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Earthquake Vibration Control using Modified Frame Shear Wall

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ABSTRACT: The Structure undergo extensive damage and even suffer total collapse in a result of seismic activity. Normal buildings have low stiffness and strength and are very much vulnerable during the occurrence of an earthquake. Earthquake resistant building has become immensely important now days, especially in places prone to earthquake. However, no structure can be fully immune to damage from earthquakes; the aim of constructing earthquake-resistant building is to erect the structures that perform better during seismic activity compared to conventional structures. Shear walls in a building are constructed to counter act the effects of lateral load coming on a structure. The buildings with shear wall design properly have shown very good performance. People usually adopt core shear wall for the high rise buildings due to its ease of construction and simplicity. This study deals with the investigation of seismic effects on the buildings modified with different types of the shear walls. The study also focuses on types of the shear wall which perform more efficiently on rectangular building i.e structure having one dimension greater than the other.

KEYWORDS: Base shear, Earthquake, Shear wall, Dynamic Analysis method, Static Analysis Method

I. INTRODUCTION

An earthquake is a sudden tremor of the Earth's crust, caused due to abrupt release of slowly accumulated strain that is stored in the rocks beneath the crusts surface. It is also define as an oscillatory movement resulting from the release of the strain energy below or within the crust of the earth surface[1,2] . It generates elastic waves or vibrations which cause movement in all the direction from the point of origin and cause tremor of earth surface. No structures can remain fully free of damage during the earthquake, but still all houses whether big or small can be made to withstand tremor of a particular magnitude by adopting the certain structural modification and precaution. Building collapse happen because of inertia forces [3, 4]. When an earthquake occurs the lower portion of a building tends to vibrate, as it is indirect contact with ground. However the inertia forces keeps upper position static. Four main reason that leads to an earthquake are cited below: -

- 1) shaking of ground
- 2) Failure of ground
- 3) fire and
- 4) tsunamis.

In high rise buildings thr lateral loads are more premier that will increase rapidly with an increase in the buildings height. Generally the requirements of strength, rigidity and stability are taken cared by the designs provided. The structural system which is designed to carry the vertical load may not have the capacity to resist lateral load, and even if it has, the design for lateral load will lead to increase in the structural cost substantially with an increase in stories number. To achieve economy in high rise buildings special systems to resist the lateral load have to be adopted. One of such systems to resist the lateral load in tall buildings is cited below.

1.1 Shear wall: -

A shear wall is a structural system which provides the stability against earthquake, fires and blast that derives its stiffness from inherent structural forms. The shear wall starts at the foundation level and continuous throughout height of the building. These walls can be either open sections or closed sections around elevators and stair cores or planar sections. The shear wall may be constructed using concrete or steel, that may be perforated or in the solids. The shear walls act as a deep and a slender cantilevers. Structurally these walls can be classified into shear panel, coupled shear walls, shear wall frames and staggered wall into two wallsthat is coupled by the beams at every floor level of the building.

1.2 Shear wall types

- Rectangular shear wall
- Flanged cantilever shear walls
- Coupled shear walls
- Shear wall with an opening
- Core type shear wall
- Cantilever shear wall

II. LITERATURE REVIEW

Recent Advancements in Retrofit of RC Shear Walls by K. galal And H. El-sokkary Oct 2008.

This literature says that Reinforced concrete (RC) shear walls has widely application in medium and high-rise buildings used for the various residential as well as commercial purposes to provide the lateral strength, stiffness and energy dissipation capacity required to resist lateral loads arising from earthquake or wind loading. In past decades, there have been considerable modifications adopted in the design of RC shear walls for the new construction as well as for old constructions. The modern adopted performance evaluation methods and capacity design principles are the examples of this important advancement in earthquake engineering. Therefore, there is a mandatory need to enhance the seismic performance of old building using RC shear walls. So they meet the need of the new performance-based seismic design techniques. Several retrofit techniques using the different materials are reported in this literature. These vary from using steel, concrete, fiber reinforced polymers, and shape memory alloys as retrofitting materials used in the different methods of application. This paper presents different types of retrofit techniques that are used to upgrade seismic resistance of existing building with RC shear walls. The paper discusses the various types of advantages and the disadvantages of each retrofit technique and their characteristic enhancements. The objective of this paper is to provide modern techniques on the recent advancements and challenges in the area of the retrofit of RC shear walls.

An Experimental Investigation for External RC Shear Wall Applications by M. Y. Kaltakci, M.Ozturk, And M. H. Arslan, Sep 2010.

This literature dealing with the strength and rigidity of various reinforced concrete (RC) buildings in Turkey, which are recently damaged by destructive earthquakes, is not at a sufficient level. Therefore earthquake causes a significant loss of life and property. The strengthening method most commonly preferred for these types of RC buildings is the application of RC infill walls (shear walls) in the frame openings of the building. The whole building has to be vacated and huge costs needed during this type of retrofitting, most of the population preferred not to rehabilitate their buildings although they were in heavy risk. Therefore, it is immediately necessary to develop easier method to apply and more effective methods for the retrofitting of residential purpose buildings and public buildings which cannot be vacated during the strengthening process (such as hospitals and schools). This study empirically provide the different methods which can meet this need. In these methods, named "external shear wall application", RC shear walls are applied on the external surface of the structures, along the frame plane despite of inside the building. To this end, 7 test samples in 1/2 and 1/3 geometrical scale were designed to analyzed the performance of the retrofitting technique where the shear wall leans on the frame from outside of the building (external shear wall application) and of the strengthening technique where a specific space is left between the frame and the external shear wall by using a coupling beam to connect elements (application of external shear wall with coupling beam).

Seismic Strengthening of RC Structures With Exterior Shear Walls by Hasan Kaplan, Salih Yilmaz, Nihat Cetinkaya And Ergin Atimtay Feb 2011.

This study on seismic strengthening of the RC buildings by exterior shear walls has been carried out. Structures of the two story framed model were tested under the imposed reversed cyclic lateral sway to simulate seismic loadings. It is observed that the implementation of shear walls to the structural system has improved the capacity of the bare frame as expected.

International Journal of Innovative Research in Science, Engineering and Technology by Venkata Sairam Kumar.N, Surendra Babu.R, Usha Kranti.J. Feb 2014

Shear walls are the structural systems that provide lateral stability to structures from lateral loads like wind, earthquake loads. These structural systems are constructed by reinforced concrete, plywood/timber unreinforced masonry, reinforced masonry at which they are sub divided into coupled shear walls, shear wall frames, shear panels and staggered walls. The present paper work was made in the interest of studying various research works involved in modifications of shear walls and their behavior towards lateral loads. As we know shear walls resists major portions of lateral loads in the bottom portion of the structures and the framed element supports the lateral loads in the top portions of structures which is necessary for soft story medium and high rise buildings, buildings which are similar in

nature constructed in India, In India basements are generally used for parking and garages or offices and top floors are used for residential purposes. Vibrations which are caused under the earth's surface generate waves which disturb the earth's surface, termed as earthquakes. It was said that earthquakes will not kill human but structures which are not constructed in considering the earthquake forces do. 60% of India lying in earthquake prone zone at which there is a frequent need of increase of understanding the behavior of earthquake, and methods for constructing and developing earthquake resistant buildings. Shear walls created are used to resist the lateral forces generated during earthquake. Shear walls behavior ultimately depends upon the material used for its construction, shear wall thickness, wall length, wall positioning in building frame and many more factors like reinforcement provided in it is according to code provisions. www.ijemr.net ISSN (ONLINE): 2250-0758, ISSN (PRINT): 2394-6962 745 Copyright © 2016. Vandana Publications. All Rights Reserved.

Seismic Evaluation and Strengthening of Existing Buildings by Dr. Durgesh C. Rai

This study on Seismic Evaluation and Strengthening of Existing Buildings. Emphasis is on identifying the most vulnerable components of the buildings at risk, and retrofitting them with their risk level to decrease the risk of partial or complete collapse. However, these steps do not necessarily stop earthquake damage in strengthened buildings, besides these procedures used in strengthening, improves the building performance in earthquakes. In simple words we can say that 'strengthening' means same as 'retrofitting' or improving the seismic performance. Global strengthening of the structure may be an economical and effective rehabilitation strategy where a seismic Evaluation shows unacceptable performance due to overall structural strengthened. This can be identified when the onset of global inelastic behavior occurs at levels of ground shaking that are substantially less than code design levels. By introducing additional strength to such lateral-force resisting system, it is possible to raise the threshold value of ground motion at which the occurrence of damage occurs. Shear walls and braced frames are the elements used for this purpose, but they should have sufficient stiffness than that of the building to which they are supplemented. This requires their design to provide nearly all of the structure's lateral resistance. This is necessary whenever desirable, as the existing members will probably have very little inelastic strength. Adding of new structural system in an existing building will automatically change the dynamic behavior of the complete building considerably during the earthquake. The choice of the type of element, its number and their size of the added elements depends on the vulnerability of the existing building and the functional layout of the building. Shear walls, because of its greater stiffness and lateral strength, may provide the most significant part of the earthquake resistance of the building structure

III. METHODOLOGY

There are mainly two methods of analysis to determine the earthquake effects on structures

- i) Static Analysis method
- ii) Dynamic Analysis method.

i) Static Analysis method: The seismic actions on the structures are evaluated by using the equivalent Static analysis which is a conservative method that considers a design seismic coefficient as specified in the IS Code 1893 (2002). The design seismic coefficient include factor such as importance factor, - zone factor - Response reduction factor - soil foundation factor etc. For the simplification of analysis in order to determine the earthquake effects on structures IS code has recommended seismic coefficient method. But there are anomalies associated with this method as mention below.

1). the method does not consider dynamic character of ground motion and damping effects in structure. 2). Effects of higher modes are not considered 3). Soil structure interaction is not considerable.

ii) Dynamic method: These methods of analysis of the structure involves free vibration analysis to determine the mode shapes and frequencies of the structure. The structure can be analyzed for seismic loading in the form of response Spectrum or time history (acceleration). The Dynamic Analysis Procedures are characterized as below:

1. Response Spectrum Analysis for Linear Structures
2. Time History Analysis for Linear and Non Linear Structure

2.1 The dynamic analysis method used in study is the Time History Analysis. In this method of analysis the earthquake loading is varied upon the time. Different magnitudes of the load are applied with change or increase in the time. The loading and the response history are evaluated at successive time increments, Δt - steps.

During every step the response is evaluated from initial conditions existing at the beginning of the step i.e displacement and velocities and the loading history in the interval. The non-linear behaviour is easily considered in this method by changing structural properties (e.g. stiffness) from one step to the next. Hence this method is one of the most effective for solution of non-linear response, among the many methods available. Time-history analysis provides for the linear or nonlinear evaluation of dynamic structural response under loading which may vary



according to the specified time function. The time step size has to be sufficiently small for accurate analysis. However, the smaller the time step size, the higher is the “cost” of analysis in terms of computational for a given duration of analysis.

IV. CONCLUSION

From the study done results obtained we reach on conclusion that these buildings can be strengthened by determining the degree of their susceptibility to weaken, by using external shear wall along with parallel side of the building & connected effectively the external shear wall & existing building using Dowel bar of required diameter (steel bar) to act as homogenous structure when the lateral forces act upon. By using external shear wall structure wall structure can be made stiffer, as most of lateral load is taken by the shear wall, & thus prevent structure from damage.

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