Cyclic and Nonlinear analysis of different steel plate shear walls under near field ground motions and their comparative study.

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Sustainable Development Goals:

SDG No	Description of SDG	SDG No	Description of SDG
SDG 9	Industry, Innovation, and Infrastructure	SDG 11	Sustainable Cities and Communities
SDG 13	Climate Change	SDG 17	Partnerships for the Goals

Complex Engineering Problems:			
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
7	Consequences	Have significant consequences in a range of contexts.	

Complex Engineering Activities:			
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	

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Abstract

The proposed research aims to conduct an extensive analysis of various **steel plate shear wall** systems, including **corrugated**, **stiffened**, and **unstiffened** configurations, within the context of a 6x6x5 building subjected to five different near-field earthquake scenarios. The primary objectives are to investigate the individual performance characteristics of these systems and their collective behavior when integrated into a structural system. The research will involve developing and examining thirty distinct models to assess lateral load resistance, deformation capacity, stiffness, and energy dissipation capacity. Advanced simulations will be conducted using **ABAQUS Software**. The key deliverables include a research report, comprehensive data, analysis, design guidelines, and optimized solutions for improved building design.

Keywords: Steel Plate Shear walls, Corrugated, stiffened, unstiffened, ABAQUS

Undertaking

I certify that the project **[Cyclic and Nonlinear analysis of different steel plate shear walls under near field ground motions and their comparative study.]** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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Chapter 1

1.1 Introduction

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Chapter 1

1.1. Introduction:

In the tumultuous landscape of natural disasters, earthquakes stand as relentless forces, capable of unleashing catastrophic destruction upon communities and infrastructure. From the historic tremors that shattered San Francisco in 1906 to the recent devastation wreaked upon Haiti in 2010 and Japan in 2011, seismic events have left indelible marks on human history, claiming lives, decimating buildings, and disrupting entire societies.

As we navigate the ever-present threat of earthquakes, the quest for innovative solutions to mitigate their impact has become paramount. Among the arsenal of engineering marvels stands the steel plate shear wall (SPSW), a beacon of resilience amidst seismic chaos. Engineered to absorb and disperse the formidable energy unleashed by earthquakes, SPSWs have emerged as pioneering structures in earthquake-resistant design.

In the heart of this seismic battleground lies a critical research endeavor, poised to delve deep into the dynamic realm of SPSW configurations. Our mission? To unravel the mysteries of stiffened, unstiffened, and corrugated SPSWs, under the relentless scrutiny of diverse earthquake magnitudes. Within the confines of a 6x6x5 structural framework, our journey takes us through the intricate web of finite element modeling, sophisticated simulations, and rigorous data analysis.

With each earthquake scenario extracted from the Pacific Earthquake Engineering Research Center (PEER) ground motion database, we embark on a quest for knowledge, seeking to decipher the nuanced interplay between seismic forces and structural integrity. Armed with insights gleaned from past experiments and validated through meticulous comparisons with simulated models, we stand at the precipice of discovery.

Yet, amidst the fervent pursuit of answers lies a glaring gap in our understanding—the cyclic performance of SPSWs under varying seismic intensities remains shrouded in ambiguity. It is this unmet requirement that propels our research forward, driving us to bridge the chasm between theory and practice, between speculation and certainty.

For in the face of nature's fury, ignorance is not an option. The stakes are too high, the consequences too dire. With every tremor, lives hang in the balance, and communities teeter on the brink of despair. It is our solemn duty, our unwavering commitment, to fortify the foundations upon which our cities stand, to erect bulwarks of safety against the tempests that rage beneath the earth's surface.

In the crucible of seismic uncertainty, we strive not merely for knowledge, but for transformation—for the creation of a world where resilience reigns supreme, where buildings stand as bastions of hope amidst the chaos of catastrophe. This is our mission, our calling—to pioneer the path towards a future where earthquakes no longer sow seeds of fear, but instead, inspire acts of ingenuity and defiance.

Together, let us embark on this journey of discovery, as we unravel the secrets of steel plate shear walls and forge a brighter, safer tomorrow in the crucible of seismic uncertainty.

1.2. Problem Statement:

The gap in knowledge and information on the cyclic performance of steel plate shear walls (SPSW) with stiffened and unstiffened configurations under various earthquake magnitudes is the unmet requirement addressed by this research. The inability to design structures that can survive a variety of seismic occurrences and the difficulty in developing appropriate seismic design standards are both consequences of this knowledge gap. The dearth of experimental and analytical studies directly comparing these setups across various earthquake magnitudes quantitatively highlights this gap.

When one considers the possible effects of insufficient earthquake design, the seriousness of this unaddressed issue becomes clear. Earthquakes pose a serious threat to the security of buildings and human life, especially in seismically active areas. To reduce these hazards, effective seismic design methodologies are essential. By tackling this issue, we want to contribute to the creation of infrastructure and buildings that are safer and more robust, thereby saving lives and lowering financial losses.

1.3 LITERATURE REVIEW

The paper proposes a new special steel frame with a stiffened double steel plate shear wall (SSFSDSPSW) that aims to enhance earthquake resilience and allow for post-earthquake repairability. The seismic behavior and repairable function of SSF-SDSPSW were studied through low-cycle reciprocating loading tests and ultimate state loading tests on one basic specimen and two repaired specimens. The experiment results showed that the buckling of steel faceplates and overall instability of the SDSPSW were the main failure modes. The SDSPSW cooperated well with the special steel frame, with the main members remaining elastic during loading. The peak load of the repaired specimen was higher than 87% of the basic specimen, demonstrating the feasibility of post-earthquake repairability. The displacement ductility coefficient of the SSFSDSPSW was larger than 3.67, indicating good deformation performance. Finite element analysis accurately predicted the peak load, with only a 3.2% error compared to the experimental results. Parameters analysis showed that the rational relationship between link beams, SDSPSW, and columns contributed to the damage control of SSF-SDSPSW.

The experiment results indicated that the buckling of steel faceplates and overall instability of the SDSPSW were the main failure modes of the SDSPSW. The SDSPSW showed good seismic behavior and fast construction speed. The main members of the basic specimen remained elastic during loading, and the peak load of the repaired specimen was higher than 87% of the basic specimen, demonstrating the feasibility of post-earthquake repairability. The displacement ductility coefficient of the SSF-SDSPSW was larger than 3.67, indicating good deformation performance. [1]

The paper presents a study on the cyclic performance of stiffened and unstiffened steel plate shear walls under cyclic loading. Five specimens were tested, including unstiffened aluminum and steel infill plates, as well as three configurations of stiffened steel plates: cross-stiffened, circular-stiffened, and diagonally stiffened. The results showed that the aluminum infill plate exhibited less ductility, while the unstiffened steel plate was very ductile and showed no tearing. All stiffening configurations increased the energy-absorption capacity of the steel plate shear walls, with the cross-shaped stiffeners showing the most significant increase in shear stiffness, ductility, and energy-dissipation capacity. A lateral support system was provided to ensure ideal cyclic displacement without out-of-plane displacement. Displacement history was calculated based on FEMA 461, and LVDTs and strain gauges were used for data collection. The plate frame interaction method was able to predict the ultimate shear strengths of the unstiffened and crossstiffened panels accurately. The circular-stiffened steel shear wall showed more desirable behavior in high-amplitude displacements. The study also discussed the test setup, material properties, and the use of a lateral support system to ensure the ideal cyclic displacement of the specimens. Overall, the findings of this study provide valuable insights into the performance of stiffened steel plate shear walls and can contribute to the design and optimization of such structural systems[2]

The paper focuses on the cyclic behavior of corrugated steel plate shear walls (CoSPSW) and compares them with unstiffened special plate shear walls (SPSWs). Nonlinear push-over and cyclic analyses were conducted on CoSPSW and SPSW models to study their behavior and performance. Parametric studies were performed with different panel and frame configurations, as well as gravity load effects. Lateral displacement was applied gradually to observe the lateral load versus drift ratio curves for the shear wall systems and the wall panels. ABAQUS software was used for numerical simulations and modeling of the SPSW and CoSPSW systems. considering different panel and frame configurations and gravity load effects. CoSPSWs with deep corrugation exhibit higher lateral stiffness, lateral strength, and energy dissipation compared to SPSWs, while CoSPSWs with shallow corrugation have higher lateral stiffness and ductility but lower lateral strength than SPSWs. CoSPSWs have stable hysteric curves with no pinching and are less sensitive to gravity loads or weaker boundary frames compared to SPSWs.

Steel plate shear walls, including CoSPSWs, are widely used in multistory and high-rise buildings due to their advantages such as lightweight, high lateral strength, high ductility, and efficient use of floor space. It was found that reducing the frame stiffness had a greater impact on the lateral strength of SPSWs compared to CoSPSWs, indicating that CoSPSWs were less sensitive to the influence of boundary frame stiffness The paper provides insights into the behavior and performance of CoSPSWs, contributing to the understanding and development of steel plate shear wall systems. It turns out that CoSPSWs with deep corrugation have higher lateral stiffness, lateral strength, and energy dissipation than SPSWs, whereas CoSPSWs with shallow corrugation have higher lateral stiffness and ductility.[3]

The paper proposes a coupled system of steel plate shear walls with slits (C-SPSWS) and investigates its mechanical behavior. It derives expressions for ultimate strength and degree of coupling (DC) based on the desired plastic mechanism. Two one-third scale, four-story specimens, including coupled and uncoupled SPSWS, were tested to verify the seismic performance of the system. The coupling action of the coupling beam significantly improved the initial stiffness, strength, and energy dissipation capacity of the system. It also decreased the axial force of the frame columns, particularly for interior frame columns. The deformation mode of the C-SPSWS specimen changed from flexural to shear due to the coupling action. The proposed ultimate strength formula can conservatively predict the maximum lateral force of the system.

The influence of the coupling action of coupling beams on the seismic performance of the structure was investigated based on the test results[4]

The paper presents the seismic performance of a coupled system of steel plate shear walls with slits (SPSWS), called C-SPSWS, through experimental testing of two one-third scale, four-story specimens. The C-SPSWS specimen exhibited robust cyclic performance and proved to be an efficient lateral load-resisting system. The coupling action of the coupling beam significantly improved the initial stiffness, strength, and energy dissipation capacity of the system. The deformation mode of the C-SPSWS specimen changed from flexural to shear due to the coupling action. The hysteresis curves of the specimens indicated good energy dissipation capacity, and both samples demonstrated good ductility.Click or tap here to enter text.

The paper discusses the use of Steel Plate Shear Wall (SPSW) as an alternative system for constructing high-rise structures. The application of "low yield" steel walls in high-rises has been studied, leading to the design and construction of structures using this system. The AISC Seismic Provisions for Structural Steel Building now include design recommendations for SPSW systems, providing guidelines for calculating lateral load capacity and recommendations on seismic characteristics. Experimental and analytical studies have been conducted to study the lateral load-resisting capacity of SPSW systems, leading to the development of code provisions. The tallest building with steel plate shear walls in a highly seismic area of the United States is a 52story residential tower in San Francisco. Full-scale testing of two-story specimens representing shear walls for high-rise buildings showed that the conventional beam theory can be used to calculate the stiffness and strength of stiffened walls. Overall, the paper provides insights into the performance, testing, and case studies of Steel Plate Shear Wall systems in high-rise structures, highlighting their potential as an alternative construction system.[5]

By performing cyclic quasi-static tests on three 1/3-scale two-story single-bay Corrugated Steel Plate Shear Walls specimens with various corrugation orientations and geometric features, the research described here analyzes Corrugated Steel Plate Shear Walls (CoSPSW) as a unique lateral load resisting system. Similar tests performed on traditional Steel Plate Shear Wall (SPSW) specimens were compared to these tests. According to the results, CoSPSW specimens demonstrated extremely ductile behavior, consistent cyclic performance, and the capacity to withstand narrative drifts of at least 4%. Corrugated steel panels also increased lateral stiffness and elastic buckling capacity, and the link between the wall panel and boundary frame successfully developed the entire strength of the infill panel.

However, there are certain drawbacks to the study, such as the use of scaled-down models that might not accurately represent the behavior of full-scale structures. Furthermore, because of the quasi-static stress conditions used throughout the trials, the dynamic character of seismic occurrences was not replicated. Further study is required to examine the economic viability and practical use of CoSPSW in actual construction projects, as well as to confirm these findings at full scale and under dynamic stress.[6]

In this study, stiffened steel plate shear walls (SPSWs) are the subject of a seismic collapse analysis, and a newly constructed constitutive material model is used to simulate the behavior of stiffened steel plates under repeated reversed loading. In the study, pushover and cycle evaluations on multi-story SPSW models are used to evaluate the performance of stiffened and unstiffened SPSWs the results indicate that stiffened SPSWs can provide higher initial stiffness and higher strength compare with unstiffened SPSWs

The study examines typical buckling modes, buckling of infill plate in elastic region can decrease initial elastic stiffness as well as energy absorbance in the system.

The median collapse capacity of SPSW systems is greatly increased by stiffeners, according to incremental dynamic analyses (IDA). [7]

The literature study explores the work by Astaneh-Asl (2000), providing a thorough synopsis of the research findings, historical evolution, and contemporary issues related to steel plate shear walls in seismic design. These walls, which are made up of a steel plate wall, boundary columns, and horizontal floor beams, are most recognized for their function as a lateral load resisting system against horizontal story shear. This article provides an overview of the development of steel plate shear walls in North America since the 1970s, with a focus on seismic retrofitting and the building of mid- and high-rise structures.

The analysis highlights previous studies carried out in Japan and North America within the past 20 years. Seismic performance assessments of earthquake-prone structures, such the 35-story Kobe skyscraper during the 1995 tremor, are among the noteworthy projects. The discussion includes laboratory investigations from the US, Canada, and the UK, including Elgaaly's research in the US and cyclic tests by Rezaii et al. (2000). Furthermore, the encouraging advancement of low-yield steel utilization in shear walls in Japan is delineated.

We introduce Astaneh-Asl's continuing research at UC Berkeley, which includes two parallel projects on steel plate shear walls and composite shear walls. The emphasis is on creating design recommendations and determining behavior through repeated testing of genuine 1/2-scale shear wall specimens. The necessity for a desirable and ductile performance is emphasized as design concerns pertaining to seismic performance and failure types are discussed. The significance of precise modeling for seismic design is highlighted by the presentation of several modeling techniques for assessing steel plate shear walls, including the multi-angle strip model by Rex, Ventura, and Prion (2000) and the truss model put forth by Thorburn et al. (1983).

The assessment highlights the narrow provisions for steel plate shear walls and highlights the present issues with seismic design regulations in the United States. Code development issues are explored, with a focus on the need for further research data to inform and improve code provisions, including the formation of R-factors. The acknowledgements provide thanks for the financial support and assistance from entities such as the General Services Administration and Skilling, Ward, Magnusson, Berkshire; they also thank the project engineers and graduate students who have contributed to the ongoing research. [8]

This comprehensive study by Adam S. Lubell, Helmut G. L. Prion, Carlos E. Ventura, and Mahmoud Rezai explores the complex performance properties of unstiffened thin steel plate shear walls, especially in relation to their use in medium- and high-rise structures. The underlying principle of these shear walls is that they depend on the panels' postbuckling strength, much like the thin web in a plate girder does. Through a series of experimental tests on single- and four-story steel shear wall specimens that are painstakingly manufactured to approximate scaled replicas of common office building cores, the investigative technique is carried out. The main goals of these experiments are to conduct a comprehensive analysis that explores the complexities of load-deformation characteristics, to carefully analyze the stresses in different structural components, and to critically evaluate the suitability and effectiveness of current design guidelines.

Under the direction of Adam S. Lubell, Helmut G. L. Prion, Carlos E. Ventura, and Mahmoud Rezai, the results of these investigations show a number of encouraging characteristics present in unstiffened thin steel plate shear walls. Notably, the shear walls have excellent qualities like strong energy dissipation and a notable displacement ductility capacity. But in the interest of a thorough knowledge, the work conducted by these authors uncovers and defines the main inelastic damage mechanisms, with the yielding of infill plates and columns being a major feature. This detailed comprehension of the behavior of the structure under quasi-static, cyclic stress offers priceless insights into how well these shear walls perform seismically.

The study carefully assesses the analytical models used, especially those that are derived from the Canadian code for steel structures. Although these models show a respectable degree of accuracy in terms of postyield strength prediction, a more thorough analysis exposes several limits, especially with regard to calculating elastic stiffness under particular circumstances. Under the jurisdiction of these authors, the implications derived from these analytical assessments point to areas where the current design principles require revision and improvement.

In summary, this research provides a comprehensive understanding of the seismic characteristics of steel plate shear walls, highlighting both their positive aspects and the critical need for sophisticated design guidelines. The complexities of multistory frames, overturning moment concerns, and the interaction of infill panel aspect ratios become important focal points that need more study and improvement in the field of structural engineering. [9]

The study carried out by Dr. B P Annapoorna and Mohammed Ali Boodihal thoroughly examines the seismic behavior of steel plate shear walls, emphasizing the effect of stiffening on several performance metrics. The study's main goal is to evaluate the behavior of steel plate shear walls, both stiffened and unstiffened, under seismic stresses in order to provide important information for structural design concerns. The scope of the experiment entails modeling several configurations, including unstiffened steel plate shear walls of varied thicknesses as well as their doubly and singly stiffened equivalents. With load inputs taken from ETABS, ANSYS v16, a sophisticated software program, is used for the simulation and validation procedure.

Notable patterns in the seismic reaction of the various configurations are revealed by the research findings. Higher in-plane and out-of-plane displacements are seen in unstiffened steel plate shear walls; however, as the thickness of the plates increases, a noticeable decrease is seen. It is discovered that the addition of stiffeners, either in a single or double diagonal configuration, affects the seismic behavior. Remarkably, stiffeners have a negligible impact on the in-plane displacement, indicating that their contribution to reducing this particular parameter is minimal.

Nonetheless, the study highlights that the addition of stiffeners has a major effect on out-of-plane deflection, particularly for thinner plates. When stiffeners are used, the out-of-plane deflection—a crucial factor in the design of steel structures—is significantly decreased. For single and double diagonal stiffening arrangements, this reduction is more noticeable and especially useful in reducing out-of-plane buckling. The study's practical recommendations for structural design are included in its conclusion. Specifically, it is suggested that steel plates thicker than 8 mm should be used for ten-story buildings. In addition, double diagonal stiffeners should be used when using thinner plates in order to improve seismic performance.

In conclusion, this study offers a comprehensive investigation of the seismic behavior of steel plate shear walls, providing designers and engineers who are building structures that are susceptible to seismic hazards with insightful information. The results add to the continuing discussion over how to best design and operate steel structures in seismically vulnerable areas. [10]

The research conducted by Shahzad, M. M., Wang, X., & Abdulhadi (2022), provides an in-depth investigation into the seismic response evaluation of various Steel Plate Shear Walls (SPSWs) to near-field ground vibrations. Understanding how important SPSWs are as a novel lateral resisting system in seismically active areas, the study is carefully planned to disentangle the complex behavior displayed by different types of infill panels. There are two distinct phases to the study. First, single-story SPSW models with aspect ratios of 1:1 and 2:1 undergo cyclic loading tests. This stage carefully investigates the energy dissipation properties and hysteretic behavior of various infill panel configurations, such as unstiffened, corrugated, ring-shaped, and honeycomb designs.

A nonlinear time history study of four-story SPSW models exposed to the dynamic stresses of near-field ground motions is the focus of the research's second phase. A more accurate understanding of the structural inelastic response to seismic excitations is provided by this phase. By means of contrasting analyses of energy dissipation, acceleration, and drift, the study reveals unique features intrinsic to every kind of SPSW. Of particular note are the unstiffened SPSWs with a 2:1 aspect ratio, which exhibit exceptional viscous effects. These SPSWs show a notable 10% increase in lateral stiffness at the same time as a notable decrease in plastic dissipation.

The study's importance comes from its careful examination of how various infill panels react to near-field seismic occurrences as well as cyclic stress. It clarifies the complex relationship between different SPSW configurations and seismic forces, offering important information for the construction of seismic-resistant structures. The research's dedication to expanding our understanding of earthquake engineering is demonstrated by its attention on comprehending the subtle differences in performance between each SPSW type in near-field settings. Therefore, our study is a critical step toward improving the performance of unstiffened SPSW systems in the presence of near-field ground vibrations. Moreover, it provides a baseline for further research, generating questions about how various infill panels behave in the presence of high-rise buildings and under far-field ground vibrations. [11].

1.4. AIMS & Objectives:

Aims:

- Evaluate the seismic performance of diverse steel plate shear wall (SPSW) systems, including stiffened, unstiffened, and corrugated configurations, in a 6x6x5 building through advanced finite element modeling and time history analysis.
- Investigate the impact of different SPSW types on structural behavior, focusing on factors such as lateral drift, earthquake resistance, energy absorption, and ductility over time
- Optimize Retrofitting Strategies: Develop recommendations for the retrofitting of buildings by determining the most suitable SPSW configurations for various structural scenarios.
- Promote sustainability goals aligned with the United Nations by designing earthquake-resistant structures that safeguard lives and historical heritage.
- Improve the ability of steel structures to withstand earthquakes by studying the behavior of different steel plate shear wall (SPSW) configurations

Objective:

- Develop 30 distinct models of a steel structure building with various SPSW configurations and subject them to five different near-field earthquake scenarios using ABAQUS Software.
- Assess the lateral load resistance, deformation capacity, stiffness, and energy dissipation capabilities of the SPSW systems, enabling a thorough understanding of their performance.
- Conduct time history analysis to monitor changes in lateral drift, earthquake resistance, energy absorption, and ductility, elucidating the dynamic behavior of the building under seismic stress.
- Provide design recommendations and solutions to optimize building performance and contribute to global sustainability goals by enhancing earthquake resilience in architectural heritage.
- Contribute to the preservation of historical structures by proposing earthquake-resistant design solutions.

1.5. Methodology:

To thoroughly examine the performance of various steel plate shear wall (SPSW) configurations in a 6x6x5 building under various near-field earthquake scenarios, this research employs ABAQUS Software for finite element modeling (FEM) and time history analysis (THA).

Finite element Modeling:

Geometry and Mesh Generation:

The SPSWs (corrugated, stiffened, and unstiffened) are precisely represented in a virtual environment within the ABAQUS Software, together with the 6x6x5 building and its structural elements. The geometry of the building is established, and the entire structure is discretized using a mesh of finite elements. For the structural reaction to be accurately simulated, this mesh is crucial.

Material used:

We just used Steel structure and material used for the construction of steel structure. All beams and column (moment-resisting frame) is steel structure. These characteristics of steel include yield strength, Poisson's ratio, elastic modulus, and other mechanical traits. For precisely replicating the behavior of the construction components, material data is essential

Analysis of Time History (THA):

The fundamental component of this study is Time History Analysis, which models the dynamic reaction of the structure and its SPSW systems to near-field seismic ground movements. The technique incorporates THA in the following manner:

Ground Motion Records:

The study is based on real ground motion data from near-field earthquake occurrences or synthetic records. These records include information on the functions of time for acceleration, velocity, and displacement.

Numerical integration:

To get time histories of base shear forces and base displacements, ABAQUS Software numerically integrates the ground motion data. This procedure makes sure that the virtual building encounters dynamic loads just like it would in a genuine earthquake.

Dynamic Response Analysis:

The finite element model is put through this analysis after being supplied with time histories of ground motion. The building and SPSW systems' deformation and response over time are determined by solving the equations of motion repeatedly.

Data collection:

A lot of information on structural behavior is produced by the analysis, including displacements, accelerations, internal forces, and stresses inside the building's constituent parts. This information is essential for evaluating the effectiveness of various SPSW designs.

Performance Evaluation:

Each SPSW configuration's specific performance traits, such as lateral load resistance, deformation capacity, stiffness, and energy dissipation capacity, are assessed using the THA findings. To identify the advantages and disadvantages of each design, comparative assessments are carried out.

Reasons/Justification for Selection of Topic. State your reasons for choosing this topic.

It is a complex and challenges topic that can provide a solid founder for your design or structure studies. Here are several reasons and arguments for choosing this specific project:

1. Relevance to Real-World Engineering Challenges: -

This topic addresses the pressing issue of seismic resistance in structural engineering**,** which is highly relevant, especially in seismically active regions.

2. Enhancing Structural Engineering Knowledge: -

Achieving this project will deepen one's understanding of steel plate shear walls, seismic forces, and their implications for structural design and safety.

3. Application of Theoretical Concepts: -

It offers a path to apply theoretical knowledge of structural mechanics and earthquake engineering to useful, real-life scenarios .

4. Advancing Research in Seismic Engineering: -

Findings from this research may contribute to the field of seismic engineering, specifically in steel plate shear walls and earthquake resistance**.**

5. Interdisciplinary Learning: -

This project integrates principles from civil engineering, structural engineering, seismic mechanics, and numeric modeling, fostering interdisciplinary skills development**.**

6. Academic and Professional Development: -

Achieved finished this project will enhance your academic portfolio and make you more competitive in the structure design job market.

7. Valuable Problem-Solving Skills: -

The project will hone your skills in problem identification, hypothesis formulation, experiment design, data review, and report writing.

8. Career Prospects: -

Expertise in earthquake-proof design is highly sought after in regions prone to shaking, offering promising career chances.

9. Personal Interest and Motivation: -

A genuine interest in earthquake engineering and structural analysis can drive motivation and enjoyment throughout the project.

10. Resilience and Project Management: -

Tackling the complexity of this project will provide lessons in resilience and project management, valuable qualities for an engineering career.

Chapter 2

2.1 Results & Discussion

Basic Features:

The structural analysis of a 6x6x5 building exposed to five different near-field earthquake scenarios was included in the software's basic features. To evaluate lateral load resistance, deformation capacity, stiffness, and energy dissipation, it involved simulating different Steel Plate Shear Wall (SPSW) designs, including corrugated, unstiffened, and stiffened versions. By contrasting runtime outcomes with the original specifications, the software underwent a thorough evaluation. Controlled libraries, templates, and code walkthroughs were used to verify the precision, efficiency, and scalability of the suggested solution. To make sure the program complied with the requirements, it was evaluated in relation to the problem statements that were found.

Initial Results:

As far as initial results are concerned. For each story, we first chose columns whose nominal strengths were noticeably greater than their final strengths. Based on this criterion, columns like W36x160, W30x99, W24x94, W21x68, and W12x72 were selected. Throughout the construction, the A992 steel sections and the chosen beam, W12x30, were the same. These are basically our sections of beam and column which are steel column and beams according to properties given in manual AISC 7. 14 we have selected and finalized our beams and columns of 6 story building.

Software Implementation:

ETABS was used to design the building model, and ABAQUS was used to analyze the design for more intricate and sophisticated simulations. The software process ensured a thorough structural study by facilitating a smooth transfer and interoperability between the two platforms.

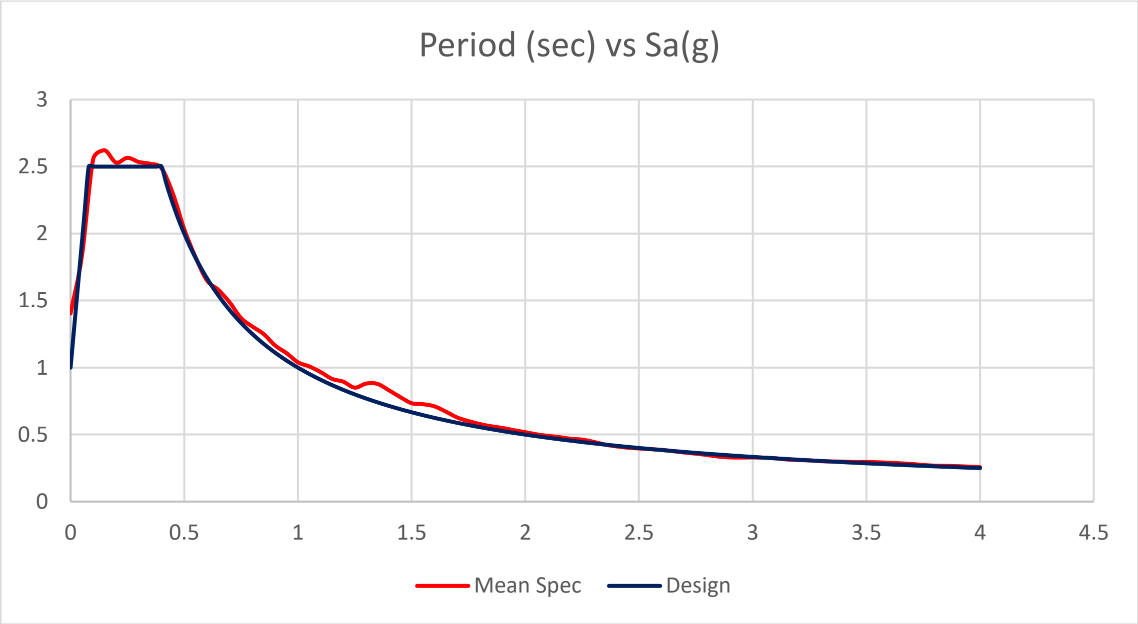
Results and Figures:

NTHA was conducted to analyze the seismic response of SPSWs during near-field ground motion. For this purpose, five near-field ground accelerations were selected from the Pacific Earthquake Engineering Research (PEER) database, and their details are given. These are the graphical representation of a structure's response to ground motion at various frequencies. The spectrum displays the maximum response (displacement, velocity, or acceleration) of a structure at each natural frequency.

MCE Spectral Response Acceleration, S_{MS} [ASCE 11.4.3, Eq. 11.4-1]	$S_{MS} F_a S_S$	S_{MS}=3.75g
MCE Spectral Response Acceleration, S_{M1} [ASCE 11.4.3, Eq. 11.4-2]	$S_{M1} F_v S_1$	S_{M1}=1.3035g
Design Spectral Response Acceleration, S_{DS} [ASCE 11.4.4, Eq. 11.4-3]	$S_{DS} \frac{2}{3} S_{MS}$	S_{DS}=2.5g
Design Spectral Response Acceleration, S_{D1} [ASCE 11.4.4, Eq. 11.4-4]	$S_{D1} \frac{2}{3} S_{M1}$	S_{D1}=0.869g

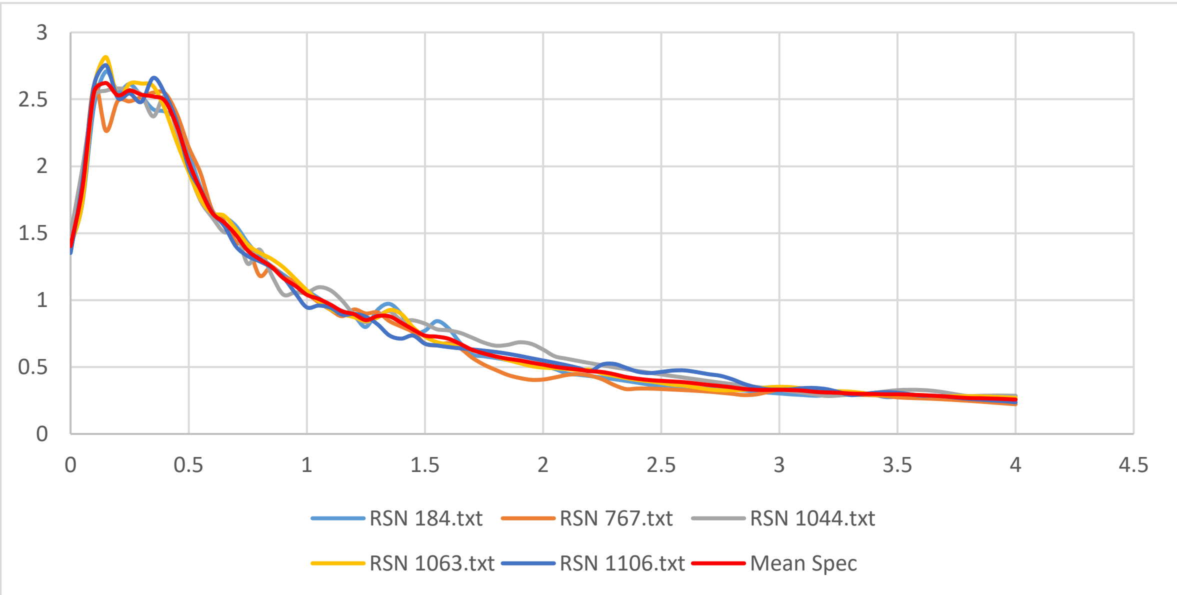
All the time histories were scaled to a design spectrum by using the spectral matching technique, which was initially proposed in 1987 and 1988 [12,13]. Spectral matching was performed by using SesimoMatch, which is based on the wavelet algorithm named RSPMatch, which was initially proposed in 1992 and further improved in 2006 [14,15].

Mean & Design Spectrum:



(Spectral matching mean with the target Spectrum)

Spectrum matching for selected ground motions:



(Spectral matching for selected ground motions)

Chapter 3

3.1 Summary and Future work

Summary:

The research embarked on a comprehensive exploration of various steel plate shear wall (SPSW) systems, including stiffened, unstiffened, and corrugated configurations, within the context of a 6x6x5 building subjected to five distinct near-field earthquake scenarios. The primary objectives were to assess the individual performance characteristics of these systems and their collective behavior when integrated into a structural framework. Thirty distinct models were developed and examined using advanced simulations conducted with ABAQUS Software. Key factors such as lateral load resistance, deformation capacity, stiffness, and energy dissipation capacity were evaluated to provide insights into the seismic resilience of different SPSW configurations.

Through finite element modeling and time history analysis, the research generated significant data on the dynamic response of SPSW systems under varying seismic intensities. The findings shed light on the strengths and limitations of each configuration, informing design recommendations and retrofitting strategies aimed at enhancing earthquake resilience in structural engineering.

Future Work:

While the research has made substantial progress in understanding the seismic performance of SPSW systems, several avenues for future exploration and refinement exist:

1. Experimental Validation: Despite the rigorous simulations conducted, experimental validation remains critical to corroborate the findings and ensure the accuracy of the models. Future endeavors should prioritize experimental testing of SPSW systems to validate simulation results and refine design parameters.

2. Multi-Hazard Resilience: While earthquakes were the primary focus of this study, future research could broaden its scope to encompass other natural hazards such as windstorms, floods, and tsunamis. Understanding the multifaceted resilience of SPSW systems to various hazards is essential for holistic disaster risk reduction strategies.

3. Optimization and Innovation: Continued research efforts should seek to optimize SPSW designs and explore innovative materials and construction techniques to further enhance

seismic resilience. Incorporating advancements in material science, robotics, and digital fabrication could unlock new possibilities for resilient structural engineering solutions.

Conclusion & Recommendation:

Investigating 5 earthquake magnitudes, this research assesses the cyclic performance of 30 distinct steel plate shear wall (SPSW) configurations. The study focuses on ductility and energy dissipation across stiffened, unstiffened, and corrugated SPSWs under cyclic stress. Key findings emphasize the vital role of stiffeners in damage mitigation, enhancing structural stability, and overall integrity. A comparative analysis of simulation-based and experimental projects underscores the accuracy of simulation-based outcomes. Future research opportunities lie in exploring alternative stiffness arrangements.

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