International Journal of Scientific Research in Civil Engineering
© 2022 | IJSRCE | Volume 6 | Issue 6 | ISSN : 2456-6667

Parametric Analysis of a Steel Industrial Building Frame Considering Wind Load, Dampers and Bracings Using ETABS A Review

Mohit Lal Saket[1], Dharmendra Prajapati, Anudeep Nema
P.G. Scholar[1], Assistant Professor[2], HOD[3]
Department of Civil Engineering, School of Engineering, Eklavya University, Damoh, Madhya Pradesh, India

Article Info
November-December-2022

Publication Issue :
Volume 6, Issue 6

Page Number : 68-74

Article History
Accepted : 03 Nov 2022
Published : 15 Nov 2022

ABSTRACT

In addition to gravity stresses, the building's structural structure must handle lateral loads caused by earthquakes and wind. A lateral load causes significant stresses and instability, which results in vibration and drift. If industrial steel structures are not designed to withstand lateral loads, they may collapse, resulting in the death or destruction of people or property. As a result, the structure must not only be strong enough to withstand gravity loads, but also stiff enough to withstand lateral forces. According to a review of the literature, LLRSS (Lateral load Resisting structural system) components such as base isolation and dampers are used to manage seismic vibration and lateral drift.

In this paper presenting review of literatures related to analysis of steel building structures.

Keywords - Steel Frame Building, Viscous Damper, Bracing System Storey Drift, Displacement, Base Shear, ETABS

I. INTRODUCTION

Steel Worldwide different types of RC and steel structures with various floor systems are being used for multi-storey buildings. In the past, masonry structures were widely used for building construction. Day by day technology has developed. Later, steel structural systems were started for multi-storey buildings. RC structural techniques for multi-story building construction started with the establishment of reinforced concrete. Non-composite RC floor systems supported on steel beams have been used in the past. It became necessary to form mechanical shear connectors to consider composite action after the invention of welding. Because many multi-story and low-rise RC and masonry buildings have failed due to earthquakes, structural engineers are seeking for alternate construction methods. The use of composite or hybrid materials is very intriguing. The fire resistance of a bare steel structure is low. Different fireproofing systems have advanced greatly in recent years. In India, masonry and RC constructions were the most common. Steel structural technologies have become increasingly popular during the previous decade. As a result, alternative structural systems are gradually gaining ground on RC structural systems. The use of stone structures is now extremely limited. In India, RC constructions predominate, with steel structures gradually making their way into multi-story building structures. As a result, a comparison analysis is required to determine the most effective structural system for a given structure.

Structures in high-risk seismic zones may be vulnerable to serious damage. In addition to gravity, the load structure must bear lateral loads that can cause significant stress. Steel is by far the most useful material for building construction in the world, and steel structures have played a significant part in the construction industry during the previous few decades. One such structural system that is an intrinsic part of the frame is the bracing system. Before deciding on the optimum type or effective arrangement of bracing, such a structure must be examined. The authors around the globe have reviewed different steel structures whether in multi storey structure or industrial structures. Some of the research papers from different authors are summarized below:

II. Review of Literature Survey

Chao Gong et al (2022) research paper presented the seismic performance of structures subjected to earthquake mainshock-aftershock sequences. There is comparison of two types of the additional BRB elements, and also there is comparison between them and the original steel frame to show the effect of using BRB and SCBRB elements. To compare the seismic performance of BRBF and SCBRBF, the same mainshock-aftershock sequences were used in this part. Because of the flag-shaped hysteretic curve of the SCBRB elements, big amount of the energy was dissipated during the motion.

Results stated that structure with SCBRB elements subjected to earthquakes have smaller responses than ones without it. Amount of the energy which was dissipated is increased. Using SCBRB and BRB elements increase frequency of the structure. Residual deformations of the SCBRBF in more than 6.6 times smaller than ones of SF, residual deformations of the BRBF more than 2.11 times smaller than ones of SF. Conclusion stated that using SCBRB elements can decrease the damage of the structure during earthquakes, and also lead to improvement of characteristics of the building such as maintainability and service life in the seismic region.

Zhe-Xi Zhang et al (2022) in the research paper, a novel type of self-centering brace, namely the self-centering SMA-viscoelastic hybrid brace (SCVEB) was proposed. The energy dissipation was provided by the SMA cables, as well as the viscoelastic dampers (VEDs), whilst the self-centering capacity was provided by the former. The fundamental mechanical behavior of individual SMA cables and viscoelastic dampers was first investigated, followed by a more comprehensive experimental study on a proof-of-concept SCVEB specimen.

Results stated that the SMA cable exhibits typical flag-shaped hysteretic loops with a large recovery strain. Reasonable cyclic pre-training is suggested before anchoring to SCVEB, since this process was shown to help stabilize the hysteretic response. The VED is capable of providing reliable energy dissipation. The rubber in the test did not show rate-dependence property, such as typical viscoelastic material, and this may be due to the differences in their compositions. The frames using the intended SCVEB fulfilled peak inter-story drifts under the MCE and had nearly no residual interstory drifts, according to the system-level analysis. More crucially, the SCVEB can reduce the frames' peak floor acceleration even more. These positive results show that the suggested SCVEB could be a cost-effective self-centering solution by reducing boundary frame member size while using less SMA.

Dario De Domenico and Iman Hajirasouliha (2021) The research paper presents a comprehensive multi-level performance-based optimisation strategy for seismic retrofit of existing substandard steel frames using nonlinear viscous dampers (NVDs). The dampers are modelled using a fractional power-law force–velocity relationship, while the supporting brace stiffness and damper axial stiffness are incorporated using a Maxwell model, and the structure's nonlinearity is modelled using a distributed-plasticity fibre-based section technique. The method is based on the uniform damage distribution (UDD) design philosophy applied within an iterative scheme, and its efficiency is illustrated through examples on 3-, 7- and 12-storey substandard steel frames under both artificial and natural earthquakes that are compatible with the EC8 design response spectrum.

When compared to an equal-cost uniform damping distribution, the optimum damping distribution discovered by the suggested methodology results in frames with lower maximum inter-storey drift, local damage (maximum plastic rotation), and global damage index. However, seismic performance is often better when employing a drift-based UDD technique. It is demonstrated that the suggested UDD optimisation method may be used to efficiently achieve numerous performance targets at various earthquake intensity levels, in accordance with current seismic code performance-based design recommendations. The proposed method is straightforward to use for practical design reasons, and it is a cost-effective tool for seismic retrofitting steel frames with NVDs.

Ergang Xiong et al (2020) The seismic presentation of a four-story self-focusing concentrically supported outline (SC-CBF) structure was examined utilizing static elastoplastic examination, low-cycle continued stacking investigation, and elastoplastic time-history examination, when contrasted with a conventional concentrically propped outline (CBF) structure. The impacts of various GAP stiffnesses and cross-sectional areas of prestressed ligament were explored on oneself focusing and seismic execution of the SC-CBF structure.

The outcomes show that the SC-CBF structure has major areas of strength for an obstruction, a little base shear under seismic tremor activity, and a slight remaining float in the wake of dumping. %e SC-CBF structure has a preferable malleability over the CBF structure. %e uprooting of the SC-CBF structure under the activity of intriguing and incredibly uncommon tremors is enormous, and the design can disseminate more energy; the interstory float is huge, however the remaining float is little, displaying its optimal seismic and self-focusing execution. The firmness of the GAP, then again, extensively affects the mechanical way of behaving of prestressed ligaments. The solidness of the GAP minorly affects the whole design's mechanical and seismic presentation, while the cross-sectional region of the prestressed ligaments altogether affects the general construction's exhibition.

Pei Chi et al (2020) The nonlinear seismic reaction of multistory steel outlines worked with self-focusing strain just supports (SC-TOBs) to interior power, float, and energy dissemination was concentrated on top to bottom in this study report. Sucker study exposed to two horizontal burden circulations and nonlinear unique examination under ground movement outfits relating to four danger levels were embraced. The SC-TOBs can be designed to fill in as customary pressure just supports (TOBs) that just give horizontal solidness during light quakes, to work with energy dissemination as the greatness of the seismic tremor develops, and to completely recenter a construction even after serious tremors.

Results expressed that with an expansion in the quake power, both the power reaction and float reaction of the SC-TOB outlines (SC-TOBFs) expanded; nonetheless, the power appropriation and float circulation states of the SC-TOBFs remained practically steady. The SC-TOBFs dispersed more energy in the lower portions of the structure, though the upper floors disseminated basically no energy under specific burden circumstances, suggesting that the bracings on those accounts might be supplanted with standard TOBs for cost reserve funds. The SC-TOBs have been displayed to offer tremendous commitment for successfully working on seismic versatility in structures, lessening recovery costs and functional disturbances after tremors.

Patrick McCready et al (2020) research paper examined the presentation of a clever self-centring CBF (SC-CBF) which plans to lessen between story floats and remaining misshapenings in a design. The trial information was used to approve the practicality of the instrumentations and to assess the exhibition of the SC-CBF structures. By contrasting the parallel powers determined from the three informational collections (to be specific the LVDT, strain check and the speed increase), it was found that the horizontal power got from the strain information concurred well with that from the speed increase information. This not just shows the great unwavering quality of the deliberate strain and speed increase information, yet in addition demonstrates the fantastic plausibility of the energy dispersal strategy used by the SC-CBF.

The exhibition of the original SC-CBF as a self-centring framework, assessed as far as the between story floats, is great since the lingering floats for the four tests were under 0.6 mm. These unimportant parallel floats ensure that the SC-CBF structure had gotten back to its unique situation toward the finish of each test. By utilizing the presentation approval technique, the choice of hearty informational collections was conceivable permitting it to showed that the seismic burdens were sent to the support examples effectively which make the supports the main individual from the SCCBF dispersing energy.

Masruri Anwar and Budi Suswanto (2019) in the research, Eccentrically Braced Frame Self-Procurement (SCEBF) was modeled with 3 types of link model that is short link, intermediate link and long link. By modeling the structure of the multi-story building with the number of 12 floors using SAP 2000 to get the feasibility of the earthquake resistant building structure and for the portal model using ABAQUS.

Results stated that building structure using short link (short link) giving better response on drift and inter-floor value than intermediate link (medium link) or long link (long link). Portal structures using intermediate links (intermediate links) provide better response to hysteresis values than short links (short links) and long links (long links).

Hamed Jabbari et al (2019) the target of the exploration was to assess the seismic way of behaving of 7-story and 15-story steel outlines with a second edge framework having a chevron concentric support furnished with Shape Memory Alloys (SMAs). Supports containing different measure of combination (counting 20%, 40%, 60%, 80%, and 100 percent) were applied to concentrate on the impact of SMAs on primary execution. Somewhat diligent relocation of the construction as well as its overall most extreme removal under the seismic tremor forcing on outline models, were researched utilizing non-straight unique examination by OpenSees limited component programming. The seismic tremors were in close shortcoming nine accelerographs, which included different most extreme speed increases.

Results showed a decrease in moderately steady uprooting utilizing 20% SMAs in supports. Furthermore, more measure of combination brought about less relative removal when contrasted with steel supports. Applying SMAs support showed a decrease in tireless primary relocation in a casing. Besides, adding over 20% SMAs to the support, brought about a reduction in primary relocation.

E. Tahmasebi et al (2017) research paper developed damage scenario fragilities for buildings with either special concentrically braced frame (SCBF) system or a self-centering concentrically braced frame (SC-CBF) system as the seismic lateral force resisting system. A pre-event damage analysis was conducted using the damage scenario tree analysis (DSTA) technique and incremental dynamic analysis (IDA). The possibility of building demolition when collapse has not occurred is included in the DSTA. Three damage scenarios are considered, namely building collapse; non-collapse with demolition; and non-collapse with non-demolition and component damage. Damage scenario fragilities for buildings with SCBF and SC-CBF systems are compared and analyzed. The probabilities of damage to braces of the SCBF and SC-CBF at the maximum considered earthquake (MCE) hazard level are compared.

The probability of non-collapse with demolition is observed to be negligible at the DBE hazard level for the SCBF and the SC-CBF archetype buildings. At the MCE hazard level, the probability of non-collapse with demolition is observed to be negligible for the SC-CBF archetype buildings but non-negligible for the SCBF archetype buildings. The probabilities for the damage scenarios including brace damage are observed to be considerably smaller for the SC-CBF archetype buildings in comparison with the SCBF archetype buildings. The number of stories with negligible probability of brace damage at the MCE hazard level was considerably larger for the SC-CBF archetype buildings than for the SCBF archetype buildings.

Habib Ghasemi Jouneghani et. al (2016) research paper appraises the seismic performance of a new braced steel structural system called elliptic braced moment resisting frame (ELBRF). ELBRF is determined to be non-problematic for the bracing system in a specific architectural area, in addition to improving the behaviour of a building. The suggested ELBRF was evaluated using a single cycle time in this investigation. An adaptive pushover analysis was used to demonstrate techniques of seismic design of structures as well as effective parameters in the seismic design of steel braced structures, such as ductility factor, overstrength coefficient, and behaviour factors, which were produced using capacity curves (APA).

Result of the nonlinear analysis showed that the strength and capacity of energy dissipation in the elliptic bracing system (ELBRF) is more than the system of special moment resisting frames (SMRF), coaxial braced frame (CBF) X-Braced, Inverted-V Braced CBF. Likewise, the permitted relative displacement, where the braced frame reaches to step buckling, is more in ELBRF.

Jagadeesh B N and Dr. Prakash M R (2016) research paper assessed the seismic response of steel structure with concentric bracing system. Vertical irregular model (VIRM) and vertical irregular model with mega bracing (VIRM MB) were used as structural configurations. For all zones of soil type II, a 15-story steel moment resistant structure was studied (medium). The tests were done to see how well the structure would hold up in the event of an earthquake. These models are compared in different aspects such as storey drift, storey displacement and base shear. ETABS was used for the modelling and analysis of the structure.

Results of the performed inelastic analyses demonstrate that mega bracing frames are most effective to resist earthquake. Conclusion stated that the reduction of storey drifts in mega braced frame occurs with respect to the without braced frame. The adoption of a mega bracing system reduces the storey displacement of a vertical uneven structure by 77.64 percent when compared to not using one. As a result, the bracing system has a greater impact on the restriction as compared to floor movement. When compared to VIRM without a bracing frame, the maximum base shear for mega (VIRM MB) is reduced by 23.42 percent.

G.J. O'Reilly et al (2012) research paper presented a new type of self-centering system that uses tubular brace members together with a post-tensioning arrangement to give a self-centering concentrically braced frame (SC-CBF). To demonstrate the performance of the SC-CBF against some performance goals, a numerical model of the SC-CBF was built and a design example of a 3-story frame was presented. The tensile yielding and inelastic global buckling of the bracing components inconcentrically braced frames (CBFs) are designed to undergo several cycles of inelastic deformation. Because of its inelastic behaviour, structures developed using existing standardised methodologies are more likely to experience residual deformations after a major earthquake.

The SC-CBF is a system capable of withstanding enormous seismic forces while also minimising residual drifts following a major seismic event, according to the results of a series of time-history analyses.

D. Roke et al (2008) in the research paper, Under the design basis earthquake, self-centering concentrically-braced frame (SC-CBF) systems were created with the purpose of providing adequate nonlinear drift capacity without considerable damage or residual drift. To analyse the reaction of multiple SC-CBF configurations to earthquake loading, analytical pushover and dynamic analyses were undertaken. Under earthquake loading, each SC-CBF self-centers.

The dynamic analysis results show that these design demands safely account for the higher mode demands introduced by the nonlinear rocking response of the frame.

Richard Sause et.al (2006) To analyse the reaction of numerous Self-centering concentrically-braced frame (SC-CBF) designs to earthquake loads, analytical pushover and dynamic analyses were done in the research paper. Under earthquake loads, each SC-CBF self-centered, and some post-tensioning was lost in one frame arrangement. The SC-CBF systems' dynamic reaction, on the other hand, was in line with what was expected.

The results stated that dynamic analysis results clearly demonstrate the effects of higher mode response in the frames, which must be included in the design process. Each frame considered in this study is designed to limit the first mode dynamic response of the structure. The control mechanism for Frame A and Frame B12 is the yielding of the PT steel. Frame B12ED also incorporates an ED element, which resists only base overturning moment, a first mode response quantity.

III.CONCLUSION

- Usage of fully steel superstructure and concrete foundation to develop the structural behavior to act on the bracing systems.
- Various loading cases including equipment loads and other important conditions used for the static as well as dynamic analysis.
- Nodal displacement at the same node for all the models considered for comparison which determines the response of the bracings.

IV. REFERENCES

[1]. D. Roke, R. Sause, J.M. Ricles, and N. Gonner, [DESIGN CONCEPTS FOR DAMAGE-FREE SEISMIC-RESISTANT SELF-CENTERING STEEL CONCENTRICALLY-BRACED FRAMES], The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.

[2]. Zhe-Xi Zhang, Yiwei Ping and Xiuzhang He, [Self-Centering Shape Memory Alloy-

Viscoelastic Hybrid Braces for Seismic Resilience], Materials 2022, 15, 2349.

[3]. Pei Chi, Jun Dong, Wenlong Tian and Dafu Cao, [Nonlinear Seismic Response of Multistory Steel Frames with Self-Centering Tension-Only Braces], Appl. Sci. 2020, 10, 1819.

[4]. Chao Gong, MingMing Jia, XuanHao Cheng and Mishel Gritcuk, [Seismic performance of buckling-restrained braced steel frames subjected to earthquake mainshock-aftershock sequences], 2022 International Conference on Applied Mechanics and Advanced Materials.

[5]. Masruri Anwar and Budi Suswanto, [Analysis of Eccentrycally Braced Frame (EBF) Structure With Self Centering System Modification], International Journal of Science and Research (IJSR), Volume 8 Issue 1, January 2019.

[6]. Patrick McCready, Yadong Jiang, Suhaib Salawdeh, Hatim AlWahsh, Brian Broderick and Jamie Goggins, [Performance validation of a self-centring steel structure using robust data sets from shake table testing], Civil Engineering Research in Ireland 2020.

[7]. G.J. O'Reilly, J. Goggins and S.A. Mahin, [Behaviour and Design of a Self-Centering Concentrically Braced Steel Frame System], 15 WCEE LISBOA 2012.

[8]. Ergang Xiong, Kun Zu, and Qian Zhang, [Seismic Performance Analysis of Self-Centering Concentrically Braced Steel Frame Structures], Hindawi Shock and Vibration Volume 2020, Article ID 8826272, 13 pages.

[9]. Richard Sause, James M. Ricles, David Roke, Choung-Yeol Seo, and Kyung-Sik Lee, [DESIGN OF SELF-CENTERING STEEL CONCENTRICALLY-BRACED FRAMES], 4th International Conference on Earthquake Engineering Taipei, Taiwan October 12-13, 2006.

[10]. Dario De Domenico and Iman Hajirasouliha, [Multi-level performance-based design optimization of steel frames with nonlinear viscous dampers], Bulletin of Earthquake Engineering (2021) 19:5015–5049.

[11]. Hamed Jabbari, Reza Vahdani, Mohsen Gerami and Hossein Naderpour, [Seismic Performance of Steel Moment Frames Containing Concentric Bracing Equipped with Shape Memory Alloys], The Open Civil Engineering Journal, 2019, Volume 13.

[12]. Jagadeesh B N and Dr. Prakash M R, [SEISMIC RESPONSE OF STEEL STRUCTURE WITH MEGA BRACING SYSTEM], INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, International Journal of Engineering Sciences & Research Technology, ISSN: 2277-9655, September, 2016.

[13]. E. Tahmasebi, R. Sause and J. M. Ricles, [Probabilistic Seismic Damage Analysis of Steel Self-Centering Concentrically Braced Frame Systems], 16th World Conference on Earthquake, 16WCEE 2017.

[14]. Habib Ghasemi Jouneghani, Abbas Haghollahi, Hassan Moghaddam and Abdolreza Sarvghad Moghadam, [Study of the seismic performance of steel frames in the elliptic bracing], INTERNATIONAL LTD.JOURNAL OF VIBROENGINEERING. AUG 2016, VOL. 18, ISSUE 5. ISSN 1392-8716.

Cite this article as :

Mohit Lal Saket, Dharmendra Prajapati, Anudeep Nema, "Parametric Analysis of a Steel Industrial Building Frame Considering Wind Load, Dampers and Bracings Using ETABS A Review", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 6 Issue 6, pp. 68-74, November-December 2022.

URL : https://ijsrce.com/IJSRCE22669