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Comparative Study of the Improvement of Cyclic Reinforced Concrete Columns with Different Layouts of Polymer Fibers

S. Kharazmi, A. R. Rasekhi Sahneh

Department of Civil Engineering, Islamic Azad University, Qeshm Branch, Qeshm, Iran

ABSTRACT: Rehabilitation (improvement) is a process and repairing method or modifying one structure in order to achieve the new operating conditions or increasing the useful life operation. In fact, in designing and implementation the retrofit, we are looking to achieve the new condition for concrete structure in terms of operating or loading. Retrofit operations can be necessity for design errors and problem causes, administrative problems and errors, changes in standards and regulations, increasing the useful life of the operation, changing the structure, increasing the classes and imposed load. Also, damaging in reinforced concrete columns can be cause the irreparable and strong damages. So, study the retrofitting the reinforced concrete columns by polymer fibers and with different layouts of polymer fibers. Improvements with polymer fibers and proper laboratory study have been used in order to validation exam for modeling. Then, proper retrofit layout of polymer fibers is discussed in Abaqus finite element software with simulation with several various models. After studying the hysteresis-bar curves transformation, load-displacement curve cover-transformation, ultimate load and the contribution of polymer fibers of models was found that samples those have polymer fibers have a greater ability to more loading bearing and also, have more absorb property and more energy amortization (82 percentage of increasing the capacity) than samples without fiber.

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1- Introduction

Availability of the materials, being economic and other features of the polymeric sheet have changed it into a material that is considered the most suitable material by the specialist for retrofitting, and concerning the fact that most of the regions in Iran are earthquake prone and it is possible that the seismic force has not been taken into account accurately in designing many of the structures built over the past years; therefore, a large number of structures require to be strengthened and retrofitted against the cyclic load. Strengthening the structure to resist against the vibrations and the forces of the earthquakes using different and new methods is one of the relatively new scientific topics. It has been tried to investigate into the behavior of the columns under cyclic loads. For this purpose, the finite element method has been employed. Many studies have been conducted on the behavior of reinforced concrete columns. Aviram et al. examined and collected the studies conducted in the past on the reinforced concrete columns under biaxial seismic loading [1].

Belal et al. examined the behavior of the concrete columns reinforced by the steel sheets. The conducted studies are laboratory and numerical, and the Ansys software was used to conduct the numerical study. In total, 6 sample columns measuring 200×200 were examined. The axial loading was imposed on all columns and finally the load displacement diagrams obtained from the laboratory study and numerical analysis were compared with each other [2]. Desprez et al. examined the reinforced columns deterioration model or polymer fibers under the axial load and seismic loading. One of the methods to enhance the strength of concrete columns is to use polymer fibers. In the research conducted by the researchers, the effect of using these fibers on unidirectional loading and seismic loading has been shown [3].

Corresponding author, E-mail: nishtman@gmail.com

2- Research method

At first, the laboratory study conducted by Desprez et al. has been used to validate the modeling through finite element Abaqus software. After the validation through making the proposed models with different arrangements of polymer fiber, the behavior of these columns were examined numerically by finite element Abaqus simulation software [3].

In the present research, a sample of reinforced concrete column that is under the axial loading and lateral displacement was considered and it was examined laboratory by Desprez et al. in order to validate the modelling in finite element Abaqus software. Finally, 8 other samples with different polymer fibers arrangements were proposed and modeled [3].

3- Connections

FRP connection to the concrete is of the tie constraint for all elements and the parts stick to each other through employing

this constraint regardless of the type of mesh. We employed the mentioned connections for all modeled samples in the plan.

4- Examination of the behavior of proposed samples

Concerning the fact that the load imposed on the structure is cyclic, the load-displacement diagram is a hysteresis (snail) diagram. Since the hysteresis diagram is of the load-displacement type, the greater the area under the hysteresis diagram is, the greater the structure's energy absorption and ductility will be. The symmetry in the hysteresis diagram shows the same behavior towards the earthquakes. The more slender a member is, the smaller the area under the diagram and the lesser the number of cycle failures will be.

5- Conclusion

1. The ultimate load obtained from the numerical analysis in relation to the laboratory results match fairly well for all columns (mean error percentage of 4%), and the samples include a result that is close to the laboratory result.
2. The numerical results show that using FRP materials increases the ultimate strength of the reinforced columns by 82% for the columns using the completely spiral fibers in comparison with the non-reinforced columns.
3. The numerical solutions show that the way the fibers are positioned has a considerable effect on the increase in the ultimate strength and relevant displacement and using the polymer fibers has the greatest effect in the column base (82%) and it has the least effect (7%) at the column cap on increasing the capacity of samples.
4. The way the polymer fibers are positioned as completely spiral fibers all along the column that are double-thick has the greatest effect on the ultimate load in such a way that there is an increase in the loading capacity by 82% in the sample P1-4-2L.
5. As it can be clearly seen in the figures related to the envelope diagrams, the envelope curves show greater displacement and load in the model with the greatest spiral.

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