Seismic response analysis of corrugated steel wall under Earth load - Seismic Fault area far and near

Erfan PourMohammadi
Department of civil engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran

Abstract

This study examines the seismic response of corrugated steel shear walls under land load-seismic seismic distant and near fault zone. Corrugated steel shear walls are used as an efficient lateral resistance system in earthquake-resistant structures due to their formability and high energy dissipation capacity. The use of corrugated steel sheets has several benefits, including increased shear strength, improved bow behavior, and reduced structural weight. However, earthquakes in the nearby fault zone, due to the presence of high-speed pulses and permanent displacement, can cause more damage to these walls.

In this study, using Abacus software, a three-dimensional model of a corrugated steel shear wall was created and subjected to accelerated loading of seismic scales in the distant and near fault area, nonlinear dynamic analysis was carried out. The results showed that corrugated steel shear walls exhibit optimal seismic performance against earthquakes in the far and near fault zone. However, the seismic response of these walls under near fault zone earthquakes differs significantly from their response under far fault zone earthquakes. In the design of corrugated steel shear walls for areas near the fault, the effects of velocity pulses and permanent shifting should be considered.

Key words

Corrugated steel shear wall, seismic response, earthquake loading, far Fault area, near fault area, structural analysis

Introduction

Although it is very difficult to completely prevent damage from a severe earthquake, by increasing the level of information in the country's seismic relationship, public education and promoting a culture of safety, identifying and studying the situation in the country's seismic relationship, identifying and studying the vulnerability of vulnerabilities and their proper and principled immunization, casualties and damages caused by future earthquakes can be reduced to the optimal extent. In the first regulations on the design of buildings against earthquakes, the argument is that during an earthquake, the building accelerates under the influence of the Earth's acceleration, and this acceleration leads to the formation of inertial force. The weight of the building and the materials and other loads in it were affected by the horizontal force on the building, and the ruling thought that by ensuring the resistance of structural components and elements to this force in the reactionary environment, earthquake safety can be ensured and the building can be prevented from deteriorating

In this way, the design of "earthquake resistance" was formed. But due to the high destructive power observed in strong earthquakes and its uncertainty, in each revision, the percentage referred to in the regulations was increased and it soon became clear that by accepting the reactionary behavior of structural components and elements, the dimensions of this execution and elements are unconventionally enlarged, and in practice the existing possibilities are not responsive to this solution. Earthquake damage can be divided into three categories: direct physical damage, social damage, and economic damage. Structural failure occurs when large, permanent deformations are caused by loads on the structure. Various systems are used to make structures resistant to earthquakes, one of which has recently received a lot of attention from designers is the steel bending frame with a steel brush wall, and since the 1970s it has been one of the lateral load systems. Steel brush walls are usually made in two types: hardened and hardened. In general, hardened types are more suitable for seismic performance and exploitation issues, but due to the presence of numerous hardeners and many executive details, a lot of time and money must be spent on their construction. So the idea of corrugated steel cutting Walls has been proposed as a replacement for hardened cutting walls, and these sheets are expected to have high bow strength due to their inherent external hardness and ultimately have the same function as hardened cutting walls. Since the history of this system is not long, there are no precise code of Conduct for its behavior in various situations. So the need to examine how these structures work under different conditions, including how the system works in a nonlinear area and in the face of lateral loads, seems necessary

1-2-objectives of the study

The purpose of this thesis is to achieve the following in the analyses carried out:

1 -Create a calibrated model for the analysis of the finite components of corrugated steel walls, according to

Laboratory results from the latest research on the corrugated wall of the trapezoidal) preferably Tung and go Research in 2015؛

2- analysis of the sensitivity of the model and selection of the optimal mode of the type and dimensions of the elements used

In reaching a lasting answer؛

3- analysis of short steel bending frame structures 3 floors, between 7 floors and 15 floors

In five openings and the extraction and simulation of a frame of each structure and its equipping with a corrugated steel wall, the openings are tried to be 5 meters long and 3 meters high,and only the opening in the middle of the structure, with a height-to-width ratio of 0.6, is equipped with a steel wall؛

4- structural behavioral measurement includes calculation of hysteresis graphs, energy absorption, stress and base cutting against

Different types of earthquakes: three distant earthquakes and three near-fault earthquakes.؛

5- comparison and evaluation of the coefficient of behavior of structures designed in the face of earthquakes near and far faults.

1-3-innovation in the subject of the article

So far, there's been a lot of research on the behavioral measurement of all kinds of frame structures and steel walls. But given the extraordinary benefits of corrugated steel shear walls in increasing the load capacity of the structure,

In this study, we analyze and analyze the behavior of this structure in the face of different types of earthquakes with a close nature.

The fault is paid for and its behavior is compared in the face of distant fault earthquakes. In addition, the effects of using this structural system on the frames of short, medium and high-rise structures are evaluated(3), 7, and 15 floors (and therefore the present article has an innovative aspect.

1-4-Main and sub-hypotheses of the article

The main hypotheses of this study are according to the following paragraphs the orientation of the present study is based on the proof of these hypotheses:

1- by adding a corrugated steel wall to the steel frame, the system behavior including the shear load capacity and energy absorption can be improved to the desired extent, and subsequently minimize the cost of the final design structure؛

2- it is assumed that after applying the corrugated wall to the steel bending frames, the amount of force that is absorbed from the formation of the first plastic joint to the complete breakdown in the structure has increased; therefore, the coefficient of behavior of the steel bending frame structure along with the corrugated wall will be higher than that of the structure without the corrugated wall)finding the exact coefficient of behavior of the said structure is also one of the objectives of the present study.

1-5-how to do the research

In the process of analyzing the behavior of corrugated steel walls in this study the following steps were taken:

1- Abi ab abaqus, using the studies of the ،

In connection with the analysis of the corrugated steel walls.؛

2- analysis of three short-order, mid-order and high-rise steel structures (3), 7 and 15 floors (in five openings using

Et etabs) the connections of the above structures are analyzed in a similar way (؛

3- Consider A frame structure and equip it with a steel wall؛

4- receiving the raw spectrum of the acceleration of earthquakes far and near from the site of the like and Correction and contiguous

Earthquake detection using Seismic software؛

Abi abi ab abaqus؛

6- estimate the values of the base cuts in linear and nonlinear states to calculate the coefficient of behavior؛

To do the above, a few points must be mentioned:

1- The Unit C measurement system is used in the analysis.؛

2- three-dimensional linear elements are used to simulate the arrow and column.؛

3- German shells are used to simulate the cross-sectional wall plate.؛

4- for the accuracy of responses, experiments conducted in authoritative articles of Al-zawir have been used in recent years؛

5- since all the statutes, earthquakes that the seismic recording Center at a distance of less than 10 kilometers

The epicenter of an earthquake is known as a near Fault earthquake, so the spectrum of earthquake acceleration is called a fault Close, from the sit PEER.

They get it. Similarly, the spectrum of earthquakes whose recording Center is more than 20 kilometers from the earthquake Canon is also searched, and the necessary modifications are made to them using Seismosignal software, and using Abaqus, they are applied to the corrugated steel wall-cutting system, and the structural response is calculated and evaluated in each case.

The data required and the methods used in this study are extracted using library studies, the internet and other articles ' data, and the current research method is based on numerical modeling by the public. As mentioned, using Abaqus, numerical data is presented in tables and graphs. To more accurately and clearly examine this information, they will be transferred to excel software and analyzed the information obtained from the research with appropriate expression and description of the outputs. The statistical community of the present study is also the corrugated steel wall response in the face of all fault earthquakes far and near.

1-6-the variables in question

The variables discussed in this study include several:

1- analysis of the effect of the use of corrugated steel cross-sectional wall in increasing the bearing capacity of the steel bending frame؛

2- analysis of the effect of using a corrugated steel cross-sectional wall on the formability and energy absorption of the steel bending frame؛

3- Comparison of the effect of various earthquakes near and far from the fault in response to the corrugated steel wall cutting system؛

4- estimation of the coefficient of behavior of steel structures with corrugated steel wall

2-review of previous studies

Mohammad Hussain Akhavan and his colleagues criticized the diagonally reinforced steel wall in 2015. Their research was done in a laboratory and numerical way. The simulation scale in their experiment was one-third. Three pieces were examined in the study. The first piece of the sample was a witness that was unvolved. Two other samples were retrofitted using different methods and placed in the loading cycle. Finally, they proposed a relationship that could be used as a prediction of the load capacity of the wall. In 2016, Ms. Massouma qalipour and Mohammad Mehdi Aliani evaluated the behavior of a multi-storey steel-walled frame. They created openings of different dimensions in steel wall cutting for frames 4, 7, 10, 13, 16 and 19 floors to provide a suitable model of the behavior of steel wall cutting. According to the order of the AISC-341,the opening rate of steel walls should be between 0.8 and 2.5. The rates of rectangular opening dimensions in their research were 0.83, 1.67 and 2.5. In simulation, they also used a reduced wing connecting arrow at the junction of the column. Their results showed that the use of reduced-dimensional paper would have a significant impact on increasing the bearing capacity of the frame, especially against upright loads. In 2016, Mr. Sohail Shafi and his colleagues discussed the impact of the different thicknesses of the concrete panel covering one side of the wall on the load-bearing capacity of the wall. They also considered different scenarios of failure. The result of their research is that the use of concrete panels will significantly increase the load capacity of the wall. In 2015, Mr. jinping1 and his colleagues evaluated the stability of the steel cutting walls along with the formation of a slit on the cutting wall plate. They also put two layers of concrete panels around the wall plate and then analyzed it. They finally presented theoretical relationships to predict the surrender, calculate the surrender rate, and also the shear resistance of the shear wall.

Alireza farzampour and his colleagues in 2015 conducted numerous studies of the different thicknesses of the cutting wall plate and the location of the opening and its effects on the behavior of the steel cutting Wall. They eventually developed relationships to predict the behavior of steel-cut walls. In 2015, Mr. Tada zirakian2 and Mr. Jian zhang3 evaluated the structural performance of steel-cut walls with a low flow limit and without hardening. They presented a model that provides a system that is appropriate and adapts to the resistance of Steel, where the steel shear wall has reached the same level of flow under seismic load before all other elements and will prevent damage to other elements before the shear wall. Meng wang4 and his colleagues examined the hardening-free steel wall in 2015 in laboratory and numerical studies. They studied the different parameters of a steel cross-sectional wall in a four-story frame. These parameters were the ratio of height to wall thickness, the ratio of length to width of the wall plate, and the middle inhibitor, which was vertically located in the middle of the wall. In this test, the hammer coefficient, the malfunction modes and the energy consumption ratio were carefully examined and analyzed on the wall plate under cyclic loading. The important result of their research was to provide a decent and economical amount of hardness for the columns around the wall plate. In 2015, Mr. Ronnie porba5 and Mr. Michael bruno6 conducted a laboratory study of steel-cut walls and the plasticity of materials in the transverse bands on the side boundaries of the wall. Their study was a three-story frame in which the plasticization of materials during earthquakes was discussed. Lunar researchers and colleagues in 2015 examined the cracks and behavior of steel fracturing walls during the earthquake. They created twenty-two different models of brush walls using the software of Abaqus and ensis. Since there is very little laboratory and numerical data on the cracks in the steel cutting walls, they used simple models to calibrate the software and relied on the outputs of the limited component model. The nonlinearization of materials and geometric nonlinearization were also included in their research. Finally, they calibrated and presented the appropriate finite element model for their analysis.

3-theoretical foundations of research

Steel shear walls (SPSW) are widely used in earthquake-resistant structures as an efficient lateral resistance system, due to their hardness, formability and high energy dissipation capacity. The use of corrugated steel sheets in these walls has several benefits, including increased shear strength, improved bow behavior, and reduced structural weight. Given the importance of precise analysis of the seismic response of these types of walls, especially in the conditions of earthquakes in the near fault zone, these theoretical foundations examine the factors influencing the seismic behavior of corrugated steel shear walls and their analysis methods.

3-1-corrugated steel shear walls

Corrugated steel shear walls are a type of steel shear walls in which corrugated steel sheets are used instead of flat sheets. These waves can be sine, trapezoidal, or square. The use of corrugated sheets increases the shear resistance and improves the bow behavior of the wall. Also, these waves can cause the structure to lose weight, as they reduce the need to use thicker sheets.

3-2-seismic behavior of corrugated steel shear walls

The seismic behavior of corrugated steel shear walls is influenced by various factors, including the type and geometry of waves, sheet thickness, material specifications, sheet connection type to boundary members, and loading type. In general, these walls have high hardness and formability and can effectively absorb and deplete earthquake energy. However, in the conditions of earthquakes in the near fault zone, due to the presence of high-speed pulses, more intense nonlinear behavior may be observed in these walls.

3-3-earthquakes in the far and near fault zone

Near fault earthquakes are earthquakes that occur less than 20 kilometers from the fault. These earthquakes have certain characteristics, including the presence of high-speed pulses and permanent displacement, which can cause more damage to structures. Earthquakes in the distant fault zone are earthquakes that occur at a distance of more than 20 kilometers from the fault. These earthquakes usually have a longer duration and different frequency content than earthquakes in the near fault zone.

3-4-methods of analyzing the seismic response

Various methods can be used to analyze the seismic response of corrugated steel shear walls, including nonlinear static analysis (covering), nonlinear time history analysis, and finite component analysis. Nonlinear time history analysis is the most accurate method for analyzing the seismic response of structures under near fault zone seismic load. In this method, real accelerometers of near fault zone earthquakes are used as inputs, and the structural response is calculated over time.

3-5-factors affecting the seismic response

Several factors affect the seismic response of corrugated steel shear walls including the following:

A) wave type and geometry: wave type and geometry have a significant impact on the hardness, strength and formability of the wall.

Sheet thickness: increasing the sheet thickness increases the strength and hardness of the wall.

B) material specifications: steel material specifications, including Surrender resistance and final resistance, have a significant impact on the seismic behavior of the wall.

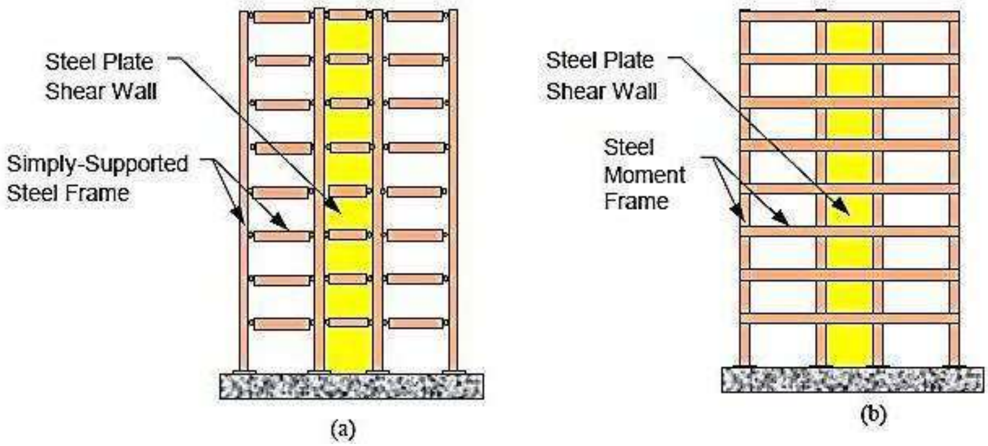
Type of sheet connection to Border members: type of sheet connection to Border members affects how forces are transmitted and tensions are distributed in the wall.

C) loading type: the loading type, including earthquakes in the distant and near fault zone, has a significant impact on the seismic response of the wall.

1-3-presentation of the characteristics of the steel wall

The theoretical structure governing the behavior of simple walls is examined in this section. Two types of cutting Arrows are shown in Figure 1-3. The standard and double type, which is the standard type of connection of the arrow to the articular column, so the cross-sectional wall resists the lateral load.

Figure .1-3 two steel wall samples: a standard and b dual system



In terms of the performance of steel wall structures, it can be divided into two groups: reinforced and not reinforced. Hardeners are used to strengthen the sheet to prevent bow in the elastic area. The high-thickness reinforced shear wall is caused by the resistance of the columns and the destruction of the structure before the shear wall is destroyed. In thin unforced walls, structural failure is controlled by the formation of a diagonal tensile field and wall failure. The lateral displacement of the reinforced system is less than the thin-plate wall system, which cannot be bowed.the hardening wall will not be able to spread tension and eventually distribute tension more appropriately in the side elements.

3-6-existing methods of structural analysis

So far, various methods have been developed to identify the strengths and weaknesses of structures, in other words, structural analysis by researchers. The methods are:

(1 linear static method

(2 linear dynamic method

(3 nonlinear static methods

(4 nonlinear dynamic methods

The following is a brief description of each of these methods.

1.Static analysis methods:

Linear static analysis:

This method is the simplest type of analysis and is suitable for structures that are subject to static loads and within the linear behavior range of materials.

In this method, it is assumed that structural deformations are small and the relationship between forces and deformations is linear.

Linear static analysis calculates internal forces, anchors, and structural deformations in a state of equilibrium.

Nonlinear static analysis:

This method is used to investigate the nonlinear behavior of structures under increasing lateral loads, such as earthquake loads.

In the coating analysis, the lateral load is gradually applied to the structure until the structure is in a state of failure.

This method provides useful information about the load capacity, formability and weaknesses of the structure.

2.Methods of dynamic analysis:

Linear dynamic analysis:

This method is used to investigate the response of structures under dynamic loads, such as earthquake loads, within the linear behavior of materials.

Linear dynamic analysis can be done in two ways: spectral analysis and TIME History analysis:

Spectral analysis: in this method, the earthquake response spectrum is used to estimate the maximum structural response.

TIME History analysis: in this method, real earthquake accelerometers are used to calculate the structural response over time.

Nonlinear dynamic analysis:

This method is the most accurate type of dynamic analysis and is used to investigate the nonlinear behavior of structures under dynamic loads, such as heavy earthquake loads.

In this method, real earthquake accelerometers and nonlinear models of materials are used to calculate the structural response over time.

The direct integration method is presented step by step in the form of numerical methods such as Newmark Wilson Taylor Halbert.

3. Methods of numerical analysis:

Finite component method (FEM):

This method is a powerful numerical method used to analyze complex structures with geometry and nonlinear materials.

In the finite component method, the structure is divided into smaller components and the equations governing the behavior of each component are solved.

This method allows careful examination of the distribution of stresses, deformations and other structural parameters.

4. Manual computing:

Simple manual computing is considered a quick and simple way to assess the effects of simple forces on simple structures. For example, calculating a bending anchor on a horizontal beam is done using manual calculations.

Choosing the right method of structural analysis depends on several factors, including the type of structure, the type of loading, the behavior of the materials and the level of accuracy required.

4 - familiarity with ABAQUS software

Today, the use of the German limited method in the analysis of various complex industrial issues to reduce time and cost and increase productivity has become widespread, and among the software that uses this method, ABAQUS has a special place.

ABAQUS is a powerful set of engineering simulation programs based on the German limited method that can solve problems from relatively simple linear analysis to complex and challenging nonlinear simulation problems.

It has a large set of elements that can model any geometry. It also has a complete set of materials models that can behave in many engineering materials including tires Polymers Composites reinforced concrete flexible foams

It simulates compactness, or the ingredients of the Earth's crust, such as soil and rock, and as

A versatile design simulation tool has been proposed. This software can be used in structural analysis of stress - strain issues(and at various levels such as heat transfer, mass transfer, heat control of electrical components, sound analysis, Soil Mechanics and piezoelectric analysis).

Other uses of this software include the analysis of the failure of parts and the examination of the mechanism of crack growth, the analysis of dynamic loads on structures and the analysis and prediction of the destruction caused by earthquakes and many other applications of mechanics and aerospace.

4-1-software capabilities

ABAQUS software includes two important analytical capabilities:

- ABAQU/STANDARD with a special implicit solution method for German limited public issues.

- ABAQUS/EXPLICIT with a direct solution to German limited dynamic problems.

In Abacus software, there are two main methods for solving differential equations governing problems: implicit and explicit. Each of these methods is suitable for a specific type of problem and has its own advantages and disadvantages.

1.Implicit method in Abacus:

How it works:

In the implicit method, solving equations at each time step leads to solving a system of nonlinear equations. In other words, the value of variables in the future tense (n+1) depends on the values of the same variables at the same time (n+1).

Abacus uses numerical methods such as the Newton-Rafson method to solve this system of equations.

Applications:

Static issues (under constant loads)

Low-speed dynamic issues (such as the vibrations of structures)

Heat transfer issues

Stress and strain analysis issues

2.Explicit method in Abacus:

How it works:

In the explicit method, the value of variables in the future tense (n+1) is calculated directly from the values of variables in the present tense (n).

This method does not require solving a system of nonlinear equations, and calculations are performed much faster at each time step.

Applications:

High-speed dynamic issues (such as impact, explosion, metal forming)

Issues with large deformations and material failure

Complex contact issues

Choosing the right method:

The choice between implicit and explicit method depends on the type of issue and the loading conditions.

For static and dynamic issues with low speed, the implicit method is a more appropriate choice.

For high-speed dynamic issues and extreme nonlinear issues, an explicit method is a more appropriate choice.

In Abacus, you can choose the solution method you want by selecting the appropriate analyzer Abaqus/Standard for the implicit method and Abaqus/Explicit for the explicit method

4-2-introduction to the earthquakes

For the design of earthquake-resistant structures, it is of particular importance to recognize the movement and vibrations of the underlying earth plate that is expected to occur during the useful life of the structure. The best way.

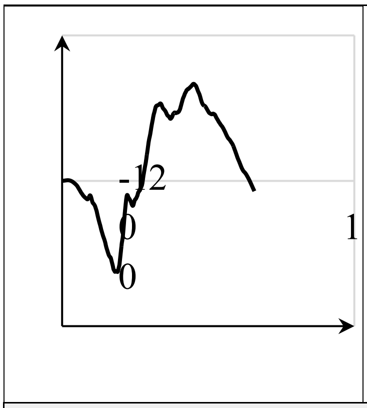
To understand the characteristics of the extreme movement of the Earth, it is bad to draw a graph of the Earth's motion, including the intensity and magnitude of the Earth's acceleration during the event of the MeToo earthquakes. This is due to the accelerator station at the site and the earthquake occurring in the near area. Given that for the design of earthquake-resistant structures in seismic areas, it is not possible to deploy accelerator stations for each location and remain in the immediate area waiting for an earthquake to occur, to record a suitable vibration graph and record of the Earth's kinetic and kinetic energy, but today in the world's seismic areas, the deployment of networks is not possible. accelerators and seismologists are working to record the strong vibrations of the Earth from the large number of earthquakes in these networks so that they can achieve results with numerous studies that lead to the preparation of seismic mapping and the parameters of the vibrations of the Earth's infrastructure can be based on the These maps were predicted and used to load

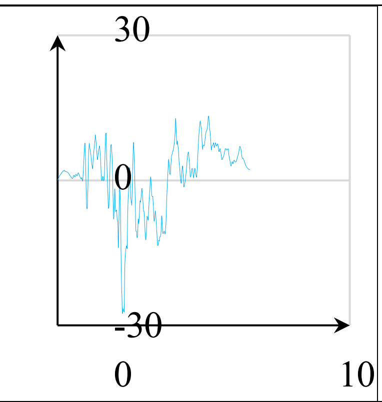
Earthquake Spectra on the structures. Since desperation of authoritative and raw earthquake records is the first step in TIME History analysis, the site /http://peer.berkeley.edu it provides a comprehensive source of these records, and how to get earthquakes from this site is provided in the appendix.

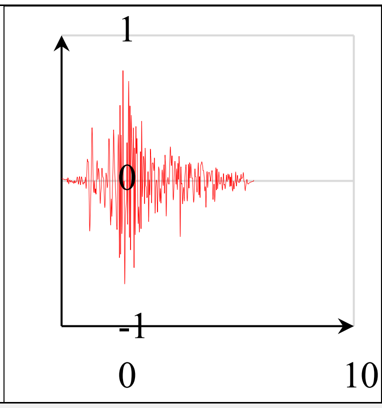
To perform dynamic analysis and select and apply the seismic spectrum in the model, three seismic surfaces with near-fault nature and three earthquakes far from the G-cell were selected and applied to the upper frame arrow in the form of an acceleration spectrum. Since the acceleration spectrum is bad, it comes from the acceleration of the Earth's gravity, so to convert this spectrum into a unit of the SI standard,all the acceleration values in the software line,in the value of the Earth's gravity, were multiplied by 9.81 meters per second. The following is a spectrum of acceleration, speed, and land change due to earthquakes that have been misplaced using SEISMOSIGNAL software. It should be noted that the graphs presented from left to right represent the acceleration, speed and change of the earthquake. The horizontal dimension of the charts also represents the time. First, nearby fault earthquakes will be introduced.

Table 4-3-characteristics of near fault earthquakes used in the present article

Earthquake name: (1) Tabas earthquake RSN code: 143 Date of occurrence: (16/9/1978	Seismic station seismic record: Tabas best function in baseline modification: Constant Name used in the present study: N143



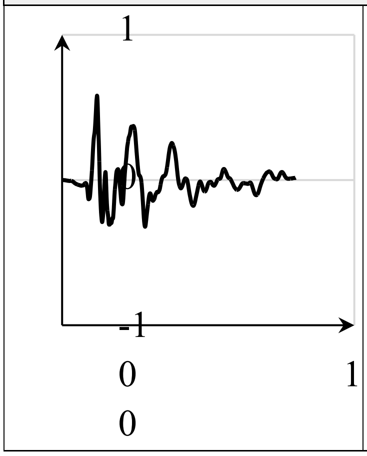


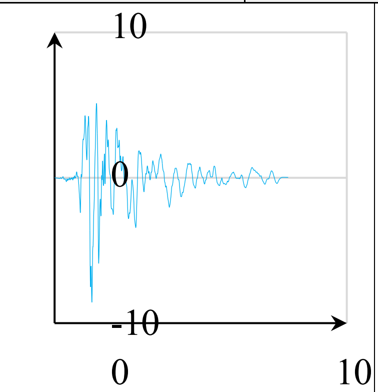


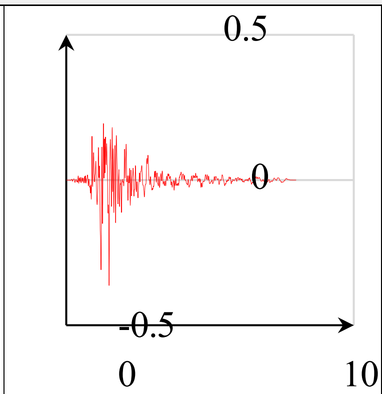
Seismological station earthquake recording: Aloha Saratoga best function in baseline modification: Linear
Name used in the present study: N802

Seismic recording station: Lucerne best function in baseline modification: Linear
Name used in the present study: N879

Earthquake name: (2) Prieta Loma earthquake
RSN code: 802
Date of occurrence: 1989/10/18

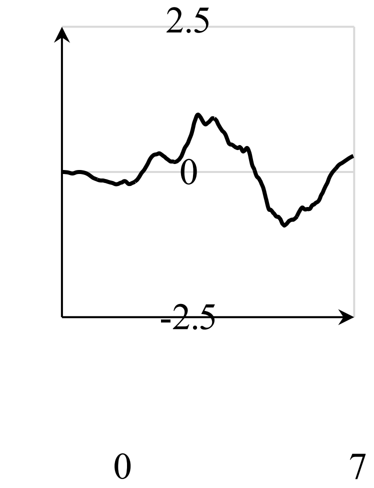


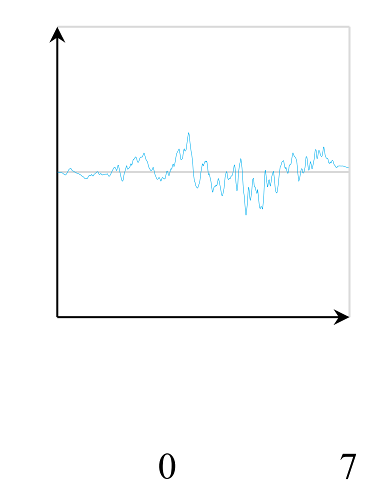




The following are the chronological diagrams of the acceleration, speed and change of the location of the G-tuberculosis earthquakes.

Seismic station earthquake recording: Boshrooyeh best function in baseline modification: Quadratic Name used in the present study: F138	Earthquake name: (1) Tabas earthquake RSN code: 138 Date of occurrence: 1978/9/16





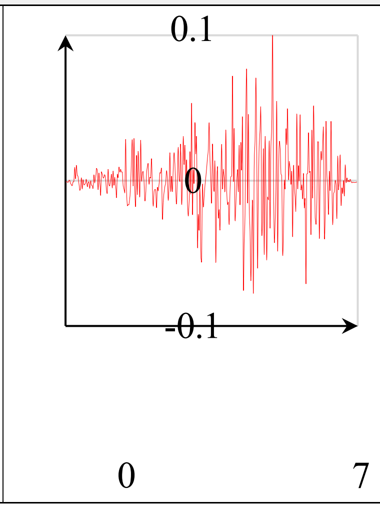
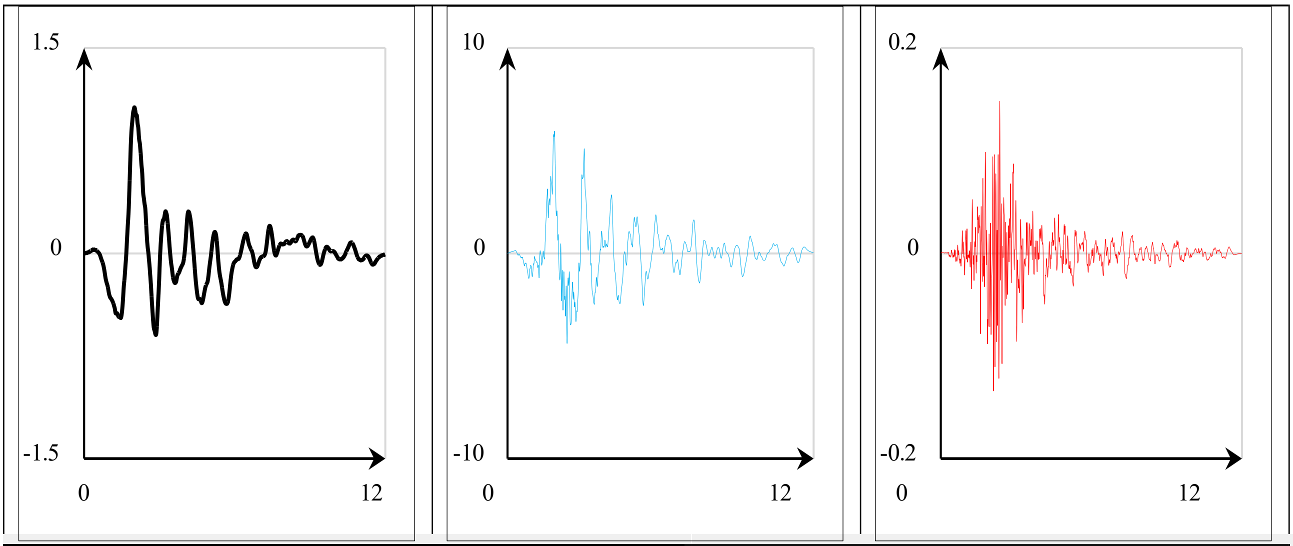


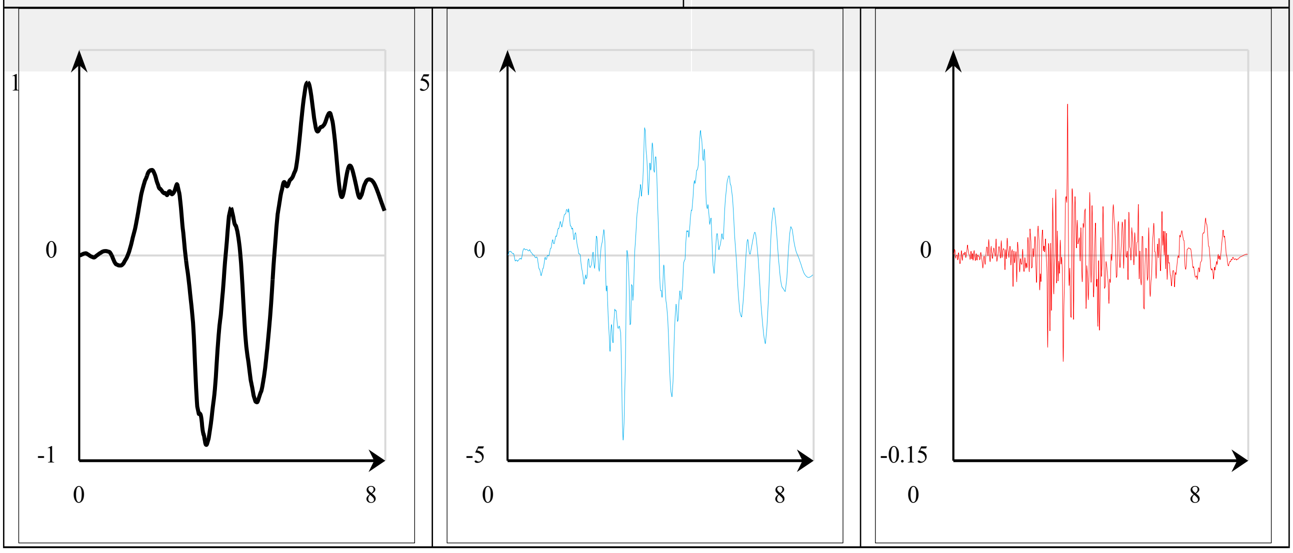
Table 4-2 - characteristics of remote fault earthquakes used in the present study

Earthquake name: (2) Prieta Loma earthquake RSN code: 737 Date of occurrence: (18/10/1989	Seismological station earthquake recording: State Agnews best function in baseline modification: Quadratic Name used in the present study: F737

The accelerated response spectrum of distant fault earthquakes is similar to the previous one using SEISMOSIGNAL software and is given in the figure below. By comparing the three of these two forms, there is a huge difference in the acceleration of a degree of freedom under near and far earthquakes. The maximum response acceleration in a distant Fault earthquake is limited to about 0.61 Earth gravity acceleration. But this is because this parameter was 2.75 times the Earth's gravitational acceleration for near-fault earthquakes. This is evidence of the extreme destructive power of nearby fault earthquakes.



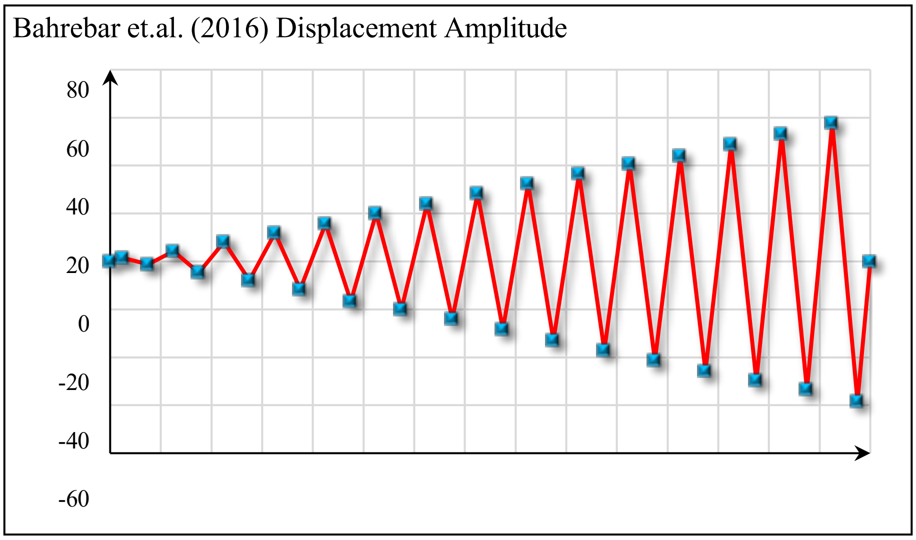
Seismological station of the earthquake record: Barstow Best function in baseline modification: Linear Name used in the present study: F838	M earthquake: (3) Landers The earthquake code is 838. Date of occurrence: (1992/6/28

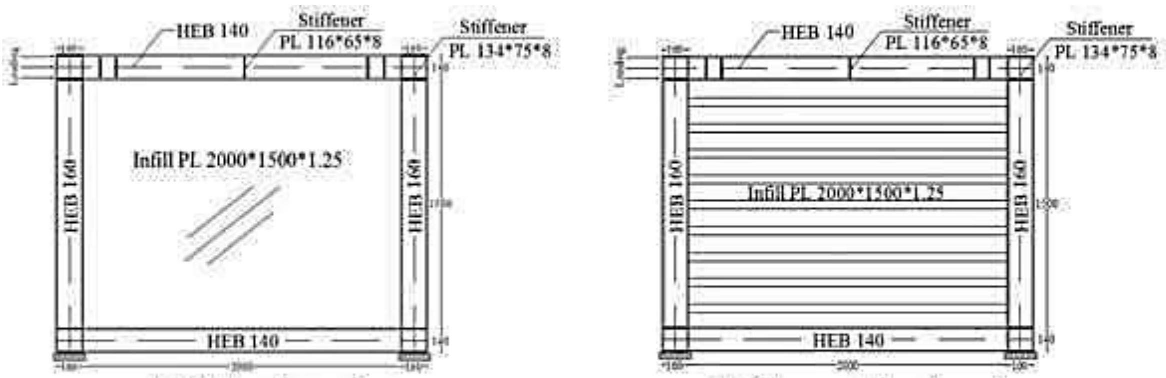


In this example, they first examined and compared the behavior of a single-story steel panel with a common thin-walled steel wall with the behavior of a steel panel equipped with a corrugated steel wall, which was tested by Imam and colleagues, and presented its behavioral charts including the hysteresis chart.

Figure 4-3-Imami, useful and loyal Wall model in 2013

As shown in Figure 4-3,the steel frame model is placed under a cyclic load in length and width of 1,5 and 2 meters respectively and a thickness of 1,25 mm installed in the frame. The load in the test was in the form of hysteresis, which is presented in Figure 4-4.





(a) Flat-web specimen (b) Corrugated-web specimen

Figure 4-2-hysteresis loading spectrum in the research of the user and colleagues in 2016

The specifications of the steel materials used in this experiment are in accordance with the diagrams presented in Figure 4-5, which are divided into sections

Various includes arrows, columns and dedicated wall panels

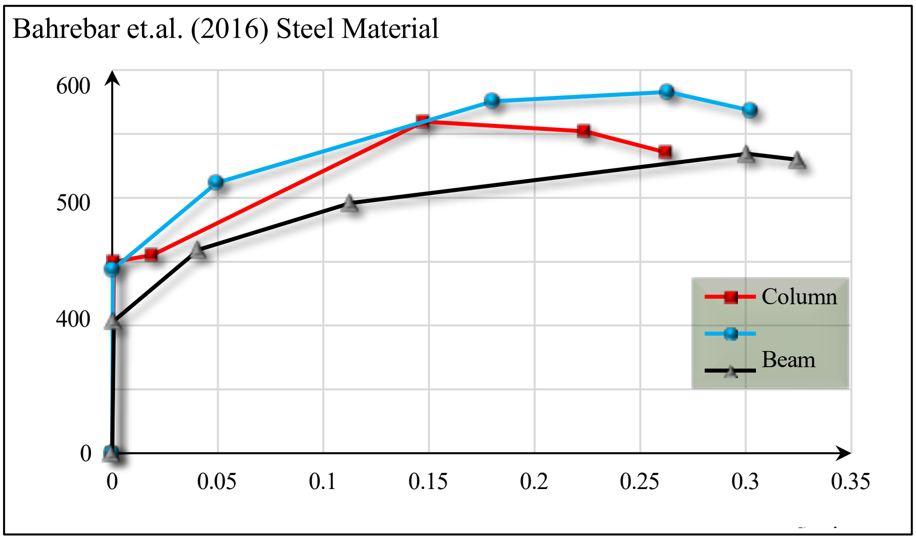
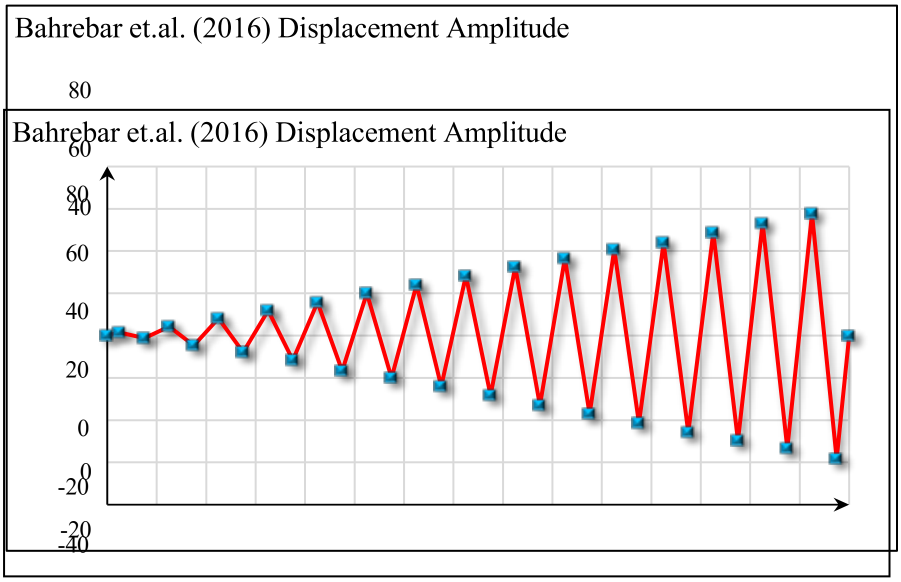
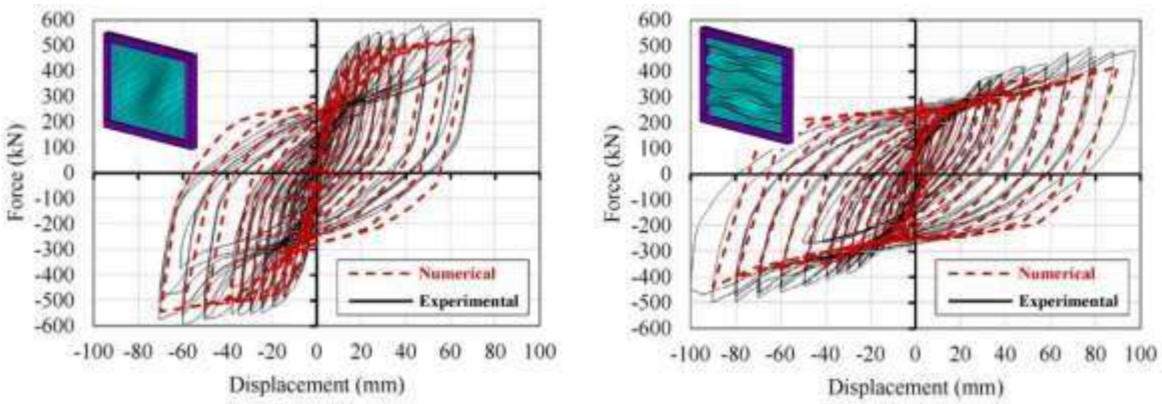


Figure 4-3-chart of material characteristics in the study of the beneficiary and colleagues





(a) Flat-web SPSW (b) Corrugated-web SPSW

Figure .4-4-simple and corrugated steel wall behavior in the study of the user and colleagues in 2016

It should be noted that the above three sections include a column marked with a red line(with a surrender resistance of 300 megapascals, Arrows)marked with a blue line) and with a surrender resistance of 288 megapascals and a wall panel marked with a black line(with a surrender resistance of 207 megapascals).

The answer of the wall-cutting system in two common and corrugated modes in the study in the diagrams of figure 4-3

It is stated that in the present study for the accuracy of the measurement

Use the graph for the corrugated wall.

Now we're going to simulate all the parameters that affect the behavior of the system in the abacus finite element software to achieve an accuracy rate of more than 95 percent. For this purpose, in the validation discussion, it is intended to obtain an optimal model that has an error of less than 5% with the values stated. The steps required in the simulation discussion by the finite component software are described below.

Part module 4-3

In this step, the geometry of the organs is created separately to form the overall model. To simulate the model in question it is necessary to make the parts as follows.

In this module, the properties of the materials analyzed are defined by the cross-sectional area and attributed to the defined properties to the parts. It is said that in the Abaqus software, the user is responsible for selecting the units used. In this study, the SI system is used to define materials. The units used in this system are shown in Table 4-8.

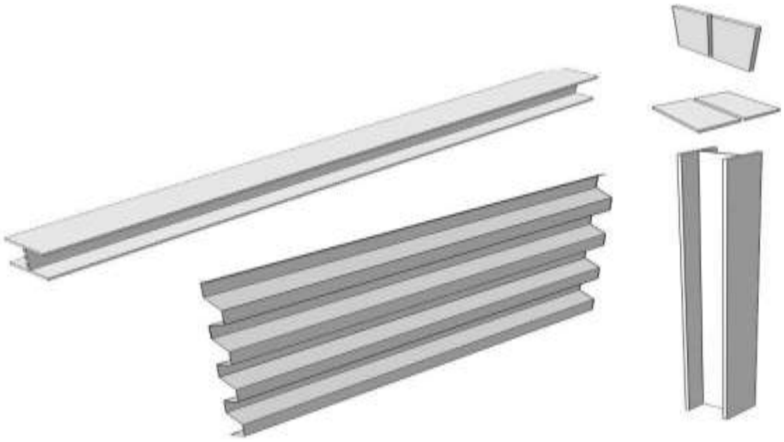


Figure 5-4components needed to simulate a corrugated steel wall cutting system

In this module, the properties of the materials analyzed are defined by the cross-sectional area and attributed to the defined properties to the parts. It is said that in the Abaqus software, the user is responsible for selecting the units used. In this study, the SI
system is used to define materials. The units used in this system are shown in Table .8-4

Table .1-4 SI units in the software

Length	Crime	Time	Tension
Meter	Kg	Seconds	Pascal

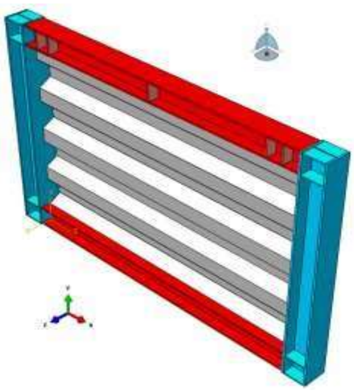
As a result, model outputs are displayed accordingly. Steel specifications are based on the data of the main article with a specific weight of 7,850 kg per cubic meter and an elasticity modulus of 210 GPA,as well as a Poisson coefficient of 0.3. The plastic behavior of the materials is defined as graphs of figure 4-4 of the stress and strain of the steels.
For future research and further discussion, table 2 can be used and the corresponding numbers can be copied in the plastic stress-strain section of Abacus.

Table .2-4 numbers related to the stress-strain of steel of different parts of the system

Panel		Beam		Column	
Stress (Mpa)	Strain	Stress (Mpa)	Strain	Stress (Mpa)	Strain
۰.۰۰E+۰۰	۰	۰.۰۰E+۰۰	۰	۰.۰۰E+۰۰	۰
۲.۰۷E+۰۸	۰.۰۰۰۸۳	۲.۸۸E+۰۸	۰.۰۰۰۳۲۱	۳.۰۰E+۰۸	۰.۰۰۰۷۸۲
۳.۱۹E+۰۸	۰.۰۴۱۰۱۳	۴.۲۳E+۰۸	۰.۰۴۹۳۸۱	۳.۱۰E+۰۸	۰.۰۱۹۰۲۵
۳.۹۲E+۰۸	۰.۱۱۳۰۳۴	۵.۵۱E+۰۸	۰.۱۸۰۳۳۱	۵.۱۹E+۰۸	۰.۱۴۷۵۹۴
۴.۶۹E+۰۸	۰.۳۰۰۶۲۸	۵.۶۶E+۰۸	۰.۲۶۳۱۴۴	۵.۰۴E+۰۸	۰.۲۲۳۸۷۲
۴.۵۹E+۰۸	۰.۳۲۴۹۶۴	۵.۳۷E+۰۸	۰.۳۰۲۴۶۴	۴.۷۱E+۰۸	۰.۲۶۲۲۵۷

After introducing the specifications of the materials, the section used for each section is introduced to the software, which will be created homogeneously with the specified sections, and then the section made is assigned to the piece.

Assembly module 4-5
This module determines the assembly of different parts and the geometric position of the parts relative to each other. The following model is obtained by



replacing the various parts of the system according to figure 6-4 in its correct location and assembling the parts created in the part module.

Figure .4-6 final assembled model

Step module 6-4

This section selects the steps to solve the problem. the type of analysis is specified.(For the type of analysis,the General Static solution method is selected and the duration of the analysis for it is defined as 15 seconds with a time step of 0.25 seconds. The required outputs can also be specified in this section. The required output data includes changing the locations of the arrows as well as plastic strains and reactive forces at points

It's about the support of the two ends at the bottom of the column and the chronological chart of the total depleted energy in the structure.

Interaction module 7-4

In this environment, the physical property of contact between surfaces is determined. To do this, by Merge the components in the Assembly module, the interaction between all the components is introduced in a fully enclosed manner. So there's no need to change this module.

Load module 8-4

At this point, the loading and Border conditions are determined. For this purpose, the lower ends of the columns are closed and considered to be clamped. The freedom of the Upper Arrow in the z direction is also closed. In the Upper Arrow, The Load is applied according to the load spectrum in the test within 15 seconds. It should be noted that in static analysis, time has no meaning. Rather, the semester of time is entered into the model figuratively and unrealistically. So a 15-second analysis with a time step of 0.1seconds is equivalent to 150 (0.1/15) static analysis, where all the required parameters are calculated in each analysis

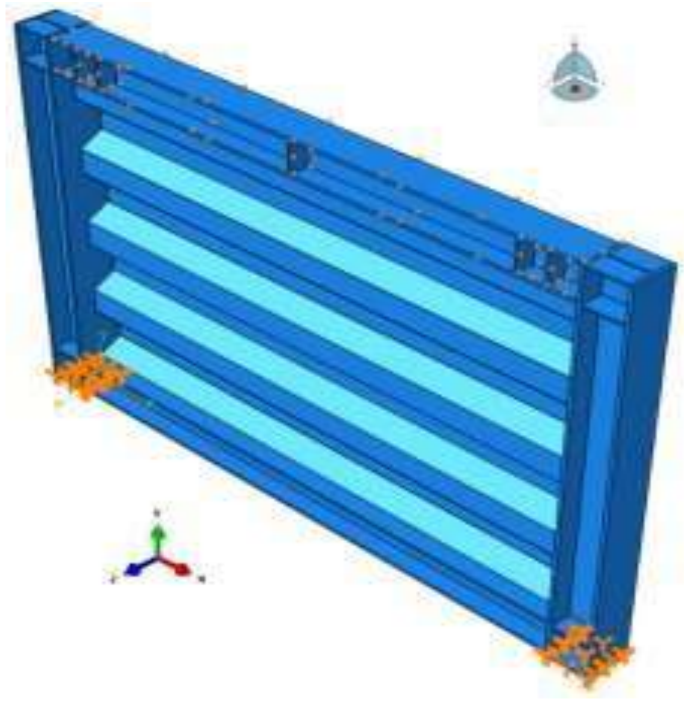


Figure .7-4 applying border conditions to the end of the columns

Form .7-4 the works of the said farm, you Stone a It is important to note that by applying increasing load, parts of the system will reach the plastic area. When the steel of the beam and column reaches its final capacity or breaks in the steel panel sheets, the analysis is completed and at this point the end of the breakdown, the maximum load that caused the breakdown is determined. It should be noted that the structural behavior chart including the load-change graph is obtained by drawing the reaction graph of the lower end of the column against the change of place created at the end of the Upper Arrow. As mentioned the load is introduced as hysteresis to the Upper Arrow similar to the figure below.

The numbers for the load spectrum are also presented in the table below, which can be used for future studies in
The Amplitude part of the abacus, which is accessible from the tree diagram, copied it.

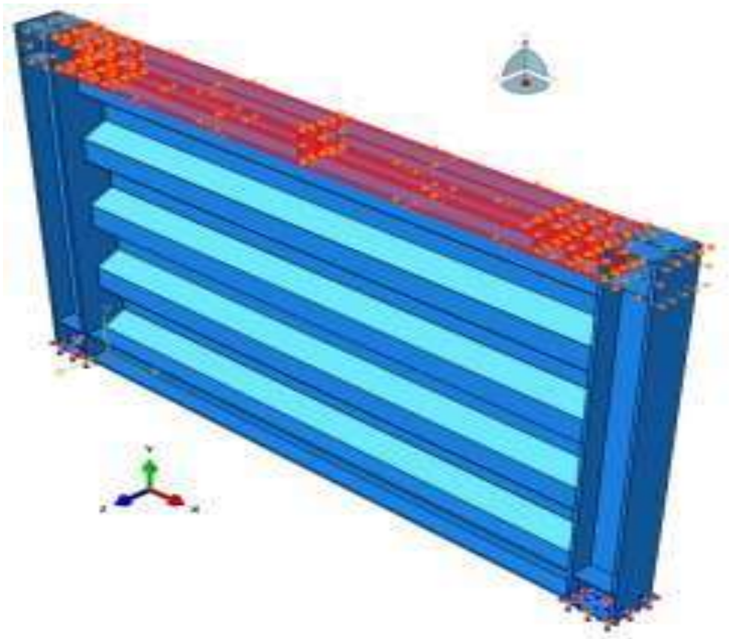


Figure .8-4 selecting the upper hand to apply the burden of going back and forth

Mesh module 4-9

In this module, the Germanization of the parts is done. To achieve the number of optimal meshes used in each of the model segments and reduce the percentage of errors caused by large meshing and avoid spending a lot of time analyzing the result of very small meshing, meshing convergence analysis has been carried out. For this purpose, 10 different values are considered for the number of meshes, as well as the effect of the German type on the structural response including the maximum stress created at the end of the column. The approximate dimensions and number of elements in four different types are seen in the table below.

Conclusion :
According to the analysis carried out in the field of seismic response of corrugated steel cross-sectional walls under land load-earthquakes in the far and near fault zone, the following specialized results can be presented:

1. Seismic performance of corrugated steel shear walls:
Corrugated steel shear walls, due to their formability and high energy dissipation capacity, exhibit optimal seismic performance against earthquakes in the far and near fault zone.
The geometry of waves has a significant impact on the seismic behavior of these walls. Proper waves can increase the resistance and formability of the wall.
Connections between steel sheet and Border members play an important role in the transmission of forces and the distribution of tensions. Proper fittings can prevent premature wall failure.

2. The impact of earthquakes in the near fault zone:
Earthquakes in the near fault zone, due to the presence of high-speed pulses and permanent shifting, can cause more damage to corrugated steel shear walls.
The seismic response of these walls under near fault zone earthquakes differs significantly from their response under far fault zone earthquakes.
In the design of corrugated steel shear walls for areas near the fault, the effects of velocity pulses and permanent shifting should be considered.

3. Methods of analysis:
Nonlinear dynamic analysis is the most accurate way to investigate the seismic response of corrugated steel shear walls under the loading of earthquakes in the far and near fault zone.
Abacus software is a powerful tool for conducting complex analyses in this field.
Choosing the right solution method (implied or explicit), depends on the type of problem and the loading conditions.

4. Suggestions:
More research is being done on the seismic improvement of corrugated steel shear walls for areas near the fault.
The effects of different parameters (wave geometry, material characteristics, type of connections) on the seismic response of these walls should be examined in more detail.
The results of numerical analyses are compared with the results of practical experiments.
In short, corrugated steel shear walls are efficient lateral resistant systems

that can perform favorably against earthquakes in the distant and near fault zone. However, the design of these walls for areas near the fault requires special attention to the effects of velocity pulses and permanent repositioning.

Reference

1. Razavi, M., & Bhowmick, A. (2024). Seismic Response of Self-Centering Steel Plate Shear Walls. In Proceedings of the Canadian Society for Civil Engineering Annual Conference 2023 (pp. 365–379). Springer.
2. Yang Lv. Steel Plate Shear Walls with Gravity Load: Theory and Design. Springer, 2022. ISBN: 1-8693-16-981-978.
3. Chen, X., & Wang, H. (2021). Effects of Near-Fault Earthquakes on the Seismic Performance of Steel Structures with Mass Irregularities. Civil Engineering Research Journal, 10(2), 555813.
4. Masoud Hoseinzadeh Asl. "Experimental Program on Steel Plate Shear Wall with Tension Field Guiding Stiffeners under Cyclic Loading." University of Tabriz, 2023-2022.
5. Li, Y., & Wang, Z. (2021). Equivalent loading protocols for steel plate shear wall considering near-fault seismic effects. Journal of Constructional Steel Research, 187, 107685.
6. Zabihi et al. "Numerical and Experimental Investigation of Steel Frames Equipped with Steel Plate Shear Walls with Diamond Openings." Civil Engineering Infrastructures Journal, 2025.
7. Laissy. "Investigation of Shear Walls Openings on the Performance of Seismic Structures." SCIREA Journal of Civil Engineering, 2023.
8. Zhou, Y., & Li, G. (2022). Damage assessment of stiffened steel plate shear walls with different configurations. Journal of Constructional Steel Research, 189, 107685.
9. Akbar, M. et al. "Seismic Analysis of Lateral Force Resisting Steel Frame with Honeycombed Steel Thin Plate Shear Wall." Journal of Vibroengineering, 2021.
10. Masoumi Verki, A., & Ghaffarzadeh, H. (2022). Seismic performance of moment resisting steel frames retrofitted with coupled steel plate shear walls with different link beams. Journal of Constructional Steel Research, 189, 107685.
11. Bai, J. et al. "Loading Protocols for Seismic Qualification of Steel Plate Shear Walls." Engineering Structures, 2022.
12.Zhang, Y., & Li, X. (2021). Study on seismic behaviors of self-centering steel plate shear walls. Journal of Constructional Steel Research, 181, 106574.
13. Chen, X., & Zhang, H. (2021). Seismic responses and damage assessment of a mid-rise cold-formed steel building under near-fault and far-fault ground motions. Engineering Structures, 234, 111977.
14. Singhai, K. et al. "Material Evaluation for Shear Walls in (G+17)

Residential Buildings Across Indian Seismic Zones using ETABS 2021." National Academy Science Letters, 2025.
15. Behnamfar, F., Almohammad-albakkar, M. "Seismic Behavior and Design of Steel Shear Walls." International Journal of Engineering, 2022.
16. Li, Y., & Wang, H. (2021). Seismic performance assessment of steel frame structures with steel plate shear walls under near-fault ground motions. Journal of Constructional Steel Research, 180, 106566.
17. Hoseinzadeh Asl, M. "Experimental Program on Steel Plate Shear Wall with Tension Field Guiding Stiffeners under Cyclic Loading." University of Tabriz, 2023-2022.
18. Zhou, Y., & Li, G. (2022). Damage assessment of stiffened steel plate shear walls with different configurations. Journal of Constructional Steel Research, 189, 107685.
19. Wang, L., & Zhang, Y. (2021). Loading protocols for seismic qualification of steel plate shear walls. Structures, 31, 1045–1055.
20. Zabihi, M. et al. "Numerical and Experimental Investigation of Steel Frames Equipped with Steel Plate Shear Walls with Diamond Openings." Civil Engineering Infrastructures Journal, 2025.
21. Laissy. "Investigation of Shear Walls Openings on the Performance of Seismic Structures." SCIREA Journal of Civil Engineering, 2023.
22. Li, Y., & Wang, Z. (2021). Equivalent loading protocols for steel plate shear wall considering near-fault seismic effects. Journal of Constructional Steel Research, 187, 107685.
23.American Institute of Steel Construction (AISC). Seismic Design Manual, 4th Edition. AISC, 2022. ISBN: 7-104-56424-1-978.
24. Tahaii, S. M., Hamidi, H., & Vaseghi Amiri, J. (2022). Inelastic Seismic Demand of Steel-Plate Shear Wall Structures: Emphasis on the PTD Effect. International Journal of Civil Engineering, 20, 1145–1163.
25.Akbar, M. et al. "Seismic Analysis of Lateral Force Resisting Steel Frame with Honeycombed Steel Thin Plate Shear Wall." Journal of Vibroengineering, .2021
26.Masoumi Verki, A., & Ghaffarzadeh, H. (2022). Seismic performance of moment resisting steel frames retrofitted with coupled steel plate shear walls with different link beams. Journal of Constructional Steel Research, 189, .107685
27.Mazzolani, F., Dubina, D., Stratan, A. (Eds.). Proceedings of the 10th International Conference on Behaviour of Steel Structures in Seismic Areas (STESSA 2022). Springer, 2022. ISBN: 5-03810-031-3-978.
28.Zhang, Y., & Li, X. (2021). Study on seismic behaviors of self-centering steel plate shear walls. Journal of Constructional Steel Research, 181,

106574.
29.Li, Y., & Wang, H. (2021). Seismic performance assessment of steel frame structures with steel plate shear walls under near-fault ground motions. Journal of Constructional Steel Research, 180, 106566.
30. Yang Lv. Steel Plate Shear Walls with Gravity Load: Theory and Design. Springer, 2022. ISBN: 1-8693-16-981-978.
31. Chen, X., & Zhang, H. (2021). Seismic responses and damage assessment of a mid-rise cold-formed steel building under near-fault and far-fault ground motions. Engineering Structures, 234, 111977.
32. Paul Guyer. An Introduction to Seismic Building Shear Walls. Guyer Partners, 2018. ISBN: 3-547-64057-1-978.
33. Liu, J., & Wang, Z. (2021). Nonlinear seismic analysis of perforated steel plate shear walls using finite element method. Engineering Structures, 234, 111980.
34. Trans Tech Publications Ltd. Earthquake Engineering. Scientific.Net, 2023. ISBN: 5-1349-0364-3-978.
35. Jiulin Bai et al. "Loading Protocols for Seismic Qualification of Steel Plate Shear Walls." Engineering Structures, 2022.
36. Zhou, Y., & Li, G. (2022). Damage assessment of stiffened steel plate shear walls with different configurations. Journal of Constructional Steel Research, 189, 107685.
37. Kamal Singhai et al. "Material Evaluation for Shear Walls in (G+17) Residential Buildings Across Indian Seismic Zones using ETABS 2021." National Academy Science Letters, 2025.
38. Wang, L., & Zhang, Y. (2021). Loading protocols for seismic qualification of steel plate shear walls. Structures, 31, 1045–1055.
39. F. Behnamfar, M. Almohammad-albakkar. "Seismic Behavior and Design of Steel Shear Walls." International Journal of Engineering, 2022.
40. Zhang, H., & Li, Y. (2021). Seismic fragility assessment of steel frame structures equipped with steel slit shear walls. Engineering Structures, 234, 111979.