Analysis and Design of Pre-Stressed Concrete Box girder Deck Slab Bridge

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Abstract *: An attempt has been carried out to perform the analysis of PSC Box Girder Deck Slab bridge using Staad Pro software. To study of PSC Box Girder Deck Slab bridge behavior during earthquakes always depends on its strength, durability , stiffness of the regular configuration of the bridge and adequacy The work focus on an effect of seismic behavior of conventional RCC bridge. Seismic behavior studied for different parts of fly over bridges in Staad Pro software . of PSC Box Girder Deck Slab bridge is the bridge constructed along an intersecting highway over an at-grade intersection. It allows two- direction traffic to flow at free flow speed on the bridge. The is one of the methods for solving traffic problems at-grade junctions on highways. reduced travelling time of vehicles, reduced accident risks, economical savings of fuel consumptions, easy way move, The result shows that 35%-40% of the total traffic volume diverted by the Bridge, vehicle delays are reduced by 30.41% over the same period. The methodology we are using here is Staad Pro analysis . Therefore, we will work on seismic analysis of fly over bridge.*

Key Words: Deck Slab, Girder Analysis, STAAD PRO V8i,, SlabDesign.Shear and Moments.

1. INTRODUCTION

The response of bridges under seismic loading is a complex phenomenon. It depends on many factors of bridge as well as ground motion characteristics. Bridge factors include stiffness, geometry, damping characteristics, yielding properties and many more. Ground motion characteristics involve peak ground acceleration, frequency content and duration of shaking. Also there are other elements in the bridge whose non-linear behavior influences the overall bridge response. Previous studies have already identified the effects of many variables on the response of bridges. In this study some other variables will be investigated. Bridges all over the world can be placed into four basic categories: girder bridges, arch bridges, cable-stayed bridges, and suspension bridges. All of these major bridge types are almost as old as human civilization. In some primitive form, all were first built many, many centuries ago. However, the evolution of today's more sophisticated and versatile bridge forms can be traced to the introduction of various construction materials of different times Some 4000 years ago, and until the beginning of the 19th century, the only construction materials available were wood and stone. Wood from tree trunks could be used piers were created so that tree trunks could span between them; however, these bridges were not sturdy. They did not last l on and could not encompass large spans.

Looking to the future, many new materials such as carbon fibers ultra-high performance concrete, and nano materials may be useable in the development of new bridge forms. However, these materials are not yet ready for large-scale applications. Therefore, we can conclude that in the last four to five millennia, humans have only invented four bridge forms.

PSC Box Girder Deck Slab bridge have been constructed since early seventies. They are mainly constructed for the purpose of traffic congestion elimination. However planning, design, construction, and erection of fly-over consume great span of time. The same have been the case with the emerging fly-over over NH By-pass, ON GOLE, and spanning 600m with a width of 6.6m.Greater seismic resistance, life span, and lesser life cycle cost nullify the excess cost of construction of flyover. Bridges and fly-over's are structures providing passage over an obstacle without closing the way beneath

1.1 PROCEDURE FOR DESIGN AND ANALYSIS

- Given section.
- Calculate section properties.
- Estimate Bending moment / Shear force.
- Given no & size of cables.
- Apply pre-stress force.

- Determine stresses in concrete.
- Check with permissible stresses.
- Check ultimate moment / shear.
- Design shear reinforcement.

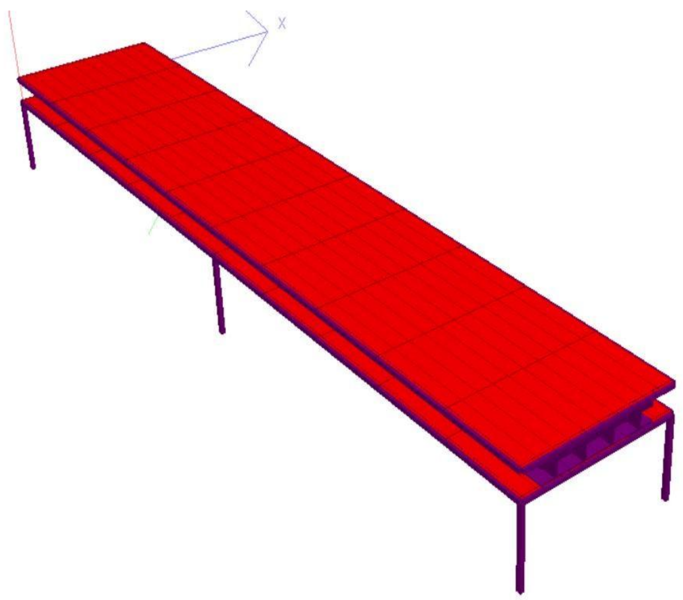
1.2 METHODOLOGY FOR RESEARCH

1) Survey and review of literature.
2) Collection and review IS and IRC codes.
3) Analytical model idealization

2. GEOMETRIC DETAIL OF PRECAST PSC GIRDER BRIDGE

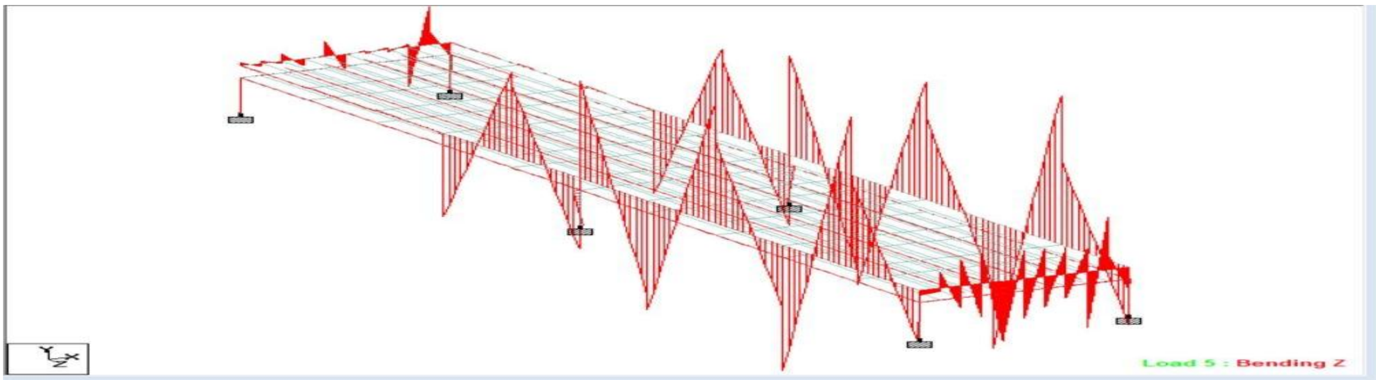
Sr. no	Parameter	Design Value
1)	No Of Overhang Sides(Z)	2m
2)	Effective Span(L)	37.7m
3)	Carriage Way(L)	11m
4)	Thickness Of Wearing Coat(T)	0.081m
5)	Kerb Width(Kb)	0.5m
6)	Total width Of Bridge (B)	13.5m
7)	Spacing Between Webs	2.5m

DECK SLAB ANALYSIS MODEL IN STAAD PRO.



BEAM END FORCES SUMMARY:-

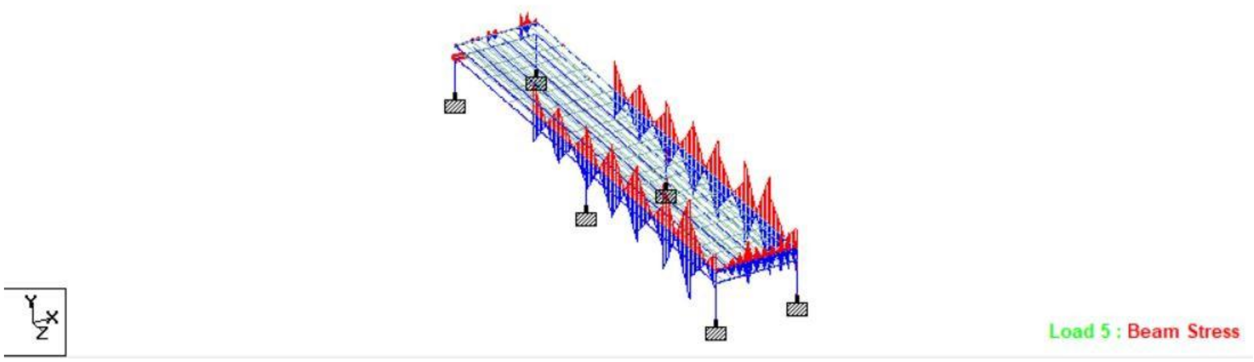
	Beam	L/C	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
Max Fx	9	1 DL	3112.86	-102.393	-2.311	-0.022	-5.292	204.228
Max Fy	268	1 DL	0	24039.7	0	6237.26	0	13591.4
Max Fz	10	1 DL	1101.32	-51.018	410.96	0.093	-1650.2	-204.505
MaxMx	268	1 DL	0	24039.7	0	6237.26	0	13591.4
MaxMy	7	1 DL	1102.1	-51.604	-408.9	-0.135	1640.7	-206.26
MaxMz	230	1 DL	0	-3197.78	0	0	0	1.21E+05
Min Fx	27	1 DL	-27.58	-24.463	0.129	-19.961	0.19	-68.466
Min Fy	286	1 DL	0	-17574.1	0	-5103	0	9316.12
Min Fz	7	1 DL	1102.1	-51.604	-408.9	-0.135	1640.7	-206.26
MinMx	267	1 DL	0	-17570.3	0	-5103	0	-14406.4
MinMy	10	1 DL	1101.32	-51.018	410.96	0.093	-1650.2	-204.505
MinMz	261	1 DL	0	-9294.1	0	544.076	0	-31847.6



BEAM STRESSES SUMMARY:-

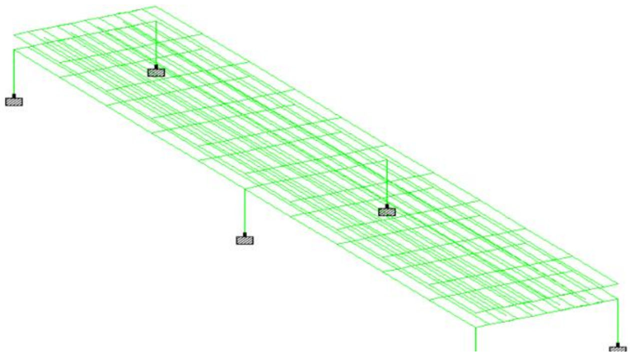
Load Case	Length m	Stress N/mm2	Dist m	corner	Stress N/mm2	Dist m	Corner
3 IRC: SLS CLASS AA LOADING N162: DISP Y +VE	1.35						
4 IRC: SLS CLASS AA LOADING N7: DISP Z +VE	1.35						
5 IRC: SLS CLASS AA LOADING B9: FORCE	1.35	0.14	0	1	-0.148	0	3

END A: FX +VE							
6 IRC: SLS CLASS AA LOADING B268: FORCE END A: FY +VE	1.35						
7 IRC: SLS CLASS AA LOADING B10: FORCE END A: FZ +VE	1.35	0.06	1.35	4	-0.069	1.35	2
8 IRC: SLS CLASS AA LOADING N9: REACT FX +VE	1.35	0.152	0	1	-0.16	0	3
9 IRC: SLS CLASS AA LOADING N9: REACT FY +VE	1.35	0.14	0	1	-0.148	0	3
10 IRC: SLS CLASS AA LOADING N7: REACT FZ +VE	1.35	1.828	0	1	-1.889	0	3
1 DL	7.54	11.444	7.54	1	-10.655	7.54	3
2 IRC: SLS CLASS AA LOADING N6: DISP X +VE	7.54						
3 IRC: SLS CLASS AA LOADING N162: DISP Y +VE	7.54						
4 IRC: SLS CLASS AA LOADING N7: DISP Z +VE	7.54						
5 IRC: SLS CLASS AA LOADING B9: FORCE END A: FX +VE	7.54	0.095	0	3	-0.088	0	1
6 IRC: SLS CLASS AA LOADING B268: +VE	7.54						



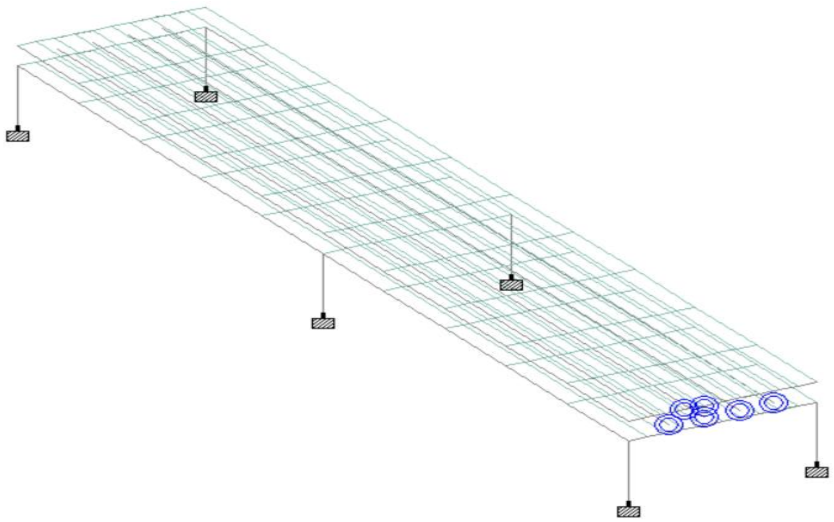
BEAM DISPLACEMENT SUMMARY:-

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	22	7 IRC: SLS CLASS AA LOADING B10: FORCE END A: FZ +VE	1.442	1.119	-15.629	15.735	-0.005	0	0
Min X	4	7 IRC: SLS CLASS AA LOADING B10: FORCE END A: FZ +VE	-0.781	-0.715	-15.928	15.963	-0.026	0	-0.002
Max Y	162	1 DL	0	3.86E+08	0	3.86E+08	########	0	-74559.3
Min Y	151	1 DL	0	########	0	1.97E+11	########	0	0
Max Z	1	10 IRC: SLS CLASS AA LOADING N7: REACT FZ +VE	-0.752	-0.722	16.069	16.102	0.026	0	-0.003
Min Z	4	7 IRC: SLS CLASS AA LOADING B10: FORCE END A: FZ +VE	-0.781	-0.715	-15.928	15.963	-0.026	0	-0.002
Max rX	13	1 DL	-0.466	-22.883	-0.107	22.888	0.073	0	-0.014
Min rX	151	1 DL	0	########	0	1.97E+11	########	0	0
Max rY	6	1 DL	0.173	-2.556	-0.787	2.68	-0.072	0	0.016
Min rY	4	7 IRC: SLS CLASS AA LOADING B10: FORCE END A: FZ +VE	-0.781	-0.715	-15.928	15.963	-0.026	0	-0.002
Max rZ	206	10 IRC: SLS CLASS AA LOADING N7: REACT FZ +VE	0	########	0	8.45E+09	########	0	9478.578
Min rZ	162	1 DL	0	3.86E+08	0	3.86E+08	########	0	-74559.3
Max Rst	151	1 DL	0	########	0	1.97E+11	########	0	0



BEAM DEFLECTION SUMMARY:-

L/C	SQX (local) N/mm2	SQY (local) N/mm2	SX (local) N/mm2	SY (local) N/mm2	SXY (local) N/mm2	MxkNm/m	My kNm/m	MxykNm/m
	Shear		Membrane			Bending Moment		
1 DL	-1.921	-19.536	0	0	0	-1046.08	-19367.7	2844.017
3 IRC: SLS CLASS AA LOADING N162: DISP Y +VE	0	0	0	0	0	0	0	0
4 IRC: SLS CLASS AA LOADING N7: DISP Z +VE	0	0	0	0	0	0	0	0
5 IRC: SLS CLASS AA LOADING B9: FORCE END A: FX +VE	0.004	-0.002	0	-0.001	0	0.413	-0.472	1.883
6 IRC: SLS CLASS AA LOADING B268: FORCE END A: FY +VE	0	0	0	0	0	0	0	0
7 IRC: SLS CLASS AA LOADING B10: FORCE END A: FZ +VE	-0.005	0.001	0	0	0.001	-1.658	-6.402	-6.413
8 IRC: SLS CLASS AA LOADING N9: REACT FX +VE	0.004	-0.002	0	-0.001	0	0.413	-0.523	1.685
9 IRC: SLS CLASS AA LOADING N9: REACT FY +VE	0.004	-0.002	0	-0.001	0	0.413	-0.472	1.883
10 IRC: SLS CLASS AA LOADING N7: REACT FZ +VE	0.097	-0.035	-0.008	-0.043	-0.019	25.641	54.979	86.918



LITERATURE SURVEY

I.Asynchronous earthquake strong motion and RC bridges response

Silvia Santini ,ivoVanzi

This paper deals with the response of isolated and nonisolated continuous bridges subjected to asynchronous ground motions. A new procedure to generate asynchronous seismic signals is presented. Real signal characteristics permit to consider soil-wave interaction phenomena. This paper deals with the response of isolated and non isolated continuous bridges subjected to asynchronous ground motions. Different soil relative displacement should be investigated to maximize the bridge deformation and so stresses in case of no synchronous action for isolated or not isolated case.

II. Probability-based practice- oriented seismic behavior assessment of simply supported RC bridges considering the variation and correlation in pier performance. Long Zhang , Cao Wang

A probability-based method has been proposed in this paper for the seismic behavior assessment of simply supported RC bridges. The proposed method enables the bridge pushover curve to be obtained explicitly without complex finite element modeling.Moreover An illustrative bridge is chosen to demonstrate the applicability of the proposed method and to investigate the role of variation and correlation in bridge pier performance in the seismic behavior assessment. The following conclusions can be drawn from the illustrative results.

III. Experimental investigations and sensitivity analysis to explain the large creep of concrete deformations in the bridge of Cheviré. Wassim Raphaela,*, Elise Zgheiba, et al.

The creep of concrete is an important phenomenon that affects the structure safety and shall be well predicted and controlled.We have studied the possible reasons of creep excessive deflection of Chevirébridge. In this study, the possible reasons for creep under-estimation in the bridge of Cheviré are explored. The sensitivity measures show that pre stressing stress variable influences structural reliability the most especially in BPEL that was used in designing Chevirébridge.

IV. DESIGN OF FLYOVER BRIDGE IN TRICHY

Rajeev Sharma

Published Date -2015

This paper deals with the evaluation studies for the existing, RC bridge using non-linear static analysis. For the seismic assessment of the bridge a 3 span bridge is selected which is located on the hindon river at Ghaziabad (Uttar Pradesh) In this paper deals what are the problems occurring in high traffic intensity area in Trichy.

V.Fiber-Reinforced Polymer Bridge Design in the Netherlands: Architectural Challenges toward Innovative, Sustainable, and Durable Bridges

Author: Joris Smits , Publish Date:17 October 2016

This paper reviews the use of fiber-reinforced polymers (FRPs) in architectural and structural bridge design. In the field of architecture, the recent establishment of FRP as a building material for bridges has resulted in numerous successful projects in which FRP serves both architectural and aesthetic purposes.

VI. The analysis of thermal effect on concrete box girder bridge

LukásKrkoškaa, Martin Moravčíka

University of Zilina, Faculty of Civil Engineering, Department of Structures and Bridges, Univerzitna

In this paper, short overview of thermal loading on concrete bridge structures was analyzed. The measurement of real temperature gradient along the cross-section of concrete box girder bridge realized by balanced cantilever method has been analyzed and compared to the five different bridge design codes. Analysis shows that thermal effects due to vertical temperature gradient impact significantly on the stress condition of the bridge. Especially in the combination with traffic load can these effects completely set up the compressive reserve of pre-stressed concrete and tensile stress may occur, what is unacceptable for example for requirement of decompression.

VII. Lifetime reliability-based optimization of post-tensioned box-girder bridges

Tatiana García-Segura

Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hung Hom, Hong Kong, China.

This paper presents a lifetime reliability-based approach for the optimization of post-tensioned concrete boxgirder bridges under corrosion attack. The proposed approach is illustrated by determining the optimal life-cycle cost and CO2 emissions of several initial designs of post-tensioned box-girder bridges with different objectives, i.e. the lowest initial costs, the longest corrosion initiation time, or the maximum safety

VIII.Behavior of prestressed concrete box bridge girders Under hydrocarbon fire condition

Gang Zhang ,VenkateshKodur

Department of Civil and Environmental Engineering, Michigan State University, East Lansing, MI 48824, USA

To understand the behavior of a typical PC bridge girder under hydrocarbon fire condition, a simply supported PC box girder was selected to performing analysis of fire performance using ANSYS by subjecting it to structural loading and fire exposure.

CONCLUSION

37.7 m length bridge is considered for analysis of box girder deck slab bridge, and for all the cases, deflection, and stresses are within the permissible limit.

To obtain even better working result the pre-stressed concrete girder configuration deck slab can be subjected pre/ post tensioning.

Pre-stressed concrete girder configuration gives us most of the design parameter within permissible limits of serviceability, deflection and shear compare to ordinary deck slab configuration.

REFERENCES

1. Addoul, W. Raphael, A. Chateauneuf, A. Soubra, Maintenance planning for multi- component systems subject to reliability constraints, Proc. of the Int. Conf. on Appl. of Statistics and Probability in Civil Engineering, ICASP 11, Zürich, Switzerland, 2011.

2. T.L.M. Morgado, A. Sousa e Brito, A failure analysis study of a prestressed steel cable of a suspension bridge, Case Stud. Constr. Mater. 3 (2015) 40–47. [3] W. Raphael, A. Chateauneuf, B. Seif, J.A. el Dine, Calgaro, Reliability-based assessment of creep models for high performance concrete using Bayesian updating, FIB Symposium: Keep Concrete Attractive, Budapest, Hongrie, 2005.

3. R. Benaim, The Design of Prestressed Concrete Bridges, Taylor & Francis, 2007.

4. B. Stecin sky Wall Arches of railway bridges. Journal Roads & Railways, Ostrava May 2015.

5. L. Klusacek, J. Strnad, Reconstruction and strengthening of masonry arch bridges using concrete face walls and transversal prestressingcabels. Journal Roads Railways, Ostrava July2010, pp. 132–143.

6. L. Klusacek, R. Mitrenga, Strengthening of masonrz arch bridges using transversal post/tensioning. Structural Faults & Repair – 2006,Edinburgh June 2006.

7. J. Strnad, Influence of post-tensioning on masonry arches and methodology of measurement. Dissertation, Brno 2009.

8. L. Klusacek, R. Necas, J. Strnad, M. Pozar, The verification of the collaboration separated parts of bridge vaults. Bridges 2014, Brno 2014, pp. 267 – 272.

9. M. Pozar, L. Klusacek, R. Necas, Results of stabilization of the railway vault bridge using trasversal posttensioning. Bridges 2015, Brno 2015, pp. 249 – 254.

10. IRC:21-2000; Standard Specifications and code of practice for road bridges; Section III: Cement Concrete (Plain and Reinforced, 3rd revision); The Indian Roads Congress (New Delhi, 2000

11. IRC:112-2011; Code of practice for concrete road bridges; The Indian Roads Congress 2011 (New Delhi, 2011)

12. IRC 83 part II (1987), "Standard Specifications and Code of Practice for Road Bridges Section IX, Elastomeric Bearings", The Indian Road of Congress, New Delhi, India

13. Unjoh, S., Terayama, T., 1998. 1996 Design Specifications for Highway Bridges, Part V Seismic Design (English translation). Technical Memorandum of Earthquake Engineering Division, no. 9801. Public Works Research Institute.

14. Veletsos, A.S., Newmark, N.M., 1960. Effect of inelastic behavior on the response of simple systems to earthquake motion. In: Proceedings of the Second World Conference on Earthquake Engineering. Yokoyama, K., Tamura, K., Matsuo, O., 1997.