A REVIEW ON COMPARATIVE STUDY OF BASE ISOLATION TECHNIQUES IN REDUCING SEISMIC EFFECT IN STRUCTURES

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Abstract : It is the need of present time to build structures which can withstand against the seismic conditions.It has been observed that Occurrence of earthquake was very less in the past ,but in present time it has become common. As now a days our cities are becoming more denser , skyscrapers has been built side by side, so if any structure collapses it will also leads to damage the structure near its surrounding. To counteract this problem, our building technique is shifting from fixed to flexible structures . Flexible structures are more safe than rigid and conventional structures because they are capable of dissipating the seismic energy. As the technology is upgrading ,new techniques have came out ,among them most popular is " Base isolation technique" and it is widely used all across the world.

KEYWORDS :- Base isolation, Rigid structures, seismic effects.

INTRODUCTION :-

Earthquake resistant design of Structures depends upon strength ,stiffness and inelastic deformation capacity of a building which are enough to resist earthquake force.

This is achieved by implementing appropriate structural configuration and careful detailing of structural member. Most promising and advance technique for earthquake resistance is not to strengthen the structure ,but to reduce the earthquake generated forces acting upon it.

Two major techniques are:-

1- Base isolation

2- Energy dissipation devices.

- a- Friction Dampers
- b- Metallic Dampers
- c- Visco elastic Dampers
- d- Viscous Dampers

BASE ISOLATION:-

It is the technique of separating the structure from its foundation by introducing isolator in between them. However it is impossible to fully separate the structures from its foundation.

The aim of base isolation is to minimize the energy that is transferred from ground motion to the structure by buffering it with a bearing layer at the foundation which has relatively low stiffness .

It is most widely implemented and accepted seismic protection system . The isolator are flexible which are helpful in dissipating the seismic energy. It is more effective when applied to high stiffness low rise buildings. Base isolation technique is necessary for the following situations:-

. When structure is located in a high seismic intensity zone.

. Existing structure is unsafe.

. Minimise the damage to primary and secondary structural members.

. Cost economic of the structure with and without isolator.

There are two basic types of base isolation technique:-

1- Elastometric based system

2- Isolation system based on sliding

Literature review:-

For the past times, Earthquakes has been the source of damage to life and property . They may occur any time And at any place,often in high seismic zone and rarely in other areas . They come once but their impact remains for many years . Sometimes the cause is natural and sometimes the cause is man made.

As our technology is growing day by day we are also affecting the nature , thus this imbalance results in various hazards . Earthquake is one of them. As the population is growing and cities are becoming denser there is need for high rise buildings and to protect these structures from the impact of earthquake, the earthquake resistance design in the form of base isolation is needed.
In conventional design of buildings the focus is mainly on the stiffness of the building so that they do not collapse even if there is strong earthquake.
The structure may survive in it but after the earthquake ,it lefts the structure non functionable. Also during earthquake it also damages the non structural elements and some structural elements, this leads to a big problem.
Some of the structures such as hospitals needs to be always functional even after the earthquake.
Thus there came a need to implement base isolation technique, which can protect the structure and also maintains its functionality. It is cost effective in its initial period but it is economical in its long term.
The base isolation works by decoupling the structure from its base to foundation and introducing a base isolator with low horizontal stiffness and high vertical stiffness ,so if the ground is moving then the structure will experience little movement

1st application in New Zealand in 1974

1st US application in 1984

1st Japanese application in 1985

US has 80 buildings and 150 bridges

Japan has 1000 buildings and 500 bridges

1st Indian application in 2003

Frank Lloyed wright (1921) ,was the first person to implement the base isolation technique for imperial hotel in Tokyo . He inserted short length piles closely spaced in 8 ft thick soil layer lying under the thick mud layer over the hard strata.
The building survived the earthquake of 1923.

Martel (1929), Green (1935) ,Jacobson (1938), firstly proposed by Martel the concept of "flexible first storey" in which the lateral stiffness of first storey columns were designed with very low stiffness as compared to columns of other storey above it. So that under earthquake loading the deformation would be concentrated in these first storey columns.**RYUITI (1941,1951,1952) & caspe (1970,1984)** , they proposed many types of rollers bearing system to overcome the problems of "flexible first storey" concept. Due to unpredictable direction of earthquake this system did not succeed
MEDLAND (1979), TADJBAKSH (1982), Pan and Kelly (1983,1984), they examined the effectiveness of lead rubber bearings as base isolator in multi storey building and studied the seismic response by modelling the structure as a rigid block supported on an isolation system.
TADJBAKSH (1983,1985), studies the response of a shear type building supported on the laminated rubber bearing system under random ground motion.

Dona meriya chacko (1966,1970), he proposed that a building with irregular opening (L shaped) at the middle of the structure is less resisted to earthquake as compared to the other models. And when LRB is placed as an isolator in the building there occurs a displacement in the building as compared to zero displacement in fixed building , also the time period of base isolation building is increased.
CONSTANTINOUS et .al (1991), proposed an isolation system consisting of multidirectional sliding teflon bearings and displacement control devices. The device was capable of Re centering and controlling displacement during earthquake and rigidity under service loads.

Kunde and JANGID (2003) , the vertical mounting and bearings are used to reduce vertical vibrations in bridges and also to control thermal stresses.
Panayiotis & Michael (2006), in elastomeric isolation system damping is provided by lead extrusion and in frictional system friction provides the means for energy dissipation. Rubber and steel are combined together to form elastomeric based isolation system
MATSAGAR and Jangid (2008), earthquake leads to loss of non structural components and also leaves the structure non functional which needs to be repaired ,this costs more than installing the base isolator.It is found that base isolation is useful in retrofitting of old structures.
TAKEWAKI (2011), some countries with high seismic zones such as New Zealand , United States and Japan are rapidly using this technique and are leading countries to adopt this technique . In recent earthquakes some base isolated buildings and structures have performed well in Japan.

Vinod Kumar verma (2015) , after analysis it is observed that using base isolation the flexibility is increased at the base level . Using LRB the time period is also increased which results in less transfer of lateral forces at the time of earthquake.
Time period at vertical irregular base model is increased as compared to that of plane irregular model.

G S Hiremath (2015), base shear is low in base isolated buildings as compared to plane irregular base isolated building, the vertical irregular base isolated building has less base shear.
At higher seismic prone areas the vertical irregular buildings gives better performances with base isolation as compared to plane vertical base isolated building.

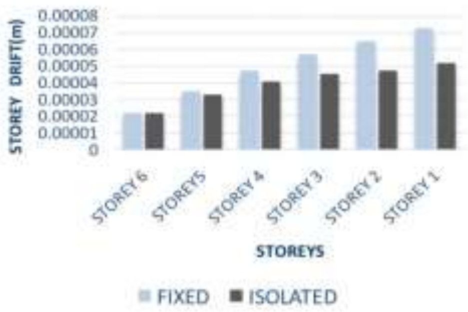
Dr.B.L.Agarwal (2016),G.Mounica (2016), Akhil Eliyas (2017), it is found that while providing LRB in G+5 storey buildings the base shear is reduced by 40% due to which the structure becomes stable as compared to fixed base during earthquake. Also the top storey drift is reduced by 60% in base isolated structures as compared to fixed base. There is increase in response from 0.26 sec to 0.36 sec for isolated base building.

S.No	Main Parameters of Building	Values
1.	No. Of storeys	G+5
2.	Length in X direction(m)	44.72
3.	Length in Y direction(m)	21.2
4.	Length in Z direction(m)	18.23
5.	Height of each storey(m)	3.2
6.	Depth of foundation(m)	2
7.	Seismic Zone	Zone IV
8.	Response Reduction Factor(R)	3
9.	Importance factor(I)	1
10	Zone Factor(Z)	0.24

Fig, Input parameters of building

S.No.	Parameter of Building	Result
1	Maximum Bending Moment(kNm)	264.16
2	Maximum Storey Drift (m)	0.00073
3	Maximum Storey Acceleration(m/s2)	1.2516
4	Maximum Lateral Displacement(m)	0.0043
5	Time period(sec)	0.36

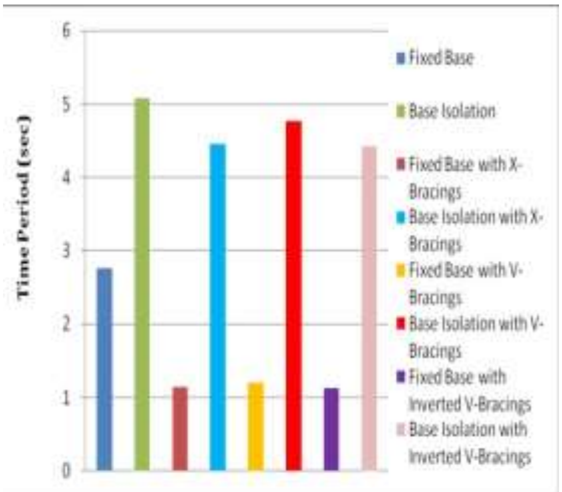
Fig, analysis result of base isolated building

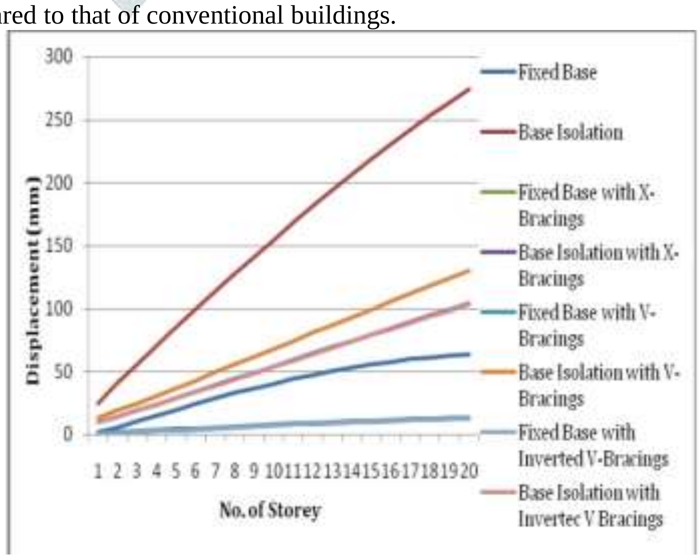


Fig, Storey acceleration vs No.of storeys

Fig, Storey drift vs No.of storey

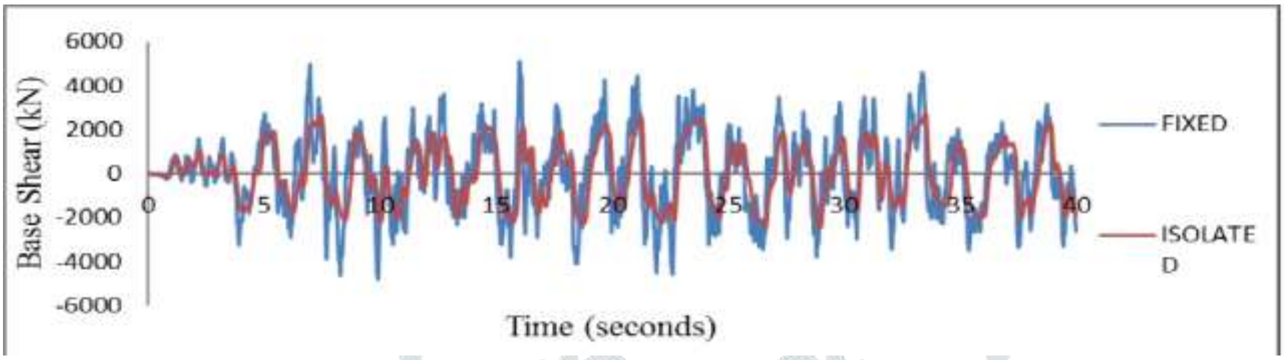
Ashish R (2016), Akhtar (2017) ,Tejas R wankhade (2017),
After a lot of research ,results shows that while using HDRB and FPS isolator , the base shear in X direction is reduced by 70% using HDRB and 94% using FPS .
In Y direction it is reduced by 70% using HDRB and 85% using FPS .
Time period of both the isolated structures is increased as compared to fixed base.
Storey drift and acceleration is also reduced as compared to that of conventional buildings.



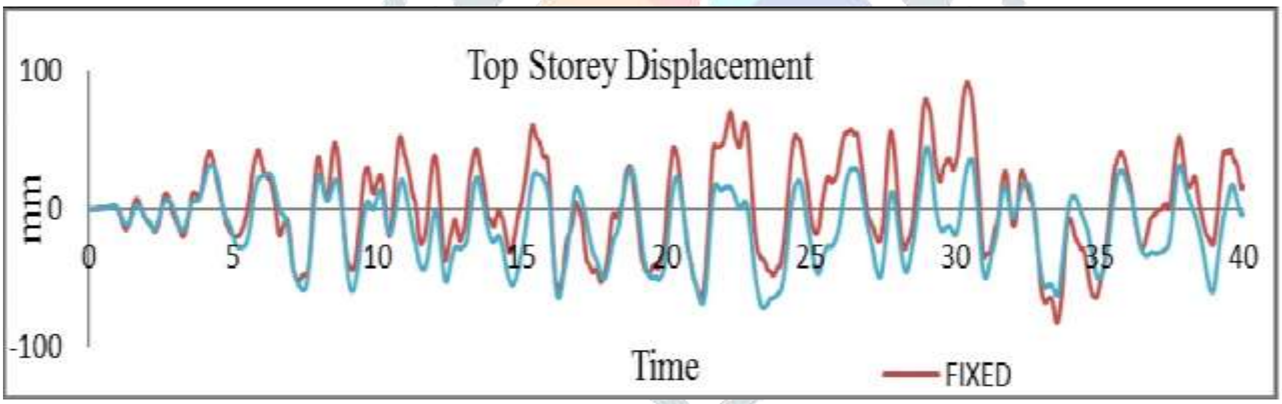


Praveen J.V (2017), B.R Govardhan (2017),Naveen k (2017),
The performance of RC frames under fixed and isolated base in seismic zone 5 is checked.
8 different models of 20 storey were considered for analysis.
It was found that storey displacement was more in base isolated model as compared to fixed model.
Storey drift was less in base isolated model as compared to fixed model.
Storey acceleration was low in base isolated model as compared to fixed base.
The displacement was higher in base isolated model as compared to fixed base and drift was also reduced in base isolated model.

FAHAD BIN KHURSHID (2016), He performed a case study to compare the response of base isolated building with conventional building using finite element software (SAP 2000) and observed that the base isolation reduces the demand forces by shifting the time period of the structure. The displacement can be controlled by using additional damper in the structure. He considered G+8 storey rc framed building with LRB isolator to compare response of fixed base and isolated base. And there 47% reduction in base shear was observed. And there was maximum storey drift from 0.3% to 0.1%.

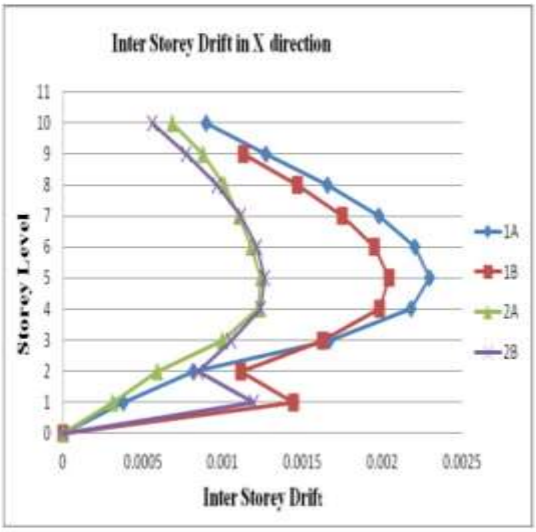


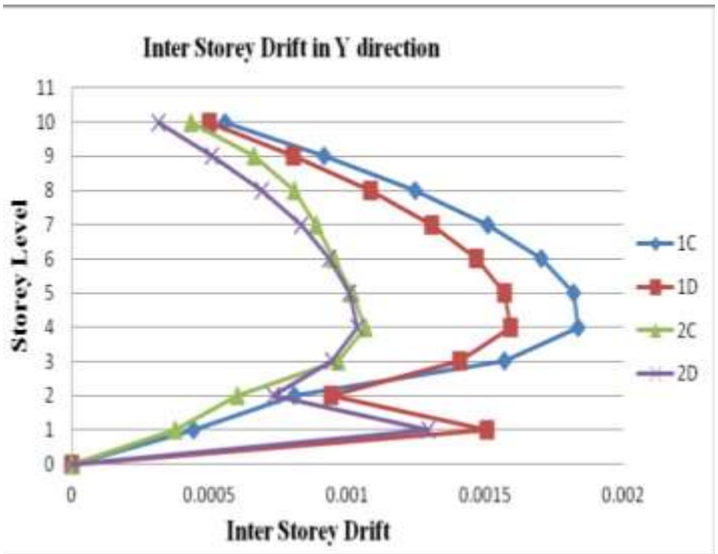
Fig, comparison between fixed and isolated base shear



Fig, comparison between top storey displacement of fixed and isolated building

SHAMEENA KHNANNARAR,M.H KOLHAR (2016), They performed analysis of 10 storey RC building in ETABS (15.1) for both fixed and base isolated building by static and response spectrum method with LRB as isolator .They observed that fixed base models have zero displacement at base where as isolated model have some lateral displacement at base , with increase in fixed base as compared to isolated base model.Also with increase in heoght inter storey drift reduces in isolated base model as compared to fixed base . In case of storey acceleration, with increase in height the storey acceleration increases in fixed base as compared to isolated base model.





Conclusion:-

Base isolation technique is very much useful in high seismic zone. They not only resist seismic forces but also leaves the structure functionable after earthquake.Base isolators such as LRB provides high vertical stiffness and low horizontal stiffness as compared to vertical,thus reduces the base shear and inter storey drift with increase in height.They also increase the response time of structure and dissipates the seismic energy.

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