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COMPARATIVE STUDY ON MASONRY INFILL, FRICTION DAMPERS AND BARE FRAME STRUCTURES UNDER SEISMIC FORCES

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Abstract - *Masonry infill reinforced concrete frame are a most common type of structures used in many countries, Masonry infill increase stiffness and strength of reinforced concrete frame buildings. These masonry infills are considered as non-structural members and are excluded from analysis and design of the structure. But, when these structures are laterally loaded, the masonry infills tend to intermingle with the reinforced concrete frame, changing the structural performance. Here, masonry infill in the form of Equivalent Diagonal Strut is incorporated, whose width is calculated using the Paulay and Priestley method. Friction dampers are passive supplemental damping device bearing appropriate stiffness can be used in new and retrofitted buildings, to regulate the amplitude of structure due to seismic action. A friction damper comprises of steel plates which dispel energy by gliding against each other in opposed direction. In this paper, an attempt is made to compare the response of the building under the frame with masonry infill and damped frame to that of a bare frame. For the analysis, a building of G+9 storey structure with three different models one with a bare frame, the second model in masonry infill and third with dampers are modeled in ETABS 2015 software subjected to EL Centro records. Non-Linear Model with Time History Method has been used to compare storey acceleration, column bending moment, storey displacement and base shear.*

Key Words*: *Masonry Infill, Equivalent Diagonal Strut, Friction Dampers, Dispel energy, Bare Frame, EL Centro, and Non-Linear Model.

1. INTRODUCTION

Earthquakes are natural hazards and structural damage due to that depends on many constraints, including intensity, duration and frequency content of earth motion, soil state and excellence in construction. Conservative seismic design efforts to make buildings that do not ruin under strong earthquake quaking, but may, withstand damage to non-structural components (like glass facades) and to some structural members in the building. This may render the *buil*ding non-functional after the earthquake, which may be challenging in some structures, like hospitals, which need to remain serviceable after effects of the earthquake. Distinct techniques are essential to design buildings such that they endure practically undamaged even in a severe seismic action. Buildings with such enhanced seismic performance usually cost more than regular buildings do. However, this cost is justified through developed earthquake performance. The design of the building should be such as to ensure that the building has adequate strength, high ductility, and will remain as one unit, even while subjected to very large deformation.

Masonry Infills (MI) are commonly used in buildings for functional and architectural purposes. They are frequently used to shield within the working from the outer environs (wind, rain, snow etc.) or used as barriers - to separate the spaces inside. The MI will upgrade the base shear of the structure and these gravity loads don't posture quite a bit of an issue. It is assumed that the MI does not contribute in resisting any kind of loads either axial or lateral and hence their structural contributions are usually neglected in the design process. However, masonry infill tends to interact with the surrounding reinforced concrete (RC) frame when the structure is subjected to lateral loads. It has been perceived that RC frames with masonry infill have more strength and rigidity in comparison to that of the bare frames and the ignorance of masonry infill has become the cause of failure of many multi-storey buildings. The key reason for failure being the stiffening effect of the MI frame, which alters the basic behavior of buildings when laterally loaded and leading to a new failure mechanism.

The investigation of the collaboration of MI with RC frames has been attempted by using analysis of finite element analysis (FEA) or theory of elasticity. An estimated technique for examination was satisfactory due to the instability that was included in characterizing the interface conditions between the MI frames with the RC frames. A few techniques for analysis of MI frames had been proposed by different specialists, these strategies could be isolated into two gatherings relying upon the level of refinement used to model the structure. The first group consists of the macro models, to which the simplified models belong, which is based on physical understanding of the structure (Equivalent Diagonal Strut). The second group involves the micro models including the finite element formulations where local effects in detail are taken into account.

Extreme ground shaking induces lateral inertial forces on buildings, making them influence forward and backward with amplitude proportional to the energy fed in. In the event that a noteworthy segment of this vitality can be devoured amid building movement, the seismic reaction can be extensively made strides. The way in which this vitality is devoured in the structure decides the level of harm

Friction Dampers are simple and foolproof in construction. These are provided in steel bracing in steel/concrete frames. Fundamentally, these comprise of an arrangement of steel plates, which are specially treated to develop very reliable friction. These plates are clasped together and permitted to slip at a foreordained load. Many years of research and testing have led to perfecting the art of friction. Their performance is reliable, repeatable and they possess large rectangular hysteresis loops with negligible fade. Friction Dampers are passive energy dissipation devices and, therefore, need no energy source other than earthquakes to operate it. They don't require any repair or substitution after the seismic tremor and are constantly prepared to carry out their employment.

Friction Dampers are available in long slender tension-only cross bracing, single diagonal tension-compression bracing and chevron bracing. The damper for cross bracing is a unique mechanism.

Fig -1: 1) Friction Dampers in Chevron Brace, 2) Friction Damper in Tension-Compression Brace, 3) Friction Damper for Tension-only Cross Brace

2. OBJECTIVES

- The main aim of the research program is to analyze the building with masonry, with friction dampers and bare frame subjected to Non-linear time history method with symmetrical in a plan.
- To compare the response of R.C frame under masonry and friction damper.
- To investigate the contribution of masonry infill walls and friction dampers to lateral strength and lateral stiffness of the buildings.
- To quantify the structural behavior due to the presence of infill as a diagonal strut and friction dampers.
- To know percentage energy dissipated under seismic force.
- To compare Shear force and bending moments in a column.

3. METHODOLOGY

Software ETABS will be used to analyze the effect of masonry infill, friction damper on seismic response of the building. The study will be carried out for 3D building models having symmetric in a plan. The masonry and friction dampers are provided on the periphery. Each building model will be analyzed for Non-linear time history analysis under three conditions which are as follows:

I. 3D bare frame building model without friction damper and without masonry infill.
II. 3D bare frame building model with masonry infill and without friction damper.
III. 3D bare frame building model with friction damped and without masonry infill.

The seismic reaction of the structure will be examined on the premise of examinations of storey acceleration, column bending moment, storey displacement and base shear of the bare frame, frame with masonry infill and damped frame.

3.1 Design Data

For the study, a ten storey with symmetric three bay plan is been considered. The plan is shown in the below fig 2.

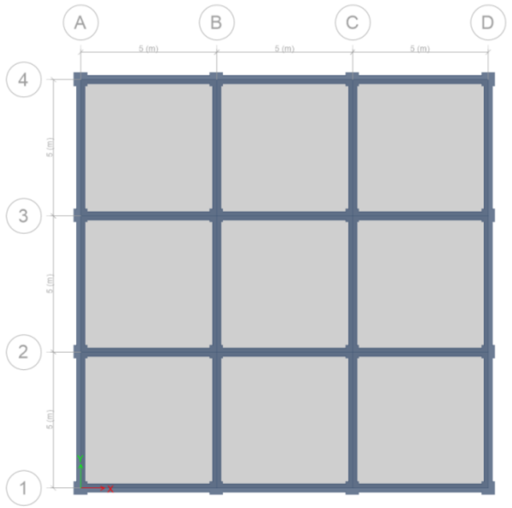

Fig -2: Model Plan

3.1.1 Materials

a) Concrete: Concrete using following properties are considered for the study.

- Characteristic compressive strength (beam & column) (fck) = 30 MPa
- Characteristic compressive strength (slab) (fck) = 20 MPa
- Poisson's Ratio = 0.3
- Density = 25 kN/m3
- Modulus of Elasticity (E) = 22360.67 MPa

b) Steel: Steel with following properties is considered for the study.

- Yield Stress (fy) = 415 MPa
- Modulus of Elasticity (E) = 2x105 MPa

3.1.2 Model Description

a. Number of stories = G+9
b. C/C dist between columns in X- dir = 5 m
c. C/C dist between columns in Y- dir = 5 m
d. Foundation level to ground level = 2 m
e. Floor to floor height = 3 m
f. Live load on all floors = 3 kN/m^2
g. Live load on roof = 1.5 kN/m^2
h. Size of column = 500 X 500 mm
i. Size of beam = 300 X 500 mm
j. Depth of slab = 150 mm

3.1.3 Equivalent Diagonal Strut Method

In this method, the analysis is carried out by simulating the action of infills similar to that of diagonal struts bracing the frame. The infills are replaced by an equivalent strut of length D, and width W and the analysis of the frame-strut system is carried out using usual frame analysis methods. The relationships proposed by Paulay and Preistley have to resist the shear forces that try to push the walls over.

According to Paulay and Preistley Equivalent strut width is given by:

$$w = 0.25 \times D = 0.25 \times 5.14 = 1.285 \text{ m}$$

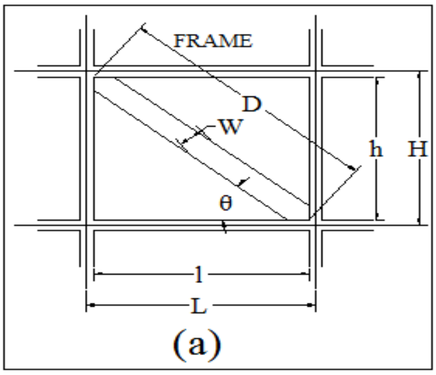

Fig -3: Equivalent diagonal strut width

3.1.4 Model Description of Masonry Infill

- Clay burnt brick, Class A, confined unreinforced masonry
- Compressive strength of Brick, f_m = 10 MPa
- Modulus of Elasticity of masonry, E = 5500 MPa
- Poisson's Ratio = 0.15
- Thickness of infill = 200 mm

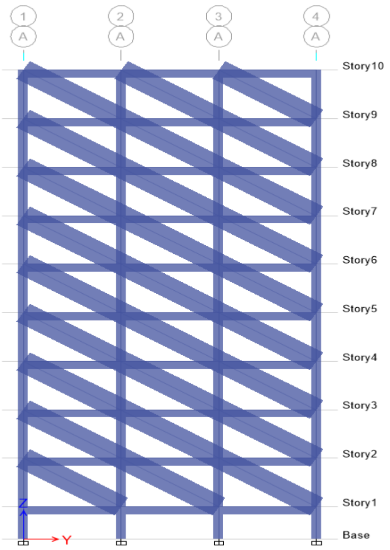

Fig -4: Structure with Masonry Infill

3.1.5 Model description of Friction Dampers

ISA 150X150X10 equal angle steel brace section is been considered.

- Mass, M = 117.192 kg
- Weight, W = 1.1496 kN
- Post yield stiffness ratio = 0.0001
- Yield strength/Slip load of damper = 225 kN
- Yielding exponent = 10
- Effective stiffness of brace, Ke = 112957.2 kN/m

3.1.6 Optimal Slip Load calculations

In the design of friction dampers, it is necessary to know the load at what the damper slips. The rate of energy dissipation is directly proportional to load at which the two damper plate slip. Slip load is the critical factor which can alter the response of the structure. For this reason different range of slip load ranging from 50 to 500kN with a 50kN interval. The dampers are placed at the periphery of structure from lower to upper storey as shown in fig 6-

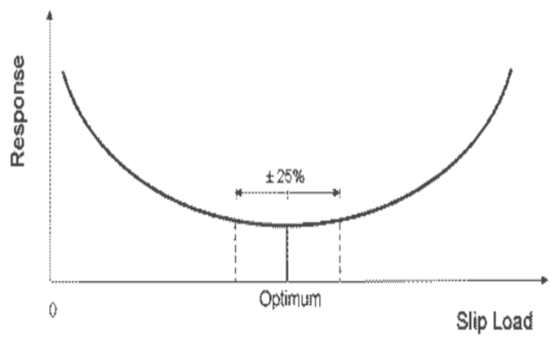

Fig -5: Response of building at different Slip load

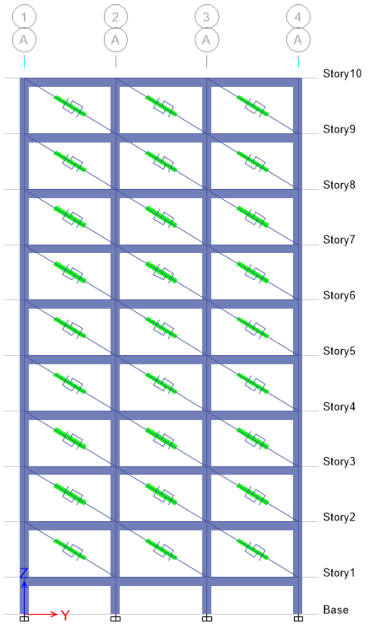

Fig -6: Structure with friction damper

4. REULTS

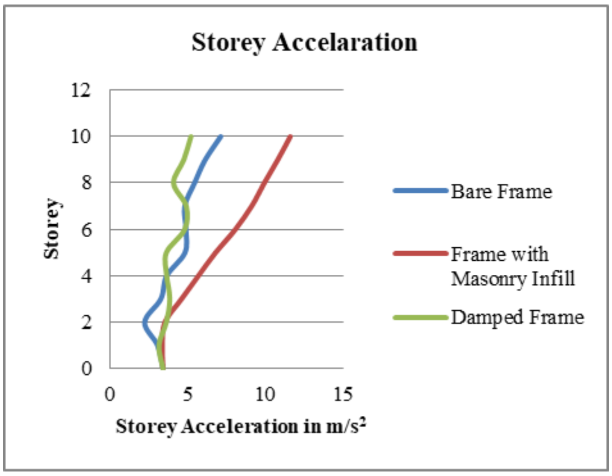

Chart -1: Storey Acceleration

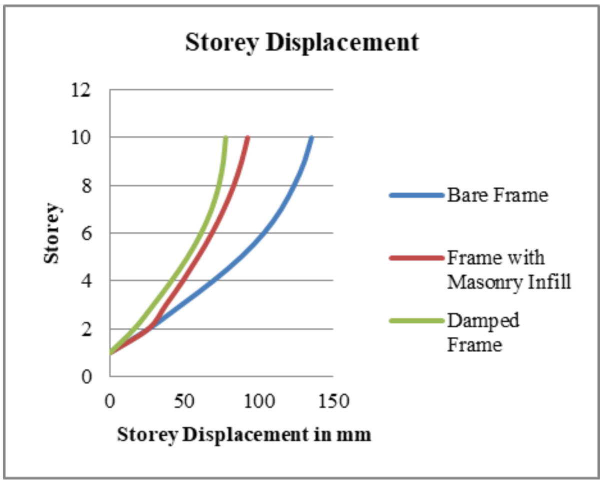

Chart -2: Storey Displacement

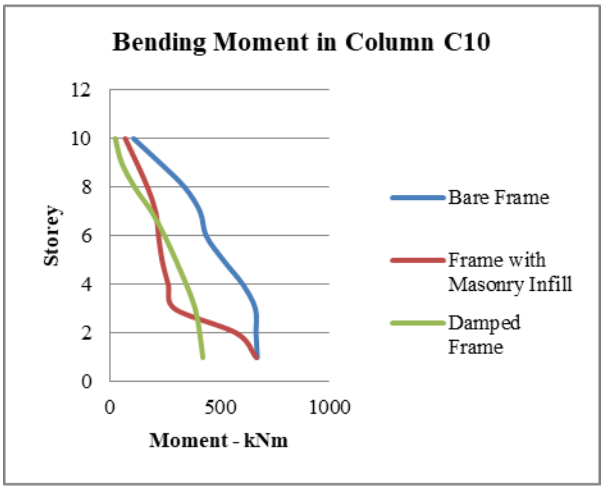

Chart -3: Column bending moment

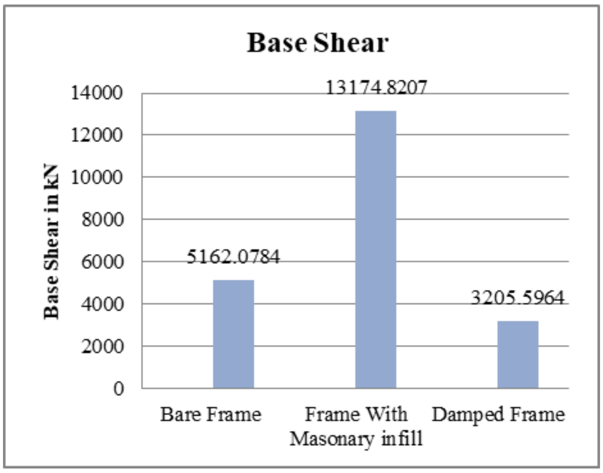

Chart -4: Base Shear

5. CONCLUSION

From the above comparative graphs, it says that use of friction damper and masonry infill both are effective in reducing the response of the structure to that of the bare frame structure. In masonry infill as the stiffness increases, bring about decrease in displacement and column bending moment, but leading to rise in base shear, storey shear and storey acceleration. The use of friction dampers dispels energy fed to the structure by an earthquake. The use of friction dampers proved to be effective in reducing the response of the structure and thereby decreasing the damage to the structure.

REFERENCES

[1]. G.Prasanna Lakshmi, Dr M.Helen Santhi, "Seismic Evaluation Of Residential Building With Masonry Wall Using ETABS" International Journal of Engineering Sciences & Research Technology, May 2016.
[2]. K. H. Abdelkareem, F. K. Abdel Sayed, M. H. Ahmed, N. AL-Mekhlafy "Equivalent Strut Width for Modeling R.C. Infilled Frames" Journal of Engineering Sciences, Assiut University, Faculty of Engineering, Vol. 41, No. 3, May 2013.
[3]. Nikhil S Agrawal, Prof. P. B Kulkarni. "Static Analysis Of Masonry Infilled R.C. Frame With &Without Opening Including Soft Story of Symmetric Building" IOSR Journal of Mechanical and Civil Engineering, Vol 8, Issue 1, Jul. - Aug. 2013, PP 78-87.
[4]. S. S. Sanghai and S. N. Khante "Seismic Response of Unsymmetric Building With Optimally Placed Friction Dampers" International Journal of Civil Engineering and Technology Vol 8, Issue 2, February 2017, pp. 72–88.
[5]. Milin N. Rajkotia And S. S. Sanghai "Seismic Analysis of Unsymmetrical Building Using Supplemented Device" International Journal for Scientific Research & Development| Vol. 4, Issue 03, 2016.
[6]. Avtar PALL And R. Tina PALL "Performance-Based Design Using Pall Friction Dampers - An Economical Design Solution" 13th World Conference on Earthquake Engineering Vancouver, B.C., Canada August 1-6 2004 Paper No. 1955.
[7]. Ramesh Chandra, Moti Masand, S K Nandi, C P Tripathi, Rashmi PALL and Avtar PALL "Friction-Dampers for Seismic Control of La Gardenia Towers South City, Gurgaon, India" 12th World Conference on Earthquake Engineering, 2008.

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