Rail-Cum-Road Swing Bridge

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Abstract— **In 19th century movable span technology considered as modern era and that was ruled initially by swing span bridge. After the early 1819s by bascule (A French word meaning Balance) bridge.As considering the requirement of bridges for roadway and railway in low traffic density areas, rail-cum-road swing bridge technique will be most beneficial and economical as compare to conventional techniques .This technique satisfies the requirement of three way transportation that are railway, roadway and also waterway. In developing countries like India and other country, this technique can be taken in account.**

Keywords: Rail-cum-Road Swing Bridge, Bascule

I. INTRODUCTION

Rail-cum-Road Swing Bridge is defined as, "The Bridge in which rails are embedded in a concrete slab road pavement which is rested on deck of the bridge and this deck can rotate about its vertical axis with suitable mechanism".

In foreign countries like France, Germany the waterway is mostly used by the people for daily transportation, for them it is very useful technique. Also highly populated country like India having the largest rail network throughout the world, and due to the rapid development, the roadways are also used heavily by the people in low traffic density area. So there is a need of two separate bridges for convenience but by providing this technique we can save the money as well as increase the aesthetical appearance of the area.

In this type of bridges single deck is provided rather than two different decks for two different transportation ways which may be beneficial in congested areas where less land is available and also where land cost is very high for constructing two different bridges. It will be economical in the way of construction and maintenance cost.

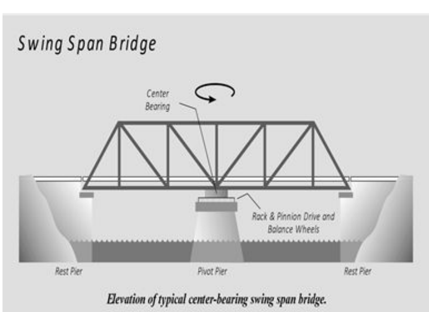

Fig.1.Elevation of Swing Span Bridge

In this bridge only one pier is provided at the center of the deck on which deck can be rotate about its vertical axis.

The bridge we are constructing has a single deck for the two transportation purposes, that is the concrete slab works as pavement for the roadway, and the rails which are provided in that concrete slab useful for the railway transportation. If bridge is over the water body which is used for the waterway transportation and the bridge is obstructing that way, in that case by rotating the bridge up to 90 degree we can clear the path for passing ship or cruse.

At the time of flood the water level increases up to considerable height, due to that the old bridges are determined as the obstruction for the ships which have greater height. The area where water level is higher or nearer to the ground surface or the areas where density of river and canal is very high, at that area waterway is the most suitable and efficient way of transportation. So, there will be common problem of height of ships and this problem can be minimized by this technique.

II. METHODOLOGY

When the Rail cum Road Bridge is in its original position then it works as a roadway bridge and at the time of railway transportation it is necessary to swing the bridge at a certain angle to connect railway tracks. So, as above explanation the main challenge is to swing the bridge at certain angle and that problem of swing the bridge can be solve by two major mechanisms to swing the bridge, one is Rack and pinion method, and second one is hydraulic system.

i) Rack and pinion method

In Rack and pinion method, the linear motion of rack is converted into circular motion of pinion, which helps to swing the bridge. The whole assembly of rack and pinion system is placed on the pier, which is at the center of the bridge. It's the most suitable system of power transfer. As there is no any difficulties so this system is very economical. The mechanism is very simple, so the maintenance cost of this system is very low. But the power requirement for this system is more, which is not suitable as point of economical view.

ii) Hydraulic System

The second method is a hydraulic system. By using the hydraulic power the bridge can be swing. The Swing Bridge has two identical hydraulic systems, one in each pivot pie. The two systems can operate independently or simultaneously .The operator has independent control of each system. Each hydraulic system consists of lift and slew actuators, fluid Transmission lines, savior and a power pack which contains pumps and control valves.

The hydraulic system is used by various accumulator, which are as follows: Hydraulic Accumulator TowersRaised weightAir-filled accumulatorCompressed gas (or gas-charged) closed accumulatorSpring type Metal bellows type

III. FUNCTIONS OF ACCUMULATOR:

I. In the case of piston-type pumps accumulator to absorbpulsations of energy from the multi-piston pump. II. Accumulator helps protect the system from fluid hammer. III. Accumulator protects system components, particularly pipework, from both potentially destructive forces.IV. The additional energy that can be stored while the pump is subject to low demand so, the designer can use a smaller capacity pump.

V. Accumulator can maintain the pressure in a system for periods when there are slight leaks without the pump being cycled on and off constantly. VI. Accumulator helps to maintain change in pressure due to the temperature changes.

ANALYSIS WORK

For the design of this bridge we can use the simple welded plate girder of 20M span and 5M width. On which the concrete slab is provided whose thickness is 300mm. In that concrete slab as per Indian standard the rails are laid.

For the design of deck we can consider the loads are as follows:

Dead Load

Live Load

Impact load

Self-weight of girder

We design only the deck for the first phase and in next phase we design the pier and foundation. The design is done on trial and error basis, for the design we use the IRC (Indian Road Congress), IS 456:2000, IS 800:2007.

Example:

Loads:

Dead load:

Weight of Rail with fastening:

Total U.D.L = 1.21KN/m

Weight of concrete slab on girder:

Thickness of concrete slab = 300mm

W = 5×0.3×25

= 37.5 KN/m

Total Dead load = a + b

= 38.71 KN/m

Live Load:

Considering as per IRC 70R classification or roads

Total U.D.L. = 153.17 KN/m

Impact Load:-

Impact factor =(20/40+L)

= 0.588

Impact load = 0.588×153.17

= 90.06KN/m

Total Load = 38.71+153.17+90.06

= 281.94KN/M

Self-weight of girder = Factored load/200

$= 422.91\times10^3/200$

= 2.11 KN/m

Total U.DL. = 422.91 + 2.11

= 425 KN/m

Maximum Bending Moment:

By moment distribution method:

Table.I.Distribution Factor

Joint	Member	Relative stiffness	Total R. S.	Distribution factor
B	BA	$\frac{3}{4}\times\frac{I}{10}=\frac{32}{40}$	$\frac{3I}{20}$	0.5
B	BC	$\frac{3}{4}\times\frac{I}{10}=\frac{32}{40}$	$\frac{3I}{20}$	0.5

First End Moment:

Mab = -3541.67KN.m

Mba = 3541.67KN.m

-Mbc = Mcb = 35401.67 KN.m

Reactions:

Bending Moment @ B = 0

Vc = 1593.75 KN

Vb = 5312.5 KN

Reaction at A = 1593.75 KN

Reaction at B = 5312.5 KN

Reaction at C = 1593.75KN

Maximum bending moment = 5312.5KN.M

Maximum shear force = 2656.25KN

Dimensions of plate girder:

Depth of web plate = 1500mm

Thickness of web plate = 16mm

Width of flange = 500mm

Thickness of flange = 32mm

Overall depth of girder = 1500+ (2×32)

= 1564mm

Checks:

For moment capacity of girder –

Md= Ze.fy/γm0 [IS 800:2007, cl. No. 8.2.1.2, Pg. no. 53]

Md = 5425.83 KN.m> 5312.5

Shear Capacity of web –

Vd = Av.fyw/ γm0 .√3 [IS 800:2007, cl .no. 8.4, Pg. no. 59]

Vd = 3149.18 KN > 2656.25

Serviceability – 93.75< 200

Shear buckling of web –

$\tau cr = kv.\pi^2E/12(1-\mu^2).(d/tw)^2$ [IS 800:2007 ,cl. no. 8.4.2.2 ,Pg. no.59 & 60]

Check for end bearing:

τcr= 156.3
Vn = 3020.69 KN>2656.25KN

Fw = 654.54 KN < 2656KN

Design of end bearing stiffeners:
Provide 200mm wide and 24mm thick end bearing stiffeners on either side of web.

Design of weld between web and flange:
Provide 10mm intermittent Weldon both side of web plate with weld length 60mm with a gap 160mm.

MACHINERIES IN SWING BRIDGE

It's important in Swing Bridge to select proper machines to swinging the bridge. Some of the swing bridge machineries may operate fast such as rim bearing. When standing on moving span or under it one the pier, its need to avoid the crush between a moving and stationary pivot of the bridge.
The swing bridge are divided into three classes according to machinery on center pier of the bridge. They are as follows,
Center bearing
Rim bearing
Combination of both

I. Center bearing:
This type of bearing required less power for working. It has smaller number of parts and is also less expensive to construct and maintain. Most important advantage of this type of bearing is that, it is not affected by irregular settlements of pier. They are mostly adopted for single span and single track bridges.
II. Rim bearing:
On the other hand the rim-bearing type gives a greaterturning surface and balancing the bridge better while turning. It gives a better distribution of loads, and hence a less wear of turningparts. Rim bearing required additional power in turning as comparedwith the center-bearing type. They are mostly adapted to long single-track, and all double,or four-track bridges.
III. Combination of both:
By combining the two types of the machines it is possible to overcome the limitations of each of them.
Combination of these two machines can improve the working of bridge.
The opening of a swing bridge involves four operations as follows,
Turning or opening the bridge.
When brought backthe ends must be "set up" or raised.
The bridge must belocked.
The rails must be aligned with those on the fixed track.
The bridge is "set up" and locked by hydraulic power, while the rotation of the bridge is carried out by electric power. It is largely used, especially in America and is said to be simpler and to assure more certainty of operation.

PIER

In case of Swing Bridge selection of type of pier and design of pier is important. Machines which are used to swing the bridge are rest on the pier so it is important to carry the load of deck and machineries used for swinging by the pier. Types of pier, size of the pier and the dimensions of the pier depend on the dead of deck and machine also on area available and type of site where bridge is constructing.
In swing bridge, solid circular type of piers are used and its design similar to the ordinary types of piers used for bridges but only difference is that, in swing or any movable type of bridge, self-weight of machine's is taken.

VI. CONCLUSION

From this review paper conclude that, the rail cum road Swing Bridge is more convenient for two different ways of transportation like railway and roadway. Construction of two different bridges required large area as compared to rail-cum-road Swing Bridge. The analysis and design required less time as compared time required for design and analysis of two bridges. This bridge also swing in particular angle hence it can be also convenient for waterways transportation. It also improve aesthetical importance of country.

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