BASE ISOLATATION EFFECT ON PERFORMANCE BASED PUSHOVER BEHAVIOR OF RC FRAMED BUILDING

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Abstract: **The idea that the building can be uncoupled from the damaging effects of ground movement produced by a strong earth quake has appealed to engineers and inventors for more than a century. The purpose is to provide a safe and an earthquake resistant building. Studies shows that the analysis performed on a fixed base and isolated structures with nonaligned isolator elements, it was discovering that the isolators minimize the lateral load imposed on the structure. So, the adoption of base isolation using rubber isolator at foundation is done for our project for the protection of buildings and lives from the fatal earth quake vibration. The study compromise of new designing software's for the analysis taking a building structure as a model into consideration. We are comparing the seismic response of normal structure with fixed base and base isolated structure from the results in performing analysis of static, response spectrum along with push over in E tabs software for evaluating the various parameters of displacements, roof shears etc. for the particular isolation.**

Keywords: Retrofitting, Base Isolation, Push Over, Seismic, Various Parameters, Building Section Properties.

1. INTRODUCTION

Earthquake around the world are single-handedly responsible for the destruction to life and property in large numbers. Recently occurred earthquakes have delineated the vulnerability issues faced by the existing buildings due to the changes in the ground motions lately or which may have been constructed based on earlier codes. In order to protect from the risk triggered by seismic disaster to the life and property.

The performance of the structures must be improved and thus seismic retrofitting plays its role. Retrofitting also proves to be a better option catering to the economic considerations and immediate shelter problems rather than replacement of seismic deficient buildings. Two alternative approaches are conceptually adopted and implemented in practice for seismic retrofitting: the first approach focuses on upgrading the structure to resist earthquake induced forces (i.e., modifying the capacity) and is called conventional method of retrofitting.

The second approach focuses on reduction of earthquake induced forces (i.e., modifying the demand) or unconventional approach. The contribution of existing buildings in regards to sustainability should not be under estimate. Through retrofitting, existing buildings can be benefited for sustainability purposes hence lessening the wastage. The time has come to begin concentrating on retrofitting the existing buildings. Tangible and intangible benefits from greening the existing buildings could be achieved through retrofitting. The tangible benefits are any benefits or advantages that can be measured in financial terms such as cost of construction and intangible benefits are any benefits or advantages that cannot be measured by financial term but it still has significant impact to business or project such as comfort level and satisfactory level.

A. Base Isolation

The earthquake resistant structures can be categorized into rigid structures and flexible structures. In rigid structures, the control methods that are applied to withstand extreme loads are basically reducing the inter story displacement with the help of diagonal bracing, the installation of shear walls and the use of composite materials. In flexible structures, such as base-isolated buildings, the key control approach is to reduce the excitation input with the use of dampers and isolators. The control strategies of rigid structures were preferred to be earthquake hazard mitigation alternatives due to long-lasting established knowledge and the maturity of technologies pertinent to structural stiffening. However, significant inter story drift and floor accelerations of highly stiffening structures raise risks of severe devastation of the building, especially under large scale of earthquake. Flexible structures such as high-rise buildings can avoid resonant condition and effectively reduce structural responses

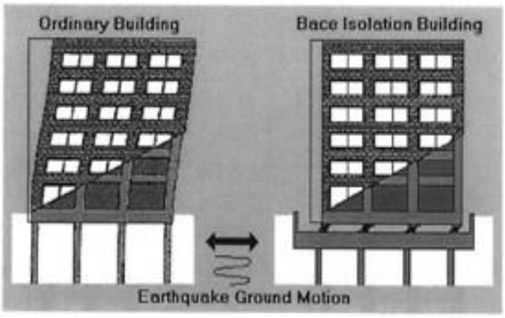


Figure 1: Earthquake Ground Motion

2. LITERATURE REVIEW

A.N.Lin et.al., presented the seismic results of rigid base and base isolated concentrically brace and special moment resistant steel frames. Different codes were referred to design the base isolation and fixed base frames. Fixed base frames are designed according to 1990 structural engineering association of California (SEAOC) for recommended design base shear. While the base isolated building was designed for 100%, 50% and 25% of SEAOC recommended lateral forces.54 different ground motion record records used for study purpose. On-linear time history analysis has been performed for different results like roof displacement, collapsed frames etc. along with these yielded frames, yielded elements, total relative roof displacement was found out. The results so obtained for different condition showed that the 50% of SEAOC recommended lateral force gives compatibility superior performance then other combination. For braced steel frame. (A. N. Lin, 1992)

H.W. Shenton III , compared and analyzed relative results of fix based and base isolated structure. The concrete fix base structure was designed by referring structural agencies association of California (SEAOC). The base-isolated response was compared with fixed baseresponse. The base shear was varying according to the SEAOC recommendation. Three different type of time history, post- earthquake record were selected to perform nonlinear dynamic analysis for fixed base and base isolated structure. Results were compared to 25% and 50% of the specified lateral force by SEAOC. The performance of building was checked for different lateral forces. (A. N. Lin, 1992)

Todd W Erickson , presented response of the industrial structure under seismic forces, building was designed according to IBC code. The results of superstructure under dynamic loading was found out for an elastic response. Present work shows that three industrial buildings rest on one isolation slab. All problems related to design, analysis, placement of isolator are comparatively discussed. (Altoontash2, 2010)

J. Enrique Luco , determined the soil structure interaction effect on base isolated building. The results showed that the deformation of an inelastic structure is higher when soil effect has been taken into consideration. When soil structure interaction was neglected an undammed vibration was considered, critical harmonic excitation occurs after which the behavior of structure and isolator was unbounded. The results obtained depended on damping of the isolator .The resonant response of isolator and superstructure has been increased when SSI was taken into account. (Luco, (2014))

3. PARMETRIC STUDY

Earth quake around the world are singlehandedly responsible for the destruction of life and property in large numbers it is important to incorporate norms that will enhance the seismic performance of the structure for the case of seismic analysis static analysis is done which is insufficient for the major structures so along with this dynamic analysis is also performed for satisfactory results

A. Fixed Base Structure

In the present case a nine story R.C framed structure situated in zone III is taken for the purpose of study.

It consists of 4 bays of 5m each in X direction and 4 bays of each 4m in Z direction The total height of the building is 27m

Building Section Properties

Table 1 building section properties

Plot area	=	16 x 20 m^2
Thickness of the slab	=	150 mm
Beams		
• Main beams	=	450 x 300mm^2
• Secondary beams	=	400 x 300 mm^2
Columns		
• Base column	=	300 x 650 mm^2
• Column	=	300 x 600 mm^2
Thickness of wall	=	150 mm
Each storey height	=	3000 mm
Live Load Intensities:		
• Roof	=	2.5 KN/mm^2
• Floor	=	5 KN/mm^2

Material Properties

Characteristic strength of concrete, for beams fck = 25 MPa

Characteristic strength of concrete, for columns fck = 30 Mpa

Yield strength for steel, fy = 500 MPa

Modulus of Elasticity of steel, Es =200000 MPa

Modulus of Elasticity of concrete = 250000 MPa

The stress – strain

relationship is used, as per IS 456:2000

This seismic data is based on as per IS 1893:2000 (Part – 1)

B.Load Considerations

Table 2 dead loads

	=	5 x 0.2 x 3 x 20
	=	12 KN/m
• Dead load due to parapet wall load	=	4.6 KN/m
• Dead load due to slab load	=	0.15 x 1 x 25
	=	3.75 KN/m

Figure 2: New model data

Table 3 combination of loads

• 1 x (dead load) • 1 x (live load) • 1.5 x (seismic load)		
3.1.6. FUNCTIONS		
Function	=	Response Spectrum
Function type	=	IS 1893-2002
Damping ratio	=	0.05
Site class	=	B

C. Input About Basic Grid Parameters Of The Model

The basic layout of the model showing the elements in both the X and Y directions containing the interval of spacing and number of joint points where the frame sections are to be placed in an order depending on the type of the structure and orientation of elements

Fig 3 layout

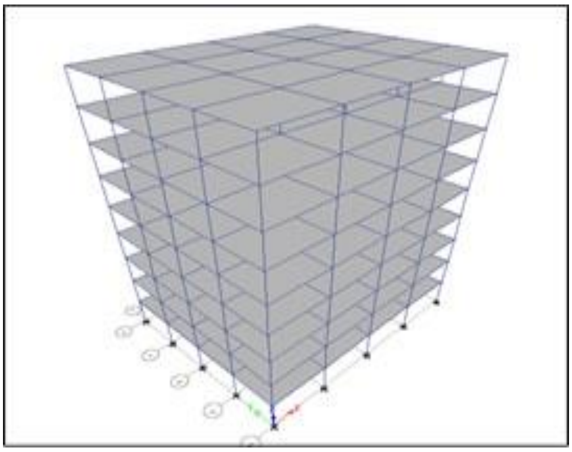


Fig 4 3D modelling

Figure 5: beam arrangement

Figure 6: column arrangement

4. RESULTS AND DISCUSSIONS

A.Base Isolated Structure

Buildings built with fixed base may restrain with the loads from the lateral and longitudinal case depending on the design parameters and factor of safety. In case of lateral loads for the structure the major extent may be obtained from seismic case with compared to wind. earthquake may cause severe damage to the building.

Table 4 building section properties

Plot area		=	16 x 20 m^2
Thickness of the slab		=	150 mm
Beams			
	• Main beams	=	450 x 300mm^2
	• Secondary beams	=	400 x 300 mm^2
Columns			
	• Base column	=	300 x 650 mm^2
	• Column	=	300 x 600 mm^2
Thickness of wall		=	150 mm
Each storey height		=	3000 mm
Live Load Intensities:			
	• Roof	=	2.5 KN/mm2
	• Floor	=	5 KN/mm2

Table 5 isolation properties

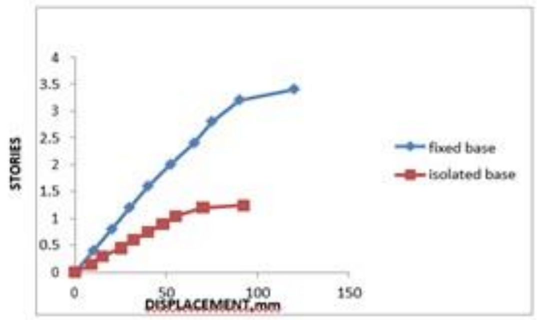
3.4.3. ISOLATOR PROPERTIES		
Type of isolator	=	rubber isolator
Direction	=	**U1**

Table 6 structure properties

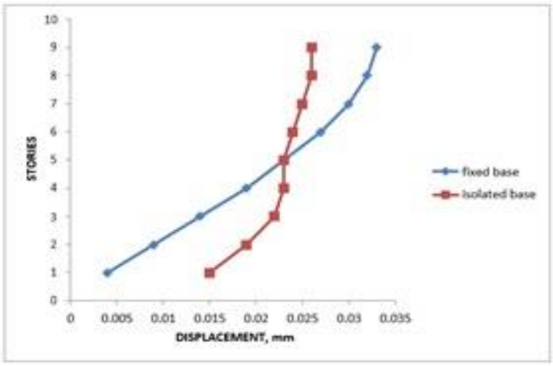
• Effective stiffness • Effective dampness	= =	1500000 KN/m 0.05 KN-s/ m
Direction	=	**U2**
LINEAR PROPERTIES		
• Effective stiffness • Effective damping	= =	800 KN/m 0.05 KN-s/ m
NONLINEAR PROPERTIES		
• Stiffness • Yield strength • Post yield stiffness ratio	= = =	2500 KN/m 80 KN 0.1
Direction	=	**U3**
LINEAR PROPERTIES		
• Effective stiffness	=	800 KN/m
• Effective damping	=	0.05 KN-s/ m
Nonlinear properties:		
• Stiffness	=	2500 KN/m
• Yield strength	=	80 KN
• Post yield stiffness ratio	=	0.1

B. Push Over Analysis

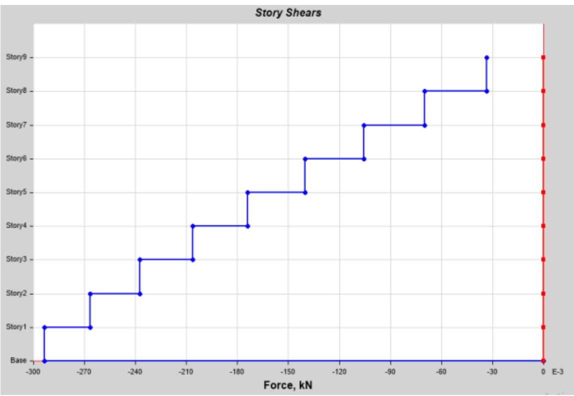
Push over analysis monitors the progressive stiffness degradation of a frame structure as it is loaded into the post elastic range of behavior. As described in the following, a generic moment-curvature relation is adopted to characterize the nonlinear variation in post elastic flexural stiffness of plastic-hinge sections under increasing moment



Graph 1 Push over curve for both the fixed and rubber isolated base



Graph 2 Displacement curve for all the stories for both fixed and rubber isolated bases



Graph 3 storey shear curve for isolated base structure

C. Storey Displacement

Table 7 storey displacement

Storey	For Fixed base Displacement (mm)	or rubber isolated base Displacement (mm)
Storey - 1	0.004	0.015
Storey - 2	0.009	0.019
Storey - 3	0.014	0.022
Storey - 4	0.019	0.023
Storey - 5	0.023	0.023
Storey - 6	0.027	0.024
Storey - 7	0.030	0.025
Storey - 8	0.032	0.026
Storey - 9	0.033	0.026

D. Storey drifts

Table 8 Storey drift values of both fixed and isolated base

Storey	Load case	storey drift values for fixed base structure	storey drift values for isolated base structure
1	RSX	0.000589	0.001415
1	Push X	0.011287	0.015901
2	RSX	0.000791	0.000526
2	Push X	0.007804	0.002252
3	RSX	0.000761	0.000414
3	Push X	0.006495	0.001699
4	RSX	0.000728	0.000376
4	Push X	0.005325	0.001501
5	RSX	0.000657	0.000376
5	Push X	0.004203	0.001256
6	RSX	0.000574	0.000271
6	Push X	0.00301	0.001013
7	RSX	0.000474	0.000271
7	Push X	0.002122	0.000769
8	RSX	0.00035	0.000148
8	Push X	0.0014122	0.000525
9	RSX	0.0002	0.000082
9	Push X	0.000768	0.00029

CONCLUSION:

The result of study shows that the structure response can be reduced by using base isolation system.

The base isolation reduces the base shear when compared to without base isolation building. A base isolation building, displacement is less, when compared to without base isolation building.

For fixed base building displacements vary significantly from bottom to top storey. But for base isolation building displacements are nearly same from bottom to top.

Compared to fixed base building frequency is very less in base isolated buildings. So base isolation method is more sufficient

As from the performed analysis for the fixed base and base isolated structures there is a reduction in base shear up to 40% for isolated base as compared to fixed base.

The storey displacements for all the respective stories are reduced in respect to top storey 30% of storey displacement has reduced for base isolated structure compared to fixed base structure

For the case of seismic zones where the lateral loads vary designing of structure with seismic isolation may be more prominent with respect to fixed base. These lateral loads accounted towards seismic nature may show less effect on the structure

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