International Journal For Technological Research In Engineering
Volume 4, Issue 8, April-2017 *ISSN (Online): 2347 - 4718*

COMPARATIVE STUDY OF CONVENTIONAL STRUCTURAL SYSTEM WITH MONOLITHIC STRUCTURAL SYSTEM

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Abstract: In this research, comparative study carried out between conventional structural system with monolithic structural system (reinforced concrete wall structure). In India, monolithic construction system carried out only for lower rise structure; if we consider this structural system mid to high rise structure then it may more feasible, adoptable and economic comparing conventional structural system. In this system all slabs, stairs, wall with opening or without opening are casted together in one operation. Etabs software is used for analysis and design of both structural systems.

I. INTRODUCTION

Generally, a building can be defined as 'An enclosed structure intended for human occupancy'. A building has two basic parts; Substructure or foundations and Superstructure. Over many years, engineers have observed that, there are different type of structural system which categorized by construction material (e.g. concrete, masonry, steel, or wood) and each structural system have different performance against lateral forces or gravity loads. Broad categories of structural systems are: Load Bearing wall systems (e.g. masonry, concrete), Building frame systems (e.g.concrete, steel, and wood), Moment-resisting frame systems, Dual systems, Cantilever column systems. In this, reinforced concrete shear walls are widely used in tall building for its excellent seismic behavior. A well designed structure with shear wall can decrease the project cost. In this research two different structural systems were made, (i) Beam-column structure (conventional system) (ii) Shear wall structure (monolithic system). In Monolithic System; all walls, slabs, stairs, together with door and window openings are cast in place in one operation at site by use of specially designed, easy to handle with less labour and equipment efforts modular form work made of Aluminum Plastic composite. In this system the lateral and gravity load resisting system consists of reinforced concrete walls and reinforced concretes labs. Reinforced concrete structural walls are the main vertical structural elements with a dual role of resisting both the gravity and lateral loads.

II. OBJECTIVE AND SCOPE

The main objectives of this study are to determine the suitability, adoptability and economic feasibility of conventional structural system against monolithic structural system and comparative study of conventional structural system with monolithic structural system and for both structural system comparison of storey drift, storey shear, storey displacement, modal time and base shear.

The main scope of this study is to study related to different type of Structural Systems, to study of various provisions of IS 13920:1993 for shear wall, to perform dynamic analysis of G+15 storey building using response spectrum method, problem formulation for zone III and Comparative study will be carried out for; Different thickness of shear wall.

III. LITERATURE REVIEW

Seismic vulnerability, behavior and design of tunnel form building structures by Can balkaya and Erolkalkan. Multi storey reinforced concrete wall building is considered and FEM analysis is carried out. It has been concluded that, due to high stress concentrations around the openings, the use of the diagonal shear reinforcement in addition to the edge reinforcement in these locations may lead to significant contribution for retarding and slowing down the crack propagation. Also monolithic buildings provide better seismic performance in addition to their low construction cost compared to conventional buildings. Seismic performance of buildings with thin RC bearing walls by H. Gonzales and F. López-AlmansaThe Author presents a numerical seismic assessment of seven existing thin shear–wall and mid-height buildings which located in Peru. Static and dynamic nonlinear analyses have been carried out for both system. They concluded that, the seismic strengths of all the analyzed buildings are insufficient. In most of the cases the Damage Limit States for Life Safety, Immediate Occupancy and Collapse Prevention are achieved first in the coupling beams. Seismic Performance of Wall-Slab Joints in Industrialized Building System (IBS) Under Out-Of-Plane Reversible Cyclic Loading byN. H. Abdul Hamid and M. A. Masrom The research is carried out forslab-wall joint performance in RC wall construction during lateral loading. They prepare a slab-wall model and by using linear potentiometers and actuator they concluded that, stiffness of wall-slab joint started to decrease from 0.2% drift until 2.1% drift and lost it stiffness after 2.1% drift. Seismic performance study on RC wall buildings from pushover analysis by Rajesh m n and SK PrasadRC wall building modeled and analyzed using SAP 2000's pushover analysis by using layered shell elements.. Finallythey concluded that by providing boundary element base shear capacity increases.

IV. METHODOLOGY

Data:
Type of Building: Residential Building
Height of Building: 45 m
Thickness of slab: 150 mm

Grade of Concrete : M20 M25
Grade of Steel: Fe415
Seismic zone: III
Unit Weight of RCC – 25kN/m3
Type of soil – Medium
Software used: ETABSV16
Conventional system
Column size: 300 x 900 mm
Beam Size : 300 x 600 mm
Monolithic system
Thickness of shear walls: 160 mm
By using the above given data two different models one for conventional and other for monolithic structural system are created. After performing the analysis various parameters like storey drift, storey shear ,displacement and lateral forces are obtained from software and comparative study is carried out.

V. RESULTS

Table 1:Comparison of drift in X-direction for G+15storey

STRUCTURAL SYSTEM	CONVENTIONAL	MONOLITHIC
Storey 15	0.000697	0.000054
Storey 14	0.000865	0.000054
Storey 13	0.001051	0.000056
Storey 12	0.001227	0.000057
Storey 11	0.001381	0.000059
Storey 10	0.001507	0.000060
Storey 9	0.001605	0.000061
Storey 8	0.001673	0.000060
Storey 7	0.01712	0.000059
Storey 6	0.00172	0.000057
Storey 5	0.001693	0.000053
Storey 4	0.001615	0.000050
Storey 3	0.001453	0.000048
Storey 2	0.001151	0.000045
Storey 1	0.000555	0.000053

Table 2:Comparison of drift in Y-direction for G+15 storey

STRUCTURAL SYSTEM	CONVENTIONAL	MONOLITHIC
Storey 15	0.000845	0.000073
Storey 14	0.000976	0.000074
Storey 13	0.001106	0.000077
Storey 12	0.001226	0.000080
Storey 11	0.001330	0.000082
Storey 10	0.001417	0.000084
Storey 9	0.001488	0.000085
Storey 8	0.001544	0.000084
Storey 7	0.001583	0.000083
Storey 6	0.001600	0.000080
Storey 5	0.001582	0.000076
Storey 4	0.001512	0.000071
Storey 3	0.001360	0.000063
Storey 2	0.001082	0.000052
Storey 1	0.000561	0.000059

Table3:Comparison of displacement in X-direction for G+15storey

STRUCTURAL SYSTEM	CONVENTIONAL (mm)	MONOLITHIC (mm)
Storey 15	59.6	2.26
Storey 14	57.5	2.11
Storey 13	54.9	1.96
Storey 12	51.7	1.81
Storey 11	48.0	1.65
Storey 10	43.9	1.46
Storey 9	39.4	1.31
Storey 8	34.6	1.14
Storey 7	29.5	0.97
Storey 6	24.4	0.81
Storey 5	19.3	0.65
Storey 4	14.2	0.52
Storey 3	9.40	0.40
Storey 2	5.10	0.28
Storey 1	1.60	0.16

Table 4:Comparison of displacement in Y-direction for G+15 storey

STRUCTURAL SYSTEM	CONVENTIONAL (mm)	MONOLITHIC (mm)
Storey 15	54.7	3.17
Storey 14	52.4	2.96
Storey 13	49.8	2.76
Storey 12	46.9	2.56
Storey 11	43.6	2.33
Storey 10	40.0	2.11
Storey 9	36.1	1.87
Storey 8	31.9	1.65
Storey 7	27.5	1.39
Storey 6	22.9	1.16
Storey 5	18.2	0.93
Storey 4	13.5	0.71
Storey 3	9.0	0.51
Storey 2	4.9	0.33
Storey 1	1.7	0.17

Table 5:Comparison of lateral loads for G+15storey

STRUCTURAL SYSTEM	CONVENTIONAL (KN)	MONOLITHIC (KN)
Storey 15	1507	2008
Storey 14	3131	3695
Storey 13	4515	5133
Storey 12	5678	6341
Storey 11	6640	7339
Storey 10	7418	8148
Storey 9	8033	8787
Storey 8	8504	9276
Storey 7	8851	9635
Storey 6	9091	9885

Storey 5	9245	10045
Storey 4	9331	10134
Storey 3	9550	10174
Storey 2	9951	10184
Storey 1	9959	10184

Table6:Comparison of storey shear for G+15storey

STRUCTURAL SYSTEM	CONVENTIONAL (KN)	MONOLITHIC (KN)
Storey 15	1624	1687
Storey 14	1384	1438
Storey 13	1163	1208
Storey 12	962	998
Storey 11	778	809
Storey 10	615	600
Storey 9	471	489
Storey 8	347	359
Storey 7	240	250
Storey 6	154	160
Storey 5	86	89
Storey 4	10	13
Storey 3	8	10
Storey 2	0	0

Table 7: Comparison of time period and base shear

STRUCTURAL SYSTEM	CONVENTIONAL	MONOLITHIC
Time period	1.801 SEC.	0.309 SEC.
Base shear	9959 KN	10184 KN

Table- 8: comparisons of quantity of steel &concrete(Only for single Storey)

STRUCTURAL SYSTEM	CONVENTIONAL	MONOLITHIC
STEEL	7128 KG	67.7 m^3
CONCRETE	8885 KG	86 m^3

VI. CONCLUSION

- When building is constructed with monolithic system than the displacement is less as compared to building constructed with conventional system in X-direction and Y-direction. The decrease in displacement is due to increase in stiffness.
- There is not abrupt change in the stiffness at various storeys and the storey drift is very less. For G+15 storey building story drift is less in both direction for monolithic system as compared to conventional system.
- Even though lateral loads are higher in case of monolithic system there is decrease in displacement in both directions.
- Time Period value decreases and base shear value increases for monolithic system as compared to conventional system.
- Cost for construction for monolithic structure is 20% more as compared to that of conventional structure for G + 15 storey structure. It can be concluded that as height of building increases the cost of construction will decrease for monolithic construction.

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