ANALYSIS OF BOX GIRDER BRIDGES UNDER IRC LOADING

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ABSTRACT: **Bridges square measure outlined as structures that square measure provided a passage over a spot while not closing manner below. they'll be required for a passage of railway, roadway, pathway and even for carriage of fluid. The design of a Highway bridge is critically dependant on standards and criteria for the safety, quality and overall cost of the project. Box girder bridges are terribly unremarkably used. It's a bridge that has its main beams comprising of girders within the form of hollow boxes. The box beam ordinarily includes of pre-stressed concrete, steel or steel concrete. Various software's can be used for the Analysis and design of bridges which will be much better and less time consuming compared to manual calculations. This project discusses the Analysis of Box girder bridges under IRC loading of two different types Single1cell and Multi cell with IRC standard codes followed superstructures subjected to load of heavy vehicles using CSi Bridge software 2015 version to know its structural behaviour and to decide which standard code is better when comparing the results in determining the economical section in all aspects for the assumed problem statement. Also to know about the modelling pattern using CSi bridge and to know the structural behaviour1considering the bridge object responses and horizontal moments of both single cell and multi cell box girders under IRC loading conditions.**

KEYWORDS-**Box Girder, Single Cell, Multi Cell, Nonlinear Analysis and CSi Bridge.**

1. INTRODUCTION
1.1: GENERAL

Bridges square measure outlined as structures that square measure provided a passage over a spot while not closing manner below. they'll be required for a passage of railway, roadway, pathway and even for carriage of fluid, bridge web site ought to be therefore chosen that it offers most business and social edges, efficiency, effectiveness and equality. Bridges square measure nation's lifelines and backbones within the event of war. Bridges symbolize ideals and aspirations of humanity. They span barriers that divide, bring folks, communities and nations into nearer proximity. They shorten distances, speed transportation and facilitate commerce. Bridges square measure symbols of humanity's heroic struggle towards mastery of forces of nature and these square measure silent monuments of mankind's unconquerable can to achieve it.

BOX GIRDER:

Box girders are used extensively within the construction of associate elevated underground rail bridge and therefore the use of horizontally re-curved in set up box beam bridges in fashionable underground rail systems is kind of appropriate in resisting torsion and distortion effects elicited by curvatures. The torsion and distortion rigidity of box beam is thanks to the closed section of box beam. The box section conjointly possesses high bending stiffness associated there's an economical use of the entire cross section. Segmental box girders (segments) square measure used for building structure for bridges / different structure in replacement of standard construction via pre-cast beams and cast-in-situ decks. The segments system reduces the environmental disturbance compare to the traditional technique by ending the concreting works more removed from the development web site wherever is typically settled at town centres. Segmental box girders square measure primarily engineered as single span structures to avoid coupling of post tensioning cables.

Fig-1.1: Floating column

Fig-1.2 Palestra in London, United Kingdom

1.2 ADVANTAGES AND DISADVANTAGES OF BOX GIRDER BRIDGE

ADVANTAGES

i) In case of long span bridges, large width of deck is available to accommodate pre stressing cables at bottom flange level.

ii) In recent years , single or multi-cell reinforced concrete box girder bridge have been proposed and widely used as economic aesthetic solution for the over crossings, under crossings, grade separation structures and viaducts found in modern highal system.

iii) Interiors of box girder bridges can be used to accommodate service such as gas pipes, water mains etc.

DISADVANTAGES

i) One of the main disadvantages of box decks is that they are difficult to cast in-situ due to the inaccessibility of the bottom slab and the need to extract the internal shutter. Either the box has to be designed so that the entire cross section may be cast in one continuous pour, or the cross section has to be cast in stages

1.3 ABOUT CSi BRIDGE

INTRODUCTION TO CSi BRIDGE:

Modelling, analysis, and style of bridge structures are integrated into CSi Bridge to form the final word in computerised tools tailored to satisfy the wants of the engineering skilled. the convenience with that all of those tasks is accomplished makes CSi Bridge the foremost versatile and productive package program within the trade. Mistreatment CSi Bridge, engineers will simply outline advanced bridge geometries, boundary conditions and cargo cases. The bridge models are outlined parametrically, mistreatment terms that are acquainted to bridge engineers, like layout lines, spans, bearings, abutments, bents, hinges, and post tensioning. The package creates spine, shell, or solid object models that update mechanically because the bridge definition parameters are modified. CSi Bridge style permits for fast and simple style and retrofitting of steel and concrete bridges.

CSi Bridge implements a constant quantity object-based modelling approach once developing analytical bridge systems. this permits designers to assign bridge composition as Associate in Nursing assembly of objects (roadway construction, substructure, abutments, piers, foundation system, etc.

After modelling, CSi Bridge provides choices for the assignment of load cases and combos. Vehicle, seismic, and wind loading are generated consistent with codification (AASHTO LRFD, Canadian, etc.) and assigned consistent with model pure mathematics. A series of templates for assignment and close load conditions create CSi Bridge intuitive and sensible. once the first object-based model has been translated into a finite-element model and subjected to load cases and combos, the analysis method follows directly.

2. OBJECTIVES

The main objectives of the proposed work are:

1. To study the parametric behaviour of a prototype models i.e., single cell and four cell Box Girder Bridges.
2. To compare the results for IRC Class AA loading with respect to different prototype models considered.

3. METHODOLOGY

1. Presents problem formulation for the present work regarding four cell and single cell box Girder Bridge subjected to IRC class AA loading.

2.Describes the features of CSi Bridge software used in the analysis, modelling, bridge configurations, loading cases and analysis & interpretation of results.

3. Presents the outcome of the parametric study performed on the bridge prototypes.

3.1 PROBLEM STATEMENT:

Consider a box girder for 2 lane national highway bridge, with the data below:-

Type of support:- simply supported length:- 30 m

Carriageway width:- 7.5m foot path width:- 1.25m segmental width :- 10m load type :- IRC class AA loading

concrete grade: M60 for both the cell types

Loading on Box Girder:

The various sorts of masses, forces and stresses to be thought of within the analysis and style of the varied parts of the bridge are given in IRC 6:2000 (Section II) however the common forces are thought of to style the model are as follows:

For IRC Class AA loading (IRC 6: 2000, Clause no 207.1, Page no. 10)

3.3.8 Calculation of Ultimate Strength (As per IRC: 18-2000, Clause no. 13)

i) Steel failure by yield (under reinforced section) Mult = 0.9dbAsFp

ii) Concrete failure by crush

Mult = 0.176 db^2fck

Ultimate Moment of Resistance

Positive Moment:

Internal BM, MEd = 14893.728kN.m

Designed MOR , MRd

MRd=Fc.ac+Fs.as+Σ(Fpi.api)=85812.438kN.m (MEd<MRd)

Hence, Structure is safe.

Negative Moment:
Internal BM, MEd = 0.00kN.m
Designed MOR, MRd
MRd=Fc.ac+Fs.as+Σ(Fpi.api)=103656.221kN.m (MEd<MRd)
Hence, Structure is safe.

Shear reinforcement (As per IRC 18: 2000 Clause 14.1.4):
When *V* , the shear5force due to ultimate load is less than *Vc/2* then no shear reinforcement need to be1provided. Minimum shear reinforcement shall be provided when *V* is greater than *Vc/2 in* the form of links

Asv/sv x0.87Fyv/b = 0.4MP

If V> Vc, the shear reinforcement provided.

Internal SF, VEd = 600.456kN

Designed SF,

$VRd = (I \cdot bw / S) \cdot \sqrt{((fctd)2 + \alpha l \cdot \sigma cp \cdot fctd)} \geq (\nu min + k1 \cdot \sigma cp) \cdot bw \cdot dp =$ =4668.975kN
VEd < VRd
Maximum BM @ mid section = 6276.96 kN.m
Maximum Deflection at mid section = 7.189 mm
Concrete quantity = 138.6 m^3
Steel quantity = 18.167 MT
Strand quantity = 180.285 m

Four Cells Concrete Box-Girder with two traffic lanes Vertical side walls (As per IRC 18:2000)

Top slab thickness = 300 mm
Bottom Slab thickness = 300 mm
External wall thickness = 300 mm
Internal Wall thickness = 300 mm
Span = 30m
Cross-sectional Area = 8.31 m^2
Center: y = 5 m
Width of Carriage way = 7.5m
Total width = 10m Road
Wearing coat = 80mm
Ixx = 1.304 X 10m^4
Iyy = 4.591 m^4
Izz = 6.012 X 10 m^4
Center: z = 1.0521 m

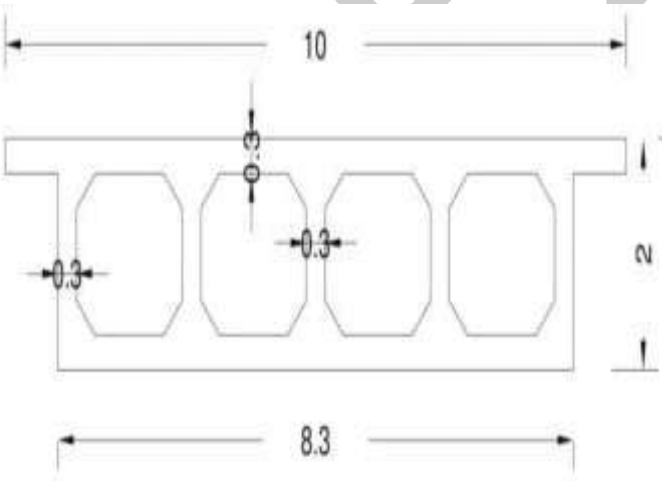

Fig-3.1: CROSS SECTION

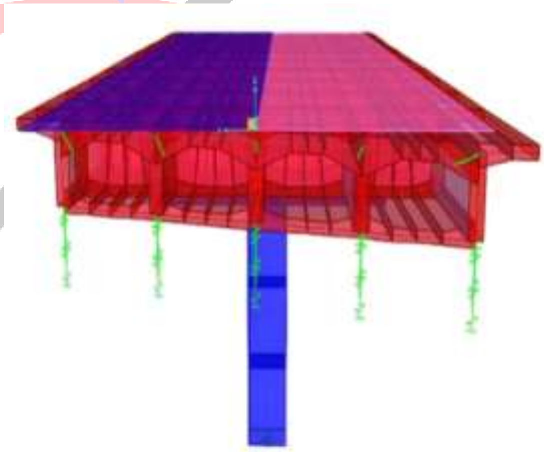

Fig-3.2: 3D-ELEVATION

Single Cell Concrete Box-Girder with two traffic lanes Vertical side walls (As per IRC 18:2000)
Top slab thickness (Tapered) = at the centre 300 mm & at corner 200 mm Bottom Slab thickness = 200 mm
External wall thickness = 300 mm
Span = 30m
Total width = 10m Road
Carriage way width = 7.5m
Wearing coat = 80mm
Center: z = 1.355 m
Cross-sectional Area = 4.620 m^2
Ixx = 5.199 X 10 m^4
Iyy = 2.353 m^4
Izz = 2.652 X 10 m^4
Center: y = 5 m

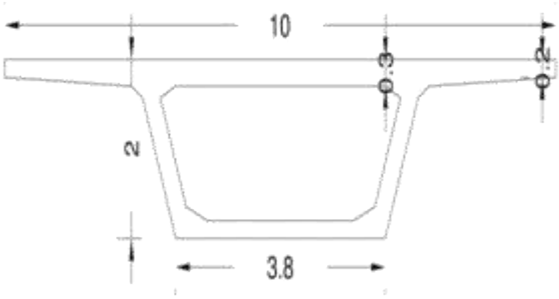

Fig-3.3: CROSS SECTION

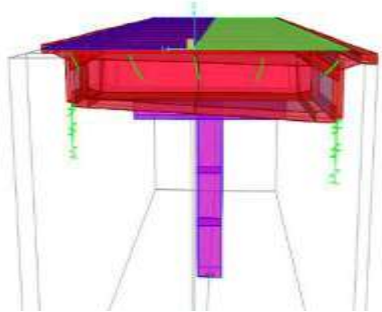

Fig-3.4: 3D-ELEVATION

4. RESULTS AND DISCUSSION

4.1 Single Cell Box girder:

Dead load under IRC loading

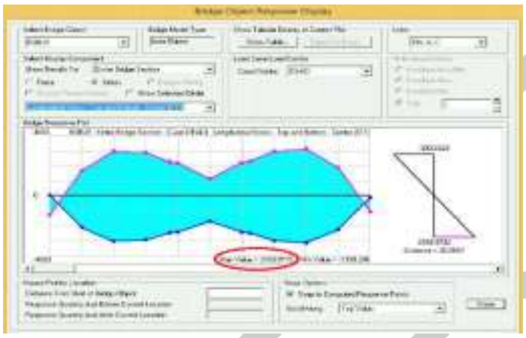

Fig-4.1: BRIDGE RESPONSE DATA.

Vehicular load under IRC loading

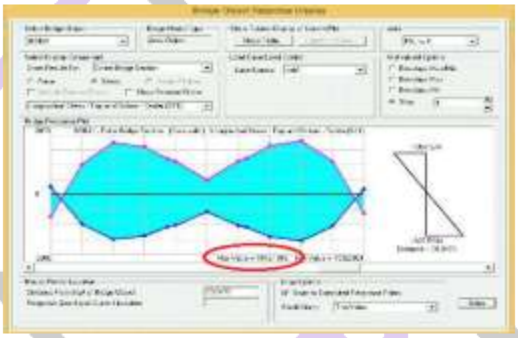

Fig-4.2: BRIDGE RESPONSE DATA

From Fig 4.1 Maximum Bridge response data found to be 3474.290kN/m^2 at distance 23.36m under IRC loading for Dead load and from Fig 4.2 maximum is 1916.1016kN/m^2 at distance 20.04m.

Four Cells Box girder:

Dead load under IRC loading

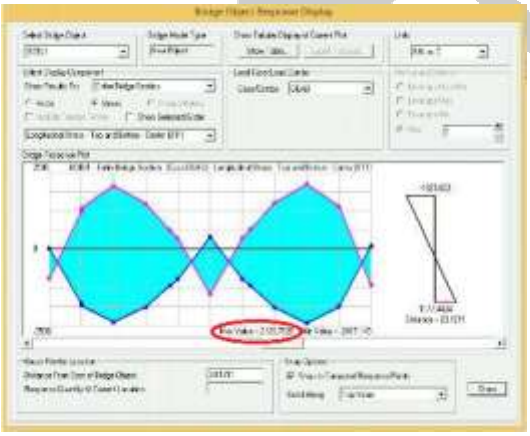

Fig-4.3: BRIDGE RESPONSE DATA.

Vehicular load under IRC loading

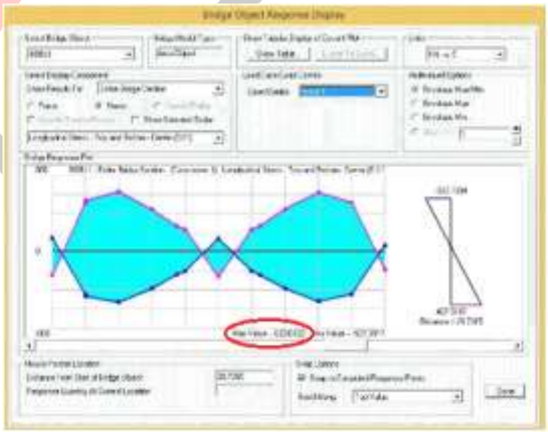

Fig-4.3: BRIDGE RESPONSE DATA.

From Fig 4.3 Maximum Bridge response data found to be 2290.042kN/m^2 at distance 20.72m under IRC loading for Dead load and from Fig 4.2 maximum is 1235.0422kN/m^2 at distance 21.74m.

SL.No	ANALYSIS RESULTS OF SECTION UNDER IRC CLASS AA LOADING	MAX MOMENT(kN-m)
1	Multi cell Left exterior girder under IRC Class AA	1991.5323
2	Multi cell Interior girder 1 under IRC Class AA	4606.945
3	Multi cell Interior girder 2 under IRC Class AA	2043.0695
4	Multi cell Right exterior girder under IRC Class AA	1570.5596
5	Single cell left exterior girder under IRC Class AA	3412.3876
6	Single cell Right exterior girder under IRC Class AA	3962.236

Table-4.1: BENDING MOMENT TABLE OBTAINED UNDER IRC LOADING.

From Table-4.1 Maximum Bending moment value for multi cell is found to be 4606.945kN/m^2 and Single cell is found to be 3962.236kN/m^2

5. CONCLUSIONS

Single and Multi cell box girder bridges are considered for the analysis. Models were subjected under IRC class AA loading conditions and corresponding bending moments and Object response stress values were compared.

Results can be summarized as follows:

1. According to results obtained, the bending moment was found to be maximum for the Single cell box girder while compared with Four cell girder.
2. The varied span to depth quantitative relation are taken for the analysis of beam bridges, and for all the cases, deflection and stresses are at intervals the permissible limits
3. It is found that the deflection obtained thanks to varied loading conditions and at service condition is well at intervals permissible limits as per IRC. the utmost vertical deflection is found to occur close to mid-span location of the beam.
4. Results of bending moment and stress for self-weight and superimposed weight are same, however those are totally different for the moving load thought, as a result of IRC codes offers style for the significant loading
5. Finally supported this comparative study it's clear that Single cell girder bridge is economical than Four cell girder bridge.

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