IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 3 Ver. VII (May- Jun. 2014), PP 27-31
www.iosrjournals.org

"Effect of Structural Wall Indexes for 5 Storey Reinforced Concrete Building"

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Abstract : *In last few decades, structural walls have been used extensively in countries where high seismic risk is observed. The main reason behind inclusion of structural wall is ability to minimize lateral drift, simplicity in design and good performance in past earthquakes. At present various measures against the earthquakes are applied to reduce the damages. It is desired to check the effect of structural wall indexes. In this paper, Approximate Procedure (Wallace method), Elastic Analysis & In – elastic Analysis on 5 Storey building with different wall indexes is proposed. The effect of wall indexes under Dead load is adopted. The approximate procedure (Wallace method) is adopted from TEC 2007. The Elastic Analysis & In – elastic Analysis is performed in SAP2000.*
Keywords: *Structural Wall, Elastic Analysis, In – elastic Analysis, Approximate procedure*

I. INTRODUCTION

1.1 Structural Wall: Structural walls are designed to resist gravity load and overturning moments as well as shear force. Thus, shear wall is incomplete to define the structural attributes of the wall since they resist not only the shear force but also overturning moment & Gravity load. Therefore the term structural wall is introduced. They have very large in-plane stiffness that limit the value of lateral drift of the building under lateral loadings. Structural walls are intended to behave elastically during wind loading and in case of low to moderate seismic loading to prevent non-structural damage in the building. However, it is expected that the walls will be exposed to inelastic deformation during less frequent, severe earthquakes. Therefore, structural walls must be designed to withstand forces that cause inelastic deformations while maintaining their ability to carry load and dissipate energy. Structural and non-structural damage is expected during severe earthquakes; however collapse prevention and Life safety is main concern. Structural walls are very effective at limiting damage according to the post-earthquake evaluations. Observed damage is dependent on the building and wall configuration. All of the early design codes regarding the design of structural walls were strength-based. The main aim was to provide flexural behavior by adequate deformability to prevent sudden and brittle failure with the use of heavily confined boundary elements. However, strict detailing requirements caused code requirements to be overly conservative for a majority of the buildings with structural wall systems. The performances of buildings in Chile Earthquake led to changes in building codes over the world.

The structural wall dominant buildings, showed good performance during the aforementioned earthquake. This draw attention of engineers to the structural walls and analytical studies indicated that light damage due to earthquake could be attributed to the stiffness of the structural systems, which limited the deformations imposed on the buildings. Studies indicated that the analytical procedure used to calculate the drift capacities tends to yield conservative estimates of wall deformation capacity. Then, a displacement-based design approach was proposed. Displacement-based design establishes a direct link between expected building response and the need to provide a single system ductility factor for a given building configuration. Rather than strength, a deformation parameter (displacement, rotation, curvature, etc.) is used in displacement-based design. Computed building response and wall properties are used to determine transverse reinforcement at the wall boundaries. Today, design codes necessitate fulfillment of minimum criteria on strength, stiffness (or drift control) and ductility requirements for all members of a building so as to provide better performance during a seismic action.

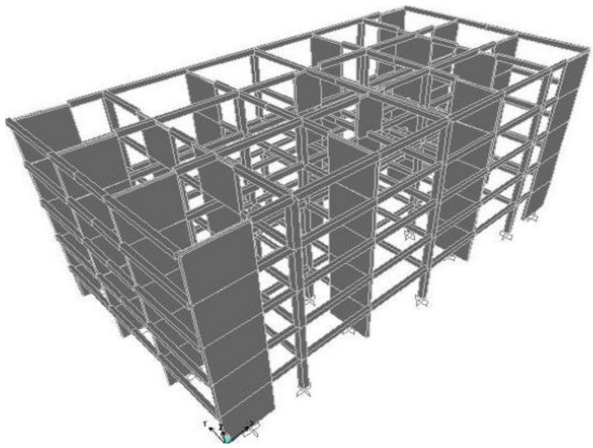

Fig. 1.1 3D – Structural model of 5 storey

1.2 Approximate procedure: Wallace proposes determination of elastic spectral displacement and modifying it with a coefficient to find the elastic lateral drift. Therefore, elastic response spectrum is utilized in characterization of ground motion. Wallace suggests the response spectrum given in ATC-3-06. However, in order to ensure compatibility in analyses, elastic response spectrum of TEC 2007 is used in spectral displacement calculations. Earthquake zone and soil class are assumed to be "1". According to TEC 2007, Elastic spectral displacement (S_d (T)) is found from elastic spectral acceleration (S_{ae} (T)) as follows. Assuming that the roof displacement can be approximated by 1.5 times the spectral displacement to account for the difference between the displacement of a single degree of freedom oscillator and the building system the oscillator represents, Wallace approximates roof drift ratio (roof displacement divided by building height, δ_u / h_w)

1.3 Elastic Analysis: Linear elastic analysis of the model buildings are performed according to the Indian standard code IS 1893 2002 via SAP2000. The zone factor for maximum considered earthquake and service life of the structure is for very severe. The soil considered is medium soil. The importance factor (I) depending upon the functional use of the structure characterized by hazardous consequences of its failure, post – earthquake functional needs, historical value or economic importance is "1". Response reduction factor (R) depending on the perceived seismic damage performance of the structure characterized by ductile or brittle deformation is 5. The other parameter like time period (T) can be used as program calculated. The seismic analysis of the all modeled building is performed by SAP2000 in X and Y direction.

1.4 In – Elastic Analysis: Pushover analysis is a static, nonlinear procedure in which the magnitude of the structural loading is incrementally enhanced in accordance with a certain pre-concerted pattern. With the extended magnitude of the loading, weak links and failure modes of the structure are found. The loading is monotonic with the influence of the cyclic behavior and load reversals being estimated by using a modified monotonic force-deformation criteria and with damping approximations. Pushover analysis is an effort by the structural engineering profession to enumerate the real strength of the structure and it promises to be a useful and effective tool for performance based design.

1.4.1 The way of cracks, yielding, plastic hinge formation and failure of various structural components are noted.

1.4.2 The iterative analysis and design goes on until the design satisfies a pre-established criterion.

1.4.3 The performance criteria are generally defined as Target - displacement of the structure at roof level.

1.5 Description of model: The structural models of the analyzed buildings are prepared and analyzed by SAP2000. The geometric properties of the building models like storey height, floor area and location of wall are determined according to the average values obtained from usual practiced. 5 different models for each number of storey having different shear wall ratio are created for use in the analyses. Wall ratios change from 0.53 to 3.60 percent in the models. A general format of "Mi_n_Tx" is used. In this format, the letter "M" is the abbreviation of the word "Model", the letter n designates the storey number and the letter "T" shows shear wall thickness.

II. Objective

2.1 To know the effect of Structural wall indexes on Drift ratio for 5 storey building.
2.2 To compare result obtained from Wallace method, Elastic Analysis and In – Elastic Analysis.

III. Tables and figures

Modal ID	Wall Ratio %	(Drift ratio)wx	(Drift ratio)Ex	(Drift ratio)Ix
M1_5_T200	1.24	0.026	0.069	0.862
M1_5_T250	1.56	0.020	0.052	0.810
M1_5_T300	1.87	0.016	0.034	0.759
M2_5_T200	0.71	0.048	0.121	1.069
M2_5_T250	0.89	0.037	0.093	0.931
M2_5_T300	1.07	0.030	0.086	0.897
M3_5_T200	1.78	0.017	0.038	0.793
M3_5_T250	2.22	0.013	0.034	0.707
M3_5_T300	2.67	0.011	0.034	0.655
M4_5_T200	2.31	0.013	0.034	0.693
M4_5_T250	2.89	0.010	0.033	0.586
M4_5_T300	3.47	0.008	0.030	0.569
M5_5_T200	0.53	0.067	0.172	1.138
M5_5_T250	0.67	0.051	0.138	1.103
M5_5_T300	0.8	0.042	0.103	1.000

Table 3.1 Estimation of Drift Ratio by Wallace Method, Elastic Analysis & In – elastic Analysis in X direction

Modal ID	Wall Ratio %	(Drift ratio)wy	(Drift ratio)Ey	(Drift ratio)Iy
M1_5_T200	1.24	0.076	0.103	1.414
M1_5_T250	1.56	0.059	0.069	1.379
M1_5_T300	1.87	0.048	0.041	1.345
M2_5_T200	0.71	0.174	0.172	1.586
M2_5_T250	0.89	0.132	0.162	1.552
M2_5_T300	1.07	0.107	0.145	1.483
M3_5_T200	1.78	0.051	0.048	1.362
M3_5_T250	2.22	0.040	0.038	1.241
M3_5_T300	2.67	0.032	0.034	1.207
M4_5_T200	2.31	0.107	0.131	1.483
M4_5_T250	2.89	0.082	0.114	1.483
M4_5_T300	3.47	0.067	0.086	1.431
M5_5_T200	0.53	0.030	0.034	1.172
M5_5_T250	0.67	0.024	0.034	1.103
M5_5_T300	0.8	0.019	0.032	1.069

Table 3.2 Estimation of Drift Ratio by Wallace Method, Elastic Analysis & In – elastic Analysis in Y direction

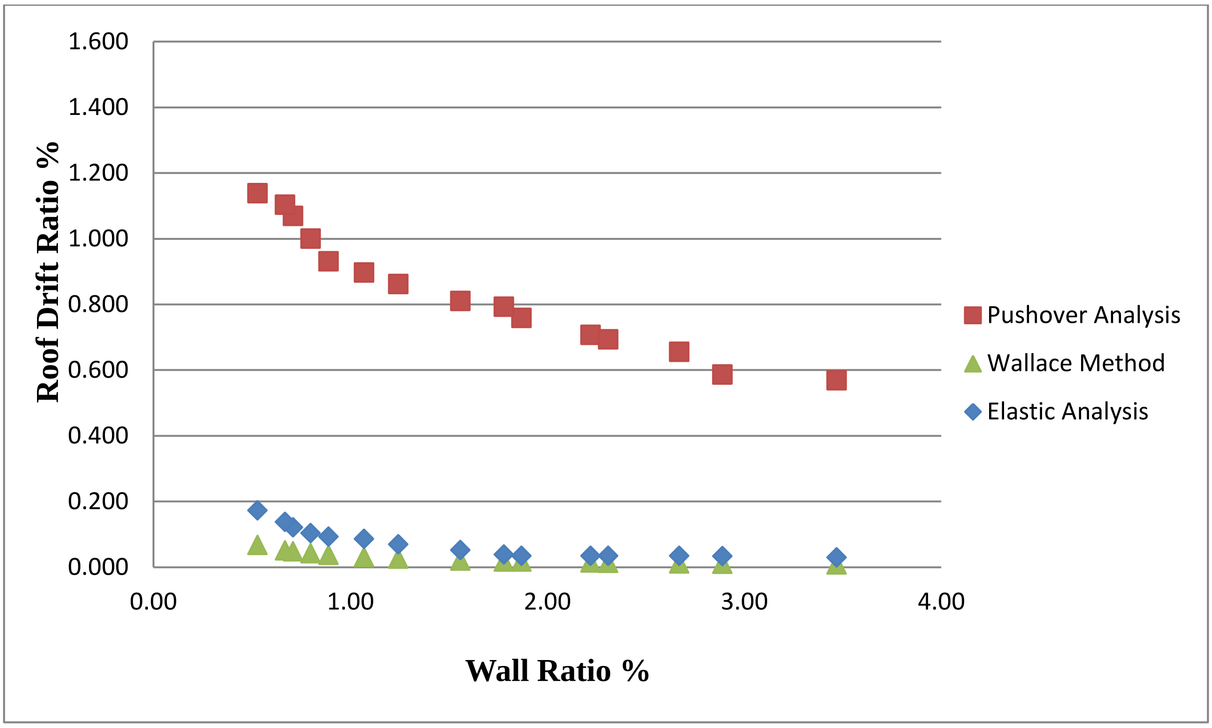

Fig. 3.1 Variation of Drift Ratio obtained by Wallace Method, Elastic Analysis & In – elastic Analysis in X direction

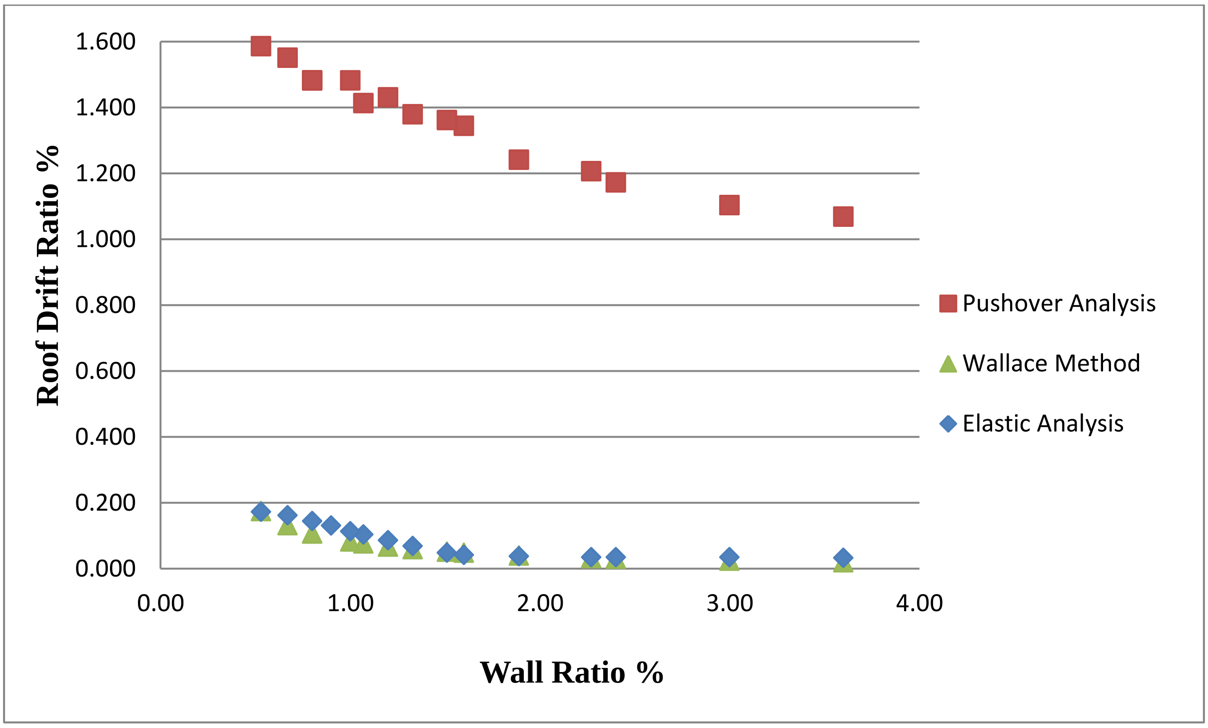

Fig. 3.2 Variation of Drift Ratio obtained by Wallace Method, Elastic Analysis & In – elastic Analysis in Y direction

IV. CONCLUSION

4.1 The value of roof drift ratio decreases with increase in wall ratio.

4.2 In all the methods, the value of drift ratio changes significantly at lower wall ratio and becomes nearly constant at higher wall ratio.

4.3 For the entire wall ratio, the roof drift ratio is less in Wallace method from Elastic analysis and very less obtained in case of In – elastic analysis.

4.4 The In – elastic analysis highly overestimate the value of roof drift ratio for all wall ratio when compared to other two methods.

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