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Review on Integral Abutment Bridge and RC PSC Bridge

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A B S T R A C T

This review report discusses about the design methods and the criteria and the performances of integral abutment bridge and reinforced concrete prestressed bridge. Each bridge has its own aspect of applications, pros, and cons. The various aspects of these two bridges are studied and compared and reviewed in this paper.

Keywords: Integral abutment bridge, RC PSC Bridge, Comparison.

1. Introduction

Bridges are essential structures that connect people, communities, and resources. They play a critical role in transportation and commerce, enabling people to travel over water bodies, valleys, and other types of obstacles. However, despite their importance, bridges are also prone to failures and accidents, which can have severe consequences for people and the environment. Understanding the causes and risks of bridge failures is crucial for ensuring the safety and sustainability of these structures. Bridge failures can occur due to various reasons, including design errors, material degradation, environmental factors, and human errors. Some of the common causes of bridge failures include inadequate maintenance, corrosion of metal components, improper design and construction, and natural disasters such as floods and earthquakes. One of the most notable examples of bridge failures is the collapse of the Silver Bridge in West Virginia in 1967. The bridge, which was carrying heavy traffic over the Ohio River, collapsed suddenly, killing 46 people. The investigation revealed that the failure was caused by the fracture of a single eye bar, which had weakened due to corrosion and stress. The tragedy highlighted the importance of regular inspections and maintenance of bridges, as well as the need for improved design and construction standards. In recent years, advances in technology and engineering have enabled the development of more sophisticated methods for monitoring and detecting potential bridge failures. For instance, structural health monitoring systems can detect changes in the structural behaviour of bridges and alert authorities of potential risks. Additionally, advanced materials such as fibre-reinforced polymers and carbon fibre composites are being used to construct bridges that are more durable and resistant to corrosion. Despite these advances, bridge failures remain a significant challenge for engineers and authorities. The increasing demand for transportation and infrastructure, coupled with limited resources and funding, has put a strain on the maintenance and safety of bridges worldwide. Therefore, it is crucial to continue investing in research and development to improve the design and construction standards of bridges and ensure their safety and sustainability.

2. Methods of constructions

1. Cast-in-Place Construction: This involves pouring concrete into forms that are set up on site. This method is commonly used for building concrete bridges.
2. Pre-Cast Construction: Pre-cast construction involves manufacturing the bridge components off-site and then transporting them to the bridge location for assembly. This method is often used for building bridges made of steel or concrete.
3. Steel Erection: This method involves assembling the bridge on site using steel components. It is often used for building steel bridges.
4. Balanced Cantilever Construction: This involves building the bridge in sections, with each section extending out from the previous one until the two sections meet in the middle. This method is often used for building concrete bridges.
5. Cable-Stayed Construction: This involves building towers to support the bridge deck and then attaching cables to the towers to hold up the deck. The cables are then anchored to the ground on either side of the bridge. This method is often used for building cable-stayed bridges.

3. Previous literature works

Maryam Naji et.al., (2020) The purpose of this study is to recognize the most effective parameters of analysis IABs. Bridges are one of the most critical parts of transportation networks that may suffer damages against earthquakes. Also, seismic responses of most bridges are significantly influenced by soil-structure interaction effects. Findings show that the backfill material behind the IABs has a significant effect on the performance of IABs. Using a compressible material behind the abutments would enhance the in-service performance of IABs. Finally, behaviour of abutment may be greatly affected by thermal load and soil pressure. Thermal expansion coefficient significantly.

Anoosh Shamsabadi1 et.al., (2007) This paper employs limit-equilibrium methods using mobilized logarithmic-spiral failure surfaces coupled with a modified hyperbolic soil stress–strain behaviour _LSH model_ to estimate abutment nonlinear force-displacement capacity as a function of wall displacement and soil backfill properties. The authors provide suggested parameters to develop the nonlinear force displacement curve for compacted abutment backfills when no geotechnical data is available. The LSH and HFD models are practical and versatile tools that can be used by structural and geotechnical engineers for seismic bridge design.

Mohamed Zaid et.al., (2019) This paper focuses on the local scouring at bridge piers, as it considered a complex issue. Various studies are conducted to identify the factors that affect the local scour formation. Therefore, some researchers have designed useful countermeasures to help reduce the scour depth. From the research, it is certain that; the bridge piers inclination angle contributes to effects on the scour hole, generation around a specified single cylinder pier. Thus, the increased flow intensity and pier size contributes to an increased scour depth, a scour volume surface area and a hole.

Sotirios A. Argyroudis, et.al., (2021) This paper is a primer on the vulnerability of flood-critical bridges as it models the entire water-soil-bridge system, taking into account critical hydraulic stressors (scour, debris accumulation, hydraulic forces), the uncertainty in scour hole formation, and all components of integral and isolated bridges: deck, bearings, piers and abutments, backfill, and the foundation soil. The significance and practicality of this research is that it enables reliable risk assessments for network owners and operators to quantify the performance and expected losses from single or multiple hazards on bridges.

Luigia Brandimarte et.al., (2012) This paper offers a broad review of the main aspects to be considered when analysing bridge pier scour, to better understand the dynamics triggering pier scour, an analysis of the type of scour occurring at bridge piers, the most influencing factors, failure mechanisms and local pier scour dynamics is carried out. One of the main difficulties faced in the real-world practice is scour data collection; this session reviews the latest techniques available for the measurements of the scour depth at bridge piers. These advances provide tools for supporting engineers in the design phase of adequate bridge foundations.

Marco Bonopera et.al., (2020) The paper is principally focused on a static non-destructive method, and a comparison with dynamic ones is elaborated. Comments and recommendations are made at proper places, while concluding remarks including future studies and field developments are mentioned at the end of the paper. It concluded that to make the NDT method applicable in situ, further studies should focus on the measurement of vertical deflections induced by bending tests with vehicle loading along PC bridge girders, in which their constraint stiffness should be evaluated with unknown boundary conditions.

4. Comparison

Integral abutment bridges and RC PSC bridges are two distinct types of bridges with different structural designs and construction methods. Here's a comparison between the two types:

a) Structural Design: Integral abutment bridges have a continuous superstructure that is directly connected to the abutments, which eliminates the need for expansion joints. In contrast, RC PSC bridges use precast concrete beams that are held together with high-strength steel cables that are prestressed, or put under tension, to withstand the weight of the bridge and the loads it carries.

b) Span Length: RC PSC bridges can span longer distances than integral abutment bridges. This is because the precast concrete beams used in RC PSC bridges can be made in longer lengths and can be easily transported to the site, while integral abutment bridges typically have shorter span lengths.

c) Construction Method: Integral abutment bridges are more cost-effective and require less maintenance than RC PSC bridges. They are constructed using cast-in-place concrete, which eliminates the need for costly precast elements and reduces construction time. RC PSC bridges require more expensive precast elements and specialized equipment for installation, which makes them more expensive and time-consuming to construct.

d) Durability: Both types of bridges are durable and can withstand environmental factors such as temperature changes and heavy loads. However, integral abutment bridges may be more susceptible to settlement and movement due to their continuous superstructure, while RC PSC bridges have better resistance to earthquakes and other natural disasters.

e) Maintenance: Integral abutment bridges require less maintenance than RC PSC bridges. This is because integral abutment bridges do not have any expansion joints, which are typically the most vulnerable parts of traditional bridges. RC PSC bridges require periodic inspections and maintenance to ensure the cables and concrete beams remain in good conditionrete.

5. Conclusion

In conclusion, Integral abutment bridges and RC PSC bridges are two distinct types of bridges that each offer their own set of benefits and drawbacks. While integral abutment bridges provide a cost-effective solution and require less maintenance, RC PSC bridges offer higher strength and durability and can span longer distances. The choice between these two types of bridges depends on various factors, such as the span length, environmental conditions, and project budget. It is important to carefully evaluate these factors before making a decision about which type of bridge to construct. Consulting with experienced engineers and bridge experts can help in making an informed decision. Regardless of the type of bridge chosen, it is critical to ensure that it is designed, constructed, and maintained to meet all safety and performance requirements. Overall, both integral abutment bridges and RC PSC bridges have their unique strengths and limitations, and the best choice depends on the specific requirements of each project. By considering these factors, project owners can make a well-informed decision about which type of bridge will best meet their needs.

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