ANALYSIS AND DESIGN OF PSC I-GIRDER SUPER STRUCTURE WITH PRECAST TECHNOLOGY AS PER IRC: 112-2020

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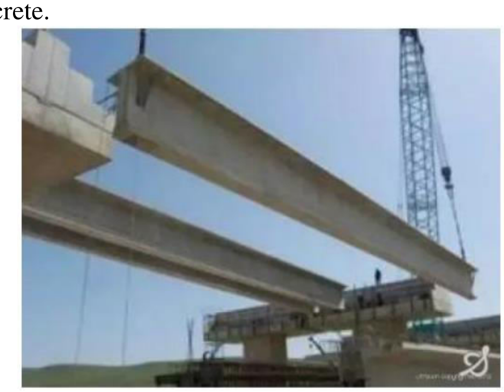
ABSTRACT
One of the most important industries in the world today is bridge construction. National highways and urban traffic control are now essential for every contemporary country. In today's cities, elevated transit systems like flyovers and viaducts are essential pieces of infrastructure. are the kinds of bridges that need the use of state-of-the-art construction methods and prestretching tools. Prestress girder bridges are becoming more and more common in the area of bridge engineering because of its advantages in terms of economies, stability, serviceability, visual appeal, and structural efficiency. Bridges are vital parts of every transportation system. Ibeam bridges, one of the most popular types of bridges, need constant investigation and revisions to analytical techniques and design principles. Structurally, building them is not difficult at all. This indicates that they are the best choice for bridging relatively short distances. We discuss the design and analysis of a longitudinal girder bridge in this article. Here, STAAD Pro is used for analysis, and the building's design is influenced by IRC1122020 criteria.

I. INTRODUCTION

A girder is a horizontal support beam used in building construction. They are often built of steel, concrete, or a mix of these materials. The bridge deck of a girder bridge rests on the supporting beams, which in turn rest on the piers and abutments that hold up the bridges span. Box girder beams, often built of steel or concrete, are formed like an open box, whereas Ibeam girders are named for their resemblance to the capital Roman letter I. Light rail bridges, pedestrian overpasses, and highway flyovers typically range in length from 33 feet 10 metres to 650 feet 200 metres, where girder bridges shine. The Brazilian girder bridge is 2,300 feet 700 metres in length, making it the largest in the world

Based on the building materials and girders used, four distinct categories of girder bridges may be identified. Plate girder bridges have their Ibeams welded together onsite from flat slabs of steel, whereas rolled steel girder bridges use prefabricated Ibeams. Concrete Ibeam girders, which are used to build concrete girder bridges, may be formed of either prestressed or posttensioned reinforced concrete. The deck of a box girder bridge is supported by box girders, which may be either steel or concrete.



Many criteria determine whether Ibeam girders or box girders are utilised to build a girder bridge. Ibeam girders make girder bridge construction and maintenance more simpler and more costeffective. However, these girders are susceptible to the twisting forces, or torque, such a span is subject to, and may not provide enough structural strength and stability if the bridge is particularly long or the bridge span is curved. For these kinds of bridges, box girders are often used. Rainwater seeping into the void within box girders has been cited as a potential source of corrosion.

II. LITERATURE REVIEW

Grillage analysis and STAAD PRO are used to model the Superstructure and analyse how the BM and SF are distributed across the different girders. The grillage analysis is used to determine the value of bending moments and shear forces. Beam analysis in STAAD Plane is used to calculate the BM due to self wt of girder and the BM due to deck slab weight.

The design opts for the longitudinal components with the highest bending moments in this case, the End Girder on the side of the crash barrier.

Among the many load scenarios taken into account are

a Class A lane closest to sidewalk Class R lane for heavier vehicles 70 R Class A Traffic, 3 Lanes, b Special Vehicles, c Other

Beam and slab bridge decks are the most common applications for grillages. Grillages may also be used to simulate solid slab decks, however finite elements are more often utilised for this sort of deck.

Members of the longitudinal grillage are organised to represent the main beams, while members of the transverse grillage are arranged to represent the deck slab and diaphragm beams.

Members of the transverse grillage are typically spaced at a ratio of 1.51 to the major longitudinal members, however this may vary within a 21 range. In order to have a member at midspan, an odd number of transverse members must be used at the diaphragm places.

Moments and deflections in skew decks may be properly scaled by aligning the transverse members orthogonally to the main members. However, at skew angles under 35 degrees, this setup may be difficult and a skew mesh is often used instead. The skew mesh is considered a safe option since it will overstate the amplitude of moments and deflections by a small amount. Orthogonal spacing should be used when calculating the section characteristics of transverse members in a skew mesh.

SPAN ARRANGEMENT

Table 21

1. Center to Center of Piers	=	30.0 m
2. Total length of girder	=	29.6m
3. Center to Center of Bearings (Effective Span)	=	28.8 m
4. Overall width	=	14.5 m
5. Number of Main Girders	=	4 No's

Many PSC Itype girder bridges are built in the nation because of the excellent flexural stiffness and endurance of the precast concrete girders. To build a PSC girder bridge, many girders are first created on the pier using onsite fabrication methods the slab and crossbeams are then added to create a composite bridge deck. Due to the PSC girders superior flexural rigidity compared to the slabs, the lab is often idealised as a continuous beam over the stiff girders and the girders are regarded the supports in deck design.

Positive and negative bending moments created in the slab under the live load may have equal magnitudes if the girder on the slabongirder deck operates in a rigid way. This is why we make sure to evenly space the reinforcements at the top and bottom of the slab. In contrast, top reinforcement put in the slab, especially slab over the internal girders, may not be essential if the girders are flexible and the magnitude of the negative bending moment created in the slab is small owing to the girder deflections.

The girder deflections must be taken into account when determining the amount of top reinforcement needed for the slab, since corrosion of top reinforcement may lead to degradation of the bridge deck. The planar grillage approach is the most popular choice for modelling a slabongirder bridge deck, however it may be inaccurate if the difference between the neutral axes of the girder, crossbeam, and slab is not taken into account.

The technique may overestimate the behaviour of the slabongirder system and fail to accurately represent its unique load distribution features. As a result, its important to use the right modelling approach when simulating a slabongirder bridge deck. Methods of analysis include Standard plate theory and analysis of the girder deflections owing to flexible girder behavior are provided to calculate the negative bending moment created in the bridge deck.

III. ANALYSIS TECHNIQUES

The maximum bending moment of a slab taking the girder deflections into account cannot be determined analytically at this time. It is possible to utilise the finite element method to determine the negative bending moment in a slab, although doing so may require a lengthy modelling procedure and be fraught with difficulty. In addition, the finite element analysis may not be sufficient to develop universal design standards.

Method of Analysis

An analytical approach is devised to calculate the negative bending moment of a slab with flexible girders, based on the standard thin plate theory. Since the deck of a PSCgirder bridge has very varied longitudinal and transverse stiffnesses, the orthotropic plate model should be used to analyse the decks behaviour. This model allows for the incorporation of potential factors including stiffness, girder space, and the impact of span length on girder deflections.

Method of Grilling on a Plane

An analogous grillage of girders, as illustrated in Fig.2.1c, is used to idealise the slabongirder deck in a and b of the figure. If the grillage mesh is fine enough, the deck may flex and twist without cracking.

This technique of analysis may provide close approximations. One of the problems with grillage analysis, even if the findings are precise enough for design purposes, is as follows. Neutral axes of inner and exterior girders of Prestressed concrete Igirder bridges may be varied. Furthermore, the composite deck sections neutral axes may deviate greatly from the crossbeam and slab axes shown. In contrast, the grillage approach models both longitudinal and transverse grid components on a single plane. Therefore, because to nonuniform loads, the typical grillage technique cannot account for the bending, twisting, and inplane shear actions of the deck.

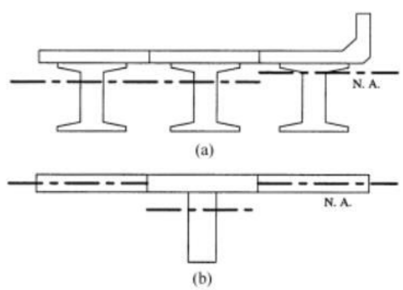


Fig.1 Differential neutral axis of interior and exterior girders

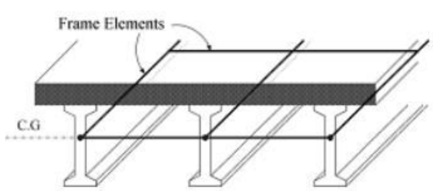


Fig2. c. 2D Plane grillage method

IV. BEAM THEORY

The bridge deck would be reviewed as both a girder for various wheel role here on duration but instead collinear maximum stress were also valued on the basis of both the hypermobile joints methodology and by simple cantilever beam. Tangential evaluation just that charge tecso projects different places of such transmitted seems to be done whilst also contemplating it and cross sectional area like a restrictive meshed view, currently consists anyway upward rather than predisposed internet representative but also lateral tile staffers backed now at tangent finish as well as using standard measurement to locate that whole occasion with in tiny slice. The beam element whereas providing inexact data based to also variety of different postulations, everything just would provide its creative director so much simplistic just like in comparison to some other existing options. Penalty points are really that as for timoshenko beam, one might concept it and conceptual improprieties, illustration its variance, its beveled topologic, this same load level and otherwise initial layer adequately. Still there understating postulations, it and beam element provides more than faster and easier, way quicker but also excellent results again for slight flat time frame support beams. As all this theorist can sometimes appears to give a christian outcome, for the most of the intended purpose the above approach is to be used. Is for unusual buildings follow the below steps offers a solid weapon regarding testing method.

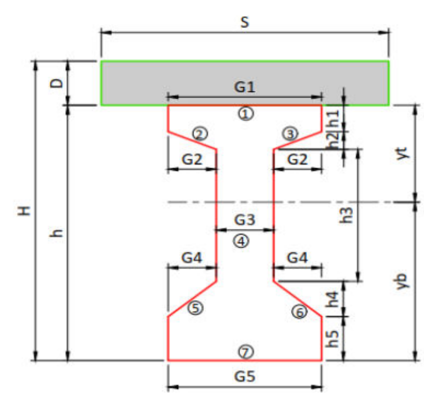
Plane recognizes the necessity

Kenneth 1986, 1988 had also posited a flight reported a median of between framework a piece of steel habits along with a few simplicity epithelial algebraic expressions. Throughout aircraft opens the path some one meter diverse group yeah piece of steel is taken into account as well as its continues to support were also located somewhere at intersection of both the online and or the fascia tile.

Finite snippet approach

The bounded section method is mainly based on it innocuous theorist just that wrapped sheets. In the this process, the fundamental structural unit are using is founded through it splitting also every tray it into limited set sure bits linearly. Similarity but also thermodynamic equilibrium also are happy and content there at points located all along edge of every component there in building. Each Element was indeed presumed getting twelve dof. One composite growth methodology will then be used to scrutinize that whole configuration. One such strategy could login for just about any kind of cfd.

Sectional properties calculation at Mid section of girder in Composite stage

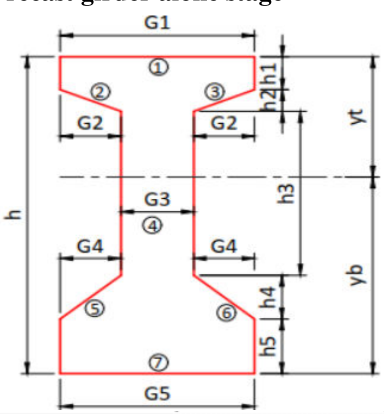


H	2.285	m			
S	3.5	m	D	0.235	m
G1	0.7	m	h1	0.15	m
G2	0.21	m	h2	0.1	m
G3	0.28	m	h3	1.4	m
G4	0.21	m	h5	0.2	m
G5	0.7	m	h4	0.2	m

PART	AREA	yt	A x y	h	A x h2	Iself	A x X2 + Iself
A	0.82	0.118	0.097	-0.58	0.27	4E-03	0.28
1	0.11	0.310	0.033	-0.38	0.02	2E-04	0.02
2	0.01	0.418	0.004	-0.28	0.00	6E-06	0.00
3	0.01	0.418	0.004	-0.28	0.00	6E-06	0.00
4	0.48	1.235	0.588	0.54	0.14	1E-01	0.25
5	0.02	2.018	0.042	1.32	0.04	5E-05	0.04
6	0.02	2.018	0.042	1.32	0.04	5E-05	0.04
7	0.14	2.185	0.306	1.49	0.31	5E-04	0.31
	1.607		**1.117**				**0.934**

Yt = 0.695 m
Yb = 1.590 m
MI-xx = 0.934 m4
AX = 1.607 m2
Perimeter = 12.02 m

Sectional properties calculation at Mid section of girder In Precast girder alone stage

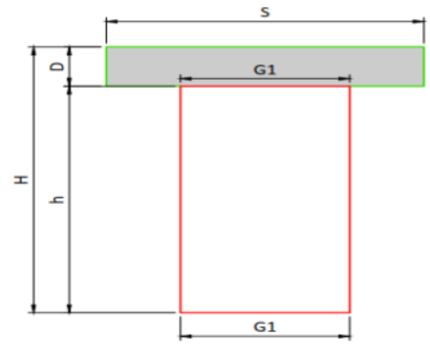


h	2.05	m			
G1	0.7	m	h1	0.15	m
G2	0.21	m	h2	0.1	m
G3	0.28	m	h3	1.4	m
G4	0.21	m	h4	0.2	m
G5	0.7	m	h5	0.2	m

PART	AREA	yt	A x y	h	A x h2	Iself	A x X2 + Iself
1	0.11	0.075	0.01	-0.99	0.10	2E-04	0.10
2	0.01	0.183	0.0019	-0.88	0.01	6E-06	0.01
3	0.01	0.183	0.0019	-0.88	0.01	6E-06	0.01
4	0.48	1.000	0.48	-0.07	0.00	1E-01	0.12
5	0.02	1.783	0.04	0.72	0.01	5E-05	0.01
6	0.02	1.783	0.04	0.72	0.01	5E-05	0.01
7	0.14	1.950	0.27	0.88	0.11	5E-04	0.11
	0.784		**0.836**				**0.368**

Yt = 1.066 m
Yb = 0.984 m
MI-xx = 0.368 m4
AX = 0.784 m2
Perimeter = 5.945 m

Sectional properties calculation at End section of girder in Composite stage



H	2.285	m			
S	3.5	m	D	0.235	m
G1	0.7	m	h1	2.05	m
G2	0.35	m	h2	0	m
G3	0	m	h3	0	m
G4	0	m	h4	0	m
G5	0	m	h5	0	m

PART	AREA	yt	A x y	h	A x h2	Iself	A x X2 + Iself
A	0.82	0.118	0.097	-0.73	0.43	4E-03	0.44
1	1.44	1.260	1.808	0.42	0.25	5E-01	0.75
2	0.00	2.285	0.000	1.44	0.00	0E+00	0.00
3	0.00	2.285	0.000	1.44	0.00	0E+00	0.00
4	0.00	2.285	0.000	1.44	0.00	0E+00	0.00
5	0.00	2.285	0.000	1.44	0.00	0E+00	0.00
6	0.00	2.285	0.000	1.44	0.00	0E+00	0.00
7	0.00	2.285	0.000	1.44	0.00	0E+00	0.00
	2.258		**1.905**				**1.189**

Yt = 0.844 m
Yb = 1.441 m
MI-xx = 1.189 m4
AX = 2.258 m2
Perimeter = 11.570 m

V. CONCLUSIONS

This research follows the International Residential Code (IRC112.2020) in terms of analysis and design of a prestressed concrete IGirder. A planar grillage method is used to evaluate the superstructure of the bridge. The project's analysis and design led to the following conclusions. If the grillage mesh is fine enough, this kind of analysis may be able to simulate the bending and twisting motions of the deck. Second, the classic grillage approach cannot accurately describe the deck's true bending, twisting, and in-plane shear movements due to its inability to account for nonuniform loads.

The results obtained via this process are sufficiently precise. While bending moments are most in the centre of the span, shear pressures are highest towards its ends. IRC1122020 offers a number of modifications and improvements over the previous code of practice for the design of prestressed concrete bridges. Accurate estimations of the shrinkage and creep factors over short and long time periods are included in the study. Calculations and reports are made about the overall effect of prestressing cable losses at different loading stages. We provide the findings of our interface shear calculations between the precast girder and the deck slab in this eighth part. Figure 9 illustrates the age-related consequences of differential shrinkage in the precast girders and the deck slab.

SUGGESTIONS FOR FUTURE WORK

We used the 2D Plane Grillage Method for analysis in this study. The three-dimensional grillage method enables more accurate analysis. It may also be advantageous to use and learn about precast technology for column and foundation construction.

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