COMPARATIVE STUDY OF PRECAST RCC I-GIRDER CONFIGURATION FOR VARIOUS SPAN ARRANGEMENTS IN A BRIDGE SUPER STRUCTURE

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Abstract - *Design and Analysis of I girder is done for the present work, Computer Structural Ink modular software is been used for the analysis of the structure and design is carried out by using self-made EXCELL spread sheets, the analysis is mainly done for live loads as per IRC codal requirements that is 70R and class A and load combinations are made as per IRC stipulations. shear force and bending moment values for dead load, live load, SIDL, 70R and class A condition are extracted at various location of the span length and graph were plotted for individual loading condition for various span length with different girder arrangements, the check for ultimate moment of concrete section and ultimate shear resistance of the concrete section is done, percentage of the steel provided is checked for percentage limit of the steel and deflection of the I-girder for various span is checked for the maximum deflection of the I-girders and graphs were plotted. The precast RCC I-girder is used for the present work 20, 25 and 30m with three girder and four girder arrangement system, with 12m cast in situ deck slab width and with same sectional properties, span length with girder arrangement which is more stable is found.*

***Key Words*: Precast RCC I girder1, RCC Slab2, Simply Supported Bridge3, Various Span Length4, CSI Bridge modular Software5.**

1. INTRODUCTION

A bridge or flyover is a structure having a minimum total length of above 6 meters between the inner face of walls for carrying traffic or other moving loads, a bridge or flyover can defined as a including supports erected over a inclination or obstruction, such as water, channel, highway, or railway, and having a passageway or track for carrying traffic or other moving loads, bridges are classified in to two types such as minor and major bridges, minor bridges are bridges having a total length of up to 60 meters, and major bridges are bridges having a total length of above 60 meters.

The reinforced concrete bridges are well suitable for the construction of the highway bridges in the small and medium span range. These bridges have gained vary big popularity due to their versatility in construction and economical in cost and maintenance, also they can be cast in any convenient shape and forms to meet required architectural shape requirements, the structure must be durable and should not be damaged or collapsed below the design period of the structure. The deck slab is cast in situ structure where the engineer utilizes locally available materials such as stone chips, gravels, sand etc.

For the present work precast RCC I girder with cast in situ deck slab has been analyzed for different span length with different girder arrangements and modal is analyzed for all load cases after analyzing completed analysis result will be extracted and graph will be plotted for all RCC I girder arrangements and this arrangement are checked for economical design. The various loads considered on the bridge is comprises of dead load including self-weight of girders, standard vehicle loads (considered as moving loads), crash barrier, wearing coat loads as per IRC stipulations. The different IRC moving loads for the bridges construction considered are a) IRC class A loading b) IRC class 70R loading with vehicle impact effect. A finite element method is used for the analyses, finite element mathematical model will be developed using versatile FE software such as CSI bridge modeler. Analysis will be performed considering various load cases including vehicular moving load. The bridge super structure is constructed by providing simply supported I –girder over piers and using cast in situ deck slab over this I girder. And design are done by manually by preparing spread sheets and designs are done as per IRC code standards.

2. METHOD OF ANALYSIS

Finite element method is most commonly used method, by using FEM method we can resolve the structures of any completed shapes and boundary condition. It involves in discretization of whole structure into number of small elements which are inter connected with each other through nodal points. Displacement produced within the element in field can be assumed in terms of nodal displacement. The element properties can be shown in matrix form, and the governing equation of the structural response is then established through the application of suitable variation principal. At final purely algebraic equation are obtained which is used to solve and obtain the response of the structure by choosing proper elements and suitable discretization of the structure into number of small elements any kind of structure can be resolved and desired accuracy can be achieved through finite element method.

BRIDGE DATA

Span length	20.0m, 25m and 30m
Depth of I-Girder	1.8m
Width of the web	0.3m
Width of top flange	1.1m
Width of bottom flange	0.6m
Length of I-Girder	19.4m, 24.4m and 29.4m
Effective span	18.6m, 23.6m and 28.6m
Thickness of the deck slab	0.25m
Length of cantilever deck slab	2.0m
Number of girders	3no'S and 4no`S
Clear span	17.5m, 22.5m, 27.5m
Thickness of end diaphragm	0.4m
Thickness of mid diaphragm	0.3m
Top flange width	1.1m
Bottom flange width	0.6m
Width of web	0.3m
Total width of the I-girder	12m
Wearing coat thickness	0.65mm
Vehicle class	3L of class A and 70R+class A

3. SUMMARY OF THE BENDING MOMENT AND SHEAR FORCE FOR DIFFERENT SPAN AT DIFFRENT SECTION

3.1 DEAD LOAD

Following results are extracted from the models of the I-girders of span 20m, 25m and 30m length and effective end to end span is 19.4m, 24.4m and 29.4m for dead load condition. Dead load is the self-weight of the I-girder and from the analysis maximum moment is found at the center of the span at 9.7m, 12.2m and 14.7m which is done for three I-girder and four I-girder system respectively. I-girder is modeled as a simply supported case maximum moment will be at the center and minimum moment will be at support, and shear force in the I-girder the maximum shear force will be at the support and minimum shear force will be at the center of the span.

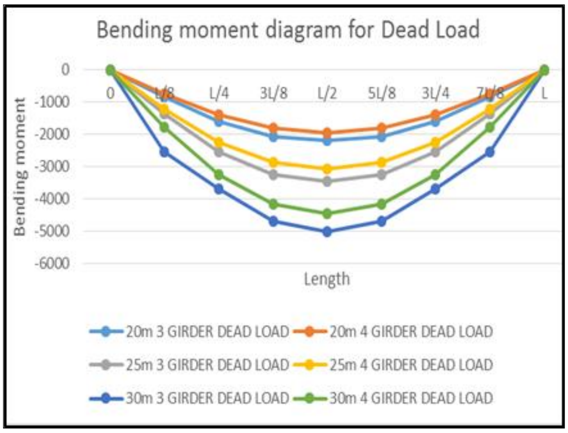

Chart-1: Bending moment diagram for dead load

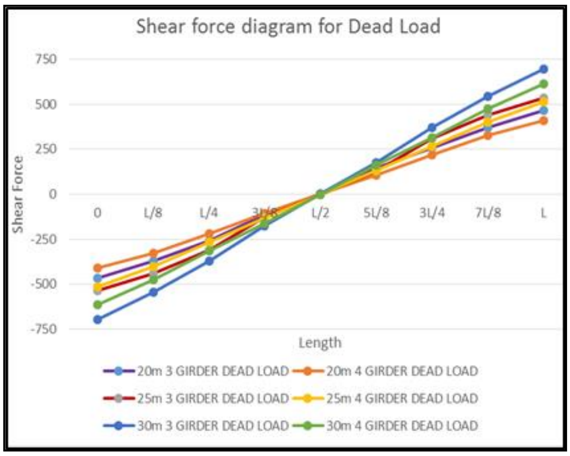

Chart-2: Shear Force diagram for Dead Load

3.2 LIVE LOAD

Following are the results which are extracted from modals for different span and different loading cases the results obtained for standard IRC load combination of live load, two load pattern were used i.e. three lane class A and class A+70R.

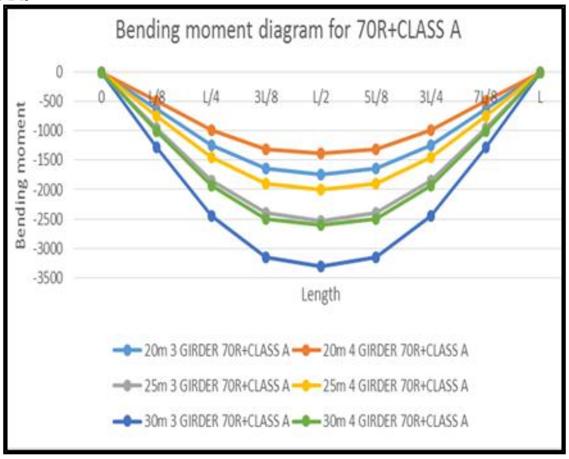

Chart-3: Bending moment diagram for 70R + CLASS A

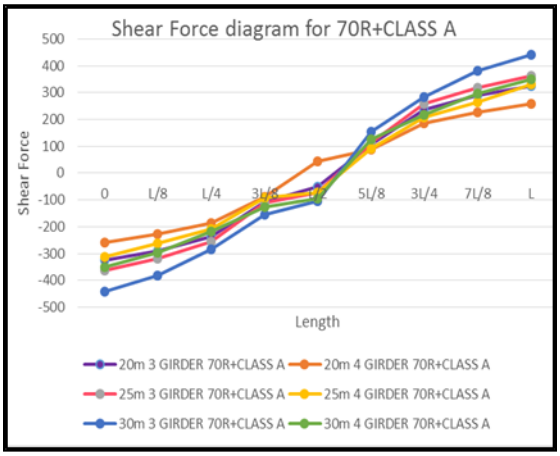

Chart-4: Shear Force diagram for 70R + CLASS A

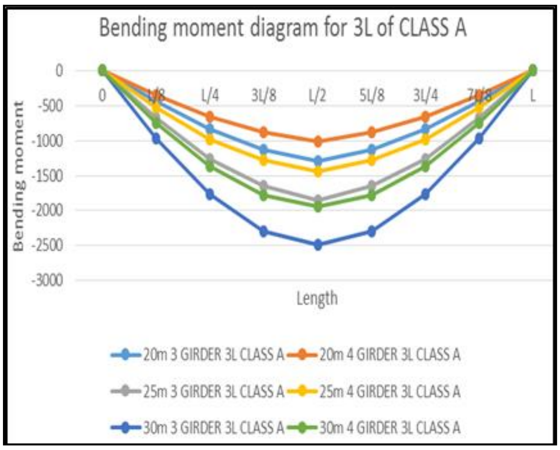

Chart-5: Bending moment diagram for 3L of CLASS A

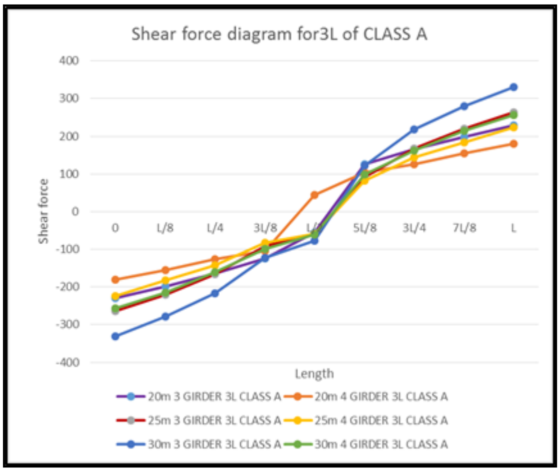

Chart-6: Shear force diagram for 3L of CLASS A

4. JOINT DISPLACEMENT OF I-GIRDER

Results for the displacement for different loading cases are obtained by analysis and Displacement value will be always maximum at the center of the span i.e. at 9.7m. 12.2m and 14.7m and results are extracted at the mid span where we can get maximum deflection. The maximum displacement is show in blue color and minimum displacement value in pink color from the variation in the color we can judge where is maximum displacement is appearing in the I-girder, the maximum displacement is present at edge of the I-girder at the center of span in the present model.

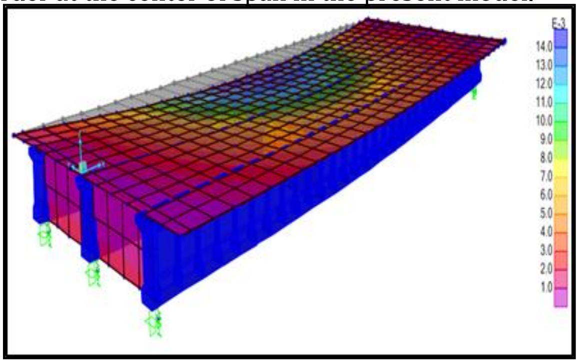

Fig-1: Deformed shape of the 20m span 3 NO RCC I-girder

5. ULTIMATE MOMENT RESISTANCE AND SHEAR RESISTANCE OF THE CONCRETE SECTION

The variation of resistance of concrete section for various spans are plotted in graphs and clearly that the resistance of the concrete section due to bending and shear is for the same girder depth with various span arrangements for three girder and four girders arrangements with 12m deck moment of resistance and shear of resistance has been checked and the results are it shows clearly that the resistance of the concrete section due to bending and shear is well within the limit and the arrangement of four girder system for a span of 20m is feasible, and remaining span length with girder arrangements were not within the limit.

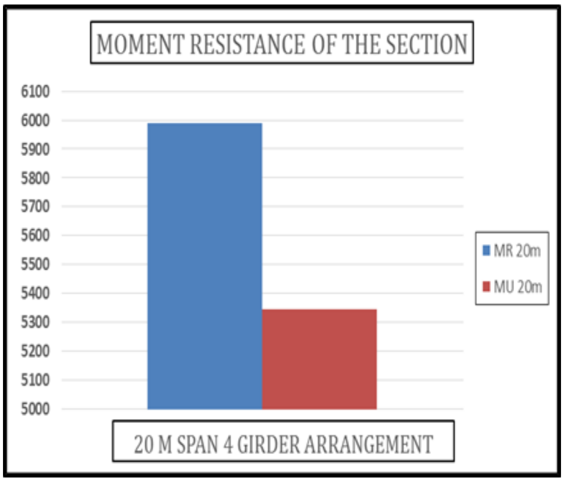

Chart-7: Moment Resistance of concrete section for 20m span 4 girder arrangement

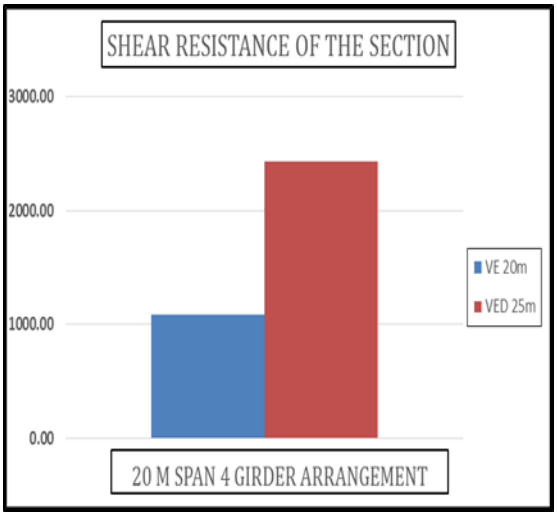

Chart-8: Shear Resistance of concrete section for 20m span 4 girder arrangement

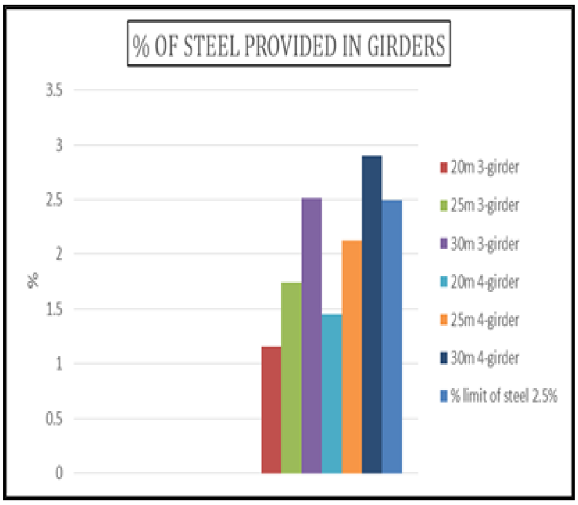

Chart-9: Percentage of Steel provided variations in Precast RCC I-Girders

6. PERCENTAGE OF STEEL PROVIDED IN PRECAST RCC I-GIRDERS

After the design check for resistance of concrete section the girder is further checked for the provision of steel reinforcement in girders and in any case the provided reinforcement should not cross the limit as per the codal requirements as per IRC:112-2011 the maximum percentage limit for bending is 0.025Ac where Ac is the area of concrete section and the values recorded from the various designs for different span and girder arrangements are plotted in a graph to show the variation's and there limit are shown in fig 1.10 and it clearly picturizes that the three girder arrangement and four girder arrangement for a span of 20m is only safe for the reinforcement percentage limit rest all girder arrangement of three girder and four girder arrangement for 25m span and 30m span are crossing the limit and for 30m span three girder and four girder arrangement the limit crossing is very high when compared to the other girder and span arrangements.

7. MAXIMUM DEFLECTIONS OF I-GIRDERS

Deflection check is done as per the standards and the resultant defection from various loads and from various span and girder arrangements are tabulated below in fig 8.86 and from fig 8.86 it clearly shows that the deflection is well within the limit for span of 20, 25 and 30m for three and four girder arrangements and the deflection is within the limit of standard codal stipulations.

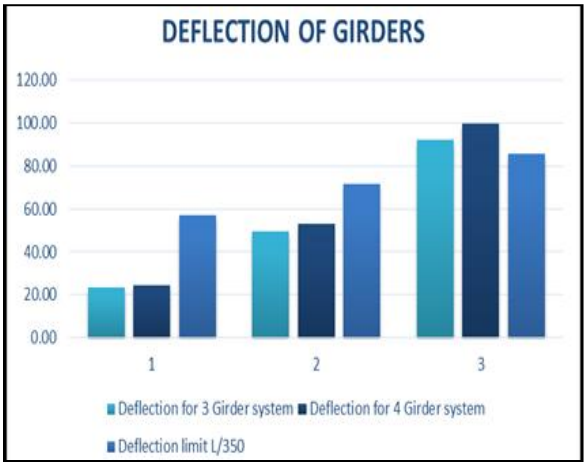

Chart-10: Deflection of girders due to different loadings and span

8. CONCLUSIONS

- The design of Precast RCC I-girder with cast in-situ deck slab arrangement having 1.8m girder depth is economical only for span for 20m with four girder arrangement and this system gives more economical design for construction.

- T guidelines for different span lengths with different girder arrangements such as 3 girders and 4 girders system the four girders system for a span of 20m with a girder depth of 1.8m is safe against ultimate moment resistance, the other system for span such as 25m and 30m does not satisfy the IRC requirements.
- The design has been checked for Ultimate shear resistance check as per IRC guidelines for different span lengths with different girder arrangements such as 3 girders and 4 girders system the four girders system for a span of 20m, 25m and 30m with a girder depth of 1.8m is safe against ultimate shear resistance.
- It is found that the deflection obtained for various loading conditions and at service condition is well within permissible limits as per IRC. The maximum vertical deflection is found at near mid-span location of the girder.
- It is found that steel requirement is crossing the permissible limit in some of the girders of different spans and girder arrangements but for 20m span with four girder system, it satisfies all the cases and conditions.

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BIOGRAPHIES

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