SEISMIC ANALYSIS OF FOOT OVER BRIDGE

[1]Mr.Aniket Rewatkar, [2]Mr.Vishal Gajghate

[1]PG student, [2]Assistant Professor

Department of Civil Engineering

G. H. Raisoni College of Engineering, Nagpur, India

Abstract:*A footbridge (also called a pedestrian bridge, pedestrian overpass, or pedestrian overcrossing) is a bridge designed for pedestrians and in some cases cyclists, animal traffic, and horse riders, instead of vehicular traffic. In many* developed countries*, footbridges are both functional and can be beautiful works of art and sculpture. For poor rural communities in the developing world, a footbridge may be a community's only access to medical clinics, schools and markets, which would otherwise be unreachable when rivers are too high to cross.*

In this project work seismic analysis of foot over bridge for different soil conditions are carried out. This paper highlights the effect of different soil conditions in different earthquake zones with Response Spectrum analysis using Staad-Pro.

***Keywords*:- Seismic Analysis, Different Zones, Different Soil Conditions, STAAD Pro**

INTRODUCTION -

Soil is one of the most abundant materials available throughout the world. This fact along with the demand for local construction material led to this investigation on the suitability of soil for use as a building material.

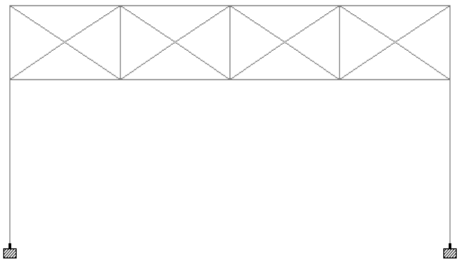
Foot over bridge are important passenger amenity and passenger safely items in station yards provided to facilitate easy movement of passenger and goods from one platform to other or from platform to outside of railway station or for crossing station yards. Footbridges are mostly constructed to allow pedestrians to cross water or railways. They are situated across the roads for pedestrians to cross safely without slowing down the traffic. As per the Indian code IS 1893:2002 Part1, about 60% Indian land comes under seismic zone III, IV, V. The main objective of structural analysis is to determine internal forces, stresses and deformations of structures under various load effects. There has been much progress in foot over bridge design in recent years with increasing use of advanced analytical design methods, use of new materials and new bridge concepts.

Fig.:- Foot Over Bridge

Objectives:-

- Analysis of foot over bridge using STAAD Pro software.
- To understand the effects of earthquake on foot over bridge in different earthquake zones (II, III, IV, V).
- To examine the effects of different soil conditions in different earthquake zones for foot over bridge.
- To give most structurally efficient and economic foot over bridge superstructure according to earthquake zone and suitable soil condition.

Modelling:



GEOMETRY OF FOOT OVER BRIDGE -

SN	Details	Dimensions
1	EFFECTIVE SPAN OF FOOT OVER BRIDGE	20m & 30m
2	HEIGHT OF BRIDGE DECK FROM GROUND LEVEL	6m
3	PANEL LENGTH	5m
4	NO. OF PANELS	4(20m) & 6(30m)
5	WIDTH OF BRIDGE DECK	3m

LOADIND CALCULATIONS –

1) Dead Load Calculation of concrete deck slab –

Thickness of concrete deck slab- 200MM
Density of concrete- 25 KN/m3
Dead load of deck slab = 25 * 0.2 * 1
= 5 kN/m2

2) Live load – 4 kN/m2

Physical Properties of Structural Steel :-
i)Unit mass of steel, p = 7850 kg/m³
ii)Modulus of elasticity, E = 2.0 x 10s N/mm2 (MPa)
iii)Poisson ratio, p = 0.3
iv)Modulus of rigidity, G = 0.769 x 10s N/mm2 (MPa)

STRUCTURAL ANALYSIS –

Node Reactions for 20m Span Foot Over Bridge Model with First Soil condition i.e. Hard Soil for Different EQ Zones

			Horizonta	Vertical	Horizonta	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	29	5 1.5(DL+LL)	5.165	250.625	-2.114	-0.624	-0.01	-12.141
Min Fx	32	10 1.5(DL+EQX)	-10.628	163.147	1.505	0.43	-0.04	34.558
Max Fy	30	5 1.5(DL+LL)	5.165	250.625	2.114	0.624	0.01	-12.141
Min Fy	30	2 EQZ	-0.086	-22.272	-5.034	-1.599	0	0.205
Max Fz	30	5 1.5(DL+LL)	5.165	250.625	2.114	0.624	0.01	-12.141
Min Fz	29	12 1.5(DL+EQZ)	3.207	194.033	-9.036	-2.822	-0.006	-7.574
Max Mx	30	5 1.5(DL+LL)	5.165	250.625	2.114	0.624	0.01	-12.141
Min Mx	29	12 1.5(DL+EQZ)	3.207	194.033	-9.036	-2.822	-0.006	-7.574
Max My	31	10 1.5(DL+EQX)	-10.628	163.147	-1.505	-0.43	0.04	34.558
Min My	32	10 1.5(DL+EQX)	-10.628	163.147	1.505	0.43	-0.04	34.558
Max Mz	31	10 1.5(DL+EQX)	-10.628	163.147	-1.505	-0.43	0.04	34.558
Min Mz	30	5 1.5(DL+LL)	5.165	250.625	2.114	0.624	0.01	-12.141

Table:– It Shows Node Reactions for EQ. Zone II

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	29	5 1.5(DL+LL)	5.001	250.48	-2.114	-0.624	-0.01	-11.699
Min Fx	31	10 1.5(DL+EQX)	-14.992	164.506	-1.515	-0.433	0.061	50.111
Max Fy	29	5 1.5(DL+LL)	5.001	250.48	-2.114	-0.624	-0.01	-11.699
Min Fy	30	2 EQZ	-0.122	-35.356	-8.005	-2.543	0	0.29
Max Fz	30	5 1.5(DL+LL)	5.001	250.48	2.114	0.624	0.01	-11.699
Min Fz	29	12 1.5(DL+EQZ)	3.168	213.514	-13.493	-4.238	-0.006	-7.444
Max Mx	30	5 1.5(DL+LL)	5.001	250.48	2.114	0.624	0.01	-11.699
Min Mx	29	12 1.5(DL+EQZ)	3.168	213.514	-13.493	-4.238	-0.006	-7.444
Max My	31	10 1.5(DL+EQX)	-14.992	164.506	-1.515	-0.433	0.061	50.111
Min My	32	10 1.5(DL+EQX)	-14.992	164.506	1.515	0.433	-0.061	50.111
Max Mz	31	10 1.5(DL+EQX)	-14.992	164.506	-1.515	-0.433	0.061	50.111
Min Mz	30	5 1.5(DL+LL)	5.001	250.48	2.114	0.624	0.01	-11.699

Table:– It Shows Node Reactions for EQ. Zone III

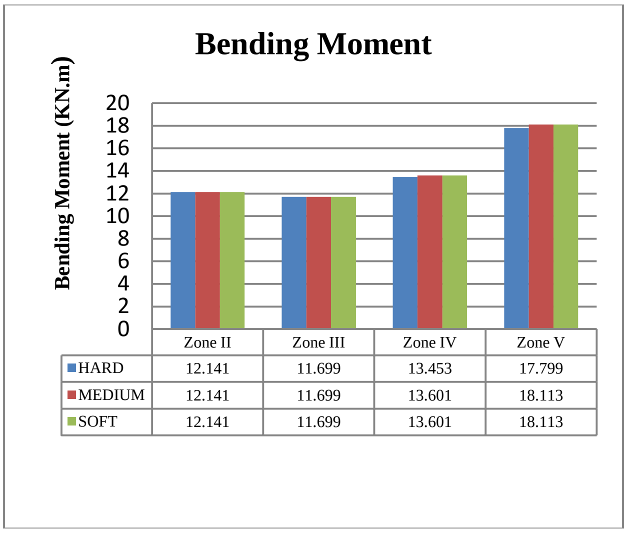
			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	30	5 1.5(DL+LL)	6.544	252.475	2.151	0.632	0.01	-15.652
Min Fx	31	10 1.5(DL+EQX)	-23.88	169.408	-1.574	-0.448	0.068	82.216
Max Fy	29	8 1.2(DL+LL+EQZ)	5.599	274.402	-17.678	-5.554	-0.008	-13.453
Min Fy	30	2 EQZ	-0.303	-60.352	-13.297	-4.207	0	0.776
Max Fz	30	5 1.5(DL+LL)	6.544	252.475	2.151	0.632	0.01	-15.652
Min Fz	29	12 1.5(DL+EQZ)	4.388	253.002	-21.47	-6.742	-0.006	-10.613
Max Mx	30	5 1.5(DL+LL)	6.544	252.475	2.151	0.632	0.01	-15.652
Min Mx	29	12 1.5(DL+EQZ)	4.388	253.002	-21.47	-6.742	-0.006	-10.613
Max My	31	10 1.5(DL+EQX)	-23.88	169.408	-1.574	-0.448	0.068	82.216
Min My	32	10 1.5(DL+EQX)	-23.88	169.408	1.574	0.448	-0.068	82.216
Max Mz	31	10 1.5(DL+EQX)	-23.88	169.408	-1.574	-0.448	0.068	82.216
Min Mz	30	5 1.5(DL+LL)	6.544	252.475	2.151	0.632	0.01	-15.652

Table:– It Shows Node Reactions for EQ. Zone IV

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	29	5 1.5(DL+LL)	8.131	253.913	-1.987	-0.578	-0.01	-19.78
Min Fx	31	10 1.5(DL+EQX)	-34.837	174.207	-1.479	-0.417	0.081	122.234
Max Fy	29	8 1.2(DL+LL+EQZ)	7.245	311.814	-25.525	-7.96	-0.008	-17.799
Min Fy	30	2 EQZ	-0.617	-90.57	-19.946	-6.248	0.001	1.646
Max Fz	30	5 1.5(DL+LL)	8.131	253.913	1.987	0.578	0.01	-19.78
Min Fz	29	12 1.5(DL+EQZ)	5.843	299.767	-31.33	-9.767	-0.006	-14.485
Max Mx	30	5 1.5(DL+LL)	8.131	253.913	1.987	0.578	0.01	-19.78
Min Mx	29	12 1.5(DL+EQZ)	5.843	299.767	-31.33	-9.767	-0.006	-14.485
Max My	31	10 1.5(DL+EQX)	-34.837	174.207	-1.479	-0.417	0.081	122.234
Min My	32	10 1.5(DL+EQX)	-34.837	174.207	1.479	0.417	-0.081	122.234
Max Mz	31	10 1.5(DL+EQX)	-34.837	174.207	-1.479	-0.417	0.081	122.234
Min Mz	29	5 1.5(DL+LL)	8.131	253.913	-1.987	-0.578	-0.01	-19.78

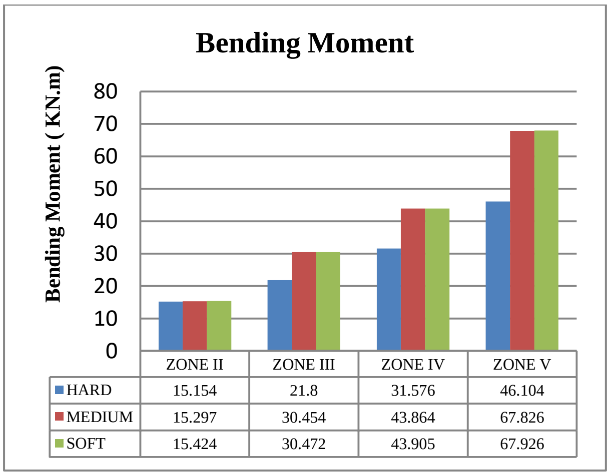
Table:– It Shows Node Reactions for EQ. Zone V

Similarly, Node Reactions for 30m Span Foot Over Bridge Model with different soil condition for Different EQ Zones were obtained.



	Zone II	Zone III	Zone IV	Zone V
HARD	12.141	11.699	13.453	17.799
MEDIUM	12.141	11.699	13.601	18.113
SOFT	12.141	11.699	13.601	18.113

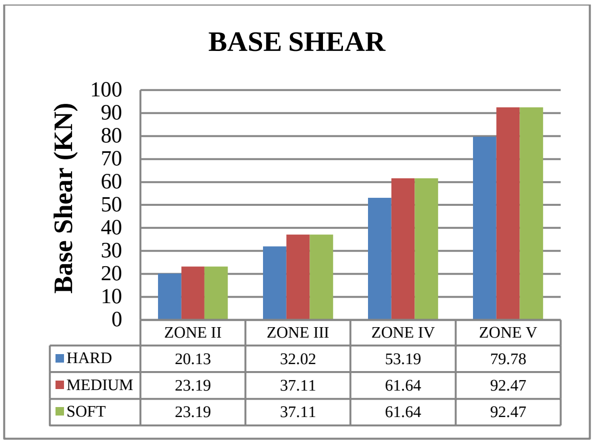
Fig:- Bending moment comparison of 20m span column members



	ZONE II	ZONE III	ZONE IV	ZONE V
HARD	15.154	21.8	31.576	46.104
MEDIUM	15.297	30.454	43.864	67.826
SOFT	15.424	30.472	43.905	67.926

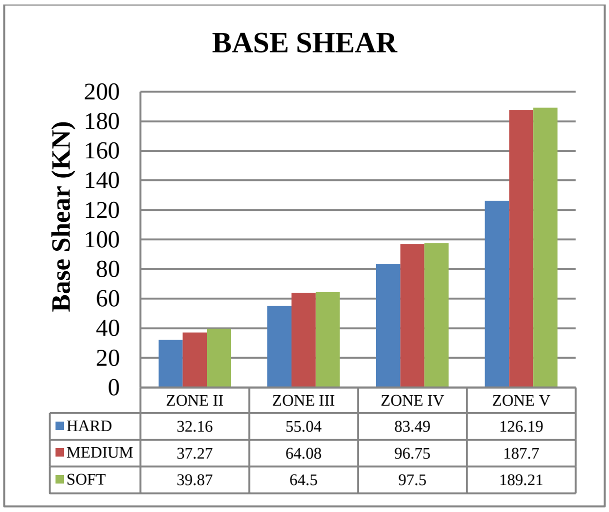
Fig:- Bending moment comparison of 30m span column members

Base shear comparison:



	ZONE II	ZONE III	ZONE IV	ZONE V
HARD	20.13	32.02	53.19	79.78
MEDIUM	23.19	37.11	61.64	92.47
SOFT	23.19	37.11	61.64	92.47

Fig:- Base shear comparison of 20m span FOB



	ZONE II	ZONE III	ZONE IV	ZONE V
HARD	32.16	55.04	83.49	126.19
MEDIUM	37.27	64.08	96.75	187.7
SOFT	39.87	64.5	97.5	189.21

Fig:- Base shear comparison of 30m span FOB

CONCLUSION:

i) Column's sectional property changes with the change in soil condition of 30m span and no change in 20m span model of foot over bridge for different earthquake zones.

ii) Sectional members which passes in Earthquake Zone II & III, fails in Earthquake Zone IV & V.

iii) Support reaction increases with change in Earthquake Zone and soil condition.

iv) Maximum axial force and bending moment in column members of 20m & 30m span foot over bridge increases with change in soil condition and change in earthquake zones.

v) Base shear in 20m and 30m span foot over bridge increases with the change in soil condition and earthquake zones.

REFERENCES:

1) Buckle, I.G. and Mayes, R.L., (1987), "Seismic Isolation of Bridge Structures in the United States of America," Proceedings of the Third U.S. Japan Workshop on Bridge Engineering, Public Works Research Institute, Ministry of Construction, Tsukuba,Japan, pp. 379-401.
2) . M. Ciampoli and P.E. Pinto. "Effects of soil-structure interaction on inelastic seismic response of bridge piers". Journal of structural engineering, 121(5):806–814, 1995.
3) 2. Durkee, Jackson L., "Foot Over Bridge Erected by Launching", Journal of The
4) Structural Division, ASCE, Vol. 98, No. ST7, Proc. Paper 9028, Pp. 1443-1463, July,1997
5) 3. Durkee, Jackson, "Steel Bridge Construction", Bridge Engineering Handbook, Crcpress, PP 45-58, 2000.
6) 4. Granath, P., "Distribution of Support Reaction Against A Steel Girder On A Launching Shoe." Journal of Constructional Steel Research, Vol. 47, No.3, Pp. 245-270, 1998.
7) 5. G. Mylonakis and G. Gazetas. "Seismic soil-structure interaction: beneficial or detrimental", Journal of Earthquake Engineering, 4(03):277–301, 2000.
8) 6. M.J.N. Priestley and R. Park. "Strength and ductility of concrete bridge columns under
9) Seismic loading". ACI Structural Journal, 84(1):61–76, 1987.