ISSN No:-2456-2165

Design and Safety Measures Analysis in Construction of Bhopal Metro Project

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Abstract:- Various aspects relevant to precast segmental bridges such as vibration characteristics, Behaviour of pre-stressing tendons, methods of improving ductility are addressed towards estimating dynamic response and resisting seismic forces. Findings of several International codes and recent worldwide research are discussed. The discussion and conclusions provided herein will be useful in designing precast segmentally constructed bridges against high seismic forces with greater reliability. The bridge is designed to resist seismic forces in which certain parts of the structure are allowed to yield (ductility) to dissipate energy. In the precast segmental construction, various segments (transverse slices) normal to the longitudinal axis of the bridge are joined together with or without use of epoxy. The segment-to-segment joints can undergo large displacement and rotation of repeated opening and closure under reversed cyclic loading induced in seismic events. Therefore, designing the precast segmental bridge resisting high seismic forces is more challenging; as it offers a more complex Behaviour and the ductility demand imposed by substructure may be more than conventional bridges.

Keywords:- *Safety in construction, Dynamic analysis, Damping of structure, Ductile Behaviour, Bhopal REGION.*

I. INTRODUCTION

Metro structures construction process for Bhopal region has been starts in 2019 year. The planned Metro in Bhopal is a heavy metro system. This system consists of a Network of 105 km and with lines overlapping and branching. In May 2013. Rohit Associates Cities & Rails Pvt.Ltd consultants were appointed to prepare a detailed project report for the MRTS including the selection of the system for the city. Based on the multicriteria analysis and recommendations of consultants, the Government of Madhya Pradesh approved the inception report prepared by the consultant on 30 June 2014. As of 2 December 2014 Geotechnical surveys and formation of the company is being carried on for the implementation of the project. The project will be completed by 2023 with first phase-I start in 2019. DPR approved by State Cabinet. Assessment. However design and safety measures analysis in construction of Bhopal metro project will estimate on site to find out relative strength and overall quality of metro project but also helps in deciding whether more rigorous tests like load testing and safety in construction ,dynamic analysis and Ductile behavior required in ongoing work.

- **Dynamic response parameters** Dynamic analysis is to be carried out if the fundamental frequency of the bridge is less than 3.0 Hz, but no detailed vibration requirements are given by AASHTO. These can be considered as per Ontario code recommending for highway bridge and for pedestrian bridge. Similarly, Cpl 7, Part2 (UK) provides limits on bridge deck vibrations.

II. METHODOLOGY

A. Ductile performance of segmental bridges

To perform ductile Behaviour of prestressed bridges AASHTO provides limit on the maximum prestressing steel. This is to ensure that the (total) steel yields ultimate capacity is approached. IRC code does not impose any upper limit on steel.

Combination of internal bonded and external bonded tendons in precast segmental bridge superstructure in high seismic zones should be avoided because the force resistance is not shared simultaneously but in a sequentially manner with the internally bonded tendons carrying most of loads up to failure. This may cause premature yielding, loss of initial prestressing forces and rupture of the internally bonded tendons. Therefore, fully external post- tensioning be preferred to minimize post-earthquake permanent displacement of the superstructure as well as permanent opening of the segment-to-segment joints to improve seismic performance in terms of ductility, displacement capacity, post-earthquake vibration characteristics of segmental bridges.

B. Vertical pre stressed columns and substructure

Substructure systems using segmental construction are devised by Bollington et al. Ikeda et al, Masayoshi et al have studied seismic performance of Prestressed Segmental Concrete (PSC) columns experimentally. The number and the size of cracks in concrete were observed to be smaller in the prestressed columns than RC columns during loading as well as unloading cycles. They concluded that various merits of PSC columns dominate than demerits of possessing lesser energy dissipation, and recommend use of such columns particularly in the region of near field earthquakes. The new materials e.g., FRP tendons have an advantage of being non-corrosive. An improvement in stress- strain behaviour of confined concrete as well as in ductile behaviour was observed by ensuring flexural compression failure. Takizawa et al observed that cracking and deformation Behaviour vary with the prestress force and bond property of FRP bars and the reasonable serviceability condition can be achieved by controlling these parameters.

ISSN No:-2456-2165

C. Improving ductility using cementitious composites

The need to improve ductility of concrete is felt and attempts are being made by modifying its constituents. Fibber-reinforced cement-based composites called DFRCC have been studied andfound to possess greater ductility. Such materials have usefulness in repairing I retrofitting structures and can also be selectively used at critical locations where high ductility demands are expected in the bridge such as plastic zones or joints.

D. Retrofitting & amprole of isolation /dissipation devices

With upgradation of seismicity of various zones in India it might be desirable to retrofit several of existing bridges. Although several retrofitting techniques are in practice, yet each case requires special treatment and remains a unique event. A bridge in California using precast prestressed segmental frames bridge piers was retrofitted. Various aspects of retrofitting the bridge are described.

S. no.	Condition Rating	Condition Description	Recommended Action
1.	85-100	Excellent: No noticeable defects. Some aging or wear may be visible.	Immediate action is not
	70-84	Very Good: Only minor deterioration or defects are evident	
2.	55-69	Good: Some deterioration or defects are evident, but function is not significantly affected	
	40-54	Fair: Moderate deterioration. Function is still adequate	
3.	25-39	Poor: Serious deterioration in at least some portions of the structure. Function is inadequate.	
	10-24	Very Poor: Extensive deterioration Barely Functional	
	0-9	Failed: No longer functions complete failure of major structural component	Economic analysis ofrepair alternatives is recommended to determine appropriate action Detailed evaluation is required to determine the need for repair, Rehabilitation or reconstruction. Safety evaluation is recommended

Table 1: Condition Scale

III. CASE STUDY

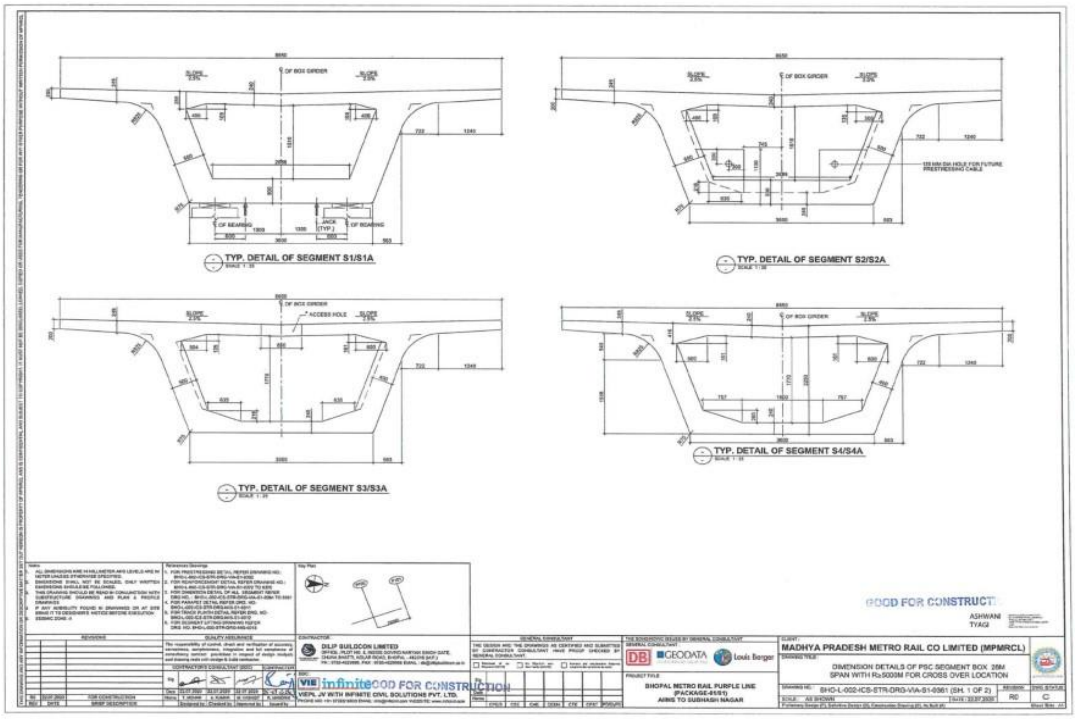

Fig. 1: Segment Design of Bhopal Metro

ISSN No:-2456-2165

It is highlighted that the deflection limit in terms of vibration response is also an important parameter which has not been covered with IRC codes. Based on data for limited period of 3- 4 decades, prestressed segmental bridges can be considered to have performed quite well but systematic design with ductile performance is stressed in high seismic zones. To ensure ductile Behaviour, the maximum longitudinal steel is to be limited. Fully external post-tensioning be preferred to minimize post-earthquake permanent displacement of the superstructure. New materials possessing greater ductility, non-corrosive tendons etc. and techniques like vertical prestressing have promising future to improve Behaviour of bridges against dynamic forces. Segmental prestressed technique is not only prevalent in new bridges but can be successfully used in retrofitting of bridges.

A detailed visual inspection was carried out on almost all assessable location of the Metro project. This included several visually under construction members the component of structure with maximum portion was. The field work was carried out which consists of visual inspection and site testing. The tests are as follows.

- Visual inspection/observation
- Damping of structure
- Dynamic analysis,
- Damping of structure,
- Safety result.

IV. CONCLUSION AND SAFETY AUDIT

Leads the user through a structured process to identify and record essential information about each risk management critical task, such as which posts are responsible for executing and supervising these tasks, and how the task is documented and verified. This allows the practical implementation of the risk management process and provides full visibility of risk controls.

This work provides for-

- Structured method of activity and task analysis.
- A structured method for qualitative analysis of hazards and effects or for recording results of more formal hazards and effects analysis.
- Clear references to company standards and procedures.
- Clear cross referencing between hazards and the activities and tasks providing control
- The ability to set objectives and targets for hazard management
- Facilities to check on completeness of data and to highlight conflicts or gaps
- An easily comprehensible graphical presentation of HSE information
- Customized hard copy reports.

V. CONCLUSION

The quality of our individual contributions to the management of safety determines whether the colleagues we work with live or die " Brian Appleton, ICI, Technical Advisor to the Piper Alpha Enquiry.THESIS provides the linkages to develop, demonstrate and enforce these contributions and in doing so provides a useful addition to the process of making HSE management real and live to the workforce.

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