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DYNAMIC ANALYSIS OF INDUSTRIAL STEEL STRUCTURE BY USING BRACINGS AND DAMPERS UNDER WIND LOAD AND EARTHQUAKE LOAD: A REVIEW

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Abstract--* The structural system of the building has to support the lateral loads due to earthquake and wind in addition to gravity loads. If the industrial steel structures are not designed to resist the lateral loads, then they may be collapse resulting into the loss of life or its content. Earthquakes create vibrations on the ground that are translated into dynamic loads which cause the ground and anything attached to it to vibrate in a complex manner and cause damage to buildings and other structures. Conventional strategies of strengthening the system consume more materials and energy. Alternative strategies such as passive control systems, dampers which are found to be effective in reducing the seismic and other dynamic effects on civil engineering structures. Plan bracing is perhaps the most obvious way to prevent lateral buckling of a compression flange.

KEYWORDS- Bracings, Dampers, Time history analysis, Time period, Base shear, Lateral displacement, ETABS software

I. INTRODUCTION

Earthquakes are perhaps the most unpredictable and devastating of all natural disasters. They not only cause great destruction in terms of human casualties, but also have a tremendous economic impact on the affected area. An earthquake may be defined as a wave like motion generated by forces in constant turmoil under the surface layer of the earth (lithosphere), travelling through the earth's crust. It may also be defined as the vibration, sometimes violent, of the earth's surface as a result of a release of energy in the earth's crust. This release of energy can cause by sudden dislocations of segments of the crust, volcanic eruption, or even explosion created by humans. Dislocations of crust segments, however, lead to the most destructive quakes. In the process of dislocation, vibrations called seismic waves are generated. These waves travel outward from the source of the earthquake at varying speed, causing the earth to quiver or ring like a bell or tuning fork. The concern about seismic hazards has led to an increasing awareness and demand for structures designed to withstand seismic forces. In such a scenario, the onus of making the building and structure safe in earthquake-prone areas lies on the designers, architects, and engineers who conceptualize these structures. Codes and recommendations, postulated by the relevant authorities, study of the behavior of structures in past earthquakes and understanding the physics of earthquake are some of the factors that helps in the designing of an earthquake resistant structure.

Earthquakes create vibrations on the ground that are translated into dynamic loads which cause the ground and anything attached to it to vibrate in a complex manner and cause damage to buildings and other structures. Civil engineering is continuously improving ways to cope with this inherent phenomenon. An efficient ideology of providing dampers in the structure to reduce its vibrations has seen appreciating response in recent years. Numerous dampers with flexible designs and smart base isolation techniques have been used to effectively reduce vibrations caused by seismic waves.

II. PLAN BRACING

Plan bracing is perhaps the most obvious way to prevent lateral buckling of a compression flange. This is because plan bracing provides lateral restraint, i.e. it stops the compression flanges of beams from moving sideways. Plan bracing takes the form of diagonal members, usually angle sections, connecting the compression flanges of the main beams, to form a truss when viewed in plan. This makes a structure that is very stiff in response to lateral movement. With lateral movement of the compression flanges thus resisted, the half wave length for buckling is reduced to the length between bracings. Most plan bracing will be at top flange level. For steel composite bridges, this allows plan bracing to be cast within the deck slab, so it does not need to be painted and the underside of the bridge will have a clean, bracing-free appearance. However, where there are hogging moments in the main girders, there may need to be bracing on the bottom flange. Plan bracing is not common in modern steel composite bridges. The main reason it is not used is because the plan bracing above the top flange conflicts with deck permanent formwork. It is, however, possible to position the plan bracing below the deck slab. If plan bracing is not cast within the deck and is going to remain in the structure on completion, the performance of the bracing in service needs to be verified. Because the bracing is spanning partly in the longitudinal direction, longitudinal stresses will be induced in the bracing. Stresses can be determined by calculating the global displacements of the structure and imposing them on the bracing, or by adding the bracing to a comprehensive 3D structural model. No checks are needed for bracing within the deck slab, because the extra stiffness of the steel will be insignificant and concrete restrains the bracing against buckling. Plan bracing can be used to form a "virtual box" girder. This is an alternative to the box girder which avoids the health and safety risks associated with the confined space interiors of box girders . The virtual box uses the deck slab or deck plate and plan bracing between the bottom flanges of two adjacent I girders to form a shape with torsional stiffness which can be used instead of a box girder.

III. DAMPERS

The second of the major new techniques for improving the earthquake resistance of buildings also relies upon damping and energy dissipation. Different types of structural control devices have been developed and a possible classification is done by their dissipative nature. Structural control systems can be classified as passive, active, semi-active and hybrid. A passive control device is a device that develops forces at the location of the device by utilizing the motion of the structure. Through the forces developed, a passive control device reduces the energy dissipation demand on the structure by absorbing some of the input energy. Thus, a passive control device cannot add energy to the structural system. Furthermore, a passive control device does not require an external power supply. Examples of passive devices include base isolation, tuned mass dampers (TMD), tuned liquid dampers (TLD), metallic yield dampers, viscous fluid dampers and friction dampers.

The active control systems are the opposite side of passive systems, because they can provide additional energy to the controlled structure and opposite to that delivered by the dynamic loading. Active control devices require considerable amount of external power to operate actuators that supply a control force to the structure. An active control strategy can measure and estimate the response over the entire structure to determine appropriate control forces. As a result, active control strategies are more complex than passive strategies, requiring sensors and evaluator / controller equipment's. Cost and maintenance of such systems are also significantly higher than that of passive devices. Examples among active control devices include active tuned mass damper, active tuned liquid column damper and active variable stiffness damper.

IV. SEISMIC DAMPERS

Another approach for controlling seismic damage in buildings and improving their seismic performance is by installing seismic dampers in place of structural elements, such as diagonal braces. These dampers act like the hydraulic shock absorbers in cars much of the sudden jerks are absorbed in the hydraulic fluids and only little is transmitted above to the chassis of the car. When seismic energy is transmitted through them, dampers absorb part of it, and thus damp the motion of the building. Dampers were used since 1960s to protect tall buildings against wind effects. However, it was only since 1990s, that they were used to protect buildings against earthquake effects. Commonly used types of seismic dampers include viscous dampers (energy is absorbed by silicone-based fluid passing between piston-cylinder arrangement), friction dampers (energy is absorbed by surfaces with friction between them rubbing against each other), and yielding dampers (energy is absorbed by metallic components that yield).

V. STRUCTURAL IDEALIZATION

1. The objective of the present work is to Study the use of bracings and dampers placed at different locations subjected to wind and earthquake load.
2. The design of wind load was calculated based on IS 875 (Part-3) and the earthquake load obtained using IS1893(Part-1):2002.
3. The location of bracings and dampers for reducing the lateral displacement, lateral drift are evaluated.
4. The ETABS software program is selected to perform analysis.

VI. PRINCIPLES OF DAMPING

Damping on a general basis means to stop the vibrations. In structural engineering, damping can be defined as the inherent property of the structure to oppose movement. The higher the damping of the structure, the quicker it will return to its original position from displacement. Damping, β also changes the period of response of the undamped structure T, to damped period Td.

$$Td = T/(1-\beta 2)0.5$$

Where, $\beta = Wd/(4\pi Ws)$

Wd = cyclic energy dissipated.

Ws= is the strain energy.

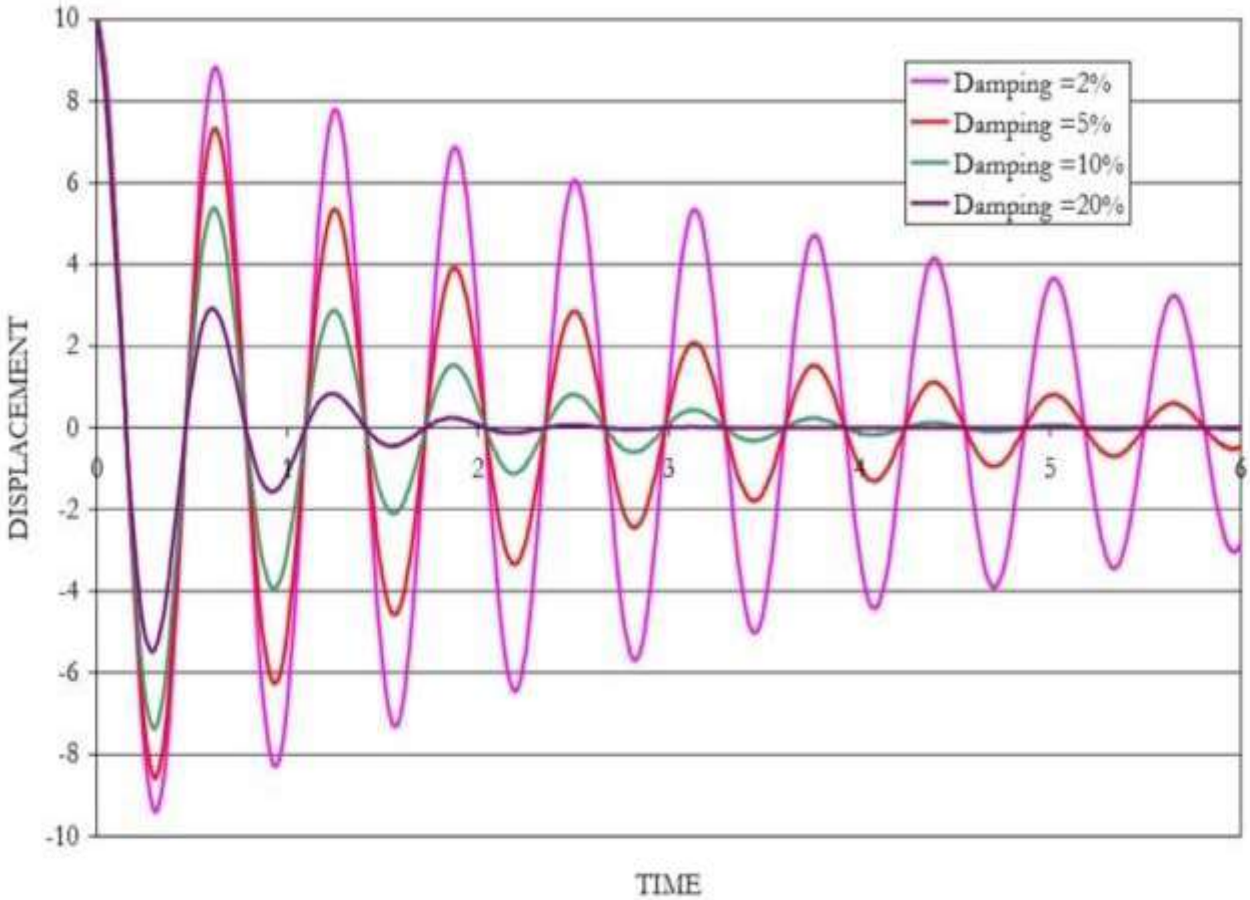


Figure 1: Effect Of Damping

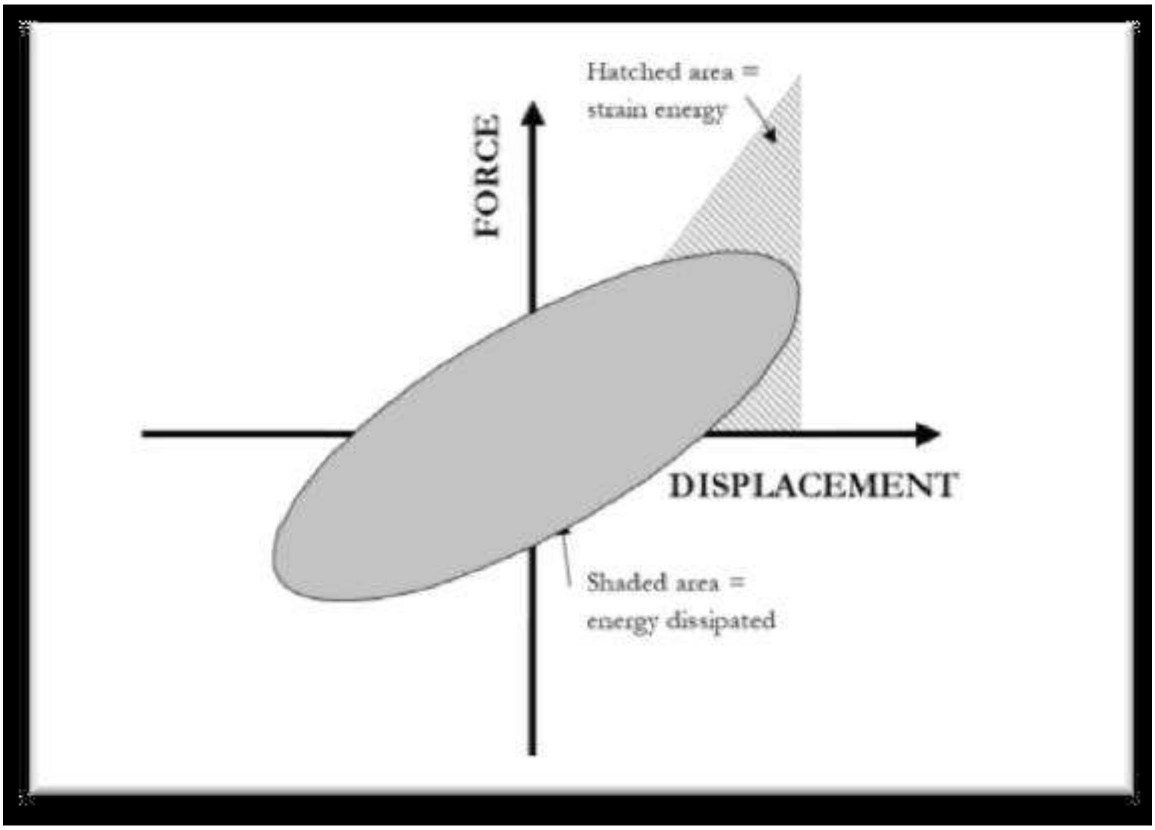
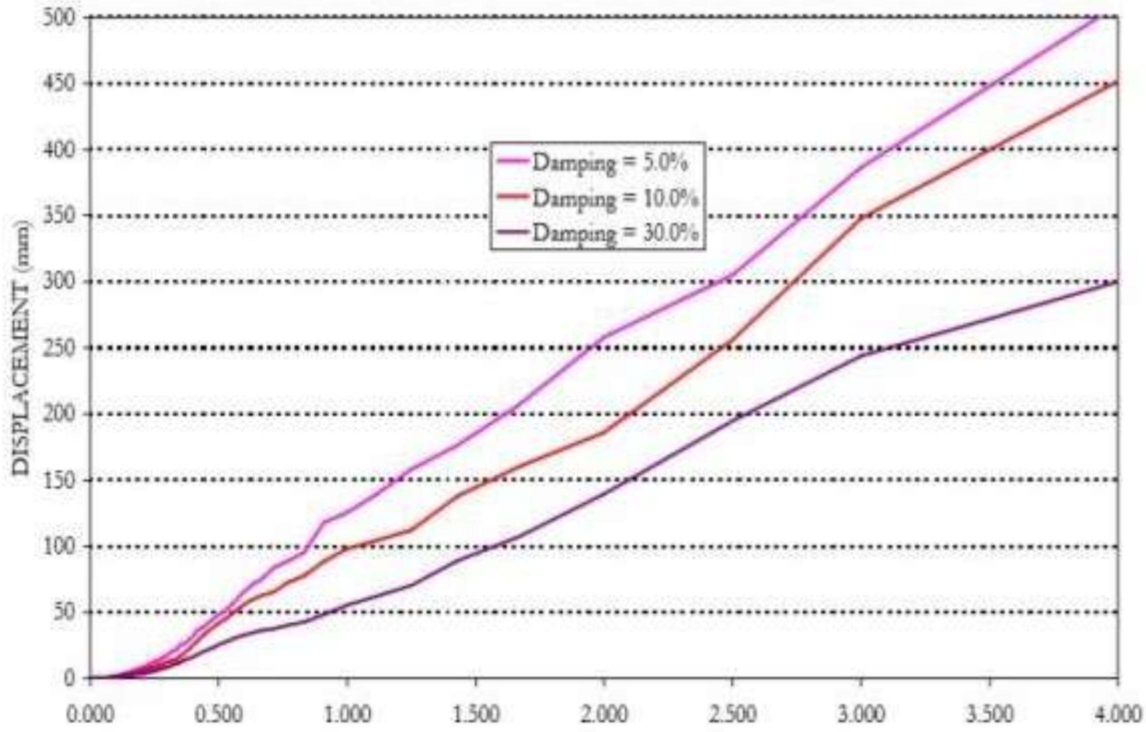


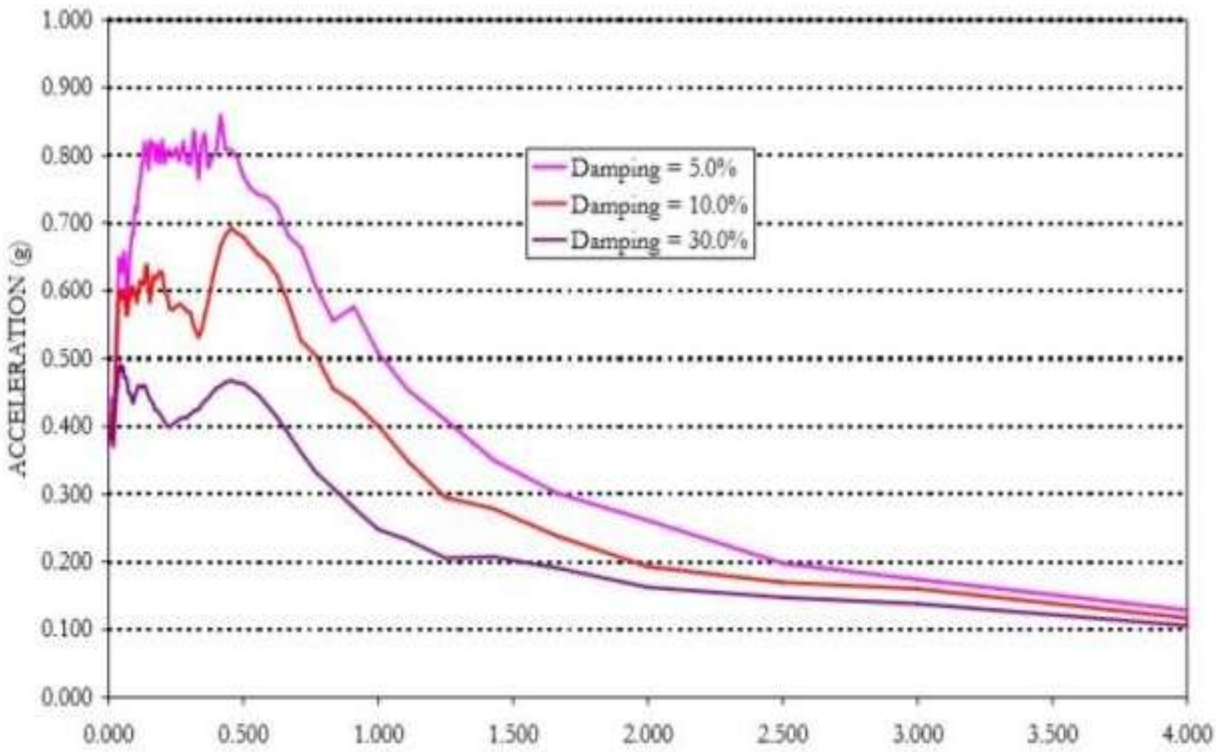
Figure 2: Hysteresis Loop

VII. EFFECT OF DAMPING ON RESPONCE

Increased damping reduces the response of the structure with respect to displacement and acceleration. However, the reduction is not constant over the full period range of response and it also varies with Earthquake. At zero periods, damping has no effect as the spectrum value is equal to maximum ground acceleration. At very long periods, damping also tends to have little effect on accelerations but has more effects on displacement.



Period(seconds)
Figure 3: Effect of damping on Displacement



Period(seconds)
Figure 4: Effect of damping on Acceleration

VIII. CONCLUSION:

The thesis attempts to study the effect of bracings and dampers under earthquake and wind loads for industrial steel structures. This study has been mainly carried out to determine the change in various dynamic parameters due to consideration different bracings, dampers with different mass ratio and height by breadth ratios. Modals with bracings are more effective in reducing structural parameters than dampers. Modals with damper are most effective in reducing systematic parameters than bracings. Combinations of dampers can increase the stiffness and the damping of structures, and reduce the seismic responses of structures effectively. The more combinations of dampers do not mean the better shock absorption effect; the shock absorption effect of dampers is best when the location of dampers is optimal.

REFERENCES

[1] Chandrashekhar B Adin , Praveen J.V., Raveesh R. M, *Dynamic analysis of industrial steel structure by using bracings and dampers under wind load and earthquake load*, International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181.

[2] P.M.B. Raj Kiran Nanduri1, B.Suresh2, MD. Ihtesham Hussain3 "*Optimum Position of Outrigger System for High-Rise Reinforced Concrete Buildings Under Wind And Earthquake Loadings".*

[3] Sagar Dhok, Prof. P. V. Muley, Dr. T. N. Boob, Prof. P. R. Barbude, *Review on applicability of combinations of Damper for Steel Frame Structure,* International Research Journal of Engineering and Technology (IRJET)

[4] Alireza Heysami, "*Types of Dampers and their Seismic Performance during an Earthquake*" Current World Environment Vol. 10(Special Issue 1), 1002-1015, 2015.

[5] Azin Shakibabarough, Mojtaba Valinejadshoubi, Ashutosh Bagchi, *Effects of Damper Locations and Base Isolators on Seismic Response of a Building Frame,* World Academy of Science, Engineering and Technology International Journal of Civil and Environmental Engineering , Vol:10, No:6, 2016

[6] Babak Esmaillzadeh hakimi , Alireza Rahnavard , Teymour Honarbakhs, *seismic design of structures using friction dampers*, 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6, 2004

[7] N. K. Al-Oukaili, S. R. Al-Zaidee, and N. M. Al Mallah, *Modeling of bracing dampers in steel buildings under seismiv loadings,* Fourth Asia-Pacific Conference on FRP in Structures (APFIS 2013).