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"STUDY OF SWING BRIDGE BY HYDRAULIC SYSTEM"

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ABSTRACT

This study focuses on the basic concepts and the steps involved in the design and analysis of a swing bridge. Various types of movable bridges are used worldwide in bridge construction; however, the swing bridge is considered a better alternative in terms of safety and economy. Nowadays, waterway transportation has become popular and useful for reducing travel distances. Generally, waterway transportation is associated either with ships crossing a river or with a bridge carrying vehicular traffic over it. This study considers the possibility of achieving both ship navigation and vehicular movement at the same location and at the same time. The main objective of this study is to provide information about swing bridges and to encourage their use in bridge construction.

Keywords: Swing bridge, types, center bearing, rim bearing, design, calculation, loads, rotation, construction.

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I. INTRODUCTION

A rotating bridge by hydraulic system is an advanced mechanism that utilizes hydraulic power to achieve controlled rotation of the bridge deck. The hydraulic system, comprising cylinders, pumps, valves, and fluid reservoirs, converts the hydraulic pressure into mechanical motion, enabling smooth and powerful operation even under heavy loads.

II. AIM

To investigate the design, operation, and efficiency of a hydraulically actuated rotating bridge, analyzing its mechanical, hydraulic, and structural performance, and to evaluate the feasibility, advantages, and challenges of hydraulic systems for safe and reliable bridge rotation under variable load conditions.

III. OBJECTIVE

- Swing Bridge better alternative from the point of view of safety and economy.
- To support mixed traffic condition.

- To reduce construction cost.

IV.LITERATURE REVIEW

1.Introduction

Rotating (swing) bridges have a long engineering lineage dating back to the 18th and 19th centuries, when early movable bridges were developed to reconcile rising river traffic with land transport needs.

D. Healy (march 2015): The next development in swing bridge design was apparent on the Hay Bridge completed in 1873. The design consisted of lattice girder span supporting timber decking and the bridge was operated by hand. The drum was a composite of cast and wrought iron that was finally founded on a center pier. It was noted by Mr. G. S. Mullen, past Resident Engineer, that the Hay Bridge was operating satisfactorily with the frequency of openings being over times per annum in the 1880s (Main Roads, 1973).

M. Tilley found that: In 1885 a different type of Swing Bridge was constructed on the Fig Tree Bridge over the Lane Cove River the swing span was a bob-tailed design which consisted of a shortened rear span. This type of bridge is usually adopted due to limited land availability. In order to balance the resultant differential in span masses a counterweight is mounted on the shorter span.

V. DESIGN AND CALCULATION OF ROADWAY–RAILWAY SWING BRIDGE

1. Basic Design Data (Assumed)

Particular	**Value**
Total swing span	60 m
Length on each side of pivot	30 m
Width of roadway	7.5 m
Railway track	Broad Gauge
Type of operation	Hydraulic
Concrete grade	M30
Steel grade	Fe 500
Wind pressure	1.5 kN/m²
Water current force	5 kN/m

2. Loads Considered in Design

(a) Dead Load (DL)

Assume:

Deck slab thickness = 0.25 m
Total width = 10 m
Volume per meter = 10 x 0.25 = 2.5 m^3
DL_{deck} = 2.5 x 25 = 62.5 kN/m

Additional loads:
Girders = 30 kN/m
Rails, sleepers, ballast = 15 kN/m
Wearing coat = 10 kN/m
DL = 117.5 kN/m

(b) Live Load (LL)

Railway live load = 80 kN/m (IRS loading)
Roadway live load = 30 kN/m (IRC Class AA)
LL = 110 kN/m

(c) Impact Load (Railway)

$$I = \frac{4.5}{6 + L} = \frac{4.5}{6 + 60} = 0.068$$

Impact load = 0.068 x 80 = 5.44 kN/m

(d) Total Load per Meter

w = DL + LL + I
w = 117.5 + 110 + 5.44 = 232.94 kN/m

5. Structural Analysis of Swing Span

(a) Maximum Bending Moment

$$BM = \frac{wL^2}{8} = \frac{232.94 \times 60^2}{8} = 104823 \text{ kN.m}$$

(b) Maximum Shear Force

$$SF = \frac{wL}{2} \quad \frac{232.94 \times 60}{2} = 6{,}988 \text{ kN}$$

6. Balance Condition of Swing Bridge

For smooth hydraulic rotation:

$\sum W_L \times d_L = \sum W_R \times d_R$
Since span is symmetrical:
232.94 x 30 = 232.94 x 30

Bridge is perfectly balanced

7. Design of Central Pivot Pier

Total Vertical Load on Pivot:
= 232.94 x 60 = 13,976 kN
Assume pivot bearing area = 12 m^2

$$\text{Bearing pressure} = \frac{13{,}976}{12} = 1{,}164.7 \text{ kN/m}^2$$

Safe against allowable soil pressure

8. Hydraulic System Design

(a) Purpose of Hydraulic System

To rotate the swing span smoothly
To control acceleration and braking
To ensure safe opening and closing

(b) Hydraulic Torque Requirement

Assume:
Frictional resistance = 3% of total load
F = 0.03 x 13,976 = 419.3 kN
Radius of rotation = 30 m
T = F x r = 419.3 x 30
T = 12,579 kN.m

(c) Hydraulic Motor Power
Assume:
Angular speed = 0.01 rad/s
Power = T x ω
P = 12,579 x 0.01
P = 125.8 kW

(d) Hydraulic Components Used
Hydraulic pump
Oil reservoir
Hydraulic motor
Control valves
Emergency hand pump

10. Turning Mechanism
Electric motor designed for:
Dead load
Wind load
Frictional resistance
Locking system provided after closing

11. Safety Features
Railway & road signal interlocking
End locks before train movement
Emergency manual rotation
Braking arrangement

VI. TYPES OF MOVABLE BRIDGES

- Bascule Bridge
- Swing Bridge
- Vertical lifting Bridge

Bascule Bridge: Bascule bridge, which is also called as drawbridge, is fixed and supported on an axis which is perpendicular to the bridge longitudinal centerline axis. The horizontal line on which the bridge is pivoted is commonly located at the center of gravity of the bridge to create a balance between the weight of the bridge on either side of the horizontal pivotal axis.

Swing Bridge: Swing Bridge is fixed on horizontal plane that turns around vertical axis to provide ways for vessels and ships to travel through the bridge. The horizontal plane is on a bearing Installed on a pier which is termed as pivotal pier. When the swing bridge is closed, the end of the span should be supported by resting piers or abutments if the total length of the bridge span is not very long.

Vertical Lifting Bridge: It is one of the most widely constructed and used type of movable bridge. It is composed of a span commonly truss type span which is supported by towers at the end of the span or at each corner of the span. Counterweight is usually used to balance the weight of the span.

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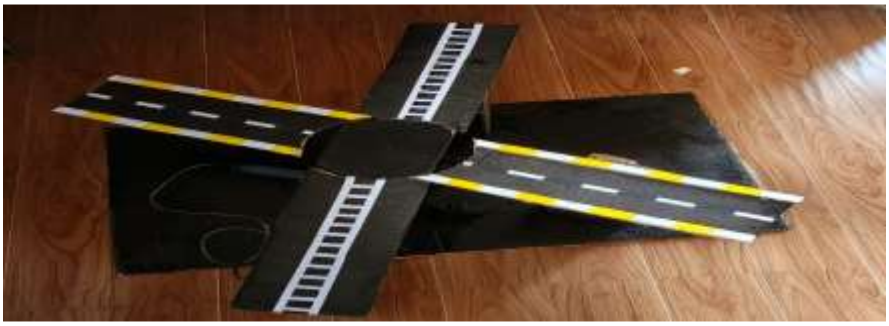
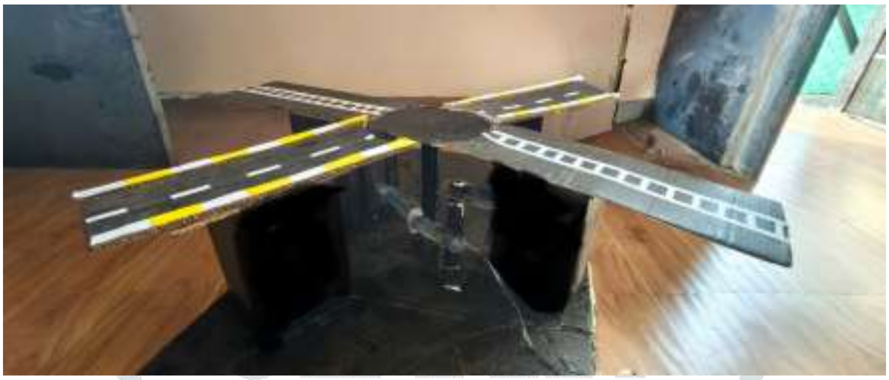
IMAGES OF WORKING MODEL





CONCLUSION

A swing bridge used for both railway and roadway traffic is a highly efficient and practical structure. It provides safe passage for trains and vehicles while also allowing ships and boats to pass by swinging the bridge span horizontally. This controlled operation improves overall traffic safety by properly managing both land and water traffic.
From an economic point of view, such a swing bridge is more cost-effective than constructing separate bridges or high-level fixed bridges for rail and road traffic. It reduces construction cost by avoiding tall piers, long approach ramps, and heavy foundations.

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