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Study of factors affecting stability of Precast Segmental Box Girder

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Abstract :Box girders are being made into use at many places. Various studies has been Performed so as to develop a more stable structure design. This paper aims at studying the effect of varying shape of box girder, effect of material uncertainties of concrete on the dynamic response of segmental box girder& effect of torsion on the segmental prestressed box girder.

Keywords: segmental box girder, shape, torsion, material uncertainties, stability

INTRODUCTION

Box girder bridges are very commonly used. It is a bridge which has its main beams comprising of girders in the shape of hollow boxes. The box girder normally comprises of pre-stressed concrete, structural steel or steel reinforced concrete. As shown in Figure 1, a box-girder cross section may take the form of single cell (one box), multiple spines (separate boxes), or multi-cell with a common bottom flange (continuous cells) the box girder bridge achieves its stability mainly because of two key features: shape and pre-stressed tendons.

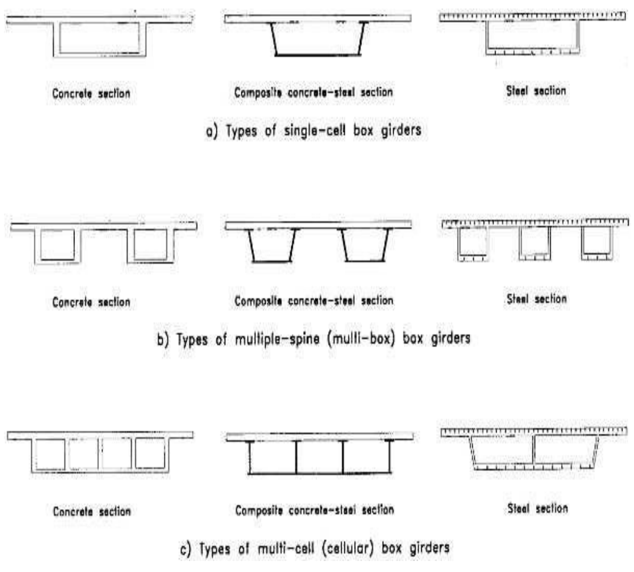

Fig 1- Types of segmental box girder

Segmental box girders (segments) are used for building superstructure for bridges / other structure in replacement of conventional construction via pre-cast beams and cast-in-situ decks. The segments system reduces the environmental disturbance compare to the conventional method by carrying out the concreting works further away From the construction site where is usually located at city centers. Segmental box girders are mainly built as single span structures to avoid coupling of post tensioning cables. Furthermore in single spans the greater shear force is not located in the same section as the greatest bending moment, though the joint between the segments is always closed. A standard span has a length of approximately 45m. It consists of 12 to 14 segments as per the design. No continuous reinforcement is provided across the match cast joints between the segments. A main benefit of the segmental bridge design is that it can help builders more easily construct bridges over areas where it is difficult to transport large sections of concrete. Segmental bridge construction is also revising the basic thinking of design engineers.

Effects of various shapes on box girder:

Chirag Garg & M V N sivakumar (May 2014)[1], studied the effect of various shape of a box girder on a stability of structure.

This study basically covers the study of analyzing the bridge structure with thickened joints and elongated over-hanging beams together. Figure 1 shows the variation in the shape studied. He studied & different cases by varying loads on bridge structure. The pre-defined Concrete Bridge AASHTO -PCI-ASBI has been considered for the study. The loading taken for the analysis of these bridge sections was a combination of three moving vehicle loads, moving in the two lanes of the bridge deck; two sections were studied for the combination of these loadings in SAP 2000.

After analyzing both the sections it was found that the modified shape of a box girder with thickened joints and elongated overhanging beam was more stable than the ordinary one, as the increased thickness at the fixed end of the cantilever beam reduces the stress acting on the entire span of the beam. The benefit of this is that the bending moment acting at the fixed end is reduced and the beam becomes more stable. Also it helps to distribute stress transferred through the sloping edges from deck easily, thus increases efficiency of the section.

Fig.2 Difference in Shape of the Basic and the Modified Bridge Section

Dynamic response of segmental box girder:

Limkatanyu, S. and Kuntiyawichai, (2007)[2], presented the effect of material uncertainties of concrete on the dynamic response of segmental box girder bridge using the finite element software SAP2000 Nonlinear. The analyses deal with the material properties, i.e. uniform material properties (uniform case) and non-uniform material properties (non-uniform case) of the bridge. For the uniform case, the dynamic responses of the bridge gave the highest response at the resonance speed (V=174 km/hr) because of the resonance phenomena. When considering the non-uniform material properties (non-uniform case), the effect of material uncertainties appears to have an effect on both displacement and acceleration response. There is an important evidence from this study that the dynamic factor provided in the design code is sufficient for designing the segmental box girder bridge containing either uniform or non-uniform material properties for the train speeds considered in this study.

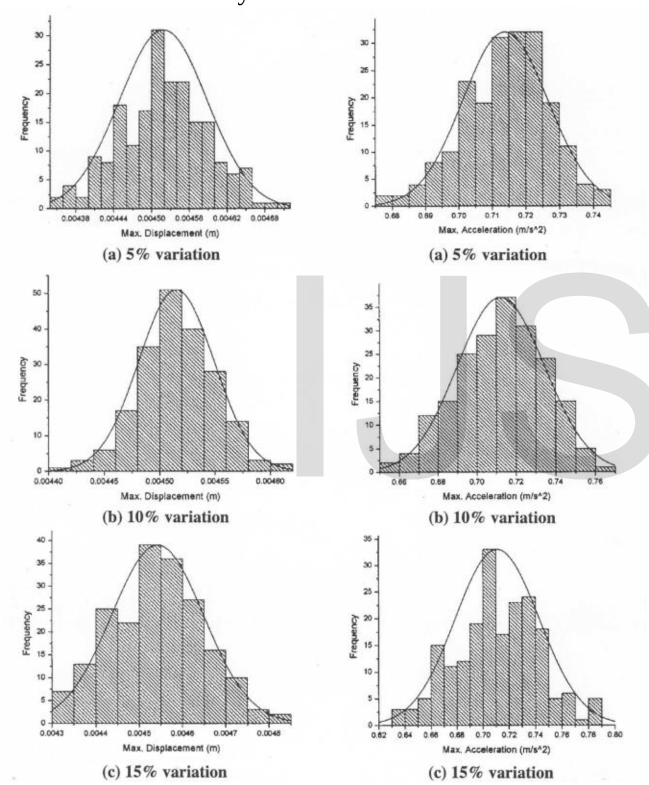

Fig 3. Histograms of maximum displacement and acceleration at mid span, V=100km/hr with 5, 10 & 15% variation.

Effects of Torsion on box girder:

M. A. Al-Gorafi, A. A. A. Ali, I. Othman, M. S. Jaafar, (2008)[3], they provided experimental and analytical study on the effect of torsion on the segmental prestressed girder. They tested two pilot modelled specimen in laboratory and compared initial results with numerical model using ANSYS software. The model is based on the finite element method and accounts for deformation compatibility of the entire member, and material, geometrical and contact nonlinearities.

To investigate the effect of torsion in SEP box girder bridge two beams with 3 m length were test. Each beam has three segments (two edges and one middle). The cross section is box beam with dimensions of 0.5 m x 0.5 m. the thickness of box beam is 0.1 m. It used double 7 wires Φ 0.6 inch strand prestressed tendon which are totally external and only contact with the beam at anchorages and deviator. Each beam loaded with three points load with 2.4m span length. The analysis focused on the effect of torsion on the SEP box girder bridge. The response was investigated in terms of deformation chrematistics, strain variation, failure load and failure mechanism.

From the experimental and analytical study they provided that, the torsion load has a significant effect in the response of segmental external prestressed box girder beams. The torsion load effect does not only alter the value of load failure of the beam but it will also alter the type of failure mechanism.

LOADING ON SEGMENT

The various types of loads, forces, and stresses to be considered in the analysis and design of the various components of the bridge are given in IRC: 6-2000

- Dead load (DL)

The dead load carried by the member consists of its own weight and portions of the weight of the superstructure and any fixed load supported by the member. The dead load can be estimated fairly accurately during design and can be controlled during erection and service.

- Superimposed dead load (SIDL)

The weight of superimposed dead load includes footpaths, earth-fills, wearing course, stay-in-place forms, ballast, water-proofing, signs, pipes, conduits and any other immovable appurtenances installed on the structures.

- Live Load (LL)

Live loads are those caused by vehicles which pass over the bridge and transient in nature. These loads cannot be estimated precisely, and the designer has very little control over them once the bridge is opened to traffic. However, hypothetical loadings which are reasonably realistic need to be evolved and specified to serve as design criteria. There are four types of standard loadings for which road bridges are designed.

1 IRC class 70R loading
2 IRC class AA loading
3 IRC class A loading
4 IRC class B loading

- IRC Loadings (IRC:6-2000 Clause No. 207)

The Indian Roads Congress (IRC) specifies three classes of loads, designated as Class 70-R, Class AA and Class A for the design of permanent bridges, and all of them are followed in India. The Class 70-R and Class AA are of two types each.

The first is a 700 KN tracked vehicle which .is common to both the classes; the only difference is in the loaded length, which is slightly more for the Class 70-R. The second, which is of the wheeled type is a 1000 KN train of vehicles on seven axles for the Class 70-R, and a 400 KN vehicle on two closely spaced axles for the class AA. The Class A loading is a 554 KN train of wheeled vehicles on eight axles. Impact is to be allowed for in all the loadings as per the formulae given. The formulae are different for steel and concrete bridges.

All the three classes of loads ·are to be separately considered in the design and the worst effect is to be taken. For the design of two-lane bridges, only one lane of Class 70-R or Class AA load is considered, whereas both the -lanes are assumed to be occupied by Class A loading if that gives worst effects.

Table 1 Classification of different types of loadings

S.N.	Type of class	Total load (tones)	Nose to tail length of vehicle (meter)	Spacing between successive vehicles
1	70-R Tracked loading	70	7.92	30
2	70-R wheeled loading	100	6.5	30
3	AA Tracked loading	70	7.2	30
4	AA Wheeled loading	40	6.3	90
5	A loading	55.4	20.5	18.4

Table 2 Lane classification

Carriageway width	Number of lanes for design purpose	Load combination
Less than 5.3m	1	One lane of class A considered occupying 2.3m.
5.3m above but less than 9.6m	2	One lane of class 70R or two lanes of class A
9.3m above but Less than 13.1m	3	One lane of class 70R with one lane of class A Or 3 lanes of class A
13.1m above but Less than 16.6m	4	One lane of class 70R for every two lanes
16.6m above but Less than 20.1m	5	with one lane of class A for the remaining lanes, if any
20.1m above but Less than 23.6m	6	Or one lane of class if any

Analysis of 17.2m width of segment:

As per tender recommendation,

a) Thickness of Deck Slab = 0.20 m
b) Thickness of Wearing Coat = 0.087 m

Class A Max - ve Moment for Cantilever

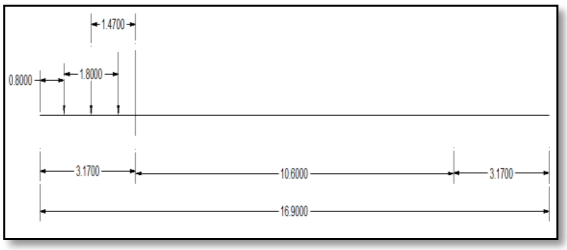

Fig 4. Loading on section

Class A Max - ve Moment for Cantilever

1) For W1,

bef = 1.20 x 2.37+0.424 = 3.268 m > 1.200 m
bef = 2.23 m

2) For W2,

bef = 1.20 x 0.57 + 0.424 = 1.108 m < 1.200 m
bef = 1.1080 m

Intensity calculation

1. W1 = (57 X 1.5)/(1.074 X 2.234) = 35.635 KN/m2
2. W2 = (57 X 1.5)/(1.074 X 1.108) = 71.849 KN/m2

CONCLUSIONS

From the Study it is concluded that

- The Shape of box girder, material uncertainities,and torsion induced has a pivotal effect on stability of Segmental box girder.
- Because of pre-stressing more strength of concrete is utilized and also well governs serviceability as compared to normal concrete.
- The segments system reduces the environmental disturbance compared to the conventional method by carrying out the concreting works further away from the construction site which is usually located at city centers.

REFERENCES

[1] Chirag Garg[1] & M. V. N. S Iva Kumar[2], "Study of Basic design of Precast Segmental Box Girder," *International Journal of Civil Engineering (IJCE) ISS N(P): 2278-9987; ISS N(E):2278-9995* Vol . 3, Issue 3, May 2014, 103-112
[2] Limkatanyu, S[1] and Kuntiyawichai, K[2], "Effect of material uncertainties on dynamic response of segmental box girder," *songklanakarin J. sci. Technol, 29(6) : 1537-1550,* May2007
[3] M. A. Al Gorafi[1], A A A Ali[2], I othman[3] & M S Jaafer[4], " FEM Study on the Structural Behaviour of Segmental Prestressed Concrete Bridge under Torsion and Dry Joint," *International conference on construction and building Technologies, 2008.*
[4] Book of " Prestressed Concrete" Krishna Raju
[5] IRC:18-2000 "Design Criteria For Pre-Stressed Concrete Road Bridges (Post-Tensioned Concrete)" The Indian Road Congress
[6] IRC: 6-2000 "Standard Specifications And Code Of Practice For Road Bridges" The Indian Road Congress.
[7] IRC: 21-2000 "Design Criteria For Road Bridges (Plain & Reinforced Concrete)" The Indian Road Congress.
[8] IS: 456-2000 "Plain And Reinforced Concrete"-Code Of Practice.