

Review on Non-Linear Analysis of New 3D Skip-Floor Staggered Shear Wall Structure

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ABSTRACT: Nonlinear Analysis of a New 3D Skip-Floor Staggered Shear Wall Structure. The elastoplastic nonlinear analysis is provided by considering both spatial effect and influence of slab and connecting beam. Therefore, this new structural system has good economic benefits and wide applications. Due to scarcity of space and also shifting of people from rural to urban areas, it's currently necessary to establish high rise structures. Earthquake forces can be viewed before figuring out the security of a framework. Hence stiffness of columns should be sufficient to remain safe during an earthquake, it was discovered that for offering high stiffness in the columns, the dimensions of columns turn out to be huge plus it's tough to create huge size columns because of congestion of space. Hence a substitute was discovered for high rise buildings that are called as shear wall. Shear wall behaves as a broad column. It's extremely large in plane stiffness and also supports gravity load. It offers the objective of carrying load that is heavy and offers resistance against earthquake forces. When shear walls are situated in beneficial positions in a construction, they are able to be extremely effective in resisting lateral loads originating from earthquakes or wind, moreover we can't give shear walls at the places because of financial considerations, therefore it's really needed determining highly effective, ideal and efficient location of shear walls; therefore, primary target is usually to establish the optimum place of shear wall space in multi storey buildings. Thus it's crucial to get an ideal and accurate place of shear walls. An effort was put forth finding the spot of shear walls in staggered shear wall structure. A 3 D analysis of shear wall structures was performed by using the ANSYS software package. Various models are pulled by developing configurations and locations different of shear walls. Different parameters studied are Storey Displacement. Based upon these variables, best model have been recommended.

KEYWORDS: staggered shear wall structure; coupled shear wall structure; nonlinear analysis;

I. INTRODUCTION

1.1 Reinforced Concrete (RC) Shear Wall

The elastoplastic nonlinear analysis is provided by considering both spatial effect and influence of slab and connecting beam. The seismic internal force distribution is also studied. It shows that compared with the 2D model and traditional 3D coupled shear wall structure, 3D skip-floor staggered shear wall structure has superiority in many respects, such as initial rigidity, uniformity of force, energy dissipation, etc. Reinforced concrete (RC) shear walls are especially developed structural walls contained in the buildings to refuse horizontal forces that are caused in the plane on the structure because of wind, other forces and earthquake. Shear walls have really tall in plane strength and stiffness, that may be utilized to simultaneously resist considerably large horizontal support and loads gravity loads.

Reinforced concrete wall thickness differs from 140 mm to 500 mm, based on horizontal forces because of wind, building age, earthquake etc, and thermal insulation requirements. Generally, these walls are constant throughout the construction height; however, several walls are shut down at the road face or maybe basement level to allow for business or maybe parking spaces. Normally the wall structure is symmetrical with regard to one axis of symmetry in the plan.

RC shear walls carry earthquake loads down to the foundation. They provide large strength and stiffness to buildings in the direction of their orientation.

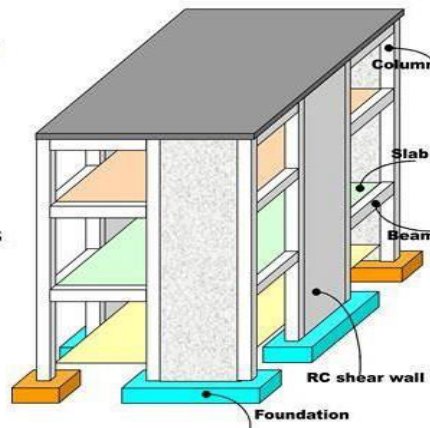


Fig. 1.1 General Configuration of a Shear Wall (Courtesy: <http://www.nicee.org>)

Shear walls offer lateral load resistance by transferring the wind or maybe earthquake load to foundation. Besides, they impart lateral stiffness to the system and in addition sell gravity loads. When shear walls are situated in beneficial positions in the structure, they are able to develop an effective lateral force resisting system.

1.2 Functions of a Shear Wall

Shear wall are among the outstanding ways of offering earthquake resistance to multi storeyed reinforced concrete buildings. When RC Multi Storey development was created with no shear walls afterward column sizes are very heavy and metal necessary is large. Therefore there's great deal of congestion at these bones and also it's tough to place and vibrate concrete at these locations and also displacement is very heavy which induces major forces in member. Shear walls can become crucial from the perspective of control and economy of horizontal displacement.

1.3 Conventional Study of Shear Wall with Respect to Load Bearing Wall

Load bearing masonry wall is really fragile in nature. Because of various types of stresses including shear, tension, torsion etc brought on by the earthquake, the traditional unreinforced brick masonry structure may possibly collapse immediately in the unexpected earthquake. The RCC frame structures are slender, in comparison with shear wall concept of box like 3 dimensional structures. However, it's likely to develop earthquake resistant RCC frame, it takes very everyday abilities in design, detailing and construction, that can't be anticipated in most kinds of building project.

1.4 External Forces Acting on Shear Wall

Shear walls resist 2 forms of forces shear forces and uplift forces. Shear forces are produced in stationary buildings by accelerations resulting from ground motion and also by outside forces as P-waves and wind. This activity creates shear forces through the level of the structure and also the bottom and top shear wall connections.

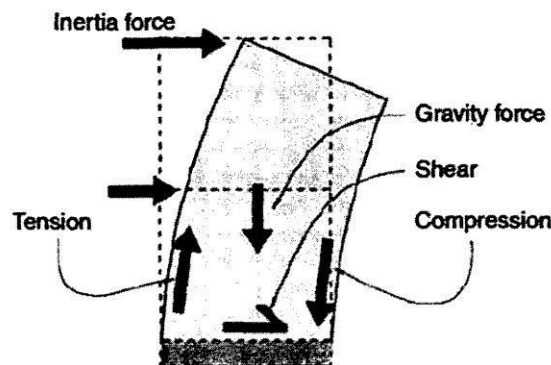


Fig. 1.2 Forces Acting on a Shear Wall

1.5 Architectural Aspects of Shear Wall

Shear walls tend to be supplied between column lines, in stair wells, lift wells, in shafts which house additional utilities. Most RC buildings with shear walls have columns; these columns primarily have gravity loads (i.e. those thanks to self-weight and contents of building). Shear walls offer lateral stiffness and large strength to structures in the path of the orientation of theirs that substantially reduces lateral sway of the structure and thereby reduces harm to design and its contents. Since shear walls offer big horizontal earthquake forces, the overturning influences on them are big.

1.6 Seismic Design Philosophy

The viewpoint of a specific document suggests the normal amount of security it can easily be expected to give. Code documents clearly suggest which their criteria are minimum needs which are intended to offer the security but to not insure against damage.

1.7 Ductile Design of Shear Walls

Even though this study doesn't cope with the design of shear wall but guide to the fundamental code guidelines aids in improved understanding the principles. Just love reinforced concrete (RC) beams and also columns, RC shear walls also do better if meant to be ductile. Overall geometric ratios of the structure, amount and types of reinforcement, and link with remaining components in the construction aid in enhancing the ductility of walls. The Indian Standard Ductile Detailing Code for RC members (IS: 13920 1993) offers very special design tips for ductile detailing of shear walls.

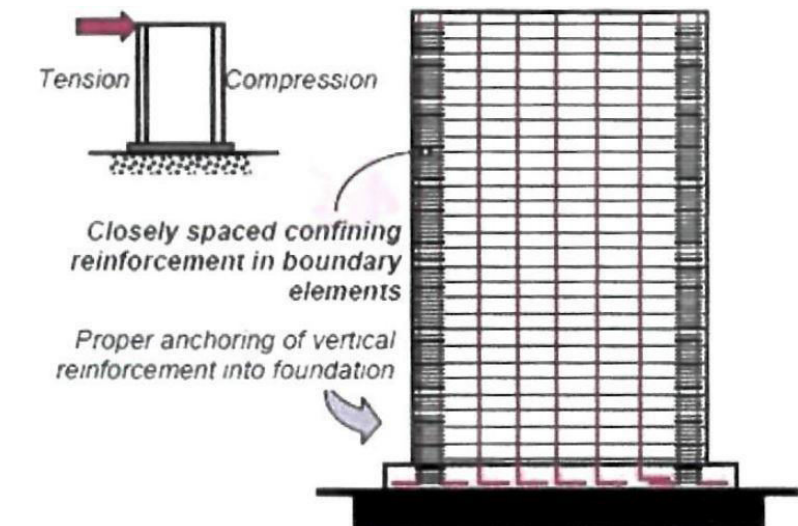


Fig. 1.3 Layout of Main Reinforcement in Shear Walls as per IS: 13920-1993 (Courtesy: <http://www.nicee.org>)

1.8 Boundary Elements

Under the big overturning effects brought on by horizontal earthquake forces, tips of shear walls experience excessive compressive plus tensile stresses. To confirm that shear walls act in a ductile way, concrete from the wall end regions have to be reinforced in a unique manner to experience these load reversals without losing toughness. End areas of a structure with improved confinement belong in the boundary elements. This special confining transverse reinforcement in boundary elements is similar to that offered in columns of RC frames. Often, the thickness of the shear wall in these boundary elements is higher. RC walls with boundary elements have considerably better bending horizontal shear force and strength carrying capacity, and are thus less prone to earthquake damage than walls with no boundary elements.

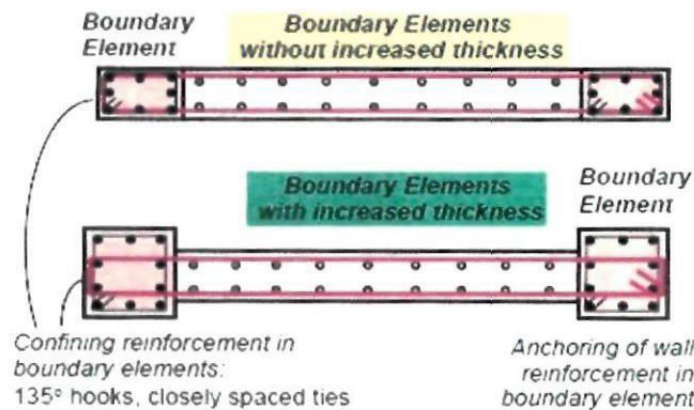


Fig. 1.4 Boundary Elements (Courtesy: <http://www.nicee.org>)

1.9 Overall Geometry of Shear Walls

Shear walls are oblong in cross section, i.e. one dimension of the cross section is significantly bigger than the other person. While rectangular cross section is most common. C-shape and L- sections may also be utilized (Figure 1.5). Thin-walled hollow RC shafts around the elevator core of buildings also serve as shear walls, and must be taken advantage of to withstand earthquake forces.

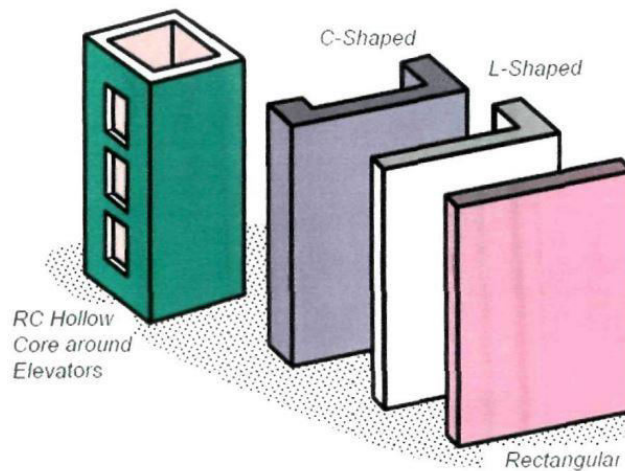


Fig. 1.5 Different Geometries of Shear Wall

1.10 Staggered Shear Wall Panels

It's well established truth that shear walls are very optional in lateral load resistance, though it's restricted to low rise to medium rise reinforced concrete buildings. It's thought that shear walls will be good at high rise constructions as well, but its overall performance will be completely different from low rise buildings. Restriction within the architectural design by the existence on the shear walls might help intimidate the designers from following the shear walls. As a result of this a fresh idea of delivering storey strong and bay broad discrete staggered shear wall panels was released.

1.10.1 Concept of Staggered Shear Wall Structure

The method of the staggered shear wall system is displayed in Fig.1. In this specific new type shear wall structural structure, each shear wall is set at staggered location on adjacent floor and adjacent shear walls are staggered with one another. Only one end of floor slab is supported on leading edge of a single shear wall; the opposite end of floor slab is supported on bottom edge of adjacent shear wall. The advantage column plus beam are placed beside every single shear wall. The embedded column as well as connected beam is set on each floor. The benefit of this particular structural system is its major utilize space with little span floor slab.

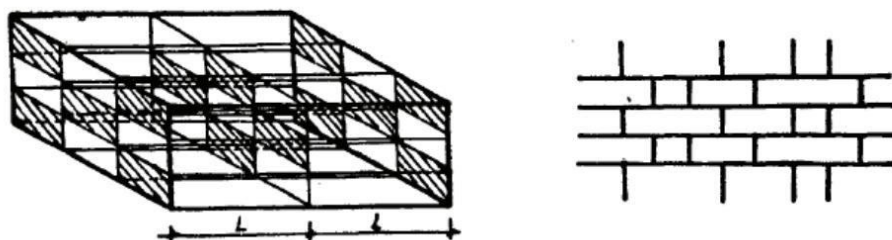


Figure 1.6. Mode of staggered shear wall structure

1.10.2 Dynamic Analysis of Staggered Shear Wall Structure

Dynamic analysis of staggered shear wall system suggests that this brand new framework has really good powerful properties and seismic performance. With exactly the same materials and dimensions, the lateral stiffness and also seismic behaviours of the staggered shear wall system is like those of coupled shear wall system, and then time history curves show extremely near results. It may be obtained the brand new framework has really good structural behaviours. This framework is able to decrease the bottom level shear seismic coefficient of shear wall structures; therefore it is able to solve several issues in regular shear wall structures, for example larger space and lateral stiffness, as well as greater seismic pressure that will result in larger bottom shear seismic coefficient. It too may be an effective technique adjusting structural stiffness and also dead weigh in design.

1.11 Reinforced Concrete Braces

Braced frames widen the resistance of theirs to lateral forces by the bracing action of inclined members. The braces stimulate forces in the connected columns and beams so which all work as one just like a truss with all the participants put through stresses which are for probably the most part axial. This axial response leads to much less occasions and consequently smaller sizes of beam and also column areas than moment resisting frames.

1.12. Advantages and Disadvantages of Shear Wall in RC Buildings

1.12.1 Advantages

- Appropriately created and detailed buildings with shear walls have revealed excellent performance in past earthquakes.
- 1 Shear walls in high seismic regions require special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse.
 - 2 Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site.
 - 3 Shear walls are efficient, both in terms of construction cost and effectiveness in Minimizing earthquake damage in structural and non- structural elements (like glass windows and building contents.
 - 4 Determining the adequacy of existing floor and roofs slabs to carry the seismic forces.
 - 5 Transfer of diaphragm shear into the new shear walls by dowels.
 - 6 Adding new collectors and drag members to the diaphragm.

1.12.2. Disadvantages

- 1 The discontinuity within the shear wall additionally a kind of stiffness irregularity that makes the structure as soft storey.
- 2 The structure with discontinued shear wall enhanced the overturning moments at foundation creating extremely high uplifting that requires both new foundations.
- 3 Increases the dead load of the structure

1.13 Problem Statement

It's well established truth that shear walls are very good at lateral load resistance of reinforced concrete buildings. The functionality of shear walls in high rise buildings will be completely different from low rise buildings. Restriction within the architectural design by the existence on the shear walls might help intimidate the engineers from following the shear walls. As a result of this particular reasons a fresh idea of delivering storey deep and bay broad discrete staggered shear wall panels are already created and nonlinear analysis had been carried out on the models.

Of the configurations studied, the zigzag shear wall configuration is discovered to be much better compared to another systems studied in managing the reaction to earthquake loading. The diagonal configuration is discovered to be getting significant part in managing the result of buildings to earthquake.

1.14 Scope of project

Shear wall behaves as a wide column. It's extremely high in plane stiffness and also supports gravity load. It offers the objective of carrying load that is heavy and offers resistance against earthquake forces. When shear walls are situated in beneficial positions in a construction, they are able to be extremely effective in resisting lateral loads originating from earthquakes or wind, moreover we can't give shear walls at the places because of financial considerations, therefore it's really important to decide ideal, efficient, and effective location of shear walls

II. LITERATURE REVIEW

Chandurkar, Pajgade et.al (2013)(1) evaluated the result of a 10 storey developing with seismic shear wall structure using ETAB v 9.5. Main concentration was looking at the changes of response by changing the place of shear wall system within the multi storey structure. four models were studied a person to become a bare frame structural system in addition to rest 3 were of two style structural system. The outcome was great for shear wall in span which stands at corners. Much larger dimension of shear wall was found to be insufficient in ten and even under 10 stories. Shear wall surface is an effective and economical option for high rise structures. It was observed that changing roles of shear wall was found to entice forces, therefore proper positioning of shear wall system is crucial. Significant quantity of horizontal forces was brought by shear wall system every time the dimension is big. It had also been discovered that shear wall space at considerable locations decreased displacements as an outcome of earthquake.

Viswanath K.G et.al (2010)(7) investigated the seismic overall performance of reinforced concrete structures utilizing concentric steel bracing. Analysis of a four, eight, twelve at the same time as sixteen storied building in seismic zone IV was finished by using Staad Pro program, as per Is actually 1893: 2002 (Part I). The bracing was provided for peripheral columns, and also the convenience of steel bracing distribution across the amount of the framework, over the seismic performance of the framework was studied.

Chavan, Jadhav et.al (2014)(2) studied seismic evaluation of reinforced concrete with assorted bracing plans by equivalent fixed method through the Staad Pro. Software. The plans considered were diagonal, V type, inverted V-type and X-type. It was observed that lateral displacements lowered by 50 % to 60 % and maximum displacement lowered by using X type bracing. Base shear of the framework had also been discovered to increase through the blank frame, with of X type bracing, indicating increased stiffness.

Esmaili et al. (2008) (3) assessed the structural component of a 50 6 stories high tower, placed in a remarkable seismic zone in Tehran. Seismic analysis of the framework was conducted by nonlinear compelling analysis. The present structure had main surface and also the side walls of it's as shear walls, placed on the main wall structure by coupling of beams. The realization was planning on time dependency of concrete. Steel bracing item should be provided for energy absorption for ductility, but axial load can have unwanted effect on the functionality of theirs. It is both conceptually and economically unacceptable to utilize shear wall structure as each gravity plus bracing technique. Confinement of concrete in shear wall space is solution which is great for providing ductility and stability.

Akbari et al. (2015)(4) assessed seismic vulnerability of steel X braced and chevron braced Reinforced Concrete by developing analytical fragility curve. Research of various variables as amount of the frame, the p delta influence along with the percentage of bottom shear only for the bracing technique was finished. For some created base shear, steel braced RC two methods have really small injury probability and larger capacity than unbraced telephone operating system. Mixture of even more powerful bracing and weakened frame cuts down on the harm likelihood on the entire system

Regardless of height of the frame, Chevron braces are certainly more powerful compared to X type bracing. Only just in case of X type bracing method, it is much far better to distribute foundation shear regularly between the brackets and definitely the RC frame, whereas in case of Chevron braced method it is appropriate to allot greater worth of share of base shear over the brackets. Including p delta effect increases harm probability by 20 % for smaller two systems as well as by 100 %

Kappos, Manafpour et.al (2000)(5) presented completely new strategy for seismic design of RC developing primarily based upon achievable partial inelastic type of the framework in addition to performance requirements for two special limit states. The treatment is produced to a format which might be integrated with design codes as Euro code 8. Time-

History (Nonlinear dynamic) analysis and also Pushover analysis (Nonlinear Static analysis) is examined. The adopted technique confirmed far better seismic performance than normal code procedure; at minimum in case of typical RC frame building. It was learned that behavior under "life safety" was much easier to handle than under serviceability earthquake because of the adoption of performance demands affecting ductility really needs of users for "life safety" earthquake.

Yamada et al.(2015) (6) studied, experimentally and analytically, deformation & fracture qualities of lateral load resisting systems shear wall structure for Steel and rcc frame bracing for metal multi storey frame below earthquake, since designs having 3 different spans together with 3, 6 also as 9 storeys. Deformations along with facture results for every one of the three cases are compared and differences are clarified by normalization of suggested horizontal resisting proportions.

S.S. Patil et al.2013 (7) presented seismic evaluation of increased rise building through the use of various lateral load resisting system that are one) bare frame, 2)brace frame, three) shear wall structure frame. This evaluation is completed with Response Spectrum Method, as well as utilizing STAAD Pro application. Test final result is grounded on details as base shear, story drift and story deflection. They recognized that shear wall design offers a reduced amount of story deflection in addition to story drift than bare frame and braced frame.

Hassaballa A.E. et al.(2013)(8) eight studied the seismic analysis of any RC developing, and check out the performance of current building in case put through seismic loads. This specific structure frame was analyzed by Response Spectrum Method in addition to frame is computed via STAAD Pro application. For seismic evaluation of multistory structure they being used static load and seismic load for end result that design primarily based on reaction spectrum technique necessary sizable dimension of to fight big displacement. And also discovered that drift resulting from nodal displacement as an outcome of blend of static load and seismic loads was around 2 to 3 times the allowable drifts.

Mindaye et al, (2016)(9) analyzed the seismic impact of noncommercial G 10 RC frame development is analyzed through the linear assessment methods of equivalent fixed lateral forces along with Response spectrum technique using ETAB primary 2015 software as per Is actually 1893:2002 part1. Various result like lateral force, overturning moment, story drift, displacement, base shear are plotted to assess the result of the static and dynamic analysis. They realized that effective story shear is under story shear for all those situations. Equivalent fixed lateral force technique provides greater worth of pressure in addition to moments that make creating uneconomical hence consideration of reaction spectrum approach is essential..

Padol S. et al.(2015)(10) studied the seismic evaluation of multistoried RCC construction with mass irregularity at numerous floor amount are performed. This paper highlights the effect of mass irregularity on different floors in RCC construction with Time History Method in addition to evaluation is achieved by ETABS software. They recognized that when program has many irregularity the effect of earthquake on structure might be lower through shear wall, base isolation etc..

Patil A. S, et.al (2013) (11) studied nonlinear effective analysis of 10 storied RCC developing considering different seismic intensities and analyzed seismic consequence of that framework. The anatomical structure under consideration is modeled using Sap 2000 fifteen software as well as 5 unique time records are being used. The results of re-search demonstrates comparable variations design in seismic effect as base shear and storey displacements and recognized that time past is useful method used for seismic analysis. It has a better check on the security of system examined and produced.

Bhagwat et al.(2014)(12) studied effective analysis of G 12 multistoried practiced RCC developing considering for Koyana and Bhuj earthquake is taken away. The precious time History Analysis and Response Spectrum Analysis together with seismic responses of the framework are comparatively studied. The modeled using ETABS9.7.2 application. two time histories (i.e. Bhuj and Koyana) happen to be used to develop different criteria (base shear, storey displacement, storey shear), as well as discovered that, the valuation of base shear for Bhuj earthquake is 49.11 % a lot more than the Koyana earthquake, and Response Spectrum technique offers 50 % more consequence than Time History Analysis.

Dubey et al. (2015) (13) presented design of multistoried unusual construction with 20 accounts and modeled it with software STAAD PRO for seismic zone IV in India, potent effect of making under actual earthquake, DELINA

(ALASKA)2000 are deemed. This paper highlights the comparison of Time History Method and Response Spectrum Method.

Rampure et al. (2016) (14) studied the effective time history analysis along with reaction spectrum analysis related to a concrete gravity dam by using STAAD PRO. Finite component tactic is used to assess the dam together with a concrete gravity dam style is prepared in STAAD PRO to do time history analysis & reaction spectrum evaluation and comparison is finished between both these strategies. They realized that STAAD PRO is extremely realistic & much less difficult for powerful analyses which comes with a computing environment to explore modeling assumption and computational tasks affiliated with the restored along with seismic structural balance of gravity dam. It is crucial to assess the framework by powerful analysis of both these method for below the amount of dam 100m and above the level of dam 100m.

Hawaldar et al. (2015) (15) presented G+12 storey developing type with and also without infill the time period history analysis used for Bhuj and koyna earthquake have it is taken through in ETABS 2013 application. The seismic responses of story displacements, storey drifts are commonly found. Time history plots of base force v/s time along with roof displacement v/s period for every time history capabilities are compared plus examined. They recognized the displacement values for bhuj functionality are larger when compared with the displacement value for koyna performance as well as many for infill building are under that without any in filled creating and drift importance of bhuj function was much more in comparison with drifts for koyna functionality and infill drift values are comparatively a lot less than for with no infill drift values for just as time history feature.

2.3 Gap Areas and Problem Formulation

From the above literature review it's found that the majority of the investigation effort stressed on reduced configurations of shear walls in plan. Further configurations of shear wall panels in elevation i.e. staggered shear wall panels and mixtures of shear wall surfaces plus RC braces in multi storey buildings aren't much talked about in literature. The existing study is performed to deal with these spaces and also offer the base for better understanding and enhanced use of shear wall plus RC braces.

III. CONCLUSION

Comparative analysis of weak parts and cracks development of skip floor staggered shear wall system, Treatment ideas for weak components and weak parts are suggested in this specific project. Relevant research results are able to deliver the specialized basis as well as important details for promoting the use of skip-floor staggered shear wall structure as well as the planning of the technical specifications. The structural stiffness and also deformation is consistent, therefore it is able to better the entire stiffness efficiently and also allow it to show up wholly bending state, that are helpful to boost the capability of resistance to horizontal force and ductility. The structural analysis result indicates the wall amount decreases by 25 % and also the old weight decreased by 20 % comparing the staggered shear wall with traditional shear wall, while each have identical lateral stiffness. The joint stresses of above and below shear walls are very complicated that the shear failure or maybe the failure brought on by the diagonal cracks quickly occurs. And so at the joints the strengthening diagonal bars can be worn except the embedded column as well as connected beam to make certain the joint stiffness and strength.

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