ASPS Conference Proceedings 1: 1237-1239 (2022)

Proceedings of

12th Structural Engineering Convention-An International Event (SEC 2022)

Available at https://asps-journals.com/index.php/acp

Blast Mitigations of Mid rise structural systems by using Base Isolations

K.K. Kiran[1, *], Jagadish G. Kori[2], K. Krishne Gowda

[1] Associate Professor, Department of Civil Engineering, SJB Institute of Technology, Bangalore, India
[2] Department of Civil Engineering, Professor and HOD, Government Engineering College, Haveri, 581110, India
[3] Department of Civil Engineering, Professor and HOD, UBDTCE, Davanagere, 577004, India

Paper ID - 090335

Abstract

Shelter is a basic need for living creatures. The shelter should be safe and secure. The damage of the shelter occurs due to natural hazards and manmade activities. Natural hazards such as earthquake, volcanic eruptions, landslides, flood, etc. Manmade activities may be accidental or intentional. Accidental activities include, internal explosions such as chemical reactions occurring at nuclear power plants, mining, rock cutting etc, gas explosions leakage etc. Hence while designing the structure, additional precautions and considerations should be taken to resist the unpredictable load. Boatload is a dynamic and impulse loads. The earth load occurs in seconds, In the height of the structures force are distributed and is proportion to mass concentrations, the blast load occurs in milli seconds that is one thousand shorter than the earthquake load and magnitude and locations of the blast load rather than mass the force is concentrated. In the present study Five storey structural system exposed to blast load is considered. MATLAB simulation technique is used in the analysis of the Five storey structural The load is acting on the structural system are calculated. Base isolations method is one the recent method is used to reduce the response of the structural system. The semi active control system is used in the analysis. The response is reduced by considerable amount by using Base isolation.

Keywords: Blast load, Base isolation with LRB, Pressure impulse diagram, normalised pressure impulse curve

1. Introduction

Shelter is a basic need for living creatures. The shelter should be safe and secure. The damage of the shelter occurs due to natural hazards and manmade activities. Natural hazards such as earthquake, volcanic eruptions, landslides, flood, etc. Manmade activities may be accidental or intentional. Accidental activities include, internal explosions such as chemical reactions occurring at nuclear power plants, mining, rock cutting etc, gas explosions leakage etc. Hence while designing the structure, additional precautions and considerations should be taken to resist the unpredictable load [1].The effects of blast load on a structure resulting in risk analysis, reduction, avoidance, general considerations and design process, blast load solutions of technologies and verifications of environmental performance. It also includes blast load phenomena, loading functions, response analysis and fragmentation effects for analyses, structural, building envelope, component space, site perimeter, and building system designs [2].
The motions of fault near of seismic results of MDOF and isolated bridges by Lead Rubber Bearing (LRB) is calculated. The minimum earthquake response of isolated building is control by using the optimum parameters of the LRB near fault zones [3]. An analytical analysis of 40 storey structure exposed to seismic load by using ANSYS simulation software. The 40-storey structure is a multi-degree of freedom structure model exposed to seismic forces. The response is reduced by using hybrid base isolations systems. The considerable amount of displacement, velocity and accelerations is reduced [4]. the response of multi storey structure by seismic forces controlled by isolators. The two different models are chosen, mathematical model of bi linear and hysteretic and mathematical model is equivalent linear elastic viscous behaviours. Different bilinear models of hysteretic and its equivalent model obtained the comparisons of base isolated flexible building. The parameters of yield displacement and force on the effective isolations systems influence the shape of isolators of hysteresis loops [5].
The importance of SDOF system exposed to blast load. Analytical procedure of plotting the pressure impulse curve for SDOF system is stated. The characteristics of PI curve are mentioned. The three-damage curve of PI is stated that is impulse measured damage, peak load and impulse controlled damage and peak load-controlled damage.
The maximum deflection damage criteria are based on PI curve. An elastic SDOF modal is considered for plotting PI curve [6]. The procedure of plotting the PI diagrams for elastic-plastic-hardening and elastic plastic softening of the SDOF systems under blast load. The analytical model of plotting the PI diagram is also explained in brief. The practical applications of blast load on offshore wall are

*Corresponding author. Tel: +919739017954; E-mail address: kirankk0202@gmail.com

Proceedings of the 12th Structural Engineering Convention (SEC 2022), NCDMM, MNIT Jaipur, India| 19-22 December, 2022

Published online: December 19, 2022
doi:10.38208/acp.v1.646

explained. The components of the PI curve and derivations is mentioned [7].

Normalised pressure impulse diagram, plotted for ventilated blast load and also unventilated blast load. The normalised pressure impulse diagram procedure is given. The applications of normalised pressure impulse diagram is mentioned [8].

The paper presents the following parameter (i) Blast load acting on the five-storey structure (ii)Response of the five-storey structure is calculated (iii) Response are reduced by considerable amount by using Base isolations with LRB and (iv) Pressure impulse and normalised pressure impulse curve are also plotted

2. Structural Models

Fig.1. shows the blast load acting on the blast load acting on five store structure. Table .1. shows the parameter used in the structural model.

Blast load of storey five structure is shown in Fig.2. The maximum load occurs 12000 kN at first floor and minimum load 3800 kN at fixed base.

3. Results and Discussions

Fig.3. shows the second floor the reduction of velocity by using base isolation system. The time occurs for 0.25 sec and maximum velocity is 0.028 m/msec.

Table 2 shows the reductions of velocity of structural system by using base isolation system.

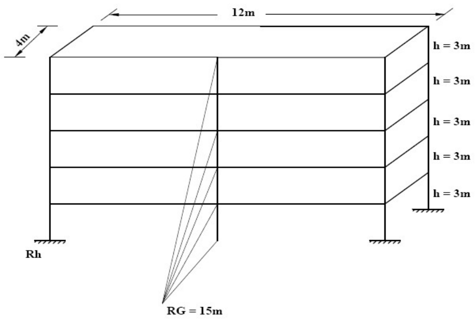

Fig.1.Blast load acting on the 5-storey structure

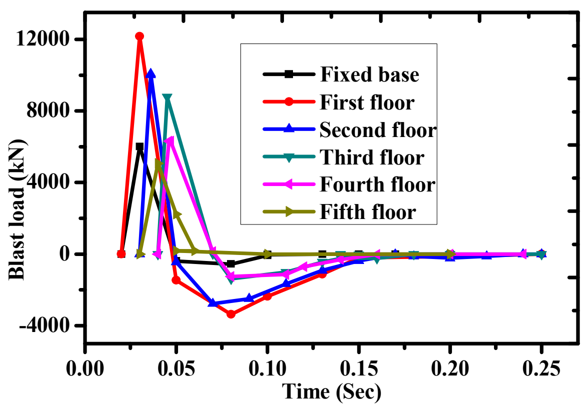

Fig.2 Blast load of 500 kg TNT on the 5-storey structure.

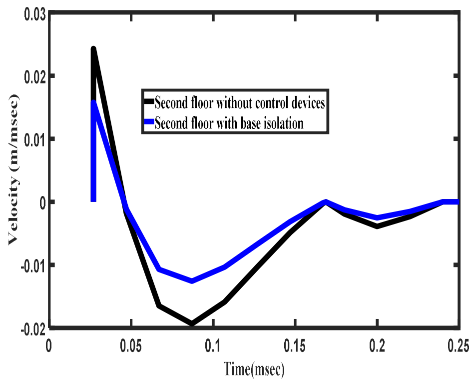

Fig.3.Reduction of displacement of second floor by base isolation

Table .1. Parameters of five storey structural model

Floor level	Mass at each storey (kg)	Stiffness at each storey (kN/m)	Co-efficient of damping (kg/s)
Base	m_0=61,200	k_0=2129.8	c_0=69,938
1	m_1=53,073	k_1=101,196	c_1=348,140
2	m_2=53,073	k_2=87,279	c_2=301,380
3	m_3=53,073	k_3=85,863	c_3=296,180
4	m_4=53,073	k_4=74,862	c_4=259,810
5	m_5=53,073	k_5=57,177	c_5=197,450

Table 2 Percentage of reduction of velocity on 5-story structure models

Sl no	Floor	Bare velocity (m/msec)	Base isolation Velocity (m/msec)	Percentage reduction
1	Fixed base	0.025	0.015	40
2	First floor	0.04	0.015	63
3	Second floor	0.04	0.02	50
4	Third floor	0.14	0.08	43
5	Fourth floor	0.03	0.015	50
6	Fifth floor	0.02	0.015	25

Fig.4. shows the accelerations of the various floor occurring in the structural system.

Fig .5. shows the increase of pressure impulse curve at first floor by using base isolations. The pressure impulse falls below the right curve will be safe, if the pressure impulse falls above right curve will be unsafe. The pressure increases from 0.1 kPa to 0.3 kPa and also impulse 0.0001 kPa sec to 0.001 kPa msec.

Fig.6. shows the normalized impulse curve of the firs floor. Normalized impulse curve is the advanced pressure impulse curve. In this curve represents the non-dimensional curve.

Fig.7. shows the reduction of the story drift by using the base isolations. The maximum story drift occurs at 4 floor and minimum drift occurs at first floor.

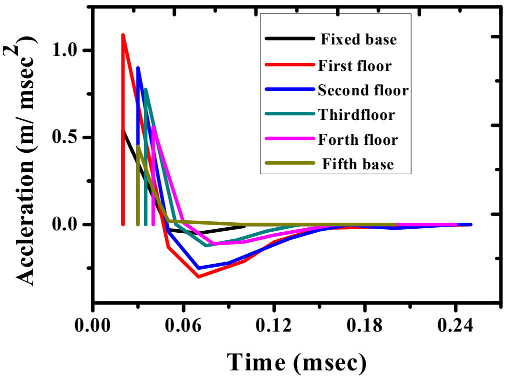

Fig.4.Accleration of a structural system

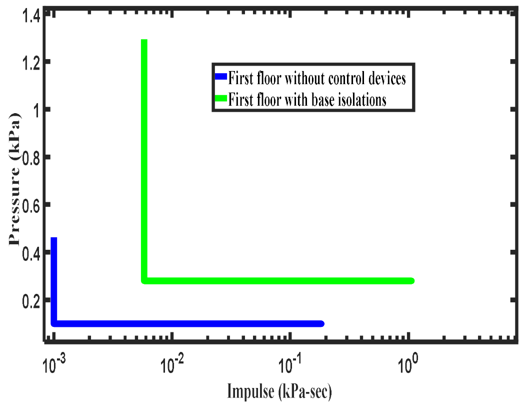

Fig.5. Increase in pressure at first floor by base isolation

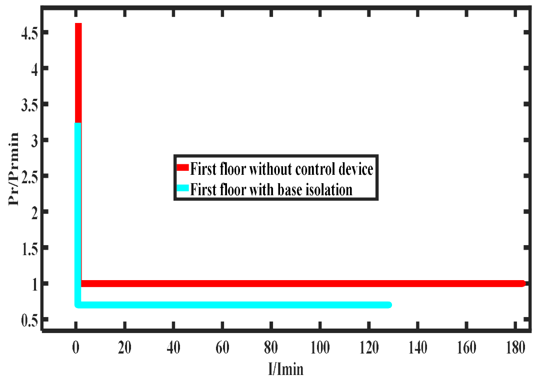

Fig.6. Normalized pressure impulse curve of first floor by base isolation

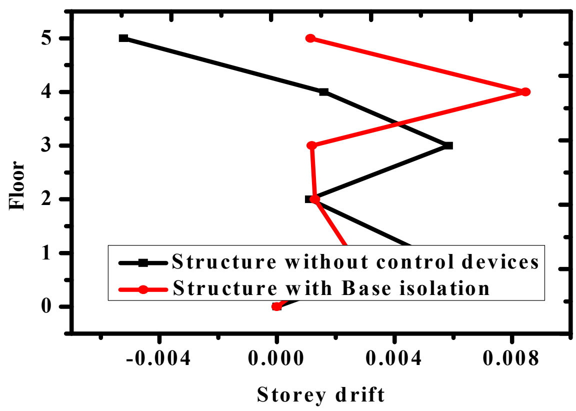

Figure .7. Reduction of storey drift of a structural system by base isolation

4. Conclusions

Based on above results the following are the observations made

i. The maximum displacement of 0.14m occurs at fourth and fifth floor, velocity of 3.5 m/msec occurs at third floor and accelerations of 1.1 m/msec^2 occurs at fourth and fifth floor.

ii. The maximum pressure occurs at 0.1 kPa at first floor and impulse of 0.008 kPa sec.

iii. The maximum drift occurs at 0.006 at third floor

iv. The 50% of the displacement, 45% of the velocity and 48% accelerations is reduced by using the base isolations of the structural system.

v. 50% of increase in pressure and impulse, 20% of increase in normalized pressure impulse curve will not cause failure to the structural system by using the base isolations systems

vi. 30% of the of reductions of the base shear is done by using the base isolations systems.

Disclosures

Free Access to this article is sponsored by SARL ALPHA CRISTO INDUSTRIAL.

References

1. Theodor Krauthammer (2008) "Modern Protective Structures" CRC Press.
2. Donald O. Dusenberry (2010). HANDBOOK FOR BLAST-RESISTANT DESIGN OF BUILDINGS John Wiley & Sons, Inc.
3. R. S. Jangid.(2007). "Optimum lead-rubber isolation bearings for near fault motions" Engineering Structures, Vol. 29, pp no 2503-2513.
4. Salah Almusbahi and Ali Gungor (2018). "A composite building isolation system for earthquake protection" Engineering Science and Technology (Article in press).
5. Vasanth A Matsagar and R S Jangid. (2003). "Seismic response of base-isolated structures during impact with adjacent structures" Engineering Structure, Vol. 25, pp no 1311-1323.
6. Q. M. Li and H. Meng. (2002). "Pulse loading shape effects on pressure impulse diagram of an elastic plastic single degree of freedom structural model" International journal of Mechanical science, Vol. 44, pp no 1985-1998.
7. A. Soleiman Fallah and L. A. Louca. (2007). "Pressure-impulse diagrams for elastic-plastic-hardening and softening single-degree-of-freedom models subjected to blast loading" International Journal of Impact Engineering, Vol. 34, pp no 823-842.
8. Jonathon Dragos and Chengqing Wu. (2014) "Application of normalized pressure impulse diagrams for vented and unvented confined blasts" Journal of Engineering Mechanics, Vol. 140, No. 3, pp no 593-603.