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A Literature Review on the Cyclic Loading Behaviour of Rc Bridge Pier

Aman Gautam[a]*, Vijay Kumar Shukla[b]

[a]*Mtech Scholor(Structural Engineering), VEC Ambikapur ,(CG)*
[b]*Assitant Proffesor,Civil Engineering Departement, VEC Ambikapur, (CG)*

A B S T R A C T

The Bridge pier is type of structure that is used for support the super structure such as bridge deck. The bridge pier is constructed to withstand horizontal and vertical load. Cyclic loading in bridge pier occurs due to sudden vibration of seismic effect or vibration due running water waves in river that mainly causes the fatigue failure of the structure. Cyclic loading effect on structure are evaluated by hysteresis response of structure. Hysteresis loss , energy dissipation, deformation, displacement & hysteresis loop are analyzed. In this study we take a review analysis of various method adopted by earlier researchers to evaluate the cyclic loading effect on the various type of RC bridge piers like CFST , composite , self centring hammer head bridge pier etc.

Keywords: Cyclic loading, hysteresis response, fatigue failure, seismic effect.

1. Introduction

Bridge pier is the structure that gives the upright support to the super structure like arch and bridge deck .Mostly bridge piers are constructed in the river beds and due to seismic vibration or vibration due to running water waves the bridge pier is subject to cyclic loading effect. Cyclic loading is type in which loads that are applied , removed and reapplied as a sinusoidal from at once it is applied with some magnitude and in next cycle it is applied with same magnitude in opposite direction. Cyclic loading causes the loss in load carrying capacity of structure or deformation in bridge piers. Cyclic loading cause the failure of bridge piers in fatigue. Repetitive loading cause the torsion and twisting effect on the structure that leads to fatigue failure of the bridge piers. In general it is seen that only cyclic loading doesn't cause the serious failure of structure but when axial load and cyclic loads both are applied on the structure it causes the serious damage of the structure and leads to fatigue failure of the structure.

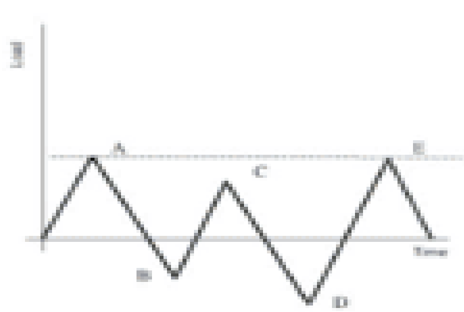

Fig.1 Cyclic loading example

* Corresponding author. Tel.: +91-9713363473.
E-mail address: amangautam2711@gmail.com

If the yield stress in cyclic loading reaches the (notches) maximum in structure ,hysteresis loop can be formed around the notches of the structure. After the continuous effect of cyclic loading large ,hysteresis loop can be formed that leads to fatigue damage in general it is a long term phenomena. In this paper we take review of various method adapted by earlier researchers to analyze the cyclic loading effect on the bridge pier.

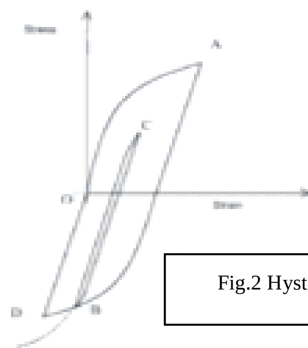

Fig.2 Hysteresis loop example

2. Literature review

There is a satisfactory work is done by the researchers in field of cyclic loading and fatigue analysis of a different kind of bridge piers. Following Research work has been done in the direction of making the structure safe under cyclic action of loading.

2.1.Kazuhiko KA WASHIMA et al . submitted his paper on **“Effects of Cyclic Loading Hysteresis on dynamic behaviour of reinforced concrete bridge pier’’** in which they followed their research that a RC bridge pier subject to 3 different type of loading during a seismic vibration. In type 1 loading displacement was monotonically increased with increasing number of load reversals, type 2 is reversal order of type1 & type 3 is combination of type 2 & type 1. Five specimen is prepared with same characteristic over the Cs 80x40x240 cm & shear span ratio is 6.8 concluding remark in his research due to series of three dynamic loading hysteresis they reach the conclusion that effect of cyclic loading is less significant on maximum load but energy dissipation is depend on types of hysteresis loading[1]. Mode of failure was caused by the reversal loading isn’t significantly developed unless the loading displacement is not larger then previous one & hysteresis loop formation are depends on loading path.

2.2. Rui FARIA et al . said on his paper entitled **“Seismic Behaviour of R/C Bridge Piers: Numerical Simulation and Experimental Validation”** in which they explained about a deficiencies created by a earthquake over R/C bridge pier situated in Los Angeles & Kobe. Where R/C bridge pier shows non liner behaviour there fore study of non linear behaviour of R/C structure is important for design. In which they performed a pseudo dynamic model for analysis they used 2D pin truss which reproduce the steel rebars quite accurately. In his study they make their model related to a pre existing bridge pier naming “Talübergang Warth bridge” in which hollow C/s is used due to cyclic loading over pier it is clear that pier is failed due to loss in stiffness of concrete and the effect called Pinching effect due to which concrete cracks & shows continues change in structural stiffness.

2.3. Ick-Hyun KIM et al. said on his paper entitled **“Cyclic loading test of small scale bridge pier models without seismic detailing”** in this paper a prototype hollow rectangular cross section is selected to with stand cyclic loading and type of methods to use seismic upgrading of bridge. In his paper author discussed mainly two methods one is jacketing and other one is providing shear key. In hollow rectangular cross section steel jacketing may not be a good solution because of uncertainty in confinement effect, shear key may be good option compare to jacketing. shear key with shear key stoppers is a good retrofitting option and it enhance the model to with stand effectively under moderate seismic region. Contrary to the design assumption shear key lost its capacity due to the pullout of the stud bolts in very brittle pattern to over come this need appropriate factor of safety for shear key stoppers.

2.4. Dina M. Fathi et al on his paper on **“Cyclic load behaviour of precast selfcentring hammer head bridge piers”** in this paper they focused on to make compression between cast in situ and pre cast hammered head bridge pier. They modelled 5 models one monolithic specimen and four precast bridge bents. The test result were used to verify the Finite Element Model (FEM) developed in this study. Tested specimens were modelled using the ABAQUS platform under quasi-static loading. The analytical model considered interaction between precast elements, unbonded strands, and surrounding concrete and bond slip between column main reinforcement and concrete. Developed FEM for monolithic bridge pier showed comparable results with the experimental tests. FEM was able to predict the hysteretic behaviour of modelled bridge piers with high degree of accuracy. In addition, FEM confirmed the experimental observations and showed that precast self-centring hammer head bridge piers system is capable of withstanding any large lateral displacements before achieving the peak lateral strength. In order to capture a realistic behaviour of the bridge piers under cyclic displacement loading, the reinforcement was modelled using nonlinear combined isotropic/kinematic hardening model considering the interaction properties at discrete surfaces and material properties such as steel reinforcement cyclic behaviour. Also interaction should be defined between post tensioned strands and surrounding duct even if it was unbonded to control strands movement into the embedded duct through the cyclic displacement. And to prevent strands penetration in surrounding concrete.

2.5. Raghvendra yadav et al presents his paper entitled **"Analytical behaviour of CFST bridge pier under cyclic loading"** in his paper he explains about behaviour of CFST (concrete filled steel tube) pier under dynamic loading CFST bridge column shows excellent ductility and energy absorption capacity. CFST columns are composite structure in which steel tube is filled with concrete. Steel tube serve as a formwork while concrete reduces the construction cost. Tube act as a longitudinal and lateral reinforcement no other reinforcement is needed at core where concrete places. In his research he finally concluded after his experimental analysis that in CFST piers smaller increases in D/t ratio shows increase in load carrying capacity, initial flexural strength is free from yield strength of steel it is only a function of long term effect, initial flexural stiffness depends on the strength of concrete & it can't get effect over long term, lateral deflection is directly proportional and ultimate lateral load capacity is inversely proportional to slenderness ratio of column.

2.6. Sumnieng Ongsupankul et al on **"Behaviour of Reinforced Concrete Bridge Pier Columns Subjected to Moderate Seismic Load"** explained the behaviour of six square bridge pier column models with different amount and arrangement of tie bars subjected to constant axial load and cyclic lateral load was studied experimentally. The cyclic loading tests and verification by fibre element analysis were conducted. It can be found that increasing the amount of tie bars does not affect the maximum lateral load force and the yield lateral force. Increasing the amount of tie bars increases the maximum deflection and ductility ratios of the specimens.

3. Scope of work

In above study, it is clear when cyclic loading is imposed in steel structure it is found that yield strength after reverse loading is decreases compare to initial yield strength and stiffness degradation occurs in concrete due to repeated opening and closing of cracks and bar slip at anchorage zones. In many researches gives the clear indication that while designing bridge pier many of professionals have not taken seismic analysis as serious concern that's why most of failure occurs in bridge pier due to dynamic loading. So providing best method for seismic analysis and designing and upgrading retrofitting techniques to improve bridge pier strength against cyclic loading have great concerns.

4. Conclusion

When Bridge pier is subject to series of cyclic loading it loses its long term strength in terms of stiffness degradation in concrete & hysteresis loss in steel. yield strength of steel in bridge pier is dependent on the grade of steel & using high strength of concrete we will be able to increases the strength of the concrete. According to earlier researches mention in this paper ultimate strength of bridge pier depends on many other factors like D/t ratio, material properties, hysteresis losses, energy dissipations, anchorage dislocations , bond slippage & displacements etc. In this paper we tried to find the most economical & efficient way to design & analyze the structure.

REFERENCES

[1] Kazuhiko KA WASHIMA et al "Effects of Cyclic Loading Hysteresis on dynamic behaviour of reinforced concrete bridge pier" , Proc. of JSCE No. 398/1- 10, Structural Eng/Earthquake Eng. Vol. 5. No. 2, 343s-350s. October 1988.

[2] Rui FARIA et al "SEISMIC BEHAVIOUR OF R/C BRIDGE PIERS: NUMERICAL SIMULATION AND EXPERIMENTAL VALIDATION",12WCEE 2000,0673

[3] Ick-Hyun KIM et al "Analytical behaviour of CFST bridge pier under cyclic loading" 12WCEE 2000,1817

[4] Dina M. Fathi et al "Cyclic load behaviour of precast self-centring hammer head bridge piers" HBRC JOURNAL 2020, VOL. 16, NO. 1, 113–141 https://doi.org/10.1080/16874048.2020.1789385

[5] Raghvendra yadav et al " Analytical behaviour of CFST bridge pier under cyclic loading" science direct, procedia engineering 173(2017) 1731-1738

[6] Sumnieng Ongsupankul et al "Behaviour of Reinforced Concrete Bridge Pier Columns Subjected to Moderate Seismic Load" ScienceAsia 33 (2007): 175-185

[7] IS 1893(part-1)(2002) Criteria for earthquake resistant design of structures.

[8] IS 875(part I-V) design loads.

[9] IS 13920-1993Ductile detailing of reinforced concrete structures subjected to seismic forces.

[10] Text book "Reinforced concrete Design" by S Pillai & Devdas Menon