EFFECT OF NONLINEARITY IN PIER AND WELL FOUNDATION ON SEISMIC RESPONSE OF BRIDGES

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ABSTRACT: *For bridges passing water bodies, pier-well foundation is provided as support to the girder is common practice in many countries. Even after the strong earthquakes hits the structure and at the same time it is important that thestructure should be functional in terms of trade or defense. The structure methodology arrays the function of structure during and after an earthquake. To estimate seismic response nonlinear dynamic soil structure interaction analysis methodology is developed. By considering nonlinearity in piers and well foundation, Nonlinear seismic analysis of soil-well-pier system of a bridge supported on well foundation can be carried out.*

Key Words: *Bridge, Nonlinear seismic response, well-pier foundation, soil-foundation-structure-interaction*

1. INTRODUCTION

During major earthquake forces induced into the reinforced structure pier of the bridge which may exceed yield capacity of some piers and cause inelastic deformation which leads to major damage to the piers. In past elastic analysis procedure is used to assessment of the bridge structure which is not sufficient for inelastic action occurred. The modeling and seismic analysis of bridge structures have been a major evolution over recent decades linked directly to the rapid development of digital computing. Non linear dynamic analysis is essential for the inelastic occurred into the piers during the earthquake.Nonlinear dynamic analysis of a typical bridge supported on well foundation is performedconsidering pier and well nonlinearity. Nonlinear relations between forces and deformations/displacements due to material and/or geometric nonlinearities are now widely used in structural analysis. The structural response history due to an earthquakecan be computed through dynamic analysis. A number of researchers have recently investigated through analytical studies the seismic behavior of bridges including the effects of soil-structure interaction (SSI).

2. FUNDAMENTAL CONCEPTS

Complexity in the analysis considering soil-structure interaction and unavailability of validated standard techniques results in ignoring the influence of the foundation for the structural design. The main challenge for soil-structure interaction incorporation is that the two disciplines of geotechnical and structural engineering meet simultaneously.Bridge deck displacement and pier column shear force were affected more by pier column inelasticity than SSI. Therefore, more attention needs to be focused on including the effect of pier column inelasticity in design than SSI for the class of bridges founded on shallow rock foundations. SAP2000 is the finite element that is used in simulation of nonlinear super structure and soil structure interaction by linear springs. The advance in computational capabilities of soil structure interaction effects on the static nonlinear analysis (pushover analysis) has been fully reflected in improved seismic design of new, or vulnerability assessment and retrofit of existing bridge structures.Besides a thorough investigation of the relative significance of various physical parameters of the system response, an easy-to-use approach that can be incorporated for a preliminary design of bridges and helpful for structural assessment, strengthening and/or rehabilitation of existing short spanRC bridges.The non-linear dynamic analysis method is implemented for the analytical study because of its precision and effectiveness in identifying the inelastic seismic response of a system exposed to the ground motion data.

3. LITERATURE REVIEW

[1]**Gerolymos and Gazetas(2006)**have presented generalize Winkler model by four springs and dashpots for studying the behavior of rigid caisson foundationwhich is embedded in nonlinear homogeneous soil under lateral loading. Caisson foundation is modelled in generalize Winkler model which includes four springs; along the height lateral and rocking springs and at the caisson base concentrated shear and rotational springs. To capture the viscous properties of soil coming from both radiational damping and hysteresis damping dashpots are attached in parallel. Two cases were studied to investigate the static and dynamic response of caisson foundation: one observing soil non linearity and other observing soil and interface non linearities. By observing these two cases the result shows that the inertial response of caisson foundation notably affected by soil and interface non linearity.

[2]**Mondal and Jain (2008)**uses 2D finite element method to identify the seismic response of bridge piers supported on well foundation by considering nonlinearity in pier and well foundation also soil-well-interaction effect.Two longitudinal earthquake motions are applied on 3 different embedment length considering structure and interface non linearity. Compression only gap element method is applied to modelled the separation between soil and well.The study was carried out in two steps in which to obtain the motion at base of finite element for given time history analysis and apply this motion in finite element model of soil-well-pier system. For piers and wellBending moment demands exceeding the capacity by 20% to 70% and 30% to 75% respectively for linear analysis. Two-time history was applied to analyses the linear and non linear for different scour depth. Pierdemanding enough rotational ductility and need to increase the capacity of well where notable reduction of 15% to 50 % in nonlinearity of pier and well.

[3]**Tsiggions et al. (2008)** investigated the seismic response of the bridge piers supported on rigid caisson foundation surrounded by homogeneous soil. 2DOF is used to modelthe superstructure and thepierwas modelled as beam as the concentrated load was applied on pier head.The proposed model with translation and rotational springs and dashpots shaken by the free field displacement profile. From the analysis the system length of time is depend on the slenderness ratio. The proposed method is reliable.

[4]**Chowdhury et al. (2012)** prepare a model demonstrate with an example of bridge piers supported on well foundation considering soil-well-interaction. The outcome of analysis shows that the soil-well-interaction boosts the reaction of fixed base and with the decrement of soil stiffness this effect of rigid foundation increase.

[5]**Drosos et al. (2012)**performed an experiment in which monotonic and slow cyclic loading is applied to investigate the effectiveness of foundation rocking on the seismic response of the slender bridge pier. To resolve this three possibly designed foundation large, medium, small with FOS 1.07, 0.55, 0.43 respectively considered.Conclusion that the rocking foundation resist the earthquake shaking and protect the structure.

4. CONCLUSION

It is observed that the for all type of soil i.e. hard, medium, soft the base shear increase with increase of zone factor. there is decrement in base shear value when the linear soil spring replace by nonlinear soil spring; this is because the nonlinear soil spring gives more flexibility to the soil. The base moment is almost like the base shear because it is obtained by multiplying base shear values to the height given to the moment. The factors that increases the top displacement are pier height, seismic zones and all type of soil i.e. hard, medium, soft.

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