A Study of Design & Analysis of a Swing Bridge

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Abstract

With the construction evolution and consequent roads and railways progressive development, emerged the need for the population to make crossings, not only to overcome geographical obstacles, but also to reduce the necessary travel time. However , one of the major problems until today has been the crossing of navigable waters. As one of the key means of global transport, seariver navigation could not be less important than the construction of bridges, which would affect its course. It was then ne cessary to find a solution that would enable navigation of rivers and at the same time their crossing. Since building bridges with adequate clearance for the passage of ships required a more elaborate work in terms of very high inclination, movable bridges became the most viable solution to this dilemma, despite all the challenges on their design.

Nevertheless, movable bridges have not always had this purpose. In the Middle Age, these were used for protection against enemy's armies.

The design of movable bridges, h ave primary explored over the last century the typical three types of movable bridges, bascule; swing; and vertical lift. Regardless of this, innovative solutions are increasingly taking form.

I. INTRODUCTION

Swing bridges are those who can provide a navigation channel by rotating about a vertical axis by a horizontal plane, normally 90 degrees. This movement is possible by pivoting on a central pier through bearings connecting the deck and this pier, making it a pivot point. The movable span of a swing bridge - also called draw – is designated of bobtailed or unequal-armed when the arms are not of equal length and designated of symmetrical or equal-armed when the arms are of equal length (with the pivot point in the middle of the draw). These, comparatively with other type of movable bridges, like bascule and vertical lift, are not lifted, so the lift mechanism is not equilibrated by gravity, being required a device to stop the span at the right position, i.e in the direction of the channel traffic.

The principle characteristic noticed on these bridges is the necessity of having a big area to store the moving span when in open position. In the case of a two arms swing bridge, this has be sited in the middle of the navigation channel, thus reducing the length for navigation and turning the maintenance task more inaccessible and difficult.

II. WHY SWING BRIDGE?

1. It is time consuming. It is useful to control traffic.
2. Transportation of vehicle is done easily and reduce collisions.
3. Bridge can extend a network by acting as a repeater.
4. Economical for all spans, i.e. 10 – 300m.
5. Less installed power needed than other types (less wind load);
6. No limit on air draught when in open position.
7. Superstructure and substructure (apart from foundation piles) can be kept above the River water level which facilitates construction.

III. DISADVANTAGE OF SWING BRIDGE

Along with advantages there always come some disadvantages. There are some disadvantages of Swing bridge :

1. It requires considerable maintenance because of large number of moving element.
2. It need longer time to operate compare to other type of moving bridges because it has large number of main mechanical functions undergo during opening and closing.
3. Swing Bridge need more machinery to open and close to waterway compare to bascule and vertical lifting bridge.
4. Tool or devices used to detach swing railroad bridges is considerably expensive and fragile.
5. Collision protection is needed along the full length of the superstructure - a serious disadvantage in this location where ship impact loads are potentially very large.

IV. TYPES OF SWING BRIDGE

Swing bridges are categorized according to their type of bearing - centre bearing, rim bearing, combined-bearing, slewing-bearing and pontoon-supported swing bridges. The most common types and described here are the first two.

1 CENTRE BEARING SWING BRIDGE:

- In this type, span of the bridge is totally dependent on central pivoting pier
- To prevent the bridge span from failure under unbalanced loads i.e. wind load, balance wheels are provided which rolls on a large-diameter circular track concentric with the pivot bearing.
- The design is based on the fact that the centre bearing supports all of the dead load when the span is in its open position.
- The live load is usually supported by centre and end lift devices which are actuated when the span is returned to the closed position.
- Rotation of the span is provided with the help of machines which are operated manually.

2. RIM BEARING SWING BRIDGE:

- In rim bearing swing bridges, a minimum of two longitudinal spanning members are required to support the super structure.
- Tapered rollers are also provided because the distance travelled by the outer end is longer than that travelled by the inner end of the roller, for the provided angle of bridge rotation.

- In case of rim bearing mechanism when the bridge is fixed or in its closed position, it supports both dead load and live load. Rim bearings are quite handful for wide and heavily-loaded swing bridges
- Load is transferred by the drum girder to a tapered tread plate which is supported by tapered rollers. Rotation of the span is achieved in the same manner as it was for the centre-bearing swing bridge

V. CONSTRUCTIVE MATERIALS.

In the past, the most common materials used for structural elements in movable bridges were wrought iron and steel. In the past few years some innovative movable bridges have been developed with aluminum and FRP (fiber-reinforced polymers).

The main aspects that the materials are required to have are:

1. Hardness
2. Fracture
3. Tensile properties
4. Residual stresses
5. Corrosion
6. Hydrogen embrittlement

VI. MACHINERY USED.

It will be considered here the most common types of machinery used according to the three main types of swinging bridges.

1. CENTRE SUPPORTS:

Centre supports purpose is to provide live load support when the bridge is in closed position and restrict the rotation of the bridge when subjected to traffic and wind loads. These supports are disengaged when the bridge needs to swing to an open position.

2. END SUPPORTS:

As well as centre supports, the end supports provides for live load support and restrict the bridge to rotate when in closed position. However, these have also a very important purpose, which is to prevent an uplift of the end le aves (described in sectio n). There are various arrangements for this type of supports but one of the most common.

3. BALANCE WHEELS:

When the end and center supports are disengaged to allow the swing span to rotate, it is needed some kind of support that helps to stabilize the span and prevent tilting from loads, like the wind. The design of this balance wheels consists in a minimum of eight wheel assemblies that roll on a large diameter (close to the width of the bridge) circular track, sitting on the center pier.

4. CENTERING AND LOCKING DEVICES:

In swing bridges these two devices can work separate or together as one device. These have the same purpose as described for bascule bridges, which is align and lock the leaves in their final position. They can be used as a horizontal bar mounted in the swing span or as a vertical bar with a roller that can slide up to secure the leaf. Also, it is possible on swing bridges wit h end wedges to take advantage of this and use this devices for centering and locking the bridge.

5. BUMPERS:

As for the bascule bridges, these type of devices serves the purpose of stopping or slow down the bridge. In this case, it is only used for swing bridges that do not rotate 360°. These bumpers are typically rigid devices to prevent any excessive displacement when the leaf stop .

6. TRAFFIC CONTROL:

All these equipment's described below have to follow specific and detailed requirements. These requirements classify the type of equipment and arrangements depending the type of bridge. However the project owners can requirements'.

VII. MAINTENANCE:

The maintenance and inspection is impose additional always a key part for a long and safe life of any structure and so in the design this is a fundamental criteria. Nonetheless movable bridges have some particular maintenance issues referring to the interaction of the structural and the electrical and mechanical components, which poses a more significant risk of mal every swing function of the movable bridge. Having this into consideration, bridge is designed differently and it has unique features, so each one should have its own Operation and Maintenance Manual. Normally when inspected, swinging bridges have some common problems:

- Worn machinery;
- Broken machinery supports;
- Lack of lubrication;
- Misalignments of the locks and bearings;
- Problems with the power of the motors;
- Balance of the span.

VIII. STUDY OF DESIGN & ANALYSIS OF SWING BRIDGE:

1. DESIGN

Whenever it comes to design any structure general dimension such as basic length and width are firstly calculated or assumed. In case of Swing Bridge the dimension the bridge are calculated on the basis of existing bridge on the same river.

2. TYPE OF STRUCTURE

For the designing purpose the most common type of swing bridges may be divided into three classes :

a. Two span continuous

b. Three span continuous

c. Three span partially continuous

Chosen structure depends upon the length of the track to be designed.

3. GENERAL DIMENSION

The width of the bridge is fixed by the width of the track and side clearance is also considered in addition in width. It usually varies from seven to eight feet from the centre of track to the nearest inner part of the truss. The depth of the floor system is taken between twenty-eight to swing bridges. The height of the bridge is calculated with the help of required clearance.

IX. ANALYSIS.

1. Load calculation

Load (self weight) can be calculated using the following formula: w = 6 L + 350

Where L = length of span in feet, w = weight of bridge per linear foot of span in pounds. (1 pounds = 4.448 Newton).

2. Calculation of stresses

Following stresses are calculated

1. Dead load bridge swinging,
2. Dead load bridge continuous,
3. Full line Load Bridge continuous,
4. Each arm as simple span for line
5. Line load on one arm, approaching on other.

3 DESIGN OF SECTION:

From the maximum and minimum stresses the section of the member are calculated. Following sections are designed according to their required numbers:

1. Diagonal.
2. Upper chord section.
3. Lower chord section.
4. Section of post.
5. Transverse and lateral bracings.

4 DEFLECTIONS:

Section should be checked for following given deflections:

1. Dead load deflection
2. Camber deflection
3. Deflection due to temperature
4. Inelastic deflection
5. Combined deflection
6. Amount of lift.

5 OPERATING MACHINERY:

The operating machinery of a swing bridge involves four operations. First, turning or opening the bridge. Second, when brought back the ends must be "set up" or raised. Third, the bridge must be locked. Fourth, the rails must be aligned with those on the fixed track. The bridge is" set up" and locked by hydraulic power, whilst the rotation of the bridge is carried out by electric power. This combined system has been selected in preference to using electric power exclusively, since it is largely used, especially in America, and is said to be simpler and to assure more certainty of operation.

X. CONCLUSION

At last it is concluded that Swing Bridge is the best alternative for the short span rivers and canals and also suitable for large spans if carefully designed. It is more preferable than that of Bascule Bridge. Accidents and many failures caused in these types of bridges are because of the improper operation and functioning and also improper designing. If during the time of construction and designing proper designing is done also if material chosen for the bridge serves all properties there is no chance of failure for a long duration.

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