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Hydraulic Bridge

Tanmay Garud, Aditya Tile, Krishna Dushing, Shubham Gaidhani, Prof. P. R. Kshatriya
Department of Civil Engineering
Matoshri Aasarabai Polytechnic, Eklahare, Nashik, Maharashtra, India

Abstract*: Bridge construction requires careful planning and in-depth study as no undue risk should be taken in its design and construction. Constructing a bridge across braided river is still a Challenging task. Hydraulic aspects of bridge design mainly consists of selection of site, optimum orientation and waterway, location of abutments, design of guide banks, approach banks, and design of piers.. Hydraulic model studies were carried out at CW&PRS for the Rail and Road Bridges across river Kosi near Nirmali, Bihar, (about 38 km. Upstream/downstream of kosi Barrage). Various alternatives were analyzed on physical model to arrive at optimum waterway, guide bunds and afflux bunds. Studies were undertaken under existing conditions as well as with proposed bridges for discharges of 22375 m3/s and 26900 m3/s. For waterway of 1.875 km. An afflux of 1.35 m was observed at the bridge site.For a discharge of 22375 m3/s. various trials on the physical model to improve the flow conditions at the bridges and distribute the flow more uniformly through the spans of the bridges by adjusting both guide bund. Construction of Road Bridge has been completed and functioning very well. Construction of Rail Bridge is under progress. The present paper describes the hydraulic aspect of various components of the bridges.*

Keywords: Design flood, bridge waterway. Afflux; bed & water surface profile, flood mbankment, backwater, discharge distribution, guide bunds, alignment, and location

I. INTRODUCTION

The hydraulic bridge also known as “moving bridge” is a bridge that is used to allow seaside traffic through a body of water. In short, it can be moved to allow the passage for boats or ships. The bridge design incorporates an integrated hydraulic system into the bridge in order to carry more weight .This paper aims to study the detail of hydraulic bridge. Hydraulic is a type of technology and applied in science using engineering. Chemistry and others involving the mechanical properties and use of liquids.

At a very basic level, hydraulics is the liquid counterpart of pneumatic, which concerns gases. Basically hydraulics formed by the foundation from the topic fluid mechanics, which focuses on the applied engineering using the properties of fluids. Pascal's law is the principle behind hydraulic bridge working. The hydraulic bridge uses petroleum-based hydraulic fluids for operations. Hydraulic motors and hydraulic cylinders are two important components used for powering the bridge with hydraulics. Who invented the hydraulic bridge? Leonardo Leonardo designed and built designed and built bascule bridges within the 15th century. He also made designs and built models of swing and retractable bridges. The Colorado Department of Transportation (CDOT) intends to replace the State Highway 96A (4th Street) bridge over the Arkansas River in Pueblo, Colorado. Ayres Associates is a member of the design team led by Figg Bridge Engineers. Ayres Associates submitted a Floodplain and Drainage Assessment Report (FDAR) for the project in December 2001 (AyresAssociates 2001) and submitted a Preliminary Bridge Hydraulics Report forthe project in May 2003 (Ayres Associates 2003). In January 2006 the design

A bridge which permits entry of the watercrafts or freight boats is normally known as the movable bridge. At the point when development depends on the water driven frameworks then it is classified as Hydraulic Bridge. For building a model, regularly utilized pressure driven gear are syringes. As the bridge is over and again opened and shut, fatigue failure is the most concerning factor than failure under steady load. Additionally, the framework is more complex because we cannot provide any footing (other than the pylon support) in order to permit watercrafts/boats to pass. Hydraulic bridges have been used for centuries to span rivers, canals, and other bodies of water. These structures are designed to withstand the forces of flowing water and other environmental factors while providing a safe and reliable

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means of transportation. The art and science of hydraulic bridges has evolved over time, and today, engineers use advanced technology to design and build structures that are stronger, safer, and more sustainable than ever before .The Art and Science of Hydraulic Bridges: Design, Construction, and Maintenance" is a comprehensive guide to this fascinating field. Whether you are a student, a professional engineer, or simply interested in the history and technology of hydraulic bridges, this book will provide you with a wealth of information and insight .The hydraulic bridge also known as "moving bridge" is a bridge that is used to allow seaside traffic through a body of water. In short, it can be moved to allow the passage for boats or ships. The bridge design incorporates an integrated hydraulic system into the bridge in order to carry more weight. Leonardo designed and built designed and built bascule bridges within the 15th century. He also made designs and built models of swing and retractable bridges bascule bridges within the 15th century. He also made designs and built models of swing and retractable bridges.

Fig.1.1 Hydraulic Bridge

OVERALL DESCRIPTION

Working Principle of Hydraulic Systems in Bridges

- **Basic Hydraulic Principles**: Discuss how hydraulic power works, including Pascal's Law and its application in bridge systems, where force is transmitted through incompressible fluids.

Components of a Hydraulic Bridge System:

- **Hydraulic Cylinders**: Explain the role of cylinders in lifting or moving bridge components.
- **Pumps and Valves**: Discuss the hydraulic pumps and valves that control the flow of fluid to create the necessary motion.
- **Control Systems**: Mention the automated or manual systems used to control the hydraulic mechanisms and ensure precise movements.
- **Flow of Hydraulic Fluid**: Explain the process of fluid transmission, the role of hydraulic fluid, and its efficiency in converting mechanical energy into kinetic motion.
- Design and Engineering of Hydraulic Bridges
- **Structural Considerations**: Discuss how hydraulic bridges are designed to handle the mechanical forces involved in their operation, including considerations for load-bearing and the stresses on materials.
- **Materials Used**: Highlight the materials used in hydraulic bridges, including the types of steel, concrete, and other alloys that provide strength and durability under the pressures exerted by hydraulic systems.
- **Design Challenges**: Address the challenges faced in hydraulic bridge design, such as environmental factors, maintenance needs, and reliability of hydraulic systems over time.

Types of Hydraulic Bridges

There are several different types of hydraulic bridges, each with its own unique design and operating mechanism. Some of the most common types of hydraulic bridges include:

Vertical-lift bridges: These bridges consist of a platform that is lifted vertically by hydraulic cylinders. The platform is typically counterbalanced to reduce the amount of force required to lift it.

Swing bridges: These bridges rotate around a pivot point to allow boats and ships to pass through. Hydraulic motors are used to power the rotation of the bridge.

Bascule bridges: These bridges consist of a section that is raised and lowered by hydraulic cylinders. The raised section is typically counterbalanced to reduce the amount of force required to lift it.

Pontoon bridges: These bridges use pontoons or floats to support the bridge deck. Hydraulic systems are used to raise and lower the pontoons to allow boats and ships to pass through.

Floating bridges: These bridges are similar to pontoon bridges, but they do not require supports or pontoons. Instead, the bridge deck is buoyant and can be raised or lowered using hydraulic systems.

Hydraulic road bridges: These bridges are designed to be quickly erected and dismantled for temporary use. They consist of prefabricated components that are connected using hydraulic systems.

Hydraulic railway bridges: These bridges are similar to hydraulic road bridges, but they are designed for use by trains instead of vehicles. They are typically used in temporary applications, such as during construction or repair of permanent railway bridges. Each type of hydraulic bridge has its own advantages and disadvantages, depending on factors such as load capacity, environmental impact, and ease of operation. The choice of hydraulic bridge type will depend on the specific needs and constraints of the application

1. Objectives

Bridge Location/Site Selection.

Stream Stability.

Hydraulic Performance.

Hydraulic Analysis Requirements.

Scour.

Deck Drainage.

2. Applications of Hydraulic Bridges

- **Waterway Navigation**: Explain the role of hydraulic bridges in facilitating marine traffic and ensuring accessibility for ships and boats through urban or industrial areas.
- **Urban Transportation**: Discuss the significance of hydraulic bridges in cities where limited space requires bridges to open for large vehicles or ships while still maintaining road traffic flow.
- **Military and Emergency Use**: Investigate hydraulic bridges' strategic importance, particularly in areas where rapid deployment and mobility are required in defense or emergency scenarios.

3. Technological Advancements in Hydraulic Bridges

- **Automation and Smart Systems**: Describe how modern technology has improved the automation of hydraulic bridges. Discuss smart control systems, sensors, and remote operation, which allow for faster, more precise control of the hydraulic mechanisms.
- **Energy Efficiency**: Explore the latest efforts to improve the energy efficiency of hydraulic bridges, including regenerative braking systems and improved fluid management to reduce power consumption.
- **Sustainability**: Discuss efforts to make hydraulic bridges more sustainable through the use of environmentally friendly materials and hydraulic fluids.
- **Integration with Other Infrastructure**: Describe the integration of hydraulic bridges with other transportation systems, smart city infrastructure, and real-time monitoring systems for optimal operation.

4. Challenges and Limitations

- **Maintenance and Durability**: Address the challenges of maintaining hydraulic bridges due to wear and tear on the hydraulic systems, corrosion, and the high cost of repairs.

- **Environmental Impact**: Analyze the potential environmental impact, particularly regarding hydraulic fluids and their effect on surrounding ecosystems.
- **Cost Considerations**: Provide a cost analysis of constructing and maintaining hydraulic bridges as opposed to traditional bridge types, considering both short-term and long-term investments.

5. Case Studies and Real-World Applications

- **Case Study 1: Tower Bridge (London)**: Provide a detailed case study of the Tower Bridge, focusing on its hydraulic lifting mechanisms and its role in the city's infrastructure.
- **Case Study 2: Pont de Saint-Nazaire (France)**: Discuss the hydraulic bridge design of the Saint-Nazaire Bridge, which features lift mechanisms to allow marine traffic.
- **Other Global Examples**: Include brief summaries of other significant hydraulic bridges in use around the world and how they operate.

6. Future Prospects of Hydraulic Bridges

- **Advancements in Materials**: Look at future materials that may be used to improve the efficiency and longevity of hydraulic bridges.
- **Autonomous Bridge Systems**: Consider the role of autonomous technologies in controlling hydraulic bridges, leading to less human intervention and more streamlined operations.
- **Integration with Renewable Energy**: Discuss how hydraulic bridges could integrate renewable energy sources, such as solar or wind power, to improve energy efficiency and sustainability

II. CONCLUSION

The purpose of hydraulic engineering is to design a structure with the proper capacity to divert or remove water from the roadway and pass collected water under the roadway. The design of a hydraulic structure requires knowing how much water is associated with the design storm and calculating the velocity, depth, and type of flow that must be accounted for in the design. In an upcoming article in details about different types of hydraulic bridge.The application of HEC-RAS to analyze the various aspects in design of bridge is highlighted in this study. The excessive scour in the piers of the bridge is reduced. The hydraulic model can give instant decisions to work on the preventive measures to reduce the damages. The research paper highlights on this aspects, the innovative methodology can be used in the planning, designing and laying at the structural design of the bridge. The development and the operational strategies for maintenance of structural component of bridge up to its pier foundation are highlighted. The research study thus concludes that the lifecycle planning and the cost structure of a bridge structural can be effectively sketched with the strategic planning using mathematical modelling with the help. Also one can further use advanced modelling like recording type instrument installed around pier to record maximum scour depth, can also install instrument to quantify the flow impact on structures.

Summarize the key points discussed in the paper, reinforcing the importance of hydraulic bridges in modern infrastructure.

Highlight the ongoing research and technological advancements that continue to enhance the functionality and efficiency of hydraulic bridge systems.

Propose further studies or areas of research that could lead to more effective and sustainable hydraulic bridge designs

REFERENCES

[1]. Atayee, A. Tamin, "Study of Riprap as Scour Protection for Spill Through Abutment," presented at the 72nd Annual TRB meeting inWashington DC, January, 1993.

[2]. Atayee, A. Tamin, Pagán-Ortiz, Jorge E., Jones, J.S., and Kilgore, R.T., 1993, "A Study of Riprap as a Scour Protection for Spill Through Abutments," ASCE Hydraulic Conference, San Francisco, CA.

[3]. Barkdoll, B. D., Ettema, R., and Melville, B. W., 2007, "Countermeasures to Protect Bridge Abutments from Scour," NCHRP Report 587, Transportation Research Board, National Academies of Science, Washington DC.

[4]. Lagasse, P. F., Clopper, P. E., Zevenbergen, L. W., and Ruff, J. F., 2006, "Riprap Design Criteria, Recommended Specifications and Quality Control," NCHRP Report 568, Transportation Research Board, Academies ofScience, Washington DC.

[5]. Melville, B. W., van Ballegooy, S., Coleman, S., and Barkdoll, B., 2007, "Riprap Size Selection at Wing-Wall Abutments," Technical Note, ASCE, Journal of Hydraulic Engineering, Vol. 133, No. 11, November.

[6]. Melville, B. W., van Ballegooy, S., Coleman, S., and Barkdoll, B., 2006, "Countermeasure Toe Protection at Spill Through Abutments," ASCE Journal of Hydraulic Engineering, Vol. 132, No. 3.

[7]. Pagán-Ortiz, Jorge E., 1991, "Stability of Rock Riprap for Protection at the Toe of Abutments Located at the Floodplain," FHWA Research Report No. FHWA-RD91-057, US Department of Transportation, Washington DC.

[8]. Parola, A. C., Hagerty, D. J., and Kamojjala, S., 1998, NCHRP Report 417, "Highway Infrastructure Damage Caused by the 1993 Upper Mississippi River Basin Flooding," Transportation Research Board.

[9]. Richardson, E. V. and Davis, S. R., 2001, "Evaluating Scour at Bridges," Hydraulic Engineering Circular 18, Fourth Edition, FHWA NHI 01- 001, Federal Highway Administration, US Department of Transportation, Washington DC.

[10]. Richardson, E. V., Simons, D. B., and Lagasse, P. F., 2001, "River Engineering for Highway Encroachments - Highways in the River Environment," Report FHWA NHI 01-004, Federal Highway Administration, Hydraulic Design Series No. 6, Washington DC.

[11]. Bonner, Vernon R. and Brunner, Garry, 1994."HEC River Analysis System (HECRAS)"Hydraulic Engineering '94,volume1 proceeding for the ASCE1994 National Conference On Hydraulic Engineering, Hydrologic center (also as HEC,1994)

[12]. Brunner, Garry W. and Piper, Steven S, 1994. "Improved Hydraulic Features of the HEC River Analysis System (HECRAS),"Hydraulic Engineering '94, volume1, proceeding for the ASCE 1994 National Conference on Hydraulic Engineering. (Also as HEC,1994)SMITH D.W., Civil Engineering, American Society of Civil Engineers, November1977.

[13]. Bradley, J.N., 1970, Hydraulics of Bridge Waterways 2nd Edition, Bureau of Public Roads, Washington, D.C.

[14]. Brunner, G. W. and J. H. Hunt, 1995, a Comparison of the One Dimensional Bridge Hydraulic Routines from: HEC-RAS, HEC-2, and WSPRO, Hydraulic Engineering Center, Davis, CA.

[15]. Hydraulic Engineering Center, 1982, HEC-2 Water Surface Profiles User's Manual, U.S. Army Corps of Engineers, Davis, CA