Study of Different Parameters For Skew Curve Bridge For Varying Girders

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Abstract- *Due to their intricate load transmission mechanisms, curved and skew bridges have been shown to be more susceptible to earthquake-induced failure than a regular bridge in previous earthquakes. Their capacity to satisfy the geometric constraints imposed by existing roadway components, bridges with skew and curvature are becoming a more prevalent part of the current highway transportation system. Such bridges behaviour under dynamic stress changes as skew and curvature angle change. the modelling and analysis of a curved skew bridge are the topics of the current study. the use of the finite element method to study an I-girder, box girder, and U-girder bridge under both dead load and IRC imposed loads. A parametric study is performed that examines the effects of skewness and curvature on the maximum bending moments, shear forces, torsional moments, and vertical deflection. The curve and skew angle is varies from 0° to 45° and girder type for same width and span will be done using finite element software CSiBridge. Knowing the behavioural responses of skew and curve highway bridges will help design safe transportation systems for training engineers in the future.*

Keywords*-* Skew, Curve, Curvature, Bending moment, Torsion, Deflection

I. INTRODUCTION

A bridge is a structure built to span a physical obstacle such as a body of water, valley, road, or rail without blocking the way underneath. The history of bridge engineering is closely associated with the progress of human civilization spread over several centuries. The earliest bridge on record is traced to the lake dwellers of Switzerland who pioneered the timber trestle construction for crossing of rivers around 4000 B.C. The oldest bridge still standing is a pedestrian stone slab bridge which is at least 2800 years old built across the meles river in Smyrna, Turkey. Many of the important ancient bridge were built by armies. As per homer and Herodotus, the floating bridge were made of inflated skins(used as float) around 800 B.C. A bridge of this kind was built in the year 556 B.C. by king cyrus.

The first treatise on bridge engineering was published in 1714 by the French engineer, Robert Guiter ushering the age of reason. The first engineering school in the world "The Ecole de Ponts et Chaussees" was founded at Paris in the yaer 1747 with Rodolphe Perronet, consideredas the "Father of the modern bridge building" as the first director of the school.

Types of bridges

1.1. Arch bridge
1.2. Beam bridge
1.3. Cable-stayed bridge
1.4. Suspension bridge
1.5. Truss bridge

1.1 Geometry and configuration

Bridges had straight construction at first, with piers that were perpendicular to the centre line. The demand for sophisticated transportation systems has expanded along with the rate of urbanisation and infrastructure development, which frequently results in the design of roads and bridges with unusual skew or curved configurations, or both at once.

1.2 Skew bridge:

It is often not possible to arrange that a bridge spans square to the feature that it crosses, particularly where it is important to maintain a relatively straight alignment of a roadway above or below the bridge. Thus a 'skew' bridge is required. This increases the spans but more significantly usually results in the end and intermediate supports being at an angle to the longitudinal axis of the bridge, rather than square to it. In comparison to non-skewed bridges, the force flow in skewed bridges is more complex. When there is an earthquake, an oblique influence has an impact. Because there is a straight line connecting the two oppositeedges of a straight bridge, the load is transferred straight to the supports. While it is more complicated with skewed bridges. These bridges are more likely to rotate and become unseated. Skew support arrangements give rise to torsional effects that must be taken into account in design.

1.3 Curved bridge:

A sizable part of all bridges in existence worldwide are horizontally curved. In order to reduce traffic congestion and improve the structure's aesthetics, these bridges are frequently employed to build substantial and intricate highway interchanges into highly populated neighbourhoods. However, because of the curvature effect, such bridges' dynamic behaviour is more complex than that of straight bridges, which presents difficulties for engineers.

1.4 Curved skew bridge:

In complex situations, there are things that curvature and skewness cannot overcome. In some conditions, a combination of bridge skew and curvature should be used. A bridge that shows both a skew and a curve in plan view is known as a curved slope bridge. It's complicated when both skew and curvature are present. Skew and curvature angle will show their effect during dynamic loading and makes its behaviour hard to predict. Rotation due to skew and torsion due to curvature will make behaviour random and complicated and hard to predict failure mechanism.

II. RESEARCH SIGNIFICANCE

The objective of this study is to evaluate the combined effects of skew and curvature on the seismic performance of reinforced concrete bridges.To analyze the effectiveness of different types of superstructure under different skew and curvature.Modelling and analysis of curved and skew bridge using CSI software.Analysis under loading conditions like dead load, moving load and seismic load will be carried out.Analyzing the behavior of different types of superstructure (I girder, Bath tub or U girder and Box girder) with respect to various skew and curvature of bridges will be done.

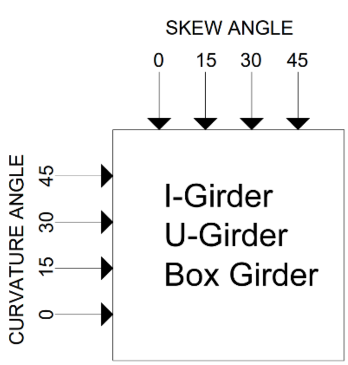

Chart-1: Combination of Skew and Curvature Angle

III. MODELLING AND ANALYSIS

3.1 Bridge Configuration

A 25-meter-long single-span bridge has been chosen for the current project. The 10.5m-long abutment is joined to the bottom of the girder. This has a bearing that connects to the abutment. A bearing is anchored in two other translations and has a longitudinal rigidity of 100,000 kn/m. The abutment is 10.5 metres long. The materials are HYSD415 bars and M30 concrete.

I girder, U girder, and box girder are the three different superstructure conditions used in the current work. All super structures have been designed with the same effective cross section area.

3.1.1 I Girder :

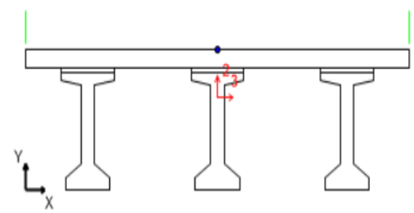

Figure-1 : I Girder Bridge Cross Section

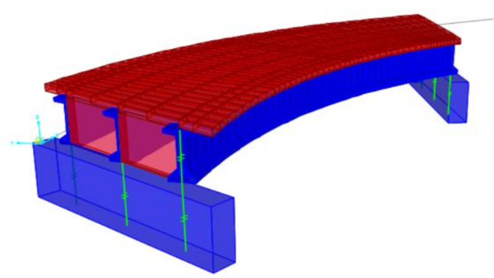

Figure-2 : Modelling Of I Girder Bridge

Data :

Thickness of slab : 0.3 m
Total width : 8.7 m
Depth of I-girder : 2 m
Top flange width : 1.2 m
Top flange thickness : 0.15 m
Bottom flange width : 1 m
Bottom flange thickness : 0.2 m
Cross section area : 5.86 m^2

3.1.2 Box Girder :

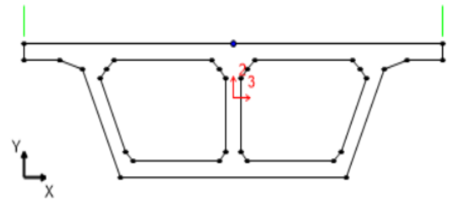

Figure-3 : Box Girder Bridge Cross Section

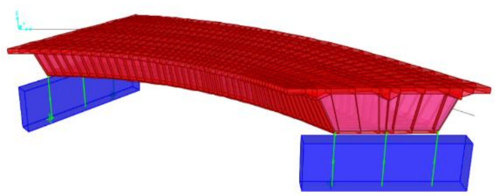

Figure-4 : Modelling of Box Girder Bridge

Data :

Thickness of top slab : 0.3 m
Thickness of bottom slab : 0.3 m
Total width : 8.7 m
Total depth : 2.3 m
No. of cell : 2
Thickness of girder : 0.3 m
Cross section area : 5.90 m^2

3.1.3 U Girder :

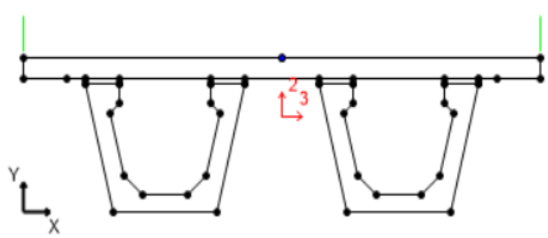

Figure-5 : U Girder Bridge Cross Section

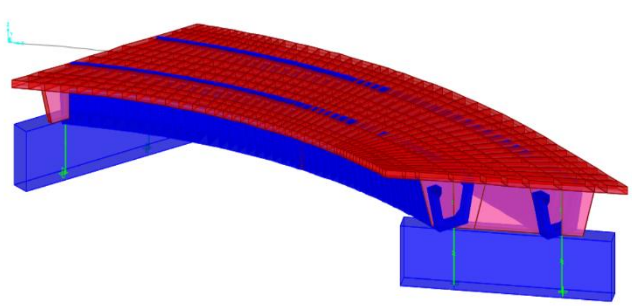

Figure-6 : Modelling of U Girder Bridge

Data :

Thickness of slab : 0.3 m
Total width : 8.7 m
Depth of U girder : 1.8 m
Top width of girder : 2.6 m
Bottom width of girder : 1.5 m
Bottom thickness of girder : 0.25 m
Cross section area : 5.87 m^2

Bridges differ in geometry two in addition to having various superstructures. Two variables are taken into consideration: superstructure curvature and abutment skew. Skew angle and curvature angle both have different values of 0, 15, 30, and 45. Thus, a total of 16 alternative situations are taken into account, each with a different angle of skew and curvature. And a total of 48 models with 3 different superstructures will be generated. 0.5 percent of super elevation is used for curved bridges.

IV. RESULT ANALYSIS

Analysis has been done using the CSI bridge software. The information needed to generate the structural model in the software is provided below:

Concrete Grade : M30
Steel Grade : HYSD 415 Bridge is 25m long and total of 8.7m wide. Two lanes are considered as each of 3.75 m wide.

4.1 Bending Moment

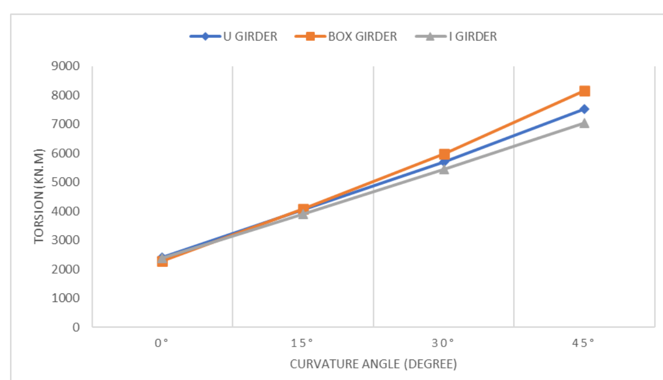

Chart-2 : Torsion for 0° Skew (kN.m)

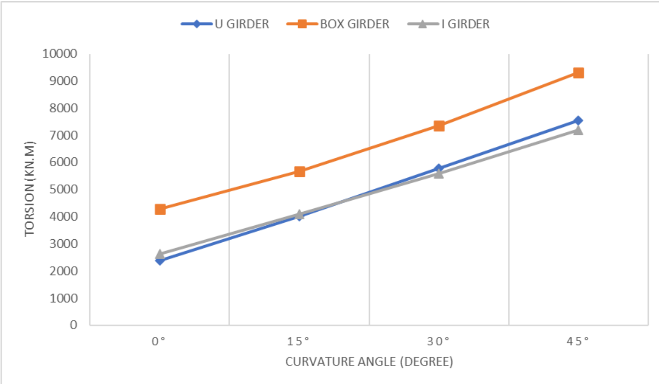

Chart-3 : Torsion for 15° Skew (kN.m)

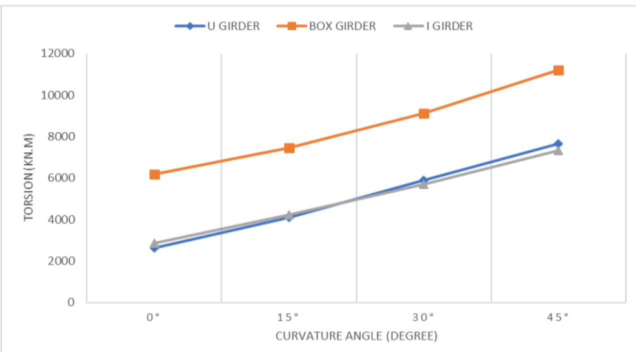

Chart-4 : Torsion for 30° Skew (kN.m)

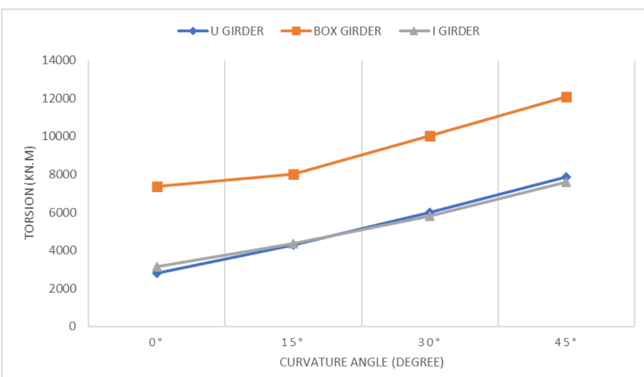

Chart-5 : Torsion for 45° Skew (kN.m)

4.2 Bending Moment

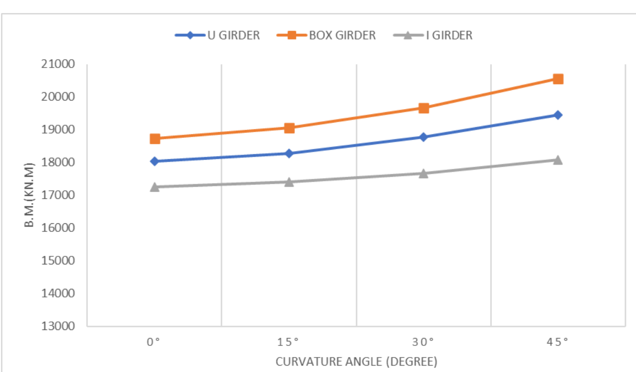

Chart-7 : Bending Moment for 0° Skew (kN.m)

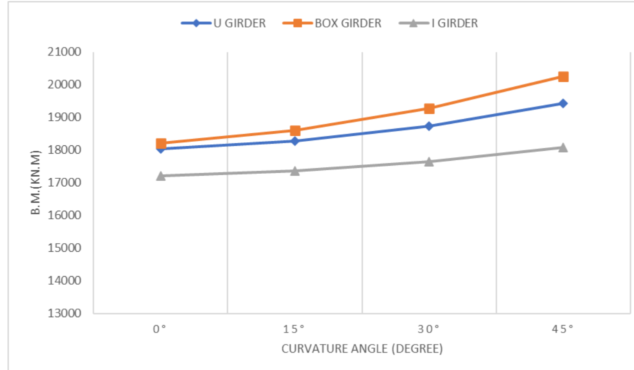

Chart-8 : Bending Moment for 15° Skew (kN.m)

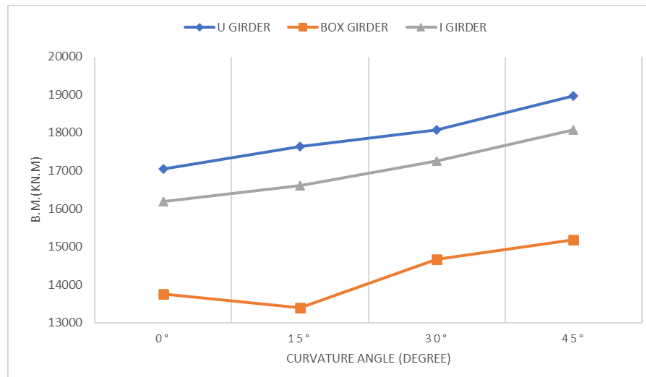

Chart-9 : Bending Moment for 30° Skew (kN.m)

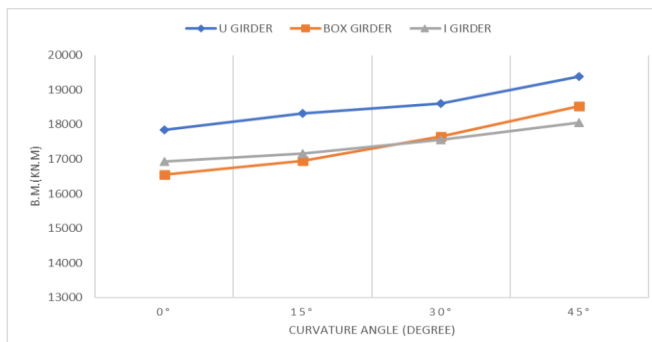

Chart-10 : Bending Moment for 45° Skew (kN.m)

4.3 Vertical Displacement

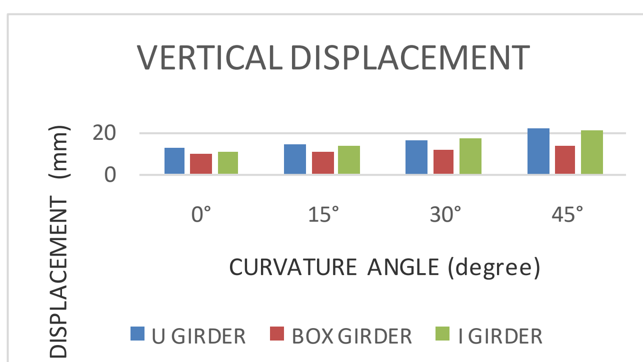

Chart -11 :Vertical Displacement for 0° Skew (mm)

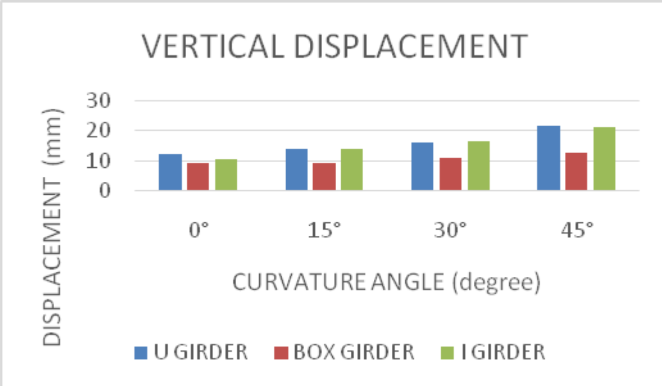

Chart -12 :Vertical Displacement for 15° Skew (mm)

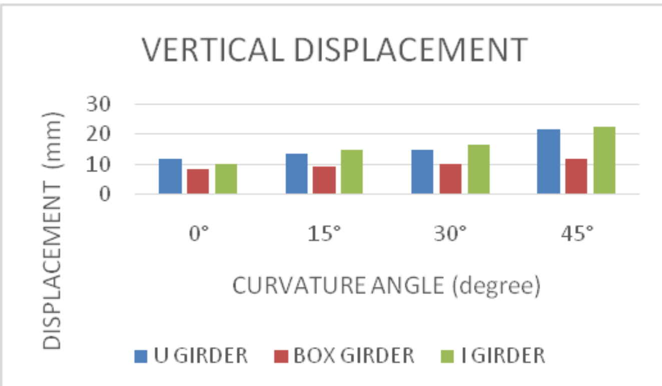

Chart -13 :Vertical Displacement for 30° Skew (mm)

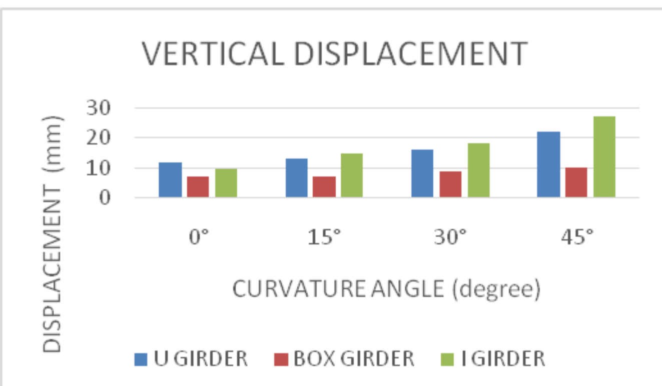

Chart -14 :Vertical Displacement for 45° Skew (mm)

V. CONCLUSIONS

The list of findings from linear time history investigations utilizing CSiBridge models is as follows:

- On the other hand, the bending moment decreases as the skew angle increases as the curvature angle increases.
- Bending moment reduces by 6.55%, 36%, and 7.23% for U, Box, and I girders, respectively, as the skew angle increases from 0° to 45°.
- Bending moment increases by 8.86%, 9.6%, and 5.84% for U, Box, and I girders, respectively, as the curvature angle increases from 0° to 45°.
- The box girder exhibits the largest bending moment when the skew angle is up to 15° with changing curvature, whereas the I girder exhibits the smallest bending moment.
- Comparing box girder to U and I girder, the bending moment of the former gradually decreases at skew angles greater than 15°. The U girder's maximum bending moment is noted at this stage.
- Torsion tends to increase as the angle of skew increases as well as the angle of curvature.
- For the angle of skew and the angle of curvature of 0°, there is a slight difference in torsion for all the beams.
- Maximum torsion in the box girder has been recorded with a rise of the skew angle, as opposed to U and I girder. The torsion value of the U girder is nearly identical to that of the I girder.
- It was shown that vertical displacement reduces as the skew angle increases. Additionally, vertical displacement increases as the curvature angle increases.
- Transverse and longitudinal displacement rise in response to increases in the skew and curvature angles.
- Maximum deflection is seen in both the transverse and vertical axes in an I-girder.
- In a U-girder, the maximum longitudinal displacement is noted.

VI. ACKNOWLEDGMENT

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