A Comparative Study on T Girder Bridge Deck using Grillage Analogy and Finite Element Method

Gaurav Somani [1]

[1]P.G. Student, Mewar University,
Chittorgarh, Rajasthan, India

Abstract - Concrete slabs and t- girder bridges have been the dominant bridges in India. Especially in recent years, many road constructions are underway, some are under construction, and some road projects are planned to be carried out in the future. As the project becomes larger, it is necessary to improve the design method and make it more effective every day. It summarizes the requirements of the new bridge and the important features of the planned site and makes it the basis for each design. Initially, the dimensions of the structural members were chosen according to the designer's experience, and at a later stage, the engineering software was used to compare the alternative software and optimize the part size. Finally, a complete analysis and analysis of all important construction phases and detailed shop drawings will be carried out.

Key Words: Skewed bridges, bending stress, shear stress

1. INTRODUCTION

The bridge is a structure that can access the barrier without closing the barrier. The necessary accesses are roads, railways, pedestrians, pipes or canals. The obstacle to overcome may be a river, a road, a railroad or a valley. From the engineering point of view, the bridge can be described as plain (or right) or sloping. A typical bridge is a bridge with a vertical axis perpendicular to the platform pillar. Further, in a conventional bridge, the deck and the support beam are disposed symmetrically with respect to the center of the bridge, and the center line is the same as the longitudinal axis thereof. This arrangement is ideal and ideal. Because bridge analysis and construction are simplified, leading to an economical structure. To analyze this, it is necessary to divide the superstructure of the bridge into smaller, more manageable components consisting of rays, deck panels, barrier systems, sections and membranes.

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1.1 Main Components of a Bridge
A typical bridge consists of the following components:
a) Deck slab.
b) Cantilever slab portion.
c) Footpaths, if provided, kerb and handrails or crash barriers.
d) Longitudinal girders, considered in design to be of T-section.
e) Cross beams or diaphragms, intermediate and end ones.

f) Wearing coat.
g) Abutments and piers.
h) Foundation (pile cap and piles).
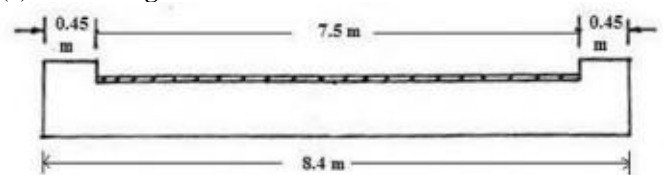
1.2 Type of Bridge Decks
(a) **Slab Bridges**

Figure 1.1: Typical Cross-section of solid slab deck
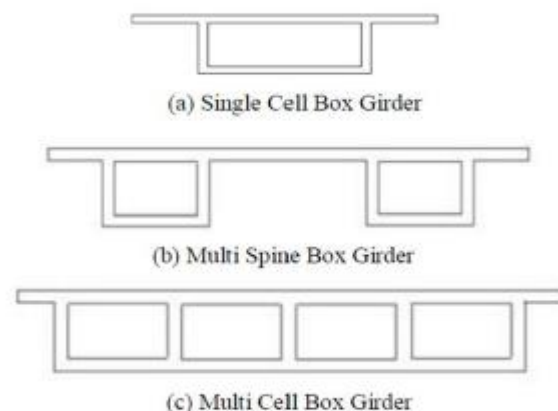
(b) **Box Girder bridges**

Figure 1.2: Typical Cross-Section of box Girder Bridge
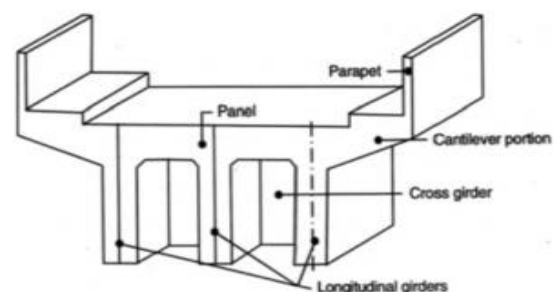
(c) **T-Beam Bridges**

Figure 1.3: Typical Cross-section of T-girder for two lane traffic

1.4 Objective of the Study

A relative investigation of T-Beam arrangement of deck piece with various IRC loadings considered for the examination. FEM investigation is finished utilizing STAAD Pro. V8i In this investigation, the destinations are accomplished by basic grouping:

- To set up and exhibit a helpful, solid, and precise philosophy for dissecting solid structures with specific accentuation on T-Girder solid extension decks
- Approving FEM Analysis and looking at grillage similarity Method of examination for shifting lengths.
- To propose which model can give more efficient plan.
- Performing FEM and GA Analysis on T-pillar arrangement by considering greatest Shear compel, most extreme twisting minute and most extreme torsional snapshots of parameters of correlation

2. LITERATURE REVIEW

The essential target of this examination was to set up and exhibit an advantageous, solid, and exact technique for breaking down fortified solid structures with specific accentuation on strengthened solid extension decks. An optional target was to build up a capacity for foreseeing anxiety dispersion through the thickness of fortified solid scaffold decks. Such data isn't effortlessly gotten through experimentation. The extension has broken down for single traverse with length changing from 12m,15m and 18m and twofold path width subjected to various IRC stacking design class An and 70R . The aggregate length of the extension Deck framework is made of cast in situ T molded cement longitudinal braces and cross supports. The extension is straight and has no skew. The standard extension models are created. The outcomes are acquired regarding examination of various parameters.

Menessa (2007) this examination work led FEA for just upheld, one-traverse, multi-path fortified solid piece spans. Four traverse lengths were considered in this parametric examination as 7.2, 10.8, 13.8, and 16.2 m with comparing chunk thickness of 450, 525, 600 and 675 mm separately. The outcomes were contrasted and straight scaffolds. SAP2000 was utilized to produce three-dimensional (3D) limited component models.

Qaqish et al (2008) In this exploration a straightforward traverse T-beam connect pivoted toward one side and opposite end sliding the longitudinal way was broke down by utilizing AASHTO particulars and stacking as a one dimensional structure, at that point a three-dimensional structure was completed by utilizing limited component plate for the deck section and shaft components for the principle pillar. The two models were subjected to AASHTO Loadings and at specific areas to create greatest bowing minute and most extreme shear. The outcomes were broke down and it was discovered that the outcomes got from the limited component demonstrate are littler than the outcomes acquired from one dimensional examination, which implies that the outcomes got from AASHTO loadings are moderate.

Shreedhar, et al (2012) a straightforward traverse T-beam connect was examined by utilizing I.R.C. particulars and stacking (dead load and live load) as a one dimensional structure. A similar T-bar Bridge was dissected as a three-dimensional structure utilizing limited component plate for the deck section and shaft components for the fundamental bar utilizing programming STAAD ProV8i. By contributing certain qualities for traverse, clear roadway width, cross brace interims and plate thickness. The two models were subjected to I.R.C. Stacking (Class AA and Class A) to deliver greatest twisting minute. The outcomes were broke down and it was discovered that the outcomes got from the limited component demonstrate were lesser than the outcomes acquired from one dimensional examination, which implies that the outcomes got from I.R.C. loadings are traditionalist and FEM gives sparing outline.

Khatri, et al (2012) their study led on grillage similarity technique for investigation of extensions. A sum of nine distinctive matrix sizes (4 to 12 divisions) are made utilizing grillage relationship with various skew edges 30°, 45° and 60° to decide the best lattice estimate. It is watched that FEM and Grillage strategy comes about are not comparative for each framework estimate contingent upon different parameters. Variety in response esteem is same in FEM and Grillage strategy however variety of B.M and torsion in FEM is lower than grillage comes about.

Samuel (2016) in his thesis endeavored to examine the consequences of T Girder superstructure utilizing both the estimated strategy which depends on the conveyance factor idea and grillage similarity technique. Both these strategies were utilized to break down RCC T and box brace superstructure and comparing to change in rush hour gridlock paths, traverse length and stomach (for e.g.,: 10.3 m width and 20 m traverse) and valuable data was obtained with respect to the variety of bowing minute and shear constrain. It was presumed that outcomes got from grillage similarity strategy were littler than rough technique aside from shear power of inside brace of T-Girder connect.

Arun L (2018) Grillage analogy is probably one of the most popular computer-aided analysis for analyzing bridge decks. The method consists of representing the actual decking system of the bridge by an equivalent grillage of beams. The dispersed bending and torsional stiffness of the decking system are assumed, for the purpose of analysis, to be concentrated in these beams. The actual deck loading is replaced by an equivalent nodal loading. The requirement of analysis is the evaluation of internal member forces, stresses and deformations of structures. After the analysis, distribution of member forces will be ascertained.

3. METHODOLOGY AND MODELLING OF T-GIRDER BRIDGE DECK

Numerous exploratory and scientific works has been finished by numerous analysts in the zone of limited component displaying and nonlinear FE analysis of RC bridges. Moreover, much research has been directed concerning the general utilization of PCs to strengthened cement. STAAD. Pro is a generally utilized basic examination program fit for breaking down several auxiliary individuals under various stacking conditions. It includes a cutting edge UI, representation instruments, intense investigation and outline motors with cutting edge limited component and dynamic examination abilities. From display age, investigation and configuration to perception and result confirmation, STAAD.Pro V8i is the expert's decision for steel, solid, timber, aluminum and cool framed steel outline of low and tall structures, courses, petrochemical plants, burrows, extensions, heaps and considerably more.

3.1 Refined Methods of Analysis

Refined strategies for examination for dissecting roadway connect superstructures and deciding brace minutes and burdens can be characterized into following classifications:

1. **The orthotropic plate approach** romanticizes the real extension structure as a proportionate orthotropic plate, which is then treated by established hypothesis. This approach was first created by Guyon for grillages with insignificant torsional solidness and later for isotropic chunks. Massonnet expanded this approach by including the impacts of torsion. The joined work of Guyon and Massonnet, alluded to as the Guyon-Massonnet stack conveyance hypothesis, has been stretched out by others.

2. **The harmonic analysis procedure,** created in the 1950's by Hendry and Jaeger, considers an indistinguishable flexural and torsional rigidities from the orthotropic plate examination, yet dismisses the torsional unbending nature the transverse way. Burdens are disseminated to the individual braces just as the section were a constant shaft over non avoiding bolsters. The stacking is communicated as a consonant arrangement or Fourier sine arrangement. Articulations for shear, minute, incline, and redirection are found by progressive mix of this heap arrangement. Support twisting minutes are controlled by thinking about the above arrangement in conjunction with transverse power balance and incline diversion articulations the transverse way.

3. **The grillage analogy method** idealizes the bridge structure using an equivalent grid system, which is then analyzed by:
    Slope-deflection and compatibility equations;
    Moment or torque distribution;
    Shear distribution;
    Reaction distribution

    This method usually involves the solution of a large number of simultaneous equations or numerous arithmetic calculations.

3.2 Load Distribution Mechanism

It is realized that the bridge loads are transmitted from the deck to the superstructure and afterward to the supporting substructure components. It is fairly hard to envision how these heaps get exchanged. On the off chance that a vehicle is proceeding onward the highest point of a specific shaft, it is sensible to state that, this specific bar is opposing the vehicle or truckload. In any case, this pillar isn't the only one; it is associated with adjoining individuals through the section and cross braces. This availability enables distinctive individuals to cooperate in opposing burdens. The supporting braces share the live load in shifting extents relying upon the flexural solidness of the deck and the situation of the live load on the deck.
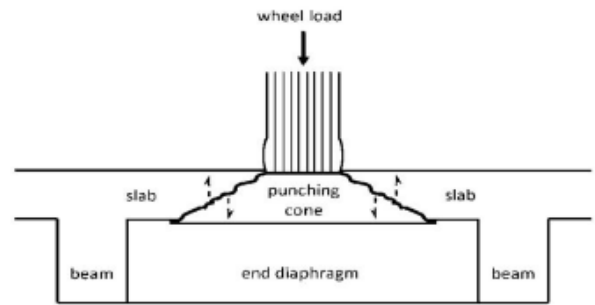

Figure 3.1: wheel load distribution in beam-slab girder

3.3 Bridge Deck Data

T-girder bridges: It has been broke down for a chunk thickness of 200 mm in the present examination. The width of carriage way has been taken as 7.5m and 8.7m in the wake of including width of kerbs and railings on the two sides.

The bridges has been broke down for 12m, 15m and 18m clear traverse with individual compelling ranges of 12.6m, 15.6m and 18.6m with skew edge of 0
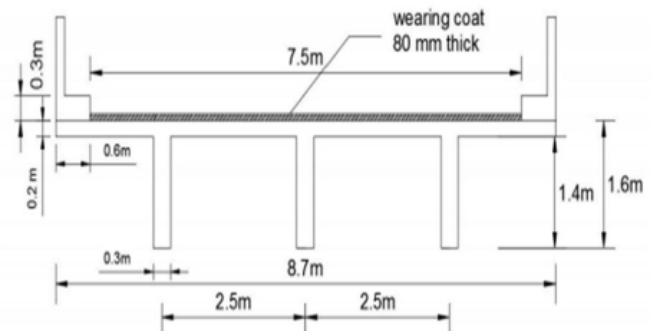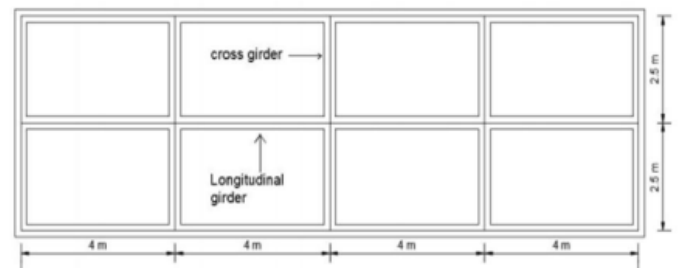

Figure 3.2: Cross-Section of T-girder deck

Figure 3.3: Plan view of T-girder deck

3.4 Methodology
3.4.1 Grillage Analogy Method

As of late, the Grillage Analogy Method, which is a PC arranged procedure, is progressively being utilized as a part of the examination and outline of extensions. The technique is additionally appropriate in situations where connect displays convoluting highlights, for example, overwhelming skew, edge solidifying and disengaged underpins .The utilization of PC encourages the examination of a few load cases in briefest conceivable time. The technique is adaptable in nature and the commitment of kerb bars and the impact of differential sinking of support closes over yielding course, (for example, neoprene bearing) can likewise be considered and extensive assortment of scaffold decks can be broke down with adequate functional exactness. Moreover, the grillage portrayal is helpful for give the originator a 'vibe' for the auxiliary conduct of the extension

and the way in which the scaffold loadings are disseminated and in the long run taken to the backings.

3.4.1.1 Idealization of Physical Deck into Equivalent Grillage

The strategy for grillage investigation includes the glorification of the extension deck as a plane grillage of discrete between associated shafts. This is the primary vital advance to be taken by the creator and requirements most extreme care and under-remaining of the basic conduct of the scaffold decks. It is hard to make exact general standards for picking a grillage work and much relies on the idea of the deck to be dissected, its help conditions, exactness required, quantum of processing office accessible and so on and just an arrangement of rules can be proposed for setting matrix lines. It might be noticed that such admiration of the deck isn't without traps and the framework lines embraced in one case may not be effective in another comparable case and the experience and judgment of the planner will dependably assume a noteworthy part.

3.4.1.2 General Guidelines for Grillage Layout

In view of the gigantic assortment of deck shapes and bolster conditions, it is hard to embrace immovable tenets for picking a grillage spread out of the genuine structure. In any case, some fundamental rules with respect to the area, heading, number, separating and so on of the longitudinal and transverse framework lines shaping the glorified grillage work, are depicted here. Be that as it may, each kind of deck has its own exceptional highlights and may require some specific game plans for setting admired framework lines and along these lines grillage glorification of section needs most extreme care.

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3.4.2 Grillage Mesh for T-Girder Bridge

The sensible decision of longitudinal lattice lines for T-beam bridge decks is to make them incidental with the middle lines of physical girders and these longitudinal girders are given the properties of the supports in addition to the related slab of the piece, which they speak to. Extra lattice lines between physical girders may likewise be set so as to enhance the exactness of the outcome. Edge gridlines might be given at the edges of the deck or at appropriate separation from the edge.

At the point when middle of the road cross supports exist in the genuine deck, the transverse framework lines speak to the properties of the cross braces and related deck sections. The grid lines are set in along the inside lines of cross supports. Grid lines are likewise set in the middle of these transverse physical cross girders, if in the wake of considering the successful rib width of these supports, bits of the slab are forgotten. A commonplace T-beam bridge with grillage layout is appeared in Figure 3.4.
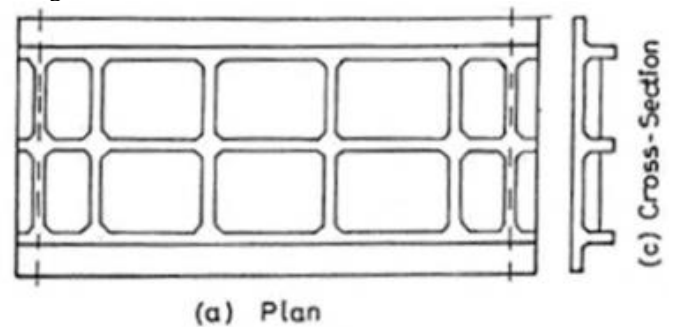

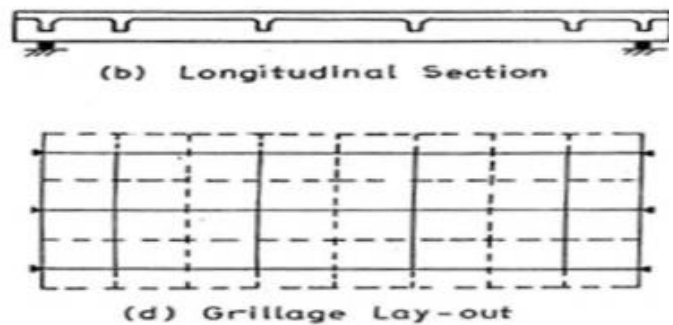Figure 3.4(a): (a) Plan and (c) cross-section of T-Girder Bridge

Figure 3.4(b): (b) longitudinal section and (d) grillage layout

3.4.3 Evaluation of Equivalent Elastic Properties

After the real extension structure is reenacted into equal grillage, comprising of longitudinal and transverse matrix lines meeting at discrete hubs, the second imperative advance in grillage relationship technique is to allocate suitable versatile properties i.e. flexural and torsional firmness' to every individual from the grillage so admired. This needs the calculation of proportionate flexural snapshot of inactivity I and torsional idleness J for the\ individuals from the grillage work. This is refined by considering secluded segments of the deck as though they are singular shafts and the idleness's are ascertained for each area and designated to the comparing grillage bars speaking to that segment.

3.4.3.1 Flexural and Torsional Inertias of Grillage Members for T-Girder bridges:

Slab-on-girders bridge decks comprise of various beams spreading over longitudinally between projections with a thin piece traversing transversely over the best. T- beam bridges are the normal cases under this classification. The beams might be thrown solidly with the section or the precast beams with in-situ slab might be utilized. The decks might be with or without middle of the road or potentially end stomachs. With the end goal of estimation of flexural and torsional dormancies, the powerful width of piece, to work as the pressure spine of T-beam or L-beam, is required. A thorough investigation for its assurance is greatly unpredictable and without more exact methodology for its assessment, IRC proposals are taken after.
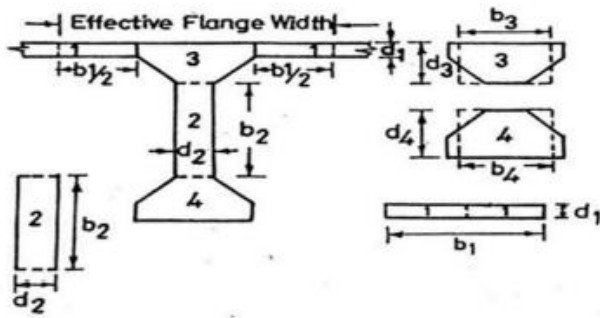
Figure 3.5: Sub-division of T-section

3.4.4 Application and Transfer of Loads to Various Nodes of Grillage

The bridge deck has been changed into an equal grillage comprising of longitudinal and transverse framework individuals with the end goal that the romanticized grillage is near the physical deck. Every individual from the grillage is apportioned flexural and torsional latencies which are proportional to the relating physical properties of the bridge deck. The longitudinal and transverse matrix lines shape a work having number of hubs. The scaffold is basically subjected to vertical burdens containing dead, live and affect loads. Grillage examination requires that these connected burdens be changed into equal burdens at hubs.

3.4.5 Design Constants

The various constants used in the analysis of bridge decks are given below:
Grade of Concrete = M30
Modulus of Elasticity, E_c = 3.05×107kN/m2 for all members
Density of RCC = 24 kN/m3
Poisson's Ratio = 0.15
Modular Ratio = 10

3.4.6 Finite Element Method

3.4.6.1 Basic theory

The limited component strategy has been a conspicuous decision for the displaying and investigation of strengthened solid frameworks for a long time. Limited components have the one of a kind capacity to fit in with essentially any geometry that could be physically executed. Along these lines, the limited component strategy has picked up acknowledgment as a proper instrument for the examination of level plates, particularly those with exceptionally sporadic or bizarre geometries where the immediate outline and equal edge methods are not substantial. In sporadic chunks, the limited component strategy can be appeared to precisely explain for the dissemination of stress where various approximations and suspicions would be summoned if the yield line or strip plan procedure were connected. The arrangement approach is construct either with respect to taking out the differential condition totally (relentless state issues), or rendering the PDE into an approximating arrangement of common differential conditions, which are then numerically incorporated utilizing standard systems. In illuminating halfway differential conditions, the essential test is to make a condition that approximates the condition to be considered, however is numerically steady, implying that blunders in the info information and middle of the road counts don't gather and cause the subsequent yield to be pointless. The

Finite Element Method is a decent decision for unraveling halfway differential conditions over complex areas.

3.4.6.2 The matrix displacement method used in FEM

The matrix relocation technique for investigation is utilized. The continuum structure is isolated into various sub- regions, called limited components, which are thought to be interconnected at the nodal focuses as it were. Inexact dislodging capacities are expected over each limited component. Dislodging similarity conditions are fulfilled and the overseeing harmony conditions that are created are tackled to yield the obscure nodal relocations. Once the removals are known, the strains may then be assessed from the strain-dislodging relations, lastly the anxieties are resolved from the pressure strain relations.
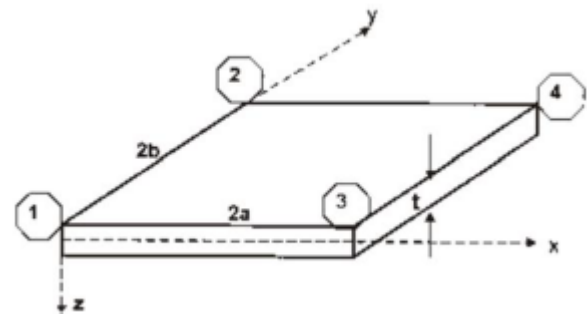

Figure 3.6: Co-ordinate system of plate element

The slab of the T-beam bridge deck is spoken to by non-adjusting yet entire rectangular plate bowing components with three degrees of flexibility for each hub (w, θx, θy) and a cubic dislodging model, (Fig 3.6). Concentrates by Gallagher demonstrated that this component is productive and yields arrangements of satisfactory precision.
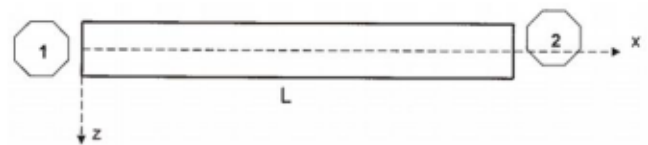

Figure 3.7: Co-ordinate system of beam element

3.5 Grillage Modelling of T-Girder Bridge Deck

The grillage displaying and investigation performed in this examination were finished utilizing a broadly useful basic examination and configuration program, STAAD. Master V8i is a business basic examination and configuration program created by Bentley Solutions Center. The program is accessible for PC. The examinations in this proposal were performed utilizing STAAD. Genius Version 2008. In this area illustrative examination is introduced thinking about 8.7m scaffold width and 12m, 15m and 18m extension traverse (length) like the regular segment appeared.
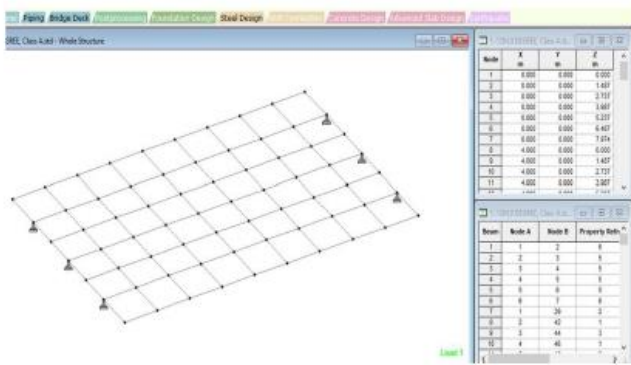
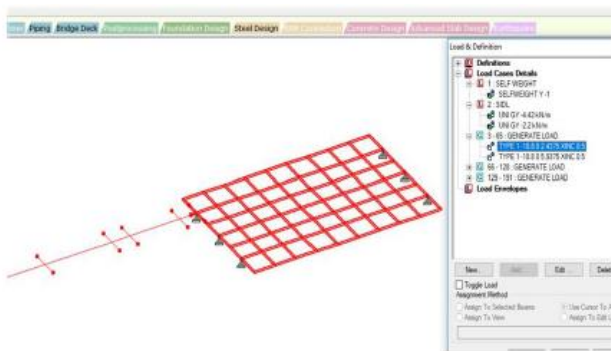Figure 3.8(a): grillage geometry of T-girder deck in STAAD Pro V8i

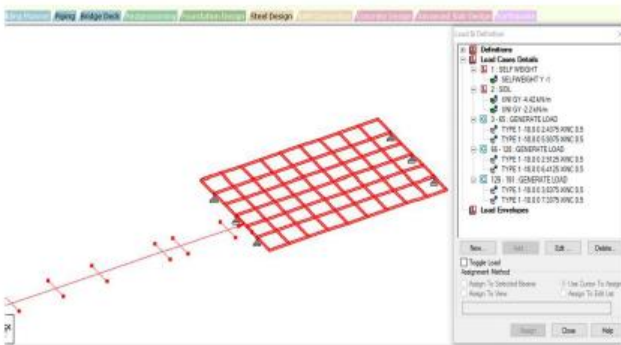Figure 3.9 (a): IRC Class A initial vehicle position case 1 (Moving Load) in STAAD.Pro V8i software.

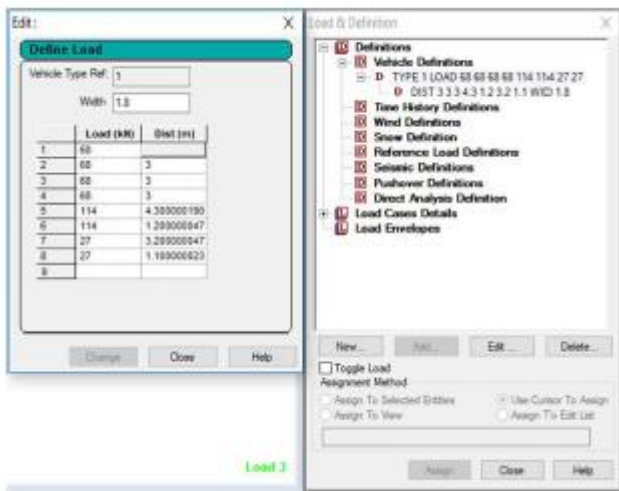Figure 3.9 (b): IRC Class A Moving load configuration case 2 in STAAD.Pro V8i Software

Figure 3.9 (c): Definition IRC Class a Moving load configuration in STAAD.Pro V8i Software.

The last advance is translation of the outcome, the yield acquired from the examination of grillage comprises of vertical redirection and X and Z revolution of every hub, shear drive and torsional snapshot of each shaft component, twisting minute at the two finishes of each bar component

3.6 Finite Element Modelling of T-Girder Bridge Deck
3.6.1 Modelling of Structure

The piece is demonstrated utilizing a plate component and it is discretized into limited component work which comprises of quadrilateral shell components. The shell components speaking to the section are 0.5m X 0.5m quadrilateral shell components with four hubs and six degrees of flexibility for each hub. The chunk has steady length of 12m and consistent width of 8.7m. This brought about a chunk show with 620 hubs, 732 plates and 3,720 degrees of opportunity. A draw of the limited component work is appeared in Fig 3.12. These plates have every one of the qualities as same as the solid piece all in all. These plates can deal with stresses independently. The flat components utilized are the standard shaft components.
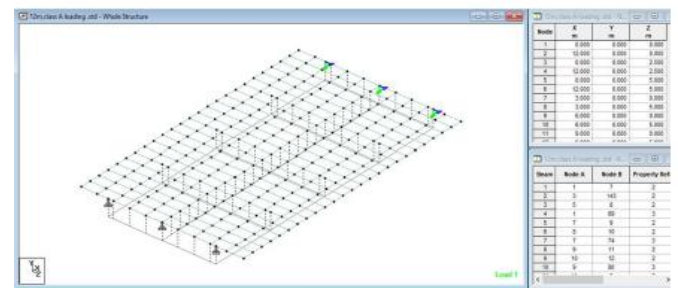
Figure 3.10: Geometry of the structure showing finite beam and plate element in STAAD.Pro V8i software.
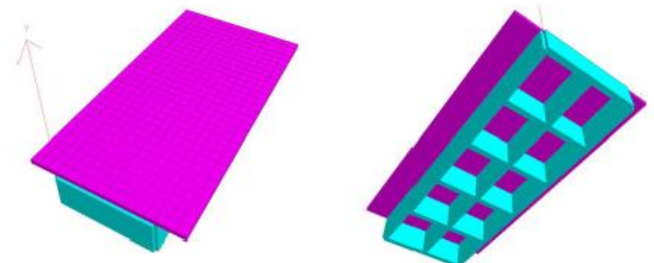
(a) Showing deck slab with quadrilateral (b) longitudinal and cross beam girders plate element

Figure 3.11: Rendered view of the structure in STAAD.Pro V8i software.

3.7 Loading Data

The following IRC 6:2014 loadings have been considered in the analysis of the bridge decks:

Dead Load: The dead load took care of by a scaffold part comprises of its fair share and bits of the heaviness of the superstructure and any settled burdens upheld by the individuals regarding super-forced dead load (SIDL).

IRC Class 70R Wheeled loading:

IRC Class70R wheeled loadings is of two types:

i) 70R Bogie loading weighing 400kN through two axles each weighing 200kN.

ii) 70R train loading weighing 1000kN through seven ales, one axle of 80kN, two axles of 120kN each and four axles of 170kN each. The wheeled vehicle is 15.22m long. The dimensions of the Class 70R wheeled loading vehicle.
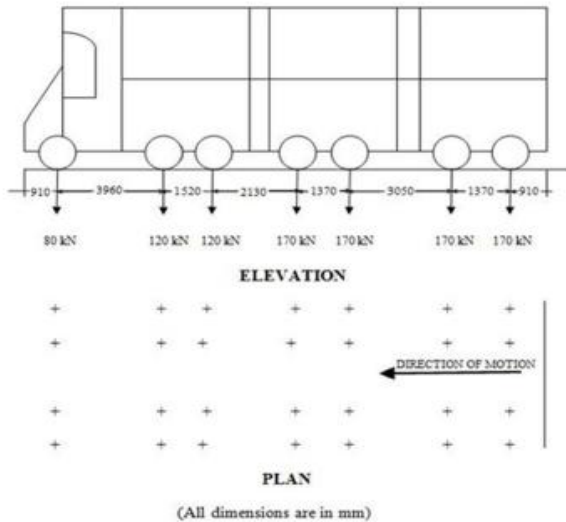
Figure 3.12: IRC 70R wheeled loading

3.8 Output Data

The two different types of bridge decks as mentioned in the objectives have been

Analyzed for the following forces:

- Maximum Longitudinal Bending MomentsMaximum
- Torsional Moments
- Maximum Shear Forces

4. Results and Discussion

In the present investigation the subtle elements have been examined and broke down for the two models of T-support kind of scaffold deck utilizing grillage similarity and limited component examination keeping in see the multifaceted nature required in the outline of extension decks for various traverses utilizing STAAD PRO V8i programming. Along these lines show work encourages in to set up and exhibit a helpful, solid, and precise procedure for breaking down strengthened solid structures with specific accentuation on fortified solid extension decks. The outcomes are thought about as far as longitudinal bowing minutes, shear powers, torsional minutes, and bolster responses for the two sorts of extension decks in the both graphical and forbidden frame.

4.1 Discussion of Results
4.1.1 Longitudinal Bending Moments (kN-m)

1. **Self-Weight:** The varieties of longitudinal bowing minute for various traverses running from 12m to 18m because of self-weight of the structure are exhibited in Table 4.1 and Figure 4.1. Variety of longitudinal BM of traverse 12m in grillage relationship and FEM is appeared in Figure 4.2(a) and 4.2(b) individually
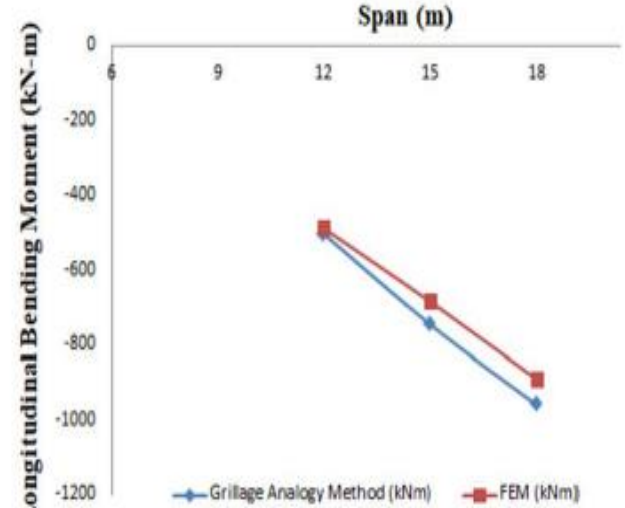
Figure 4.1: Variations of maximum longitudinal B.M. with varying span
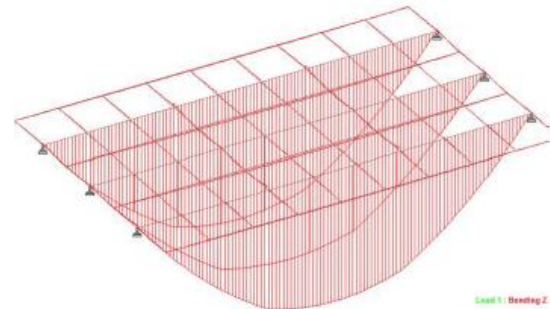
Figure 4.2(a): Variations of maximum longitudinal B.M. of span12m Under self-weight using grillage analogy

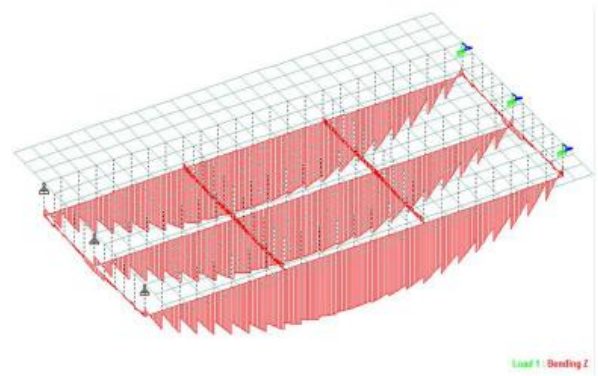

Figure 4.2(b): Variations of maximum longitudinal B.M. of span12m Under self-weight using FEM

Limited component gives the littlest positive and negative in light of the distinction in work (more discretization), while every one of the shafts are symmetrical in properties (thickness, width, materials, stacking) and the benefit of stacking is same for each model. Limited component demonstrate gives less reaction than grillage display.

2. **SIDL:** Variety of longitudinal BM of traverse 12m in grillage similarity and FEM is appeared in Figure 4.4(a) and 4.4(b) individually

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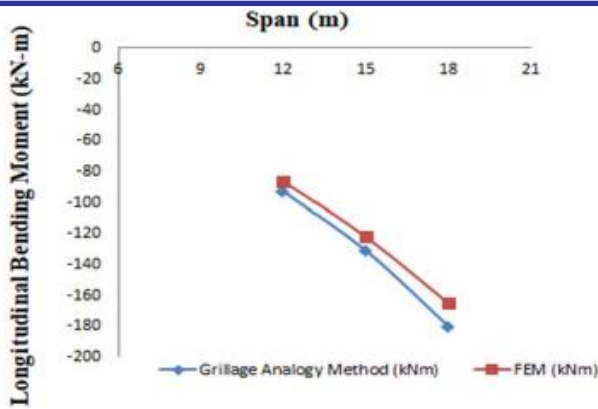**Vol. 10 Issue 06, June-2021**

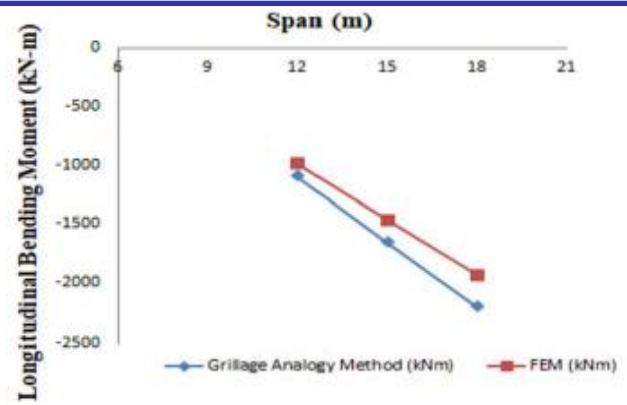Figure 4.3: Variations of maximum longitudinal B.M. (in case of SIDL)

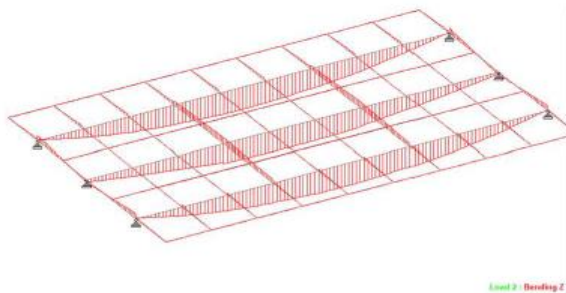Figure 4.5: Variations of maximum longitudinal B.M. with varying span (in case of IRC 70R loading)

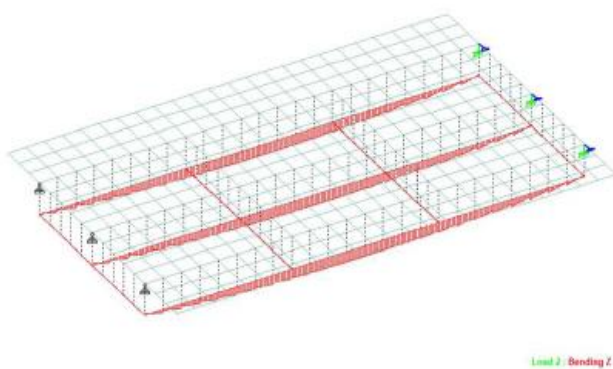Figure 4.4(a): Variations of maximum longitudinal B.M. of span 12m under SIDL using grillage analogy

Figure 4.6(a): Variations of maximum longitudinal B.M. of span 12m IRC Class 70R (W) Using grillage analogy

Figure 4.4(b): Variations of maximum longitudinal B.M. of span 12m under SIDL using FEM

3 Live Load Conditions: The extension deck has been examined according to IRC 6:2014 rules for two instances of IRC live loadings i.e. IRC Class 70R wheeled stacking and IRC Class A stacking.

IRC Class 70R(W) loading: The variety of twisting minute initiated in connect for IRC Class 70R wheeled stacking vehicle for various ranges has been exhibited in Table 4.3 and the graphical portrayal of the same has been introduced in Figure 4.5, Figure 4.6(a) and Figure 4.6(b). It has been watched that longitudinal twisting minutes demonstrate an expanding pattern for the live stacking condition 70R in both FEM and grillage similarity with increment in traverse.
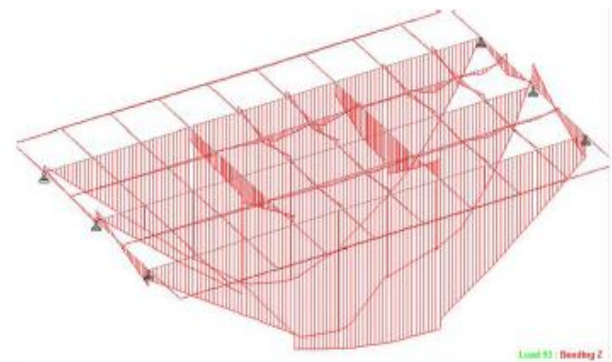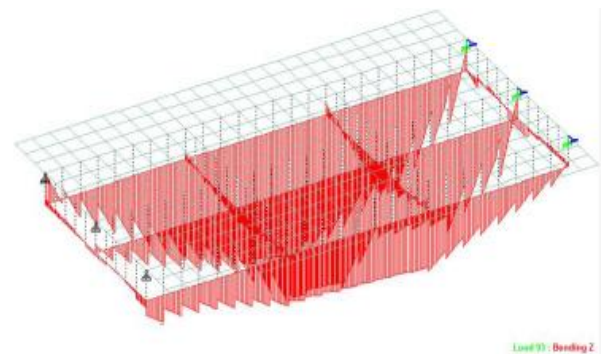

Figure 4.6(b): Variations of maximum longitudinal B.M. of span 12m IRC Class 70R (W) Using grillage analogy

4. IRC Class A loading: The varieties of plan longitudinal bowing minute in the extension deck for expanding ranges under IRC Class A live stacking have been exhibited in Table 4.4 and Figure 4.7. Variety of longitudinal BM of traverse 12m in grillage relationship and FEM is appeared in Figure 4.8(a) and 4.8(b) individually.

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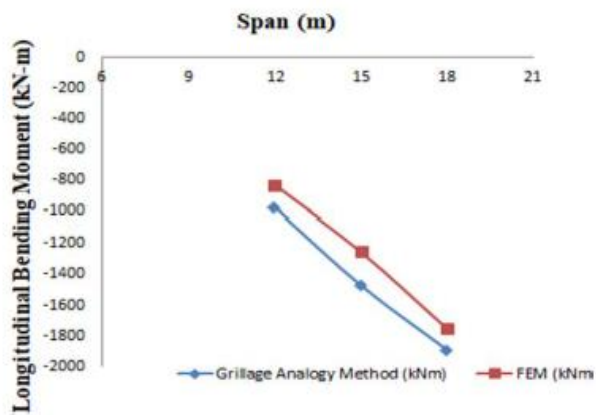**ISSN: 2278-0181**
Vol. 10 Issue 06, June-2021

Figure 4.7: Variations of maximum longitudinal B.M. with varying span (in case of IRC Class A loading)
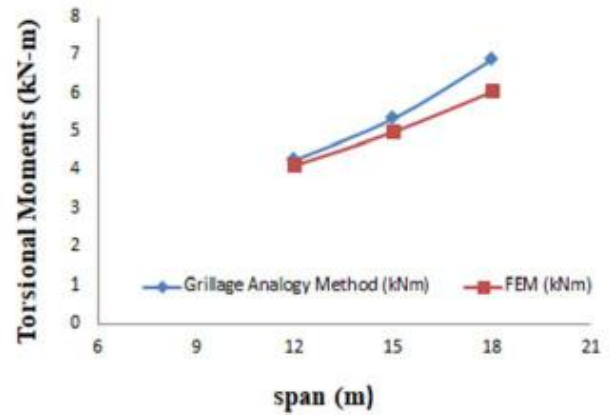

Figure 4.9: Variations of maximum Torsional moment with varying span (in case Self-weight)
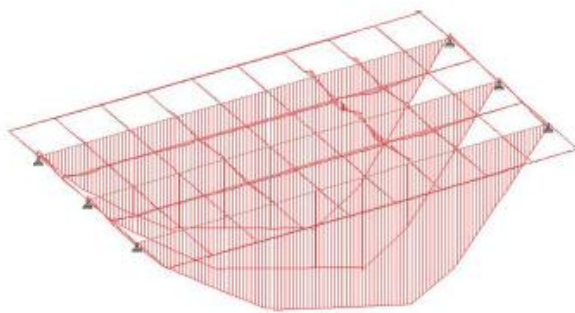

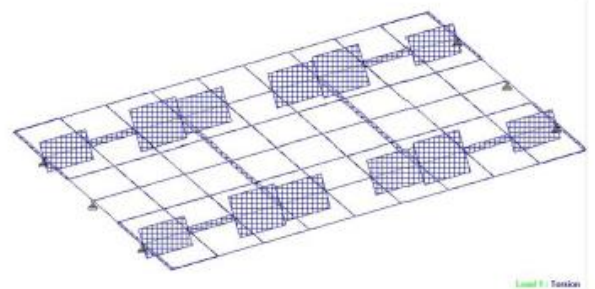Figure 4.8(a): Variations of maximum longitudinal B.M. of span 12m under IRC Class A loading using grillage analogy

Figure 4.10(a): Variations of maximum Torsional moment of span 12m under Self weight using Grillage Analogy
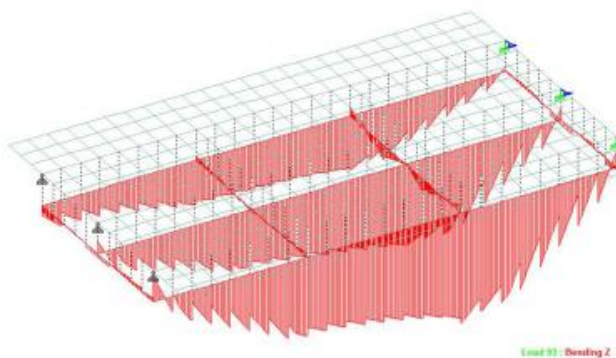
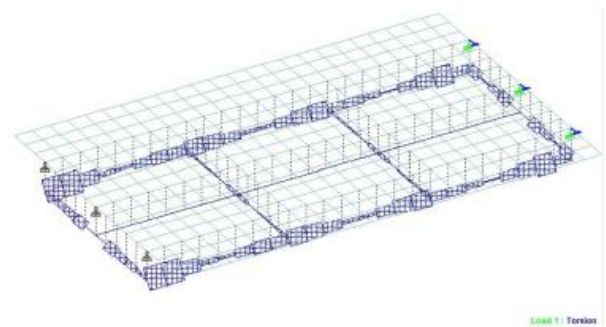Figure 4.8(b): Variations of maximum longitudinal B.M. of span 12m under IRC Class A loading using FEM

Figure 4.10(b): Variations of maximum Torsional moment of span 12m under Self weight using FEM

4.1.2 Torsional Moments (kN-m)

1. **Self-weight:** The variety of torsional minutes for traverses going from 12m to 15m because of self-weight of the structure is displayed in Table 4.5 and spoke to graphically in Figure 4.9. The investigation comes about demonstrates those most extreme torsional minutes were observed to be accumulated more at closures of the scaffold deck when contrasted with the focal point of the deck as appeared in Figure 4.10(a) and Figure 4.10(b).

2. **SIDL :** The torsional minutes incited in the scaffold deck were found to increment with the expansion in traverse as saw from the Table 4.6 and similar varieties are spoken to graphically in Figure 4.11. It is likewise watched that variety in the torsional minute in 12m traverse between grillage relationship and FEM is 3% where as it indicates expanding nature when traverse length increases\ independently in both the techniques as appeared.
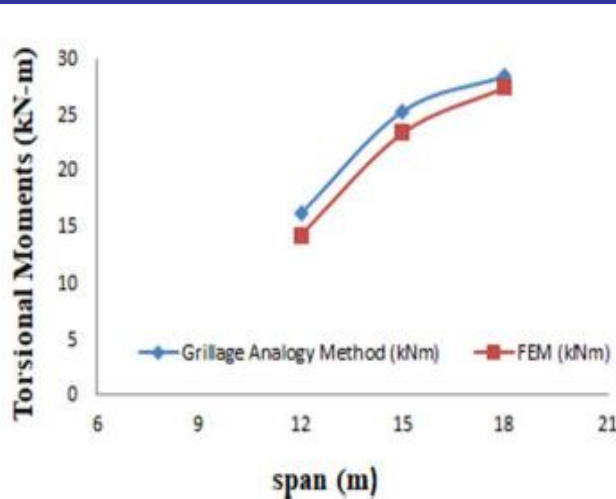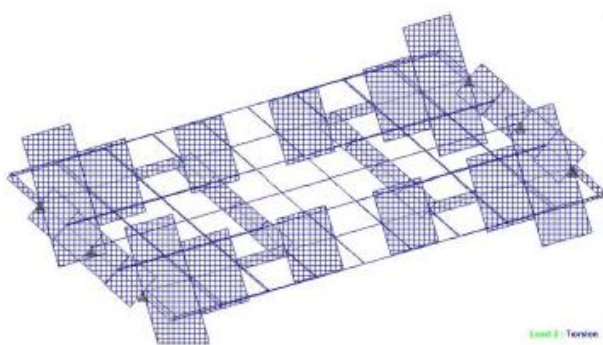
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Figure 4.11: Variations of maximum torsional moment with varying span (in case of SIDL)

Figure 4.13: Variations of maximum Torsional Moment with varying span (in case of IRC 70R loading)

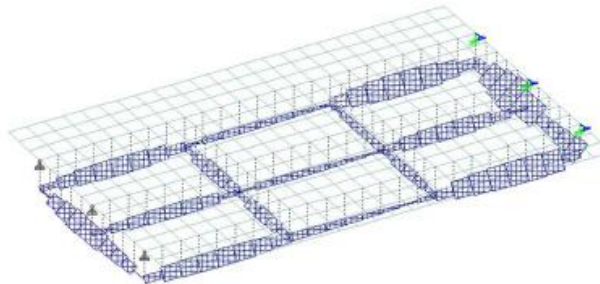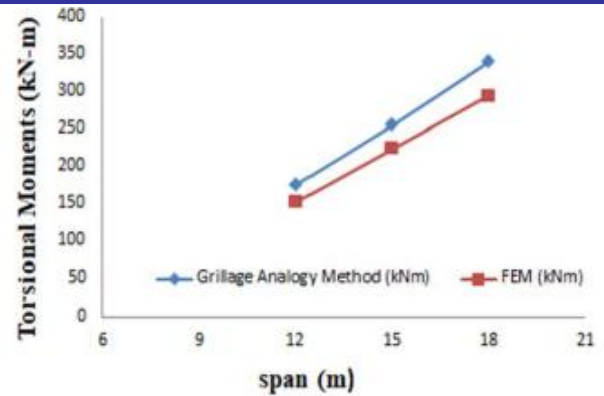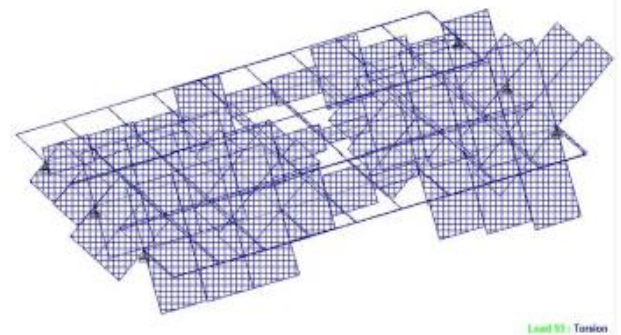Figure 4.12(a): Variations of maximum torsional moment of span 12m under SIDL Using Grillage Analogy

Figure 4.14(a): Variations of maximum Torsional Moment of 12m span under IRC 70R loading using Grillage Analogy

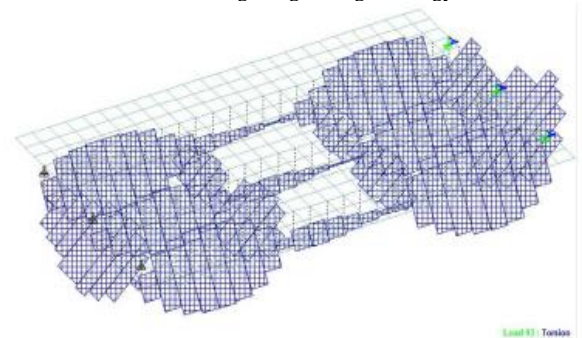Figure 4.12(b): Variations of maximum torsional moment of span 12m under SIDL Using FEM

Figure 4.14(b): Variations of maximum Torsional Moment of 12m span under IRC70R loading using FEM

3. Live load conditions: The extension deck has been investigated according to IRC 6:2014 rules for two classes of IRC live loadings-IRC Class 70R haggled Class A stacking. The investigation comes about are examined underneath:

a) IRC Class 70R(W) loading: The variety of torsional minutes because of IRC Class 70R stacking case for traverses extending from 12m to 18m has been exhibited and Figure 4.13. Varieties of most extreme torsional snapshot of traverse 12m under IRC Class 70R (w) utilizing Grillage Analogy and FEM is appeared in Figure 4.14(a) and Figure 4.14(b)

b) IRC Class A loading: IRC Class A loading: The torsional minutes have been found to have more prominent incentive in grillage similarity technique then FEM with the expansion in traverse under IRC Class A stacking and the same is spoken to graphically in Figure 4.15. Varieties of most extreme torsional snapshot of traverse 12m under IRC Class An utilizing Grillage Analogy and FEM is appeared in Figure 4.16(a) and Figure 4.16(b)
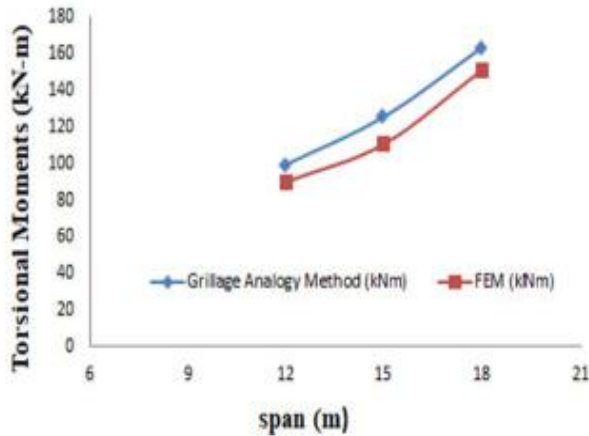
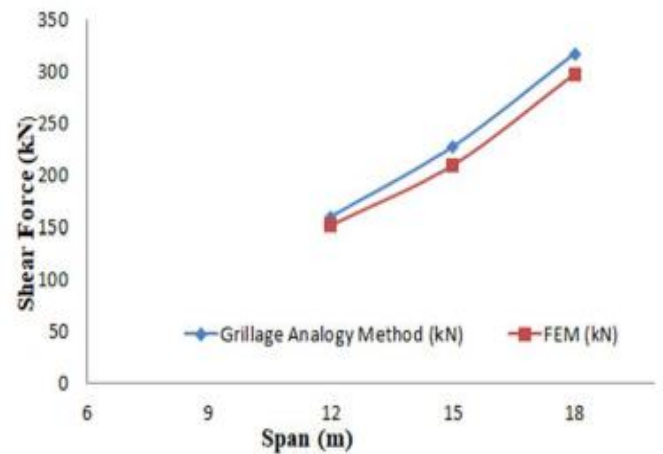Figure 4.15: Variations of maximum Torsional Moment with varying span (in case of IRC Class A loading)

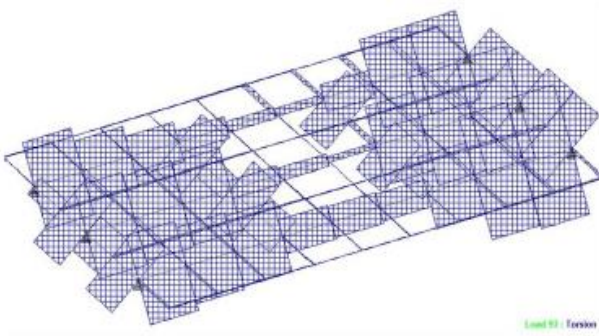Figure 4.17: Variations of shear force with varying span (in case of self-weight)

Figure 4.16(a): Variations of maximum Torsional Moment of 12m span under IRC Class A loading using Grillage Analogy
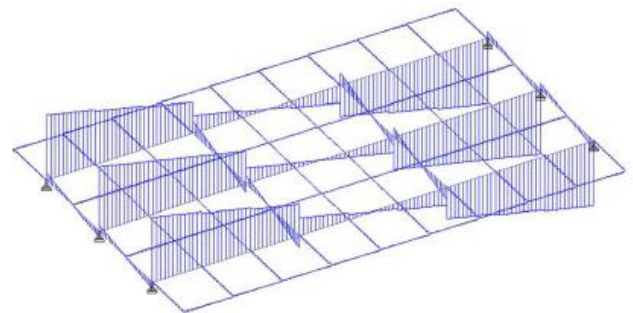

Figure 4.18(a): Variations of shear force of 12m span under self-weight using Grillage Analogy
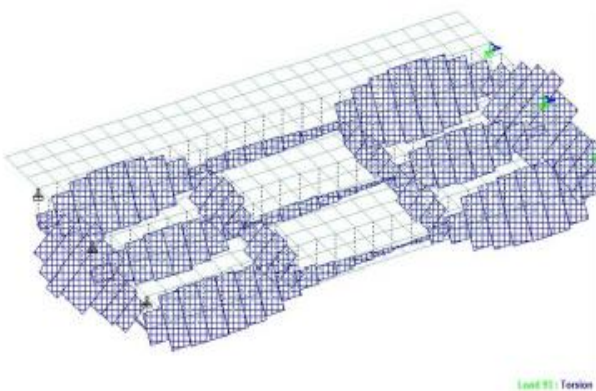

Figure 4.16(b): Variations of maximum Torsional Moment of 12m span under IRC Class A loading using FEM
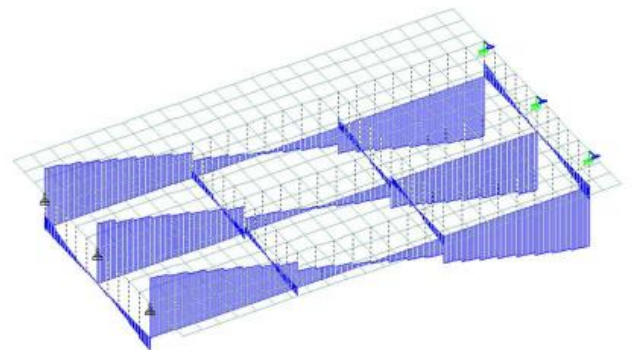

Figure 4.18(b): Variations of shear force of 12m span under self-weight using FEM

4.1.3 Shear force (kN)
1. **Self-Weight**: The variation of maximum shear force for right spans ranging from 12 m to 18m due to self-weight of the structure has been presented in Figure 4.17.

2. SIDL: The relatively same pattern for the outline shear powers has been gotten for SIDL case as got on account of self-weight stacking case, the variety in the consequences of FEM and Grillage Analogy all the more yet relatively same for various traverse length, as exhibited in Table 4.10 and graphically looked at as appeared. Varieties of shear power of 12m traverse under self-weight utilizing Grillage and FEM is appeared in Figure 4.20(a) and Figure 4.20(b)
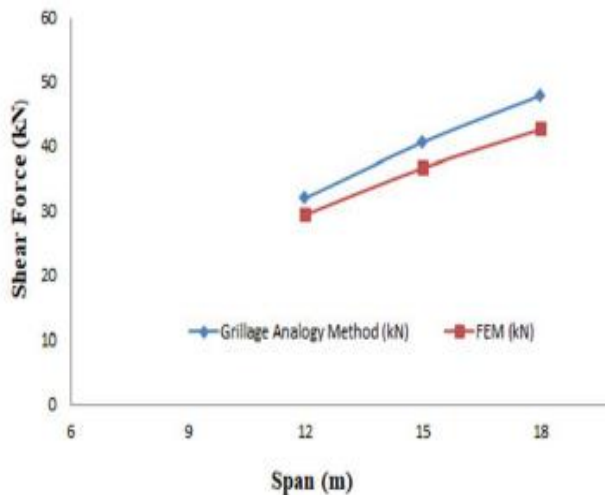
Figure 4.19: Variations of maximum shear force with varying span (in case of SIDL)
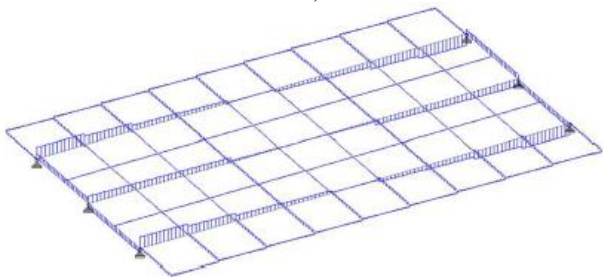

Figure 4.20(a): Variations of maximum shear force of 12m span under SIDL using Grillage Analogy

3. Live Load Conditions: The extension deck has been dissected according to IRC 6:2014 rules for two classes of IRC live loadings-Class 70R wheeled stacking and Class A stacking. The examination comes about for the two kinds are talked about underneath:

IRC Class 70R(W) stacking: The most extreme shear powers have been found to increment with increment in traverse in both the models under IRC Class 70R wheeled stacking as saw and the varieties are spoken to graphically in Figure 4.21. Varieties of shear power of 12m traverse under self-weight utilizing Grillage and FEM is appeared in Figure 4.22(a) and Figure 4.22(b)
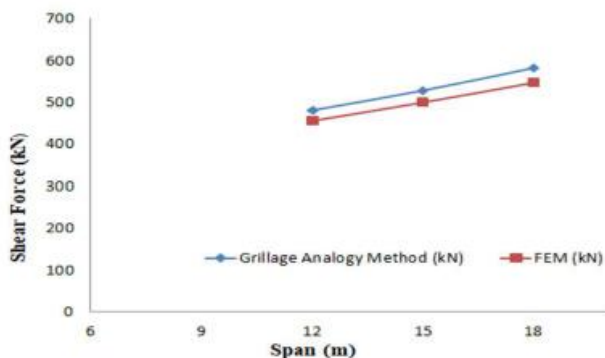

Figure 4.21: Variations of maximum shear force with varying span (in case of class 70R (W) live loading)
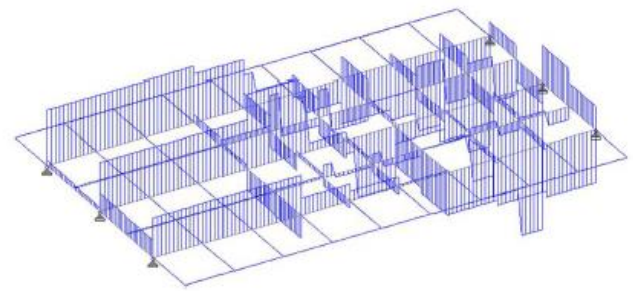

Figure 4.22(a): Variations of maximum shear force of 12m span under class 70R (W)

Live loading using Grillage Analogy

Figure 4.22(b): Variations of maximum shear force of 12m span under class 70R (W) live loading using FEM

a) IRC Class A loading: The greatest shear powers have been found to increment with increment in traverse in both the models under IRC Class A stacking and the varieties are spoken to graphically in Figure 4.23. A similar rising pattern for this situation likewise has been seen as on account of the power reactions got from the use of IRC Class 70R live stacking. . Varieties of shear power of 12m traverse under self-weight utilizing Grillage and FEM is appeared in Figure 4.24(a) and Figure 4.24(b)

Figure 4.23: Variations of maximum shear force with varying span (in case of IRC

Class A loading)

Figure 4.24(a): Variations of maximum shear force of 12m span under IRC Class A
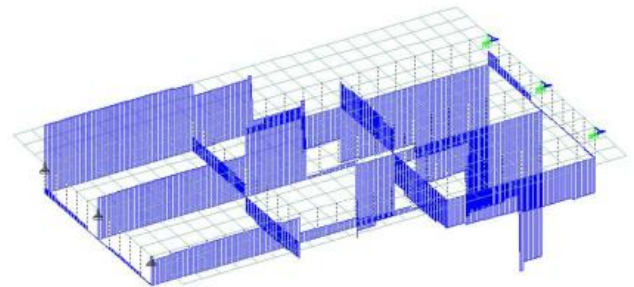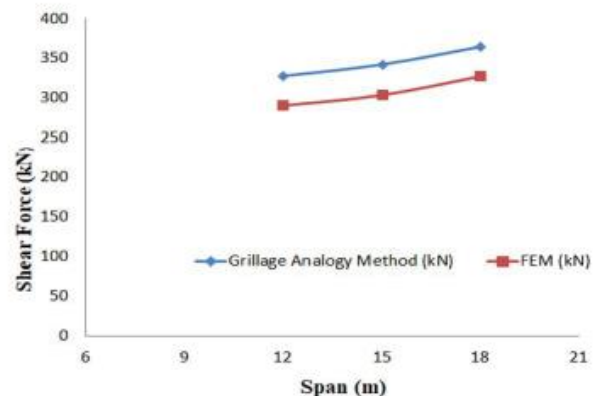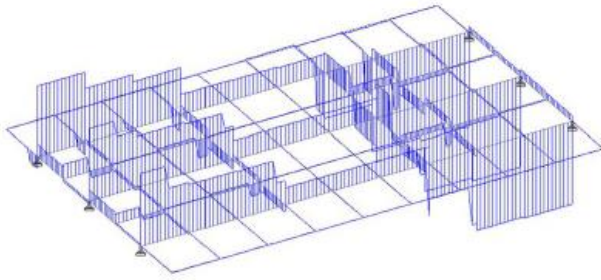
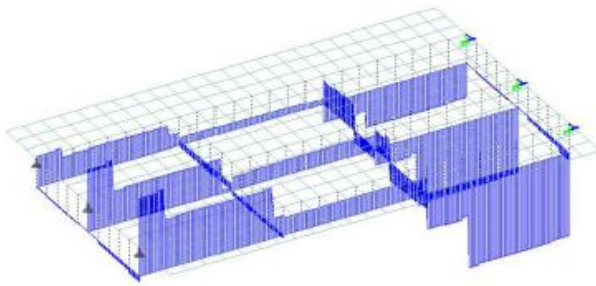**loading using Grillage Analogy**

Figure 4.24(b): Variations of maximum shear force of 12m span under IRC Class A loading using FEM

Thus for all the considered load cases, the shear force tends to increase with the increase in span ranges also with methodology. The variations in shear forces in percentage difference along the span for all the loading cases are as follows:

Self-weight- in the range of 5% to 8%

SIDL- in the range of 8% to 10%

Live IRC Class 70R wheeled loading- in the range of 5 % to 6.5 %

Live IRC Class A loading- in the range of 10% to 12%

5. CONCLUSIONS

Bridges are a standout amongst the most difficult activity of all considerate designing works. The number and sizes of scaffolds have persistently expanded in the previous couple of years. This has\ required to grow new plan systems. To adapt up to this request, gigantic endeavors everywhere throughout the world as dynamic research in the investigation, plan and development of Bridges are proceeding. The focal point of this demonstrating is to discover the reason of the outcomes' disparities of the two models, while the goal of this proposal is to recreate the conduct of scaffold structure as far as (shear drive, twisting minute, and torsion) by fluctuating the traverse. All done by STAAD.Pro V8i programming. In the present work, it has been watched that more drawn out traverse spans are one of real worry due to conjusted urban regions and in addition expanded activity development rate. The parametric investigation on T-Girder solid extension for differing traverse length has been led, the parameters like bowing minutes, torsional minutes and shear powers have been dissected for IRC Class An and 70R stacking on T-support spans. The near investigation was directed in light of the expository demonstrating of just upheld RC T-bar Bridge by grillage similarity technique and Finite component strategy utilizing Staad Pro V8i. Based on the examinations, it has been presumed that:

- Based on this examination grillage relationship technique gives the moderate outcome with deference BM esteems in the longitudinal brace when contrasted with limited component strategy.

- In the instance of T-Girder bridges, it has been watched that the longitudinal bowing minutes demonstrates a rising pattern with increment in ranges. In any case, the mid traverse longitudinal twisting snapshots of the external girders, were observed to be relatively higher than then the longitudinal bowing minutes in the center support. The varieties in rate contrast for right edge straight bridges between grillage similarity and limited component technique are found in the scope of 2% to 8 % for dead load cases and 10% to 14.5% for live load cases, which are stopped worthy qualities.

  In the instance of T-Girder bridges, it has been watched that the torsional minutes increments with increment in traverse and furthermore external brace demonstrates more torsional minute at that point center support. The varieties in rate contrast between two strategies are found in the scope of 3% to 12% for dead load cases and 12% to14% for live load cases.

- In the instance of T-Girder bridges, it has been watched that the shear compel additionally increments with increment in ranges. Likewise, it has been discovered that most extreme shear powers tend to increment close to the edge backings of the external supports for every one of the traverses considered in the investigation. The varieties in rate distinction between the grillage similarity technique and limited component strategy are found in the scope of 5% to 10% for dead load cases and 5% to 12% for live load cases.

- When the explanatory outcomes are looked at for IRC Class 70 R (W) and IRC Class A stacking, it has been discovered that the plan esteems with IRC Class 70 R (W) give relatively high reactions and in this way are represented to be utilized as a part of the outline of the extensions.

- In conclusion, Finite Element show has more discretization (more exact), so the plan base of this reaction with the littler component gives less measure of materials et cetera (that is the conservative factor), therefore limited component demonstrate is more temperate outline than grillage display.

- Maximum BM happens for class 70R wheeled vehicle. Thus class 70R vehicle case is the most basic case for greatest BM in longitudinal brace.

- Maximum SF happens for class 70R wheeled vehicle. Thus class 70R wheeled vehicle case is the most basic case for greatest Shear compel in longitudinal brace.

6. FUTURE SCOPE

However during the course of this study, it has been found that there are still some grey areas. In order to find the more details, further studies can be recommended in the following ways:

- In request to discover the points of interest, the investigation can be led on more extraordinary kind of RCC spans and diverse span cases.
- The study can be additionally stretched out to multi-lane bridges.

- The study has been led on basically upheld deck chunk. An examination might be led on consistent deck slabs.
- The study can be additionally stretched out for breaking down the impact of skew edges by considering stress and strain parameters.

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