SEISMIC PERFORMANCE EVALUATION OF RC BUILDING CONNECTED WITH AND WITHOUT X-BRACED FRICTION DAMPERS

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Abstract: ***Extensive use of friction joints in new and retrofitted buildings has demonstrated the economic advantages of this form of device to control the amplitude of building motion due to seismic action. The paper addresses in particular the use of friction devices in conjunction with rigid structural frames, either steel or concrete, for which three stages of performance are identified. Elastic overall behaviour under wind loads, slipping joints with an elastic frame when acted on by the design earthquake, and slipping joints with a yielding frame under the action of the extreme earthquake that the building is capable of resisting. In the second stage, primary structural damage is avoided while secondary damage is minimized. In the third stage the energy dissipating capability of yielding members is added to that of the friction joints. Structures for which friction dampers are suitable and the choice of the slip loads and damper structural analysis of the high rise building of G+25 , was analyzed by using response spectrum analysis under the influence of X shaped friction damper and without dampers was compared and results are figured out like story drifts, story shear , story torsion, story displacements, etc with help of the commercial software ETABS.***

Keywords: G+25, X shaped friction dampers, story shear, story displacements, ETABS etc ,.

I.INTRODUCTION

In recent years, an effort is being made to develop and improve the structural control devices to reduce seismic impact in buildings and bridges. Full scale implement of active control systems is difficult as it is expensive and less reliable. Passive supplemental damping systems such as base isolation viscoelastic dampers and tuned mass dampers are widely used in structures to reduce the dynamic response. Semi-active damping systems i.e. variable-orifice fluid dampers, controllable friction devices, variable stiffness devices, smart tuned mass dampers and tuned liquid dampers, are more effective in mitigating dynamic response than active and passive damping system. During an earthquake, seismic energy is input into the structure which results in increased vibration response. Mechanical devices e.g. dampers are provided throughout the height of structure to increase the damping hence reduce the response either by absorbing or dissipating energy. Friction dampers dissipate specifically kinetic energy through sliding of plate /surfaces. It can be equivalent to 30% critical damping ratio. Structural damage is categorized as local and global. Global damage detection techniques are based on variation in dynamics of structures such as stiffness, mass, damping and vibration modes. Structural damage results in a reduction in structure stiffness and in the modal parameters of building structures. An important characteristic of earthquake loading is the uncertainty associated with its amplitude, duration, and frequency content. Structures are normally designed to withstand gravity loads acting vertically with adequate factor of safety. Therefore the lateral loads arising due to horizontal earthquake ground motion can cause severe damage unless special provisions are made to resist them the third characteristic of earthquake ground motion is that it is cyclic and induces reversal of stresses. Therefore axially loaded members may have to resist both tension and compression while beam cross-sections will have to resist both positive and negative bending moments. The fourth characteristic is that the loading is dynamic and produces different degree of response in different structures. Dynamic analysis requires the consideration of inertia and elastic forces as well as energy dissipating mechanisms like damping (Clough and Penzien 1993). The seismic analysis of existing industrial steel structures presents some peculiar modelling aspects which have been subject of relatively little investigation with respect to other types of existing structures. One frequent type of damage observed in past earthquakes is brace buckling (e.g Ozakgul et al., 2011). To resist the drifts and large displacements in buildings which may damage the buildings and cause loss of life, can be reduced to a large extent by using bracing systems. The present work focuses on finding the suitable bracing configuration that will adequately reduce the response of the structure to seismic excitation.

DAMPERS

In seismic structures upgrading, one of the lateral force reduction caused by the earthquake is use of dampers. During an earthquake, high energy is applied to the structure. This energy is applied in two types of kinetic and potential (strain) to structure and it is absorbed or amortized. If structure is free of damping, its vibration will be continuously, but due to the material damping, vibration is reduced. Input energy caused by earthquake to structure is presented in the following equation:

$$E = E_k + E_s + E_n + E_d \quad (1)$$

Damping Effect on Structural Response

Damping increasing reduces structural response (acceleration and displacement) damping effect at low frequency (close to zero) have no effect on spectrum amount and at high frequency, it has low effect on response acceleration. Figures 1 and 2 show the most effect of damping increasing in the frequency of 0.3 to 2.5 seconds.

OBJECTIVE OF THE STUDY

The objectives of the study can be listed following:

- To remodel a high rise building structure by using x shaped friction damper.
- To locate the suitable types and positioning of friction damping system.
- To assess the building performances in terms of overall deflection, inter – story drift, and joint acceleration.
- Seismic evaluation response of high rise building structures equipped by friction damper.
- To find the seismic behaviour of the building by response spectrum method of analyisis.

SCOPE OF STUDY

Determination of Lateral Displacements, Drifts, Base Shear for bare frame using Response Spectrum Method in zone V for medium type soil.

II.LITERATURE REVIEW

Shaik Kamal Mohammed Azam, Vinod Hosur et all,. (2013) The dual structural system consisting of special moment resisting frame (SMRF) and concrete shear wall has better seismic performance due to improved lateral stiffness and lateral strength. A well designed system of shear walls in a building frame improves its seismic performance significantly. The configurations of RC moment resisting framed building structure with different arrangements of shear walls are considered for evaluation of seismic performance, so as to arrive at the suitable arrangement of shear wall in the structural framing system for better seismic resistance. A comparison of structural behaviour in terms of strength, stiffness and damping characteristics is done by arranging shear walls at different locations/configurations in the structural framing system. The elastic (response spectrum analysis) as well as in-elastic (nonlinear static pushover analysis) analyses are carried out for the evaluation of seismic performance. The results of the study indicate that the provision of shear walls symmetrically in the outermost moment resisting frames of the building and preferably interconnected in mutually perpendicular directions forming a core will lead to better seismic performance.

Anuj Chandiwala et all,.(2014) From the past records of earthquake, there is increase in the demand of earthquake resisting building which can be fulfilled by providing the shear wall systems in the buildings. For achieving economy in reinforced concrete building structures, design of critical section is carefully done to get reasonable concrete sizes and optimum steel consumption in members. In the present paper the researcher, had tried to get moment occur at a particular column including the seismic load, by taking different lateral load resisting structural systems, different number of floors, with various positions of shear wall for earthquake zone III in India has been found.

Among different location of shear wall (F- shear wall at end of “L” section) gives best result. Main reason is “END PORTION OF FLANGE ALWAYS OSCILLATE MORE DURING EARTHQUAKE”. Here shear wall directly obstruct this end oscillation, hence reduce overall bending moment of building.

III. METHODOLOGY

Response spectrum method:

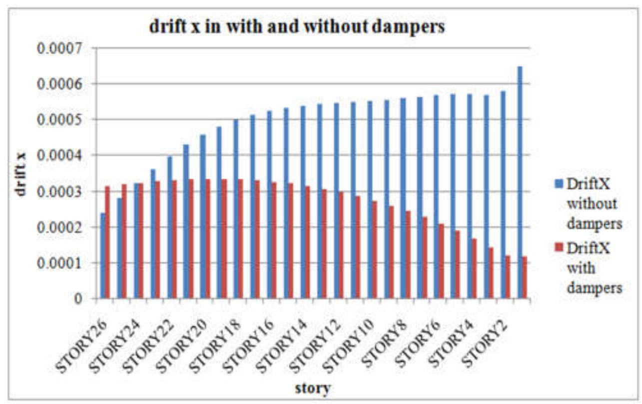
The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2002 (part1). Here type of soil, seismiczone factor should beentered from IS 1893-2002 (part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABS 2013 software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g). This approach permits the multiple modes of response of a building to be taken in to account (in the frequency domain). This is required in many building codes for all except very simple or very complex structures. The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonic" computer analysis can be used to determine these modes for a structure. . In this we have to calculate the magnitude of forces in all directions i.e. X, Y & Z and then see the effects on the building. Combination methods include the following:

- absolute - peak values are added together
- square root of the sum of the squares (SRSS)
- complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes.

IV. RESULTS AND ANALYSIS

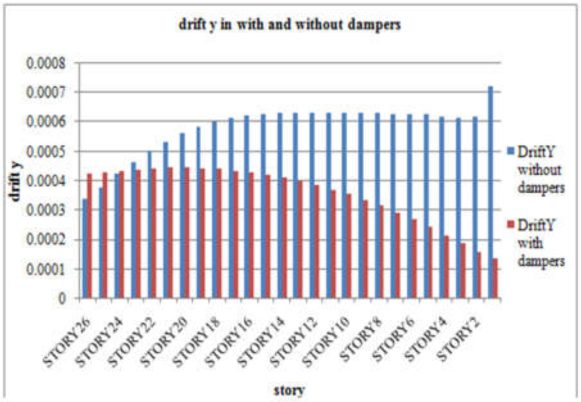
1. COMPARSION OF DRIFT IN X DIRECTION

Story	Load	Drift X without dampers (meters)	Drift X with dampers (meters)
STORY26	RSA	0.000239	0.000313
STORY25	RSA	0.000279	0.000317
STORY24	RSA	0.000321	0.000322
STORY23	RSA	0.000361	0.000326
STORY22	RSA	0.000397	0.00033
STORY21	RSA	0.000429	0.000332
STORY20	RSA	0.000457	0.000333
STORY19	RSA	0.00048	0.000333
STORY18	RSA	0.000499	0.000332
STORY17	RSA	0.000513	0.000329
STORY16	RSA	0.000524	0.000325
STORY15	RSA	0.000531	0.00032
STORY14	RSA	0.000537	0.000313
STORY13	RSA	0.000541	0.000305
STORY12	RSA	0.000544	0.000295
STORY11	RSA	0.000547	0.000284
STORY10	RSA	0.00055	0.000272
STORY9	RSA	0.000554	0.000258
STORY8	RSA	0.000558	0.000243
STORY7	RSA	0.000563	0.000226
STORY6	RSA	0.000566	0.000207
STORY5	RSA	0.000569	0.000187
STORY4	RSA	0.000569	0.000165
STORY3	RSA	0.000568	0.00014
STORY2	RSA	0.000579	0.000118
STORY1	RSA	0.000648	0.000117



2 .COMPARISON OF DRIFT IN Y DIRECTION

Story	Load	Drift Y without dampers (meters)	Drift Y with dampers (meters)
STORY26	RSA	0.000334	0.000421
STORY25	RSA	0.000376	0.000426
STORY24	RSA	0.00042	0.000431
STORY23	RSA	0.000462	0.000436
STORY22	RSA	0.000499	0.000439
STORY21	RSA	0.000531	0.000441
STORY20	RSA	0.000559	0.000441
STORY19	RSA	0.000581	0.00044
STORY18	RSA	0.000599	0.000437
STORY17	RSA	0.000611	0.000432
STORY16	RSA	0.00062	0.000426
STORY15	RSA	0.000625	0.000417
STORY14	RSA	0.000628	0.000407
STORY13	RSA	0.000628	0.000396
STORY12	RSA	0.000628	0.000382
STORY11	RSA	0.000627	0.000367
STORY10	RSA	0.000626	0.000351
STORY9	RSA	0.000626	0.000332
STORY8	RSA	0.000626	0.000312
STORY7	RSA	0.000625	0.00029
STORY6	RSA	0.000624	0.000266
STORY5	RSA	0.000622	0.00024
STORY4	RSA	0.000617	0.000212
STORY3	RSA	0.00061	0.000184
STORY2	RSA	0.000617	0.000154
STORY1	RSA	0.00072	0.000134

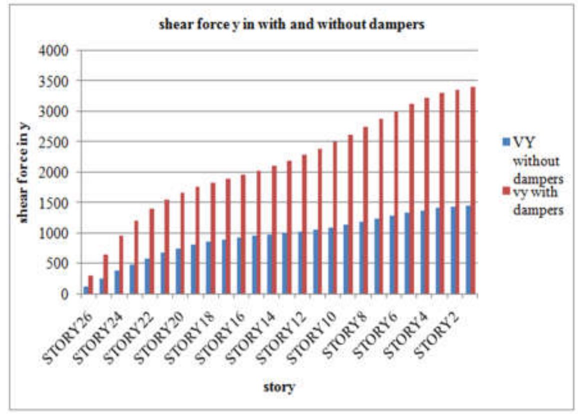


3.COMPARSION OF SHEAR FORCE IN X DIRECTION

Story	Load	VX without dampers (KN)	vx with dampers (KN)
STORY26	RSA	134.01	313.66
STORY25	RSA	281.91	688.6
STORY24	RSA	420.26	1024.81
STORY23	RSA	547.25	1321.95
STORY22	RSA	661.5	1580.75
STORY21	RSA	762.09	1803.04
STORY20	RSA	848.7	1991.89
STORY19	RSA	921.6	2151.54
STORY18	RSA	981.73	2287.24
STORY17	RSA	1030.69	2405.07
STORY16	RSA	1070.65	2511.48
STORY15	RSA	1104.29	2612.77
STORY14	RSA	1134.58	2714.51
STORY13	RSA	1164.48	2820.94
STORY12	RSA	1196.68	2934.54
STORY11	RSA	1233.18	3055.82
STORY10	RSA	1275.04	3183.43
STORY9	RSA	1322.28	3314.51
STORY8	RSA	1373.89	3445.16
STORY7	RSA	1428.06	3570.97
STORY6	RSA	1482.4	3687.53
STORY5	RSA	1534.3	3790.84
STORY4	RSA	1581.16	3877.67
STORY3	RSA	1620.6	3945.73
STORY2	RSA	1650.61	3993.89
STORY1	RSA	1670.19	4023.8

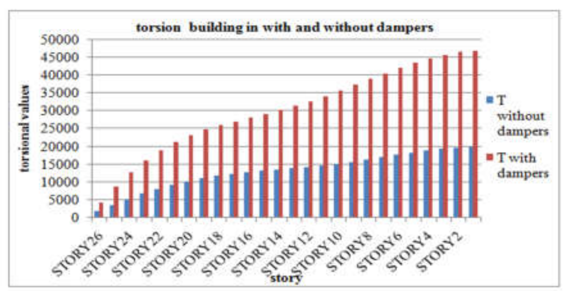
4COMPARSION OF SHEAR FORCE IN Y DIRECTION

Story	Load	VY without dampers (KN)	vy with dampers (KN)
STORY26	RSA	119.66	301.14
STORY25	RSA	250.68	649.18
STORY24	RSA	372.22	946.99
STORY23	RSA	482.84	1194.37
STORY22	RSA	581.46	1393.55
STORY21	RSA	667.42	1549.23
STORY20	RSA	740.62	1668.42
STORY19	RSA	801.45	1759.82
STORY18	RSA	850.92	1832.95
STORY17	RSA	890.6	1897.03
STORY16	RSA	922.56	1959.9
STORY15	RSA	949.34	2027.34
STORY14	RSA	973.66	2102.87
STORY13	RSA	998.27	2188.11
STORY12	RSA	1025.58	2283.41
STORY11	RSA	1057.35	2388.4
STORY10	RSA	1094.46	2502.23
STORY9	RSA	1136.81	2623.48
STORY8	RSA	1183.37	2749.84
STORY7	RSA	1232.39	2877.89
STORY6	RSA	1281.68	3003.03
STORY5	RSA	1328.83	3119.8
STORY4	RSA	1371.49	3222.49
STORY3	RSA	1407.55	3305.87
STORY2	RSA	1435.23	3366.15
STORY1	RSA	1453.68	3403.82



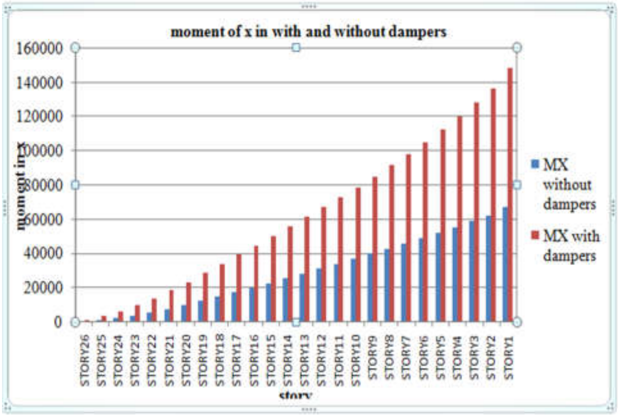
5COMPARSION OF TORSION BUILDING

Story	Load	T without dampers (KN-m)	T with dampers (KN-m)
STORY26	RSA	1609.008	3941.001
STORY25	RSA	3376.109	8551.865
STORY24	RSA	5020.856	12567.63
STORY23	RSA	6522.935	15986.73
STORY22	RSA	7866.89	18832.47
STORY21	RSA	9043.242	21153.88
STORY20	RSA	10049.36	23023.5
STORY19	RSA	10889.99	24532.35
STORY18	RSA	11577.69	25781.51
STORY17	RSA	12132.71	26872.58
STORY16	RSA	12582.39	27897.93
STORY15	RSA	12959.81	28933.28
STORY14	RSA	13301.4	30033.58
STORY13	RSA	13643.52	31232.74
STORY12	RSA	14018.41	32546.06
STORY11	RSA	14449.9	33973.42
STORY10	RSA	14950.25	35501.58
STORY9	RSA	15518.66	37105.17
STORY8	RSA	16142.08	38746.94
STORY7	RSA	16797.65	40378.42
STORY6	RSA	17456.18	41942.03
STORY5	RSA	18085.77	43375.22
STORY4	RSA	18655	44616.69
STORY3	RSA	19135.33	45613.75
STORY2	RSA	19502.69	46330
STORY1	RSA	19745.59	46777.07



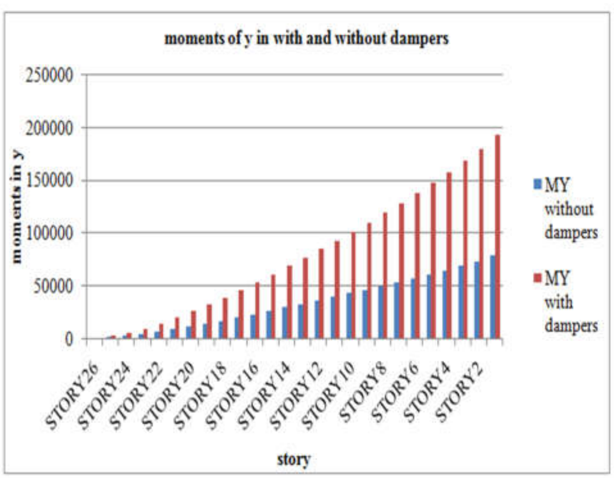
6 COMPARSION OF MOMENTS IN X DIRECTION

Story	Load	MX without dampers (KN-m)	MX with dampers (KN-m)
STORY26	RSA	358.987	903.419
STORY25	RSA	1110.988	2850.588
STORY24	RSA	2227.494	5689.647
STORY23	RSA	3675.474	9266.528
STORY22	RSA	5418.361	13431.1
STORY21	RSA	7417.242	18043.49
STORY20	RSA	9632.152	22979.9
STORY19	RSA	12023.46	28137.18
STORY18	RSA	14553.26	33435.69
STORY17	RSA	17186.77	38820.18
STORY16	RSA	19893.6	44258.68
STORY15	RSA	22648.89	49739.9
STORY14	RSA	25434.17	55269.56
STORY13	RSA	28237.9	60866.55
STORY12	RSA	31055.68	66559.22
STORY11	RSA	33889.9	72382.3
STORY10	RSA	36748.96	78374.37
STORY9	RSA	39646.03	84575.58
STORY8	RSA	42597.29	91025.24
STORY7	RSA	45620.06	97758.94
STORY6	RSA	48730.68	104805.2
STORY5	RSA	51942.63	112181.8
STORY4	RSA	55264.88	119893.1
STORY3	RSA	58700.81	127928.1
STORY2	RSA	62247.62	136260.3
STORY1	RSA	67131.99	147762



7 COMPARSION OF MOMENTS IN Y DIRECTION

Story	Load	MY without dampers (KN-m)	MY with dampers (KN-m)
STORY26	RSA	402.044	940.967
STORY25	RSA	1247.748	3006.479
STORY24	RSA	2508.36	6079.653
STORY23	RSA	4149.564	10041.76
STORY22	RSA	6132.557	14774.9
STORY21	RSA	8415.356	20164.95
STORY20	RSA	10954.27	26104.45
STORY19	RSA	13705.46	32495.59
STORY18	RSA	16626.57	39252.77
STORY17	RSA	19678.33	46304.84
STORY16	RSA	22825.99	53596.66
STORY15	RSA	26040.71	61089.83
STORY14	RSA	29300.54	68762.53
STORY13	RSA	32591.13	76608.31
STORY12	RSA	35905.94	84633.9
STORY11	RSA	39245.92	92856.03
STORY10	RSA	42618.73	101297.7
STORY9	RSA	46037.34	109984.1
STORY8	RSA	49518.21	118938.3
STORY7	RSA	53079.15	128177.9
STORY6	RSA	56737.1	137712.3
STORY5	RSA	60506.03	147540.7
STORY4	RSA	64395.09	157651.6
STORY3	RSA	68407.46	168023.8
STORY2	RSA	72539.6	178627.3
STORY1	RSA	78215.86	193061.8



V.CONCLUISIONS

- The drift values in the X and Y direction shows higher values of the structure without dampers, the displacement of story with dampers was reduced, it shows that the structure with dampers can be used for high rise buildings in the high seismic zone.
- Lateral displacements due to earthquake forces reduce by providing friction dampers.
- Storey drift also reduces thus shear resistance of the building increases.
- Base shear of the building increases by providing friction dampers.
- The effectiveness of friction dampers in controlling lateral displacements storey drifts due to earthquake force is observed in response spectrum analysis.
- From above results it is clear that by adding friction dampers in a building response of a structure get reduced by significant amount.
- The results of this investigation show that, the response of structure can be dramatically reduced by using friction damper without increasing the stiffness of the structure.
- Friction dampers are unique in combating the wind forces, for its friction material, whereas other dampers are suitable mostly for earthquake forces only.
- The performance of friction damper devices is much better for the tall buildings with slender design.
- From the above tables it is evident that when the story height goes on increasing the Base Shear increases and also when we provide Friction Dampers, the Base Shear increases.

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