International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

A Review on Seismic Analysis of Hybrid Structures

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Abstract - *Hybrid systems are widely used for high-rise and super-high-rise structure in the world, and this structural framework has the benefit of minimizing investment. The seismic study of a high-rise hybrid situated in a seismic environment is involved in this article. The study of the structure models is carried out using the CSI ETABS 2019 program. The present research comprises RC structure and steel-concrete hybrid structure reaction continuum analysis with and without shear walls and compares parameters such as storey displacement, storey drift and storey shear of the RC structure and hybrid steel-concrete structure, with and without shear walls.*

Key Words: RC structure, Steel-concrete hybrid structure, Shear walls, CSI ETABS 2019, Response Spectrum Analysis.

1. INTRODUCTION

Today many multi-storey and commercial buildings in India have open storey's as an important feature. This is adopted to utilize the storey for parking, assembly halls and reception lobbies. The total seismic base shear of any building experienced during an earthquake is dependent on its natural period. This seismic shear distribution is dependent on the stiffness of the storey's and seismic mass of storey's along the height of the building.

Based on the overall shape, size, and geometry, along with how the storey shears are transferred to the ground, the building behaves during earthquake. The storey shears at different storey's in a building need to be transferred down to the ground by the shortest path; any discontinuity in the structural members results in the change in the load path. Buildings having vertical setbacks cause a sudden variation in earthquake forces at the levels of discontinuity. Vignesh Kini et al. [4]

1.1high rise buildings

High rise buildings which have fascinated mankind primarily for defense and subsequently for religious purposes in the earlier eras have found new relevance and wide appeal in recent years due to rapid industrialization, growing urbanization and population explosion. Tall structures are generally slender and are therefore vulnerable to all types of lateral loads ranging from wind, earth quake and blast to wave impact. Amongst the various types of lateral loads, seismic forces are drawing increasing attention in recent years with growth in seismic activity witnesses all over the world and have proved its impact on to be more catastrophic as vast area surrounding the epicenter and the population and infrastructure in the region are devastated by a severe earthquake. Generally, simple framed structures are design to carry gravity and lateral loading. Tall structures on the other hand are often resisting high wind loads and may encounter huge seismic demand. In such cases, it becomes necessary to employ special seismic resisting elements and unique structural configurations. Abhishek et al. [2].

1.2 Dynamic Analysis

Dynamic analysis is performed to evaluate the vibration effects on the structures. Effect of inertia forces are taken into consideration as loads are applied to the sample. In this analysis, loads are time varying and the corresponding fallouts are also time varying. It includes complex computational process requires deep knowledge of dynamics of structures. Barjesh et al. [5]

1.3 Linear Dynamic Analysis

Linear dynamic analysis is also known as response spectrum analysis. In this analysis, the structure is modeled and analyzed as a multi-degree of freedom system with linear elastic stiffness matrix and an equivalent viscous damping matrix. The fundamental natural frequencies and the mode shapes are calculated from the Eigen value obtained. Modal transformation then decouples the coupled equations of motion where the principle of orthogonality of the mode shapes with respect to mass, damping and stiffness matrices is applied. The response of each decoupled equation which represents the motion of a single degree of freedom system is obtained using elastic response spectra. Using the appropriate modal combination rules, the peak responses of the significant modes are combined. The response spectrum procedure is accurate when compared to the linear static procedure because higher modes or all the modes are considered in the response spectrum procedure while only the first mode is considered in the equivalent static procedure. But both linear static and linear dynamic procedure are based on linear elastic response. Vignesh Kini et al. [4]

Response spectrum analysis (RSA) is a method widely used for the design of buildings. Conceptually The method is a simplification of modal analysis, i.e., response history (or time history) analysis (RHA) using modal decomposition, that benefits from the properties of the response spectrum concept. The purpose of the method is to provide quick estimates of the peak response without the need to carry out response history analysis. This is very important because response spectrum analysis (RSA) is based on a series of quick and simple calculations, while time history analysis requires the solution of the differential equation of motion over time. Despite its approximate nature, the method is very useful since it allows the use of response spectrum, a very convenient way to describe seismic hazard. RSA is very appealing to practicing engineers because seismic loading is defined by means of a response spectrum. All design codes worldwide define seismic input (or hazard) by means of a code-compliant, typically smooth, response spectrum that can be easily adjusted according to the site seismic hazard. Such spectra are able to implicitly take into consideration the fact that structures are designed to resist seismic actions by deforming in elastically. Two variations of RSA are offered in almost every seismic design code. Following the notation of Euro code 8 (EC8 2004), these variations are the "lateral force method" and the "modal response spectrum analysis." This entry discusses the underlying concepts of both methods in a comprehensive manner. The interested reader is also advised to consult the classic textbooks of Chopra (2000) and Clough and Penzien (1975). Michalis Fragiadakis [10].

1.4 Elastic time-history analysis

As a supplement of elastic response spectrum analysis, it is necessary for super high-rise building to perform elastic time-history analysis under frequent earthquake. This paper chooses one artificial wave, which is synthesized according to the standard response spectrum, and three natural earthquake records, which are El Centro-EW (1940), WufengNE-NS (1999), and YunlincitySE-NS (1999). And the latter two come from Chi-Chi earthquake of Taiwan in 1999. All these waves are shown in Fig. 2. Corresponding frequent earthquake, the peak ground acceleration (PGA) of the construction site is 35 gal. Hence, scaling the three natural records to be compatible with frequent earthquake is necessary. Fig. 3 shows the acceleration response spectra of the artificial record and scaled natural records for frequent earthquake. And Fig.4 indicates the average acceleration response spectrum of the four input ground motions and the standard acceleration spectrum. These two figures bear out that the average response spectrum of ground motions matches the standard response spectrum in a statistical sense. JIANG Jun et al. [6]

1.5 Pushover Analysis (Non Linear Static)

Pushover analysis is performed by assigning non linear plastic hinges which can be moment rotation or moment – curvature hinges or can be user defined. In these analysis more priority is given to the shear deformation controlled hinges because coupling beam are shear dominant elements so assigning moment rotation or moment curvature hinges is not appropriate choice, although reinforced coupling beams are analyzed for flexure controlled hinges and acceptance criteria is checked with accordance to FEMA356 and ATC40 given in Table 3. ETAB's itself calculates target displacement according to the FEMA356 as per the overall height of the building. Abhishek Sharma et al. [11].

2. Literature Review

Tulay Aksu Ozkul et al. [1] In this study, effect of shear wall on seismic performance of an RC building was investigated. For this purpose, two different RC frame buildings with shear walls which exist in Van, Turkey and have structural damages caused by Van 2011 earthquake are considered. Buildings were modeled in SAP 2000 and nonlinear time history analyses were conducted using Van 2011 Earthquake acceleration record to determine the damage states of structural elements of buildings.

Abhishek et al. [2] evaluated the response of braced and un braced structure subjected to seismic loads and to identify the suitable bracing system for resisting the seismic load efficiently. They design a typical RC framed structure of a typical tall building located in a high risk seismic zone and investigates the changes in the structural behavior due to the provision of seismic resistant structural systems such as different bracing systems. Have analyze the important structural response parameters such as base shear, bending moment, shear force, lateral displacement, inter-storey drift, for the configuration investigated such as bare frame and different bracing systems.

Shaikh Muffassir et al. [3] determine the most effective shape under complex wind environment and also to determine the effective structure between RCC and Composite. This paper overviews the entire effect of wind on high rise structure and detailed study of current challenges due to wind. In addition, this paper discusses to predict the wind pressure and forces on actual buildings with different shapes and also performed the wind analysis of building for different plan configuration for estimating wind load effect on high rise structure.

Vignesh Kini et al. [4] Explains study the response and behavior of a G+20 multi-storey RC and steel-concrete composite multi-storey building with floating columns at middle of penultimate bay, with and without shear walls situated in Zone IV subjected to seismic forces. They

compared the parameters like storey displacement, storey drift and storey shear with RC and steel-concrete composite structure with floating columns at middle of penultimate bay with and without shear walls.

Barjesh et al. [5] studied to standardize the Dynamic response of Tall conventional RC frame building and dissimilar Tall Hybrid frame buildings for seismic zones IV and Zone V under Linear dynamic analysis. To equate the performance of unlike composite bracing types and RC shear walls along with their altered combinations with each other. To identify Dynamic behavior of Tall frame structures integrated with Outer Frame System with composite bracing included Mega bracing and RC core shear wall at middle of the building.

JIANG Jun et al. [6] introduced the design procedure of a super high-rise hybrid structure. Elastic analysis including response spectrum method and elastic time-history analysis, and nonlinear analyses including static and dynamic procedures are conducted. There are some conclusions can be drawn: (1) The results of elastic response spectra analyses calculated by two structural programs show the correctness of the calculating model. And the results of elastic time-history are basically identical with that of response spectra analyses. (2) Nonlinear elasto-plastic analyses under fortifiable and severe earthquake are performed to indicate the behavior of structure. The results show that the hybrid structure has well seismic performance and achieves the performance objective.

DR. K. CHANDRASEKHAR REDDY et al. [7] studied A high-rise building of 30 floors subjected to seismic, wind and live loads were analyzed using ETABS 2016 software. Behavior of the high rise building was shown clearly using the graphs and lateral displacements. It is found that the lateral displacements or drifts are more in zone 5 when compared to the zones 4, 3&2. It is also found that from the base reactions of structure obtained in zone 5, the story shear is higher in zone 5 than in zone 2. All members were designed using ETABS. The members which are not appropriate will be obtained and suitable sections are recommended by the software. Better accuracy of the analysis can be obtained by using this software.

S. Bahadir Yuksel. [8] The paper under discussion presents a series of quasi-static tests used to examine the behavior of steel reinforced concrete (SRC) walls subjected to high axial force and lateral cyclic loading. A total of six wall specimens were designed, including five SRC walls and one reinforced concrete (RC) wall. In the 'Summary' section of the discussed paper, the authors state that: 'The use of SRC walls has gained popularity in the construction of high-rise buildings because of their superior performance over conventional RC walls'. The authors also proposed that, the SRC wall specimens showed increased flexural strength and deformation capacity relative to their RC wall counterpart. The discussion is prompted to rectify some statements and conclusions of the paper under discussion. Copyright © 2015 John Wiley & Sons, Ltd.

Zheng Li et al. [9] Presented the calibration of performance objectives and design method for timber–steel hybrid structures. The inter story drift limits for the IO and CP performance levels were determined, and the damping effect was discussed. The yield drift and the drift corresponding to the collapse limit state considering 95% reliability were 0.5% and 2.5%, respectively. Regarding the damping effect of timber–steel hybrid structures, 4.5% was determined as the elastic damping, and the hysteretic damping of the system was directly related to the lateral wall: frame stiffness ratio λ. Increasing the lateral wall: frame stiffness ratio lowered the hysteretic damping of the timber–steel hybrid structural system. An expression was formulated to estimate the EVD for the timber–steel hybrid structures.

Michalis Fragiadakis [10] have studied the Response spectrum modal analysis has been presented, discussing that it is a simplified version of modal analysis and appropriate for structural design. The method allows the use of smooth design spectra for the assessment and the design of structures. All concepts discussed are presented in a numerical example, while the adaptation of the method by modern design codes has been conceptually explained.

Abhishek Sharma et al. [11] investigated through a vast hinges response recorded from non - linear static analysis it was observed that assignment of plastic hinges in coupled shear walls exhibits important properties of coupling beams and overall behavior. Steel link beams shown adequate strength and ductility over concrete link beams and huge amount of shear is observed by the steel links beams. The shear controlled plastic hinges assigned to conventional RC beams was found in Collapse prevention state which is considered most damageable state in performance based design (PBD) whereas composite steel-concrete coupling beams remains in Life Safety (LS) and steel link beams performed enormous shear absorption but still plastic hinges formed gone to the Intermediate Occupancy (IO) which means core shear wall can be operated during seismic hazards and not in case of RC coupling beams. The elastic analysis of coupled shear walls can't be adopted because coupling beams undergoes large inelastic deformations in designing coupled shear walls. Braced coupled shear walls also can be a better option in high seismic zone as the diagonal braces distributed maximum axial forces from one wall pier to the joined wall pier by means diagonal braces.

Minjuan HE et al. [12] presented a type of timber and concrete hybrid structure, brought up the simplified wood diaphragm model, and did seismic analysis for a six-storey hybrid structure with three different floor models, the

wood diaphragm model, the rigid floor model and the flexible model. At last, two designs for a 6-storety building, one with wood diaphragm, the other with concrete floor, were compared. Results showed that, the lateral forces and the displacement of the concrete frame with the wood diaphragm model lay between rigid floor model and flexible model; using wood diaphragm could maximally lower down the seismic load and foundation cost.

Xiaodong Ji et al. [13] investigated A novel type of hybrid coupled wall (HCW), which consists of reinforced concrete (RC) wall piers and replaceable steel coupling beams (RSCBs), was proposed for enhancing the seismic resilience of high-rise buildings. This study assesses the seismic performance of a HCW building under high intensity levels of ground motion shaking as defined in the Chinese code: maximum considered earthquakes (MCE) and very rare earthquakes (VRE). The performance of the HCW building is compared against an equivalent RCW building with RC coupled walls (RCW). Nonlinear numerical models are developed in Open Sees for a representative 11-story building located in Beijing and designed per modern Chinese standards. The nonlinear dynamic analysis indicates that use of novel HCWs instead of conventional RCWs leads to maximum inter story drifts 24.5% lower at MCE and 32.7% lower at VRE. However, the use of novel HCWs has limited influence on the maximum floor accelerations. A seismic performance assessment of the buildings is carried out to estimate repair cost and repair time based on the FEMA P-58 method. Under MCE and VRE, in the RCW building, RC coupling beams and frames greatly contributes to the repair cost, while the HCW building efficiently controls damage in coupling beams and frames. The resulting repair cost of the HCW building is 50.8% lower at MCE and 41.9% lower at VRE than that of the RCW building. Due to the easy replacement of damaged shear links in RSCBs, the HCW building shows enhanced performance, particularly in terms of reduced repair time. The repair time of the HCW building is 60.5% lower at MCE and 50.4% lower at VRE than that of the RCW building.

Rohola Rahnavard et al. [14] tested a Two full scale experimental models were developed for the validation of the proposed modeling method. The elastic and plastic properties of steel and concrete materials were introduced. Element failure for steel members and cracking for concrete slabs were considered. All models were analyzed using dynamic explicit analysis. To ensure the accuracy of modeling, the numerical results were presented and compared with the experimental data. It suggests a reliable and affordable alternative to laboratory testing. The behavior of eight types of high rise steel composite frame buildings exposed to two lateral resistance systems, two column removal scenarios and two types of planes were investigated, applying a 3-D finite element modeling.

Mahmood Hosseini et al. [15] have investigated the employed earthquakes the buildings' performance exceeds the expected performance level, and even in some cases the buildings reach collapse level. This exceedance can be mainly due to the effect of the high intensity of vertical ground excitations. Furthermore, the distribution of plastic hinges in the buildings' structures is not uniform, and they usually concentrate in some specific levels of the buildings, depending on their height and the input earthquake characteristics. On this basis, it can be claimed that the code provisions still need improvement, particularly with regard to the inclusion of the effect of extensive vertical ground motion of near-source earthquakes, to lead to design of buildings which confidently achieve the live safety performance level.

Thavera Wihardja et al. [16] studied the Reinforced concrete (RC) couple wall systems, where RC beams couple two or more RC walls in series, are frequently used in high-rise buildings. Generally, coupling beams are made of RC materials. Steel coupling beam is an alternative for RC coupling beam which has a complex and inefficient detailing construction. This paper presents a study on the use of Hybrid Coupled Wall System (HCWS) in seismic resistant high-rise RC structures. In the study, 25 storey office buildings with three types of coupling beams and three types of walls distributed over the height of the structure and located in a region with high seismicity are designed. Applying a performance-based design approach, this study developed an efficient design for RC structures having Coupling Ratio (CR) values 64.55% and affect the behavior of the wall pier in the upper region of the structure where widespread plasticization and earlier crushing failure happen. Based on this findings, steel coupling beams can be used as an alternative with satisfying all performance criteria and perform at Life Safety(LS).

Salah Aguib. [17] investigated the mechanical behavior of a hybrid sandwich beam in magnetorheological elastomer loaded with 40% ferromagnetic particles has been studied. A finite element model has been developed for the three layers. The sandwich beam is modeled using transverse displacement at core layer. The finite element model of the damped three-layer beam is assumed that every layer has the same transverse displacement, and it is derived using the Golla–hughes–McTavish's principle. Different specimens have been modeled by varying the magnetic field intensity and static force and studied under the clamped-free and cantilever boundary conditions for modal analysis. Results show the influence of MRE adaptive stiffness and the loss factor in the static behavior of the sandwich studied. The structure proposed can be directly applied to civil engineering, for example, aeronautics, aerospace, and building foundations.

M. Moravčík et al. [18] analyzed a hybrid composite structures with GFRP element. The first part presents some

results of push tests on hybrid composite girders of the "I" shape with reinforced concrete flanges and GFRP wall. The concrete dowels and contact surface roughening were used to arrange the connection between concrete and GFRP wall. The 3 specimens of composite girders and the 2 comparative concrete girders were tested. The incremental short-term bending load tests were performed and compared to FEM analysis on 3D models in ATENA system. Some results are presented in the second part of the paper. Sufficient coincidence of the load response between the test results and numerical simulations of hybrid girders was recorded. The exceeding of the concrete dowel resistance has been observed and it seems to be the main reason of the composite girder bending failure. However, the global resistance of composite girder was higher than the comparative RC girders. Higher concrete strength contributed to the global resistance increasing due to higher resistance of concrete dowels, which allowed better utilization of GFRP wall bending resistance of hybrid structure.

Zheng Li et al. [19] studied a comprehensive seismic performance assessment for a kind of multi-story steel-timber hybrid structure. In such a hybrid structure, steel moment resisting frames are in filled with prefabricated light wood frame shear walls to serve as the lateral load resisting system (LLRS). In this paper, drift-based performance objectives under various seismic hazard levels were proposed based on experimental observations. Then, a numerical model of the hybrid structure considering damage accumulation and stiffness degradation was developed and verified by experimental results, and nonlinear time-history analyses were conducted to establish a database of seismic responses. The numerical results further serve as a technical basis for estimating the structure's fundamental period and evaluating post-yielding behavior and failure probabilities of the hybrid structure under various seismic hazard levels. A load sharing parameter was defined to describe the wall-frame lateral force distribution, and a formula was proposed and calibrated by the time-history analytical results to estimate the load sharing parameter. Moreover, earthquake-induced non-structural damage and residual deformation were also evaluated, showing that if designed properly, desirable seismic performance with acceptable repair effort can be obtained for the proposed steel-timber hybrid structural system.

G. M. S. Bernardo et al. [20] investigated Reconstruction and analysis of hybrid composite shells using meshless methods. The importance of focusing on the research of viable models to predict the behavior of structures which may possess in some cases complex geometries is an issue that is growing in different scientific areas, ranging from the civil and mechanical engineering to the architecture or biomedical devices fields. In these cases, the research effort to find an efficient approach to fit laser scanning point clouds, to the desired surface, has been increasing, leading to the possibility of modeling as-built/as-is structures and components' features. However, combining the task of surface reconstruction and the implementation of a structural analysis model is not a trivial task. Although there are works focusing those different phases in separate, there is still an effective need to find approaches able to interconnect them in an efficient way. Therefore, achieving a representative geometric model able to be subsequently submitted to a structural analysis in a similar based platform is a fundamental step to establish an effective expeditious processing workflow. With the present work, one presents an integrated methodology based on the use of mesh less approaches, to reconstruct shells described by points' clouds, and to subsequently predict their static behavior. These methods are highly appropriate on dealing with unstructured points clouds, as they do not need to have any specific spatial or geometric requirement when implemented, depending only on the distance between the points. Details on the formulation, and a set of illustrative examples focusing the reconstruction of cylindrical and double-curvature shells, and its further analysis, are presented. Keywords Points clouds _ Mesh less methods _ Structural behavior _ Fiber reinforced composite materials _ Nan composites.

D. Cancellara et al. [21] have analyzed a multi-storey reinforced concrete (RC) building in presence of a hybrid seismic protection system for highlighting the limits of the conventional fixed base seismic design of structures. This hybrid seismic protection system is a passive structural control system that combines the Base Isolation System (BIS) and the Passive Supplemental Damping (PSD). The Viscous Dampers (VS) and Friction Sliders (FS) are the devices adopted in parallel for realizing the innovative base isolation system. The fixed base structure and the base isolated structure have been designed and verified according to the European seismic code EC8 and the European code for the design of concrete structures EC2. A three-dimensional dynamic nonlinear analysis for a base isolated structure has been performed adopting recorded accelerate grams for the defined bi-directional ground motions according to the conditions imposed by EC8. The seismic isolation is a promising alternative for the earthquake resistant design of buildings and its peculiarity is that the base isolated buildings are designed such that the superstructure remains elastic and the nonlinearities are localized at the isolation level. In this paper a comparative analysis is presented between the base isolated structure, with the viscous dampers in parallel with friction sliders, and the traditional fixed-base structure.

S. M. Davari et al. [22] studied the continuum model, which is known as Kwan model, has been presented for the analysis of tall buildings that have been as an appropriate approximation of the overall behavior of the structure. Tall building was modeled as a cantilever beam and analyzed with the assumption of flexural behavior based on Euler–

Bernoulli Beam Theory, then the displacement of floors was calculated. o considers the shear lag effects in the overall displacement of the structure, Timoshenko's beam model has been considered and related relations were extracted. The lateral displacement formulas obtained and calculated for the framed tube system modeled by Kwan's method. To verify the results, numerical models were created in software (ETABS) and statically were analyzed for lateral loading. Finally the results were compared with those obtained by computer analysis and the corresponding diagrams were presented. At the end, the shape factor formula has been developed to improve the results of the Timoshenko's theory. Keywords Framed tube system · Equivalent continuous method · Euler–Bernoulli beam theory · Timoshenko's beam theory.

C. Yang et al. [23] investigated a steel frame - core tube hybrid structure commercial building design as engineering background in Kunming, steel beam and the core tube using different connection methods affect the structure of the lateral performance. All hinged model established with some rigid model, modal analysis and response spectrum analysis, comparing its dynamic characteristics and performance of multi-lateral event of an earthquake under the analysis of the seismic performance in high intensity are.

A. Agrahari et al. [24] The performed improper design and construction of the structures may cause great destruction to the structures. This has been proved by the earthquakes occurred in the recent past. So as it's essential to spot the seismic response of the structure even in high seismic zones to cut back the seismic damages in buildings. In the present work dynamic analysis and comparison of different shapes of building is carried out using ETABS 2013 software.

T.Subramani et al. [25] Have studied development of structural system goes beyond the unexpected level. To overcome the problems persist in the structural behavior numerous studies has routed out. On this present have a look at is targeted at the performance of multi outrigger structural system for a ten storey constructing with static and dynamic analyses of various fashions were examined the use of ETABS software program. The performance analysis of the tall building for distinctive fashions are performed to discover the surest function of outrigger gadget and belt truss with the aid of the usage of lateral loads. Time history analysis for floor movement statistics of the ten storey building version are carried out. The evaluation includes lateral displacement; storey's go with the flow and base shear for static and dynamic loading. From the acquired results the effective performance of building with outriggers are evaluated. Our project describes the structural layout of similar 10 storey the use of overall performance based totally strategies for seismic and wind movements.

Zheng Li et al. [26] investigated Steel-timber hybrid structural systems offer a modern solution for building multi-story structures with more environmentally-friendly features. This paper presents a comprehensive seismic performance assessment for a kind of multi-story steel-timber hybrid structure. In such a hybrid structure, steel moment resisting frames are in filled with prefabricated light wood frame shear walls to serve as the lateral load resisting system (LLRS). In this paper, drift-based performance objectives under various seismic hazard levels were proposed based on experimental observations. Then, a numerical model of the hybrid structure considering damage accumulation and stiffness degradation was developed and verified by experimental results, and nonlinear time-history analyses were conducted to establish a database of seismic responses. The numerical results further serve as a technical basis for estimating the structure's fundamental period and evaluating post-yielding behavior and failure probabilities of the hybrid structure under various seismic hazard levels. A load sharing parameter was defined to describe the wall-frame lateral force distribution, and a formula was proposed and calibrated by the time-history analytical results to estimate the load sharing parameter. Moreover, earthquake-induced non-structural damage and residual deformation were also evaluated, showing that if designed properly, desirable seismic performance with acceptable repair effort can be obtained for the proposed steel-timber hybrid structural system.

Xu et al. [27] studied on a hybrid shear wall system as a seismic force resisting element for taller buildings. Different from traditional "sandwich" shear wall, the hybrid shear wall in the study consists of two exterior precast wall layers and one interior cast-in-place concrete layer. This type of wall system has been increasingly used in moderate- to high-rise buildings in low-seismicity areas, and its seismic behavior is little known. Revealing its corresponding seismic behavior will help develop a rational seismic design details for ductile seismic force resisting system as a formidable alternative to conventional cast-in-place shear walls by combining inherent the benefits of speedy construction and sustainability of precast technology with improved structural integrity and ductility. In this research study, both experimental observation and FEM simulation validation were used to analyze the hybrid shear wall system. Three sets of full-scale shear walls including two hybrid shear walls and one cast-in-place shear wall were tested subjected to cyclic horizontal. A series of 3D non-linear finite element models which included all significant details and specifications were created in ABAQUS to simulate the experiments. The pushover analysis method was employed to reproduce the test procedures. The response of the structure was computed both at macro and micro levels in order to validate the accuracy of the analytical model. After a good agreement between the experimental observations and simulation results, a comprehensive parametric study was

conducted to determine seismic design parameters, and to explore damage mechanism of the hybrid shear wall system.

Nabin Raj et al. [28] have studied on Seismic Performance of Hybrid (DUAL) Structural System Subjected To Earthquake. Steel braced frame is one of the structural systems used to resist earthquake loads in multi-storied buildings. Many existing reinforced concrete(RC) buildings can be retrofitted to overcome deficiencies, to resist seismic loads at the same time steel bracings can be incorporated with RC frames which in combine can be called as dual system to resist lateral force in the new buildings. Steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness. In the present study, the seismic performance of reinforced concrete buildings using concentric steel bracing is investigated. The bracings are provided at peripheral columns. A six, twelve and eighteen storied buildings are analyzed for seismic zone V as per IS 1893: 2002 using SAP 2000 software. Response spectrum analysis is performed for the buildings. For getting Eigen values and Eigen vectors the MathCAD Prime software is used. And hence storey shear and base shear are computed. The seismic performance of the building is evaluated in terms of storey drifts.

3. CONCLUSIONS

In this review, Seismic analysis of hybrid structures with and without shear walls was investigated. For this objective, two separate RC And hybrid frame buildings with and without shear walls.

1. Using CSI ETABS 2019 program, a hybrid high-rise structure of 35 floors subjected to seismic, wind and live loads was studied.
2. For various seismic areas, the Bare RC frame structure indicates susceptibility to seismic forces.
3. RC shear walls performed higher in all respects compared to composite bracing, but if there is no chance of having RC shear walls then composite bracing is still capable of addressing Tall buildings' seismic weakness in itself.
4. The comparative analysis concludes that the hybrid system is broader in nature as opposed to the RCC structure and has reasonable limit parameters.
5. Hybrid structure is more vulnerable to seismic impact than RCC structure, so for seismic porn field, hybrid structure is preferable.
6. The hybrid structure offers a wide area for use and high reliability and quick erection are economical.
7. The current study reveals that the storey displacement and storey drift values obtained for shear walls for both RC and steel-concrete hybrid structures are lower relative to RC and steel-concrete hybrid structures without shear walls.
8. In order to minimize storey displacement and storey drift values and maintain them within restricting value, it is recommended to go for RC or steel-concrete hybrid framed framework with shear wall system rather than RC or steel-concrete hybrid framed structure without shear wall in seismic prone areas from the present report.
9. The current study indicates that the storey shear and base shear values obtained for both RC and steel-concrete hybrid structures with shear walls are higher compared to RC and steel-concrete hybrid structures without shear walls due to a rise in the structure's seismic weight.
10. The findings of the response spectrum study measured by the CSI ETABS 2019 programs illustrate the measurement model's correctness. The findings indicate that the hybrid structure has strong seismic efficiency and achieves the objective of success.

ACKNOWLEDGEMENT

The authors sincerely thank Professor Sandeep salhotra HOD of civil engineering Chandigarh university, Professor Dr. sandeep singh and Professor Dr. mohit bhandari for their encouragement and for providing facilities to carry out this Review work.

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