A Review of Analysis of Cable-Stayed Bridge Subjected To Seismic Excitetion Using Sap2000

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***Abstract*— The conventional type of cable-stayed bridge consists of two pylons with one main span and two side spans or one pylon with two asymmetrical spans. Owing to its increasing popularity, researchers around the world have given considerable attention to its analysis and behavior. Multi-span cable-stayed bridges with more than three spans are a logical extension of the conventional type. Bridge designers have proposed cable-stayed bridges which are several kilometers long. In spite of significant progress made in building of the cable-stayed bridges, the earthquake experience for these bridges is still limited. Very few cases of earthquake induced damage to cable-stayed bridges have been reported and no collapse due to an earthquake has been recorded. One of the reasons is that very few cable-stayed bridges have been built in high seismicity areas. However, recent trends in bridge construction show a favorable future for cable-stayed bridges. As a result, it is likely that more of these bridges will be built in zones of high seismic risk.**

Keywords-cable stayed bridge, seismic excitetion, sap2000, earthquake, etc

I. INTRODUCTION

The recent surge in the use of cable-stayed bridges is due mainly to the fact that they offer the opportunity to cross-large obstacles with elegance and economy. However this type of design is equally suitable for small and medium-span structures, which are by far the most numerous. The reasons, which can lead to the choice of cable-stayed solution, are widespread. One of the more widely appreciated is linked to the clearance below the deck, which is often restricted. The use of this type of structure is then naturally advantageous over classic through type bridges, lattice girder and arches. The technical progress in general and that of modern constructional methods in particular have ensured that cable stayed bridges have become more and more economical and competitive for spans of over 50m in length.

II. ADVANTAGES

More economical, easily carry the horizontal thrust without additional material ,geometrically unchangeable under any load position, reduction of the depth of the girders and a consequent saving in steel , The amount of steel required in the stays is comparatively small, cable stays is relatively easy with today's technology of prestressing etc.

III. GENERAL PHILOSOPHY OF FEM

Finite element method is the representation of a body or a structure by an assemblage of subdivisions called finite elements. For carrying out the effects of seismic loading, the bridge was modeled in parallel using the SAP2000 system. The whole modeling of the cable-stayed bridge part of the bay bridge was done on the SAP2000 for carrying out the non-linear analysis of the cable-stayed bridges under gravitational and seismic loading. The behavior of each element under the effect of the seismic excitation were studied from the output generated by the SAP2000.

IV. LITERATURE REVIEW :

1. A.K Desai (2011) Head, Department of Applied Mechanics SVNIT, Surat Gujarat, INDIA "Seismic time history analysis for cable-stayed bridge considering different geometrical configuration for near field earthquakes"

To increase the maximum span of cable-stayed bridges, Uwe Starossek has developed a modified statical system. The basic idea of this new concept is the use of pairs of inclined pylon legs that spread out longitudinally from the foundation base or from the girder level. Spread-pylon cable-stayed bridge has distinct advantage like reduction of sag of cables and oscillation of cable during earthquake over traditional cable-stayed bridges. Spread-pylon also improves seismic performance of deck during strong ground motion. Here in this paper dynamic behavior of cable stayed bridge with different structural configuration with seismic loading was studied. New correlation for EDR (Earthquake displacement ratio) and PGA (Peak Ground acceleration) was established.

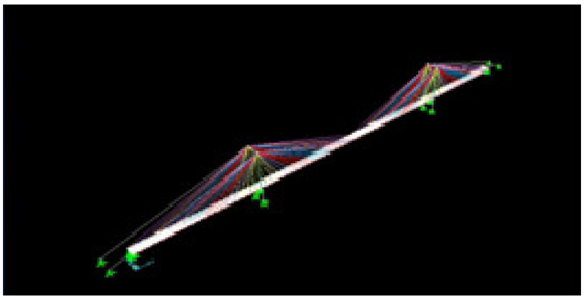


Fig.1(Straight Cable-Stayed Bridge)

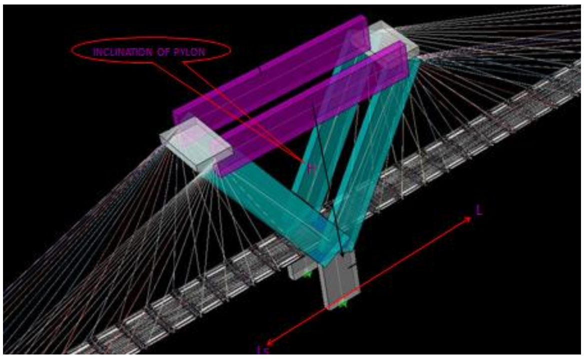


Fig.2(Y-shape pylon)

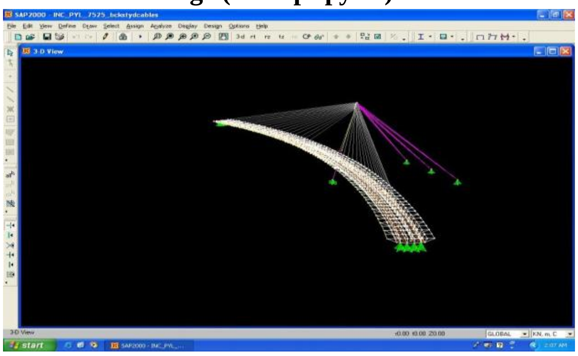


Fig.3(curved shape of brig with ISSS)

The time history analysis with different parametric model of cable stayed bridge n three time history taking in this stayed. In parametric stayed with A and Y shape pylon n a curved pylon as fig.1 show the A-shape pylon, fig.2 show the Y-shape pylon, and fig.3 shows the curved shape bridge with n without ISSS.

And for the time history analysis he conduct three history Bhuj, Koyna, and EI-centro table.1 shows the below regarding information of that.

Name	Magnitude	Duration of Earthquake (sec)	PGA Value (cm/sec2)	Time for PGA (sec)
Bhuj (2001,gujarat .india)	7.7	109.995	104	46.005
Koyna(1967 ,maharasta ,india)	6.5	7.02	54.1	2.606
EI-centro(1940, California , USA)	6.7	39.011	678.55	3.16

Table 1 time history & duration of earthquake used.

2. ALAA MOHAMED SAAD(1997) "Seismic Analysis Of Cable-Stayed Bridges"

During the last decades, cable-stayed bridges have gained a wide reputation. With the increasing central span length of modern cablesupported bridges, and consequently, the carrying capacity of structural elements, deflection and cable tension forces under service and earthquakes loadings, the demand of accurate analysis considering the geometric nonlinearity is highlighted. Different sources of geometric nonlinearity in the analysis of cable stayed bridges are contributed through three factors: changes in the geometry of the cables due to tension changes (sag effect), axial force bending moment interaction on tower as well as the girder elements, and finally the change of geometry of the whole bridge due to large displacements. Previous studies show that, for intermediate span, linear dynamic analysis is adequate but nonlinear static analysis under dead loads is still essential to start the linear dynamic analysis from the dead load deformed state.

In this thesis, a finite element computer program was developed to study simultaneously the effect of these sources of non-linearity on the behavior of cable-stayed bridges under gravitational and seismic loading. This program is used to recognize the importance and the participation factor of each parameter on the overall response of this type of bridges. The thesis

explains also, the effect of dead load stiffness and cable pretension
on the dynamic analysis. Two hypothetic conventional cable-stayed bridges are used through the analysis to represent both the present and future trends in cable-stayed bridge design. The results are of special interest for the interpretation of the complex behavior of cable-stayed bridges under gravitational and seismic loads considering nonlinear parameters.

The conclusion of his work is The linear dynamic analysis case from dead load unstrained geometry follows nearly close to the nonlinear dynamic analysis case with cable sag effect. Nonlinearity in the dynamic stage considering large displacements (L-D) is not too significant. The bridge behavior can be treated to be sufficiently linear especially for deck results. This can be explained by the presence of the pre-tension forces in cables which enhance efficiently deck deformations and consequently drop its effect, but they have a considerable effect on tower and cable forces specially, for model -B2 with relatively
large dimensions.

Future of work is The nonlinear dynamic analysis program using incremental approach has great potential for further research. The program based on finite element approach can be extended to include different kinds of 2-D and 3-D elements. As only geometric nonlinearity was considered in the present study, the program should be extended to consider material nonlinearities, and the formation of plastic hinges near ultimate loads. These effects may significantly influence the seismic response of cable-stayed bridges, especially if the duration of the earthquake ground motion is increased. The program should also be made more user friendly to make the input and output processing easier. The parametric studies done on the conventional cable-stayed bridges using 3-D models can be extended to perform seismic studies on the multi-span bridges of different deck types and different support conditions. Bridge response using elastomeric bearings at deck-tower connections should also be investigated. The Information available on damping of the cable-stayed bridges is still rather limited. Further field and laboratory tests should be done to shed further light on the damping of cable-stayed bridges. Laboratory and full scale dynamic testing and measurements, conducted in order to verify current and future analysis procedures and to measure the true mechanical or structural clamping values and dynamic characteristics of these bridges.

3. Huu-Tai Thai and Seung-Eock Kim(2008) "Second-order Inelastic Dynamic Analysis of Three-dimensional Cable-stayed Bridges"

This paper presents a second-order inelastic dynamic analysis of three-dimensional cable-stayed bridges including both geometric and material nonlinearities. Geometric nonlinearity is captured by using stability functions to minimize modeling and solution time, while material nonlinearity is considered by adopting the refined plastic hinge model. A computer program utilizing the Newmark β-method with the assumption of average acceleration is developed to predict the nonlinear inelastic dynamic behavior of the cable-stayed bridges. The accuracy and efficiency of the proposed program are verified by comparing it with SAP2000 and ABAQUS. It can be concluded that the proposed program is capable of accurately and efficiently predicting the nonlinear inelastic dynamic response of cable-stayed bridges.

The purpose of this paper is to extend the application of the stability functions and the refined plastic hinge model for the nonlinear inelastic dynamic analysis of three dimensional cable-stayed bridges. A computer program including all sources of nonlinearity is developed to predict the nonlinear inelastic dynamic response of cable stayed bridges. Two earthquake records of the El-Centro 1940 and Loma Prieta 1989 are used to verify the accuracy and efficiency of the proposed program with the SAP2000 and ABAQUS software.

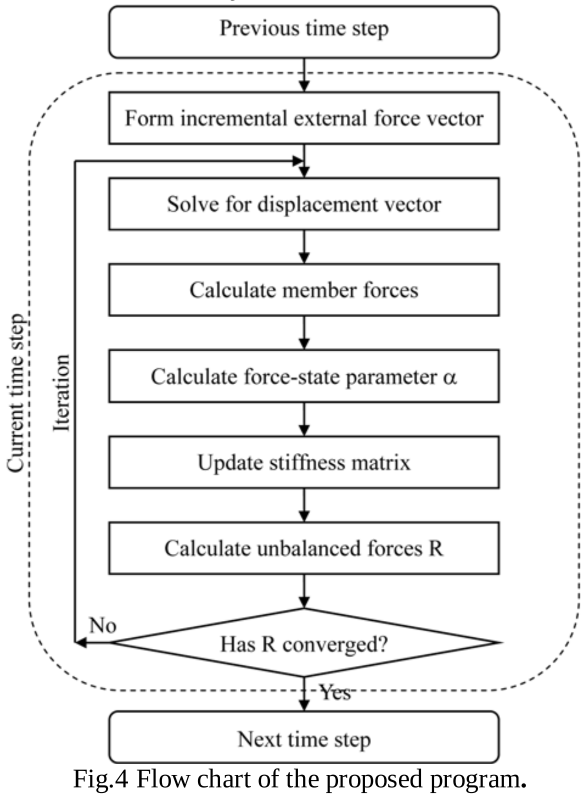


Fig.4 Flow chart of the proposed program.

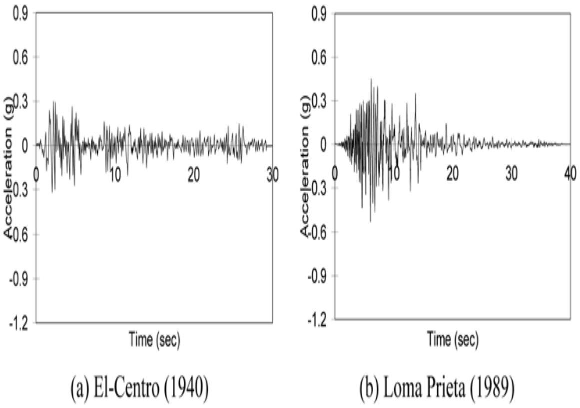


Fig.5 Earthquake records**.**

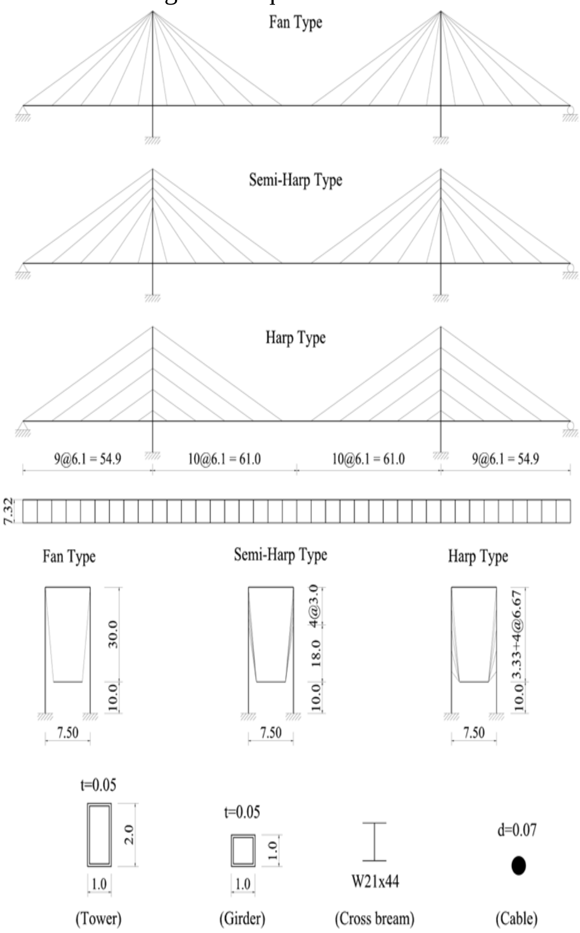
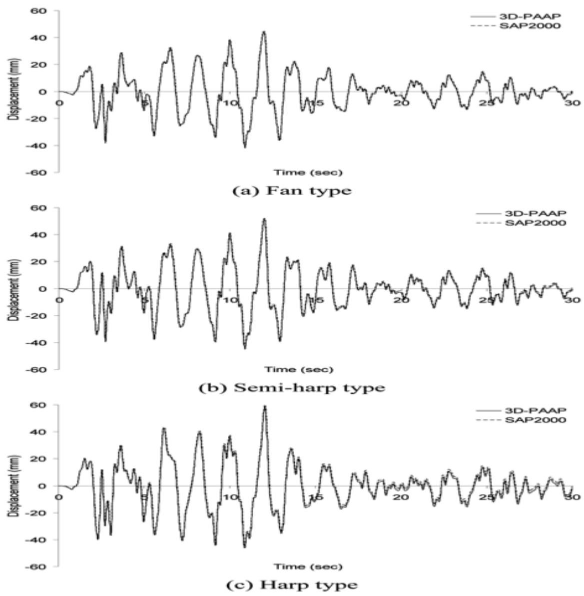


Fig.5(Cable-stayed bridges (unit: m)

This are the parametric study of work

Bridge type	Mode	ABAQUS	3D-PAPA	Error(%)
Fan type	First	1.870	1.868	0.09
	second	1.232	1.231	0.10
Semi-harp type	first	1.868	1.866	0.10
	second	1.242	1.241	0.12
Harp type	first	1.897	1.895	0.13
	second	1.333	1.330	0.2



Conclusions of his workA computer program considering both geometric and material nonlinearities in predicting the nonlinear inelastic seismic response of the three-dimensional cable-stayed bridges subjected to their own weight and earthquake loadings has been developed. The conclusions of this cases are 9.7 h and 1.3 h by ABAQUS and the proposed program, respectively. It shows that the proposed method is more practical than finite element method, and the proposed program can be effectively used as a powerful tool for use in daily design.

4. Miguel Angel (2011) "seismic behavior of cable stayed bridge: design, analysis and seismic devices"

In this study focused on the seismic response of the several classical cable stayed bridge. the objectives of study in three fold (i) to discern how project decisions affect seismic behavior of cable stayed bridge (ii) to shed light on appropriate analysis strategies in order to address there linear and non-linear dynamic response; (iii) to camper different control schemes with passive seismic device disposed along the tower.

5. R.A. Khan, T.K. Datta, S. Ahmad (2004) "Seismic risk analysis of modified fan type cable stayed bridges"

A seismic risk analysis of modified fan type cable stayed bridges is presented using the concept of damage probability matrix. The cable stayed bridge is modeled as a two dimensional system with the deck idealized as a continuous beam subjected to bending action and axial compression. The response of the bridge is obtained by the frequency domain spectral analysis. A double filtered power spectral density function with seismic intensity parameter taken as the magnitude of an earthquake and a correlation function between the support excitations are considered as seismic inputs. For a given magnitude of earthquake, the damage probability matrix is determined by defining three damage states namely, major, moderate and minor. The seismic risk index is determined by combining the damage probability matrix with the probability of occurrence of different magnitudes of earthquake. As an illustrative example, a three span modified fan type cable stayed bridge is analyzed for an extensive parametric study. The parameters include degree of correlation, angle of incidence of earthquake, ratio of the components of ground motion, and soil condition. Some of the important conclusions of the study indicate that (i) the longitudinal component of ground motion has a considerable effect on the annual probabilities of failure of the bridge deck; (ii) annual probabilities of failure are significantly more for soft soil condition; (iii) fully correlated ground motion between support excitation provides less value of the damage indices as compared to the uncorrelated ground motion; and (iv) annual probabilities of failure are not very sensitive to the variation of angle of incidence of an earthquake.

Conclusions of his work A procedure for obtaining the damage probability matrix (DPM) and consequent annual probability of failure for cable stayed bridges subjected to partially correlated random ground motion is presented. The damage probability matrix is defined by specifying limits (barrier level) on the response level (i.e. stresses at a critical section). The probability of exceeding the limit (barrier level) gives the probability of certain damage level. With this consideration, DPM is constructed for three damage states namely major, moderate and minor. For determining different damage states, the peak value of the response is obtained by spectral analysis and is assumed to follow a Gumbel distribution. Finally, annual probability of failure is obtained for each damage state by combining the DPM with the annual probability of occurrence of different earthquake intensities. The effect of different important parameters on the annual probability of failure is investigated for a cable stayed bridge. The results of the study.lead to the following conclusions:

. (i) Major and moderate annual probabilities of failure almost linearly decrease with the increase in the barrier level, whereas the minor annual probability of failure remains nearly insensitive to the variation of the barrier level.

(ii) Soil condition can significantly change the annual probabilities of failure; those for the soil condition are found to be more compared to the firm soil condition for the type of excitation considered in the study.

(iii) The ratio between the components of ground motion has considerable effect on the major and moderate annual probabilities of failure; but it does not significantly influence the minor annual probability of failure. Major and moderate annual probabilities of failure not only increase with relative increase in the vertical component of ground motion, but also the same thing is observed for the component of ground motion in the longitudinal direction of the bridge.

(iv) Annual probabilities of failure increase as the degree of correlation between the ground motions at the supports decreases. Further, fully correlated ground motion between support excitations provides a smaller value of annual probabilities of failure as compared to the uncorrelated ground motion.

(v) The variation of the effect of the angle of incidence on the annual probability of failure is not uniform; the rate of decrease of the annual probability of failure with the angle of incidence significantly increases at higher values of the angle of incidence.

(vi) The annual probability of failure is relatively insensitive to the duration of an earthquake within the practical range of 10–30 s considered in the present study.

VI. CONCLUSIONS

The cable-stayed bridge has many advantages if they analysis and successfully design in highly seismic area and it's much suitable for construction and easily design comparison with other structure.

Also it's very economical to other. The sap2000 the commercial software is available in market so we can analysis the cable stayed bridge with seismic excitation

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