Design of Skew Culvert Analysis: A review

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***Abstract**: The importance of bridge construction is rising every day. There are several types of bridges being used, such as box culverts, skew culverts, suspension bridges, and RCC bridges. The main focus of this study is the skew culvert bridge. Using a range of methods and tools, this study analyses multiple research on skew culverts and draws the conclusion that different skew angles behave differently with regard to of moments and stresses. In the conclusions, certain guidelines for quick analysis of skew slab bridges were recommended based on this analysis. The results of this analysis are useful for design engineers working on skew slab bridge analysis..*

***Keywords**: Skew angle, moment, stresses and culvert etc.*

I. INTRODUCTION

A bridge is a structure that preserves links between moving vehicles, such as cars and trains, without obstructing the station, road, river, or valley. When a structure carries traffic or a pipeline over a station or neighborhood, it is referred to as a bridge. When it does so over a road or railway line, it is referred to as an over bridge. Skew bridges are not a new invention; they have been constructed on rare occasions since the Roman era, but before the development of the railway, they were poorly understood and hardly ever used. The nature of skew bridges differs widely from that of normal bridges and therefore, the design of skew bridges needs special attention. In normal bridges, the deck slab is perpendicular to the supports and as such the load placed on the deck slab is transferred to the supports which are placed normal to the slab

II. SKEW CULVERT

Skew slabs have a wide range of applications today due to a variety of factors, including space constraints in urban areas, the need for roads to ascend or occasionally pass through irregular terrain, locations with other types of geographic restrictions, such as mountains, the need for roads to cross obstructions like rivers, and occasionally religious beliefs, such as when mosques, temples, or churches block the path of roads. Skewed slabs are slabs with non-orthogonal sides and opposing angles that are equal but not exactly 90 degrees. These slabs don't transfer the load to their supports at a 90-degree angle.

Figure 1 skew culvert

III. LITERATURE REVIEW

There are several different pieces on display on the skew culvert. The summary is as follows:

Wen (1956) In order to locate a culvert in the most cost-effective manner, economic, hydraulic, and topographical considerations must be taken into account. The analysis of a culvert that has been placed at a reduced skew confirms Californian practise, which recommends that small skews be eliminated, moderate skews be kept, and large skews be reduced.

James A. (1995) was out that large moments and shears close to the acute corner are the issue with skew slab bridges. The non-linear calculation of slab bridges was performed using the software NARCOS, and a comparisons for the two methods of skewed slab bridges showed that, while the total amount was the same, the skew slab bridge constructed using linear finite element analysis, where even more reinforcement is situated near the obtuse edge than near the acute edge, has a higher crack propagation load. There is more reinforcing towards the obtuse end of a skewed slab bridge than towards the acute edge. In comparison to a similar bridge designed with regular reinforcement, a skewed slab bridge with some more reinforcement near the obtuse side than near the acute side has a higher maximum strength.

Islam (1996) examined the operation of reinforced concrete skew slabs intended for axle loading and self-loads. A two-thirds aspect ratio slab with a 30 degree skew was used for the experimental inquiry. Right breadth was 24 feet, and the right span was 16 feet. The testing used four skew slabs. Two of the test slabs had major reinforcement applied orthogonally to the support, whereas the other two had it parallel to the free edge. For each of the four slabs, distribution reinforcement primarily refers to the supports. His main areas of interest included fracture patterns, concrete strain at pre-selected locations on the concrete surface, and vertical deformations along centered lines parallel to the supports and free edges under self- and service loads.

Karetal (2012) The loads in the slab are found to differ considerably from those in a straight slab as the skew angle increases. As a result, the slab is prone to warping since the planes of greatest stress are not parallel to the roadway's centerline. The rise in value above the average value ranges from 0 to 50% for skew angles of 20 to 50°. The responses at the obtuse angled side of the slab support are greater than other end. For skew angles larger than 50 degrees, the response is negative. When the skew angle approaches roughly 60°, the response on the acute angle side becomes zero tension while the reaction on the obtuse angle corner doubles the average reaction. With a rise in skew angle, reaction grew. It went up by around 80.

Zoghi (2008) In most cases, precast-concrete skewed bridges with integrated abutment walls are built as simpler plane rigid portal frames, ignoring the haunches between both the abutment walls and the deck, the deteriorating effects of the skew angle, and laterally non - symmetric vertical stress. For specific aspect ratios, this technique results in bridges that are under designed. It is well knowledge that cracking and local degradation are caused by greater shear and Torsional forces close to obtuse edges. An theoretical and experimental investigation for the live load reaction at the linear service level was conducted to determine the constraints of this approach. Positive and negative moment stresses have been shown to be greater for some bridge designs than those predicted using plane study. The qualitative findings were provided.

Dai (2011) This article provides an overview of two bridge studies: (1) testing and numerical modelling of a recently built skewed hybrid high-performance steel (HPS) bridge, and (2) testing of a culvert bridge close to a rock blasting operation. The first study is for structural verification, and the next is for identifying any potential explosion damage. After construction on the first HPS 100W girder bridge in North Carolina was complete, vehicle load testing were performed in the first study. To measure bridge displacements under truck loading, a LiDAR scan technology was deployed. The bridge's finite element (FE) model was constructed in 3D in great detail. Static load testing and the results of numerical analysis were compared. In the second investigation, a culvert's 3D LiDAR was scanned both before and after rock blasting. Possibility of a bridge Damages and alterations were looked at.

E. Abdel (2014) The study of a typical multi-story building on a raft foundation with and without structural soil interaction is presented in the article. Moreover, evaluate the consequences of the most severe base shear, bending moment, and deformation. The results demonstrate the enormous role that the dynamic SSI plays in the seismic behaviour of mid-rise building outlines, including significant growth in deflection and storey drift as well as altering the behaviour of the structures. As a result, it is crucial to take SSI impacts into account while determining the seismic format of a mid-ascent second opposed structure outline, especially when the structure is situated on a sensitive soil foundation. If SSI isn't consistently taken into consideration in evaluation and planning, then earthquake-related security assessments won't be as accurate as they should be.

Virendrasinh (2018) STADD PRO and/or SAP should be used for modelling and analysis of the skew bridge deck and box. For the manual single cell analysis, all load combinations as instructed in IRC-6 were taken into consideration. The issue is caused by the two-lane road's 7.5-meter width and 20-meter span. Each barrel measures 5 m by 5 m. It will be analysed for different load combinations, taking into account dead load, live load, earth pressure, and water pressures. A critical design will then be developed. Culvert is built for 0 degree skewness for single, two, three, and four barrels for analysis. Additional comparison research is done for several skew angles, including 10, 20, 30, 40, 50, and 60 degrees. Additionally, the stated problem statement was the subject of a parametric analysis by comparing bending moments while taking into account various skew angles. Another study was conducted for various base slab support conditions.

Nasir (2019) Skewed slab bridges, flyovers, and culverts are becoming increasingly common in new infrastructure, particularly in urban areas with space constraints, locations where roads cross obstacles like rivers, terrain variations, and for aesthetic reasons. In these situations, skew slabs are built rather than traditional straight slabs. Because of how it behaves under stresses differently from standard slabs, it requires extensive design, analysis, and construction. There is a wealth of research that highlights load-deflection behaviour, the effect of skew angle, span, reinforcement distribution, and the use of various finite element methods to calculate stress parameters. This study offers a concise summary of the existing literature.

Haido (2020) The generated ANN was utilised to forecast the behaviour of the culvert using the skew angle of the culvert, the span of its top slab, the thickness of the slab, and the concrete compressive strength. To determine the failure load and maximum deflection of the top slab of the skew culvert, straightforward equations were established based on the findings of this network. When taking into account the combined effect of simplicity and accuracy in the output prediction, the presented models proved to be more effective than the laborious analytical or numerical solutions that were previously used. Additionally, the results of the study of single-cell concrete culverts using finite elements are compared to those of earlier experimental work to establish the validity of the constitutive relationships utilised.

Sandeep (2020) Where the soil's carrying capacity is poor, box-type constructions are also extremely effective and suitable. These structures just have a top and bottom slab and side walls, making them the simplest of all imaginable structures. Box structure terminology varies from department to department and nation to country, but the analysis and design processes are essentially the same. For instance, the naming of boxes according to Indian Road Congress is done based on their span arrangement, however in Indian Railway, this is done based on their purpose. All structures used to cross hydraulic structures fall under the minor or major bridge category, whereas structures used for rail or subway underpasses are considered low height structures.

Philip (2021) A thorough comparison analysis of the variable live and dead load distribution through soil fill for various fill heights was also completed. The findings indicate that when fill depth is increased, the live-load impact does indeed lessen. Beyond a fill height of around 6.5 m, live-load effects can be disregarded since the live-load pressures are less than 10% of the dead-load pressure. Furthermore, it was found that the intensity of lateral earth pressure was much greater than the intensity of vertical soil fill loads.

Laxmi (2022) Where the soil's carrying capacity is poor, box-type constructions are also extremely effective and suitable. These structures just have a top and bottom slab and side walls, making them the simplest of all imaginable structures. Box structure terminology varies from department to department and nation to country, but the analysis and design processes are essentially the same. For instance, the naming of boxes according to Indian Road Congress is done based on their span arrangement, however in Indian Railway, this is done based on their purpose. All structures used to cross hydraulic structures fall under the minor or major bridge category, whereas structures used for rail or subway underpasses are considered low height structures.

Shimol (2022) According to the findings, skew has no impact on SIDL, lateral earth pressure, earth pressure from surcharge loads, or live load intensities from wind and footpath. However, when the skew angle is raised, so does the severity of the dynamic loads brought on by train axle movement, derailment, and Plasser's Quick Relaying System (PQRS) loads. However, when the skew angle rose, the impact of longitudinal forces brought on by the trains' braking and traction increased as well. Also, at lower fill heights, the impact of skew is more noticeable. The findings of this study may be helpful to the engineers when they construct RC skew box culverts for RUB applications.

Hanchate (2021) In the current study, the effects of various skew angles on pre-stressed concrete (PSC) bridges are illustrated using the finite element approach. To understand how skew angle and loading effect bridge behaviour, studies are conducted on PSC bridge decks. The results of skewed and straight bridges for IRC Class AA Tracked loads are compared. In a comparative study, the response of skewed PSC Slab Bridges is contrasted with that of matching straight bridge decks. The variation of the largest longitudinal bending moment (BM), the largest transverse moment, the largest torsional moment, and the largest longitudinal stresses deformation is examined for a bridge deck. It is shown that while live load longitudinal bending moments decrease with increased skew angle, maximum transverse and torsional moments increase with increased skew angle.

IV. CONCLUSION

After reading the aforementioned studies, we have come to the conclusion that different skew culvert angles perform differently under various moments and loads. Some angles are stronger, more durable, and more deflection-resistant than others, including some skew angles. Hence it will be beneficial to adopt the skew angle values of the skew culvert bridge at the site conditions. Overall, this means that skew culvert angle has a significant impact on bridge performance.

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