MODELLING OF SKEW BRIDGE DECK SLAB BY GRILLAGE

Kamal Kumar Pandey*1, Savita Maru*2

[1]M.E Student (Computer Aided Structural Designing & Drafting),

Dept. of Civil Engineering, UEC, Ujjain (M.P.), India

[2]Prof, Dept. of Civil Engineering, UEC, Ujjain (M.P), India

Abstract- In the modern era the uses of advanced technology is increasing very much. The computing power increases very much yet the changing of a bridge deck slab into grillage has not changed the same extant. The assumption for changing the bridge deck into grillage is very important .Therefore in this present study, a bridge deck slab is converted into grillage modeled for different skew angles. The width of carriageway and length is considered constant for different skew angles such as 30^0,35^0,40^0,45^0,50^0,55^0,60^0 .These models are made by STAAD PRO. The spacing between transverse grid lines and longitudinal grid lines are assumed in a ratio. The spacing ratio of grid lines is very important because for finding the most correct values of reactions, shear force, bending moments, torsion and deflections. The spans are used 7.5m for carriageway and length is 10m for the entire grillage model.

Keywords: Bridge Deck slab, Skew angle, span length, Grillage, Carriageway, Grid Lines ,Bending Moment, Shear Force, Torsion and deflection

1. INTRODUCTION

Grillage Analogy is a probably one of the most popular computer added methods for analyzing bridge deck. This method consists of representing the actual decking system of bridge by an equivalent grillage of beam.

This method can be applied to the deck slab when there developed complex feature such as heavy skew, deep hunching supports etc. This method is very versatile because in this the contribution of kerb beams. Footpath and the effect of differential sinking of girder ends over yielding supports can be considered.

Lightfoot and Swako, West made recommendation backed by carefully conducted experiments on the use of grillage analogy. He made suggestions towards geometrical.

2. Transformation of bridge deck into grillage

In this method we convert the deck slab into a number of such a network which works as rigidly connected beams at discrete node. Because there of a lot of variety of deck slabs shapes and support conditions therefore it is very difficult to adopt any hard and fast rules for making a grillage layout of a original structure, yet there are certain guidelines for considering the location, direction ,spacing etc. along the longitudinal and transverse direction.

The guidelines are ………………….

1) Grid line should adopted along line of strength.
2) For longitudinal direction it may be along the longitudinal webs, centre line of girders or edge beams etc. Where isolated bearings are present, the grid line may be along the line joining center of bearing.
3) For transverse direction, it should be considered as one of each end connecting the center of bearing and along the center line of transverse beam.
4) If possible, there should be an odd number of grid line should adopted in both longitudinal and transverse direction. Means the minimum number of longitudinal grid lines may be nine and minimum number of grid lines in transverse direction may be five.
5) The ratio of spacing of transverse grid line to those of longitudinal grids may be between 1 to 2.
6) The deck slab can be modeled either parallelogram mesh or by orthogonal mesh.
7) The parallelogram mesh can be only up to 20 degree because it has no member close to the direction of dominating structural action.

8) The orthogonal mesh modal is adopted for greater than 20 degree angle.
9) In general, transverse grillage member should be at right angle to the longitudinal members.
10) If the deck is at high skew or bearings are closed together, the compressibility of the bearings has considerable effect on the local shear forces.
11) The direction of longitudinal grid lines is originally parallels the free edge of deck.
12) On the basis of depth of slab, the minimum distance between longitudinal grid lines is limited to two to three times of the slab depth and the maximum separation of longitudinal members should not be more than one fourth of the effective span.
13) It is important that the idealized grillage is supported at the same position as the actual deck.

There are bridge deck slab on the basis of above assumptions having carriageway width and length is constant for different skew angle such as 30^0,35^0,40^0,45^0,50^0,55^0 and 60^0

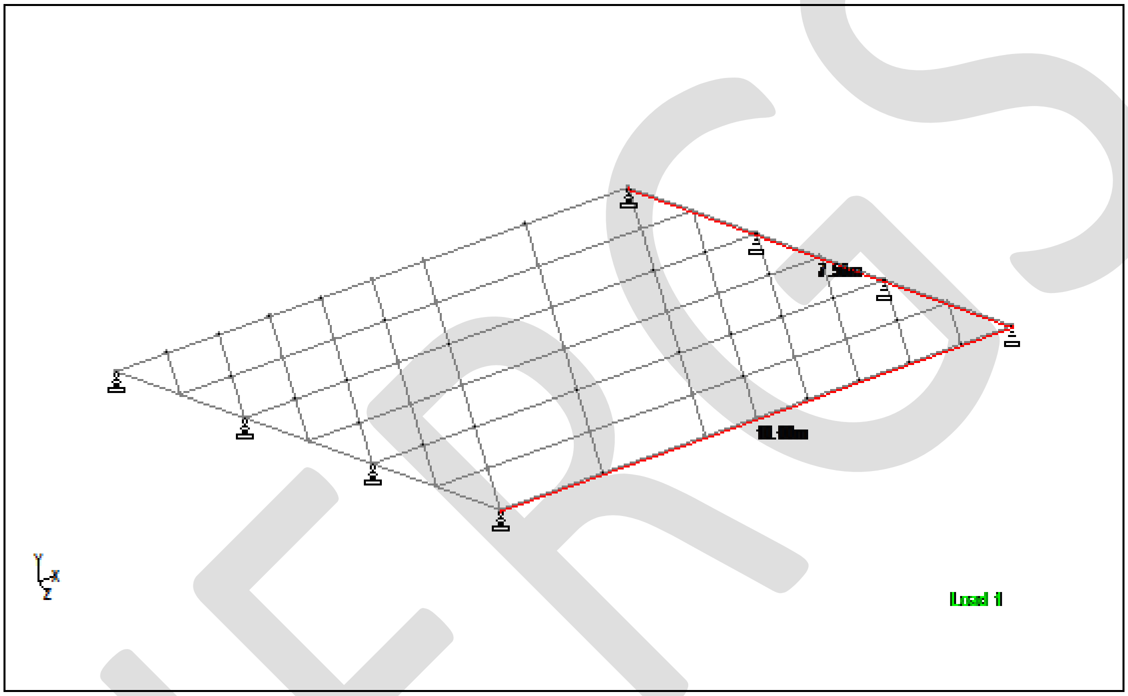

Fig1. 30

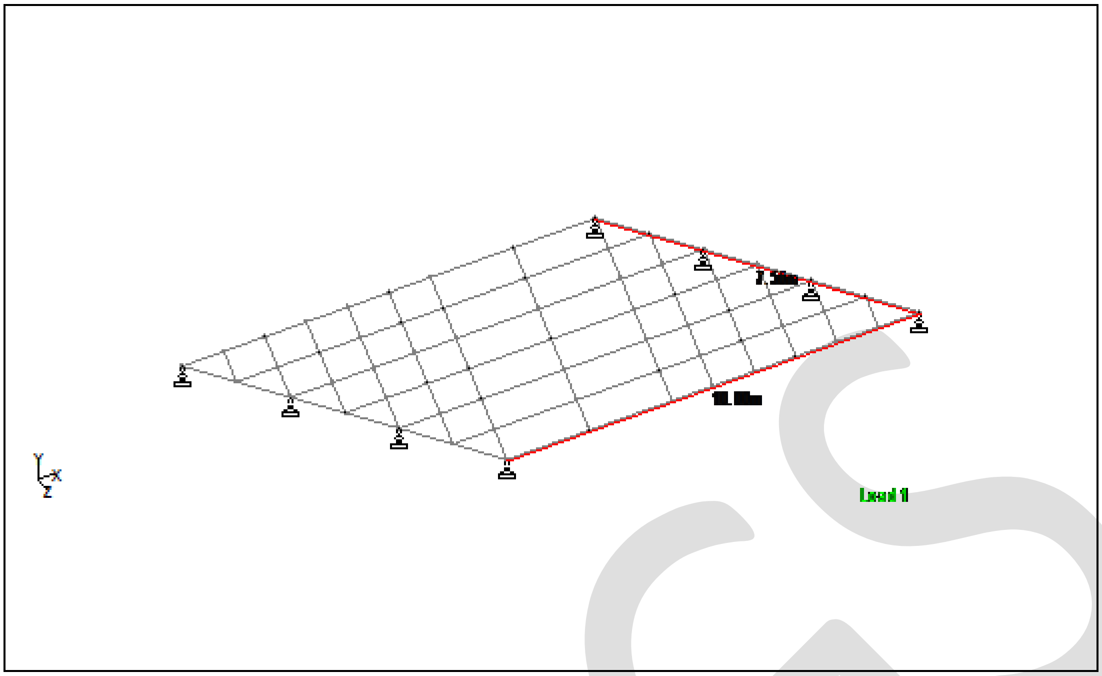

Fig2. 35^{0} skew angle grillage model

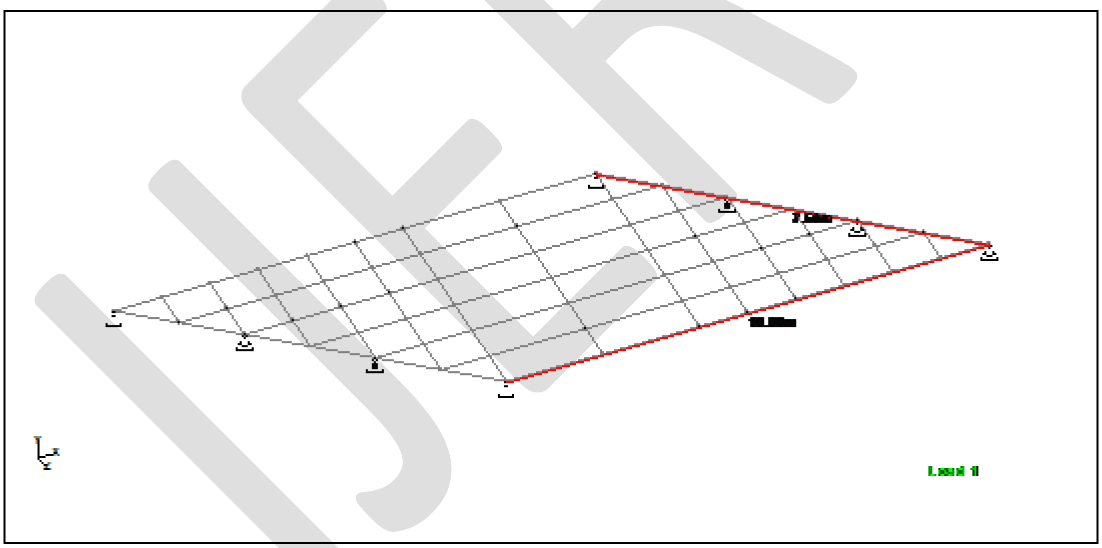

Fig3. 40^{0} skew angle grillage model

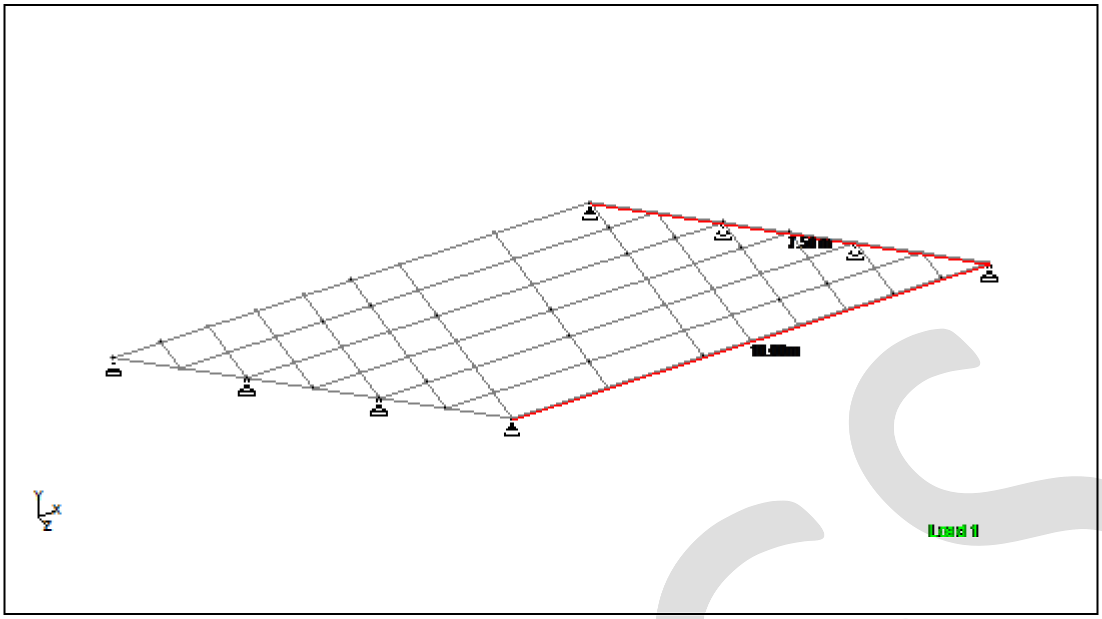

Fig4. 45^{0} skew angle grillage model

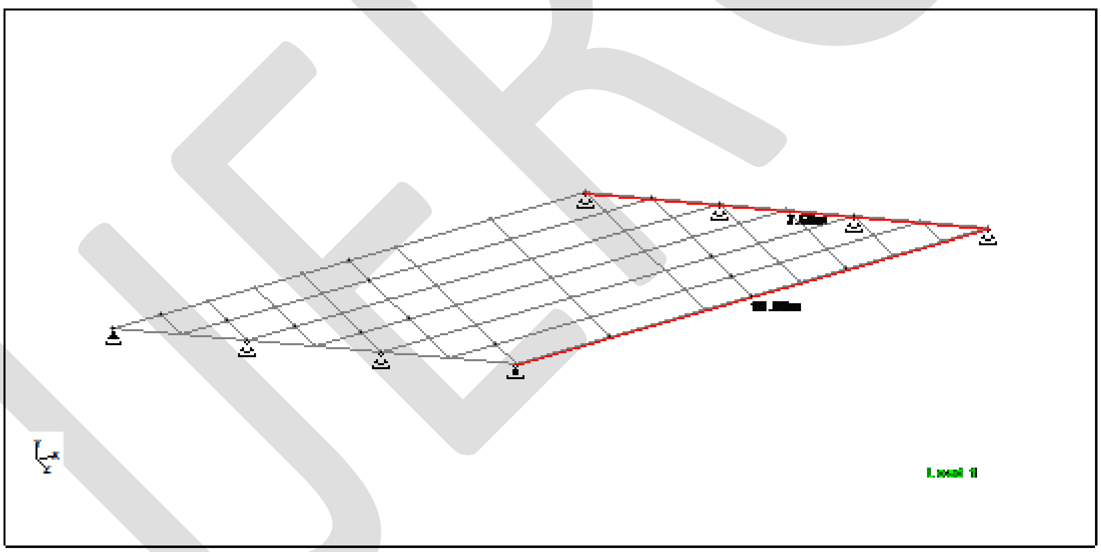

Fig5. 50^{0} skew angle grillage model

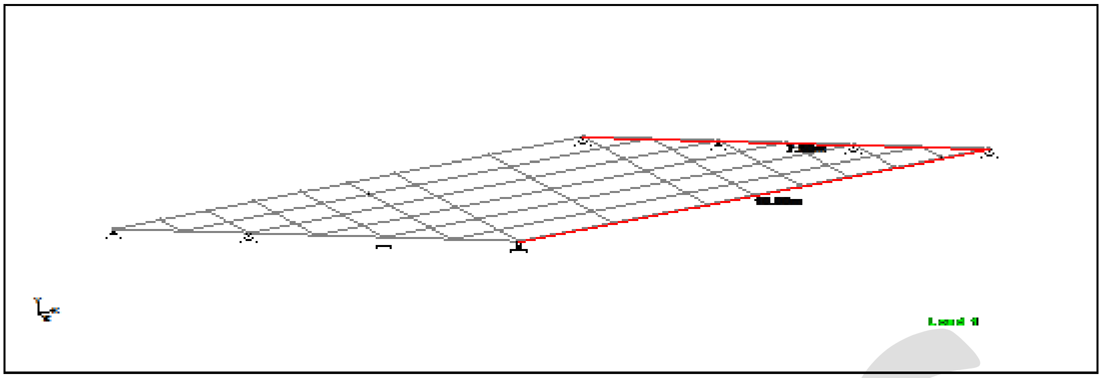

Fig6. 55^0 skew angle grillage model

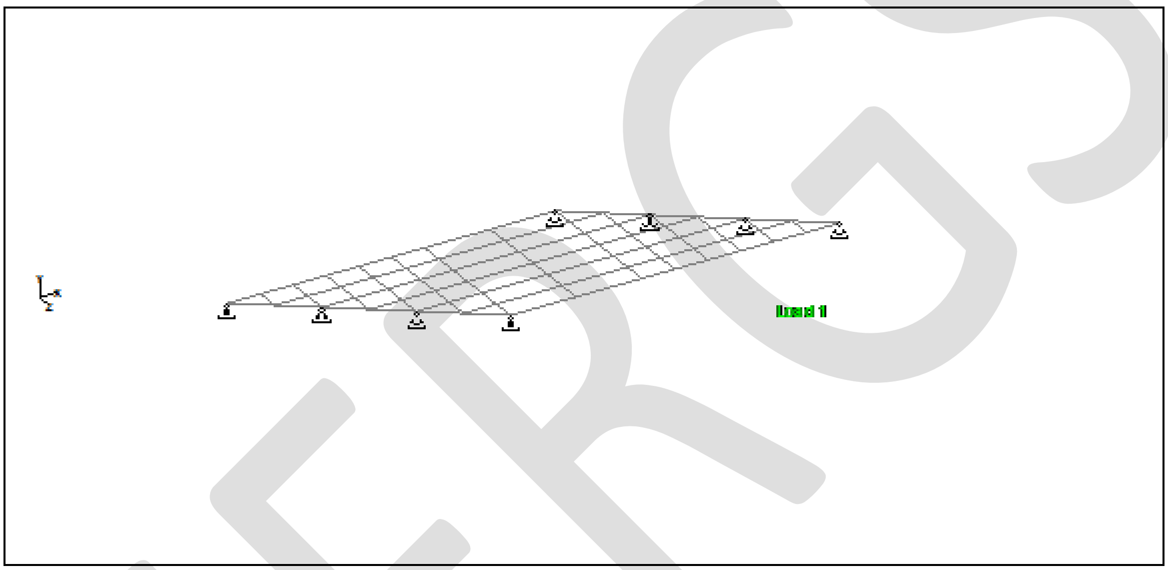

Fig7. 60^0 skew angle grillage model

3. Sectional properties of grillage members

Bending inertias: The bending inertias of the transverse and longitudinal grillage members are calculated by considering each member as representing the deck width to midway to the adjacent parallel members as shown in figure.

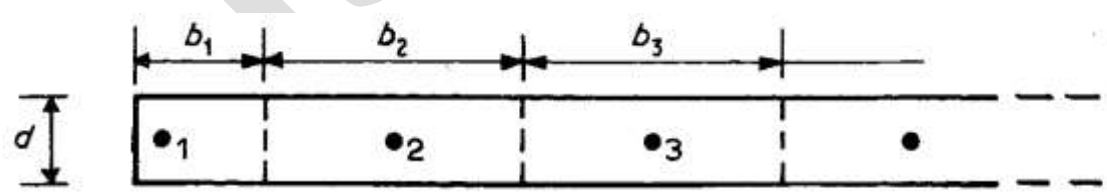

Fig8. Subdivision of deck cross –section for longitudinal grillage members

for an isotropic slab, the moment of inertia is calculated about the neutral axis of the deck so-moment of inertia (I) $=bd^3/12$

Where b=width of slab

D=depth of slab.

If the deck slab has thin cantilever or intermediate slab strips as shown in figure

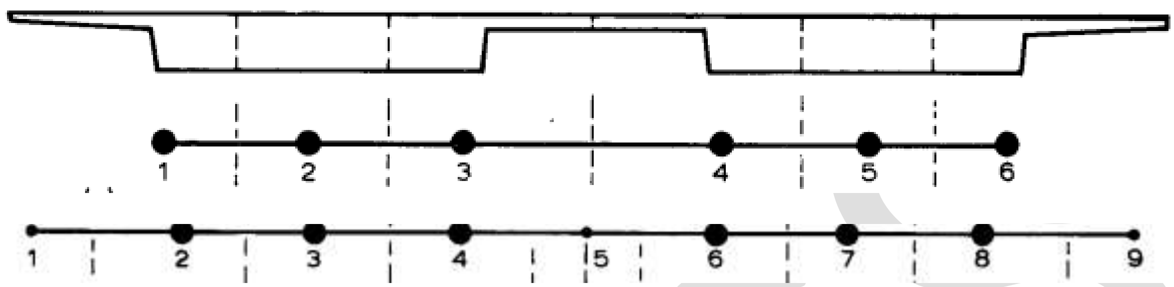

Fig9. Alternative position for longitudinal grillage members for deck with thin cantilever and connecting slabs

Then the longitudinal member can be placed as in figure.

The inertia of all the members is calculated about neutral axis. If there are thin slab, the moment of inertia is calculated about centroid of thin slab.

For voided slab as shown in figure-

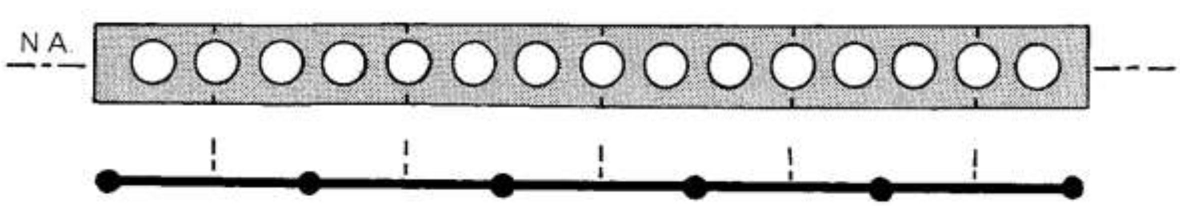

Fig10. Position of longitudinal grillage members for voided slab deck

The inertia of longitudinal members is calculated for shaded section about the neutral axis and for transverse members, the inertia is calculated as the center line of voids. However for void depth less than 60% of the overall depth, the transverse inertia can be assumed to equal to the longitudinal inertia per unit width, neither calculation is precise, but both are sufficient for design purposes.

Torsion: If width of section is b and depth is d ……………

Torsion$=bd^3/6$. So torsion is twice the magnitude of the moment of inertia and in general it is possible to assume TORSION=2I for grillage member representing slabs. There is no simple rigorous rule for calculating torsion for voided slab and the assumption T=2I is as convenient and accurate as any method. If the slab is orthotropic the torque in longitudinal and transverse direction are equal ($T_{xy}=T_{yx}$) and the sometime both twist are identical equal to $d^2w/dxdy$, consequently the transverse and longitudinal grillage members should have identical torsion constant per unit width of deck. There are following approximation given by ***Huber***…………………

$T=2\sqrt{I_x I_y}$

Where T= Torsion constant per unit width of slab

I_x=Longitudinal member inertia per unit width of slab

I_y=Transverse member inertia per unit width of slab

4. Conclusion

- It is important that the modal of skew bridge deck slab is converted into grillage have the support as same place as in actual skew deck slab.
- For converting the deck slab into grillage the Grid line should adopted along line of strength.
- For calculating the torsion in voided slab the assumption "Torsion=2*Moment of inertia" will be convenient.
- For obtaining good result of analysis the ratio of spacing of transverse grid line to those of longitudinal grids may between 1 to 2.

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