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Engineering

ANALYSIS OF HIGHRISE BUILDING WITH DIFFERENT LATERAL LOAD SYSTEMS USING SAP2000

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ABSTRACT Efficient lateral systems, decreases the lateral deformations caused by the seismic forces in the buildings. The distribution of the mass symmetrically reduces the tensional effect in the building. The lateral system should be symmetrically placed in the building to reduce both tensional and seismic forces in the structure. The type of soil also has more impact on lateral deformation of the structure subjected to seismic forces. The soft soils effect is elastic thus reduces the lateral effects compared to Hard rocky soil which is rigid, transfer the seismic effects directly to the structure results in more deflections.

In this work, it is proposed to carry out an analytical study, on multistory building of 35 stories, was carried out accounting for different seismic zones and soil types. The suitability and efficiency of different lateral bracing systems that are commonly used and also that of concrete infills were investigated. The different bracing systems viz., X-brace, V- brace, inverted V or chevron brace and infills are introduced in these analytical models. These building models are analyzed, using SAP 2000 software.

KEYWORDS : Lateral Loads, Highrise Buildings, SAP2000.

INTRODUCTION

Mankind has always had a fascination for height and throughout our history; we have constantly sought to metaphorically reach for the stars. From the ancient pyramids to today's modern skyscraper, a civilization's power and wealth has been repeatedly expressed through spectacular and monumental structures. Today, the symbol of economic power and leadership is the skyscraper. There has been a demonstrated competitiveness that exists in mankind to proclaim to have the tallest building in the world.

This undying quest for height has laid out incredible opportunities for the building profession. From the early moment frames to today's ultra-efficient mega-braced structures, the structural engineering profession has come a long way. The recent development of structural analysis and design software coupled with advances in the finite element method has allowed the creation of many structural and architecturally innovative forms. However, increased reliance on computer analysis is not the solution to the challenges that lie ahead in the profession. The basic understanding of structural behavior while leveraging on computing tools are the elements that will change the way structures are designed and built.

ENGINEERING SEISMOLOGY:

Seismology is the study of the generation, propagation and recording of elastic waves in the earth and the sources that produce them. An earthquake is a sudden tremor or movement of the earth's crust, which originates shock waves caused by nuclear tests, man-made explosions etc. About 90% of all earthquakes results from tectonic events, primarily movements on the faults. The remaining is related to volcanism, collapse of subterranean cavities or man-made effects.

The epicenters of earthquakes are not randomly distributed over the earth's surface. The epicenters of 99% earthquakes are distributed along narrow zones of interpolate seismic activity. The remainder is considered to be aseismic. According to the theory of plate tectonics, the outermost layer of the earth, known as lithosphere, is broken into numerous segments or plates. The crust and uppermost mantle down to a depth of about 70-100 km under deep ocean basins and 100-50 km under continents is rigid, forming a hard outer shell called the lithosphere. Beneath the lithosphere lies the asthenospehere, which is viscous in nature, a layer in which seismic velocities often decreases, suggesting lower rigidity. It is about 150km thick; it plays an important role in plate tectonics, because it makes possible the relative motion of the overlying lithosphere plates. The different types of lithospheric plates comprising both crust and upper mantle move relative to each other across the surface of the globe. There are three types of plate margins:

Constructive plate margin/Divergent boundaries – where new crust is generated as the plates pull away from each other.

Destructive plate margin/Convergent boundaries – where crust is destroyed as one plate drives under another Conservative plate margin/Transform boundaries – where crust is neither produced nor destroyed as the plate slide horizontally past each other.

Building dimensions

The building is 40m x 40m in plan with columns spaced at 5m from center to center. A floor to floor height of 3.0m is assumed. The location of the building is assumed to be at different zones and different types of soils.

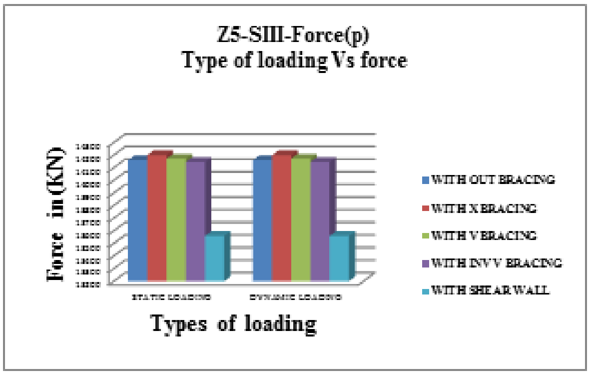
Column Size:

From ground floor to sixth floor: 1400 mm X 1400 mm
From seventh floor to twelfth floor: 1200 mm X 1200 mm
From thirteenth floor to eighteenth floor: 1000 mm X 1000 mm
From nineteenth floor to twenty fourth floors: 800 mm X 800 mm
From twenty fifth floors to thirtieth floor: 600 mm X 600 mm
From thirty first floors to thirty fifth floors: 400 mm X 400 mm
Beam Size: 600 mm X 550 mm
Slab Thickness: 150 mm
Brace Members Size: 400 mm X 230 mm
Infill Walls Thickness: 120 mm
Grade of Concrete and Steel: M40; Fe 415 Steel

RESULTS

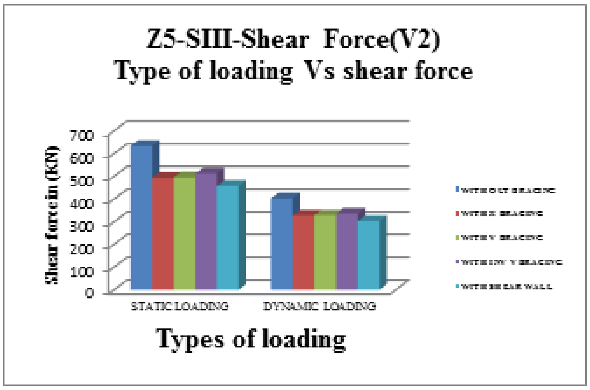
Axial Force

DIFFERENT TYPE OF BRACINGS P (KN)	TYPE OF LOADING	
	STATIC LOADING	DYNAMIC LOADING
WITH OUT BRACING	14160.4	14160.4
WITH X BRACING	14200.6	14200.6
WITH V BRACING	14172.2	14172.2
WITH INV V BRACING	14145.2	14145.2
WITH SHEAR WALL	13558.7	13558.7
NOTE: ALL UNITS ARE IN 'KN'.		



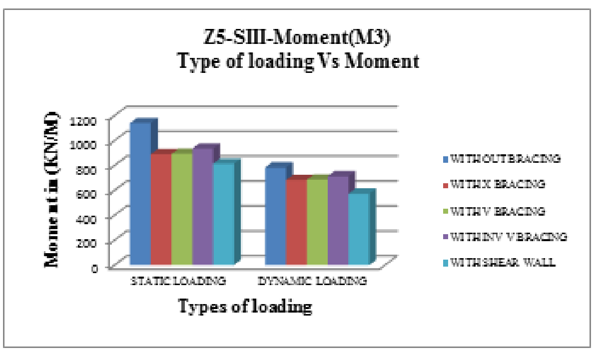
Shear Force

DIFFERENT TYPE OF BRACINGS	TYPE OF LOADING	
V2 (KN)		
	STATIC LOADING	DYNAMIC LOADING
WITH OUT BRACING	633.6	402.7
WITH X BRACING	493.1	327.7
WITH V BRACING	495.3	328.5
WITH INV V BRACING	512.9	336.1
WITH SHEAR WALL	457.5	303.2
NOTE: ALL UNITS ARE IN 'KN'		



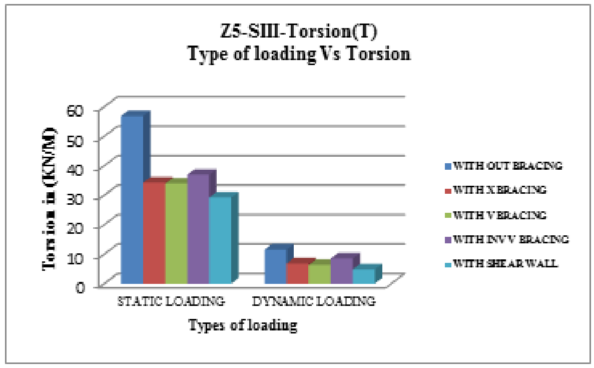
Moment

DIFFERENT TYPE OF BRACINGS	TYPE OF LOADING	
M3 (KN/M)		
	STATIC LOADING	DYNAMIC LOADING
WITH OUT BRACING	1140.5	784.1
WITH X BRACING	890.2	682.7
WITH V BRACING	893.5	685.9
WITH INV V BRACING	935.6	713.4
WITH SHEAR WALL	814.2	573.8
NOTE: ALL UNITS ARE IN 'KN/M'		



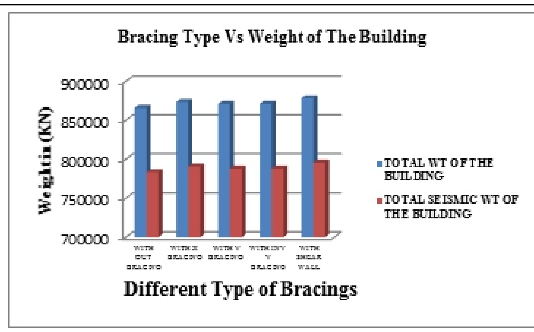
Torsion

DIFFERENT TYPE OF BRACINGS	TYPE OF LOADING	
T (KN/M)		
	STATIC LOADING	DYNAMIC LOADING
WITH OUT BRACING	56.8	11.5
WITH X BRACING	34.2	6.8
WITH V BRACING	33.9	6.3
WITH INV V BRACING	36.9	8.5
WITH SHEAR WALL	29.2	4.8
NOTE: ALL UNITS ARE IN 'KN/M'		



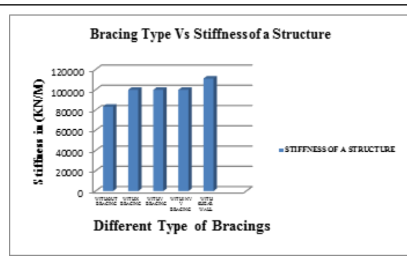
Total Weight and Seismic Weight

TYPES OF BRACINGS	TOTAL WEIGHT OF THE BUILDING(DL+LL)	TOTAL SEISMIC WEIGHT OF THE BUILDING(DL+0.5LL)
WITH OUT BRACING	866221.2	783421.2
WITH X-BRACING	873516.9	790716.9
WITH V-BRACING	871107.3	788307.3
WITH INV.V-BRACING	871107.3	788307.3
WITH SHEAR WALL	878461.2	795661.2
NOTE: ALL UNITS ARE IN 'KN'.		



Stiffness of the Structure

TYPES OF BRACINGS	STIFFNESS OF A STRUCTURE
WITH OUT BRACING	83333.3
WITH X-BRACING	100000
WITH V-BRACING	100000
WITH INV.V-BRACING	100000
WITH SHEAR WALL	111111.1
NOTE: ALL UNITS ARE IN 'KN / M'.	



CONCLUSIONS

Based on the study of analysis of results the following conclusions are drawn:

The structural performance among three bracing systems (X-brace, V-brace, Inverted V-brace),one infill (introduce at the place of braces), the variation of displacement is smaller in infill system.

This statement is true in all the zones for all the soil conditions and for different loading conditions.

a. witch the provision of bracings, infills the stiffness of the structure is increasing and there by the base shear is decreasing with the increase in height of the structure.
b. Structural capacity is greatly influence by the concrete infills.
c. Time history analysis is performed among the X-Brace, Infills and Without Brace structures and found that the infill system is have lesser displacements with respect to time.

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