ANALYSIS AND DESIGN OF COMPOSITE GIRDER WITH CURVE FOR DFC LOADING USING STADD PRO

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Abstract

Composite concrete structures are where different materials are bonded to the concrete to form a combined structural shape. The most common example is when a reinforced concrete deck slab is poured on top of a prefabricated beam. The beams are usually concrete girders or steel beams.

In steel girder I section mainly flange take moment and web take shear.

Here we design a composite girder length 31.9 m (c/c of bearing) with 2.34° curve for DFC loading according to RDSO drawing with 0° curve. In this design we analysis self-weight and live load manually and SIDL, WC and Construction load from Stad Pro software.

Generally, when I observed that in curve bending moment changes in every point but in straight girder, bending moment change after some intervals. When we use curved girder we fabricate in curve and also increase that property.

At construction stage all the loads (green concrete weight of slab, self-weight of girder, weight of shuttering) will be taken by non-composite section - only steel girder. Superimposed dead load and live loads are to be taken care of by the composite section. The cross girders / cross bracings shall be analysed and designed as simply supported members to avoid complicated connection details. In case of dead load, superimposed dead load and live load analysis, composite section properties of girders have been determined considering concrete as uncracked.

I am changing the curved girder into the straight girder for that cases we provide two extra end stiffener and increase the grade of concrete. That causes our designed will be safe..

Keywords— *- Composite concrete, deck slab, prefabricated beam, girders, moment, shear, Stad Pro, cross bracings, curved girder, straight girder*

I. INTRODUCTION

Steel girders are the most common type of bridges. It's generally used for railway crossing, rivers, road of rail etc. steel girders are generally made up of steel plates which are connected by rivets or welds. This type of bridges construct for 20 to 50 m spans and for continuous span up to 250 m. The loading of this bridges are considerable uniformly distributed loading (UDL). The design of plate girder involves the section of the cross section and design of connection between flanges and web together with the design of intermediate and bearing stiffeners and their connections of the web of the plate girder. In the deck type bridge, a wood, steel or reinforced concrete bridge deck is supported on top of two or more plate girders, And its act like a compositely them. In the case of rail over road bridges, the rail road ties themselves may from the bridge deck, or the deck may support ballast on which the track is rail road ties themselves may from the bridge deck, or the deck may support ballast on which the track is laid.

Composite concrete structures are where different materials are bonded to the concrete to form a combined structural shape. The most common example is when a reinforced concrete deck slab is poured on top of a prefabricated beam. The beams are usually concrete girders or steel beams.

There are several advantages of the composite structures. By bonding the beam and deck together the structure can be designed lighter, stronger and stiffer than when the beam and deck act independently. The cost savings result from a lighter structure and the faster construction. Often the deck slab soffit forms are attached to the beams, eliminating expensive of the falsework. The composite design technique is used for the bridges where traffic, deep water, steep canyon or environmental concerns makes falsework impractical. Bridge beams can be precast, pre-stressed AASHTO concrete girders or steel girders. Even the deck soffit forms can be eliminated by the use of precast, pre-stressed double tee girders.

Steel-Composite Steel Box and I girder Bridges have been commonly used into the construction of Highly Infrastructure due to the enhanced structural performance and their aesthetic appearance. A flexural member is designed for the buckling and occasionally for shear. When span are large and the loads are heavy we provide two or more I section, plate girder and truss girder. In these alternative for economical point of view designer always select I girder because in plate girder and truss girder connection cost are very increases.

Horizontally curved steel bridges are present many unique challenges. Despite their challenges, curved girder bridges have become widespread and are commonly used at the locations that require complex geometries and have limited right-of-way, such as urban interchanges. Some of the important issues that differentiate curved steel girders from their straight counterparts include the effects of torsion, flange lateral bending, their inherent lack of stability, and special constructability concerns. Also, the complex behavior of horizontally curved bridges necessitates the consideration of system behavior in the analysis.

Here we design the Composite I girder which span is 31.9 m with curve 2.34 degree, according to RDSO drawing with Zero degree curve. In which we provide extra two end stiffness and increase the concrete grade.

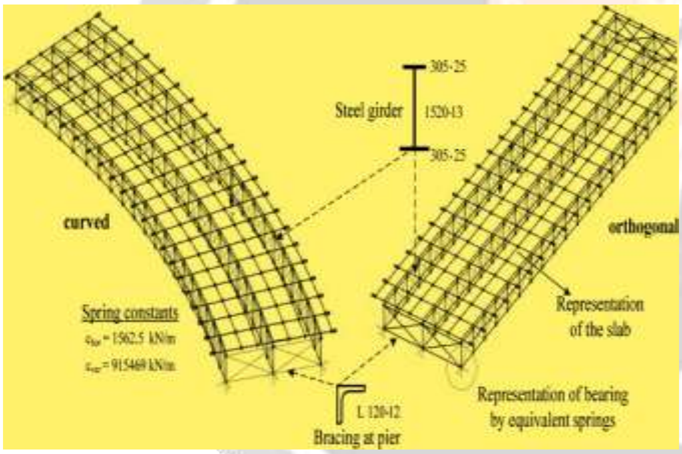


Fig 1.1: Curve Composite girder

Fig 1.2 : Construction Picture of Composite Girder

II. OVERVIEW OF WORK

To perform a manual analysis for different loading Combination as per 32.5T DFC Loading Criteria with curve 2.34° according to RDSO drawing with 0° curve.
To obtain the critical load positions that causes serves distress in the structure.
To reduce self-weight, increase grade of concrete.
Provide same size of girder thickness in curve.
To check load bearing strength, provide extra two end stiffener.

III. NEED FOR THE PROPOSED WORK

- The still girder can be a very cost-effective solution.
- The steel girders are precast offsite which allows for more quality control and thus a high quality of still.
- Provide straight girders in curve.
- Accelerate Construction time.
- Larger spans without beams
- Reduce of self-weight.
- Increased load capacity.
- Plate type steel girder show failure before cracked.

IV. LITERATURE REVIEW

Optimum design of composite steel I Girder Bridge (Fatma Ulker, 2016)
only from these weights, however minimum weighted design, meets our purpose. This way, however, a safe and economical steel bridge design that meet all the limitations can be made. The minimum weight of the composite steel I-girder bridge was obtained under the subject specification limiters. Only the weight of the steel beams is minimized. Bridge deck weight is ignored for this problem.

Design of plate girders for deck type railway bridges (parvathy Krishna kumar, 2018)
Steel is being used on highway and railway bridges successfully all over the world because of its inherent quality of better strength, resistance against fracture toughness, weld ability and a very good resistance against weathering / corrosion. The weight of the structure is reduced that causes reducing the overall life cycle cost..

Research of road bridges composite steel girder for different load condition (Amit Rajendra Malvi, Sharda P. Siddh, Uday Singh Patil, 2019)
The STAAD analysis results are indicate the designed in bending moment, shear force, and deflection for various live load conditions for class A loading, class 70R tracked and wheeled vehicle.
70R wheeled vehicle gives the maximum value of the bending moment and shear force compare to 2 classes A loading and 70R tracked vehicle..

Research of steel concrete composite bridges under blasting load (Yuan Liand shuanhai He, 2018)
In the steel concrete composite bridges cases, take a 100 Kg TNT above deck explosion right on the mid span of the bridge is identified as the most critical case.
For the below deck detonation of composite bridge, the blast propagation is more complex than that of the above deck detonation blasting loads lead to more deformations and stresses for steel girder ie damage pattern occurs mainly on the two positions 1. Steel girder near the blasting detonation 2.the conjunction with concrete deck and steel girder

Experimental research of the time dependent effect of steel concrete composite girder bridges during construction and operation periods (Guang Ming Wang, Li Zhu, Guang Pan Zhou, Bing Han and Wen Yu Ji, 2020)
The temperature variation trends beam of the steel beam and concrete slab were characterized by the sinusoidal curve without temperature leg. And the heating rate of concrete slab is higher than the cooling rate.
Internal forces changes in composite girder in three categories. The stresses changes during first 10 days were significant and the stresses changes rate decreased continuously during 10-90 days, and after 90 days stresses changes very slowly and smoothly. Along longitudinal direction moment changes sinusoidal distribution.

plastic design of steel-concrete composite girder bridge (Arpad Rozsas, 2011).
The primary purpose of this thesis is to investigate the plastic reserve of composite plate girder bridges. These structures are suitable for this due to synergetic combination of the concrete and steel the former provides the

"cheap" stiffness and strength in compression while the steel in tension ensures the ductility. Therefore the theoretical and experimental aspects of plastic design are well established.

Analytical and field investigation of horizontally curved girder bridges (jerad J. Hoffman 2013).
Based on analytical analysis results, strength I lateral bottom flange bending moments were nearly ten times greater when including temperature effects at the fixed pier. Moreover strength I axial forces were nearly three times greater when according fo temperature effects compared to only DL and LL. These results indicate that temperature is an essential consideration when addressing member forces in curved steel I-girder.
Based on analytical analysis results, Strength I lateral bottom flange bending moments were nearly ten times greater when including temperature effects at the fixed pier More over, Strength I axial forces were nearly three times greater when accounting for temperature effects compared to only DL and LL. These results indicate that temperature is an essential consideration when addressing member forces in curved steel I-girders.

V. DESCRIPTION OF STRUCTURAL MODEL

Effective Span Length	30.50	m
Section	I Section	
Span of the member	3.0	m
Linear Distance	3.0	m
Yield Strength fy	250	N /mm2
Ultimate Strength, fu	410	N /mm2

Young's Modulus of Steel, E 200000 N /mm2
Modulus of Rigidity of Steel, G 76900N /mm2
ϒmw 1.5 (For Shop Welding) , 1.25 for field Welding

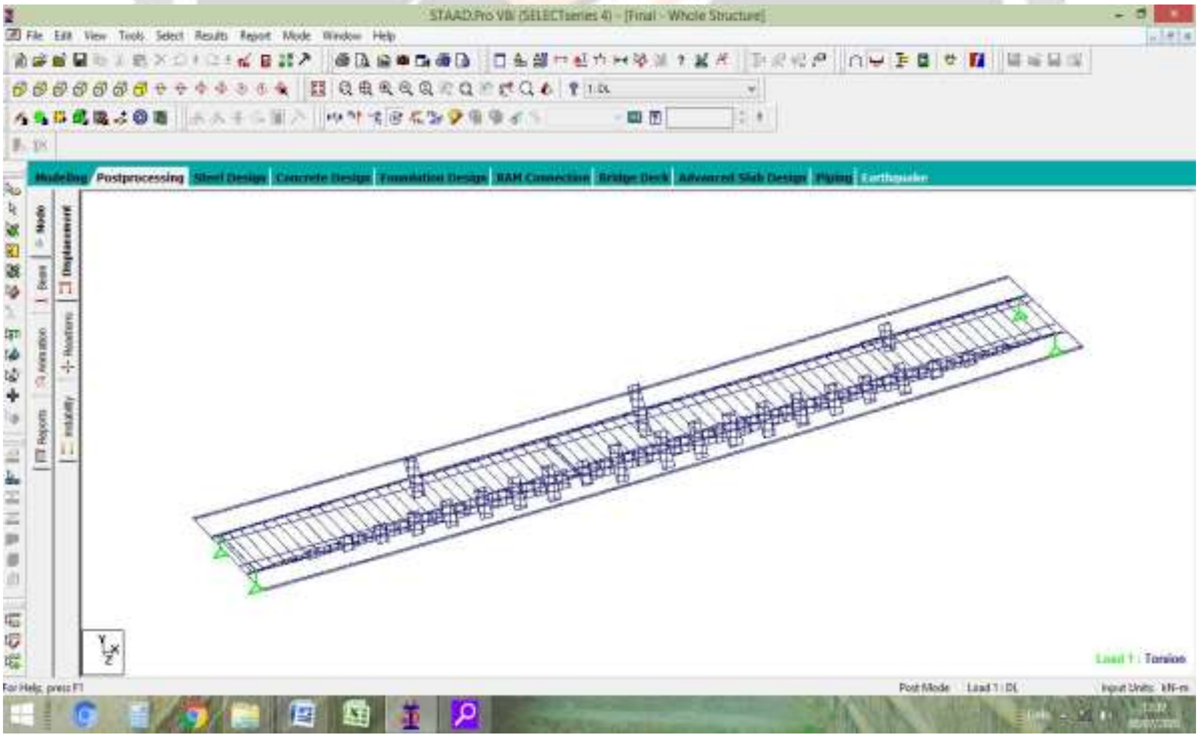
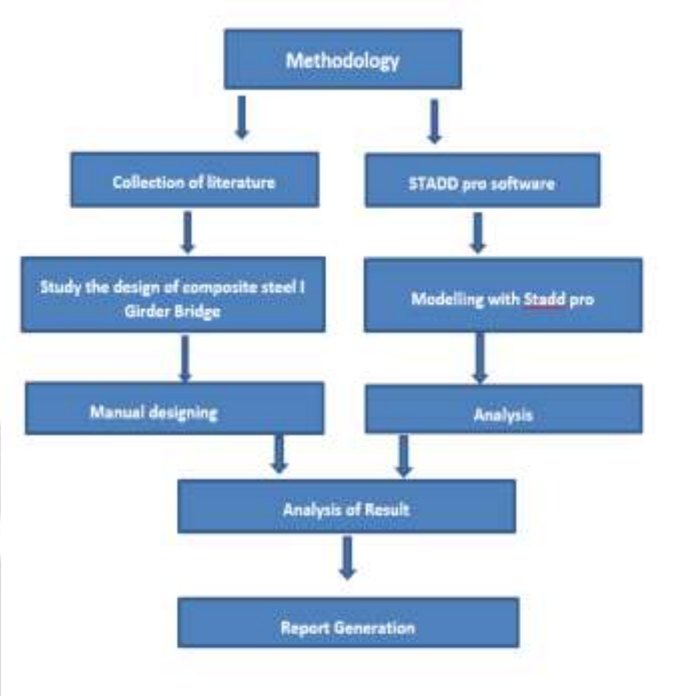


Fig. 5.1 : Torsional effect on the girder

VI. WORKING FLOW CHART



VII. RESULT

1. Shear force value in tabular

Stadd pro. Software results of shear force value given in tabular form where different beam has been given. Shear force found at every section in different beams where maximum shear force will be found at the edge of the beam

Beam	L/C	SECTION	Axial force (KN)	Shear-y (KN)	Shear-Z (KN)	Torsion KnM	Moment-Y KnM	Moment-Z KnM
313	4	0.000	0.000	4369.329	0.000	- 158.026	0.000	10.010
313	4	0.083	0.000	4364.921	0.000	- 158.026	0.000	-179.936
313	4	0.167	0.000	4360.515	0.000	- 158.026	0.000	-369.690
313	4	0.250	0.000	4356.108	0.000	- 158.026	0.000	-559.253
313	4	0.333	0.000	4351.701	0.000	-	0.000	-748.624

						158.026		
313	4	0.417	0.000	4347.294	0.000	-158.026	0.000	-937.803
313	4	0.500	0.000	4342.888	0.000	-158.026	0.000	-1126.791
313	4	0.583	0.000	4338.481	0.000	-158.026	0.000	-1351.587
313	4	0.667	0.000	4334.074	0.000	-158.026	0.000	-1504.191
313	4	0.750	0.000	4329.667	0.000	-158.026	0.000	-1692.603
313	4	0.833	0.000	4325.260	0.000	-158.026	0.000	-1880.824
313	4	0.917	0.000	4320.854	0.000	-158.026	0.000	-2068.854
313	4	1.000	0.000	4316.447	0.000	-158.026	0.000	-2256.691
314	4	0.000	0.000	4278.601	0.000	-142.595	0.000	-2260.568
314	4	0.083	0.000	4274.793	0.000	-142.595	0.000	-2421.270
314	4	0.167	0.000	4270.986	0.000	-142.595	0.000	-2581.829
314	4	0.250	0.000	4267.179	0.000	-142.595	0.000	-2742.245
241	4	0.000	0.000	4264.902	0.000	196.280	0.000	-20.582
314	4	0.333	0.000	4263.372	0.000	-142.595	0.000	-2902.518
241	4	0.083	0.000	4260.026	0.000	-142.595	0.000	-225.695
314	4	0.417	0.000	4259.565	0.000	196.280	0.000	-3062.648

1. Bending moment value in tabular form
   Stadd pro. Software results of bending moment value represent in tabular form where different beam has been given. Shear force found at every section in different beams where maximum bending moment will be found at the center of the beam

Beam	**L/C**	**Section**	**Axial Force KN**	**Shear –Y KN**	**Shear –Z KN**	**Torsion KnM**	**Moment-y KnM**	**Moment-z KnM**
349	4	0.333	0.000	-155.734	0.000	256.997	0.000	-35881.324
347	4	0.167	0.000	109.118	0.000	191.289	0.000	-358855.465
349	4	0.250	0.000	-151.927	0.000	256.997	0.000	-35887.098
347	4	0.250	0.000	105.312	0.000	191.289	0.000	-35889.488
349	4	0.167	0.000	-148.121	0.000	256.997	0.000	-35892.734
347	4	0.333	0.000	101.505	0.000	191.289	0.000	-35892.375
347	4	0.417	0.000	97.699	0.000	191.289	0.000	-35989.113
349	4	0.083	0.000	-144.315	0.000	256.997	0.000	-35898.223
347	4	0.500	0.000	93.892	0.000	191.289	0.000	-35900.715
349	4	0.000	0.000	-140.509	0.000	256.997	0.000	-35903.578
348	4	1.000	0.000	-57.584	0.000	227.860	0.000	-35903.594
347	4	0.583	0.000	90.086	0.000	191.289	0.000	-35904.172
348	4	0.197	0.000	-53.779	0.000	227.860	0.000	-35905.688
0347	4	0.667	0.000	86.280	0.000	191.289	0.000	-35905.438
348	4	0.833	0.000	-49.973	0.000	227.860	0.000	-35910.648
348	4	0.750	0.000	-46.168	0.000	227.860	0.000	-35911.105
347	4	0.750	0.000	82.473	0.000	191.289	0.000	-35912.621
348	4	0.667	0.000	-42.363	0.000	227.860	0.000	-35913.680

VIII. CONCLUSION

The following are the conclusions obtained from the studies:

According to above discussion and given data, our design is safe in curve 2.34° for DFC loading, without increasing thickness of plate according to RDSO drawing with zero degree curve.
Provide two extra end stiffener and increase grade of the concrete.
Due to curve our horizontal force will be increase but in straight its will be minimum.
Tensional moment changes in every point in curve but in straight its changes slightly at mid-point.
Our design is economically without increasing thickness of plate.
The weight of the structure is reduced, our substructure and foundation and overall reduced cost.

IX. SCOPE FOR FUTURE WORK

Railway refuse to provide RCC girder more than 25 m, so we provide a composite girder.

Earlier, truss girder used to be mostly in the railways, which the cost was higher than plate girder that causes are uses.

Its try to upgrade in to IV and V zone.

Its try to upgrade in to more degree of curve.

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