Dynamic and Vibration Analysis of Foot Over Bridge with Various Frequencies Due To Human Walking By Using Staadpro: A Review

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Abstract—
Bridges offer many opportunities for imagination and innovation. The design should be as attractive as possible. The building must be compatible with the environment. The proportions of different parts of the bridge should be proportional. Exterior cladding and painting should enhance the elegance of the bridge. The structure of pedestrian bridges has become bold, including experience and knowledge of the design and use of new products and technologies. This fact makes it highly competitive, thus changing the relative services and ultimate frontier of the state. The direct result of this design is a significant increase in vibration problems. In the special case of pedestrian bridges, this phenomenon occurs when the equipment frequency set is close to or several times higher than the load excitation frequency. This is the main motivation of this article to develop a design process that will better evaluate the comfort and safety of pedestrian bridges.

Keyword: Foot Over Bridge, Dynamic, Staadpro.

1. INTRODUCTION

Because the pedestrian bridge is over the road, people may cross it securely without causing vehicles to slow down. First, there will be pedestrianised structures; places close to colleges, universities, and busy intersections are good examples of these kinds of places. The pedestrian bridge's architectural idea is to provide infrastructure and transportation that can accommodate the requirements of the public without compromising the area's unique identity or economic significance. Safety of pedestrians was the primary reason for announcing the project, which calls for the quickest traffic and an excellent pedestrian bridge across the building. The nation's roadways will enable vehicles to move at a fast speed without interruption, conserving room and fuel while also averting hazard. Robust and long-lasting bridges are essential to the nation's economic growth. RCC bridges have a long lifespan, low initial cost, and require little maintenance, as owners and designers have long recognised. The type of bridge that is built depends on its intended use, the environment in which it is located and supported, the materials that are utilised, and the funding that is available. Larger vibration amplitudes can result from significant force due to the decrease of such structure. Larger structures require higher vibration event payments. Resonance, for instance, will happen if the frequency of the bridge and the excitation frequency match. Frequency of pedestrian footfall. On pedestrian bridges, pedestrian excitation is a significant cause of vibration. There is an uneven distribution of passengers, causing them to waver within a narrow range of excitation frequencies. Consequently, it is evident that dynamic response is crucial for vibration-sensitive model design. Vibrations on pedestrian bridges can impact pedestrian comfort and mood, which can lead to real-world issues. Rare are the accidents and even tragedies brought on by dynamics driven by humans.

2. STATE OF DEVELOPMENT

J. Kala et al (2009) Excessive pedestrian-induced dynamic loads may have an impact on pedestrian bridges because of their natural frequency and the significance of pedestrian-induced loads. Certain design models have cargo models that are easy for pedestrians to navigate and have a basic design. However, the designer is frequently the one responsible for load modelling a lot of models. This article's primary focus is on human forces applied to pedestrian bridges and load modelling techniques used in pedestrian bridge dynamic design. Additionally offered and contrasted are design and load models that were created using widely used models. Using the ANSYS programming system, a comprehensive structural model of the Kolin suspension bridge in the Czech Republic underwent dynamic study. An individual and a group of pedestrians' loads were modelled in an experiment, and the movement and speed that resulted were compared to the fitted model.

Iemke Roos et al (2009) The neighbourhood need more growth a few years ago. The advancements in architecture, building, materials, and teamwork are creating longer and thinner feet. These bridges are more likely to experience vibrations in the bridge deck due to forces from people. These vibrations can occasionally go very strong, especially when people are walking at a pace that is similar to the bridge's natural frequency. This might annoy or endanger pedestrians. As a result, this problem has grown in significance for the programme, which has always had limitations when it comes to pedestrian bridges. These figures served as the basis for an analysis of two current pedestrian bridges in Brisbane, Australia: the Goodwill Bridge and the Milton Road Bridge, using computer models. Since the real behaviour of these bridges under pedestrian loads is known, the analysis's result may be compared to it. The two bridges' modal analyses revealed that they were both susceptible to vibrations since their typical frequencies were between those of walking and leaping. Depending on the regulations, the response is given in terms of maximum acceleration or displacement. Crack reaction as seen in the load model. The UK National Annex's data yields the most accurate conclusion for the bridge's real behaviour. It is advisable to use caution while using these loading models and to make improvements to them. Analysis may result in output mistakes depending on the bridge model or time step chosen.

Stana Zivanoviý et al (2010) Modern civil engineering buildings that are exposed to dynamic stresses caused by walking by people, including long-span floors and pedestrian bridges, have gotten thinner and this has an impact on man-made structures as well. As a result, the management of these structures is now based on their vibration compliance. At the moment, consideration is given to the design procedure that is actually utilised for vibration serviceability assessments. This implies that certain factors, which are thought to be indicative of each traveller, are used to simulate walking force, such as walking frequency, stride length, and force strength. It is therefore disregarded how naturally occurring variations in these parameters brought about by various people differ from one another. Furthermore, parameters change with each step within a person's force history (intra-subject variability). This indicates that the walking force is not a deterministic force, but rather a narrow-band stochastic process. This defect means that existing design decision-making is unable to accurately forecast how a human walking on a thin, built-in structure would respond to vibration. The different walking forces must be considered in order to enhance the design process. This suggests that modelling support path experience would be a good fit for the probabilistic approach, which can account for the likelihood of the creation of different paths.

El-Sayed Mashaly et al (2013) In recent times, the building of pedestrian bridges has grown more competitive, leaving them open to attack by low-cost devices like pedestrian walkways. The influence of pedestrians crossing the bridge, where the critical frequency is near to the frequency of walking pedestrians, is what causes this phenomena. This article uses the response spectrum approach to analyse the vertical vibration response of a pedestrian bridge under dynamic stresses brought on by people walking. Two distinct loading techniques were used to apply dynamic walking loads to the bridge in a vertical manner: There is a live load along the bridge and a dead load in the middle of the span. The generic single-freedom technique was used for response spectrum analysis, and the predictions were verified by contrasting them with the outcomes of multi-degree-of-freedom modelling. The outcomes demonstrate that the response spectrum approach is capable of forecasting the pedestrian bridge's vibration response. The findings also indicate that the pedestrian bridge's size and damping ratio are the primary factors influencing the acceleration caused by pedestrian load in the vertical direction of the pedestrian bridge.

Jianing Hao et al (2015) The increase in cable force has an impact on the natural vibration of the suspension bridge, which happens when there is no load on it. The suspension bridge's vibration characteristics are quite intricate. The estimated critical frequency of the model is required during the selection and preliminary design stages of suspension bridges in order to explain how changes in bridge parameters affect the dynamic properties. For flutter analysis or spectrum analysis, which demands the use of more precise figures, precise computation of the nature and frequency of each activity is necessary at the final stage of design. The method for calculating the frequency of torsional and vertical vibrations of suspension bridges was presented in the "Code for Wind Resistance Design of Highway Bridges." The Humen suspension was given a unique design. Modal analysis yielded all vibration patterns and frequencies, which served as the foundation for further fluctuation pattern and spectrum analysis investigation. There is excellent agreement between the finite element model and the measured model. It is evident that the model's prediction property accurately captures the dynamic characteristics of the model. Using the approach, one may determine the significance of linkages early in the design process.

Heena Dewangan et al (2018) Over the past few years, long-span bridge construction has been a major global undertaking. Today's bridges often employ stronger materials. Their structures are therefore rather elongated. As a result, dynamic stresses like wind, earthquakes, and traffic might affect them. The length of the bridge makes it more flexible and vibration-prone. Vibrations may take many different forms. They can also impair user comfort and safety and reduce the functionality of bridges. Consequently, a great deal of study has been done to lessen the detrimental impacts of vibration and to comprehend the principles driving bridge vibration. As a building technique, vibration control entails enhancing the electrical machinery or controls within the structure to lessen vibration, improve occupant comfort, and keep storm- and earthquake-damaged structures from collapsing. The bridge's material vibrates a lot when the structure is hefty. We'll become tired from this stress on the bridge. This research uses STAAD Pro software to analyse the vibration analysis of steel truss bridges under live loads, examining the work of several writers. The Platte Bridge, Warren Bridge, Howe Bridge, and K-Bridge are the bridges under study.

Sabina Piras et. al. (2018) Bridges for pedestrians have evolved into artistic creations because of ingenuity and creative imagination. Longer and lighter pedestrian bridges, however, may cause human vibrations. This design explicitly addresses this issue by reducing natural frequencies and streamlining the specifications for a comfortable stroll across the bridge. Competition problems like stress tape or chain link can be excruciating, therefore it's important to carefully assess if Comfort can be achieved. This article offers recommendations for figuring out how bridges will deteriorate when there is foot activity. This article includes discusses factors that affect bridge vibration response and vibration mitigation techniques. In addition to outlining the design procedure, this article provides an analytical model of a concrete slab under high loads, which simulates the impact of foot traffic on the structure. It compares the vertical peak acceleration of pedestrian loads with the confirmed published value. Determine how many people are walking on the side of the unsafe bridge.

Mr. Kaushal Kumar et. al. (2019) The purpose of bridges is to span canals, rivers, and valleys to link highways and railroads. Trusses frequently transmit their qualities from one element to another because of their rigid construction. Truss bridge spare components, like their corners, are costly to produce and challenging to move from one location to another. Hollow profiles are, as everyone knows, business models with a big turning radius and higher compressive strength. I utilised hollow and leftover components as comparisons in this investigation. The innovative application of hollow profiles in bridge building at a cheap cost is groundbreaking. ANSYS Work Bench software was used for the two bridges' design and analysis. The goal of the overall project is to design, evaluate, and replace the truss bridge's angular section element with a hollow section, then compare the outcomes. After selling this body, I created an angled replica that was 1.2 metres long. I tested it further, then swapped it out for a cutaway and contrasted the outcomes.

José Guilherme Santos da Silva et. al. (2019) Tubular hollow profiles are becoming more and more common in exterior constructions, huge bridges, pedestrian bridges, long roofs, and other buildings due to their performance and advancements in production technology. Because of the structural parts' beauty and quality, Brazil's usage of tubular elements (as seen in Figure 1) has encouraged designers to concentrate on design problems and invention. There is currently no specialised coding for tubular constructions in Brazil nowadays. Because of this, designers have turned to alternative universal pipe design techniques. Because of this, the precision of their designs is crucial for both productivity and safety. Furthermore, new studies on tube joints suggest that more study is required, particularly for certain geometries. This holds even greater significance for specific failure scenarios where crash prediction proves to be incorrect or inefficient. Due to the pedestrian passage of concrete, steel and composite tube pedestrian bridges now behave differently. Such effects have the potential to start or exacerbate structural fissures. These flaws may shorten the lifespan of the pedestrian bridge and have a detrimental impact on the system's reaction and dependability, depending on their severity and extent.

Prakash Kumar et al (2019) This paper describes a technique for examining a girder pedestrian bridge's vibration response when a group of people is walking on it. We used ANSYS to model and analyse a basic concrete support. A portion of the natural frequencies of the bridge are within walking distance for humans. Pedestrian loads are represented as a Fourier series of the five primary harmonics and are only taken into account in the vertical direction. There is one group of pedestrians on the bridge at a time, as the same people walk on the centre line of the bridge simultaneously. This happens in three, five, and ten groups. Three groups of travellers related to each other are also involved in another scenario. The bridge's acceleration response demonstrates that the vibration of the bridge is unstable at the first resonance state. In terms of pedestrian comfort, the bridge did not live up to the design specifications. It is essential to modify the structure or implement vibration mitigation techniques in order to lessen vibration.

Arturas Kilikevicius et. al. (2019) It is possible to construct pedestrian bridges with very symmetrical construction nowadays by combining the expertise and experience of engineers. The thin construction directly contributes to the vibration issues. When the natural frequency surpasses the warning frequency on particular pedestrian bridges, an issue arises. Ensuring the safety and comfort of pedestrian bridge users during operation is vital and requires careful execution. The pedestrian bridge's finite element model was examined, with an emphasis on the critical deformation and acceleration values, based on the dynamic response mentioned above.

The model is based on Vilnius, Lithuania's pedestrian bridge model. In order to investigate the dynamic impacts brought about by pedestrians crossing the pedestrian bridge, two distinct loading techniques were created. The vibrations that occur during pedestrian bridge operation are within comfortable bounds, according to a comparison of experimental and finite element model (FEM) data.

V. R. Shinde,Prof. A. S. Patil,Prof. U. A. Mahadik (2021) The subject of this research, analysis, and design is a steel truss bridge that is 70 metres long, 7.5 metres broad, and 6 metres high. We conducted the research using STAAD PRO. Property comparisons include maximal axial force, shear force, torsion values, and moments. The entire analysis takes into account trusses like Howe, Pratt, and Warren. The bridge truss has a maximum displacement of 690.141 mm. The Howe truss bridge is five percent more expensive than the Pratt truss bridge.

Safwan Asghar Abbas et. al. (2020) A truss is a rigid construction made up of straight elements, such as beams. Tensile force and force are equivalent in a triangle. Its triangular shape serves as both a robust frame and a means of shifting weight. Numerous constructions, such as bridges, crane towers, and certain parking lots, depend on trusses. We can use fewer resources and still produce highly robust buildings by employing cages. Because they contain pin connections, whereas frames do not, trusses have a bending moment in comparison to frames. It is possible to apply the load directly to the frame members, in contrast to trusses, which only transfer the load to the connecting points. The goal of this project is to build a sturdy framework that can support 500 grammes of weight. The uniform weight distribution of truss bridge constructions guarantees that they can sustain the weight of the structure for an extended period of time. After generating three distinct designs, we selected the one with the lowest compressive and tensile stress.

Varsha Patil, et. al. (2022) The investigation of a structure's deterioration process is the main goal of failure analysis. For economical and safety reasons, it is crucial to identify structural problems as soon as possible. It is necessary to create several techniques to manage structural damage in order to guarantee the building's safety. According to this study, damage to truss bridges may be simply and successfully predicted by using the link between analysis findings and adjustments made with SAP 2000 FEA software. Using SAP 2000, the correctness of the modal analysis was verified numerically for the Louisville Bridge model's first five modes and frequencies. Important variables in the modal analysis are the six distinct tiny steel hollow pipe sections, each with a diameter of 10, 12, 14, 16, 18, and 20 mm and a plate thickness of 2 mm. On the bridge truss, three damage locations were located. We analysed both undamaged and damaged bridges using the natural frequencies and modal contributions of the first six modes. The findings demonstrate that, in the non-destructive situation, the natural frequencies and modal contributions of the first six modes remain unchanged as the bridge cage diameter grows, but the destructive modes do. Different natural frequencies and modal involvement are present in all three decays. Owing to the rise in natural frequencies and the damage scenario's modal contribution, the bridge truss's state will be observed before to collapse, and corrective action will be implemented.

S. Rajesh et. al. (2017) The design, construction, and upkeep of the built environment, including projects like roads, bridges, canals, dams, and buildings, are all within the purview of civil engineering. It is the most complete and ancient engineering profession. Civil engineering is the foundation of all engineering specialties. Environmental engineering, soil engineering, structural engineering, traffic engineering, materials engineering, surveying, and civil engineering are some of the disciplines that make up this field. Any size and stage of building can use any of the engineering techniques mentioned above for residential, commercial, industrial, and civil projects.

Gokul E. et. al. (2023) This research analyses and designs steel foundations for tube-section pedestrian bridges using STADD. Pro V8i programme. In India, steel truss pedestrian bridges are the most affordable and often utilised kind of bridges. In Indian cities, pedestrian bridges have gained a lot of popularity since they make it easier for people to cross the street safely and without interfering with traffic. As a result, using the tower section database that STADD has given, we will design and optimise the length balance of the tubular hollow section bridge. Pro V8i.

Syed Iftequar Hussaini et. al. (2023) This project's primary goal is to teach you how to measure and design trusses using STAAD Pro. Process efficiency is critical in today's dynamic and cutthroat corporate environment. Next, we attempted to measure and design the trusses using the STAAD pro programme. STAAD Pro analysis and load estimates round out the design. Models are influenced by their own weight in addition to dead load, live load, and acclimatisation using the load data file from STAAD Pro. In accordance with IS 875 specifications, STAAD Pro computes wind loads at various heights while accounting for air conditioning demand. By experimenting with various metals and forms, choosing various cross-sections, and employing Staad Pro software, we tried our hand at analysing metal samples. Determining the minimal design loads, which include applied loads, dead loads, and other external loads, is necessary for the building to comply with safety regulations. Its purpose is to maintain the integrity of the suggested model by adhering to stringent specifications. as said in this code.

Aishwarya Kulkarni et. al. (2016) The concept of employing materials to create a sturdy and long-lasting sky bridge. Over the past 30 years, a wide variety of materials have been launched, and more are now making their way onto the market as new uses. These materials may consist of glass, metal, or biological elements. In the last three years, a great deal of research on various materials has demonstrated that materials that are induced by plastic shrinkage, drying shrinkage, and temperature fluctuations between fresh and ripe may be added to feet to increase their physicality and durability. According to Broken Research, the product is quite effective when used. 10% more fibres results in a 10% increase in compressive strength; however, as fibre counts rise, compressive strength starts to fall. When compared to the concrete mixture, samples with varying characteristics exhibit much less creep and drying.

Ajit kumar Jha et. al. (2023) water, a tunnel, a bridge, etc. It is a building with a tunnel that crosses a location or an obstruction such Depending on the kind and material, different bridge types operate in different ways. One type of bridge that is frequently utilised to reduce delays and traffic congestion on highways is the pedestrian bridge. Likewise, vehicles and trains do not clash because to pedestrian bridges. Concrete, steel, and other composite materials are examples of composite materials that may be used to build bridges. These days, it has been found that steel piers are increasingly frequently utilised in bridge building because they offer economy, efficiency, safety, and speedy construction. This article's goal is to provide specifics on the several pedestrian bridge layouts and their operational models, along with the models that are now in use for crossing the bridge by bicycle or foot. We talk about these things and other things that have to do with crossing the bridge. This paper offers a thorough analysis of the body of research on pedestrian bridges, highlighting findings and contradictions in the study.

Aditya Gaikwad et. al. (2024) A pedestrian bridge's design, analysis, and optimisation are the main foci of this project. The construction of a pedestrian bridge capable of handling over 1500 automobiles or a significant accident scene is the goal here. Reducing collisions between motor vehicles and people is the primary goal. The typical traffic speed in regions where people, particularly students, often cross public spaces like schools, universities, and office buildings is at least 1,500 autos per hour. It's dangerous and difficult to drive on foot on these busy roadways. In light of this, the design places a stunning pedestrian bridge in front of a busy location at a significant crossing. The goal of the initiative is to increase safety by lowering the number of collisions between cars and pedestrians, as well as to facilitate traffic flow and minimise highway delays.

3. CONCLUSION & FURTHER STUDY

This article is solely concerned with a review of previously published studies.

- Because they make it easier for people to cross the street safely and without fear of speed bumps, pedestrian bridges have grown in popularity in Indian cities.
- Recently, there has been a greater need for expansion joints, which has resulted in the development of longer, thinner, and more sensitive pedestrian bridges for walking. Existing pedestrian bridges in Brisbane, Australia, which are prone to vibrations at natural frequencies with high foot traffic, were examined using computer modelling..
- Different models respond differently to loading patterns, and the UK National Annex model explains how the bridge behaves. Because of their superior qualities, tubular hollow profiles are being employed in bridges more and more; however, Brazil lacks design specifications, thus international codes are being used instead.
- The impacts of traffic are a factor for both steel and composite tubular pedestrian bridges; more study on tubular joint studies and failure models is required to meet service life and reliability criteria. Vibration from man-generated dynamic stresses has rendered modern civil engineering structures, such pedestrian bridges and long-span ground slabs, more sensitive and fragile.
- Most vibration serviceability testing design techniques used today are deterministic and disregard motion changes. Probabilistic techniques for forecasting vibration responses in parallel systems and simulating walking excitations.

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