A COMPARATIVE STUDY ON PUSHOVER ANALYSIS WITH LINEAR STATIC ANALYSIS OF INDUSTRIAL STEEL STRUCTURE SUBJECTED TO GRAVITY LOADS AND DYNAMIC LOADS

Mohd Abdul Atif Sulaiman[1], Shaik Mohammed Javid[2] Syed farrukh Anwar[3]

[1] Pg Student, M.tech in Structural engineering, Department of Civil Engineering, Nawab Shah Alam Khan College of Engineering and Technology, Hyderabad, Telangana 500024

[2] Assistant Professor, M.tech in Structural engineering, Department of Civil Engineering, Nawab Shah Alam Khan College of Engineering and Technology, Hyderabad, Telangana 500024

[3] Head of the Department (PHD) , Vice Principal, M.tech in Structural engineering, Department of Civil Engineering, Nawab Shah Alam Khan College of Engineering and Technology, Hyderabad, Telangana 500024

ABSTRACT :Developments in computer hardware and software have made analysis techniques that were formerly too expensive within the reach of most project budgets. Foremost among these has been equivalent static analysis and push over analysis.. This approach defines a series of forces acting on a building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when the ground moves. The response is read from a design response spectrum, given the natural frequency of the building.

The applicability of this method is extended in many building codes by applying factors to account for higher buildings with some higher modes, and for low levels of twisting. To account for effects due to "yielding" of the structure, many codes apply modification factors that reduce the design forces (e.g. force reduction factors).

Shaking and ground rupture are the main effects created by earthquakes, mainly resulting damage to buildings and other rigid structures. The severity of the local effects depends on the complex combination of the earthquake magnitude, the distance from the epicenter and the local geological and geomorphologic conditions the ground motion is measured by ground acceleration .An earthquake may cause injury and loss of life, road and bridge damage, general property damage and collapse or destabilization of buildings.

Present work deals with study of seismic analysis and design of Technology Innovation and Industry Relations with different types of bracings V bracings, and X bracings was compared with the bare frame and results are analyzed like story displacements, story shear, bending moment , shear force and building torsion with the help of commercial software like ETABS9.7.4 under the static and pushover analysis.

Keywords: V bracings, X bracings, story displacements, story shear, bending moment building torsion etc.,

I.INTRODUCTION

The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. Strengthening of structures proves to be a better option catering to the economic considerations and immediate shelter problems rather than replacement of buildings. Moreover it has been often seen that retrofitting of buildings is generally more economical as compared to demolition and reconstruction. Therefore, seismic retrofitting or strengthening of building structures is one of the most important aspects for mitigating seismic hazards especially in earthquake prone areas.

TYPES OF BRACINGS

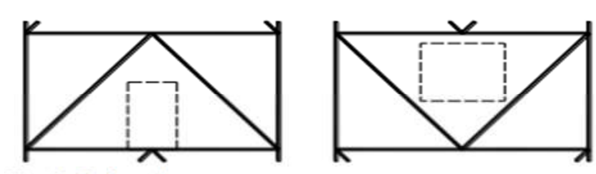
There are two types of bracing systems

1) Concentric Bracing System

All kinds of the concentrically braced frames used in the seismic rehabilitation including the Cross, Chevron V braced frames, Chevron Inverted-v-braced frames, Zipper column rehabilitated Invertedv- braced frames. Axial forces including tension and compression in concentrically braced frames are regarded as Displacement control. Columns in compression are Force control (buckling of columns is critical) and in tension are displacement control.

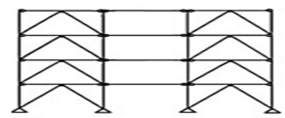
K BRACINGS

The full diagonal bracing is not used in areas where a passage is required. In such cases, k-bracings are preferred over diagonal bracing because there is a room to provide opening for doors and windows etc.



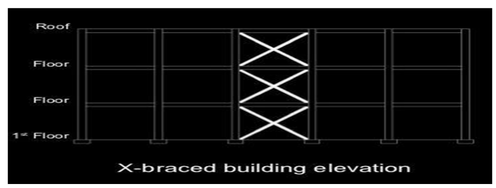
V brace: Bracing where a pair of braces joins at a single point on the beam span. Inverted V braceis that form of chevron bracing that terminates at point on beam from below.

This involves two diagonal members extending from the top two corners of a horizontal member and meeting at a centre point at the lower horizontal member, in the shape of a V. Inverted V-bracing (also known as chevron bracing) involves the two members meeting at a centre point on the upper horizontal member.



V Bracing

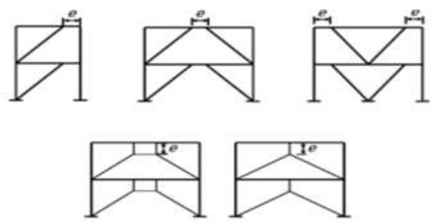
X brace: Bracing where two diagonal braces crosses near mid-length of the bracing members. c) K brace: Bracing where a pair of braces connected on one side of a column joins at a single point on another leg of column.



2) Eccentric Bracings

Reduce the lateral stiffness of the system and improve the energy dissipation capacity. The lateral stiffness of the system depends upon the flexural stiffness property of the beams and columns, thus reducing the lateral stiffness of the frame. The vertical component of the bracing forces due to earthquake causes lateral concentrated load on the beams at the point of connection of the eccentric bracing.

Eccentric bracing consists of diagonal braces located in the plane of the frame where one or both ends of the brace do not join at the end points of other framing members. The system essentially combines the features of a moment frame and a concentrically braced frame, while minimising the disadvantages of each system.



Types of eccentrically braced frames depending on the location of the link beam

OBJECTIVE OF THE STUDY

I. To understand the elastic and plastic behavior of the STEEL BUILDING building under gravity loads taken as per IS 875-1987
II. To compare the steel building with different types of bracings like X bracings and V bracings are compared with the BARE framed building .
III. To compare various parametric results such as Storey drift and Storey forces for the different models considered.
IV. To obtain pushover curves both in X and Y directions using FEM based analytical software ETABS 9.7.4.
V. To compare various parametric results such as Storey shear and column forces and beam forces for the different models considered

II.LITERATURE REVIEW

Dr. S.V. Itti[1], Prof. AbhishekPathade[2] and Ramesh B. Karadi[3] et all,.(2006) This study focuses on the comparison of the Indian Code (IS) and International Building Codes (IBC) in relation to the seismic design and analysis of Ordinary RC moment resisting frame (OMRF), Intermediate RC moment-resisting frame (IMRF) and Special RC moment-resting frame (SMRF). The analytical results of the model buildings are then compared and analyzed taking note of any significant differences. This study explores variations in the results obtained using the two codes, particularly design base shear, lateral loads, drifts and area of steel for structural members for all RC buildings in both the codes. The discussion in this study will be confined to monolithically cast reinforced concrete buildings. Specific provisions for design of seismic resistant reinforced members are presented in detail. Provisions of Indian and International Buildings Codes are identified. Target deflection of the building is achieved at a lower lateral force in SMRF IBC i.e, the concept of lesser force and more deflection is followed. However in OMRF, IMRF and SMRF of Indian Code lateral force applied in higher as a result the deflection on the top of the building exceeds the target deflection.

F. Zareian[1], D. G. Lignos[2] and H. Krawinkler[3] et all,. (2010) This paper summarizes a study focused on evaluating the design modification factors (i.e., R, Cd, Ω) for Steel Special Moment-resisting Frames (SSMFs) by application of the FEMA P695 methodology. In this study, archetype design that comprise 3-bay special SMFs that serve as lateral load resisting system of steel buildings ranging from 1 to 20 stories are designed using ASCE 7-05 and AISC 341-05design provisions. Nonlinear models are developed using latest advances in structural component modeling. Parameters for these models are extracted from a steel component database for modeling of component deterioration. The numerical models are analyzed to predict the collapse capacities of each design, and the adjusted collapse margin ratios (ACMR) are evaluated and compared to acceptance criteria.

III.METHODOLOGY

Building frame with the following geometrical types are considered for analysis in seismic zone (Zone V) for seismic and gravity loading in each case. And also the terrain category (terrain category 3 are also studied on the each case.

- PUSH OVER ANALYSIS

CASE-1: G+17building frame without bracing system (Bare Frame).

CASE-2: G+17 building frame with X bracing system.

CASE-3: G+17 building frame with V bracing system.

- EQUVALENT STATIC ANALYSIS

CASE-1: G+17building frame without bracing system (Bare Frame).

CASE-2: G+17 building frame with X bracing system.

CASE-3: G+17 building frame with V bracing system.

Push over analysis:

Pushover analysis is an approximate analysis method in which the structure is subjected to monotonically increasing lateral forces with an invariant height-wise distribution until a target displacement is reached. Pushover analysis consists of a series of sequential elastic analysis, superimposed to approximate a force-displacement curve of the overall structure. A two or three dimensional model which includes bilinear or trilinear load-deformation diagrams of all lateral force resisting elements is first created and gravity loads are applied initially. A predefined lateral load pattern which is distributed along the building height is then applied. The lateral forces are increased until some members yield. The structural model is modified to account for the reduced stiffness of yielded members and lateral forces are again increased until additional members yield. The process is continued until a control displacement at the top of building reaches a certain level of deformation or structure becomes unstable.

Pushover is a static-nonlinear analysis method where a structure is subjected to gravity loading and a monotonic displacement-controlled lateral load pattern which continuously increases through elastic and inelastic behavior until an ultimate condition is reached. Lateral load may represent the range of base shear induced by earthquake loading, and its configuration may be proportional to the distribution of mass along building height, mode shapes, or another practical means.

Output generates a static-pushover curve which plots a strength-based parameter against deflection. For example, performance may relate the strength level achieved in certain members to the lateral displacement at the top of the structure, or bending moment may be plotted against plastic rotation. Results provide insight into the ductile capacity of the structural system, and indicate the mechanism, load level, and deflection at which failure occurs.

When analyzing frame objects, material nonlinearity is assigned to discrete hinge locations where plastic rotation occurs according to FEMA-356 or another set of code-based or user-defined criteria. Strength drop, displacement control, and all other nonlinear software features, including link assignment, P-Delta effect, and staged construction, are available during static-pushover analysis.

EQUVALENT STATIC ANALYSIS

Equivalent Static Analysis:

This approach defines a series of forces acting on building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when the ground moves. The response is read from a design response spectrum, given the natural frequency of the building (either calculated or defined by the building code). The applicability of this method is extended in many building codes by applying factors to account for higher buildings with some higher modes, and for low levels of twisting. To account for effects due to “yielding” of the structure, many codes apply modification factors that reduce the design forces (e.g., force reduction factors).

The seismic design of buildings fallows the dynamic nature of the load. But equivalent static analysis would become sufficient for simpler, regular in plan configuration and it will give more efficient results. This analysis will flow in a manner with the calculation of design base shear and its distribution to all storey’s by using the formula given in the code

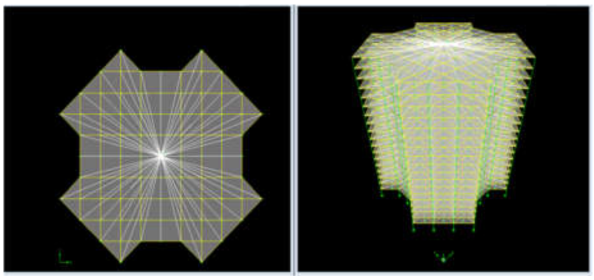
PROBLEM OF STATEMENT

In building plan was taken in seismic zone V for seismic analysis of the building (G+17) with braced building and unbraced building (general building). The basic specifications of the building are:

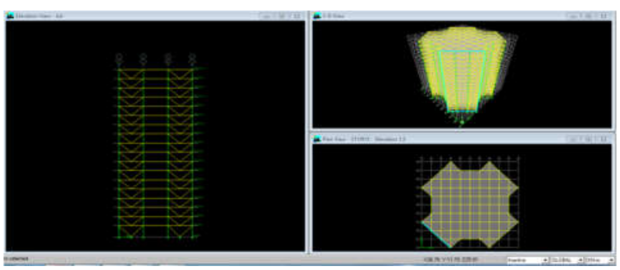
Beam Size
= ISMB300
Column size
= ISMB600
Bracings
= ISMB125(BOTH V,X BRACINGS)
Storey Height
= 3.0 mts

Bottom storey
= 3.5 mts
Column spacing
= 5 mts
Materials used
= M25 & Fe415;
Depth of slab
= 150 mm
Unit weight of concrete
= 25 kN/m^3
Code Books used
=IS1893:2002,

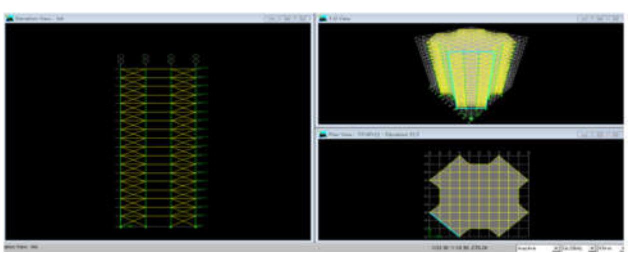
1. BARE FRAME



2. V BARCED FRAME BUILDING



3. X BARCED FRAME BUILDING

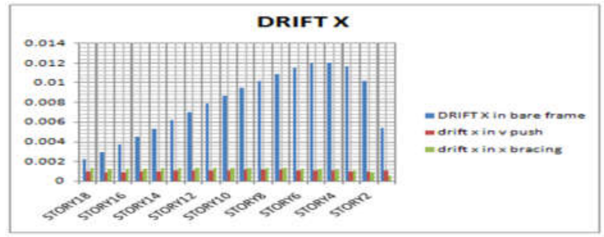


IV. RESULTS AND ANALYSIS

PUSH OVER ANALYSIS

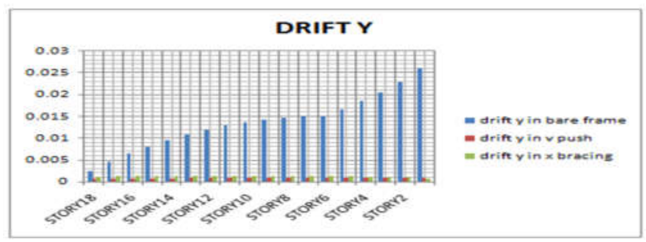
STORY DRIFT IN X DIRECTION

Story	Load	DRIFT X in bare frame	drift x in v push	drift x in x bracing
STORY18	PUSHX	0.00225	0.000963	0.001311
STORY17	PUSHX	0.00289	0.000856	0.001257
STORY16	PUSHX	0.00368	0.000916	0.001259
STORY15	PUSHX	0.00451	0.00095	0.001281
STORY14	PUSHX	0.00535	0.000988	0.001305
STORY13	PUSHX	0.00619	0.001021	0.001328
STORY12	PUSHX	0.00703	0.001051	0.001345
STORY11	PUSHX	0.00788	0.001077	0.001355
STORY10	PUSHX	0.00869	0.001096	0.001357
STORY9	PUSHX	0.00948	0.001109	0.00135
STORY8	PUSHX	0.01021	0.001114	0.001333
STORY7	PUSHX	0.01089	0.001111	0.001303
STORY6	PUSHX	0.01148	0.001096	0.00126
STORY5	PUSHX	0.01192	0.001071	0.0012
STORY4	PUSHX	0.01208	0.001033	0.001123
STORY3	PUSHX	0.0117	0.000991	0.001023
STORY2	PUSHX	0.01017	0.000999	0.000874
STORY1	PUSHX	0.00539	0.001046	0.000574



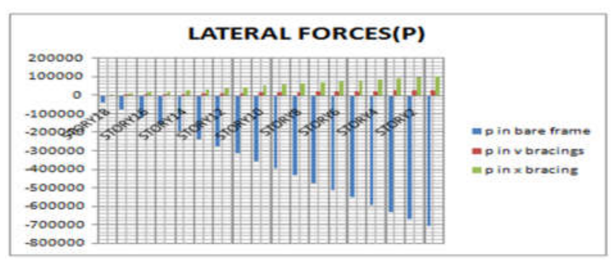
STORY DRIFT IN Y DIRECTION

Story	Load	drift y in bare frame	drift y in v push	drift y in x bracing
STORY18	PUSHY	0.00243	0.000561	0.00114
STORY17	PUSHY	0.00453	0.000613	0.001194
STORY16	PUSHY	0.00641	0.00065	0.001231
STORY15	PUSHY	0.00808	0.000685	0.001254
STORY14	PUSHY	0.00955	0.000729	0.001291
STORY13	PUSHY	0.01083	0.000771	0.001324
STORY12	PUSHY	0.01196	0.00081	0.001346
STORY11	PUSHY	0.01291	0.000844	0.001362
STORY10	PUSHY	0.0137	0.000873	0.001367
STORY9	PUSHY	0.01432	0.000896	0.001363
STORY8	PUSHY	0.01477	0.000912	0.001348
STORY7	PUSHY	0.01505	0.000921	0.00132
STORY6	PUSHY	0.01516	0.00092	0.001278
STORY5	PUSHY	0.01666	0.000911	0.001222
STORY4	PUSHY	0.01851	0.000892	0.00115
STORY3	PUSHY	0.02048	0.000869	0.001063
STORY2	PUSHY	0.02288	0.000879	0.000983
STORY1	PUSHY	0.02601	0.000951	0.000693



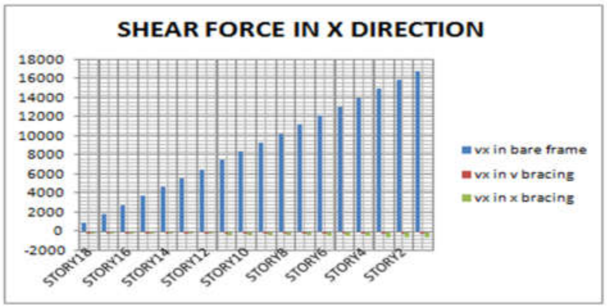
LATERAL FORCES (P)

Story	Load	Loc	p in bare frame	p in v bracing	p in x bracing
STORY18	PUSHX	Bottom	-38417.85	1592.81	5682.61
STORY17	PUSHX	Bottom	-77955.94	3199.44	11415.71
STORY16	PUSHX	Bottom	-117494	4806.1	17148.78
STORY15	PUSHX	Bottom	-157032.1	6412.76	22881.83
STORY14	PUSHX	Bottom	-196570.2	8019.43	28614.87
STORY13	PUSHX	Bottom	-236108.3	9626.1	34347.9
STORY12	PUSHX	Bottom	-275646.4	11232.78	40080.93
STORY11	PUSHX	Bottom	-315184.5	12839.48	45813.98
STORY10	PUSHX	Bottom	-354722.6	14446.18	51547.05
STORY9	PUSHX	Bottom	-394260.7	16052.91	57280.13
STORY8	PUSHX	Bottom	-433798.8	17659.64	63013.24
STORY7	PUSHX	Bottom	-473336.9	19266.39	68746.37
STORY6	PUSHX	Bottom	-512874.9	20873.16	74479.52
STORY5	PUSHX	Bottom	-552413	22479.94	80212.68
STORY4	PUSHX	Bottom	-591951.1	24086.73	85945.85
STORY3	PUSHX	Bottom	-631489.2	25693.53	91679
STORY2	PUSHX	Bottom	-671027.3	27300.3	97412.08
STORY1	PUSHX	Bottom	-710752.1	28907.8	103151.7



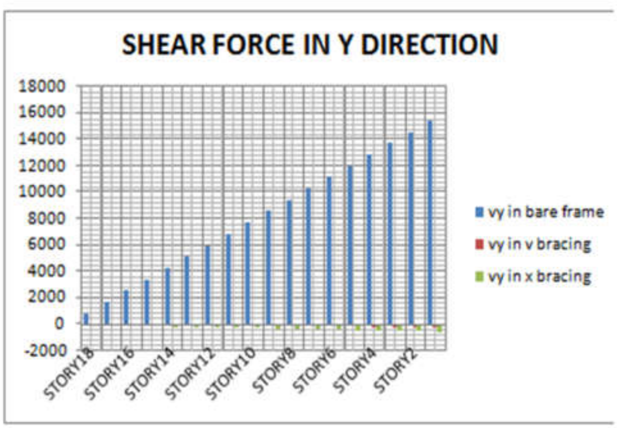
SHEAR FORCE IN X DIRECTION

Story	Load	Loc	vx in bare frame	vx in v push	vx in x bracing
STORY18	PUSHX	Bottom	936	-8.97	-34.44
STORY17	PUSHX	Bottom	1872.06	-19.24	-67.31
STORY16	PUSHX	Bottom	2808.19	-29.23	-100.01
STORY15	PUSHX	Bottom	3744.4	-38.98	-132.56
STORY14	PUSHX	Bottom	4680.7	-48.49	-164.91
STORY13	PUSHX	Bottom	5617.12	-57.75	-197
STORY12	PUSHX	Bottom	6553.74	-66.77	-228.61
STORY11	PUSHX	Bottom	7490.6	-75.58	-260.19
STORY10	PUSHX	Bottom	8427.71	-84.22	-291.54
STORY9	PUSHX	Bottom	9365.05	-92.74	-323.09
STORY8	PUSHX	Bottom	10302.58	-101.22	-354.56
STORY7	PUSHX	Bottom	11240.27	-109.73	-386.33
STORY6	PUSHX	Bottom	12177.98	-118.4	-418.39
STORY5	PUSHX	Bottom	13115.46	-127.35	-451.21
STORY4	PUSHX	Bottom	14052.31	-136.74	-485.03
STORY3	PUSHX	Bottom	14987.91	-146.65	-520.29
STORY2	PUSHX	Bottom	15921.51	-156.36	-558.35
STORY1	PUSHX	Bottom	16851.76	-158.93	-608.71



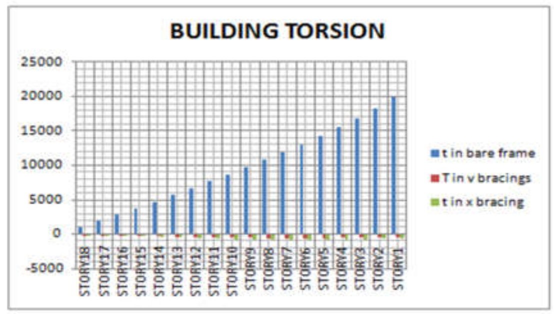
SHEAR FORCE IN Y DIRECTION

Story	Load	Loc	vy in bare frame	vy in v push	vy in x bracing
STORY18	PUSHY	Bottom	858.89	-9.74	-29.57
STORY17	PUSHY	Bottom	1717.77	-20.67	-58.79
STORY16	PUSHY	Bottom	2576.66	-31.5	-88.01
STORY15	PUSHY	Bottom	3435.55	-42.02	-117.1
STORY14	PUSHY	Bottom	4294.43	-52.25	-146.09
STORY13	PUSHY	Bottom	5153.32	-62.17	-174.99
STORY12	PUSHY	Bottom	6012.2	-71.81	-203.82
STORY11	PUSHY	Bottom	6871.09	-81.18	-232.58
STORY10	PUSHY	Bottom	7729.98	-90.31	-261.29
STORY9	PUSHY	Bottom	8588.86	-99.25	-290
STORY8	PUSHY	Bottom	9447.75	-108.04	-318.72
STORY7	PUSHY	Bottom	10306.63	-116.74	-347.43
STORY6	PUSHY	Bottom	11165.51	-125.44	-376.36
STORY5	PUSHY	Bottom	12024.4	-134.2	-405.33
STORY4	PUSHY	Bottom	12883.28	-143.12	-434.51
STORY3	PUSHY	Bottom	13742.17	-152.07	-463.91
STORY2	PUSHY	Bottom	14601.05	-160.29	-493.72
STORY1	PUSHY	Bottom	15459.94	-165.3	-526.95



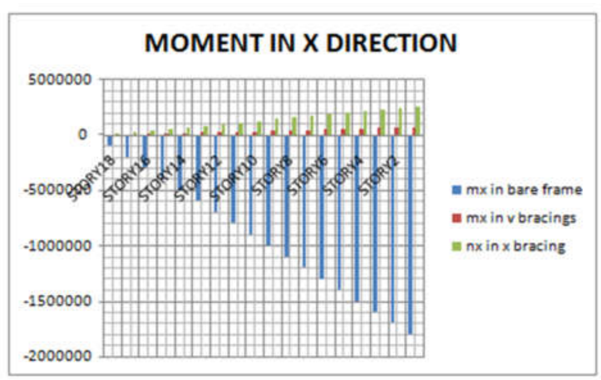
BUILDING TORSION

Story	Load	Loc	t in bare frame	T in v push	t in x bracing
STORY18	PUSHX	Bottom	936.737	-96.682	-8.181
STORY17	PUSHX	Bottom	1876.364	-136.319	-124.959
STORY16	PUSHX	Bottom	2818.734	-201.683	-230.279
STORY15	PUSHX	Bottom	3766.318	-259.127	-328.172
STORY14	PUSHX	Bottom	4722.736	-314.566	-437.993
STORY13	PUSHX	Bottom	5691.668	-366.721	-500.968
STORY12	PUSHX	Bottom	6676.065	-414.908	-573.442
STORY11	PUSHX	Bottom	7678.544	-458.359	-660.607
STORY10	PUSHX	Bottom	8702.286	-496.243	-730.947
STORY9	PUSHX	Bottom	9750.64	-527.621	-766.863
STORY8	PUSHX	Bottom	10826.819	-551.42	-820.843
STORY7	PUSHX	Bottom	11934.21	-566.372	-859.661
STORY6	PUSHX	Bottom	13077.158	-570.944	-866.833
STORY5	PUSHX	Bottom	14262.297	-563.219	-865.264
STORY4	PUSHX	Bottom	15499.548	-540.894	-841.258
STORY3	PUSHX	Bottom	16803.209	-498.053	-787.296
STORY2	PUSHX	Bottom	18226.052	-436.93	-694.046
STORY1	PUSHX	Bottom	19890.283	-454.708	-589.41



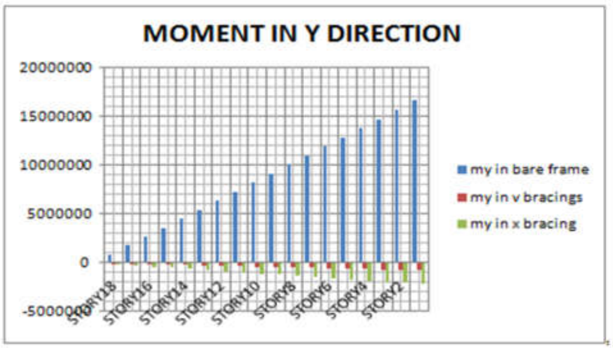
BENDING MOMENT IN X DIRECTION

Story	Load	Loc	mx in bare frame	mx in v push	Mx in x bracing
STORY18	PUSHX	Bottom	-962137.5	39857.74	142287.8
STORY17	PUSHX	Bottom	-1954585	80098.647	285968.4
STORY16	PUSHX	Bottom	-2949055	120374.26	429756.1
STORY15	PUSHX	Bottom	-3945301	160683.7	573653.1
STORY14	PUSHX	Bottom	-4943102	201026.6	717660.1
STORY13	PUSHX	Bottom	-5942257	241402.58	861777.4
STORY12	PUSHX	Bottom	-6942578	281811.3	1006006
STORY11	PUSHX	Bottom	-7943883	322252.42	1150345
STORY10	PUSHX	Bottom	-8945996	362725.63	1294795
STORY9	PUSHX	Bottom	-9948745	403230.65	1439356
STORY8	PUSHX	Bottom	-10951963	443767.26	1584027
STORY7	PUSHX	Bottom	-11955477	484335.31	1728810
STORY6	PUSHX	Bottom	-12959109	524934.73	1873702
STORY5	PUSHX	Bottom	-13962677	565565.58	2018703
STORY4	PUSHX	Bottom	-14965991	606227.97	2163812
STORY3	PUSHX	Bottom	-15968851	646921.76	2309029
STORY2	PUSHX	Bottom	-16970787	687646.73	2454349
STORY1	PUSHX	Bottom	-17977409	728495.75	2600246



BENDING MOMENT IN Y DIRECTION

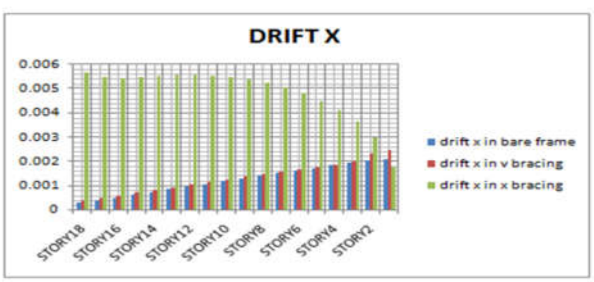
Story	Load	Loc	my in bare frame	my in v push	my in x bracing
STORY18	PUSHY	Bottom	884712.14	-39861.35	-119383
STORY17	PUSHY	Bottom	1797491.5	-80101.02	-239836
STORY16	PUSHY	Bottom	2712535.5	-120371.8	-360382
STORY15	PUSHY	Bottom	3629739.2	-160675.3	-481021
STORY14	PUSHY	Bottom	4549000	-201011	-601754
STORY13	PUSHY	Bottom	5470218.1	-241378.8	-722581
STORY12	PUSHY	Bottom	6393293.2	-281778.4	-843503
STORY11	PUSHY	Bottom	7318117.8	-322209.6	-964519
STORY10	PUSHY	Bottom	8244574.6	-362672	-1085630
STORY9	PUSHY	Bottom	9172550.1	-403165.7	-1206836
STORY8	PUSHY	Bottom	10101949	-443690.5	-1328137
STORY7	PUSHY	Bottom	11032701	-484246.4	-1449532
STORY6	PUSHY	Bottom	11964778	-524833.6	-1571021
STORY5	PUSHY	Bottom	12898237	-565452.5	-1692603
STORY4	PUSHY	Bottom	13833313	-606103.6	-1814277
STORY3	PUSHY	Bottom	14770607	-646787.5	-1936040
STORY2	PUSHY	Bottom	15711493	-687503	-2057890
STORY1	PUSHY	Bottom	16670835	-728351.9	-2180226



B.EQUVALENT STATIC ANALYSIS

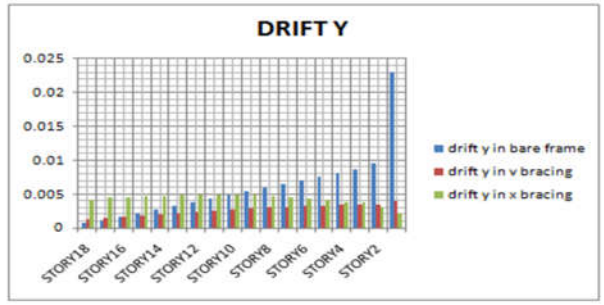
STORY DRIFT IN X DIRECTION

Story	Item	drift x in bare frame	drift x in v bracing	drift x in x bracing
STORY18	STATIC	0.000276	0.000399	0.005673
STORY17	STATIC	0.000372	0.000482	0.005499
STORY16	STATIC	0.000483	0.00059	0.005436
STORY15	STATIC	0.000598	0.000697	0.005476
STORY14	STATIC	0.000713	0.000807	0.005526
STORY13	STATIC	0.000828	0.000918	0.005557
STORY12	STATIC	0.000943	0.001028	0.005562
STORY11	STATIC	0.001057	0.001137	0.005539
STORY10	STATIC	0.001171	0.001245	0.005481
STORY9	STATIC	0.001283	0.001349	0.005384
STORY8	STATIC	0.001395	0.001449	0.005242
STORY7	STATIC	0.001505	0.001544	0.00505
STORY6	STATIC	0.001614	0.001632	0.004802
STORY5	STATIC	0.001721	0.001735	0.00449
STORY4	STATIC	0.001827	0.001855	0.004099
STORY3	STATIC	0.001931	0.001991	0.003622
STORY2	STATIC	0.00204	0.002298	0.002992
STORY1	STATIC	0.002069	0.002446	0.001741



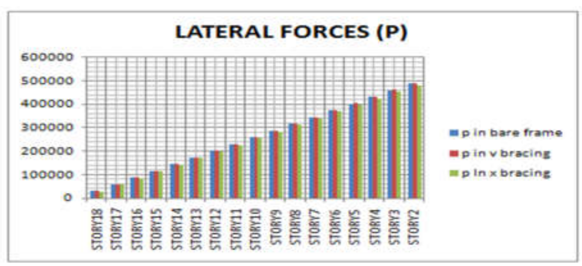
STORY DRIFT IN Y DIRECTION

Story	Item	drift y in bare frame	drift y in v bracing	drift y in x bracing
STORY18	STATIC	0.00064	0.001284	0.004215
STORY17	STATIC	0.00117	0.001426	0.004463
STORY16	STATIC	0.0017	0.001584	0.004525
STORY15	STATIC	0.00224	0.001765	0.004641
STORY14	STATIC	0.00278	0.001952	0.00475
STORY13	STATIC	0.00331	0.002142	0.004829
STORY12	STATIC	0.00385	0.002329	0.004876
STORY11	STATIC	0.00439	0.002511	0.004891
STORY10	STATIC	0.00492	0.002684	0.00487
STORY9	STATIC	0.00545	0.002844	0.00481
STORY8	STATIC	0.00598	0.002987	0.004708
STORY7	STATIC	0.00651	0.003107	0.004561
STORY6	STATIC	0.00704	0.003201	0.004366
STORY5	STATIC	0.00757	0.003282	0.004123
STORY4	STATIC	0.00809	0.003352	0.003846
STORY3	STATIC	0.00861	0.003392	0.003697
STORY2	STATIC	0.00944	0.003451	0.003113
STORY1	STATIC	0.02297	0.003871	0.002117



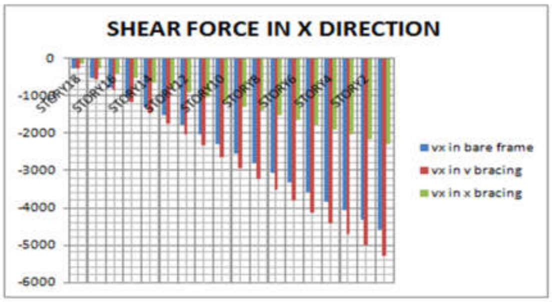
LATERAL FORCES (P)

Story	Load	Loc	p in bare frame	p in v bracing	p In x bracing
STORY18	STATIC	Bottom	28799.8	28886.79	28375.05
STORY17	STATIC	Bottom	57599.59	57731.58	56750.1
STORY16	STATIC	Bottom	86399.39	86576.37	85125.16
STORY15	STATIC	Bottom	115199.18	115421.15	113500.21
STORY14	STATIC	Bottom	143998.98	144265.94	141875.26
STORY13	STATIC	Bottom	172798.78	173110.73	170250.31
STORY12	STATIC	Bottom	201598.57	201955.52	198625.36
STORY11	STATIC	Bottom	230398.37	230800.31	227000.41
STORY10	STATIC	Bottom	259198.16	259645.1	255375.47
STORY9	STATIC	Bottom	287997.96	288489.88	283750.52
STORY8	STATIC	Bottom	316797.76	317334.67	312125.57
STORY7	STATIC	Bottom	345597.55	346179.46	340500.62
STORY6	STATIC	Bottom	374397.35	375024.25	368875.67
STORY5	STATIC	Bottom	403197.15	403869.04	397250.73
STORY4	STATIC	Bottom	431996.94	432713.83	425625.78
STORY3	STATIC	Bottom	460796.74	461558.61	454000.83
STORY2	STATIC	Bottom	489596.53	490403.4	482375.88
STORY1	STATIC	Bottom	518549.46	519407.83	511159.32



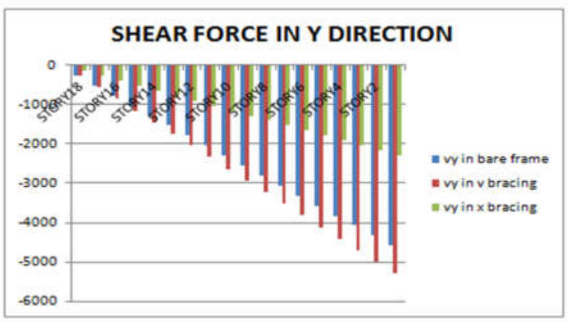
SHEAR FORCE IN X DIRECTION

Story	Load	Loc	vx in bare frame	vx in v bracing	vx in x bracing
STORY18	STATIC	Bottom	-255	-255	-127.5
STORY17	STATIC	Bottom	-510	-552	-255
STORY16	STATIC	Bottom	-765	-849	-382.5
STORY15	STATIC	Bottom	-1020	-1146	-510
STORY14	STATIC	Bottom	-1275	-1443	-637.5
STORY13	STATIC	Bottom	-1530	-1740	-765
STORY12	STATIC	Bottom	-1785	-2037	-892.5
STORY11	STATIC	Bottom	-2040	-2334	-1020
STORY10	STATIC	Bottom	-2295	-2631	-1147.5
STORY9	STATIC	Bottom	-2550	-2928	-1275
STORY8	STATIC	Bottom	-2805	-3225	-1402.5
STORY7	STATIC	Bottom	-3060	-3522	-1530
STORY6	STATIC	Bottom	-3315	-3819	-1657.5
STORY5	STATIC	Bottom	-3570	-4116	-1785
STORY4	STATIC	Bottom	-3825	-4413	-1912.5
STORY3	STATIC	Bottom	-4080	-4710	-2040
STORY2	STATIC	Bottom	-4335	-5007	-2167.5
STORY1	STATIC	Bottom	-4590	-5304	-2295



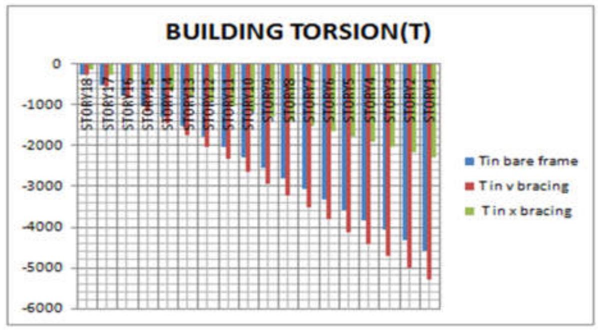
SHEAR FORCE IN Y DIRECTION

Story	Load	Loc	vy in bare frame	vy in v bracing	vy in x bracing
STORY18	STATIC	Bottom	-255	-255	-127.5
STORY17	STATIC	Bottom	-510	-552	-255
STORY16	STATIC	Bottom	-765	-849	-382.5
STORY15	STATIC	Bottom	-1020	-1146	-510
STORY14	STATIC	Bottom	-1275	-1443	-637.5
STORY13	STATIC	Bottom	-1530	-1740	-765
STORY12	STATIC	Bottom	-1785	-2037	-892.5
STORY11	STATIC	Bottom	-2040	-2334	-1020
STORY10	STATIC	Bottom	-2295	-2631	-1147.5
STORY9	STATIC	Bottom	-2550	-2928	-1275
STORY8	STATIC	Bottom	-2805	-3225	-1402.5
STORY7	STATIC	Bottom	-3060	-3522	-1530
STORY6	STATIC	Bottom	-3315	-3819	-1657.5
STORY5	STATIC	Bottom	-3570	-4116	-1785
STORY4	STATIC	Bottom	-3825	-4413	-1912.5
STORY3	STATIC	Bottom	-4080	-4710	-2040
STORY2	STATIC	Bottom	-4335	-5007	-2167.5
STORY1	STATIC	Bottom	-4590	-5304	-2295



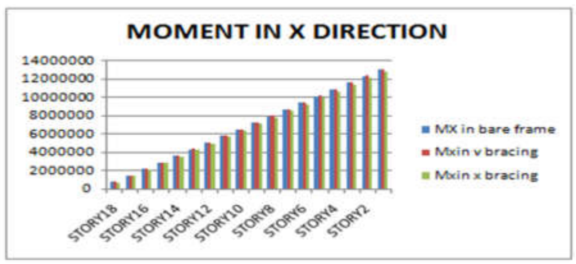
BUILDING TORSION

Story	Load	Loc	T in bare frame	T in v bracing	T in x bracing
STORY18	STATIC	Bottom	-255	-255	-127.5
STORY17	STATIC	Bottom	-510	-552	-255
STORY16	STATIC	Bottom	-765	-849	-382.5
STORY15	STATIC	Bottom	-1020	-1146.001	-510
STORY14	STATIC	Bottom	-1275	-1443.001	-637.5
STORY13	STATIC	Bottom	-1530	-1740.001	-765
STORY12	STATIC	Bottom	-1785	-2037.001	-892.5
STORY11	STATIC	Bottom	-2040	-2334.001	-1020
STORY10	STATIC	Bottom	-2295	-2631.002	-1147.5
STORY9	STATIC	Bottom	-2550	-2928.002	-1275
STORY8	STATIC	Bottom	-2805	-3225.002	-1402.5
STORY7	STATIC	Bottom	-3060	-3522.002	-1530
STORY6	STATIC	Bottom	-3315	-3819.002	-1657.5
STORY5	STATIC	Bottom	-3570	-4116.003	-1785
STORY4	STATIC	Bottom	-3825	-4413.003	-1912.5
STORY3	STATIC	Bottom	-4080	-4710.003	-2040
STORY2	STATIC	Bottom	-4335	-5007.003	-2167.5
STORY1	STATIC	Bottom	-4590	-5304.003	-2295



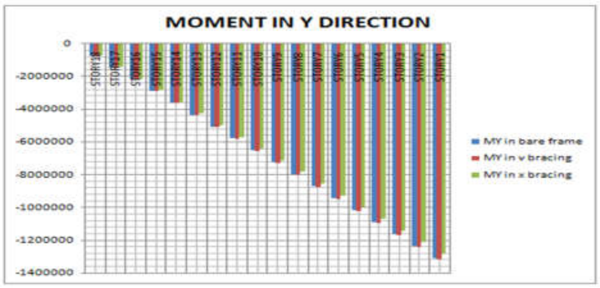
BENDING MOMENT IN X DIRECTION

Story	Load	Loc	MX in bare frame	Mxin v bracing	Mxin x bracing
STORY18	STATIC	Bottom	720504.9	723787.08	710231.4
STORY17	STATIC	Bottom	1441774.8	1447373.2	1420845.3
STORY16	STATIC	Bottom	2163809.7	2171850.2	2131841.7
STORY15	STATIC	Bottom	2886609.6	2897218.3	2843220.6
STORY14	STATIC	Bottom	3610174.5	3623477.4	3554982
STORY13	STATIC	Bottom	4334504.4	4350627.5	4267125.9
STORY12	STATIC	Bottom	5059599.3	5078668.5	4979652.3
STORY11	STATIC	Bottom	5785459.2	5807600.6	5692561.2
STORY10	STATIC	Bottom	6512084.1	6537423.7	6405852.6
STORY9	STATIC	Bottom	7239474	7268137.8	7119526.5
STORY8	STATIC	Bottom	7967628.9	7999742.8	7833582.9
STORY7	STATIC	Bottom	8696548.8	8732238.9	8548021.8
STORY6	STATIC	Bottom	9426233.7	9465626	9262843.2
STORY5	STATIC	Bottom	10156684	10199904	9978047.1
STORY4	STATIC	Bottom	10887899	10935073	10693633
STORY3	STATIC	Bottom	11619878	11671133	11409602
STORY2	STATIC	Bottom	12352623	12408084	12125954
STORY1	STATIC	Bottom	13092256	13152650	12854024



BENDING MOMENT IN Y DIRECTION

Story	Load	Loc	MY in bare frame	MY in v bracing	MY in x bracing
STORY18	STATIC	Bottom	-721014.9	-723664.3	-710031.2
STORY17	STATIC	Bottom	-1442795	-1447212	-1420445
STORY16	STATIC	Bottom	-2165340	-2171650	-2131241
STORY15	STATIC	Bottom	-2888650	-2896979	-2842420
STORY14	STATIC	Bottom	-3612725	-3623199	-3553981
STORY13	STATIC	Bottom	-4337564	-4350311	-4265924
STORY12	STATIC	Bottom	-5063169	-5078313	-4978251
STORY11	STATIC	Bottom	-5789539	-5807206	-5690959
STORY10	STATIC	Bottom	-6516674	-6536991	-6404050
STORY9	STATIC	Bottom	-7244574	-7267666	-7117524
STORY8	STATIC	Bottom	-7973239	-7999232	-7831380
STORY7	STATIC	Bottom	-8702669	-8731690	-8545619
STORY6	STATIC	Bottom	-9432864	-9465038	-9260240
STORY5	STATIC	Bottom	-10163824	-10199277	-9975244
STORY4	STATIC	Bottom	-10895549	-10934407	-10690630
STORY3	STATIC	Bottom	-11628038	-11670429	-11406399
STORY2	STATIC	Bottom	-12361293	-12407341	-12122550
STORY1	STATIC	Bottom	-13101436	-13151822	-12850408



V.CONCLUSIONS

- The pushover analysis is relatively simple way to explore the non-linear behavior of buildings and it is an elegant tool to visualize the performance level of a building under a given earthquake.
- The Drift values in the V braced building shows very less storey drifts due to arrangements of the V braces in the buildings .
- The shear force in the industrial steel structure due to arrangement of the bracings , the braced building of V braced system shows very less values when compared to the other building systems.
- The bending moments of the steel structure shows the very high moments and the least moments are observed in V braced building due to its arrangement in the buildings.
- The overturning moments of the buildings observed to more in the steel building and X braced building systems , the least values are observed in the V braced systems.

Considering all the above results the V braced building systems shows the best results and next to the that is X braced building systems.

- The Drift values in the Equivalent static analysis the steel buildings also shows very high displacements when compared to the other building systems , the V braced building systems are best suitable structures.
- The shear values in the Equivalent static analysis the V braced building systems shows that the less shear values compared to the other building systems.
- The bending in the Equivalent static analysis the V braced building systems shows that the less Bending values compared to the other building systems. due to the arrangements bracings in the buildings **.**
- The overturning moments in the equivalent static analysis results shows that the less overturning moments in V braced building systems when compared to the other steel and X braced structures.

Comparing the above results the V braced steel Building is best suited structure according to the Pushover analysis. And the X braced building is the Best structure according to the equivalent static analysis.

SCOPE OF THE FUTURE WORK:

- By using bracings in the structures, the displacement of the structure greatly reduced can be changed or altered. Hence the further study can be done by examining the behavior of the storey building due to wind load forces and Time history analysis.
- We can also study on the behavior of Bending Moment, shear Force etc.
- We can study other types of bracings in different Zones for the different soil type conditions.
- We can study for the different sections in tall structures and compare with and without bracings.

REFERANCES

[1] Theory of Structures by Ramamrutham for literature review on kani′s method
[2] Theory of structures by B.C.Punmia for literature on moment distribution method.
[3] Reinforced concrete Structures by A.K. Jain and B.C. Punmia for design of beams, columns and slab.
[4] Fundamentals of concrete structure by N. C. Sinha.

[5] S.Mahesh and Dr.B.Panduranga Rao Comparison of analysis and design of regular and irregular configuration of multi Story building in various seismic zones and various types of soils were using STAAD Volume 11, Issue 6 Ver. I (Nov- Dec. 2014), PP 45-52

[6] Kevadkar M.D., Kodag P.B., 'Lateral load (loads due to earthquake, wind, blast, fire hazards etc) (earthquake loads, wind loads, blast, fire hazards etc) Analysis of R.C.C. Building', International Journal of Modern Engineering Research (IJMER), Vol.3, Issue.3, May-June. 2013, pp-1428-1434.

[7] Salehuddin Shamshinar, Stability of a six storey steel frame structure, International Journal of Civil & Environmental Engineering, Vol.13 No.06, 2011. User Manual STAAD.Pro.

[8] Chopra, A. K., Dynamics of Structures (1995): Theory and Applications to Earthquake Engineering, Prentice-Hall. Inc., Englewood Cliffs, New Jersey.

[9] IS 1893 : 2002, Indian Standard criteria for earthquake resistant design of frames, Part 1 General provisions and buildings, Draft of Fifth Revision, Bureau of Indian Standards, New Delhi, 2002.

[10] IS: 875(Part-1)- 1987 ‘Code of Practice for Design Loads (Other than Earthquake) buildings and frames’, Part-1 Dead load, Unit weight of building materials and stored materials, Bureau of Indian Standards, New Delhi.