times 1.877 = 417$ KNm

} Divided by 2, as shared by both joist

III:- Design

Design Moment $= 18 + 435 = 453$ KNm

Design shear $= 14 + 417 = 431$ KN.

$f_y = 250$ MPa $= 250$ N/mm²

From Table of stresses

Table 5.12 Basic Permissible Stresses in Steel.

Sl No.	Description	Permissible Stress
1.	Axial tension on net area	$0.60 f_y$
2.	Axial compression on effective section	$0.60 f_y$
3.	Flexure	
	In plates, flats and tubes	$0.66 f_y$
	In girders and rolled sections	$0.62 f_y$
4.	Shear	
	Maximum stress	$0.43 f_y$
	Average stress	
	For $f_y \leq 250$ MPa	$0.38 f_y$
	For $f_y > 250$ MPa	$0.35 f_y$
5.	Bending stress on flat surface	$0.80 f_y$

Permissible bending stress $= 0.62 f_y = 0.62 \times 250 = 155$ N/mm²

Modulus of Section required $= \frac{M}{\sigma_2} = \frac{453 \times 1000 \times 1000}{155}$

$= 2923000$ mm³

$= 2923$ cm³

Provide ISWB 600 @ 1.31 KN/m

Modulus of section = $3540 \, cm^3$

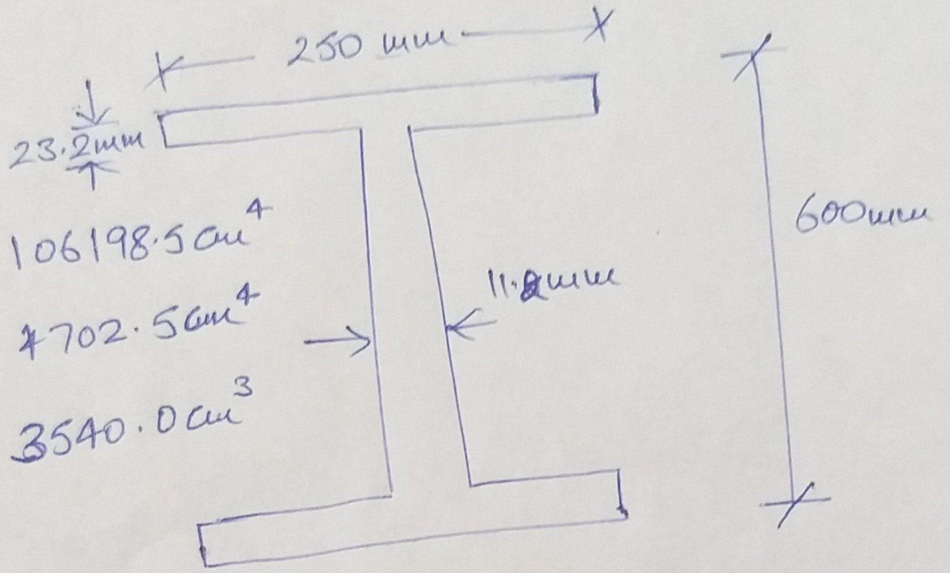
Permissible shear stress $= 0.38 f_y = 95 \, N/mm^2$

$$\text{Shear stress} = \frac{431 \times 1000}{600 \times 11.2} = 64 \, N/mm^2 < 95 \, N/mm^2$$

$I_{xx} = 106198.5 \, cm^4$

$I_{yy} = 4702.5 \, cm^4$

$Z_{xx} = 3540.0 \, cm^3$



ISWB 600 @ 1.312 KN/m