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ANALYSIS AND DESIGN OF PRESTRESSED CONCRETE BRIDGES SUBJECTED TO DYNAMIC LOADS- A REVIEW

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Abstract— Due to efficient dissemination of congested traffic, economic considerations, and aesthetic desirability horizontally box girder bridges have become increasingly popular nowadays in modern highway systems, including urban interchanges. A general description of the finite element approach is presented using the finite element program SAP 2000N and STAAD PRO that was utilized. The prestressed concrete box girder bridge superstructure analysed in the base case consists of box girders with varying span. The superstructure is loaded by different IRC class like 70 R loads and the loads are incremented until the bridge superstructure system fails. A sensitivity analysis is performed to study how variations in the bridge geometry, damage scenarios, member properties and bridge continuity affect the redundancy of the superstructure. The results are presented in the form of prestressing force, moment, shear and deflection. The deflected shape of the bridge model shows that there is a marginal increase in the value of deflection according to the various loading and increased different various time period intervals too. A comparative study was carried out between I girder and Box girder. By extracting result it has been concluded that box girder is costlier than I girder. It has also seen that losses is more in I girder as compared to Box girder. The analysis and design of Box girder bridges for any span can be obtained from the mathematical models without doing lengthy calculations.

Keywords- Dynamic Response, Moving load, Box girder, Prestressed concrete, I girder, SAP 2000v15, STAAD PRO.

I. INTRODUCTION

Prestressed concrete is fundamentally concrete in which internal stresses of suitable immensity and distribution are introduced so that the stresses resulting from external loads are prevented to a desired degree. In reinforced concrete members, the prestress is often introduced by tensioning the steel reinforcement. The development of early cracks in reinforced concrete due to incompatibility in the strains of steel and concrete was perhaps the starting point in the evolution of a new material like 'prestressed concrete". The application of permanent compressive stress to a material like concrete, which is strong in compression but weak in tension, increases the apparent tensile strength of that material, because the following application of tensile stress must first nullify the compressive prestress. Freyssinet attempted to introduce permanently acting forces in concrete to resist the elastic forces developed under the name of "prestressing" in 1904.

Bridges are the structures which gains the world wide importance as they are essential part of any road and railway network. With the immerging technology in structural engineering, very long span bridges with large span to depth ratios are built in structural steel or prestressed concrete as it have excellent riding characteristics that minimizes traffic vibrations, torsional rigidity, and strength hence results in stable, dynamic, long lasting and graceful bridges.

Dynamic analysis of bridges are necessary to ensure overall structural performance and stability during severe ground shaking motion. The main aim of performing dynamic analysis is to provide an accurate measure of expected structural response for a given earthquake or any kind of vibrations and to improve response of bridges during earthquake forces.

The main factors affecting dynamic response are the basic flexibility of structure and, more specially, the relationship between the natural frequency of the structure and exciting frequency of the vehicle. Any passage of load cause deflection from its original position and results in oscillation of bridge. This action continues until it goes back to its original position or another load acts upon it. Consequently, "dynamic behaviour of bridge deck" is essential.

II. Literature Review

1. Shear force

Ahmad Abrar & Prof. R.B. Lokhande (2017) conducted comparative analysis and design of t-beam and box girders. Working Stress Method for the Manual design whereas the CSI Bridge for Software analysis was carried out. The span of bridge considered was more than 25m and it was designed for different Indian Road Congress, IRC vehicles. It was found that the IRC 70R vehicle producing maximum effect on the sections. Both manual and analytical result showed that the Shear force at mid span section in T-beam girder is more than the Box girder. The Analytical results of shear force and typical diagram of Box girder are shown below.

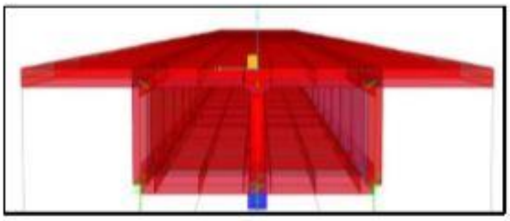

Fig.1: Front View of Box Girder

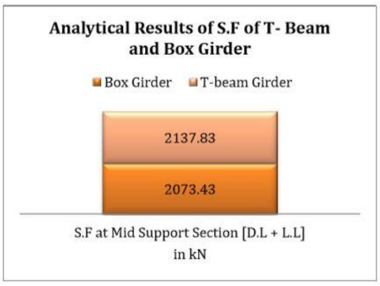

Fig.2: Analytical Results of S.F of T- Beam and Box Girder

Kumar.Ch Phani et.al. (2016) carried out study on Analysis and Design of Prestressed Box Girder Bridge by IRC: 112-2011. Limit State Design method was adopted and Live loads were taken as per IRC: 6. Cross section of box girder and mathematical modeling for box girder of span 30m was performed using SAP2000. The shear force was obtained by considering different loading conditions consisting of dead load, super imposed dead load and live load. It was found that the variation of shear force was along the length up to mid span. Table1. shows the variation of shear force along span of box girder.

Table1: Shear Force Variation along span (KN)

Span (m)	0L	0.1L	0.2L	0.3L	0.4L	0.5L
DL	194	156	117	78	39	0
LL	80	72	57	41	23	0
SIDL	23	18	14	9	5	0
Total	297	246	188	128	67	0

T Naik Chetan et.al. (2015) investigated Analysis and Design of Multi Cell Post-Tensioned PSC Box Girder. The analysis and design of box girder has been done, considering two different sheathing pipes namely HDPE and corrugated Bright metal pipes. These sheathing pipes have been used to find the economic solution of design of multi-cell box girder. CSI-bridge-2015 modular software has been used for carrying out analysis. Multi-cell PSC box girder design has been performed at various locations along the span so as to consider maximum or critical locations of the PSC box girder due to various loading conditions, the post tensioning of cables were done for jacking load at 0.765 times the UTS and jacking was done at both ends of the PSC box girder simultaneously. The box girder was analysed as a simply supported. The maximum shear force obtained was at support and minimum shear force was at midspan. The shear force diagram for different loading conditions is shown below.

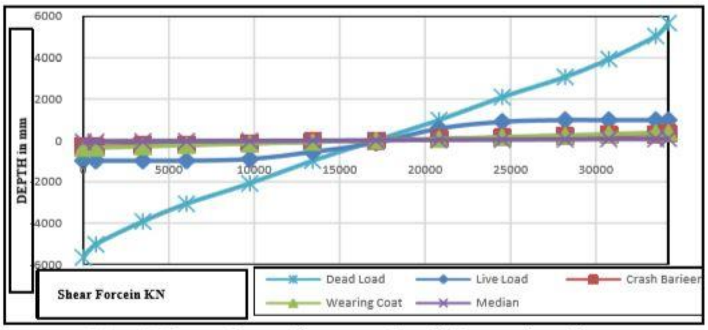

Fig. 3: Shear force diagram for different loadings

Chourasia Mayank & Dr. Saleem Akhtar (2015) conducted Design and Analysis of Prestressed Concrete Box Girder by Finite Element Method (4 Cells & 1 Cell). The box girder was designed for 2 lane national highway bridge having simply supported support, span length as 30m, width of carriageway 7.5m, width of footpath 1.25m, total width of segment 10m and moving load was applied as per IRC class AA loading. The design standard of India, IRC was followed in design of Box-girder superstructures subjected to IRC class AA loading. Analysis was carried out using the MIDAS Civil Software which is based on finite element method of analysis. It was found that designed value of the applied internal shear force as 600.456kN.

Peera D.Gouse et.al. (2015) investigated A Study on Design of Prestressed Post-Tensioned Girder by Morice-Little Method. The details of bridge were as follows: Length of bridge 2a was 25 m, width of bridge 2b was 8.7 m, number of main girders was 5, number of cross beams 6, main girder spacing p was 1.74 m, cross beam spacing q was 5m and carriage way 7.5 m. It was focused more on Morice-Little method for design of Prestressed Post-Tensioned. In the analysis, the effective width was divided into eight equal segments and Live load was applied as per IRC Class AA tracked loading and Regulation as per IRC: 5; IRC: 6; IRC: 18; IRC: 21. For the Shear Reinforcement it was Provided 10 mm ø 2-legged stirrups @ 300 mm c/c, it was designed taking the following two conditions into the consideration i.e., Shear force at working loading conditions (dead load and live load Class AA tracked loading which is equal to 181.44 kN) and Shear force at ultimate load condition (814.66 kN). Shear resistance Vu was taken as the smaller value of resistance of uncracked section Vu_o and cracked section Vcr. Shear resistance was computed at a section "d" from the support. The cross section just beyond the end block was used for calculating the resistance & finally allowable shear resistance Vcr which was equal to 814.66 kN.

Vishal U. Misal et.al. (2014) conducted Analysis and Design of Prestressed Concrete Girder. They have presented cost analysis and design of prestressed concrete girder. IRC class 70 R loading and software STAAD PRO for design and analysis was used. The comparison between results of I-girder and box girder was made. For maximum shear, load was kept such that the whole dispersion is in the span. The load was kept at (dispersion in the direction of span/2) from the edge of beam(x). Shear force per meter width was calculated as Shear force per metre width= [Load per metre width* (Clear width of panel - x)]/ Clear width of panel. The shear force was found to be more for the box girder of span 31.4 m compared to 16.30 m span.

Nikhade H.R.et.al. (2014) investigated Analysis & Design of Bridges. To begin with 55m span, box girder bridge was design as per specifications & it was found that following parameters are significant in the analysis & design of box girder bridges(Depth of Web, DLBM & LLBM at mid span section, DLBM & LLBM at mid support section, Prestressing Force, Eccentricity, Quantity of Steel & Concrete).Accordingly 60m & 70m span bridges were designed. The author adopted Standard specification and code of practice for road bridges (section:II) , Load and stresses(IRC:6-2000) , IRC class AA Loading , IRC class A Loading , IRC class B Loading. The Variation in Shear Force near Mid Support Section with different grade of concrete with different span using excel was prepared.

Kumar Rajamoori Arun et.al. (2014) investigated DESIGN OF PRE-STRESSED CONCRETE T-BEAM BRIDGES. It was presented a practical approach on a major bridge having 299 m span, 36 PSC Beams and 8 RCC Beams. The study was focused on PSC Beams, where the beam post-tensioning values, rate of elongation and behavior can be defined after stressing. The main code followed in this course was IS: 1343 – 2012 entitled Code of Practice for Pre-stressed Concrete. Shear force for PSC T-beam girder are lesser than RCC T-beam Girder Bridge. Which allow designer to have lesser heavier section for PSC T-Beam Girder than RCC T-Girder for 24 m span. Shear force resistance of PSC T-Beam Girder was more compared to RCC T- Girder for 24 m span.

Based on the literature it is found that Shear force at mid span section in T-beam girder is more than the Box girder, the variation of shear force was along the length up to mid span, the maximum shear force obtained was at support and minimum shear force was at midspan, and Shear force resistance of PSC T-Beam Girder was more compared to RCC T-Girder for 24 m span.

2. Bending moment

Ahmad Abrar & Prof. R.B. Lokhande (2017) conducted comparative analysis and design of t-beam and box girders. The span of bridge considered was more than 25m and it was designed for different Indian Road Congress, IRC vehicles. Excel Sheets were developed for manual calculations and Structural components were designed by selecting the trail section and checking for the adequacy of that section and stresses developed. Both manual and analytical result showed that the Bending moment at mid span section in T-beam girder is more than the Box girder. The results for bending moment by manual calculation and analytical are shown in fig.4.

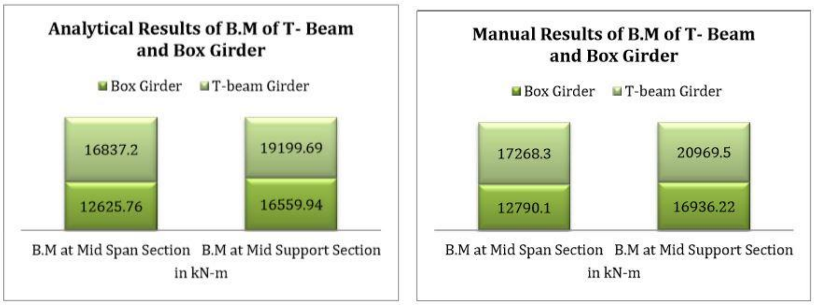

Fig. 4: Manual & Analytical Results of B.M of T- Beam and Box Girder

Kumar.Ch Phani et.al. (2016) conducted Analysis and Design of Prestressed Box Girder Bridge by IRC: 112-2011.The span of box girder considered was 30m. The Bending Moment was obtained by considering different loading conditions consisting of dead load, super imposed dead load and live load. It was found that the variation of Bending Moment along the length up to mid span. Live loads were taken as per IRC: 6. Cross section of box girder and mathematical modelling for box girder of span 30m was performed using SAP2000. Table 2. shows the bending moment variation along span.

Table 2: Bending moment variation along span (tm)

Span (m)	0L	0.1L	0.2L	0.3L	0.4L	0.5L
DL	0	526	934	1226	1400	1459
LL	0	218	381	495	565	588
SIDL	0	62	110	145	165	172
Total	0	806	1425	1866	2130	2219

T Naik Chetan et.al. (2015) conducted Analysis and Design of Multi Cell Post-Tensioned PSC Box Girder. The analysis and design of box girder has been done, considering two different sheathing pipes namely HDPE and corrugated Bright metal pipes. These sheathing pipes have been used to find the economic solution of design of multi-cell box girder. CSI-bridge-2015 modular software has been used for carrying out analysis. Multi-cell PSC box girder design has been performed at various locations along the span so as to consider maximum or critical locations of the PSC box girder due to various loading conditions, the post tensioning of cables were done for jacking load at 0.765 times the UTS and jacking was done at both ends of the PSC box girder simultaneously.

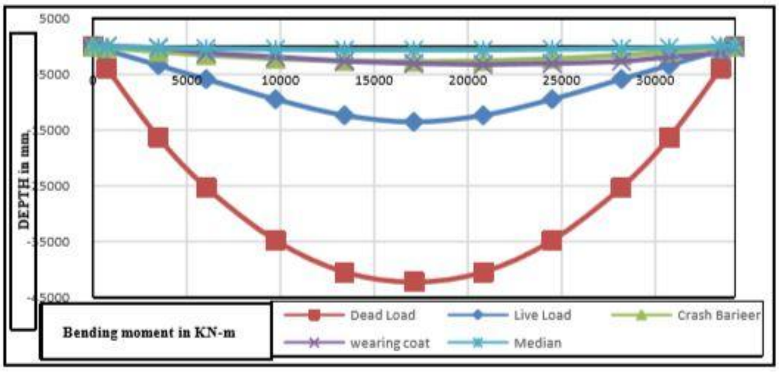

Fig. 5: Bending moment diagram for different loadings

The box girder was analysed as a simply supported. The maximum bending moments were at midspan and there negative moments were observed at supports. The bending moment diagram for different loading conditions is shown in figure 5.

Chourasia Mayank & Dr. Saleem Akhtar (2015) investigated Design and Analysis of Prestressed Concrete Box Girder by Finite Element Method (4 Cells & 1 Cell). The box girder was designed for 2 lane national highway bridge having simply supported support, span length as 30m, width of carriageway 7.5m, width of footpath 1.25m, total width of segment 10m and moving load was applied as per IRC class AA loading. The design standard of India, IRC was followed in design of Box-girder superstructures subjected to IRC class AA loading. Analysis was carried out using the MIDAS Civil Software which is based on finite element method of analysis. The bending Moment for 4 cells was 10631.1kN.m & 6276.96kN.m for 1 cell. This study showed that the single cell pre-stressed concrete box girder was most suitable and economical cross-section for 2 lane Indian national highway bridges.

Peera D.Gouse et.al. (2015) conducted A Study on Design of Prestressed Post-Tensioned Girder by Morice-Little Method. The details of bridge were as follows: Length of bridge 2a was 25 m, width of bridge 2b was 8.7 m, number of main girders was 5, number of cross beams 6, main girder spacing p was 1.74 m, cross beam spacing q was 5m and carriage way 7.5 m. It was focused more on Morice-Little method for design of Prestressed Post-Tensioned. In the analysis, the effective width was divided into eight equal segments and Live load was used as per IRC Class AA tracked loading and Regulation as per IRC: 5; IRC: 6; IRC: 18; IRC: 21. For the design of longitudinal girder It was taken only one maximum live load bending moment from intermediate girder (i.e., Girder-B) and one maximum dead load bending moment from end girder (i.e., Girder-A) and the result of dead load moment and live load moment are 1722 kN-m, 1135 kN-m respectively. Ultimate moment carrying capacity of girder should be less than that of least of the ultimate moment of resistance due to yielding of steel & crushing of concrete. In their design ultimate moment carrying capacity of girder was 5365 kN-m & yielding of steel, crushing of concrete were 6661.14 kN-m 6634 kN-m respectively.

Vishal U. Misal et.al. (2014) carried out Analysis and Design of Prestressed Concrete Girder. They have presented cost analysis and design of prestressed concrete girder. IRC class 70 R loading and software STAAD PRO for design and analysis was used. The comparison between results of I-girder and box girder was made. For bending moment calculation Live load was based on IRC class AA tracked vehicle. One wheel was placed at the centre of panel and Design bending moment was calculated as = 1.25 * 0.8 * Bending moment.

Nikhade H.R.et.al. (2014) conducted Analysis & Design of Bridges. To begin with 55m span, box girder bridge was design as per specifications & it was found that following parameters are significant in the analysis & design of box girder bridges(Depth of Web, DLBM & LLBM at mid span section, DLBM & LLBM at mid support section, Prestressing Force, Eccentricity, Quantity of Steel & Concrete).Accordingly 60m & 70m span bridges were designed. The Standard specification and code of practice for road bridges (section:II) , Load and stresses(IRC:6-2000) , IRC class AA Loading , IRC class A Loading , IRC class B Loading was adopted. The Variation in Bending Moments at mid support Section with different grade of concrete with different span (50-80) m was observed.

Kumar Rajamoori Arun et.al. (2014) carried out DESIGN OF PRE-STRESSED CONCRETE T-BEAM BRIDGES. It was presented a practical approach on a major bridge having 299 m span, 36 PSC Beams and 8 RCC Beams. The study was focused on PSC Beams, where the beam post-tensioning values, rate of elongation and behavior can be defined after stressing. The main code followed in this course was IS: 1343 – 2012 entitled Code of Practice for Pre-stressed Concrete. Bending moments for PSC T-beam girder were lesser than RCC T-beam Girder Bridge. Which allow designer to have lesser heavier section for PSC T-Beam Girder than RCC T-Girder for 24 m span. Moment of resistance of steel for both has been evaluated and conclusions drawn that PSC T-Beam Girder has more capacity for 24 m and more than 24m of span.

Based on the literature it is found that bending moment at mid span section in T-beam girder was more than the Box girder, the variation of Bending Moment was along the length up to mid span, The Variation in Bending Moments at mid support Section with different grade of concrete with different span (50-80) m was observed, bending moments for PSC T-beam girder were lesser than RCC T-beam Girder Bridge.

3. Cost Analysis

Ahmad Abrar & Prof. R.B. Lokhande (2017) investigated comparative analysis and design of t-beam and box girders. The span of bridge considered was more than 25m and it was designed for different Indian Road Congress, IRC vehicles. Manual and Analytical study were carried out and the cost comparison were done. As per their cost comparison it can be seen that the cost of 25, 30 and 35m spans are less for T-beam girder whereas for 50m span Box girder is economical. So we can provide T-beam girder if the span is less than 30m. For higher spans Box girder is suitable.

Kumar.Ch Phani et.al. (2016) investigated Analysis and Design of Prestressed Box Girder Bridge by IRC: 112-2011. Limit State Design method was adopted and Live loads were taken as per IRC: 6. Cross section of box girder and mathematical modelling for box girder of span 30m was done using SAP2000. It was concluded that for the same cross section and same applied moment, steel difference is quite noticeable compare to WSM, LSM consumes less steel than WSM and its better to change grade of steel rather increasing grade of concrete for more % steel difference.

T Naik Chetan et.al. (2015) conducted Analysis and Design of Multi Cell Post Tensioned PSC Box Girder. The analysis and design of box girder has been done, considering two different sheathing pipes namely HDPE and corrugated Bright metal pipes. These sheathing pipes were found to be economical solution for design of multi-cell box girder.

Chourasia Mayank & Dr. Saleem Akhtar (2015) conducted Design and Analysis of Prestressed Concrete Box Girder by Finite Element Method (4 Cells & 1 Cell). The box girder was designed for 2 lane national highway bridge having simply supported support, span length as 30m, width of carriageway 7.5m, width of footpath 1.25m, total width of segment 10m and moving load was applied as per IRC class AA loading. The design standard of India, IRC was followed in design of Box-girder superstructures subjected to IRC class AA loading. Analysis was carried out using the MIDAS Civil Software which is based on finite element method of analysis. It is found that the single cell pre-stressed concrete box girder is most suitable and economical cross-section for 2 lane Indian national highway bridges.

Vishal U. Misal et.al. (2014) investigated Analysis and Design of Prestressed Concrete Girder. They have presented cost analysis and design of prestressed concrete girder. IRC class 70 R loading and software STAAD PRO for design and analysis was used. The comparison between results of I-girder and box girder was made. The author calculated volume of steel i.e. 2.2313 m3 for I-girder, 2.652 m3 for box girder and volume of concrete 181.81 m3 for Igirder, 92.3 m3 for box girder for 31.4m span. By extracting result it is found that box girder is costlier than I girder.

Kumar Rajamoori Arun et.al. (2014) carried out DESIGN OF PRE-STRESSED CONCRETE T-BEAM BRIDGES. It was presented a practical approach on a major bridge having 299 m span, 36 PSC Beams and 8 RCC Beams. The study was focused on PSC Beams, where the beam post-tensioning values, rate of elongation and behavior can be defined after stressing. The main code followed in this course was IS: 1343 – 2012 entitled Code of Practice for Pre-stressed Concrete. The Quantity of steel and the Cost of concrete for PSC T-Beam Girder was less than RCC T-Beam Girder as quantity required by T-beam Girder.

Based on the literature it is found that the cost of 25, 30 and 35m spans are less for T-beam girder whereas for 50m span Box girder is economical, the single cell pre-stressed concrete box girder is most suitable and economical cross-section for 2 lane Indian national highway bridges, and box girder is costlier than I girder.

4. Prestressing force

Kumar.Ch Phani et.al. (2016) conducted studies on Analysis and Design of Prestressed Box Girder Bridge by IRC: 112-2011. The various spans to depth ratio were taken for the analysis of box girder bridges, and for all the cases, stresses were within the permissible limits. As the depth of box girder decreases, the prestressing force decreases and no. of cables decreases. Because of prestressing, more strength of concrete is utilized and also well governs serviceability. From table 3. We can clearly see that when span to depth ratio increases, the prestressing force decreases.

Table 3: Comparison of prestress force and deflection for various span to depth ratio

Span/Depth	Prestressing Force (kN)	Eccentricity (mm)	Deflection (mm)		
			DL+SIDL	DL+SIDL+PRE	DL+LL+PRE+SIDL
15	5428	850	14	11	18
16	5370	800	16	12	20
17	5309	750	17	13	23
18	5251	700	19	16	26
19	5194	650	22	18	29

T Naik Chetan at.al. (2015) conducted Analysis and Design of Multi Cell Post-Tensioned PSC Box Girder. The analysis and design of box girder has been done, considering two different sheathing pipes namely HDPE and corrugated Bright metal pipes. These sheathing pipes have been used to find the economic solution of design of multi-cell box girder. CSI-bridge-2015 modular software has been used for carrying out analysis.

Multi-cell PSC box girder design has been performed at various locations along the span so as to consider maximum or critical locations of the PSC box girder due to various loading conditions, the post tensioning of cables were done for jacking load at 0.765 times the UTS and jacking was done at both ends of the PSC box girder simultaneously. Box girder was designed by considering both end pre-stressing, the force 3789KN was applied simultaneously from the both ends of the box girder at the same time during transferring of force in box girder some sudden losses will take place. Friction and wobble effect the values considered for friction and wobble in this work was for HDPE friction coefficient value is 0.17 and wobbles coefficient value is 0.002 and for Bright metal friction coefficient value was 0.25 and wobbles coefficient value was 0.0046 respectively. These values are recommended as per IRC standards and approximate slip was considered was about 6mm in the design for checking the force reduction in the pre stressing force. As obtained from results it was found that HDPE used design gives more force than the Bright metal material used design, we can achieve more force in prestressed box girder by using HDPE material and number of cables can also be reduced by using HDPE materials in pre-stressed box girder.

Peera D.Gouse et.al. (2015) conducted A Study on Design of Prestressed Post-Tensioned Girder by Morice-Little Method. They have focused more on Morice-Little method for design of Prestressed Post-Tensioned. In the analysis, the effective width was divided into eight equal segments and Live load was used as per IRC Class AA tracked loading and Regulation as per IRC: 5; IRC: 6; IRC: 18; IRC: 21. The total loss of prestress over all the cables due to the Elastic shortening, Shrinkage in concrete, Creep in concrete, Relaxation of steel & friction. The loss of prestress due to friction was neglected, because of in post-tensioned prestressed concrete members before prestressing force applied one end of the member be the anchored. After that the prestressing force was applied to another side of the member through cables, which were tightly stretch and then anchored simultaneously. So that the loss of prestress due to friction should be rectifying by first anchorage side again applied to prestressing force. Total loss of prestress was 168.811 N/mm^2 i.e., Percentage of loss was 18.75%.

Vishal U. Misal et.al. (2014) conducted Analysis and Design of Prestressed Concrete Girder. They have presented cost analysis and design of prestressed concrete girder. IRC class 70 R loading and software STAAD PRO for design and analysis was used. The comparison between results of I-girder and box girder was made. It was adopted IS 1343-1980 for calculation of prestressing force and ultimate flexural strength. The prestressing force is increases with increasing yield stress of steel.

Nikhade H.R.et.al. (2014) conducted studies on Analysis & Design of Bridges. To begin with 55m span, box girder bridge was design as per specifications & it was found that following parameters are significant in the analysis & design of box girder bridges(Depth of Web, DLBM & LLBM at mid span section, DLBM & LLBM at mid support section, Prestressing Force, Eccentricity, Quantity of Steel & Concrete).Accordingly 60m & 70m span bridges were designed. The author adopted Standard specification and code of practice for road bridges (section:II) , Load and stresses(IRC:6-2000) , IRC class AA Loading , IRC class A Loading , IRC class B Loading. Variation in Prestressing Force & Eccentricity with different grade of concrete with different span (50-80) m was found.

Kumar Rajamoori Arun et.al. (2014) conducted DESIGN OF PRE-STRESSED CONCRETE T-BEAM BRIDGES. The author presented a practical approach on a major bridge having 299 m span, 36 PSC Beams and 8 RCC Beams. The study focuses on PSC Beams, where the beam post-tensioning values, rate of elongation and behavior can be defined after stressing. The main code followed in this course was IS: 1343 – 2012 entitled Code of Practice for Pre-stressed Concrete. The most widely used method for prestressing of structural concrete elements was longitudinal tensioning devices. Prestressing by the application of direct forces between abutments was used.

Based on the literature it is found that when span to depth ratio increases, the prestressing force decreases and the prestressing force is increases with increasing yield stress of steel.

5. Deflection

Kumar.Ch Phani et.al. (2016) carried out Analysis and Design of Prestressed Box Girder Bridge by IRC: 112-2011. The various span to depth ratio were taken for the analysis of box girder bridges, and for all the cases, deflection is within the permissible limits as shown in table 3. Limit State Design method have been adopted. Live loads were taken as per IRC: 6. Cross section of box girder and mathematical modeling for box girder of span 30m was investigated using SAP2000.

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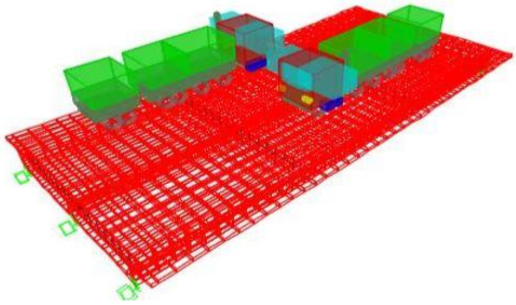

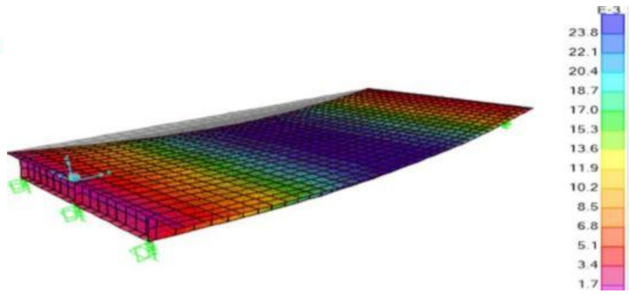

Fig.6: 70R Loading vehicle Arrangement   Fig.7: Deformed Shape of Box Girder

Chourasia Mayank & Dr. Saleem Akhtar (2015) conducted Design and Analysis of Prestressed Concrete Box Girder by Finite Element Method (4 Cells & 1 Cell). The box girder was designed for 2 lane national highway bridge having simply supported support, span length as 30m, width of carriageway 7.5m, width of footpath 1.25m, total width of segment 10m and moving load was applied as per IRC class AA loading. The design standard of India, IRC was followed in design of Box-girder superstructures subjected to IRC class AA loading. Analysis was carried out using the MIDAS Civil Software which is based on finite element method of analysis. It was found that deflection for 4 cells was 17.06 mm & 7.189 mm for 1 cell.

Peera D.Gouse et.al. (2015) carried out A Study on Design of Prestressed Post-Tensioned Girder by Morice-Little Method. It was focused more on Morice-Little method for design of Prestressed Post-Tensioned. In the analysis, the effective width was divided into eight equal segments and Live load was used as per IRC Class AA tracked loading and Regulation as per IRC: 5; IRC: 6; IRC: 18; IRC: 21. The loadings and deflections at nine standard positions were considered and all deflections were related to the average deflection. The actual deflection at each of those nine standard positions has given by an arithmetical coefficient, called distribution coefficient and denoted by the symbol K, multiplied by the average deflection produced by the load distributed uniformly across the entire effective width.

Kumar Rajamoori Arun et.al. (2014) investigated DESIGN OF PRE-STRESSED CONCRETE T-BEAM BRIDGES. The author presented a practical approach on a major bridge having 299 m span, 36 PSC Beams and 8 RCC Beams. The study was focused on PSC Beams, where the beam post-tensioning values, rate of elongation and behavior could be defined after stressing. The main code followed in this course was IS: 1343 – 2012 entitled Code of Practice for Pre-stressed Concrete. Deflection for PSC T-beam Girder was lesser than RCC T-Beam Girder Bridge.

Based on the literature it is found that HDPE gave less deflection than the Bright metal and hence in this case, structural stability was more effective, deflection for 4 cells was more compared to 1 cell and deflection for PSC T-beam Girder was lesser than RCC T-Beam Girder Bridge.

III. CONCLUSION

Based on the study done it can be concluded that prestressed concrete bridges subjected to dynamic load is suitable for highway bridges as it can resist maximum shear force and bending moment. The most economical and suitable section for two lane Indian national highway is box girder.

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