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Seismic Strengthening of Beam–Column Joint Using Cementitious Laminates

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ABSTRACT

Due to Earthquakes, reinforced concrete buildings collapse and this may lead to loss of lives and property. Most of the structures can resist moderate to major earthquakeloading. Beam-column joint are cardinal RC framed structure as any failures will in them cause damages to the whole structure, when they are subjected toseismic loading. In the joint core, horizontal and vertical joint shear forces are developed on either side of the member due to bending moment of opposite signs. This type of force causes crushing and lateral resistance capacity against brittle shear failure on the joint portion. It is essential to prevent brittlefailure by strengthening the joint. The damages during heavy earthquake RC buildings collapse due to brittle. The existing concrete are designed for pre-seismic loads. Buildings that constructed considering the vertical as a gravity load without taking the occurrences of earthquake into account, collapse during earthquake. The collapse may be due , bar slips hear deformationfailure in the joint. These pre-seismic types of joint are not constructed as per and they should be. The column is generally designed stronger than the beam in framed structure, to provide higher ductile property to the beam-column joint.In RC framed structure, the joint (Beam-column) in the frame that transfers.

A comparison was made based on strength, stiffness and energy dissipation capacity with respect to control specimen and different volume fraction of ferrocement laminates, out of which the ferrocement retrofitted specimen ND-T2L2 and DD-T2L2 performed better in all aspects. A Regression analysis was carried out for strength, stiffness and energy dissipation of retrofitted specimen using Statistical Package for the Social Sciences (SPSS 16.0) Software. Validation of present research with the data available in the literature has also been carried out.

INTRODUCTION

This chapter presents a method for the prediction of strength, displacement and energy dissipation capacity for ferrocement strengthened beam column joint under cyclic loading with respect to control specimens. The method proposed is based on cyclic behavior of beam column joint. A Large number of investigations are available in literature, displacement and energy dissipation capacity. But only very few attempts have been made to predict the flexural properties incorporating the variable as Volume fraction (Vf) of ferrocement. Results from the proposed prediction of flexural properties have been compared with the test results available in literature applicability of these equations. In the present research, the varying parameters of ferrocement are with different volume fraction of ferrocement.

REGRESSION ANALYSIS

Large number of investigations are available in literature very few attempts have been made to predict the flexural properties incorporating the variable as Volume fraction (Vf) of ferrocement. Results from the proposed prediction of flexural properties have been available in literature , the applicability of these equations. In the present research, the varying parameters of ferrocement say with different volume fraction of ferrocement

SPSS SOFTWARE

Regression analysis was carried out using Statistical Package for Social Sciences software and validation of present study is carried out with the data available in the literature. fraction of ferrocement (one layer and two layers) with constant gross area of concrete (Ag), mean compressive strength (fck), area of steel (Ast) and yield stress in steel (fy). The additional variables for Ag, fck, Ast, fy are simulated using ANSYS. With the limited experimental works, the formulation of true regression work cannot be made, and hence additional data were simulated by using ANSYS to increase the data, since the variations of experimental results compared with ANSYS is within 25 percent.

ROOF DISPLACEMENT

Ironically, roof displacement of isolated OWTs is higher than that of fixed based OWTs. Figure 4.20 shows the δ_{roof} of empty tanks and filled tanks with fixed as well as isolated base. When the Filled tanks are base isolated, roof displacement is increased around 11% for tanks 2, 3, and 4 whereas it is 32.16 % for tank 1. Meanwhile, δ_{roof} of isolated empty tanks is increased from 16% to 26 % with maximum displacement taking place at tank
1. But, in the case of base-isolated tanks, out of the total displacement, partial displacement is governed by the base isolator.

When the relative displacement is calculated with respect to base isolation, roof displacement is drastically reduced (Ayman &Mohamed 2011). For example, δ_{roof} of fixed based empty tank 1 is 21 mm. When it is base isolated, its value gets increased to 26.52 mm. But theisolation device itself displaced to the extent of 19.32 mm. Therefore, the relative displacement of the roof with respect to the base isolation level is only 7.2 mm. It is even far less than δ_{roof} of the empty tank with a fixed base. But, in the case of filled tank with base isolation, the displacement at the levelof isolation is very less. As such, the relative displacement of the roof with respect to the isolator will not be reduced considerably. Table 3.8 and Table
4.6 show the analytical and experimental results of the roof displacement of OWTs respectively.

To substantiate the results obtained analytically, two tank models have been made. Tests have been conducted for both filled and empty conditions of OWTs. Table 4.6 shows the readings of roof displacement of the tanks which are obtained by doing double-time integration of the acceleration values from the test conducted. Resembling the analytical results, the roof displacement of tank models is increased when they are provided ith base isolation.

As far as the model of tank 1 is concerned, roof displacement is slightly increased when isolation is provided for both the filled and empty conditions, i.e., the percentage of increment of roof displacement are 10 %and 15 % respectively. But, there is a significant increment of roof displacement, i.e. 4 times, for the model of tank 2 for both conditions.

SUMMARY

The regression equations have been formulated for the flexural properties of laminated specimens. These equations have been validated by making use of the experimental data available in the literature. For, practical applications, the above equation can be utilized to evaluate the flexural properties of ferrocement strengthened specimens.

CONCLUSIONS

- The increases in strength, initial stiffness and energy dissipation of ductile and non-ductile as control specimen of ND- 1compared with DD-1 shows the value of 23%,16.67%, 41.13% respectively.
- The cementitious material of ferrocement can be efficiently used for seismic retrofitting of reinforced beam-column joint. This material increased the energy dissipation capacity too and the material is more efficient for reinforced beam-column joint in seismic regions. In addition, the non-ductile reinforced beam- column joint can be strengthened using ferrocement laminates.

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