

Seismic Performance of Plan-Irregular RC Structures with Base Isolation as Scrap Tyre Rubber Pads (STR PS)

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Abstract — This present study focuses on the seismic performance of plan-irregular reinforced concrete (RC) G+5 buildings (L-shaped and T-shaped) using base isolation made from scrap tyre rubber pads (STRPs). The research models regular and irregular structures in ETABS 21 software to determine essential seismic parameters such as displacements, storey drifts, base shear, bending moments, and axial forces, implements isolators as equivalent lateral springs and viscous damping, and performs Response Spectrum Analysis (RSA) according to IS 1893 (Part 1):2016. Results compare natural periods, base shear, roof displacement, and story drifts for fixed-base and STRP-isolated configurations. The work emphasizes sustainable reuse of tyre waste and. The primary objectives include evaluating the building's response to horizontal seismic forces, determining key response parameters such as displacement and drift, and validating the analysis results against codal provisions. The research provides insights into the seismic performance of medium-rise structures and emphasizes the importance of incorporating seismic analysis in the planning and design stages to enhance structural resilience and disaster preparedness.

Keywords: Base Isolation System, Fixed Base, STRPS, Response Spectrum Method, Seismic Analysis, Plan Irregularity

Nomenclature Used: STRP: Strap tyre Rubber Pads

LRB: Lead Rubber Bearing

HDRB: High Damping Rubber Bearing

FPB: Friction Pendulum Bearing

OMRF: Ordinary Moment Resisting Frames

SMRF: Special Moment Resisting Frames

RCC: Reinforce concrete cement

RSM: Response Spectrum Method

ETABS: Extended Three-dimensional Analysis of Building Systems

CAD: Computer-aided design

BIM: Building Information Modeling

I. INTRODUCTION

Reinforced concrete (RC) buildings in India frequently exhibit irregularities in vertical or plan configuration due to modern architectural needs. While these irregularities help achieve functional and aesthetic requirements, they also make buildings vulnerable during earthquakes. Plan irregularities such as L-shaped, T-shaped, and U-shaped configurations create torsional responses in seismic events. These structures attract large shear forces and rotational accelerations, leading to severe damage or collapse.

Base isolation technology has emerged as a highly effective approach for improving the seismic performance of RC buildings. Traditional isolators such as Lead Rubber Bearings (LRBs) and High Damping Rubber Bearings (HDRBs) are highly effective but expensive, limiting their widespread use in developing nations. To overcome cost challenges, Scrap Tyre Rubber Pads (STRPs)—made from recycled tyre material—offer a sustainable, low-cost alternative with acceptable engineering performance.

This paper evaluates the seismic performance of plan-irregular G+5 RC buildings using STRP- base isolation and compares them to fixed-base structures

A. Software Used in the Research

The software employed for the structural analysis in this study was ETABS 21, a widely used tool in the field of civil and structural engineering.

II. LITERATURE REVIEW

A. Review

1) Seismic Response Control of Vertically Irregular R.C.C. Structure using Base Isolation

S. D. Darshale, N. L. Shelke. (2016)— In this paper says Many vibration-control measures like passive, active, semi-active and hybrid vibration control methods have been developed. Base isolation is a passive vibration control system. The isolator partially reflects and partially absorbs input seismic energy before it gets transmitted to the superstructure. Lead rubber bearing isolators are placed between the superstructure and foundation, which reduces the horizontal stiffness of the system. It thereby increases the time period of the structure and decreases the spectral acceleration of the structure. The superstructure acts like a rigid body; thus, inter storey drift is reduced. This study is concerned with the effects of various vertical irregularities on the seismic response of a structure and controls this response using base isolation. The objective of the study is to carry out response spectrum analysis and time history analysis of fixed base and base isolated vertically irregular RCC structure according to IS 1893:2002 (Part-1).

2) Seismic isolation using scrap tire rubber pads

Cici Jennifer Raj J., Suppiah S, (2021) - In this research paper describes Base isolation is a technique, in which a structure is protected from the devastating effects of seismic forces or any other vibrations. The isolation is achieved by installing flexible elements at the base of the structure or elements that slide under lateral loads. Interestingly, a well-conceived base isolated structure saves precious lives and property worth millions of dollars. Base isolation is implemented since ancient days using a variety of materials, for instance, coal, marble, rubber, sand, tire, wood and other materials. In the present study, a three-storey shear frame, base isolated with Scrap Tire Rubber Pad (STRP) bearings has been analyzed.

The response of this structure has been compared with that of an identical structure having a fixed base (without isolation). In both the cases natural frequencies and mode shapes have been computed through MATLAB. The response of the two cases show that the base isolation is very effective in the fundamental mode of vibration.

3) *Effect of Base Isolation in Multistoried RC Regular and Irregular Building by Using Response Spectrum Analysis*

S. Gyawali¹, D. Thapa², T. R. Bhattarai (2016) -this research illustrates that large population in the world are living in regions of seismic hazards, at risk from earthquakes of varying severity and frequency of occurrence. The significant loss of life and damage of property occurs every year due to earthquake. Here the one of the best solution to mitigate the effect of earthquake on building is base isolation technique. The main mechanism of seismic isolation is to decouple the structure from base by providing seismic isolators. The Lead Rubber Bearing (LRB) is mounted beneath the superstructure in base isolation system. The significant of base isolation device is to minimize the horizontal acceleration transmitted to the superstructure. It is very promising technology to protect different structures from seismic excitation. In this research, GF+4 storied regular, plan irregular (re-entrant corners) and vertical irregular (vertical geometric irregularity) building models were considered for both fixed base and base isolation in SAP. Response spectrum method analysis under IS1893:2002 was conducted in analysis software for the result of seismic performance parameters. The output results of seismic parameters were interpreted and compared. The SAP analysis results were compared and validated by ETABS software. Lead rubber bearings were designed as UBC 97 and used for base isolation. The research concluded that, Plan and vertical irregular LRB building found more seismically performed than regular LRB building however vertical irregular LRB building showed better performance as comparison to plan irregular LRB building.

4) *Comparative Study on Seismic Response of Regular and Plan Irregular Base isolated structures*

Dr. Kavitha B1 Ajay Kumar Kore (2023) - Earthquake is one of most destructing threat which cause severe damage to life and property. Recently, due to increasing demand and need for the present generations has made the designers and engineers to plan for structures having irregularities. It is impossible to avoid designing uneven buildings in reality. It is important to research how this irregular structure behaves in earthquake-prone areas, especially for structures with base isolation. When compared to regular structures with base isolation, structures with plan irregularity react differently. When a reinforced concrete building with varied plan configurations, such as an H, U, or L shape, is subjected to seismic loading, the impact of plan irregularity is explored. In the current study, a regular structure is also considered to compare the responses of the isolated irregular base structure. Building response spectrum analysis for seismic analysis was done in seismic zone III using IS 1893-2002 code [5]. The structural analysis software tool ETABS 18 was used to conduct the analysis. Among different types of isolators present, in the present study LRB isolator and friction isolators was used as a Nonlinear Support. The dynamic response of the structure such as base shear, time period and story displacement are used to compare the regular and

irregular structures. The effectiveness of the base isolators in the structures in earthquake prone area is evaluated in the present study.

5) *Seismic Performance of Base Isolated Buildings with Plan Irregularity*

Devi Sreenivas, Ancy Mathew (2016) -This study focuses on the base isolation, it is one of the most powerful tools of earthquake resistant design. The concept behind the base isolation technique is to reduce the amount of energy transmitted to the superstructure during an earthquake and thus it has gained increasing acceptance during the last two decades. The past experiences showed that the irregular buildings are more prone to damages when compared with the regular structures. This paper presents a response spectrum analysis performed on two plan irregular r/c building with re-entrant corners using the software ETABS 2015. The main objective here is to study the seismic response control on a structure by providing isolators and comparing between the fixed based and isolated base building. The paper investigates the effectiveness of the rubber isolator against friction pendulum system for various plan irregular building. This paper studies various parameters such as total base shear force, storey acceleration, displacement and time period of a building with respect to the fixed base and isolated base. The study also compares the performance of two irregular buildings with Lshape and plus shape in plan having same area. The study concluded that the addition of isolators reduced the storey drift, acceleration and base shear values. The study indicated that the performance of the plus shaped building is better when compared to the L-shaped building

6) *Seismic Performance Analysis of RCC Multi-Storied Buildings with Plan Irregularity*

Mohaiminul Haque¹ Sourav Ray¹, Amit Chakraborty, Mohammad Elias, Iftekharul Alam¹ (2016) -This study the seismic performance analysis is highly recommended to ensure safe and sound building structures for this region. To get better performance from reinforced concrete (RCC) structure, new seismic design provisions require structural engineers to perform both static and dynamic analysis for the design of structures. The objective of the this study is to carry out static and dynamic analysis i.e. equivalent static analysis, response spectrum analysis (RSA) and time history analysis (THA) over different regular and irregular shaped RCC building frame considering the equal span of each frame as per Bangladesh National Building Code (BNBC)- 2006. In this study, four different shaped (W-shape, L-shape, Rectangle, Square) ten storied RCC building frames are analysed using ETABS v9.7.1 and SAP 2000 v14.0.0 for seismic zone 3 (Sylhet) in Bangladesh. Comparative study on the maximum displacement of different shaped buildings due to static loading and dynamic response spectrum has been explored. From the analyzed results it has been found that, for static load analysis, effects of earthquake force approximately same to all models except model-1(W-shape).W-shape has been found most vulnerable for earthquake load case. It is also found from the response spectrum analysis that the displacements for irregular shaped building frames are more than that of regular shaped building. The overall performance of regular structures is found better than irregular structures.

7) *Assessment and dynamic nonlinear analysis of different base isolation systems for a multi-storey RC building irregular in plan*

Donato Cancellara, Fabio De Angelis (2017)- In this paper two base isolation systems are analyzed and their seismic behavior is compared with reference to a multi-storey reinforced concrete building. The base isolation systems have been designed in compliance to the European seismic codes EC2 and EC8. A base isolated building is adopted which is characterized by strong irregularity in plan. A comparative analysis is presented for evaluating the behavior of the structure subject to seismic events. Two base isolation systems have been considered in the analysis, the High Damping Rubber Bearing (HDRB) actuated in parallel with a Friction Slider (FS) and the Lead Rubber Bearing (LRB) also actuated in parallel with a Friction Slider (FS). A dynamic nonlinear analysis is performed for the three-dimensional base isolated structure. Recorded accelerograms for bi-directional ground motions compatible with the reference elastic response spectrum have been used for the evaluation of the seismic response of the structure. The seismic assessment and the dynamic nonlinear analysis of the base isolated structure are illustrated by presenting a comparative analysis of the behavior of the structure isolated by the two considered base isolation systems and the corresponding behavior of the traditional fixed base structure.

8) *Comparative Study of the Static and Dynamic Analysis of Multi-Storey Irregular Building*

Bahador Bagheri, Ehsan Salimi Firoozabad, and Mohammadreza Yahyaei, (2012): this study purposes a new seismic design provisions require Structural Engineers to perform both static and dynamic analysis for the design of structures. While Linear Equivalent Static Analysis is performed for regular buildings up to 90m height in zone I and II, Dynamic Analysis should be performed for regular and irregular buildings in zone IV and V. Dynamic Analysis can take the form of a dynamic Time History Analysis or a linear Response Spectrum Analysis. In present study, Multi-storey irregular buildings with 20 stories have been modeled using software packages ETABS and SAP 2000 v.15 for seismic zone V in India. This paper also deals with the effect of the variation of the building height on the structural response of the shear wall building. Dynamic responses of building under actual earthquakes, EL-CENTRO 1949 and CHI-CHI Taiwan 1999 have been investigated. This paper highlights the accuracy and exactness of Time History analysis in comparison with the most commonly adopted Response Spectrum Analysis and Equivalent Static Analysis.

9) *Development and application of a new base isolation system in low-rise buildings*

Sayed Behzad Talacitaba a, Mohamad Safaie b, Reza Zamani (2021) - this research study the application of base isolators undermines the drawback of earthquake to the structures. In recent decades, various base isolators have been applied, and several researchers have conducted research on the influence of base isolated structures. In this study, a rubber bearing with steel rings called RRB is designed and applied in 3 to 6- story steel and concrete structures, and the results are compared to fixed base and isolated base structures with lead rubber bearing (LRB). Isolators are first modeled in finite element software Abaqus, and hysteresis analysis is done, and

effective stiffness and damping of each isolator is obtained. The average results for effective stiffness of the LRB is 110.88 (ton/m) and for the RRB is 82.48 (ton/m). The average damping for the LRB is 18.44%, and for the RRB is 47.02%. The analysis of structures is considered nonlinear time history and is done with the earthquake records of Kobe, Tabas and Manjil. The results of drift, acceleration and base shear are presented. The acceleration results of RRB isolated base structure show that 3, 4, 5 and 6-story buildings has a reduction by 42.16, 43.36, 51.83 and 57.16%. Moreover, the shear results of RRB isolated base structures comparing to the corresponding fixed base structure has had a reduction of 55.5, 47.16, 37.93 and 56.83 for 3, 4, 5 and 6-story structures. The results for drift indicate that utilization of the RRB leads to a decrease by 35.33, 50, 54.5% and 59.66 for 3, 4, 5 and 6-story structures, respectively

10) *Dynamic assessment of base isolation systems for irregular in plan structures: Response spectrum analysis vs nonlinear analysis*

Donato Cancellara, Fabio De Angelis (2019) -this paper is on base isolation systems this system are employed in the isolation of structures by providing an efficient protection with respect to dynamic and seismic loadings. In this paper we analyze the dynamic behavior of base isolated multistorey structures characterized by high irregularity in plan. High Damping Rubber Bearings isolators are adopted herein and they are placed in parallel with Friction Sliders isolators. For the dynamic assessment of base isolated structures in the present work two different types of dynamic analyses are investigated: a dynamic analysis with response spectrum and a nonlinear dynamic analysis. The comparative evaluation of the results obtained by performing the two different dynamic analyses has a significant importance with reference to the recent Italian seismic code. In fact, when adopting the nonlinear dynamic analysis, the code prescribes a mandatory comparison of the obtained results with the ones related to a dynamic analysis with response spectrum. Accordingly, the present comparative analysis is also useful to evaluate which of the two analysis is more conservative for base isolated structures and in which aspects it is more conservative. The results of the present analysis are illustrated in terms of calculations of the deformations and the stresses of the base isolated structure. For the deformations particular interest is given to the inter-storey drifts at the different levels of the multi-storey structure. For the stresses associated to the seismic loadings the interest is focused on bending moment, axial force and shear in the columns and bending moment and shear in the beams.

B. *Research Gap Identification*

The following points represent the gaps in the research:

- 1) There are very limited research papers which focus on seismic analysis of BASE isolation as STRPs in ETABS software.
- 2) There is also very limited research papers found which were focused on buildings located in seismic zone – v.
- 3) Comparative performance in L-shaped and T-shaped plans
- 4) Performance of STRPs in *plan-irregular* buildings.

III. OBJECTIVES AND METHODOLOGY

A. Objectives

The following points represent the objectives of the research work:

- 1) To model G+5 plan-irregular RC buildings (L-shaped and T-shaped) and regular building as per IS 1893:2016.
- 2) To develop STRP base isolator properties including horizontal stiffness, vertical stiffness, and damping.
- 3) To analyse both fixed-base and STRP-base-isolated structures using the Response Spectrum Method.
- 4) Seismic analysis of a building in seismic zone- v
- 5) To compare seismic parameters such as:
 - Natural time period
 - Base shear
 - Storey drift
 - Displacement response
- 6) To evaluate suitability of STRPs as economic and sustainable isolation device

B. Methodology

1) Structural geometry

- plan-irregular (re-entrant corners) and Regular building.
- building typical G+5.

2) Numerical modelling (ETABS)

Model setup

- Create 3D frame models in ETABS representing each plan and height.
- frame elements for beams/columns, shell elements for slabs Using appropriate diaphragms to represent floor action.
- Mass modeling: include dead loads, typical live loads and equipment as per code. distribution of mass to floor diaphragms.
- Foundation: model base of columns as pinned or fixed above isolation layer — isolation links replace fixed support.

3) Analysis Type

a) Response Spectrum Analysis

A response spectrum represents the maximum response (displacement, velocity, or acceleration) of a set of single-degree-of-freedom (SDOF) oscillators with different natural frequencies subjected to the same ground motion. It allows rapid estimation of peak structural response without performing full time-history analysis, making it a widely used tool in earthquake engineering.

In linear systems, the peak modal responses of multi-degree-of-freedom (MDOF) structures are obtained from the spectrum and combined using methods such as SRSS or CQC. Since phase information is lost, results differ from direct dynamic analysis. RSA is most accurate for linear behaviour with low damping, and is the basis for seismic design in most building codes.

For this study, the design horizontal response spectrum was developed as per IS 1893:2016 (Part 1), Clause 6.4.5. Spectral acceleration values (S_a/g) were computed for different time-period ranges and scaled using the factor $SF = g(I/R)$. The spectrum was applied in both X and Y directions, modal responses were combined using the CQC method, and

directional effects were considered using the 100%–30% rule. This spectrum provides the required seismic demands such as base shear, storey forces, drifts, and modal participation.

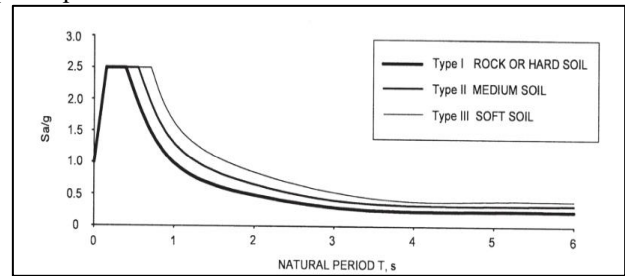


Fig. 1: Response Spectra for Rock & Soil Sites for 5% damping (IS 1893:2016 part 1)

4) Loads

- a) Dead load: The dead load is assessed based on the occupancy classifications as per IS: 875 (Part – 1) – 1987.

Internal Wall	150 mm thick Brick masonry wall 3.65 m floor to floor = 11.2 kN/m
External Wall	230 mm thick Brick masonry wall 3.65 m floor to floor = 16.7 kN/m

Table 1: Wall load Calculations:

- b) Live load: The super-imposed load or otherwise live load is assessed based on the occupancy classifications as per IS: 875 (Part –2) – 1987.

Roof Access provided	1.5 kN/m ²
Roof Access not provided	0.75 kN/m ²
Assembly area, without fixed seats	5 kN/m ²
Stage	5 kN/m ²
Bath and toilet rooms	2 kN/m ²
Corridors, passage, lobbies and Staircase including fire escapes	4 kN/m ²
Kitchen, Dining Hall	3 kN/m ²

Table 2: Live load

- c) Earthquake/Seismic Loads corresponding to Zone v of IS 1893 (Part 1): Analysis using response spectrum method

Seismic zone coefficient	0.36
RF (Response Reduction Factor)	5 (SMRF) Special moment-resisting frame
I (Importance factor)	1.5
SS (Rock or Soil factor)	2 for soil
ST (Type of structure)	1 for RC frame building
DM (Damping Ratio)	0.05

Table 3: Seismic Parameters considered

The following design steps are going to be performed:

- Modelling of the G+5 storey RC building for both regular & plan irregular structure and assigning all the material and section properties for all the members of the building such as beams, columns, slabs etc.
- Assigning the joint restraints properties as fixed at the bottom of the column.

- Assigning the loads on the members and also the lateral loads.
- Analyzing the fixed model for given loads for response spectrum for zone v and type II soil.
- Assigning properties of base isolators as Rubber Isolator as strap tyre rubber base using N-link spring at base of the structure.
- Analyzing the base isolated structure for response spectrum for zone v.
- Comparing the results of earthquake zone v for fixed base and base isolated RC buildings.

5) Design Codes Used

- IS 456:2000 – Concrete design
- IS 875 – Loads
- IS 1893 (Part 1):2016 – Earthquake analysis

6) STRP Base Isolator

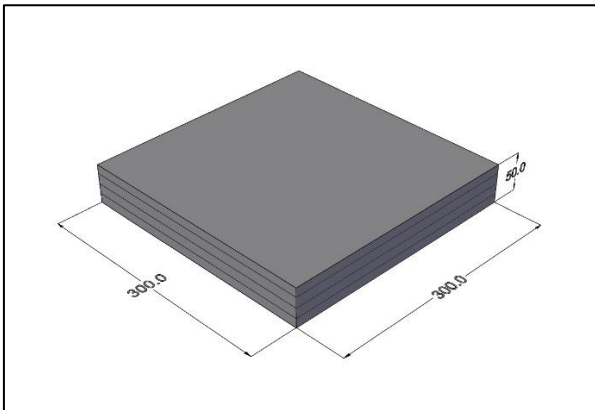


Fig. 2: Strap Rubber pads 3D Model



Fig. 3: tyre Rubber Pads

Pad plan area A	=300 mm×300 mm =0.09 m ²
Rubber	- tyre rubber (assumed similar to medium-hard natural rubber).
Young's modulus E=	= 4.0 MPa = 4.0×10 ⁶ N/m ² (typical mid-range for tyre rubber — adjust if you prefer 1–6 MPa).
Poisson's ratio v	= 0.49 (nearly incompressible).
Total rubber thickness, t	t= 50 mm = 0.05m
spring model	Linear (small-strain (no lead core, no hysteretic damping included).
Target isolated fundamental period, T (s) —	2.5s

Target equivalent viscous damping ratio, ξ	0.15
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Table 4: STRAP base isolator properties

Shear modulus G

$$G = E / 2(1 + \nu) = 4.0 \times 10^6 / 2(1 + 0.49) \approx 1.342 \times 10^6 \text{ Pa} = 1.342 \text{ Mpa}$$

formulas

Horizontal (shear) stiffness of one pad: $K_h = G A / t$

Vertical (compressive) stiffness of one pad (simple solid-block estimate): $K_y = E A / t$

IV. BUILDING MODELLING

A. Modelling

Modeling of the irregular buildings was done using the software ETABS 21. Three models with re-entrant corners (L shaped and T shaped) and Regular plan having the same plan area were considered for the study. Also, the performance of these buildings under isolation techniques, namely Rubber isolator as strap tyre rubber pads was studied.

Thus, six different models associated with the study are as follows: –

- Model I: Regular Building with Fixed Base
- Model II: Regular Building with STRP isolator
- Model III: L-shaped Building with Fixed Base
- Model IV: L-shaped Building with STRP isolator
- Model V: T-shaped Building with Fixed Base
- Model VI: T-shaped Building with STRP isolator

B. Building Description

Three G+5 storied buildings with typical floor height 3m was considered for the present study. The structural material was assumed to be isotropic and homogenous. The slab elements were modeled as rigid diaphragm.

Column Size	450 x 450 mm
Beam Size	300 x 450 mm
Slab Thickness	150 mm
External wall	230 mm
Internal wall	115 mm
Characteristics Strength of Concrete f_{ck}	30
Grade of Steel f_y	500
Poisson's ratio of concrete	0.15
Poisson's ratio of masonry	0.16
Density of Concrete	25 kN/m ³

Table 5: Building data

The modulus of elasticity of the concrete is given by 5000(f_{ck})^{0.5}. The building was assumed to be located on a medium type soil with zone factor 0.36. The building had an importance factor 1 and the response reduction factor was taken as 5. Response Spectrum Method of analysis was performed using design spectrum specified in I.S. 1893(Part1):2002. The loads acting on various rooms and passages were taken according to the specification given in IS 875(part 2). The plan and 3D model of the buildings are given below:

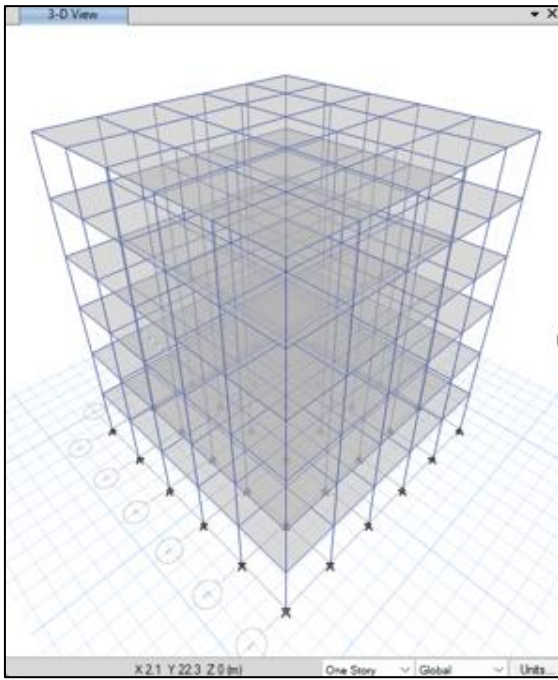


Fig. 4: Plan and 3D Model of regular Building

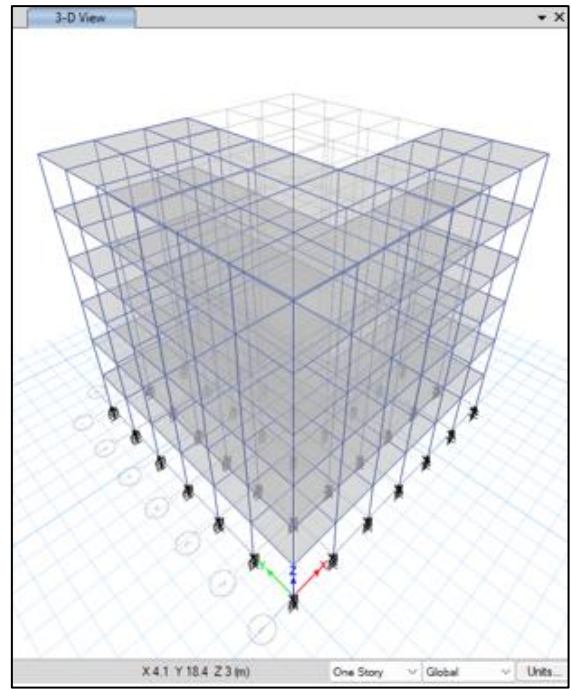


Fig. 6: 3D Model of L-shaped Building

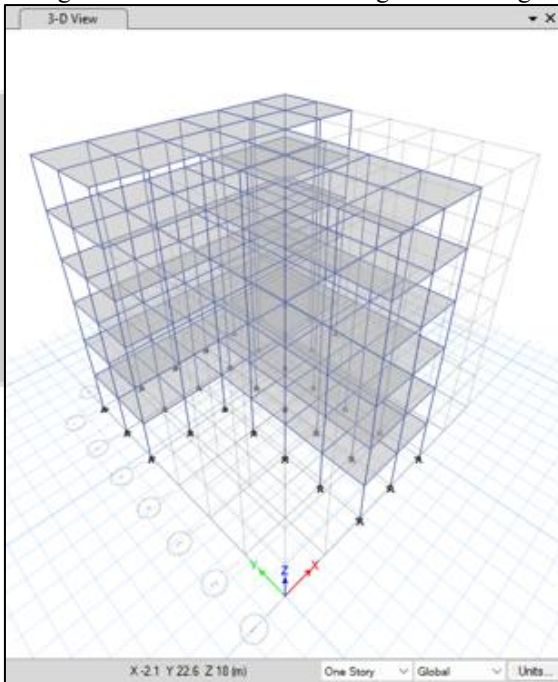


Fig. 5: 3D Model of T-shaped Building

C. Analysis Consideration

The entire analysis has been to be done for all the 3D models using ETABS Nonlinear version software. The results are tabulated to focus the parameters such as time period, base shear, story force, Storey drift and lateral displacements in response spectrum analysis.

V. EXPECTED OUTCOMES

A. Period Elongation in STRP-Isolated Structures

Base isolation works fundamentally by increasing the natural time period of the building.

When STRP pads are placed between the superstructure and the foundation:

- The structure becomes more flexible at the base
- Lateral stiffness decreases significantly
- The first mode period shifts from the high-acceleration zone to the low-acceleration zone of the response spectrum

For example:

Structure Type	Time Period (sec)
Fixed Base	0.8–1.0 sec
STRP Base	1.9–2.2 sec

Why does this help?

According to the IS 1893 response spectrum, higher time periods correspond to lower spectral acceleration, meaning:

- Lower seismic forces
- Lower shear demand
- Lower acceleration transmitted to floors

Thus, STRP isolation substantially improves seismic safety by “detuning” the building from damaging ground motion frequencies.

B. Reduced Base Shear

Base shear is directly proportional to the spectral acceleration:

$$V_b = A_h \times W$$

Where:

- A_h = design horizontal acceleration coefficient
- W = seismic weight

Since STRPs increase the time period, the acceleration coefficient A_h decreases, leading to:

- 40–50% reduction in base shear
- Lower column and foundation forces
- Reduced bending moments and reinforcement demand

This helps in designing lighter, more economical structural members and reducing potential earthquake damage.

C. Lower Storey Drift and Torsion

- Lower Storey Drift

Storey drift is the relative displacement between two consecutive floors. STRP isolators allow large displacement only at the base, not in the upper floors.

Hence:

- Drift in superstructure reduces by 40–60%
- Non-structural components (walls, partitions, windows) remain safe
- Damage to architectural finishes is minimized
- Lower Torsion

Plan-irregular buildings (L-shaped, T-shaped) behave asymmetrically during earthquakes.

They experience:

- Rotational motion
- Uneven drift along edges
- Concentrated stresses at re-entrant corners

STRPs help reduce torsion by:

- Decoupling horizontal motions from rotational components
- Providing nearly uniform horizontal flexibility
- Reducing difference between max drift and average drift

This decreases the torsional irregularity ratio closer to 1.0, meaning more balanced behaviour.

D. Improved Sustainability Index

Using STRP pads enhances sustainability by:

1) Recycling Waste Tyres

- Millions of tyres are discarded annually
- STRPs utilize waste rubber, reducing landfill and environmental pollution
- Minimizes burning of tyres, which produces toxic gases

2) Low Carbon Footprint

Compared to LRBs and HDRBs:

- No lead core
- No large steel laminations
- Much lower embodied energy

3) Economic Sustainability

- STRPs cost 60–80% less than imported base isolators.

4) Social Sustainability

More affordable seismic protection means:

- Wider adoption
- Safer buildings for low-income communities

- Better disaster resilience at national level

Thus, STRP isolation significantly improves all three pillars of sustainability: environmental, economic, and social.

E. Better Seismic Resilience for Irregular Plan Structures

“Seismic resilience” means the ability of a structure to:

- Withstand earthquakes
- Maintain functionality
- Recover quickly with minimal repair cost

STRP isolation improves resilience by:

- Reducing internal forces → less damage to structural members
- Controlling drift and torsion → prevents cracking and collapse at re-entrant corners
- Minimizing floor accelerations → protects equipment, furniture, and occupants
- Ensuring continuous functionality even after moderate earthquakes
- Allowing predictable displacement concentrated at isolator level
- Increasing safety margins for plan-irregular configurations

Irregular buildings benefit the most because they usually suffer from amplified seismic effects

VI. CONCLUSIONS

The study on the seismic performance of plan-irregular RC structures equipped with Scrap Tyre Rubber Pads (STRPs) as base isolators demonstrates that STRPs can significantly enhance structural resilience under earthquake loading. The isolation system effectively lengthens the natural period of the building, reduces base shear, and minimizes inter-storey drift, even in structures with complex geometrical irregularities.

Comparative analysis between fixed-base and STRP-isolated models shows a marked reduction in seismic demand transmitted to the superstructure. Despite the inherent torsional effects in plan-irregular buildings, STRPs help achieve more uniform displacement profiles and improved global stability.

Additionally, Scrap Tyre Rubber Pads provide a sustainable and cost-effective alternative to conventional isolation bearings. The reuse of waste tyre rubber not only reduces material costs but also contributes to environmental conservation by minimizing landfill disposal. Overall, the findings confirm that STRPs are a viable, economical, and sustainable solution to enhance the seismic safety of RC buildings with plan irregularities.

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