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Performance of Moment Resisting RC Building Equipped With X-Plate Damper under Seismic And Blast Loading

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***Abstract:** This study is an attempt to evaluate the effects of blast induced vibrations and seismic ground vibrations on reinforced concrete structure equipped with X-plate dampers and also to study the response of structure against blast and seismic vibration which can be reduced by employing protective systems such as dampers. Moment-resisting RC frame buildings were analysed to evaluate the structural responses under dynamic excitations. Non-linear Time-history analysis has been conducted on reinforced concrete structures. The ground accelerations were analytically determined and model was created in SAP2000.*

***Keywords:** X-plate Damper, Ground Induced Vibrations, Energy Dissipation Device, Time-History Analysis.*

I. INTRODUCTION

Enhancement of structure against ground induced vibrations produced by blast and seismic loading has become a major concern in designing purpose. Several researches have been carried out in order to reduce the damage. Passive control devices are introduced in order to reduce this vibrational effect. Due to the ground induced vibrations caused by magnitude of blast and seismic forces, structure behaves inelastic, which is responsible for damage in structure. Factors which govern the magnitude of blast load on structure during an explosive detonation are charge weight, stand-off distance, and geometric configuration of structure and orientation of structure. The impact of blast primarily depends on the charge weight and standoff distance with the proportionate weight of trinitrotoluene (TNT) that the building will encounter. The earthquakes considered are of the most commonly cited seismic records, precisely, Imperial Valley earthquake (magnitude 6.6) 1979, Northridge Earthquake (magnitude 6.7) 1994 for non-linear dynamic analysis of the selected structure. In this paper the X-plate dampers are introduced in structure in order to reduce ground induced vibrations. Performance of structure against blast and seismic vibrations without damper is also evaluated e.g., Manchalwar and Bakre (2016).Study on response of structure under blast loads is referred from Draganićn.H and Vladimir.S (2012) [6, 7]. Comparative study on Efficiency of fluid viscous damper and lead or rubber bearings is observed from Kangda.Z *et al* (2018) [4]. Energy dissipation using passive control systems (X plate damper) is studied from Manchalwar.A *et al* (2016) [2]. Optimal location of metallic damper is taken from Manchalwar.A and Bakre.V(2018) [3]. Ground induced vibration equations and its parameters are studied from Ranjan.K *et al* (2015) [5]. Seismic control of structure with optimal location of damper is studied from Manchalwar.A and S.V. Bakre (2018) [1]. Response of structure under blast loading is studied from Y. Hakan (2014) [8].

II. X PLATE DAMPER (XPD)

An XPD is one of the passive control devices which can sustain cycles of stable yielding deformation resulting in huge amount of energy dissipation. An XPD device energy dissipation is mainly dependant on relative displacement within the device. X plate is held together with an assembly, depending on the necessity of amount of energy to be dissipated number of components of X plates are determined. Amount of energy dissipation by these dampers is dependent on the material used and geometry of dampers. XPD provides additional damping and additional stiffness to the structure hence it is also known as ADAS.Several experimental works were conducted at Bhabha Atomic Research Centre (BARC), Mumbai, India and Indian Institute of Technology, to study the behaviour of XPDs. The subsequent results proved that XPD's exhibits nonlinear hysteretic loops under plastic deformation (Amount of energy dissipated by metallic dampers is evaluated by considering the force–displacement relationship of damper material, such relationship is known as hysteresis loop), and it is observed that there is no notable decrease in stiffness or strength. A typical XPD with holding device used in the

$$F_Y = \frac{\sigma_y b t^2}{6a} n$$

$$q = \frac{2\sigma_y a^2}{Et}$$

$$K_d = \frac{F_Y}{q}$$

$$K_d = \frac{Ebt^3}{12a^3} n$$

present work.

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Where Fy is the yield load, K_d is the initial stiffness and q is the yield displacement of the XPD. E and σ_y are elastic modulus and yield stress with damper material, resp.; a, b and t are height, width and thickness of the XPD.

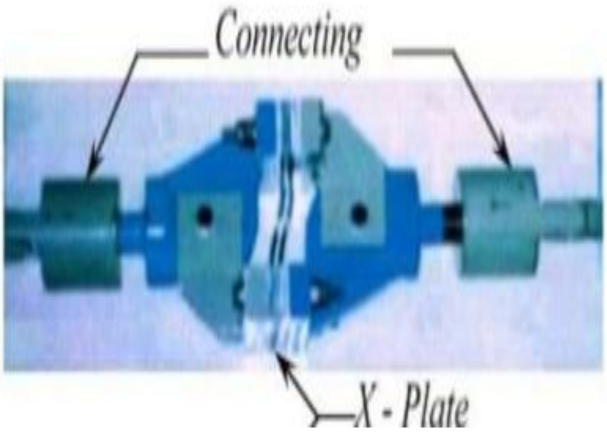


Fig.1. Typical XPD with holding devices

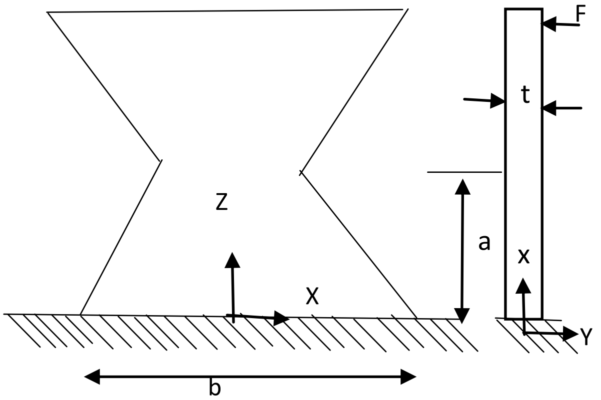


Fig.2. XPD

III. PROBLEM STATEMENT

In order to analyse the Performance of Moment resisting RC framed structure equipped with a X plate damper for ground induced vibrations caused by seismic and blast loadings.

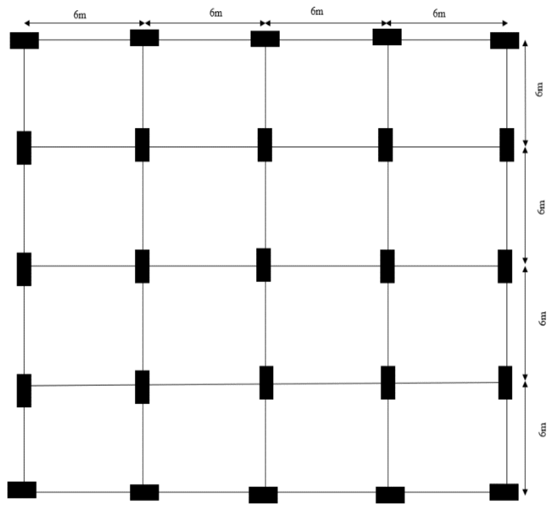


Fig.4. Two-dimensional plan of structure

Table 1 Section Properties

Structural Elements	Size(m)
COLUMN	0.5 X 0.5
BEAM	0.3 X 0.5

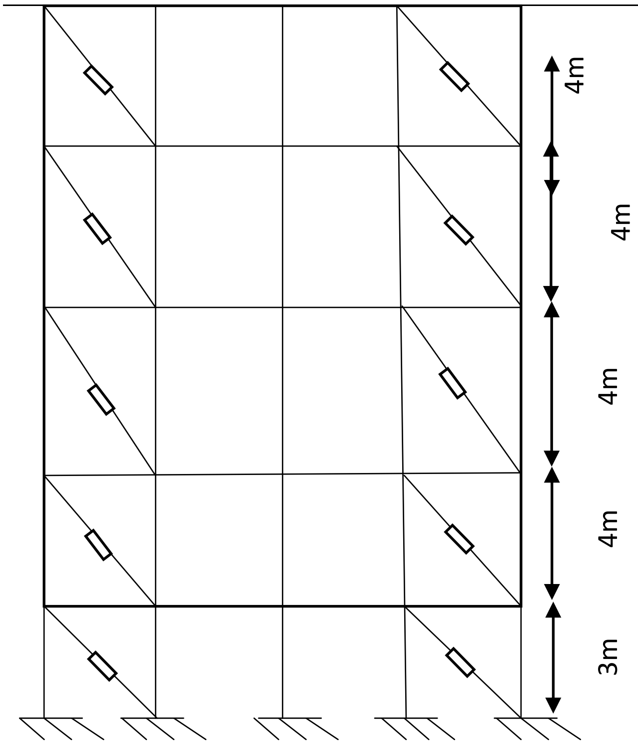
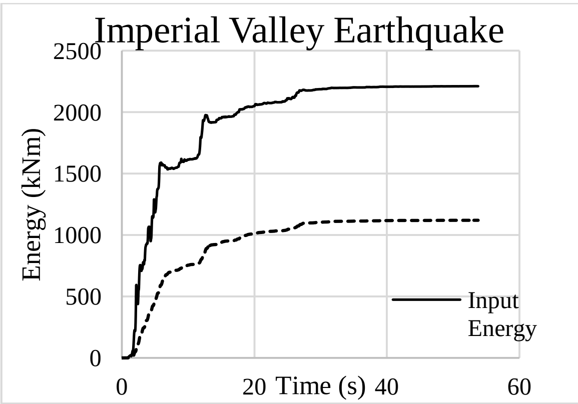


Fig.4. Elevation of structure equipped with X-plate dampers

A. ENERGY COMPARISION

Below graphs are plotted for input energy induced by considered earthquakes and also for charge weight of blast for considerable time period i.e., (Energy v/s Time).The following results shows the comparison of amount of input energy induced into the structure with and without damper for two earthquakes and for two charge weight of blast load. It is observed that maximum input energy dissipation is increased with X-plate damper.



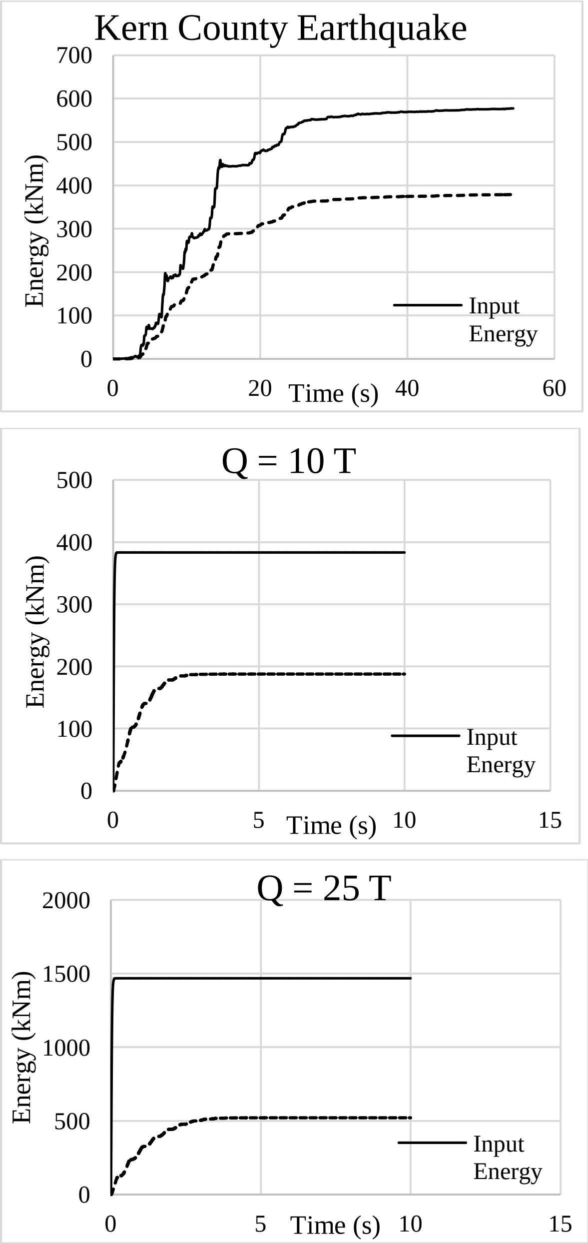
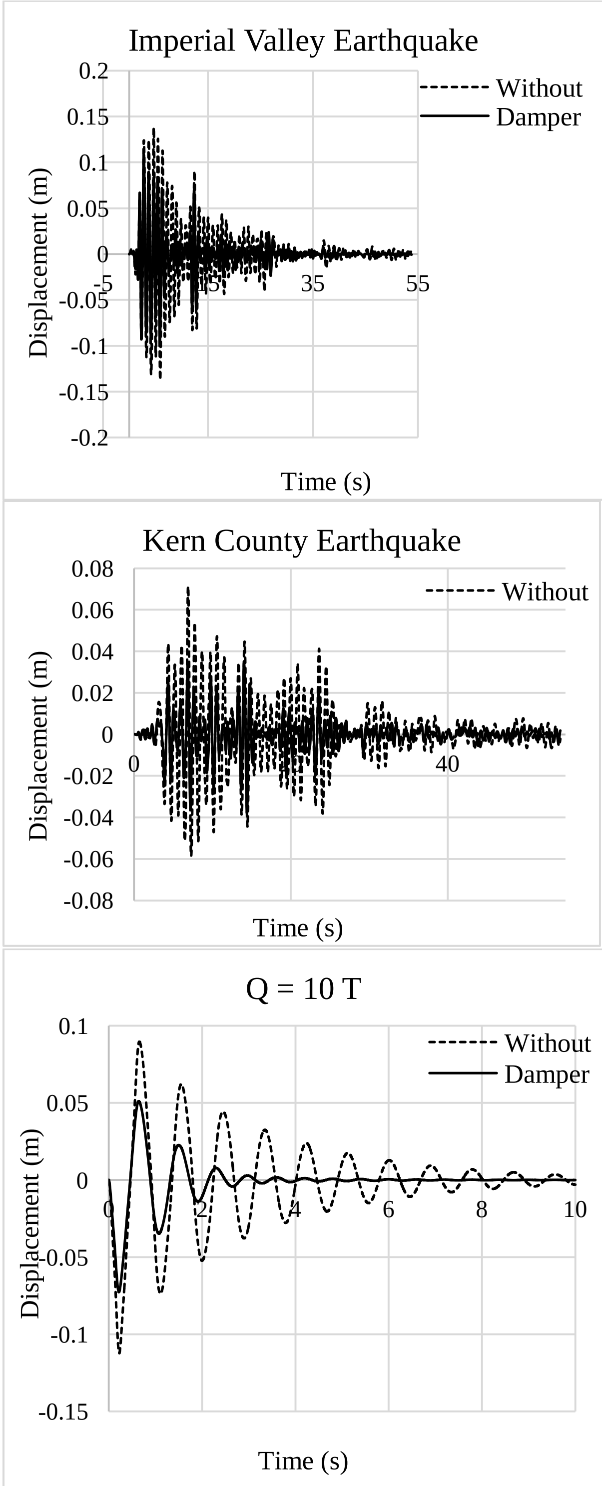


Fig 5 Energy(kNm) versus Time(s)

B. DISPLACEMENT COMPARISION

Below graphs are plotted for Displacements(mm) v/s Time(s) for considered earthquakes and charge weight of blast load.The following results shows that the maximum displacement of structure is been reduced up to 50% by using X-plate damper.



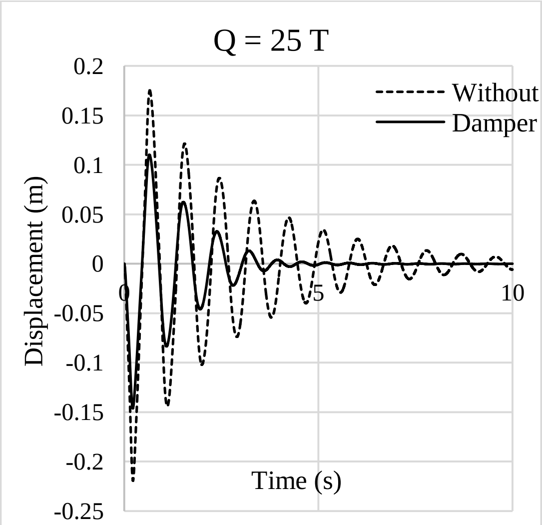
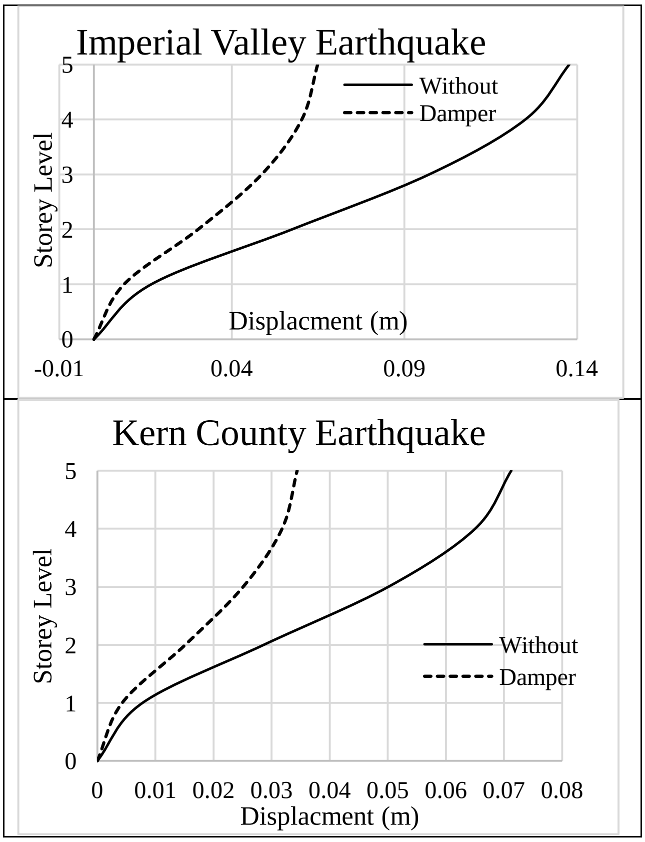


Fig.6 Displacement (m) versus Time(s)

C. STOREY DISPLACEMENT COMPARISON

Below graphs are plotted for considered level and displacement of each storey(mm). The following results shows that the storey displacement of the structure is decreased when it is equipped with X-plate damper.



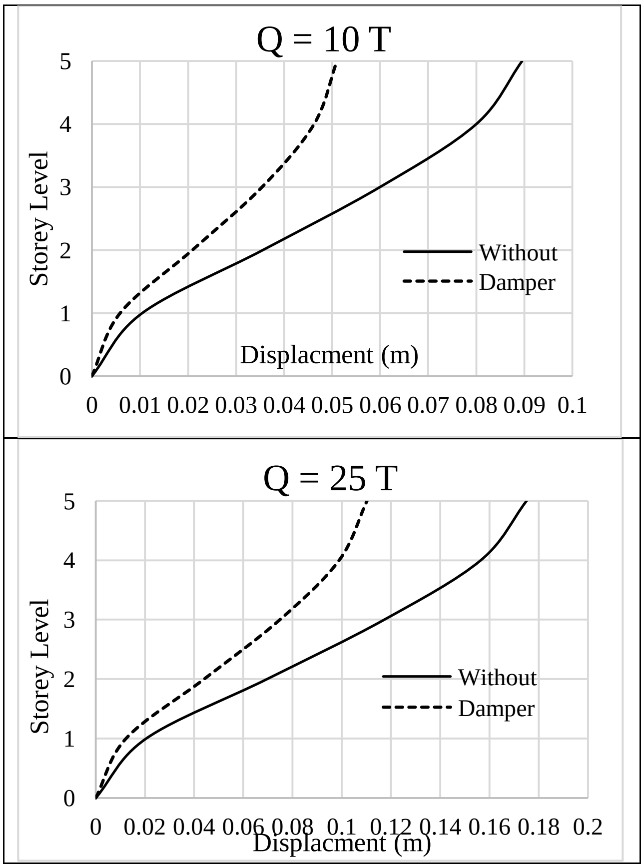


Fig.7. Story Level versus Displacement (m) Graph

IV. CONCLUSION

Performance of structure with X-plate damper for ground induced vibrations produced by seismic and blast loads is analysed. The blast is considered as an exponential decaying function, and earthquakes considered are of high magnitude. A Non-linear time history analysis is performed on structure in SAP2000. It is concluded that the usage of X-plate dampers in the structure reduces the amount of input energy induced into the structure generated by seismic and blast loads. And also, there is a significant decrease in structural responses such as maximum displacements and storey displacements.

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