Serviceability Analysis and Design in Ultimate State of Bridge for Class 70R IRC Loading

Dolly Dhomne, Research Scholar, Tulsiramji Gaikwad-Patil College of Engineering and Technology, Nagpur, India, dolly.d.dhomne@gmail.com

Amey Kedikar, Asst. Professor, Civil Engineering department, Tulsiramji Gaikwad-Patil College of Engineering and Technology, Nagpur, India, amey.khedikar@gmail.com

Abstract - **Nowadays in the field of bridge engineering, the development of pre-pressurized concrete bridge floors has been expanded due to its improved carrying capacity. The analysis was performed using IRC codal terms. T-beam bridge decks are one of the largest types of cast-in-situ concrete decks that include a concrete slab attached to belts. The problem in continuum mechanics is rated by FEM (standard feature method) in STAAD Pro, which is a standard method of structural analysis. In this study a single-span t-beam bridge is analyzed by changing the lengths of 25m, 30m, 35m and 40m when the width does not change. Models of bridges under the IRC AA category and the IRC loading system of the section 70Rtracked to determine the curve time and shear strength. From the analysis it is noted that with the increase in span, the Courbon method and the limited feature method have no significant differences.**

Keywords:* *70R IR Code, Finite element method, Bridge etc.

I. INTRODUCTION

Bridges are defined as structures which are provided a passage over a gap without closing way beneath. They may be needed for a passage of railway, roadway, footpath and even for carriage of fluid, bridge site should be so chosen that it gives maximum commercial and social benefits, efficiency, effectiveness and equality. Bridges are nation's lifelines and backbones in the event of war. Bridges symbolize ideals and aspirations of humanity. They span barriers that divide, bring people, communities and nations into closer proximity [1]. They shorten distances, speed transportation and facilitate commerce. Bridges are symbols of humanity's heroic struggle towards mastery of forces of nature and these are silent monuments of mankind's indomitable will to attain it. Bridge construction constitutes an importance element in communication and is an important factor in progress of civilization, bridges stand as tributes to the work of civil engineers [1][2].

Classification of Bridges:

Bridges are classified based on different criteria as follows According to function as aqueduct (canal over a river), viaduct (road or railways valley, pedestrian, highway, railway, road-cum-rail or pipe line bridge. According to material of construction of super structure as timber, masonry, iron, steel, reinforced concrete, prestress concrete, composite or aluminum bridge. According to form or type of super structure as slab, beam, truss, arch, suspension bridge. According to inter span relation as simple, continuous and cantilever bridge. According to position of bridge floor relative to superstructure as a deck, trough, half-trough or suspension bridge. According to span length as culvert (less than 8m), minor bridge (8m to 30m) or long span bridge [2].

A bridge is a structure having a total length above 6m for carrying moving loads or pedestrian load and across the obstacle, a bridge is a structure which is built over an obstacle and hence providing a passage without obstructing the object. The passage may be for a railway, a road, a pipeline, a valley, or a canal. The development of the country based on the infrastructure available in the country. Highway which allows the flow of human beings and vehicles is a major part of infrastructure. the construction of bridge is necessary where there is a heavy traffic congestion which results in delay for the passengers. Construction of bridge will reduce the delay and allow the vehicles to travel without interruption. And It is also important to select the suitable type deck slab for different spans keeping good appearance and economy in consideration and construction [3].

The planning of these structures has two important parts first is Traffic Assessment and second is layout and Structural design. As per IRC 92-1985, the bridge design is preferred when the [Passenger Car Unit] value at the intersection exceeds 10,000. IRC codes are developed and used from time to time based on the research work carried out all over the world. There are many different type of bridge designs that each have its particular reason for design, the designs of bridges depending on the function of the bridge, the nature of the terrain where the bridge is constructed, and the material used to make it, and the funds provided to build it. Deck slab is that part of the bridge which transmitted the load passing the same to the substructure. T-beam are so called

 DOI : 10.35291/2454-9150.2022.0319

because the longitudinal girders and deck are cast monolithically i.e at the same time to form a T shaped bridge structure. A T-beam or beam and slab is constructed when the span is between 10-20 meter. The bridge deck essentially consists of a concrete slab monolithically cast over longitudinal girders so that T-beam formed [3][4].

The number of longitudinal girders depend on the width of road. Three girders are normally provided for two lane road bridge. IRC 21-2000 code is used for designing RCC road bridges and IRC 112 are used for precast bridges design. Indian Roads Congress introduces new code of practice i.e., IRC 21 for designing of road bridges in India it is based on the WSM and IRC 112 is based on the limit state method. The Superstructure consists of longitudinal girder, cross girder, deck slab, cantilever portion, handrails, and wearing coat kerb and crash barrier, bearings etc. Cross beam is provided mainly to stiffen the girders and to minimized torsion in the exterior girders these are essential over the supports to prevent lateral spread of the girders at the bearings another function of the cross beams is to equalize or balance the deflections of the girders carrying heavy loading with those of the girders with less loading. The web of the beam below the compression flange are provided to resist shear stress [4].

II. PROJECT BACKGROUND

The bridge superstructure and other component of bridge, is subjected to a set of loadings condition which the component must with stand and effectively take the load. The design of bridge is based on these loadings. These loads may vary depending on duration, direction of action, type of deformation and nature of structural action such as (shear, bending, torsion etc.). In bridge there are mainly two type of loading first is dead load which is self-weight of bridge acting as a UDL and second is live load which is consider as vehicle load which act as a point load on the bridge and the other type of loading like wind load and impact load etc. which are taken in to the account according to the situation. In order to form a consistent basis design, the IRC has developed a set of standard loading condition, which are taken into account and use while designing while designing a bridge. IRC has developed four type of live load condition they are [5],

(1) IRC Class 70R Loading: IRC Class 70R Loading is applied for permanent bridges and culverts. Bridges designed for class 70R loading is checked for Class A loading.

(2) IRC Class AA Loading: IRC Class AA Loading is adopted within municipal limits for existing and industrial areas.

(3) IRC Class A Loading: IRC Class A loading is adopted for all roads on which permanent bridges and culverts are to be constructed.

(4) IRC Class B Loading: IRC Class B loading is adopted for timber bridges.

Bridges have been the most visible testimony to the contribution of engineers. Bridges have always figured prominently in human history. They enhance the vitalities of the cities and aid the social, cultural and economic improvements of the locations around them. Bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline and the obstacle to be crossed may be a river, a road, railways or a valley.

The portion of the bridge structure below the level of the bearing and above the founding level is generally referred to as the substructure. The design of bridge substructure is an important part of the overall design for a bridge and affects to a considerable extent the aesthetics, the safety and the economy of the bridge. Bridge substructure are a very important part of a bridge as it safely transfers the loads from the superstructure to the earth in such a manner that the stresses on the soil are not excessive & the resulting deformations are within the acceptable limits. The selection of the foundation system for a particular site depends on many considerations, including the nature of subsoil, location where a bridge is proposed to be constructed i.e., over a river, road, or a valley, etc. & the scour depth [5][6].

A bridge may have either have the following types of foundations:

1. Well foundations: It is the most common type of foundation in India for both road & railway bridges. Such foundation can be sunk to great depths and can carry very heavy vertical and lateral loads. Well foundations can also be installed in a boulder stratum. It is a massive structure and is relatively rigid in its structural behavior.

2. Pile foundations: It consist of relatively long and slender members, called piles which are used to transfer loads through weak soil or water to deeper soil or rock strata having a high bearing capacity. They are also used in normal ground conditions for elevated road ways. The analysis and the design of all the components of a bridge particularly with reference to the bridge substructure can become a very lengthy and laborious task if the calculations are attempted manually [6][7].

 DOI : 10.35291/2454-9150.2022.0319

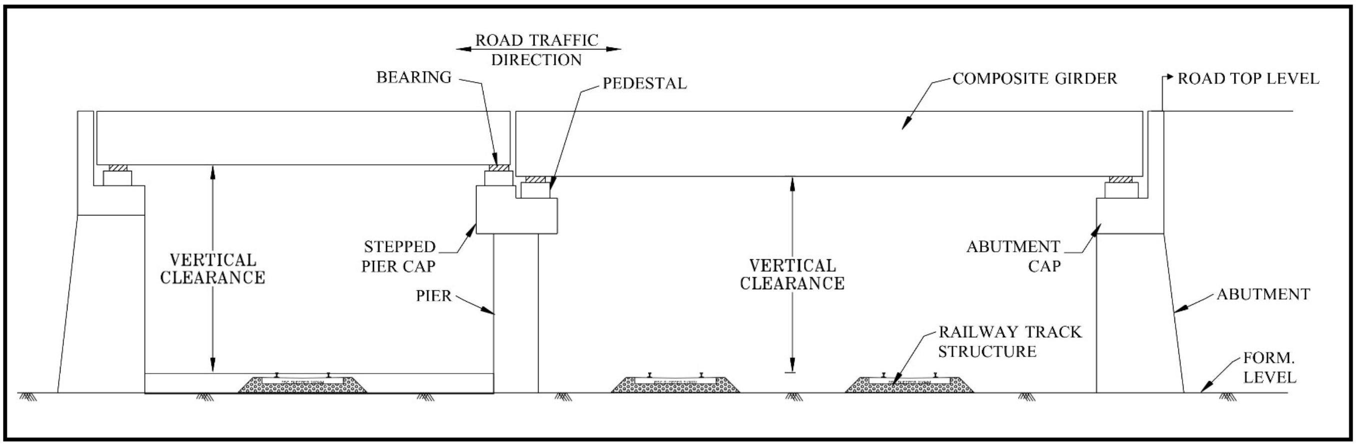

Fig. 1. Scematic Diagram of Road Over Bridge

III. OBJECTIVE

- Identifying a combination of Class A & Class 70R car IRC Load's car according to the vehicle's width.
- Create a slab & girder superstructure model in STAAD Pro and analyze the effects of live Load delivery, Real Personal Weight, SIDL coating and gain response in a controlled environment.
- Modeling and analyzing the location of the various combinations of load in accordance with the IRC Codes.
- Assessing the sustainability of the pit area as per the conditions provided in the codes.
- Provide initial reinforcement to calculate the pressure and width of the crack in the Operating System and biaxial bending times as provided in the IS & IRC codes.
- Review to confirm if the above conditions fail.

IV. PROJECT METHODOLOGY

A bridge is a structure that provides a way to pass over an obstacle without blocking the path to the bottom. Required passage may be a road, railway line, pedestrian, ditch or pipeline. The obstacle to cross can be a river, a road, a railway line or a valley. A bridge is a structure that carries traffic jams or other loads moving over stress or disruption such as a station, road or rail.

There are many types of bridges being built nowadays. In the present study our main thing is,

1) Easily supported bridge

2) Continuous bridge.

- ***Simply supported bridge***

The length of the bridge is usually divided by the number of individual spans. In each case, the member carrying the load is simply based on both ends. Easy-to-support bridges should be provided where the adjacent width inevitably differs in length and depth, or where the adjacent width has very different geometries with no-frame structures that do not lend themselves to continuity, such as variation of wooden spaces or framing frames. Ideally when the bridge is part of a building, such as an exchange, where the construction of the stage will require the removal or addition of one or more spaces.

- ***Continuous bridge***

For continuous bridges the width extends over two or more foundations. They are mathematically unstable structures. They are useful if uneven resolution of the foundations does not occur. For continuous bridges the bending time and removal anywhere in the pen is much less than in the case of Easy support. Such a reduction in bending time and deviation eventually leads to the economic phase of the bridge.

A. Types Of Bridge

- ***Based on super structure***

1) Arch Bridge

The arch bridge is a curved bridge, where horizontal thrust is developed and is blocked by abutments at the end of the bridge. There are many types of arch bridges available. In some cases, the arch may be below the deck slab as well.

2) Girder Bridge

In the case of Girder Bridge, the deck slab is supported by belts. The belt may consist of a folded metal belt or plate girder or girdle box. The load from the deck is taken up by the girder and transferred to the piers and abutments.

3) Truss Bridge

Truss is a component that combines connected elements to form triangular units. In the case of a truss bridge a large structure is provided with trusses. Usually, trusses are made of metal. There are several types of trusses available.

4) Suspension bridge

In the case of a fixed bridge, the deck slab is suspended with the help of ropes and hangers. These will give a good look. For long bridges, this type of suspension is suitable.

B. COMPONENT PARTS OF BRIDGE

1. Superstructure or Decking:

This includes slab, belt, truss, etc. This carries a load that passes over it and transmits the same amount of energy to the underlying structures.

 DOI : 10.35291/2454-9150.2022.0319

ISSN : 2454-9150 Vol-08, Issue-03, June 2022

2. Bearings:

The bearings transfer the load obtained from the decking to the substructure and are provided for equal load distribution over a structure that may not be strong enough to carry the load of the superstructure directly.

3. Ground floor:

These include piers and abutments, wing walls or restorations and their base.

4. Hats & Abutments:

These are vertical structures that support the deck / bear provided to move the load down on the bed / floor base.

5. Wing Walls and Returns:

This is provided as an extension of the shortcuts to keep the world bank approach with a natural relaxing angle.

6. Foundation:

This is provided to transfer the load and evenly distribute it over the strata from the piers or abutments and the wings or return. This should be provided deep enough so that it is not affected by the stabbing caused by the river flow and does not stop. Although the above are structural components, on hand rails for safety or fencing, rock rails or curbs are provided over the deck to prevent the vehicle or user from falling into a stream or partition of traffic streams.

V. LITERATURE SURVEY

• R. W .LI et. The fall process and the degree of damage to the bridge under a collision. A refined FE model of two simple RC bridges supporting two poles is developed and validated based on the collision of the truck pit tested on the full scale of the RCC line weight test by simulating the actual collision of a real heavy bridge.

• Akram Zaky et.al (2020): In this paper "an analysis of earthquake failure of portable bridges exposed on scour". In this study the columns of the Rcc and PSC columns that influence the seismic depth of the bridge should be examined in relation to the ground layer around the massive groups of the bridge.

• Parisa Hosseini et.al (2019): In this study "reliability analysis based on the performance of bridges that deal with motor vehicle collisions; limit and failure ". In an emergency the collision of a heavy-duty vehicle with bridges is regarded as an overloading event that could lead to dangerous consequences.

• Steven Auyeung et.al (2019): In this study "design based on the performance of bridges under car collisions". The impact of different design parameters includes the diameter of the hole and the degree of opposite stiffness, which is considered in response to bridge braces in collision. Migration, shaving power, moment of bending. Portable behavior under dynamic loading is modeled using a continuous surface cap (SCM) model.

• Amit katkar et.al (2018): In this paper "parametric study of bridge piers". Analysis of bridge materials by changing boundaries to obtain effective results. That will help the designer complete the shape or size of the pier. Various parameters such as the migration pressure of the RCC concrete pier are analyzed using the Midas Civil software. Any category size you can also save after thorough research.

• J.B. Mander et.al (1998): In this paper "metal capacity building and over-analysis of extreme strength". The capacity design approach is followed by the construction of bridges. Columns before proceeding with the design of the foundation and sub-structure. Research is being done to improve the normal process to determine the element of column overload.

VI. LOADING IRC LOADS FOR THE BRIDGE DESIGN

According to the IRC: 70 R, road bridges and culverts are divided on loading basis designed to carry.

• IRC class AA uploads

These uploads will be accepted by certain restrictions, specific or existing industrial areas, as well as highways and specific areas. Bridges are designed for the classroom.

Loading should be considered to see if Class A is loaded on each line.

• IRC class A loading

These loads are often considered in all construction of bridges and culverts. One class A train is considered for each route

• IRC class B loads

This loading is usually considered if the building is temporary and local bridges. Wooden buildings should be considered temporary structures.

VII. COMPONENTS OF BRIDGE

- ***Superstructure***

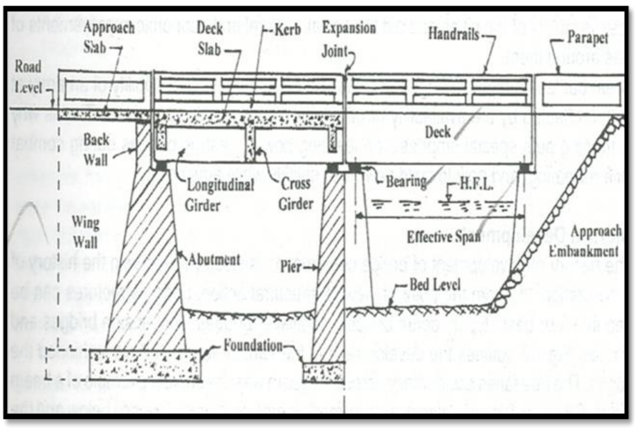

Fig. 2. Components Bridge

 DOI : 10.35291/2454-9150.2022.0319

The main structure of any bridge must be designed in such a way that it meets the geometric and load-bearing requirements set by its owner. This geometric requirement depends on the number and width of the traffic lanes and footpaths to be passed. They also depend on overall alignment and the various horizontal and vertical permits required above and below the road. The designed superstructure must meet a variety of structural design requirements such as strength, durability and stability.

VIII. PROJECT WORK

The analysis will be performed using the STAAD 3-Dimensional model with different span settings. Bridge The length of the Spaniard varies from 30m to 36m with a minimum standing allowance of 6.525m. The width of the trailer is estimated to be 10.5m (i.e. two rows) with the exception of the Crash-Barrier which is 0.5m wide on both sides. Various loads such as Dead Load, Live Load (i.e., Class A Vehicle, 70R Wheelbarrow, Special Vehicle), Braking Force, Earth Pressure, Live Load Payment will be applied to the STAAD model in the appropriate location such as IRC : 6-2017. Live animated uploads will be distributed on the top slab using the working width method specified in IRC: 112-2011 (Appendix B-3). The design will be edited using Microsoft Excel. Analysis and purpose of Design 1m width will be considered. The results of both sessions will be compared and the reinforcement requirement will be combined.

- ***Software Modelling***

- Software used to analyze base shear, rotation times, deviations and all other structural features will be STAAD Pro Version 8.
- After informal training, a bridge model will be built at Staad Pro. Ongoing research and work is underway to define the properties of the bridge. Especially considering the length of the bridge without low work is not easy, excluding all the basic requirements of ROB (Road Over Bridge), the width is determined as 1 x 30.0m + 1 x 36.0m which means the bridge will contain abutment on each side and a hole to support the width -36.0m on one side and 30.0m wide on the other.
- Continued modeling in the software continues as shown in the following image.
- The properties allocated to the projected bridge are defined by speculation as well as the basic requirements and the Standard Span provided by RDSO (as described earlier).
- After the completion of the model the main analysis at Serviceability State will follow in line with Design in Ultimate State.

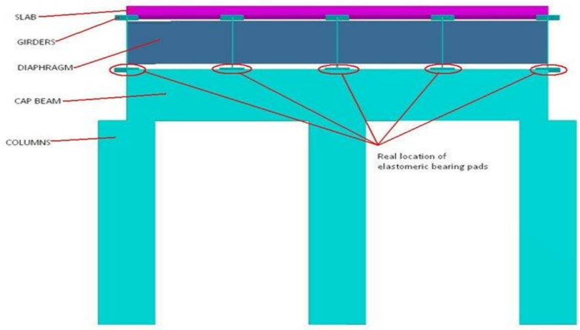

Fig 3: Staad Pro Model Representation of Pier Composite Girder

It consists of a concrete slab with Steel Girder attached to Steel Diaphragms, mounted on a Pier cap or cap beam with Multiple Column Bent.

Analysis of the T-Beam-centered tension bridge was done in a rational way for the various spaces namely 25m, 30m, 35m and 40m. Analysis of Rational method and FEM will be done using IRC Codes. The analysis was performed for the IRC Class AA and the 70R tracking vehicle. FEM analysis of the T-Beam Bridge was performed using Staad Pro V8i Software at different times. Comparative comparisons with FEM results from Staad Pro will be performed.

A. Loads acting on Bridge

- **Dead Load**

Dead or permanent loading is the loading of gravity due to the structure and other objects permanently attached to it. It simply counts as a product of volume and material density.

- ***Live loads***

Live upload means a load that travels over a long period of time. These loads are classified based on their configuration and durability. Several uploads for IRC class uploads, IRC class70R loading, IRC class A loading and IRC class B loading.

- ***IRC Class AA loading***

Two different types of vehicles are specified under this category which are classified as tracked vehicles with wheels. A vehicle followed by an IRC Class AA (imitating a military tank) 700 KN and a four-wheeled vehicle (heavy military truck) of 400 kN.

- ***IRC Class 70 R Loading***

The IRC 70 R loading contains these three types of vehicles. a) Truck car with a total load of 700 KN and two tracks each weighing 350 kN. b) A 4-wheeled vehicle, each with a load of 100 KN up to 400 kN. c) A four-wheel-drive vehicle with seven axles with a total load of 1000 kN.

IX. ANALYSIS OF BRIDGE

It can be done in several processes. The logical methods used for T beam analysis are Courbon's Method, Guyon Massonet Method and Hendry-Jaegar Method. This study was conducted using the Courbon Method.

 DOI : 10.35291/2454-9150.2022.0319

ISSN : 2454-9150 Vol-08, Issue-03, June 2022

A. *Analysis of T-beam Bridge by Rational method*

- ***Courbon's Method***

Analysis of PT T-beam bridge deck by IRC Class AA Tracked Loading for 30m

- ***Preliminary Details***

Clear width of roadway =7.5m, Footpaths = 1m wide

Thickness of wearing coat = 100mm, Spacing of cross girders = 5m c/c

Live load IRC class AA tracked vehicle

Materials: M-40 for deck slab, M-50 for girders, 7mm diameter high strength strands with ultimate tensile strength at 1500MPa.Cable consists of 12 strands anchored at the end with a suitable diameter anchor block.

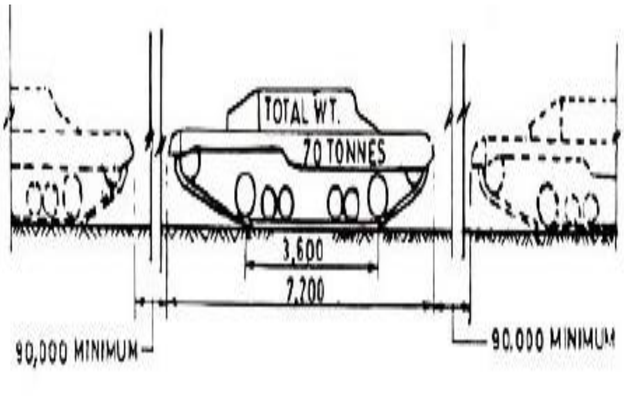

Fig. 4: IRC Loading

B. *Permissible stresses and design constants*

The permissible compressive stresses in the concrete at transfer and at working loads as recommended in IRC 18 are as follows, fct < 0.5fci = 0.5×40 = 20MPaLoss ratio = 0.8

Permissible compressive stress in concrete under service loads (fcw) =16.5MPa

Allowable tensile stress in concrete at initial transfer of prestress (ftt) =0

Allowable tensile stress in concrete under service loads (fcw) =0

Maximum Bending Moment due to Dead Load

a) Weight of Deck Slab = 0.25 X 24×1×1 = 6 KN

b) Weight of Wearing Course = 0.1 X 22×1×1= 2.2KN

c) Total Weight = 8.2KN

- ***Longitudinal Girder and Cross Girder Design***

a) Reaction Factor Bending Moment in Longitudinal Girders by Courbon's Method for Class AA Tracked Vehicle.

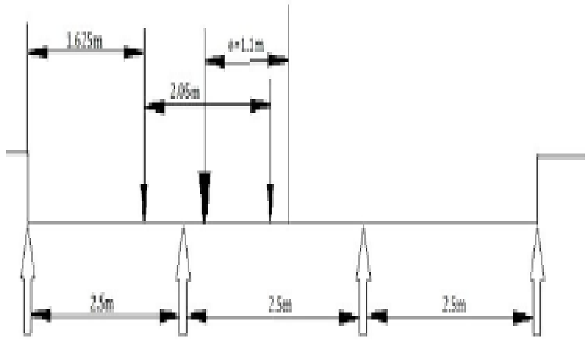

Fig. 5: Showing eccentricity and clearance

Minimum Clearance Distance**:** 1.2 + 0.85/2

= 1.625m

e = 1.1m, P = w/2 $R_x = \left(\frac{\sum w}{n}\right)\left[1 + \left(\frac{\sum I}{\sum dx^2}.I\right) dx.e\right]$

For outer girders RA = 0.382W

For inner girders RB = 0.294W.

b) Dead load from slab for girder **-** Dead load of deck Slab is calculated as follows,

Weight of

1. Parapet Railing = 0.800KN/m,

2. Footpath = (0.3 x1x24) = 7.2KN/m, 3. Deck slab

= (0.25x1.1x24) = 6KN/m,

Total = 14KNm,

Total Dead load of Deck = (2×14) + (8.2×7.5)

= 89.5KN

It is assumed that dead load is shared equally by all girders Therefore, DL/girder = 22.37KN.

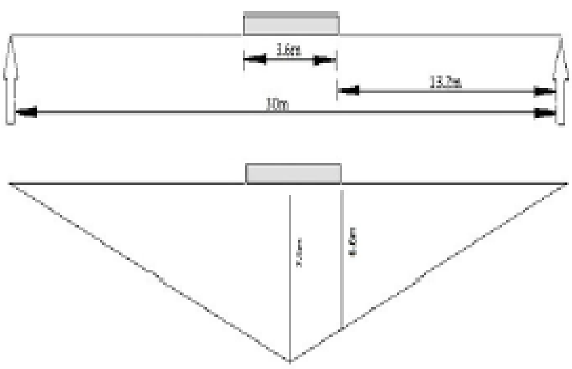

Fig. 6: Influence Line for Bending Moment in Girder

Reaction of W2 on Girder B = 63KN, Reaction of W2 on Girder A = 287KN

BM at center of girder= 0.5(7.5+6.6) × 700 = 4935KNm, Impact factor (For class AA Loads) = 10%

 DOI : 10.35291/2454-9150.2022.0319

Bending Moment including Impact and reaction factor for outer girder is = (4935x1.1x0.382)

= 2073.687 KN

Bending Moment including Impact and reaction factor for outer girder is = (4935x1.1x0.294)

= 1595.97KN

C. *Live Load Shear*

For estimating the maximum Live load shear in the girders, The IRC Class AA Load are placed

Total load on Girder B = (350+63) = 413 KN

Maximum reaction in girder B = (413x28.2)/30 = 388KN

Maximum reaction in girder A = (287x28.2)/30 = 270KN

Maximum live load shears with impact factor in

Inner girder = (388x1.1) = 427 KN,

Outer girder = (270x1.1) = 297 KN

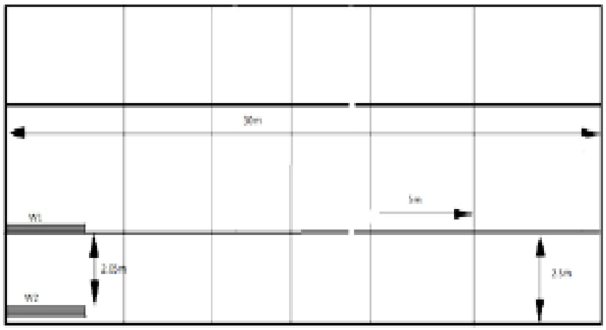

Fig.7: Position of IRC Class AA Tracked Load for Maximum Shear

D. *Dead load BM and SF in main girder.*

The depth of the girder is assumed as 1500mm

Sectional properties of the girder:

Top flange= 1200mm×250mm, Rib = 800mm×200m, Bottom flange = 500mm×450mm

Self weight per meter run of girder = 10.2kN-m

Reaction of cross girder on Main girder = 12kN

Reaction from deck slab on each girder = 22.37kN

Total dead load/m on Girder= (21.66+10.08) = 32.74kN/m

Mmax = 3948.75kNm

Dead load Shear at Support = 520.5kN

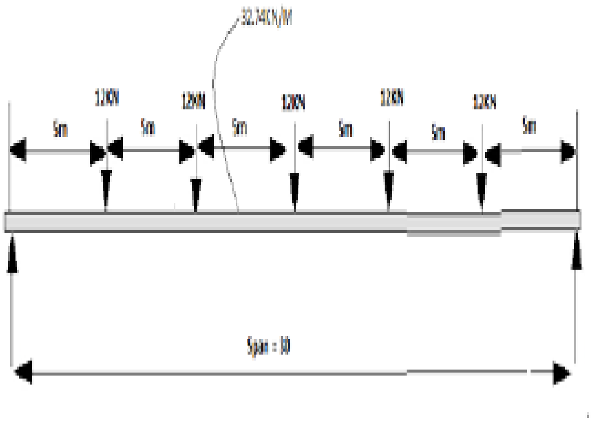

Fig. 8: Dead Load on Main Girder

For the above results, prestressing force calculated from the equation is 6870KN for class AA and 6816KN for class70R tracked loadings.

3.2. Finite element method of analysis

The finite element method is a well-known tool for the solution of complicated structural engineering problems, as it is capable of accommodating many complexities in the solution.

Table.1. BM for Class 70R tracked (KN.m)

SPAN		DESIGN VALUES	FEM VALUES
25	OG	4386	3590
	IG	4003	3295
30	OG	5975	5032
	IG	5508	4988
35	OG	7881	6142
	IG	7330	6083
40	OG	9777	7874
	IG	9142	7541

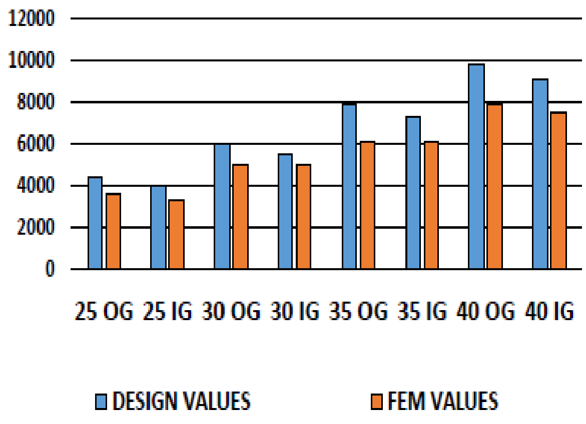

Fig. 9 BM Chart for Class 70R tracked

Table.2. BM for Class AA tracked (KN-m)

 DOI : 10.35291/2454-9150.2022.0319

SPAN		DESIGN VALUES	FEM VALUES
25	OG	4432	3640.4
	IG	4039	3487
30	OG	6022	5076
	IG	5544	5019
35	OG	7928	6211
	IG	7366	6134
40	OG	9829	7937
	IG	9190	7618

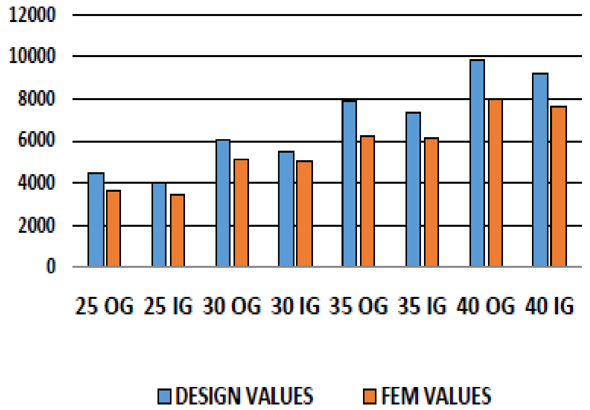

Fig. 10 BM Chart for Class AA tracked

Table.3 Shear Forces (KN)

SPAN		DESIGN VALUES	FEM VALUES
25	OG	724.5	879.4
	IG	853.1	901.1
30	OG	817.5	996
	IG	947.5	1035
35	OG	922.1	1114
	IG	1060	1125
40	OG	1010	1206
	IG	1148	1255

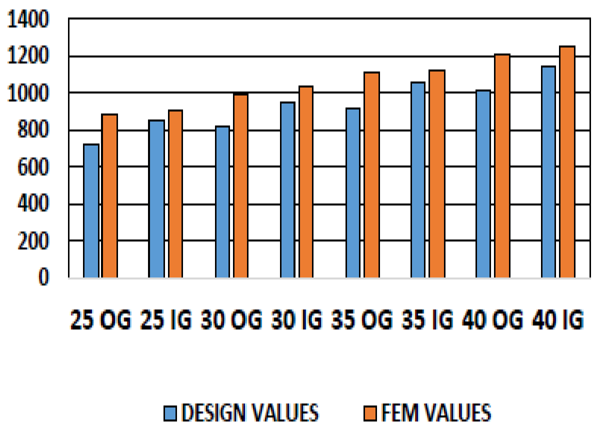

Fig. 11. Shear Force Chart

Comparative research has been done based on analytical comparisons of the easily compressed bridge deck based on the logical and Finite element method using Staad Pro. In this study using the Courbon and Staad Pro method, the bridge area is analyzed by changing the length of the bridge deck, the spaces used are 25m, 30m, 35 and 40m. Based on this study the Courbon method gives a moderate result with respect to BM BM longitudinal band values compared to the Guyon Massonet method. The results were analyzed and it was found that the results obtained from the standard feature model were smaller than the results obtained from the one-sided analysis, i.e. the results obtained from the I.R.C. uploads follow and FEM offers a cost-effective design.

X. CONCLUSION

From the analysis and design of the compressed bridge bridge of different span sizes to the following depths are performed.

- A wide range of span to depth is taken to analyze the bridges covering the boxes, and in all cases, deviations and stress are within the permissible limits.
- As the depth of the box band decreases, the compression strength decreases and there are no decreasing cables. Due to the pressure, additional strength of the concrete is used and also effectively controls the efficiency.
- The new code (IRC: 70R) requires the extension of the front cover straps and sealing pipes, which will lead to an increase in the thickness of the web and deck slab / soffit slabs of PSC guides / PSC box bridges.
- In the same phase and with the same time spent, the metal difference is noticeable compared to WSM, LSM consumes less metal than WSM and it is better to change the metal level instead of increasing the concrete level to get the metal p%.

Comparative research has been done based on analytical comparisons of the easily compressed bridge deck based on the logical and Finite element method using Staad Pro. In this study using the Courbon and Staad Pro method, the bridge area is analyzed by changing the length of the bridge deck, the spaces used are 25m, 30m, 35 and 40m. Based on this study the Courbon method gives a moderate result with respect to BM BM longitudinal band values compared to the Guyon Massonet method. The results were analyzed and it was found that the results obtained from the standard feature model were smaller than the results obtained from the one-sided analysis, i.e. the results obtained from the I.R.C. uploads follow and FEM offers a cost-effective design.

XI. SCOPE FOR FURTHER WORK

To facilitate the analysis and design of the sub-bridge structure a small software can be developed by performing all the calculations in one place instead of using multiple software. This will help the architect to save time and effort in the event of a complex design of a small bridge.

 DOI : 10.35291/2454-9150.2022.0319

ACKNOWLEDGMENT

The preferred spelling of the word "acknowledgment" in American English is without an "e" after the "g." Use the singular heading even if you have many acknowledgments.

REFERENCES

[1] Barr, P.J. (2008). "Comparison of prestress losses for a prestress concrete bridge made with high performance concrete", *J. Bridge Eng*., ASCE, 13 (5), 468-475.

[2] Byung Hwan Oh, In Hwan Yang (2001). "Realistic long term prediction of prestress forces in psc box girder bridges", *J. Structural Eng*., ASCE, 127 (9), 1109-1116.

[3] Chang-Su Shim, Pil-Goo Lee, Sung-Pil Chang (2001). "Design of shear connection in composite steel and concrete bridges with precast decks", *J. Bridge Eng*., ASCE, 15 (3), 725-733.

[4] Dereck J. Hodson, Paul J. Barr, and Marvin W. Halling (2012). "Live-Load Analysis of Post-tensioned Box-Girder Bridges", *J. Bridge Eng*., ASCE, 17(4), 644-651.

[5] Gonzalo R., Angel, C. A., Gonzalo R. and Juan R.C. (2000). "Externally prestressed high strength concrete viaduct", *J. Bridge Eng*., ASCE, 26 (4), 337-345.

[6] IRC: 18.(2000). Design criteria for prestressed concrete road bridges (post tensioned concrete), IRC, New Delhi, India.

[7] IRC: 6. (2010). Loads and stresses, IRC, New Delhi, India.

[8] IRC:112. (2011). Code of practice for concrete bridges, IRC, New Delhi, India.

[9] IS1343.(1980). Indian Standard code of practice for prestressed concrete (First Revision), BIS, New Delhi,India.

[10] Jarret Kasan, s. m., Kent, A. H. (2011). "Redevelopment of prestressing force in severed prestressed strands", *J. Bridge Eng*., ASCE,16 (3), 431-437.

[11] John B. Kennedy and Mohamed H. Soliman (1987). "Temperature distribution in composite bridges" *J. Structural Eng*., ASCE, 113 (3), 475-482.

[12] Krishna Raju, N. (1995). *Prestressed Concrete*, Tata McGraw- Hill Publishing company Limited, New Delhi.

[13] Leo E. Rodriguez, Paul J. Barr, Marv W. Halling (2013). "Temperature effects on a box girder, integral abutment bridge", journal of performance of constructed facilities, ASCE, 16(7), 548-553.

[14] Raina, V.K. (1994). *Concrete Bridge Practice-Analysis*, Design and Economics, McGraw- Hill Publishing Company Limited, New Delhi.

[15] S. Maleki (2002). "Effect of deck and support stiffness on seismic response of slab girder bridges", Engineering Structures, 24, 219-226.

[16] Vikash Khatri, Pramod Kumar Singh and P.R.Maiti (2012). "Comparative study of prestressed steel concrete composite bridge of different span length and girder spacing", International Journal of Modern Engineering Research, 2(5), 3917-3922.

 DOI : 10.35291/2454-9150.2022.0319