Case Study of Seismic Evaluation Prestressed concrete On Bridges

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Abstract: The seismic evaluation procedure is based on rigorous approach to determine existing structural Conditions. Structures are evaluated for certain extent of structural damage that is expected in the structure when subjected to earthquake. Many of the existing buildings, which do not fulfill the current seismic requirements, may suffer extensive damage. The aim of seismic evaluation is to assess the possible seismic response of buildings, which may be seismically deficient or earthquake damage for its possible future use. In this the results of several tests are summarized.

Keywords: Seismic analysis, PSC Bridge, Dynamic Evaluation, Base Shear

1. Introduction

Bridges are the one most important connecting element in Lifeline System. Bridge plays vital role for smooth circulation of traffic from one location to other. Eventually light weight prestressed concrete bridges are preferred as compared to the RCC structure. A prestressed concrete member is a member of concrete in which internal stresses are introduced in a plane manner so that the stresses resulting from the superimposed loads are concentrated to desired degrees.

Many of the existing structures, which do not fulfill the current seismic requirements, may suffer extensive damage or even collapse if shaken by a severe ground motion. The aim of evaluation is to assess the seismic capacity of earthquake vulnerable structures or earthquake damaged structures for future use. The evaluation may also prove helpful for degree of intervention required in seismically deficient structures. The aim of seismic evaluation is to assess the possible seismic response of structures, which may be seismically deficient or earthquake damage for its possible future use. The seismic evaluation is helpful for retrofitting of the structure.

At present the cantilever construction method is invariably used for long span prestressed concrete bridges mainly for quality control and rapidly of construction. During the last decade hundreds of fly over's built in the metropolitan cities of India have adopted the cantilever construction technique with minimum disruption of traffic**.**

The method available for seismic evaluation of existing structure can be broadly divided into two categories:

a) **Qualitative method-** The qualitative methods are based on the background information available of the structure and its construction site which require some or few documents like architectural and structural drawings, past performance of similar buildings under severe earthquake, visual inspection report, some nondestructive test results. The evaluation of a building is a difficult task, which requires a wide knowledge about the structures, cause and nature of damage in structures and its component, material, strength etc.

b) **Analytical method-** In analytical method seismic action can be represented in various forms, such as ground acceleration or velocity time-history (recorded or artificial), power spectrum, and response spectrum. The form of seismic action to be used in seismic resistance verification depends on the importance and complexity of the structure under consideration. Ground acceleration or velocity time history represent the direct form of representation of` seismic action, which is used to calculate the structural response, and hence, action effects. Response spectra, however, already imply the calculation of structural response. In the case where the design seismic loads are determined on the basis of response spectra, only the calculation of action effects is needed.

2. Literature Review

This part presents a review of relevant literature to bring out the background of the study undertaken in this dissertation. In the recent past tremendous work has been done on seismic behavior of various elements of prestressed concrete bridge. From the survey done in the literature, it can be noted that some of the papers and research work have added a lot of contribution to this project and acted as a strong reference for the adopted methodology and concluding results. Some of them are presented in the following lines of dissertation.

Prestressed concrete is ideally suited for construction for the construction of medium-and long–span bridges. Ever since the development of prestressed concrete by "Freyssinet " in the early 1930s, gradually replacing steel which needs costly maintenance due to the inherent disadvantages of corrosion under aggressive atmospheric conditions.

Prestressed bridges are adopted for construction of large span bridge structures in which a large space is occupied by the piers as supporting columns. Generally solid slab are used for the span range of 10 to 20 m, while T-beam slab decks are suitable for span in the range of 20 to 40 m. Single or multicell box girders are preferred for larger spans in the range of 30 to 70 m. prestressed concrete is ideally suited for long span continuous bridges in which precast box girders of variable depth are used for span exceeding 50 m.

India has a very high frequency of great earthquakes (magnitude greater than 8.0); for instance, during 1897 to 1950, the country was hit by four great earthquakes. However, the frequency of moderate earthquakes (magnitude 6.0 to 7.0) in the country is rather low. Moderate earthquakes create awareness and lead to improvements in construction at a low human cost. We have not had an earthquake of magnitude greater than 7.0 in the last 40 years. Also, we have also not seen earthquake shaking intensity of more than VIII or IX in the last 40 years. And finally, except the Jabalpur earthquake (1997), the other recent moderate earthquakes have not hit any of the large cities. This has led to complacence in our earthquake preparedness. We now have orders of magnitude higher levels of man-made construction and a significantly larger population than what we had at the time of great earthquakes of 1897, 1934, or 1950; hence, we are that much more vulnerable to earthquake disasters (Sudhir k Jain, IIT, Kanpur).

The literature survey in the performance and behavior of prestressed concrete girder bridges when subjected to seismic loads suggests that the requirement of establishing a methodology for studying the response of bridges to earthquake loads has become essential. This will move us toward implementing design by using nonlinear time history analysis and pushover analysis.

3. Analytical Program

3.1 Structural modeling of a Prestressed concrete girder Bridge

Structural analysis software SAP 2000 is used for modeling of structural elements of two prestressed concrete girder bridge. We are using two bridge models for performing seismic analysis of prestressed concrete Box girder bridges & I girder bridges.

Workbench platform according to the data as shown in table 1 & table 2.

Table 1: Section Properties of box girder bridge

Parameters	Dimensions
Length span	67m
Total width & depth of deck slab	10.97m & 0.380m
Depth of box	1.524m
Diaphragm thickness	0.3m
Box x section(3 no. of box)	3.048×1.524m
Column ht.	8m
Bent cap beam	1.524×3.04m
Column (circular)	1.524m

The models are shown in Figure 1 and Figure 2.

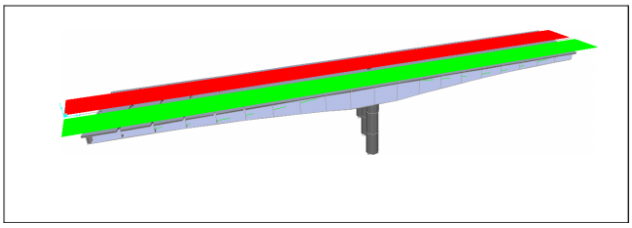

Figure 1: Model 1 of the bridge in SAP 2000

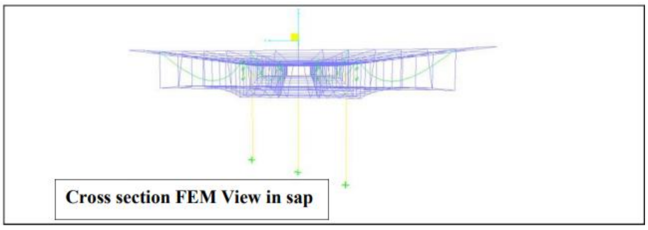

Figure 2: Cross section FEM View in SAP 2000 model1

Table 2: Section Properties of I girder bridge

Parameters	Dimensions
Total length of bridge	55.5 m
Total width & depth of deck slab	11.84 m & 0.22 m
Span length	18.5 m each
Length of column	11.50 m
Diameter of column(3 nos)	0.92 m
Length of cap beam	11.65 m
Dimensions of cap beam	0.92 × 1.00 m
Column support condition at Base	fixed

The models are shown in Figure 3 and Figure 4

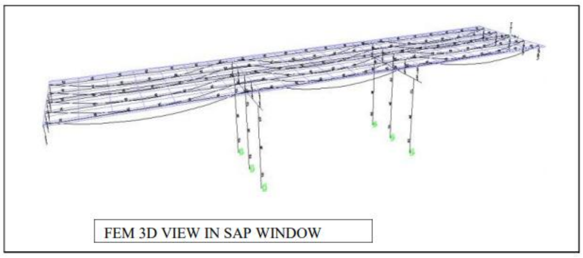

Figure 3: Model 2 of the I Girder Bridge in SAP 2000

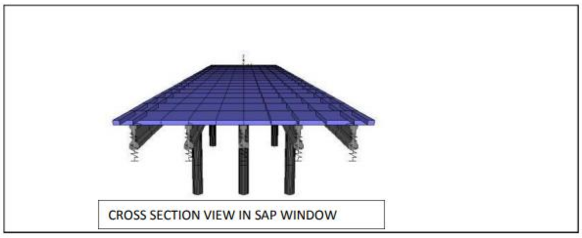

Figure 4: Cross section of 3D View in SAP 2000 model2

4. Analysis

After the linear-static analysis, a non-linear static analysis is carried out to determine the pushover curve of the building. The general finite element package SAP 2000 is used to perform the pushover analysis of buildings using displacement control strategy, where gravity loads of each building are applied prior to the pushover analysis. SAP 2000 static pushover analysis capabilities, which are fully integrated into the program, allow quick and easy implementation of the pushover procedures prescribed in

ATC-40 and FEMA 356 for both 2 dimensional and 3 dimensional buildings.

5. Result for Two Bridges

Results for first Model Bridge:

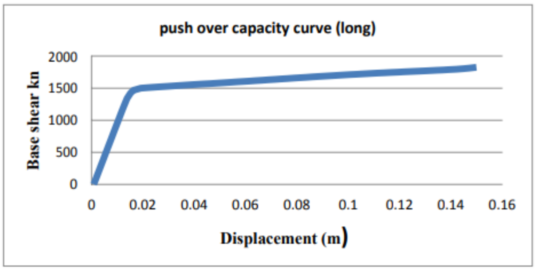

Figure 5: Pushover curve in longitudinal direction for first model

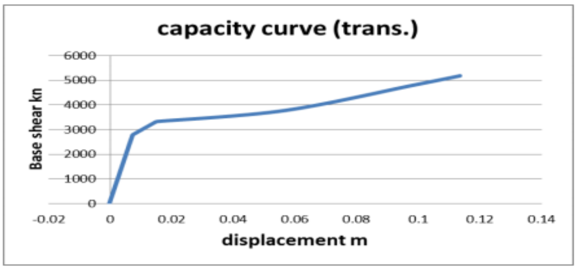

Figure 5: Pushover curve in Transverse direction for first model

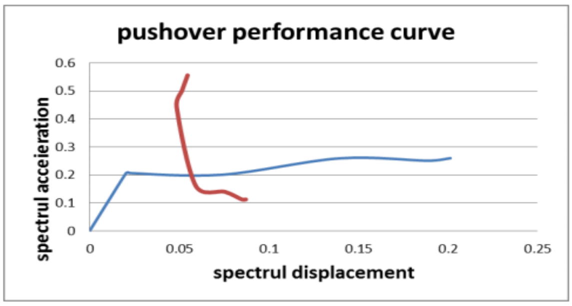

Figure 6: pushover performance curve

Table 3: Result of Base shear and the relative displacement for first model bridge

Content	Lsp	Ldp	Pushover	As per IS1893
Base shear kn	1113	1190	1564	1102
Displacement m	0.39	0.042	0.04	0.037

Results for second Model Bridge:

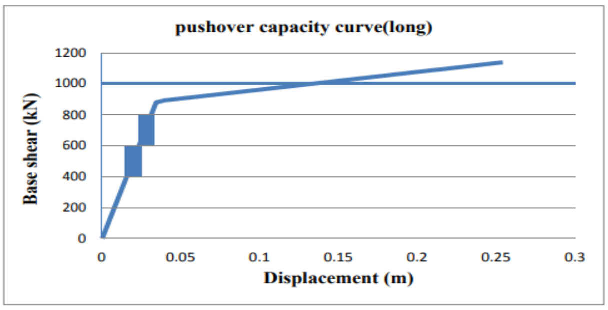

Figure 7: Pushover capacity curve in longitudinal Direction

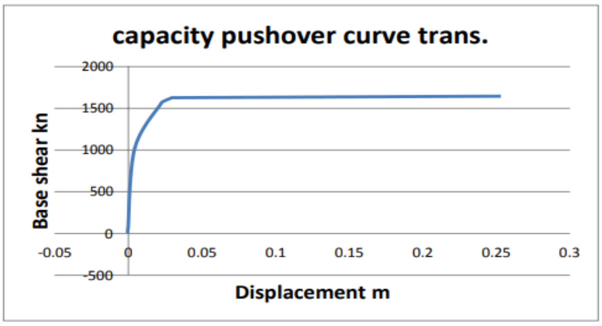

Figure 8: Pushover capacity curve in Transverse Direction

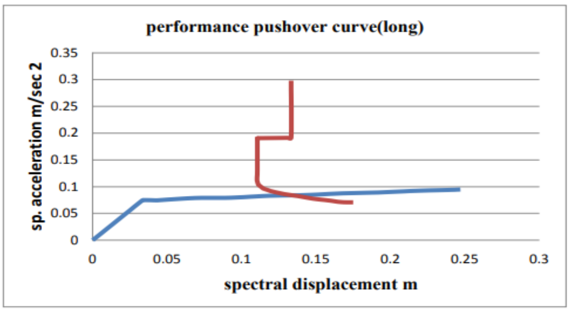

Figure 9: Performance pushover curve

Table3: Result of Base shear and the relative displacement for second Model Bridge

Content	Lsp	Ldp	Pushover	As per IS1893
Base shear kn	1385	1460	1633	1340
Displacement m	0.078	0.08	0.095	0.072

Linear procedures are applicable where our structure is to be in elastic limit but nonlinear behavior is applicable when our structures behave like inelastic model. In general condition the nonlinear procedures gave accurate result as compare to linear procedures for type of big and heavy structures like prestressed concrete girder bridge.

6. Conclusion

From the above study, three bridge models are analyzed by using linear static, linear Dynamic, nonlinear static pushover analysis & linear static as per IS: 1893, procedures.

From the results of all two prestressed concrete girder bridges it was concluded that:

For first model bridge

- The value of base shear in linear static procedure is 1113kn and the respective displacement is 0.039m and the base shear of as per IS1893 is 1102 kn and relative displacement is 0.037 m.
- The value of base shear in response spectrum 1190 kn and the relative displacement is 0.042 m.
- The value of base shear in pushover analysis is 1564 kn & the target displacement is 0.04m.

For second model bridge

- The value of base shear in linear static procedure is 1385kn and the respective displacement is 0.078m and the

base shear of as per IS1893 is 1340 kn and relative displacement is 0.072 m.
- The value of base shear in response spectrum 1460 kn and the relative displacement is 0.08 m.
- The value of base shear in response spectrum 1460 kn and the relative displacement is 0.08 m.

7. Future Scope

- Non-linear static (pushover) analysis method is force based and quick which does not give realistic performance results.
- This study will further help us to perform time history and fragility analysis on prestressed concrete bridge, which is not included in Indian standard bridge design code.

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