ANALYSIS AND DESIGN OF PRESTRESSED DECK SLAB BRIDGE WITH IRC 112-2011

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ABSTRACT:

Bridge constructions today has achieved a level of importance. Bridges are key elements in any road networks and the use of prestressed girder type bridges gaining popularity because of its serviceability, economy, better stability, appearance and structural efficiency. In this study, analysis and design of prestressed concrete bridges like Deck Slab, T-Girder and Box Girders, are done by using IRC: 112-2011. The unified concrete code (IRC:112) which was published by the Indian Road Congress in Nov 2011 combines the code of reinforced concrete structures and prestressed concrete structures represents a new code, which is comparatively different when compared to previous codes (i.e RCC structures IRC:21 and for PSC structures IRC:112).

The fundamental difference between previous codes and IRC: 112 is that the previous codes were designed based on working stress theory and IRC: 112 were designed based on limit state theory. In this study, analysis and design of deck slab bridges with curb and without curb has done using analytical approach and those results are compared with the finite element method using SAP2000 for understanding the effect of curb on deck slab bridges. While comparing both methods it has seen that there are 5-15% variations, which can be acceptable. Analysis and design of post tensioned T-Girder bridge of spans 20 m and 30 m are carried out without cross girders by using finite element method using SAP2000 bridge wizard. Based on the maximum responses (Bending, Shear, Torsion and Deflection) for three girder system are compared for different load combinations. The structural behavior of box girder is very complicated to analyze by conventional methods. In present study by using Indian Road Congress (IRC: 6) recommendations a simply supported box girder bridge two lane made up of pre stressed concrete is analyzed for moving loads. The analysis is carried out using SAP2000 bridge wizard and pre stressed with parabolic tendons in which utilize full section. The various span to depth ratio considered to get the actual depth at which stress and deflection criteria are satisfied. The thesis also includes the comparison of section 15 (general detailing requirements) of IRC: 112 with the old codes IRC: 18 and IRC: 21 and it also includes comparison of flexural and shear design approach by using IRC: 112 with the old codes.

Keywords: Deck slab, Girder, pretstressed

1. INTRODUCTION

Bridges are defined as structures which provides a passage over a gap without closing way beneath. They are required for a passage of railway, roadway, footpath and even for carriage of fluid, the selection of bridge site location should be so chosen that it gives maximum benefits, efficiency, effectiveness and equality.. Bridges symbolize ideals and aspirations of humanity. They divide, bring people, communities and nations into closer proximity. They shorten the distances, transportation become easier and facilitate easier. Bridge construction is an important factor in progress of civilization. One of the comparision I made in this paper that is Deck slab behaviour and its results.

1.2 Objective of Study

The main objective of the study is to analysis and design of prestressed concrete bridges of girder type solid deck slabs and comparative study of results using analytical and FEM. The objects in details are as follows.

i. EXCEL sheet (Appendix-A) for analysis and design of prestressed solid deck slab bridges for different IRC Loadings are prepared and comparison of those results with finite element method and finding the effect of grade of concrete and span on prestressing force and the estimation prestress losses are done.

ii. Study of effect of curbs on solid deck slab bridges using conventional and finite element method.

v. Comparative study of IRC: 112-2011 with IRC: 18 and IRC:21.

1.3 Deck Slab Bridge

A deck slab bridge is the simplest type of construction, adopted mostly for small bridges and culverts. The span should not exceed 8 m for the bridge in order to be built at minimum cost. Through the thickness of the slab will be considerably high, its construction is simpler and the cost of the formwork is less.

1.4 Types of Decks in Bridges

The three most common types of reinforced concrete bridge decks as Solid slab bridge decks are most useful for small, single or multi-span bridges and are easily adaptable for high skew. Voided slab and T-Girder bridges are used for larger, single or multi-span bridges. In circular voided decks the ratio of depth of void to depth of slab should be less than 0.79; and the maximum area of void should be less than 49% of the deck sectional area.

1.5 Method of Analysis of Deck

A wheel load is particularly considered as a concentrated load on the slab. This load will get dispersed with its effects along span wise and widthwise direction. Thus the load will get distributed along a particular length and width of the slab. If the deck slab is spanning in one direction i.e. bridge deck without cross beams or deck with diaphragms, the bending moments for dead load may be computed as a continuous slab, continuous over the longitudinal girders. For concentrated loads, the bending moment per unit width of slab may be computed using the effective width method. When the slab is supported on four sides, as for the case bridge deck with cross girders, the deck slab may be designed as a two-way slab using Pigeauds method. In deck Girder Bridge, if transverse beams are used, each panel of slab may be considered to be freely supported at its edges and assuming corners not free to lift alternatively, the slab may be considered to be continuous over supporting beams. Piegeauds coefficient method and Westergaurds method are available for analysis of each panel of slab subjected to concentrated loads. Westergaurds method is cumbersome and therefore rarely adopted for slab designs. Pigeauds curves are used for computing bending moments in a panel freely supported along four edges with unrestrained corners and carrying symmetrically placed load distributed over some well defined area. Pigeauds derived the curves for thin plates, using elastic theory of flexure, and assuming Poisson's ratio of 0.15.

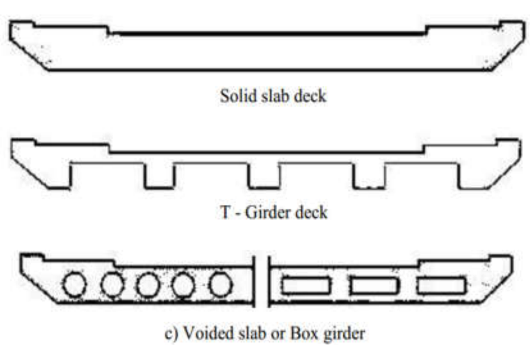

Figure A. Types of Decks in bridges

2.LITERATURE REVIEW

Barr.P.J. et al (2008) : Five prestressed concrete girders made with high performanceconcrete were instrumented using vibrating wire strain gauges. Their behaviour was monitored for three years from the time of casting. The measured change in concrete strain at the centroid of prestressing strands was used to evaluate changes in prestress. The total prestress loss was as large as 28% of the total jacking stress. The observed values of prestress losses were compared with values calculated using the recommended AASTHO LRFD and NCHRP procedures. Their experiments concluded that the AASTHO LRFD over-predicted the average prestress losses for the highly stressed span by 20% while the NCHRP method under predicted the average losses by 16%. The NCHRP method was found to be more inclusive and adoptable to regional construction.

Byung Hwan Oh, In Hwan Yang (2001) they proposed an accurate method for realisticlong term prediction of prestress forces changes due to creep and shrinkage of concrete in psc structures. long term prestress forces is achieved using Bayesian statical interface. The present study also deal with the uncertainties with regard to creep and shrinkage of concrete. The proposed method to reduce the uncertainty is to conduct short term measurements in the field before opening the structure to traffic and use them to update the prior prediction using Bayesian statistics. They also introduced sampling method to determine uncertainty regard to creep and shrinkage of concrete.

Jarret Kasan,s.m. and Kent A. Harries (2011) they suggested that the flexural capacityrating of prestressed girders having severed or corroded strands often progresses by simply neglecting the contribution of the effected strands from the girder section and assessing the capacity. While this is an adequate approach at the effected section, it is conservative elsewhere along the span, assuming that fully bonded strands are used. Once it reenters sound concrete, the severed or corroded strands continues to be bonded to the concrete; thus stress transfer b/w the concrete and strand is possible and the strand prestress force may be“redeveloped”(in the sense of transfer length) by bond transfer at a distance from the damage location. This paper reports clearly shows that prestress force is redeveloped at a distance from the location at which a strand is severed AASTHO and ACI code prescribed transfer length calculations appear to remain valid for this redevelopment behavior.

3. RESULTS AND DISCUSSION

3.1 Results Comparison

For understanding the effect of curb on deck slab in detail a simply supported deck slab of size (10 m x 7.5 m) panel has taken without and with curb of size (0.25 m x 0.25 m) and analysis is carried out for different IRC loadings and comparison of maximum bending moment and shear force using conventional and finite element method by considering the effect of curb and without curb as shown in Table 1 and remaining general data for analysis considered same as previous problem.

Live Load Cases			Without curb		With curb	
			Conventional	FEM	Conventional	FEM
Class B	DL-M11	kNm	103	131	105	138
	DL-V13	kN	40	53	43	62
	LL-M11	kNm	77	86	72	80
	LL-V13	kN	52	60	47	54
Class A	DL-M11	kNm	103	131	105	138
	DL-V13	kN	40	53	43	62
	LL-M11	kNm	96	105	85	98
	LL-V13	kN	81	89	74	77
Class B Two Train	DL-M11	kNm	103	131	105	138
	DL-V13	kN	40	53	43	62
	LL-M11	kNm	105	113	98	106
	LL-V13	kN	51	65	48	56
Class A Two Train	DL-M11	kNm	103	131	105	138
	DL-V13	kN	40	53	43	62
	LL-M11	kNm	176	193	165	187
	LL-V13	kN	80	85	76	90
Class AA Tracked	DL-M11	kNm	103	131	105	138
	DL-V13	kN	40	53	43	62
	LL-M11	kNm	224	246	214	237
	LL-V13	kN	102	149	97	142
Class AA Wheeled	DL-M11	kNm	103	131	105	138
	DL-V13	kN	40	53	43	62
	LL-M11	kNm	174	196	166	185
	LL-V13	kN	107	119	104	2
Class 70R Tracked	DL-M11	kNm	103	131	105	138
	DL-V13	kN	40	53	43	62
	LL-M11	kNm	211	223	202	221
	LL-V13	kN	92	115	87	110

Table 1 Comparison of maximum bending moment and shear force

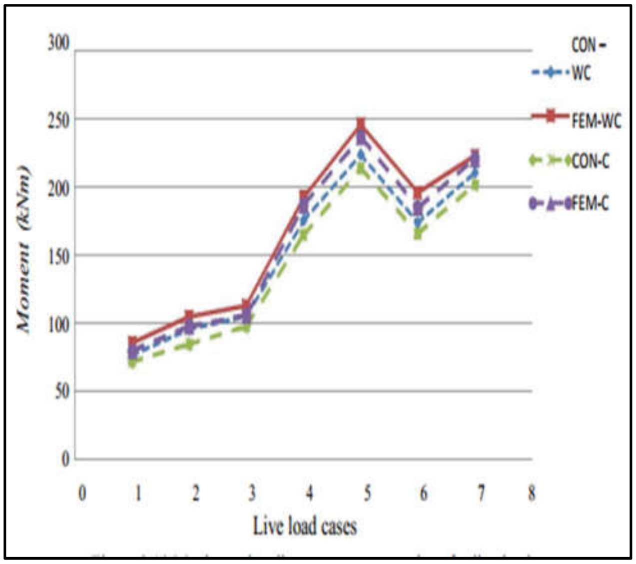

Figure 1 maximum bending moment Comparison for live load

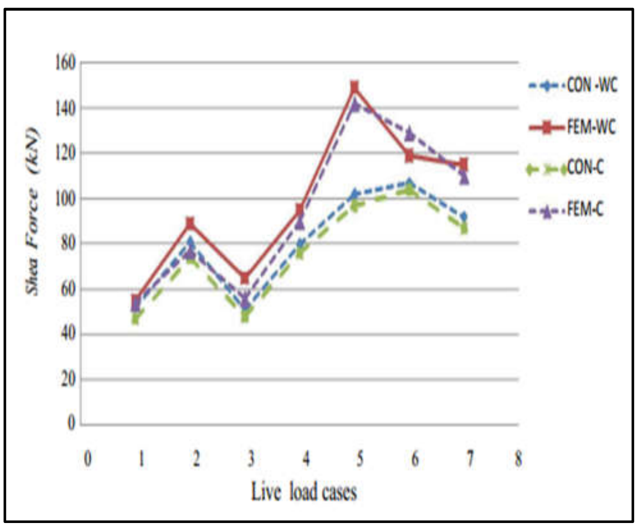

Figure 2 Maximum shear force comparison for live load

There are some variation in the result when we compared with conventional method to Finite Element Method but those are in acceptable limits hence it can be neglected. From Figure 1 and Figure 2 we can observe that maximum bending moment and shear are occurred in case of Class AA tracked vehicle. For analysis and design of deck slab bridge refer Appendix-A.

3.6.1 Observations from the above study

Based on the analysis done in this chapter the following observations are to be made.

a) Bending moment and shear force results obtain from conventional method for dead load are exactly same as that of finite element method e) For live load bending moment and shear force results from conventional method are nearly same or there are 5 to 15% variations which can be acceptable.

b) As the grade of concrete increases then %loss of prestress decreases.

c) As the span of the deck slab increases then %loss of prestress also increases.

CONCLUSION

One of the Results presented above out of Analysis. An attempt has been made in the present study to asses the static behaviour and analysis and design of different prestressed concrete girder bridges. Conclusions Summarized from the study.

From the study of deck slab bridges the bending moment and shear force results obtained from the conventional method for dead load are exactly same as that of finite element method. For live load bending moment and shear force results from conventional method are 5 to 15% variations which can be acceptable.

Due to the effect of curb on deck slab bridges the maximum responses (bending moment and shear forces) are decreasing that will reduces the design reinforcement in the deck slab bridges.

Future Scope

Study of deck slab bridges can be extended to continuous type and multiple lanes.

Study of effect of cross girders and diaphragms on T-Girder bridges.

Study of continuous type box girder bridges with dynamic analysis.

Comparison of various clauses of IRC:112 with the old codes IRC:21 and IRC:18.

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