A Review Paper on Study and Design of Footbridge to connect the first floor of Civil and Mechanical Engineering Departments of JCOET Yavatmal.

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Abstract- **A footbridge is specifically designed to facilitate safe passage for pedestrians. Unlike conventional bridges that connect two elevated points, a footbridge can also serve as a traversable pathway on lower structures like boardwalks. These structures are particularly useful in enabling pedestrians to cross areas with wet, fragile, or marshy land while maintaining accessibility and ensuring their safety. To address the requirement of connecting the first floors of Civil Department Building and Mechanical Department Building at Jagadambha College of Engineering and Technology, an initiative was undertaken to establish a passage that would provide convenient access during inclement weather conditions, while also enhancing the visual appeal of the campus. This paper delves into the concept of a footbridge, offering an understanding of its purpose and functionality. Furthermore, it investigates various types of footbridges and evaluates their suitability for integration within our college campus.**

Keywords- **Footbridge, Civil Department Building, Mechanical Department Building.**

1. INTRODUCTION

A footbridge which is also known as a pedestrian bridge acts as a dedicated bridge entirely designed for pedestrians. These structures not only serve a functional purpose but can also contribute to the visual harmony of an environment, acting as decorative elements that visually connect distinct areas or signify a transition. In developed countries, footbridges often exhibit both practicality and artistic beauty, resembling works of art or sculptures. However, in impoverished rural communities of developing nations, footbridges play a crucial role by providing the only means of accessing essential services like medical clinics, schools, and markets when rivers or lakes become impassable.

While the conventional definition of a bridge pertains to a structure connecting two points at an elevated height, a footbridge can also function as a lower structure, such as a boardwalk, enabling pedestrians to traverse wet, fragile, or marshy terrain. Bridges have evolved throughout history, ranging from basic stepping stones or fallen trees to intricate steel structures. Some footbridges exhibit both functionality and artistic beauty.

Fig 1.1- Footbridge

In the case of Jagadambha College of Engineering and Technology, Yavatmal, there arose a need to connect the two buildings of Civil and Mechanical Departments, providing passage during inclement weather conditions while also enhancing the campus aesthetics. The design aims to connect the first floors of these two buildings effectively.

2. Objectives

- To design a footbridge to connect the first floors of Civil Department Building and Mechanical Department Building for the purpose of convenient access during monsoon or otherwise.
- To study different types of footbridges
- To determine the type of footbridge which suits the Jagadambha College of Engineering and Technology's Campus the best.

3. Types of Footbridges

Footbridges offer a wide range of design options that can be tailored to meet specific needs while maintaining aesthetic appeal. Here are three commonly utilized bridge designs:

3.1 Truss Bridge: Truss bridges provide flexibility in design and can be constructed in various landscapes such as parks, nature trails, and community areas. They offer a long-span solution, ranging from 30 to 200 feet. Depending on the design requirements, truss bridges can also accommodate vehicles, if necessary.

Fig 3.1- Truss Bridge

3.2 Beam Bridge: Beam bridges, also known as girder or stringer bridges, are a cost-effective option for shorter spans. Typically, they are designed for spans under 30 feet. While primarily intended for pedestrian use, certain beam bridge designs can also support lightweight vehicles if required.

Fig 3.2- Beam Bridge

3.3 Suspension Bridge: Suspension bridges, often referred to as cable-stayed bridges, are suitable for larger areas with spans typically exceeding 200 feet. These bridges feature main cables or chains and have a distinctive free-hanging appearance. Suspension bridges are primarily designed for pedestrian use and can provide an iconic focal point in the landscape.

Fig 3.3- Suspension Bridge

These various bridge designs offer different advantages and can be customized to fit specific requirements, ensuring a functional and visually appealing footbridge solution.

Residential-scale footbridges are characterized by their relatively small span, making them suitable for various applications. These footbridges are designed to be practical and versatile, eliminating the need for complex engineering solutions. They are constructed using easily accessible materials and basic tools, ensuring simplicity and cost-effectiveness. Due to their straightforward design, these footbridges can be implemented without the requirement for specialized engineering expertise or advanced construction techniques. The emphasis is on utilizing readily available resources and simple construction methods to create functional pedestrian crossings that meet the specific needs.

4. CLASSIFICATION OF FOOTBRIDGES BASED ON MATERIALS USED

4.1 TIMBER FOOTBRIDGES:

Timber log footbridges are constructed using logs or large branches from locally available structural timbers. Hardwoods are preferred for their strength, durability, and resistance to termites. The simplest form of a timber log bridge involves using the logs as stringers, spanning the river or stream. The maximum spans depend on the available log sizes, typically ranging from 8 to 12 meters, but longer logs of 15 to 20 meters may be available in some locations. For longer spans, logs with a diameter of at least 40 to 45 centimeters over the middle one-third of the log's length, without bark and sapwood, are necessary.

For low-cost footbridges accommodating limited pedestrian traffic, timber poles of about 7 to 10 centimeters in diameter can be nailed across the log stringers to create a deck. However, for heavier traffic or diverse users, a proper deck made of sawn wooden planks is necessary. Handrails are required for spans over 3 to 4 meters to ensure safety, and kerbs are needed if carts or motor vehicles will use the bridge.

Intermediate pier supports can be used to increase the total span of log footbridges, with the log beams overlapping at the cross-beam supports.

Fig 4.1- Timber Footbridge

4.2 STEEL FOOTBRIDGES:

In terms of weight, the strength of steel and hardwoods is relatively similar. However, steel's strength per section size makes it a more compact and efficient choice for designs. Steel is well-suited for truss type bridges due to its strength and ease of member joining compared to timber. In developing countries, steel and steel cable bridges are likely to be the primary application of steel in footbridge construction.

With proper protection against corrosion, steel footbridges have a significantly longer lifespan compared to timber bridges. Simple hand methods of brushing or spraying can be effective for protection, while hot-dip galvanizing is an ideal method if available. Regular and effective maintenance can extend the life of steel bridges to at least 30 years.

Fig 4.2- Steel Footbridge

4.3 REINFORCED CONCRETE FOOTBRIDGES:
These bridges consist of a reinforced concrete slab supported by steel bars, spanning the crossing. The slab can be a plain solid rectangular section or a thinner slab reinforced with integral beams beneath it. The latter design requires less material but involves more complexity in preparation for pouring the concrete. For footbridges, the top surface of the concrete slab can serve as the walkway surface, eliminating the need for a separate deck. The maximum span for a reinforced concrete (RCC) bridge is around 12 meters, requiring piers for longer spans. In situations without large cranes, the slabs are cast in situ, necessitating the construction and support of wooden shuttering to hold the reinforcing steel and concrete during pouring. This process may be time-consuming and requires skilled carpenters, making it impractical where the riverbed does not allow the construction of timber scaffolding for shuttering support.

FIG 4.3- Reinforced Concrete Footbridge

5. LITERATURE REVIEW
5.1. Moore (1953): The author of this study has provided valuable insights into the acceptance and usability of footbridges among pedestrians, highlighting the importance of considering time-saving factors when determining the viability of footbridge projects.

5.2. Onanong Sangphong and Siradol Siridhara (2014): In this research, the authors have investigated the behavior of pedestrians in urban and suburban areas of Nakhon Ratchasima when utilizing footbridges and have collected data through observations of pedestrian road crossing behavior and conducted personal interviews using questionnaires. The authors have employed Logistic Regression Analysis to analyze the data and have suggested that footbridges be strategically located near bus stops.

5.3. R. Hasan and M. Napiah (2017): The authors of this paper discuss that despite advancements in enhancing the pedestrian environment, footbridges still fall short in their function of protecting and facilitating pedestrian transfer and that footbridges should prioritize accommodating all user types and focus on human needs over road and vehicle considerations. Factors influencing route choices have been investigated, and in this review paper, the authors have highlighted studies on footbridge utilization. Their findings indicate that perceiving footbridges as safe crossings increases usage, while lack of time is often cited as a reason for not using footbridges. They have proposed barriers as a solution to enhance footbridge usage. Additionally, they also discuss the environmental and economic benefits of constructing footbridges.

5.4. Arturo Gonzalez, Michael Schorr, Benjamin Valdez and Alejandro Mungaray (2020): The authors of this paper have provided a concise review of ancient and modern bridges, covering design, material selection, construction, and maintenance processes.

5.5. J. Bujňáka, R. Hlinkaa, J. Odrobiňáka and J. Vičana (2012): In this paper, the authors have emphasized the significance of managing, maintaining, and reconstructing footbridge structures through representative case studies. They particularly highlight the importance of regular inspections in timely identifying imperfections that may compromise safety and load-carrying capacity. They have further illustrated the impact of effective investigations on common structural systems, demonstrating the need for proactive measures to ensure the structural integrity and safety of footbridges.

5.6. Akhil Sharma, Ashwani Kumar, Sunil Sharma, Arun Singh Chib and Rakesh Abrol (2020): In this paper, the authors have discussed the need that arose at MIET College, Jammu, where two blocks required connection to access passages during adverse weather conditions and enhance the campus aesthetics. This project involves a detailed design of the footbridge, utilizing both manual and software-based approaches. The project has aimed to create a functional and visually appealing footbridge to link the two corridors of the college blocks effectively.

5.7 Dushyant A. Zamre, and Aditi H. Deshmukh (2015): The authors of this paper discuss the challenges that footbridges face related to vibration serviceability and put emphasize on understanding the characteristics of the vibration source, path, and receiver as crucial to address this problem.

5.8. Hamed Saber, Farhad S Samani and Francesco Pellicano (2022): In this research paper, the authors have focused on studying the effectiveness of vibration absorbers in mitigating the vertical deflections experienced by footbridges due to human activities. The authors have simulated the vertical component of pedestrian forces generated during walking, running, and jumping using a time-dependent force model. They then determined the optimal parameters for the attached vibration absorbers to minimize the footbridge deflection. They have further examined the performance of each vibration absorber under various types of excitations. The results have demonstrated significant reductions in vibration amplitudes for the footbridge when equipped with optimized tuned mass dampers. Compared to a bare footbridge, the optimized tuned mass damper achieves reductions of 91%, 95%, and 96% in vibration amplitude for walking, running, and jumping, respectively.

4.9. Marija Spasojević Šurdilović, Srđan Živković, Dragana Turnić and Marko Milošević (2022): The authors of this paper have presented the principles of modeling human-induced loads and characteristic pedestrian load models described in proposals and codes. Additionally, the paper has included some results from a Serviceability Limit State analysis, specifically focusing on human-induced vibrations, for a pedestrian bridge over the Nišava River in Niš.

4.10. M Kalpana and B.V Mohan Rao (2018): The authors of this paper have presented the analysis and design of an RCC pedestrian bridge using STAAD Pro, adhering to the prescribed Indian codes and standard design specifications. They have considered different loads, combinations, and lateral forces for a comprehensive frame analysis, while the structural design has followed the Limit State Method to ensure safety and stability.

CONCLUSION:

After studying these reviews, we concluded that beam footbridge made using reinforced concrete is suitable to connect the first floors of Civil and Mechanical Buildings of Jagadambha College of Engineering and Technology, Yavatmal Campus. This is because RCC bridges offer a long lifespan of at least 50 years and have low maintenance costs, making their total life cost lower compared to other bridge types that may require replacement multiple times during the RCC bridge's life. Moreover, the span for our construction is less than 10 meters making RCC footbridge the suitable choice. The completion of this project will be beneficial to faculty members, staff and students alike for convenient access from Civil Building to Mechanical Building especially during any event organized in the seminar hall in the Mechanical Building which is located on the building's first floor. During such events, the faculty members or students who are already on the first floor of the Civil Building won't have to climb down to the ground floor and then enter the Mechanical building. They can simply walk from the first floor of the Civil Building to the first floor of the Mechanical Building where the seminar hall is located using the proposed footbridge.
Moreover, the footbridge will save the inconvenience of walking on the campus ground to enter the Mechanical Building during monsoon when the ground will be marshy.

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