Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 06, June - 2017

Comparative Study of Outriggers with Braced Frame Core and Shear Core in High Rise Buildings

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***Abstract*-Today's increased need for housing in metropolitan cities leads to the emergence of high rise buildings. Tall buildings are becoming more and more slender and this leads to more possible sway during the occurrence of lateral loads. When building height increases tremendously, the structure should have lateral load resisting system other than shear walls for avoiding the effect of these loads, since the shear walls when used alone are suitable only upto 20 stories high. Outrigger systems are one such prominent system and are now considered to be the most popular and efficient because they are easier to build, save on costs and provide good lateral stiffness. Outrigger braced structures is an efficient structural form in which the central core is connected to the outer columns. The structural concept of these systems is that when the central core tries to tilt, its rotation at the outrigger level induces a tension-compression couple in the outer columns acting in opposition to that movement. Most importantly, outrigger braced structures can strengthen a building without disturbing its aesthetic appearance and this is a significant advantage over other lateral load resisting systems. This paper presents the results of an investigation on storey drift and base shear reduction in RC building frame with rigid outriggers, through Response Spectrum Analysis using the software ETABS 2015.**

Keywords: Outrigger structural system, Response spectrum Analysis , Base Shear, Storey Drift

1. INTRODUCTION

Mankind is always fascinated for Tall building. In Early era the symbol of economic power and leadership is the skyscraper. There has been a demonstrated competitiveness that exists in present mankind to proclaim to have the tallest building in the world. The design of tall and slender structures is controlled by three governing factors, strength (material capacity), stiffness (drift) and serviceability (motion perception and accelerations), produced by the action of lateral loading, such as wind. Outrigger structural system encompass of a central core wall either shear wall or braced frames with outrigger truss connecting between core and the peripheral columns. These are the horizontal members designed to control overturning moment and stiffens the building by fastening the core to the exterior column through stiff horizontal members referred as a outrigger member, where as core acts a single-redundant cantilever beam for lateral forces and hence battle the rotation at the top by stretching and shortening action results in tensile and compressive action consequentially restoring couple by combating twisting of core thus cap truss be positioned as a restraining spring at the apex which considerable reduces the lateral deflection and base moments.

II.OBJECTIVE

- To study the characteristics of a high rise building with the inclusion of outriggers.
- To arrive at the optimum outrigger position at top,at top and one fourth height,at top and mid height,at top and three fourth height.
- To investigate the comparitive lateral load resistance of the structure with a braced frame core and RC shear core along with outrigger system .
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III. SCOPE

- Analytical study on multistorey building frame with two levels of outriggers using standard structural software.
- Parameter varied in the analytical study is the location of outrigger.
- This work is limited to Response Spectrum analysis using ETABS 2015.
- This work is under seismic zone 5 and medium type soil**.**

IV. LITERATURE REVIEW

Sreelekshmi S et al.(2016) [1],studied the performance of outriggers in high rise buildings. Today in modern tall buildings, lateral loads induced by both wind and earthquake were battled by an arrangement of coupled shear walls.This paper presents the results of an investigation on displacement, drift and base shear reduction in steel building frame with rigid outriggers, through time history analysis using the software ETABS 2015. Results shows that double outrigger system can effectively reduce seismic response of the building and optimum location of outriggers was found to be 0.75 times its height along with cap truss.

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Sandesh Kumar Shirole Y et al. (2016)[2],Studied the Behavior of Outriggers in High Rise Building under seismic loading . The lateral seismic forces acting on the structure is effectively resisted by using outrigger lateral system. In the present study a 30 storey model is modelled using ETABS 2015 software. The optimum location of the outriggers is determined by the varying the location of outriggers throughout the height of the structure.

A Vijay et al(2012)[3],conducted Feasibility Studies on the use of Outrigger System for RC core frame. This research work is an attempt made to study the effect of provision of outriggers for single bay frame at single level and two levels for single bay of different heights 30m, 45m, and 60m. Finite element analysis has been done using standard structural software. The frame and outriggers are modeled by three degrees of freedom per node beam elements. Both symmetrical and unsymmetrical provisions of outriggers are included with the considered static loads. From the analysis the lateral displacements, internal forces, base shear values are obtained for each level of outrigger. The reduction in lateral displacement of core frame values is taken as the index of efficiency of outrigger system at a particular level. The optimum position of outrigger so as to give maximum efficiency is found out. Optimum position of single level symmetrical and unsymmetrical outrigger for 30m, 45m and 60m are at H/2, H/2.5 and H/2.85 from top. Where H is the storey height and height of the frame.

All of the above journals had done their study by finding out lateral displacement, storey drift, base shear, axial force etc. And their study revealed the efficiency of outriggers compare two buildings where outriggers are provided at in tall buildings. Till now, most of the studies are carried out on regular RC buildings with shear RC core. So my aim is to various positions both in braced frame core and RC shear core.

V.METHODOLOGY

The study is carried out for the behaviour of G+40 storied R.C frame buildings with a regular plan. Floor height provided as 3 m. And also properties are defined for the frame structure. 8 models are created in ETABS software by providing rigid outrigger structures at various positions of the building .

Various types of load considered are discussed in succeeding sections. For static behavior dead load of the building is considered as per IS 875 Part 1and live load is considered as per IS 875 Part II ,lateral load confirming IS 1893(part 1)2002

The three dimensional reinforced concrete structures with G+40 storey were analyzed by Response spectrum analysis using ETABS software. The analysis results will show effectiveness of outriggers in terms of storey drift, base shear etc.

The optimum location of the outriggers is determined by varying the location of outriggers throughout the height of the structure.Outriggers are provided at four different positions in order to compare the base shear and storey drift values.In this study outriggers are provided at top and one fourth position,top and two fourth position,top and three forth position and top only in both braced frame core and RC shear core.

A. BUILDING PLAN AND DIMENSION DETAILS

The Following are the specification of G+40 storied regular building located in seismic zone in medium type soil. The complete detail of the structure including modelling concepts is given below:

Table1

Parameters considered for Analysis

Total height of building	120m
No. of stories	40
Height of each storey	3 m
Grade of concrete	M30
Grade of steel	Fe415
Depth of slab	200 mm
Size of beams	300X450mm
Size of columns	500 X 500 mm
Shear wall thickness	250 mm
Plan area	432 m^2
Braces	ISA 200X200X25
Outrigger Beam	500x500mm

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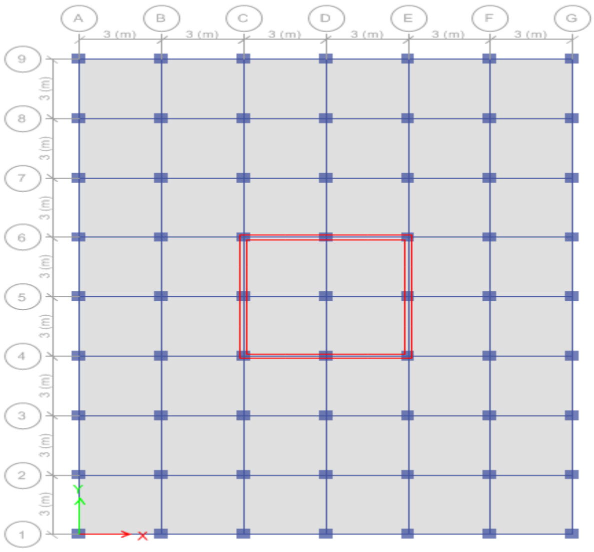

Fig.1 Plan with Braced Frame Core

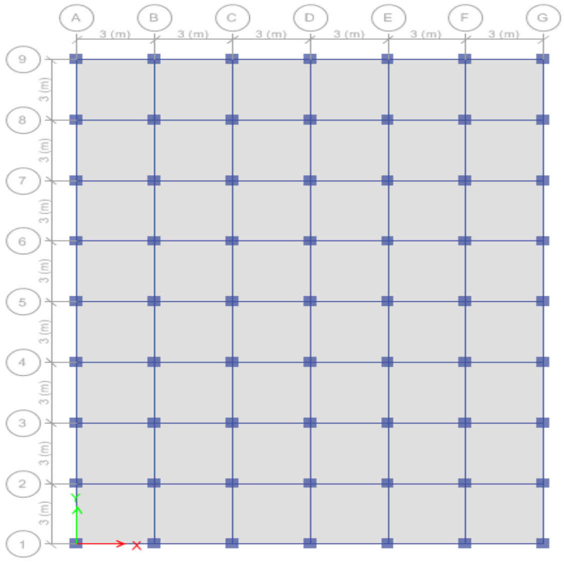

Fig.3 Elevation of Braced Frame Core

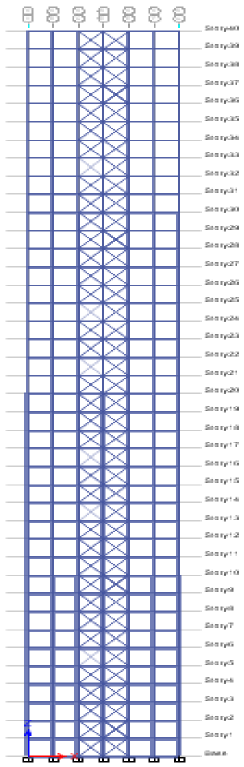

Fig.2 Plan with RC Shear Core

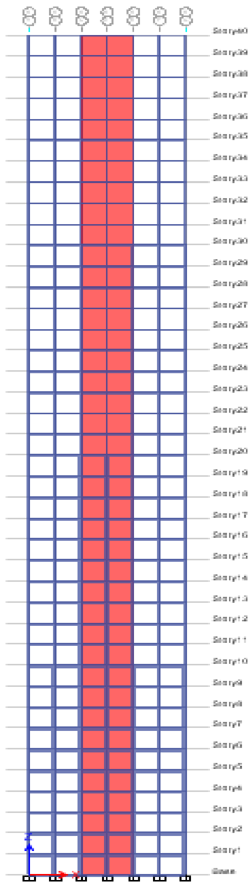

Fig.4Elevation of RC Shear Core

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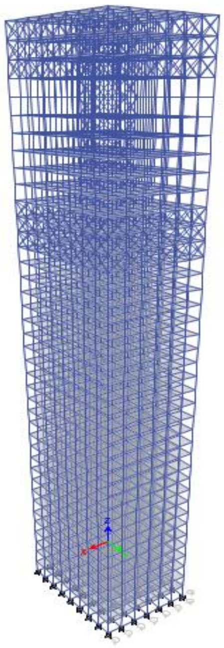

Fig.5Outrigger arrangement at Top and Three Fourth Height with Braced Frame Core

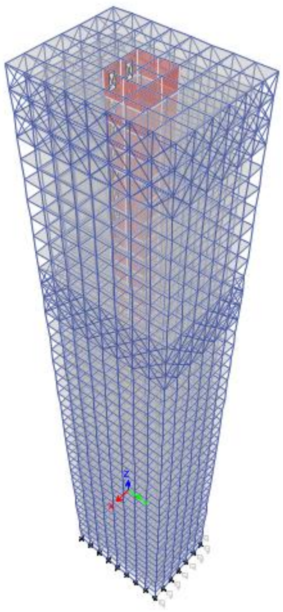

Fig.6 Outrigger arrangement at Top and Three Fourth Height with RC shear core

B. ASSIGNING LOADS

- Dead load
  Dead load intensity = 1.5 kN/m^2
- Live load
  Live Load Intensity specified (Public building) = 4kN/m^2
- Wall weight
  Wall weight = 13.8 kN/m^2
- Load combination

The following Load Combinations have been considered for the analysis,

1. DL
2. DL+LL
3. 1.5(DL+LL)
4. 1.2(DL+LL+ EQX)
5. 1.2(DL+LL+ EQY)
6. 1.2(DL+LL - EQX)
7. 1.2(DL+LL - EQY)
8. 1.5(DL+EQX)
9. 1.5(DL+EQY)
10. 1.5(DL- EQX)
11. 1.5(DL- EQY)
12. 0.9DL+1.5EQX
13. 0.9DL+1.5EQY
14. 0.9DL - 1.5EQX
15. 0.9DL - 1.5EQY

VI. SEISMIC ANALYSIS OF BUILDING

C. SEISMIC PARAMETERS CONSIDERED (AS PER 1893(PART 1): 2002

Table 2
Parameters considered for seismic analysis

Zone	V
Importance factor	1.5
Response reduction factor	5
Soil type	II
Damping Ratio	5%

Table 3
Storey Drift and Base Shear values of G+40 building with RC Shear Core

Outrigger Position	Storey Drift	Base Shear
At one fourth and Top	0.000492	2223.388
At two forth and Top	0.000529	2197.0968
At three forth and Top	0.000457	2097.558
At top only	0.001021	2418.11

Table 4
Storey Drift and Base Shear values of G+40 building with Braced Frame Core

Outrigger Position	Storey Drift	Base Shear
At one fourth and Top	0.000857	3653.15
At two forth and Top	0.000853	3829.146
At three forth and Top	0.000754	3576.1359
At top only	0.0008666	3654.7275

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VII. RESULTS AND DISCUSSIONS

D.Comparison Of Storey Drift Values For Various Position Of Outriggers In Braced Frame Core And Shear Core

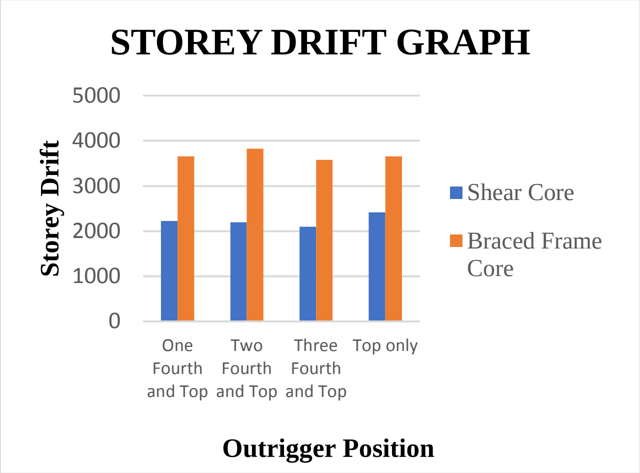

Fig.7 Storey Drift

E. COMPARISON OF BASE SHEAR VALUES FOR VARIOUS POSITION OF OUTRIGGERS IN BRACED FRAME CORE AND SHEAR CORE

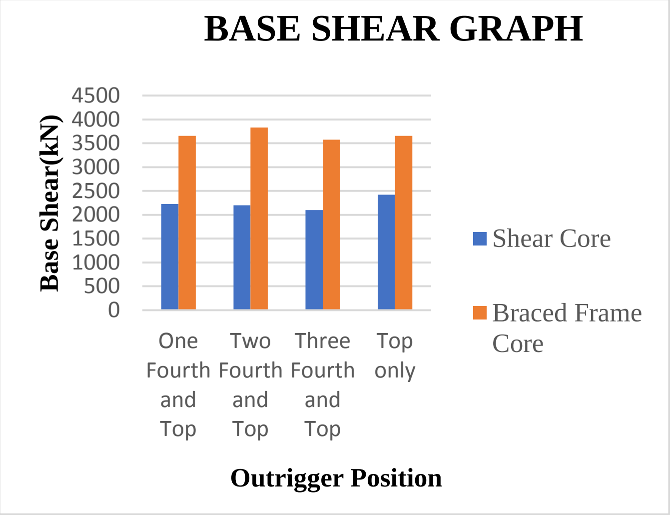

Fig.8 Base Shear

VIII. CONCLUSION

This study assessed the overall behaviour of outrigger braced building under lateral loads from which the following conclusions can be drawn based on the above results.The selected models where analysed using the response spectrum method and the conclusions obtained from the analysis are:

- Compared the seismic analysis of various positions of outriggers with braced Frame core and shear core in a regular RC building
- Response Spectrum Analysis were conducted on a 40 storied steel structure providing outriggers at top,one fourth,middle and three fourth height of the building
- The percentage reduction of storey drift for building with RC shear wall is 39.38% compared to building with braced frame core for an outrigger position of three fourth and top.

  Hence we can concluded that the building with outrigger position at 0.75times the total height is good in terms of storey drift and base shear and a notable reduction was observed while evaluating the base shear and storey drift by Response Spectrum Analysis

ACKNOWLEDGEMENT

I am thankful to my guide, Asst. Professor, Sreedevi Lekshmi in Civil Engineering Department for her constant encouragement and able guidance. Also I thank my parents, friends etc. for their continuous support in making this work complete.

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