

Comparative Seismic Analysis of Steel Foot Bridge for Human Resource Safety

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ABSTRACT: Footbridge is very well known path provided over obstacles such as rivers and lakes. Steel is one of the most widely used materials for various types of footbridges construction in the world. The strength, toughness and high ductility of steel are characteristics that are ideal for seismic design. In this paper we have done Modelling and analysis for various cases that is for case-I, case-II, case-III, considering DL, LL&EL whereas in case-I the footbridge is analysed for DL and LL only, while other remaining cases are analysed including EL also. In this study the bridge is located in zone IV and methods of analysis, loading and loading combination are taken in accordance of IS-1893-2002 and IS-800-2007. This study mainly includes static seismic analysis and dynamic seismic analysis, specifically seismic coefficient method and response spectrum method is used. The aim of this paper is to compare the results obtained due to static and dynamic analysis thoroughly. So over here the seismic analysis is done using both static and dynamic method so as to find out relative difference between the outputs of both seismic analysis methods. For many of the observations made in this, it is seen that the positive results of static analysis is quite high as compared to dynamic analysis. This indicates that if the design is done by considering the static method, it will be safe but uneconomical, whereas designing based on dynamic method will be stable as well as economical

KEYWORDS: Seismic analysis, Foot bridge, Dynamic, Static analysis, Seismology, nodal displacement, Rotational displacement, Support reaction

I. INTRODUCTION

In recent years, there has been a growing trend towards the construction of lightweight footbridges. Due to its reduced mass of such structures, the dynamic forces can cause larger amplitudes of the vibration. The more slender structures become, the more attention must be paid to vibration phenomena. The increase of vibration problems in modern footbridges shows that footbridges should no longer be designed for static loads only. But fulfilling the natural frequency requirements that are given in many codes restricts footbridge design: very slender, lightweight structures, such as stress ribbon bridges and suspension bridges may not satisfy these requirements. Moreover not only natural frequencies but also damping properties, bridge mass and pedestrian loading altogether determine the dynamic response. Design tools should consider all of these factors. Provided that the vibration behavior due to expected pedestrian traffic is checked with dynamic calculations and satisfies the required comfort; any type of footbridge can be designed and constructed. If the vibration behavior does not satisfy some comfort criteria, changes in the design or damping devices could be considered. Thus, the aim of paper is to carry out seismic analysis of Steel Foot Bridge for safety and security of human resources. The literature survey identified humans as the most important source of vibration for footbridges. However, modelling 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 behaviour 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

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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

form of their combination with other published information is prudent when designing major footbridge structures. 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.

II. LITERATURE REVIEW

A brief review of previous studies on the behaviour of various structures against seismic forces. This literature review focuses on recent contribution related to seismic analysis of steel bridges, buildings and past efforts most closely related to the need of the present work. Here, some literature reviews to study seismic analysis on various structures are studied from various journals like, IOSR Journal of civil engineering, IJPRET journal engineering and technology. Mr. Dushyant A. Zamre, Miss. Aditi H. Deshmukh (1)2015, In this the authors states total foot bridge, 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... 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. In the study done by E.T. Ingolfsson, C.T. Georgakis & J. Jonsson (2), a comprehensive review of studies related to pedestrian-induced lateral vibrations of footbridges is provided, primarily focusing on studies published within the last decade. 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. P. Kumar and A. Kumar (3) studied the effect of human vibration induced in the foot bridge. They studied and mentioned that several structures are subjected to human loading, for example, floors, footbridges, stadium, etc.. Consequently the modern structures have become flexible and prone to human induced vibrations.. Mr. Dushyant A. Zamre, Miss. Aditi H. Deshmukh (4)2015, authors describes The appearance of footbridge, 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 more lively footbridge structures. In the past few years this issue has attracted great public attention. Živanović, S., Pavić, A. and Reynolds, P. (5), 2005, In this the author studied, 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.. 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. Faraz Sadeghi, Ahmad Kueh, Ali Bagheri Fard, and Nasim Aghili (6) In this paper the authors studied numerically the various types of human running dynamic loads and compared to assess vibration characteristics of the light and slender composite footbridges.. Furthermore, it is shown that the

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investigated structure provides sufficient human comfort against vibrations for all the examined three types of running loads. J.Bien,P.Rawa,J.Zwolski(7)In this research the author predict, Forced vibration test is a method enabling us to analyse the changes of dynamic characteristics of steel bridge structures. In some cases it helps monitor their technical condition. In this paper a procedure of a monitoring system applied by team from the Wroclaw University of Technology is described. A comprehensive computer-based system for programming and control of vibration tests as well as for data acquisition and processing is presented. As an example of practical use of the monitoring system, results of steel footbridge tests are shown. The tested suspended structure after renovation was equipped with mass dampers thus special attention was paid to the identification of dynamic characteristics changes caused by the dampers. Philip ICKE(8)2011, This paper aims to highlight the benefits of using finite element (FE) analysis for different types of footbridge design and illustrate those benefits with reference to a diverse range of urban Regeneration footbridges of various construction materials that are either under construction or have been completed in recent years.. The paper concludes that the use of finite element analysis can lead to more efficient, cost-effective footbridge designs and that its use is just as valid for low-cost „practical“ footbridges as it is for the design of more technically advanced and expensive „iconic“ structures. M.Constantinou [9] .this paper by Dr. Michael Constantine describes the seismic protection of a steel multi girder highway bridge. The effect of added viscous damping is also investigated, and is found to greatly enhance the performance of the isolators, even though the dampers required are rather small. M. Constantinou, M.Symans, P.Tsopelas, D. Taylor (10), Experimental study of both a moment frame building and a single span bridge, both with and without viscous dampers, are described here. Addition of viscous dampers significantly reduced both drifts and shear forces.

III. EXPERIMENTAL RESEARCH

Problem:

Design a Foot bridge with the following given

data: Span = 24m

Width of walkway = 4m

N-type lattice Girder with 8 panels laterally supported by rackers.

110mm thick R.C.C slab & Floor finish = 0.75kN/m²

Live Load = 5kN/m², with load combination (1.5×D.L) & (1.5×D.L+1.5×L.L)

Similarly remaining two cases are to be followed by STADD-PRO, Case-II (for static analysis) and Case-III (for Dynamic Analysis).

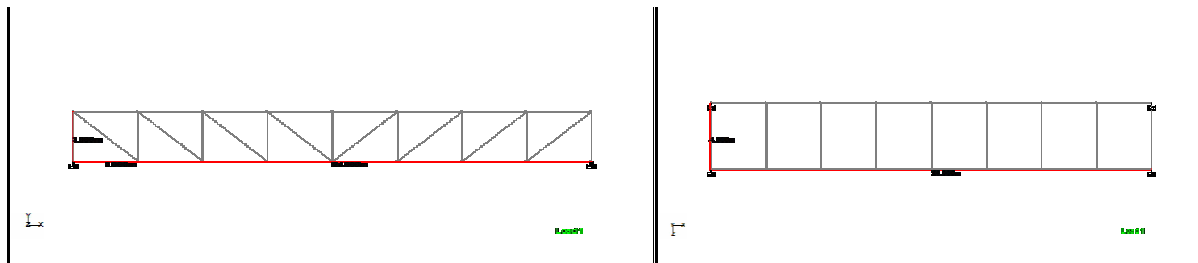
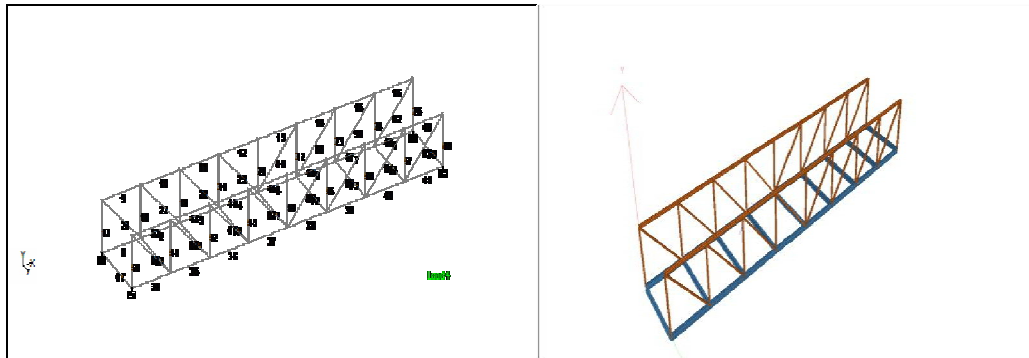


Fig.Elevation

Fig.Plan



IV. REMARKS

On the basis of observation of the forces, moments and displacement made from several tables in above sections, the comparative charts are prepared. The analysis over here is done for steel footbridge subjected to seismic forces located in zone no.IV (Indian seismograph). The effect of normal forces is considered in case-I, whereas, case-II and case-III are subjected to seismic forces. When the forces are acting on cross beam, it is very clear that the beams having the fixed support and not having forces residual in any of the case, in horizontal direction x and z. where as the magnitude of forces increase from the value 137.46kN to 155.79kN, due to consideration of seismic forces. In majority of cross beam that is beam no.67,75,69,73,70,72 and 71, the positive forces are acting in x-direction, whereas, when vertical direction is consider it can be seen that, for the cross beam located at the interval of 4m from the end beams, the magnitude of vertical forces increases, whereas at centre location of cross beams, vertical forces are less comparatively. When we consider moment in cross beam, it is observe that moment in M_x direction is negligible, whereas moment in M_y and M_z direction is comparative high. for the beam 68,74,69,73,70,72 in this static analysis value of moment is quite high, that is, 2299.42, 1783.953, respectively. For the same structure, when the analysis is done using response spectrum method, the magnitude of moment came negligible. When we consider the forces acting on bottom chords, it is observe that the magnitude of positive force are quite higher as compare to negative once, reflecting the zone of compression and tension. When the analysis is done for dead load and live load the magnitude of force is very less, however the magnitude increases specifically for static seismic analysis as visible in table no.6.23. When the observations are made for strut members, it is marked that the results of static and dynamic analysis varies by very small values as can be seen in table no.6.24. further it is observe that the resultant of axial forces are compressive in nature. When the observations are made for vertical members, it is seen that for any of vertical member from 17 to 25 as in table 6.25. the magnitude of forces obtain in case-II & case-III For f_x and f_z direction is same. Whereas the magnitude of forces in vertical direction in static analysis (case-II) gives greater value as compare to dynamic analysis (case-III). The stability of foot bridge is depends upon support reaction, which is marked in table no.6.26, from table it is clear that F_x and F_z that is horizontal direction magnitude of force is less as compare to F_y direction, along with that it is also observe that there is remarkable difference between the result obtain from case-II analysis as compare to case-III analysis. Moment in M_x and M_z direction is similar and for static analysis the value of moment is high. The observations for the nodal displacement as in table 6.27, reflects that for static analysis displacement value is higher as compare to dynamic analysis.

V. CONCLUSION

The work done in this paper is related to determination of effect of seismic forces on Foot Bridge. The foot bridge is modified and analysed subjected to dead load and live load. Further, the same bridge is examined for development of forces due to subjection of seismic forces. The bridge is located in zone IV and method of analysis, loading and loading combination are taken in accordance of IS-1893-2002 and IS-800-2007. the earthquake forces

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calculations, this earthquake forces is considered to be static analysed under static method. however. the behaviour of structure depends upon its ductility, location, geometry and fundamental time period. So over here the seismic analysis is done using both static and dynamic method so as to find out relative difference between the outputs of both seismic analysis methods. For many of the observations made in previous chapter, it is seen that the positive results of static analysis is quite high as compared to dynamic analysis.

This indicates that if the design is done by considering the static method, it will be safe but, will require more amount of material or higher grade. However, designing based on dynamic method will be stable as well as economical.

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