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Study on Performance on Force Based Design Vs Displacement Based Design in Evaluating Seismic Demand on Regular RCC Structure

Meena A. Bhagat[1]* Shubhangi Kakde[2]

[1] P.G Student, Department of Civil Engineering, JSPMS, ICOER, Wagholi Pune

[2] Professor, Department of Civil Engineering, JSPMS, ICOER, Wagholi Pune

Abstract* – *Recently many research projects related to the design of earthquake resistant structures and various robust construction methods are expected to be earthquakes and the study explains two major methods of Force Based Design (FBD) and Direct Displacement Based Design(DDBD) in which the first is a Conventional method, while later one is an approach to design performance. Design and analysis were in bare-frame dimensions of four, eight and twelve stories based on the following IS 456, IS 1893 codes: 2000, ETABSA and two design approaches should be studied.

As the earthquake design approaches, DDBD has been widely accepted by the above method, based on the FBD. In their process, the FBD uses the building displacement as the final test to determine the structural performance, while the DDBD uses as a defined performance target. If the final displacement to FBD larger is the value specified by the template, then the design process must be recalculated. In addition, under some common practices, DDBD is simpler than FBD.

Keywords: Force based design (FBD), direct displacement based design (DDBD), base shear, Ductility, storey drift, Reinforced concrete frame, ETABS Analysis.

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1. INTRODUCTION

The main cause of damage to the building due to seismic effects. As the earth shakes, the building becomes unstable and collapses. So any structure requires a seismic analysis that resists against the structure of seismic forces. In various parts of the world, several methods of seismic analysis were brought in. We consider two different seismic approaches our study.

1. Force Based Design Method (FBD).

2. Direct Displacement Based Design Method (DDBD).

India is one of the most prone to disasters, vulnerable to almost all natural disasters and anthropogenic countries. About 85% of the area is vulnerable to one or multiple disasters and about 57% of the area is a high seismic zone including the capital. The Indian Standards Bureau has made valuable services by producing a series of national standards in the design and construction of earthquake-resistant structures, as well as in the field of measurement and testing related to it. A detail of Indian standards in the field of natural earthquake mitigation risks is given by IS 1893: 1984 Criteria for Resilient Earthquake Design Structures. This standard applies to the seismic design of buildings and applied to buildings; Raised structures; Bridges; Dams, etc. It also gives a map that divides the country into five seismic zones based on seismic intensity. IS 1893 was originally published in 1962 as "Recommendations for the Design of Resistant Earthquake Structures" and then revised in 1966. As a result of additional seismic data collected in India and acquired the knowledge and experience, the standard was revised in 1970, 1975 and 1984. During the rubber phase, these forces are related to the elastic rigidity of the system, but the rigid state, the relationship becomes more complex, depending on the history of displacement along the induction. Therefore, power considerations are important in FUP. Structural strength must exceed loads designed to prevent structural collapse. Prior to the 1980s, seismic design recognized that power was less significant compared to ductility. A ductile structure capable of deforming in an inelastic way reacts earthquake without loss of resistance, although it is designed with a design of less resistance. Therefore, it is common to use the level of the design resistance reduction in the FBD process. In the 1990s, various problems identified in the application of FBD, mainly due to the interdependence between resistance and rigidity. The affiliation figures will be determined in the initial design phase, and then the forces are distributed among the members according to their alleged rigidity. If the affiliation figures changed, then the calculated design forces will no longer be valid and the planning process must be recalculated. The DDBD determines the strength required in a specified plastic hinge position to achieve the specific design conditions defined by displacement target. It should then be combined with the capacity planning processes to ensure that plastic hinges are only displayed when they are proposed and not ductile.

2. LITERATURE REVIEW

2.1 A Comparative Study on Force Based Design and Direct Displacement Based Design of Reinforced Concrete Frames Vivinkumar R.V.1, Karthiga.S2

Recently, many research papers related to the design of resilient seismic structures and the various methods of seismic robust design and study are provided for explaining two main methods of earthquake resistance planning (ie design based on design and based on direct displacement) DDBD) in which the former is a conventional method, and later one is an approach to designing performance. Design and analysis were carried out in two-dimensional naked photographs of four, eight and twelve stories based on the following IS 456, IS 1893 codes: 2000, FEMA 356 and both design approaches were studied. Analysis and design of this study were done using the Structural Analysis Software (SAP 2000) software. So design approaches have been validated through non-linear time analysis for 16 different earth movements PGA = 0.32 g. Structural parameters that emerged as the reason for the ductility and shear demand of the base were compared within the framework of different stories and design approaches. (FBD). In their process, the FBD uses the building displacement as the final test to determine the structural performance, while the DDBD uses as a defined performance target. If the final displacement to FBD is greater than the value specified by the template, then the design process should be recalculated. In addition, under some common practices, DDBD process is simpler than FBD. Unfortunately, the potential future use of the DDBD is not well implemented, especially in Indonesia. Therefore, the objective of this study is to evaluate the performance of a particular DDBD specific time frame as compared to resisting two FBD variants, the side force equivalent method and response spectrum analysis. All methods are designed using Indonesia's latest seismic code and verified using the exact method of non-linear historical time analysis. Method design method that runs in a single design cycle without any effort to improve the performance level to address the effectiveness of each method to predict seismic demand. The parameters used to evaluate structural performance derived from history, damage rates, and structural failure mechanism. As a result, DDBD performs better than FBD in prediction drift history. All methods experience an extraordinary percentage of damage. Although all methods present a poor mechanism of tension, no DDBD improvement is needed.

2.2 Direct Displacement Based Design on Moment Resisting Frame with out of Plane Offset of frame:

Direct displacement Based Design (DDBD) has been widely applied to various structural systems, such as moment resisting frame (MRF), the most common type of structures used to design practices. Due to the demand for architecture, recently many buildings, including some off-scale framework offsets the MRF system. The system existence out-of-frame displacement in creativity potential distribution differences between frames compared to normality without compensation. This study observes the effect of the frame out of changing the frame to a specific standard MRF designed by the DDBD method for two different levels of earthquakes. The historical nonlinear analysis used to verify structural behavior based on three parameters: displacement history, failure indicators and mechanism of structural damage. The frame change is assumed to level with the adjacent frame, ignoring the existence of the offset and the structure is designed as a normal MRF. The study shows that the main structural problem resulting from the pole in the compensation region due to the high shear demand. The DDBD process allows adjusting the ductility demand of these beams in order to improve the structural performance without repetitive design, as is usual in traditional seismic design. In conclusion, the DDBD also attributes to predict seismic requirements MRF system with a displacement outside the framework of the frame. The existence of compensation modules in the MRF system can be ignored during the planning process if the ductility requirements of the beams are displacement.

3. INDIAN SEISMIC ZONES:

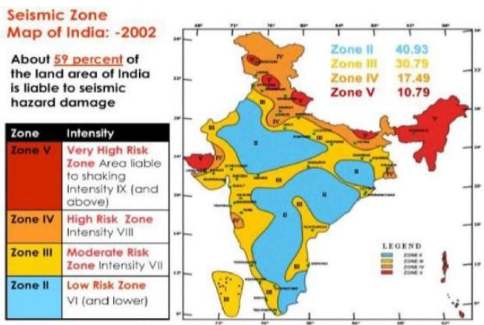

Fig. 1 Seismic zonation and intensity map of India

Direct displacement based design method

To predict the seismic demand of regular R.C.C structure considering ordinary moment resistant frame for usual building and special moment resistant frame

a) To compare seismic demand of force based design method vs direct displacement based design method.

b) To observe the level of changes in internal forces computed in force based design and direct displacement design method.

4. OBJECTIVES:

1. To predict seismic demand of regular RCC structure considering normal moment resistance frame and special moment resistance frame.

2. To compare seismic demand of force based design Vs displacement based design.

3. To observe the level of modification of internal force calculated in force based design and displacement based design.

4.1 Methodology:

- One model of a building is flanked by R.C as detailed in the statement of the problem to be considered. Using the CSI E-TAB software in seismic zones III and IV of ground II compared to IS 1893 2002 Part I.

- Interstoreydrift, shear basic ductility demand is supposed to increase by 70%, 60%, 55% for four floors, eight floors, twelve floors, respectively, in the structure of the FBD.

- It can be assumed that the values of the DDBD shear base decrease the structure by 13%, 8%, and 6% for four floors, eight floors and twelve floors, respectively, the structure of the FBD.

- Ductility demand values of DDBD structures are assumed to reduce 30%, 70%, 75% for four floors, floors of eight and twelve plants, respectively, in the FBD structure.

- The DDBD structure is less rigid than the FBD structure so it is supposed to give more force under seismic conditions.

- Using software such as E-TAB to calculate values drift between floors, ductility and shear demand for the base based on strength and design-shifting design.

5. PROBLEM STATEMENT:

Thus designing the construction including the seismic wave strength thus increasing the strength of structure leading to less obliteration to human life and property. The methods used for carrying out seismic analysis are:

1. Force Based Design Method

2. Displacement Based Design

To find out the results from force based design and displacement based design which would be more efficient. As there is an increase in use of steel in structure designed by the force based design, to attain stability from seismic waves, we have to search for better option which is used for designing the structure. Thus increasing the design strength of the structure to withstand seismic wave intensity by displacement based design is done.

To know the results of force-based design and displacement design which would be more effective? As the use of steel grows in a structure designed by force-based design, to achieve the stability of seismic waves, it is necessary to look for the best option used for the design of the structure. This increases the design of the resistance of the structure to withstand the seismic waves of intensity with the design based on the displacement.

6. HYPOTHESIS:

- DDBD structure shift values are assumed to increase by 70%, 60%, 55% for four floors, eight floors and twelve floors, respectively, in the FBD structure.

- DDBD base shear reduction values of 13%, 8%, 6%, up to four stories, eight floors and twelve floors, respectively, can be considered in the structure of the FBD.

- Ductility demand values of DDBD structures are assumed to reduce 30%, 70%, 75% for four floors, floors of eight and twelve plants, respectively, in the FBD structure.

- The DDBD structure is less rigid than the FBD structure so it is supposed to give more force under seismic conditions.

7. DETAILS OF REMAINING WORK:

1. Six models of R.C frame structure has to be considered which are analyzed using software CSI E-TAB in seismic zones III and IV for soil condition II with reference to IS 1893 2002 part I.

2. Use of software such as E-TAB to calculate the price of the internal deviation of the drift, the demand for ductility and basal shear design based on the design of force and displacement.

3. To calculate the seismic demand of regular RCC structure, looking at Special Moment Resistance Frame (SMRF) using force based on the design.

4. The area of reinforcing steel for the normal RCC structure, taking into account the context of the normal torsion resistance and a special resistance moment calculated in zone III and zone IV to condition the solicit eight, ten and Twelve storey RC frame using Displacement based design.

5. The area of the reinforcing steel for the normal frame structure RCC taking into account ordinary moment resistance frame and special moment resistance frame is to be calculated in zone III and zone IV under the soil conditions II in eight, ten twelve storey using displacement-based RC frame design.

6. The comparative study carried out for reasons of design and displacement based on the strength of the required area of the reinforced steel structure in zone III and zone IV to II ground conditions at eight, ten Twelve plants am RC framework.

7. The values of seismic parameters, such as inters Torey drift, ductility demand and base shear for FBD and DBD, calculated using the E-TABS software.

8. The seismic RC parameter structure will be calculated after designing the FBD.

9. The seismic parameters of the RC structure will be calculated after DBD design.

10. The seismic parameters obtained by both the methods will be compared.

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Corresponding Author

Meena A. Bhagat*

P.G Student, Department of Civil Engineering, JSPMS, ICOER, Wagholi Pune

E-Mail – bhagat.meena83@gmail.com