iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** II **Month of publication:** February 2015

DOI:

www.ijraset.com Volume 3 Issue II, February 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Seismic Design Considerations of Foot Bridge

Mr.Dushyant A. Zamre[1], Miss. Aditi H. Deshmukh[2]
[1](College Of Engg & Tech, Akola), [2](Faculty, College Of Engg & Tech, Akola)

Abstract: A bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline. The obstacle to be crossed may be a river, a road, railway or a valley. In other words, bridge is a structure for carrying the road traffic or other moving loads over a depression or obstruction such as channel, road or railway. Also a footbridge or a pedestrian bridge is a bridge designed for pedestrians and in some cases cyclists, animal traffic and horse riders, rather than vehicular traffic. Footbridges can also be built in the same ways as road or rail bridges. Footbridges are small, but important, because they are usually presented in townscape. The appearance of footbridges, and indeed of any other bridges, in a town, is a major concern for designers. Increasing strength of new structural materials and longer spans of new footbridges, accompanied with aesthetic requirements for greater slenderness, are resulting in livelier footbridge structures. In the past few years this issue attracted great public attention. The excessive lateral sway motion caused by crowd walking across the infamous Millennium Bridge in London is the prime example of the vibration serviceability problem of footbridges. In principle, consideration of footbridge vibration serviceability requires a characterization of the vibration source, path and receiver. The literature survey identified humans as the most important source of vibration for footbridges. However, modeling of the crowd-induced dynamic force is not clearly defined yet, despite some serious attempts to tackle this issue in the last few years. The vibration path is the mass, damping and stiffness of the footbridge. Of these, damping is the most uncertain but extremely important parameter as the resonant behavior tends to govern vibration serviceability of footbridges. A typical receiver of footbridge vibrations is a pedestrian who is quite often the source of vibrations as well. During footbridge vibration, especially under crowd load, it seems that some form of human–structure interaction occurs. The problem of influence of walking people on footbridge vibration properties, such as the natural frequency and damping is not well understood, let alone quantified. Finally, there is not a single national or international design guidance which covers all aspects of the problem comprehensively and some form of their combination with other published information is prudent when designing major footbridge structures. The overdue update of the current codes to reflect the recent research achievements is a great challenge for the next 5–10 years.

I. INTRODUCTION

A. Literature Review

The earliest scientific descriptions of excessive pedestrian-induced lateral vibrations are dated back to the 1970s, but it was not until the beginning of the new millennium that bridge engineers fully comprehended the potential negative effect of pedestrian crowds on long-span footbridges. Following the unexpected serviceability failures of Paris' Solferino and London's Millennium footbridges in 1999 and 2000, a new tract of research was initiated, focused on understanding the phenomenon which has become known as Synchronous Lateral Excitation (SLE). In the study done by **E.T.Ingolfsson , C.T..Georgakis & J.Jonsson (1)**, a comprehensive review of studies related to pedestrian-induced lateral vibrations of footbridges is provided, primarily focusing on studies published within the last decade. Research in this field were generally split into three categories; (i) full-scale testing of existing bridges subject to crowd loading, (ii) laboratory studies on human-structure interaction between single pedestrians and laterally moving platforms and (iii) mathematical modeling of the pedestrian-induced load. It is shown in the study that a significant amount of research has been carried out within each of the three categories, but there is only limited interconnection, particularly between the mathematical models on one side and the empirical observations on the other. Later on **P.Kumar and A.Kumar (2)** studied the effect of human vibaration induced in the foot bridge. They , studied and mentioned that Several structures are subjected to human loading, for example, floors, footbridges, stadium, etc. In fact, the aesthetic demand of human beings and recent advances in material and fabrication technologies have enabled the design and construction of stylish, light and slender long span structures such as bridges, stadiums, floors, etc. Consequently the modern structures have become flexible and prone to human induced vibrations.The human activities on structures cause vibration in structures and once structure starts vibrating beyond certain limit, it results a serviceability problems. Passive humans (such as humans sitting or standing on the structure) influence the dynamic properties (mass, stiffness and damping) and modal characteristics of the structure carrying them and active humans (such as humans walking, jumping, bouncing or other rhythmic activities performs on structure) can bring the structure into vibration. Excessive vibrations may occur if the motion frequency of human coincides with a resonant frequency of the structural system. Human-structure interaction is applicable to the design of structures. Human walking possesses adaptive and feedback nature, inducing motion dependent human walking forces on structures. The excessive vibration caused by humans need to be mitigated and bring within acceptable limits. Moreover, passive and active dampers provide a reliable solution. However, a proper type of damper selection and design is a crucial part in the vibration mitigation of structures. This paper presents the structural problems of human induced vibrations, formulation of human loading on structures.

Considering this human induced vibration the study was done by **Zivanovic Stanaal (3)**,The authors mentioned that increasing strength of new structural materials and longer spans of new footbridges, accompanied with aesthetic requirements for greater slenderness, are resulting in livelier footbridge structures. In the past few years this issue attracted great public attention. The excessive lateral sway motion caused by crowd walking across the infamous Millennium Bridge in London is the prime example of the vibration serviceability problem of footbridges. In principle, consideration of footbridge vibration serviceability requires a characterization of the vibration source, path and receiver. However , the study for behavior of foot bridge subjected to vibration and lateral force effect of earthquake forces are not explored enough , and thus creates attention to make seismic resistive design consideration of foot bridge for seismic stability and resistivity. The work in this paper highlights same concept and method to make it seismic resistive structure.

II. DESIGN CONSIDERATION

A. Design

The design of steel truss pedestrian bridges is based on the siting and functionality factors, the loading conditions — wind, dead, live, fatigue, snow, seismic, and stream force — required for the bridge. Seismic and stream load forces are key determinations that should be addressed by the specifying engineer during the specification phase

Design Steps:

1) Given Data:

Span of Bridge =
Width of walkway =
N-type Lattice Girder =
Thickness of RCC Slab =
Loadings:-

2) Geometry of Lattice Girder:
  a) Assuming depth of girder = Span/No of panels
  {Span/5 ≤ Span/8}
  b) Length of panel = Span/no of panels
  c) Length of Vertical member.

d) Length of Diagonal member = $\sqrt{(\text{Length of Vertical member})^2 + (\text{Length of panel})^2}$

Design of Cross Beam:
  a) Dead load = (Thickness × Density)
  b) Floor finish = (given)
  c) Live load = (given)
  d) Total load =
  e) Load per unit Length = Total load × Length of panel.
  Assume self weight of cross beam 0.5 kN/m^2
  Total load = Load per unit Length + 0.5.
  Factored load = 1.5 × Total load.
  f) Maximum Bending moment = $Wl^2/8$
  g) Factored Bending Moment = 1.5 × Maximum Bending moment.
  h) Max Shear force = Wl/2
  i) Factored Shear force = 1.5 × Max Shear force.

Considering compression flange of beam fully laterally restrained

Plastic section modulus required:-
Zp(req) = M × ϒmo/fy.
Shape factor = Zp (req)/ Ze
Now by using Steel Table:
Select the ISLB Section Whatever the answers comes
Therefore,
Zp (provided) = Ze × 1.14

3) Section Classification according to IS 800-2007

$\epsilon = (250/fy)^{1/2} = 1$

a) Flange Criteria = b/2tf
b) Web criteria = α/tw

If it satisfies then the section is Plastic.

4) Plastic section:-Bb = 1
Check for moment Resistant Capacity
Md = Bb × Zp(provided) × fy/ ϒmo

5) Design of N-Type Lattice girder:-

a) Dead load intensity = D.L due to selfweight × width of walkway/2
b) Self weight of truss in meters = Dead load intensity/10
c) Total D.L = Dead load intensity + Self weight of truss in meters.
d) Factored D.L= Total D.L × 1.5
e) Live load =L.L × width of walkway/2
f) Factored L.L = 1.5 × L.L × width of walkway/2
g) Total factored load = D.L +L.L
h) Load on each node = Total factored load/no. of panels

6) Forces in Chord Members:
In This step ILD Diagrams should be drawn and the answers should be entered in the tables:

Top Chord	**Bottom Chord**	**ILD (Area in m²)**	**Load in kN**	**Moment in kN/m (Area × load)**	**Force = Moment/Depth of panel**
(1)	(2)	(3)	(4)	(5)	(6)
				(3)×(4)	(5)/Depth of panel

7) Forces in Vertical member:-

Member	**Area**		**Net Area (N.A)**	**D.L (N.A ×10.98)**	**Total force (L.L(N.A ×11.8))**			
	+ Ve	-Ve						
					+ve	-ve	Max	Min
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			(4)=(2)-(3)				(8)=(5)+(6)	(9)=(5)-(7)

8) Forces in Diagonal member:-

Member	**Maximum**	**Minimum**
(1)	(2)	(3)
	√2 × (8)	√2 × (9)

9) Design Forces calcuations as discussed earlier :-

10) Design of Chord Member.
    Max Force =
    Assume the design stress = 90 Mpa
    Provide the necessary sections of angles (Single or Double angle section)
11) Now From Steel table Choose ISA For the final Calculations.
12) Seismic Design Calculations were done by using IS Codes specifications.
13) Sample Design Detailing :- (Source from net)

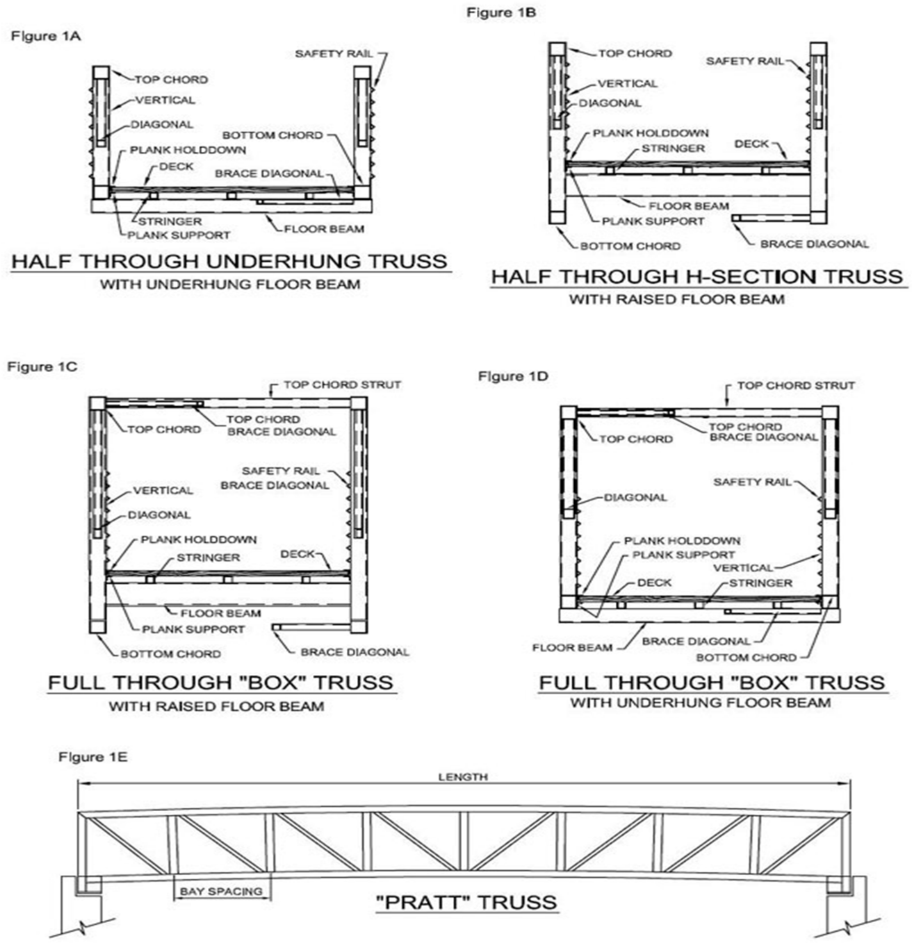


Fig. 1 : Picture taken from NET source

Criteria & Check:

Seismic loads: - The calculation of seismic forces in areas subject to earthquakes should be as set forth in the applicable design code or specification (typically IBC/ASCE 7 or AASHTO). For states with high seismic activity, such as California, it is common to be required to meet the seismic requirements of local or state agencies (i.e., CALTRANS or the California Building Code). A geotechnical investigation to determine relevant site conditions is recommended for all bridges that may encounter high seismic forces so that an appropriate seismic evaluation can be accomplished.

Design code: - two main design codes are used to govern prefabricated steel truss pedestrian bridge types:

"AASHTO Guide Specification for the Design of Pedestrian Bridges," published by the American Association of State Highway and Transportation Officials (AASHTO);

"International Building Code" (IBC) for design loads in conjunction with the specification for structural steel buildings published by the American Institute of Steel Construction (AISC) for member and connection design.

In general, AASHTO Guide Specifications for the Design of Pedestrian Bridges is referenced most commonly on projects where state and/or federal funds are allocated to the bridge construction.

Indian Standard Practice Code For Steel Structures (IS 800-2007)

Indian Steel Table By. S. Ramamrutham

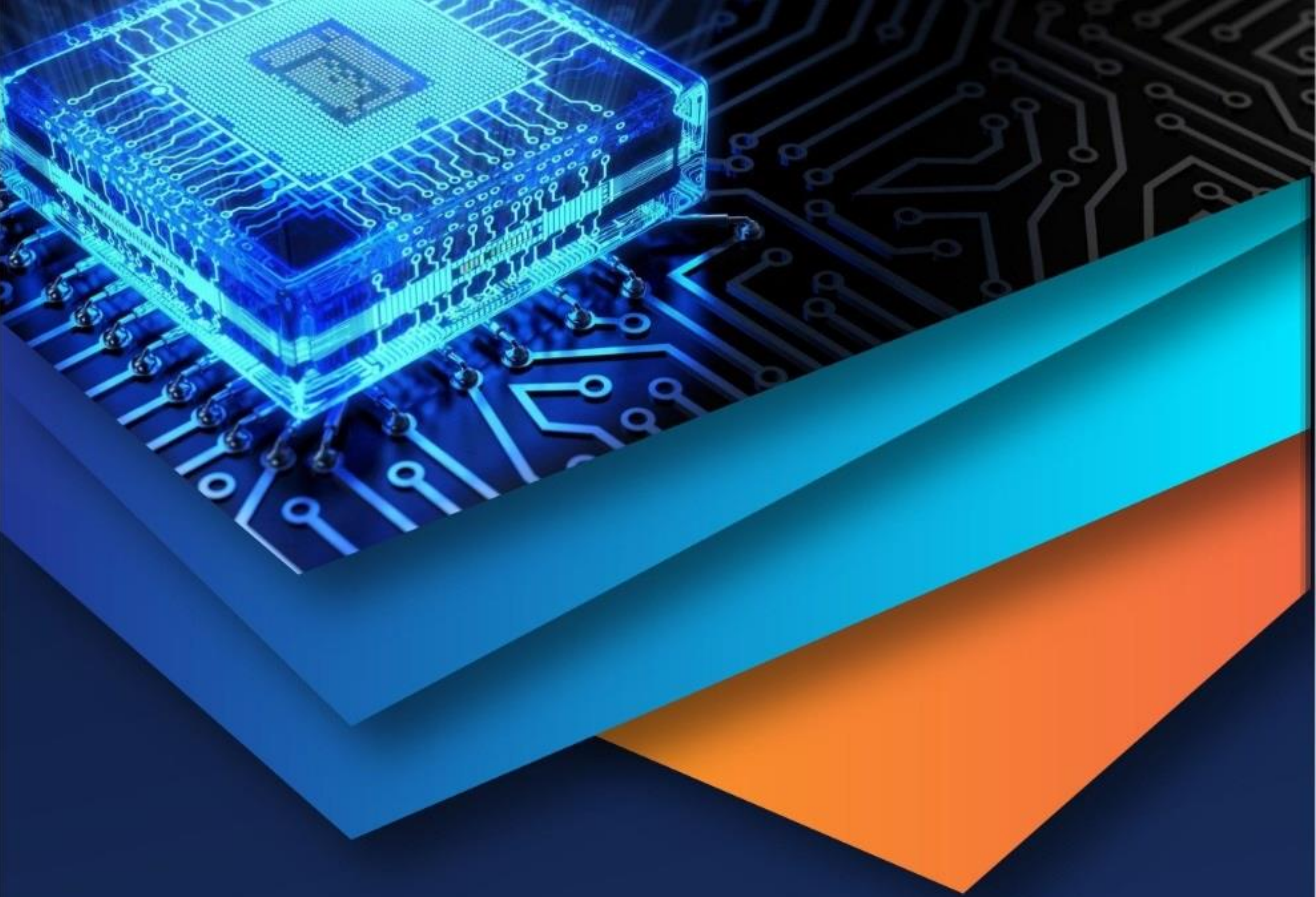
Indian Standard Code Practice Criteria For Earthquake Resistant Design Of Structures Fourth Revision (IS 1893-1984)

III.CONCLUSIONS

Construction industry being one of the important sector concerns more about human and living beings safety and thus the strength and durability of structures matter. One such important structure that is foot bridge is studied over here in this paper, force consideration, factor affecting them and its design parameters related to natural hazard like Earthquake so as to make it stable and earthquake resistive.

REFERENCES

[1] E.T.Ingolfsson , C.T..Georgakis & J.Jonsson [1], a comprehensive review of studies related to pedestrian-induced lateral vibrations of footbridges
[2] P.Kumar and A.Kumar [2] studied the effect of human vibaration induced in the foot bridge.
[3] Vibration serviceability of footbridges under human-induced excitation: a literature review Zivanovic, Stana, Pavic, Aleksandar and Reynolds, Paul.
[4] AASHTO Guide Specifications for Design of Pedestrian Bridges, American Association of State Highway and Transportation Officials.
[5] Guide for the Development of Bicycle Facilities, American Association of State Highway and Transportation Officials.
[6] Standard Specifications for Highway Bridges, 16th edition, American Association of State Highway and Transportation Officials.
[7] ASCE Standard 7-95, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers.
[8] 2006 International Building Code.
[9] Indian Standard Practice Code For Steel Structures [IS 800-2007]
[10] Indian Steel Table By. S. Ramamrutham.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY