ABSTRACT

Reliability of Structural Model of High Rise Building with Bracing Pattern to Lateral Force (earthquake)

Presence of high rise building in big city is resulted from land narrowness, highly dense population and expensive price of city land. To built high rise building is not only arranging space vertically, but the problem faced in designing high rise building is when to decide model of structure used to support and to distribute all of loads to the foundation. One factor that decides the choice of structural model of high rise building is reliability of structural model to lateral force caused by earthquake. It causes the higher building the bigger lateral force received because of earthquake and wind.

In designing building, more floors or higher building, force deviation is bigger caused by lateral force or earthquake. So that when designing high rise building, it needs to choose structural model that is suitable to lateral force that can minimize deviation, in order the building cannot be broken easily.

One of structural models of high rise building is frame structure with bracing pattern used steel material. Choice of bracing pattern model will decide reliability of building structural system, because arrangement of bracing pattern will become integrated structural system and will work to distribute force together based on pattern characteristic.

Problem in this research are: 1) how does the description of deviation in each structural model of high rise building with bracing pattern because of lateral force? 2) Which structural model in high rise building is more valid to lateral force? This research has purpose to know about description of deviation occurred, level of reliability model and characteristic of deviation pattern occurred in structural model in high rise building with bracing pattern. This research is done by experimental method to get description about reliability of structural model in high rise building with bracing pattern to lateral force (earthquake). The research approach is done by structural model in high rise building test with bracing pattern. While, technique of collecting data is done by model preparation and model testing. Technique of data analysis are a way to interpret result of testing model based on theoretical plan determined.

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Reliability of Structural Model of High Rise Building with Bracing Pattern to Lateral Force (earthquake)

A. INTRODUCTION

1. Background

Presence of high rise building in big city is resulted from land narrowness, highly dense population and expensive price of city land. To built high rise building is not only arranging space vertically, but the problem faced in designing high rise building is when deciding model of structure used to support and distribute all of loads to the foundation. One factor that decides the choice of structural model of high rise building is reliability of structural model to lateral force caused by earthquake. It causes the higher building the bigger lateral force received because of earthquake and wind.

Many buildings destroyed because of earthquake and caused many victims. In December 29th 2004, earthquake 9 scale Richter plus tsunami wave shaked up Aceh, about 180.000 people died, next on May 27th 2006, in Yogyakarta occurred earthquake with 5,8 SR that caused thousands victims. Destruction and victims when earthquake occurred were not only caused by seismic wave but also destroyed of buildings, because it could not hold back lateral force.

In building design, the more floors or the higher building are, the bigger deviation force occurs because of lateral force, which is caused by earthquake. Therefore, designing high rise building needs to choose structural model that is reliable to lateral force, which can minimize deviation, in order the building isn't broken easily and cause victims. Based on guidance of anti earthquake building, which has the following purposes:

1) In low intensity earthquake, (lower than MMI 8.0) which occurred sometimes in period of reliability, it mustn't burst and destruct structurally

2) In high intensity earthquake, (more than MMI 8.0), it mustn't get destroyed which makes victims. The aim can be achieved if in designing or determining structural model, we look after ductility, stability and elasticity in building structure.

One of structural model in high rise building is frame structure of bracing pattern with steel material. Determining model of bracing pattern will determine reliability of building structural system too.

According to the background, the researchers need to tell reliability of high rise building structure with bracing pattern to influence of lateral force, to map reliability structural model of high rise building and become part of development and engineer building technology.

2. Problem formulating

Problem formulating in this research is: how does comparison reliability of high rise building structure with bracing pattern to lateral force caused by earthquake? The research's questions in detail are:

1. How does the description of deviation level in each structural model of high rise building with bracing pattern caused by lateral force?
2. Which structural model in high rise building is more valid to lateral force?

3. Purpose of research

The main purpose of research is knowing level of deviation and producing structural model with bracing pattern that are more useful to lateral force. Especially, the purposes are:

1. knowing about description of deviation occurred,
2. knowing which building structural model with bracing pattern is more reliable.
3. knowing characteristic of pattern deviation in each structural model of high rise building with bracing pattern

4. Usage of research

1. Giving contribution and recommendation to decision maker in development of high rise building which is reliable to lateral force caused by earthquake.
2. Giving contribution in development theory and design in high rise building
3. Understanding to structural model in high rise building and influence to lateral force (earthquake). Architecturally, it can give contribution to development design of building structure which comes from experiment or model structure reliability and completing result of research before.
4. As a work is to open a way to the next research in relevance science about test of structural model of high rise building with bracing pattern, especially in architecture study of building structure and construction, as a method of building structure designing.

B. THEORY REVIEW

1. understanding building structure in supporting architecture concept

Building structure means something that distributes load into the ground, which is supporting architecture concept. A structure is called strong structure if it has strength from every direction, while strength means it can anticipate loads, so deformation occurred is minimized. While structure and function generally are protecting necessary of activity space and supporting or defending and distributing of loads. Loads of building themselves consists of:

- dead load
- live load
- meteorological load
- construction loads
- loads caused by imperfect work

Otherwise, in order function and structure can be done perfectly, condition that must be filled are: equilibrium, stable, countable mechanically, countable

mathematically, aesthetic, economical. Nowadays there are some structural system, these are:

1. frame structural system
2. advance structural system
3. unfilled skeleton frame structural system

2. Loads working in building

Loads works in structure caused directly by human's force. In the other word, there are two kinds of loads; they are geophysics and human made. While, definition of loads is something that is received by media in force form. Characteristics of loads are: stem get axial loads, get deformation (lengthen or shorten) and stem of pull force. Loads consist of some kinds. They are:

a. dead load
b. live load
c. meteorological load
d. wind load

there are two characteristics of wind rate: average wind rate/ same with gust velocity periodic, having graphic in flat, discontinue graphic. It has periodic characteristic (at exact periodic jerks). In this case gust velocity causes big swing. The effects of wind velocity in building are:

a. rate wind doesn't cause big deviation, but it is continuous
b. gust velocity brings big deviation. If it occurs periodically, deviation will be bigger. This must be avoided, because it can destroy structural system
c. deviation caused by gust velocity
d. deviation caused by building structure response

Wind load in high rise building

Building façade has to hold up loads, sipping out building and pressing in building. The configuration of 2 building masses forming narrow space will cause high wind speed and vibration to building

Earthquake loads/ seismologist

If earthquake load is observed by earthquake design, the strategy which must be looked is how the best building design in earthquake potential area does. There are some kinds of earthquake, surface destruction, land shaking, and tsunami (sea wave because of earthquake). Land movement (mold and reduction) of earthquake wave are two, those are: wave earthquake T wave (hanging vertically) and S wave (hanging horizontally). This is determined by: 1)land structure, 2) center of earthquake, 3) kind of building, 4) mass of building (dimension, height, shape), 5) structure and ductility, 6) extension and supporting of building, 7) intensity or strength.

Earthquake consist of 2, they are:

1) volcanic earthquake, it is caused by shaking on surface
2) tectonic earthquake, it is caused by movement of earth's flat, that is caused by fraction/crack in earth crust that makes high vibration under surface and continuous wave based on the land

Spreading of earthquake wave I in hard soil is faster than spreading in soft soil, it is because soft soil has characteristic as shock breaker. High rise building has characteristic like cantilever structure element caused by lateral load action. Lateral load tend to produce roll moment that must be compared with internally resistance moment which is produced by structure. To avoid earthquake influence, that can destroy building, decision shape of building's mass influence in anticipate earthquake strength, this is decision shape of building's mass that can be followed or avoided.

1. this shape is weak in defending deformation of shortest unfold, but strong to defend longer unfold.
2. shape above, if they are joined, will destroy each other, especially in mass extension.
3. reduction or addition of mass extension will be dangerous for building when earthquake comes.
4. difference of addition building ductility with old building will destroy each other.
5. building mass with design above is bigger, giving bigger load.
6. side back shape in tower causes difference ductility because difference center point of building mass.

In high earthquake scale, the building might destroy but the primer structure might not destroy causing victims. In low earthquake scale, building might not destroy and neither the structure, for example: broken wall or destroyed Plafond. Guidance level in earthquake area.

1. SC (strong column)-WB(weak beam)and SV-WH, vertical structure/column must be stronger to defend earthquake load compared with horizontal structure (beam).
2. discontinuity beam or column
3. avoiding pendulum effect that is caused by:
   - building above has bigger mass, so it causes big swing when earthquake comes
   - making part of building with mass/ dead load/ weighter live load, stay close with the ground
   - building with different ductility
4. eccentricity that caused by central forces working caused mass's center point that is not nearby each other
5. grid shape, if it is different, it causes different ductility and force's distribution, so it easy to get swing

3. Forces work in building

force is energy that is distributed through media and it has value and direction, so choice of frame structure material determines in anticipating force caused by loads distributed. Characteristic of forces are:

- force gets equilibrium
- force is distributed through media and it has value and direction

kinds of force are two, those are:

1. normally force, that is contrary direction force and has same value, located at the same line and toward to exact point (press force) and contrary direction force and has same value, located at the same line and avoid to exact point (pull force)
2. Abnormal force, that is force which is not located at the same line but the direction can be same. Abnormal force can be torsion force, that is contrary direction force and has same value, avoid to exactly point, and it is not located at the same line or roll force

Equilibrium
Equilibrium is things staying in balancing, if force system works not to cause translation or rotation. The equilibrium will exist and concurrent force working at the point or particle if resultant equal with zero. A concurrent force system which has resultant force can be balanced by giving a same force (balancing) and contrary direction with resultant.

4. **Designing philosophy in building structure**
This case interlocked with safety of structure to loads held up. In high rise building, if columns in lower structure destroy (lower vertical structure), all part of building will destruct. Because column is the primary supporting beam. Because of that, column must strong to resist force, while beam may destroy first.

- Strong column-beam weak
- Vertical strong-horizontal weak

5**. Building structural system**
Definition of building structural system can be separated as; a system is an arrangement among various elements forming a united, while structure is how loads are distributed into the ground to support architectural concept.
A structure is called strong if it has strength from every direction, while strength means it can anticipate loads, so deformation occurred is minimize. While structure and function generally are protecting necessary of activity space and supporting or defending and distributing of loads. Based on its material, building structure consist of two, these are:

- Structure use concrete material (concrete)
- Structure use steel material

While, based on its system, building structure consists of two, these are:

- Force concentration system
- Force spreading system
- Force coordination system

a. Frame structural system in upper structure

Based on guidance of structure theory, primary structural system consists of two, they are:

1) Force concentration system
   a) Frame
   b) Unsteady or steady skeleton frame

2) Force spreading system, that is plane structure
When forming structural system in multi-storied building there are three important parts in structural system, these are: building surface, inner part, and extension part or formulated as: 1) external/perimeter structure,2) internal structure, 3) Horizontal structure connecting in and out.
Forming structural system has to choose minimum 2 structural systems above. Arranging combination of structure characteristic to every part (by using frame or plane system) has to follow arrangement guidance.

Arrangement guidance

1. Arranging structure concept that has same characteristic of force distribution
2. Using different structure, but use medium system
3. Loosing one of component structural system to avoid conflict
4. Loosing weakness or weaken one of vertical component. Working of high rise building structure can be tested to:
   - Earthquake and wind load
   - Weight it self or normal force

b. Reliability high rise building structure to roll moment
c. Reliability high rise building structure to torsion moment
d. Reliability high rise building structure to deformation
e. Reliability high rise building structure to friction force
f. Reliability high rise building structure to normal force

6. Earthquake and the influence to building structure

Earthquake is a movement of earth's flat and causes dislocation earthquake (sesar). Earthquake on earth consist of two, those are:

- Ground tremor by seismic wave
- Earth movement by crack, slide off, decreasing land surface, etc
- Melting of some part of earth, so it loses the stability

If there are buildings on the earth surface, the building can be destructed by earth tremble. The effects are building destruction, dam destruction, broken of water and gas pipe (it causes secondary destruction, there are floods and fire). Ground trembling by earthquake can be grouped to:

- Ground tremble is single tremble occurred in hard land, where the epicenter and depth of earthquake center is small. Ground tremble has same direction, frequency is less than 0,2 second and amplitude is small only few centimeter
- Medium ground tremble about 20-30 second and irregular direction. Ground tremble has outspread frequency, among 0,05-6 second with big amplitude (about 20 cm), this tremble is the most general
- Low ground tremble about 5 minutes with the same direction, occurred in soft soil. Amplitude is rather big (about 30 cm)

The velocity of earth movement influences the building, because maximal value can reach pull force. Generally, building is constructed to vertical force only, while horizontal acceleration by earthquake is very dangerous for building

stability, it is connected resonance between building tremble and ground tremble, so frequency is among 0,1-6 second the most dangerous. Generally, small frequency is influence stiff building, while high frequency influences flexible building and ductility in building material influences building's stability.
Purpose to build anti earthquake building:
1) in low intensity earthquake, (lower than MMI 8.0) which occurred sometimes in period of reliability, it mustn't burst and destruct structurally
2) In high intensity earthquake, (more than MMI 8.0), it mustn't get destroyed which makes victims.

C. METHODOLOGY

1. Research Approach

Method use in this research is experimental method, it agrees with aim of research, which is getting description about reliability of high rise building model with bracing pattern to lateral force/earthquake. Approach of this research is done by structural model of high rise building with bracing pattern test.

a. Sample of research

As an experimental research, sample of this research is structural model of high rise building with bracing pattern made by 3D. Amount of sample that will be modeled are three, they have different bracing patterns, this means to description reliability comparison of structure in high rise building with bracing pattern.

b. Technique of data collection

- Preparation
  In this phase, we decide three form of structural model in high rise building with different bracing pattern. After finish to determine bracing pattern, it is continued with deciding materials and properties used in making model process
- Model making
  Model is presented in 3D version with three form of different bracing pattern, in order models can descript the real mass, model is made with same scale, those are model size, length wide, height, and structure material and construction connection system between elements. It is the real system that can represent condition of high rise building structure with bracing pattern.
- Determination of test system
  Before examination is done, for the first step we have to design testing scheme. It means as guidance in doing the real testing so, we can avoid failure when testing process.
- Testing Model
  Phase of testing model is done after model making process finished. Phase of testing model through preparation properties of lateral force (secher, amplifier, seismograph, and software computer program), producing model of deviation pattern from three of high rise building structure with bracing pattern. Model testing is done alternately. During the test, model is located above point of support which loading in building structure mass. Model testing is begun by giving tremble horizontally in the bottom/point of support model, in order model gets lateral force, so model is got bracing pattern result in each models.

c. Technique of data analysis

- Grouping test result into three structural models which are got through properties of deviation test because of lateral force influence. All of data result are selected and discussed internally or externally, this case aims to get same interpretation based on criteria of attitude and structural system because of lateral force influence.
- The next phase is trying to interpret and compare result of model test based on theory and theoretical scheme that has been decided. It consists rules of structural ductility looked from value of deviation in each bracing structural model. Interpretation is done by reading result of model test deviation record based on characteristic of structural system and bracing pattern.

D. RESULT AND DISCUSSION

1. Research result

a. Model design making (sample)

First step in sample making is arranging design three of structural models with different bracing pattern. Determining design of structural model is based on characteristic approximation of high rise building with prefabrication structural system. Materials of model have to represent the real object because materials of model structure are made by materials which have same elasticity characteristic with steel, which is aluminum bar.

The purpose of this research is producing comparison of deviation characteristic from bars component with bracing pattern structure, so model design is determined from different bracing pattern model each other. Model 1 is made by bracing pattern shaped upside down triangle pyramid/like V. model 2 is made by portal system, column, and beam, this model is made without bracing, it means testing result of this models can become rules of comparison among model using bracing pattern and model without using bracing pattern. Model 3 is made by bracing pattern shaped triangle pyramid/ like A.

These are design of structural model of high rise building with bracing pattern that is presented in 3D, this model will become sample in doing research with experimental approximation as working to test reliability structural model to lateral force (earthquake).

Picture three of structural model with bracing pattern

Model 1	Model 2	Model 3
Material: aluminum profile 6 mmx6 mm Connection tools: aluminum plat with bolt diameter 1,5 mm Model height: 14 floors Structural model: beam	Material: aluminum profile 6 mmx6 mm Connection tools: aluminum plat with bolt diameter 1,5 mm Model height: 14 floors Structural model: beam	Material: aluminum profile 6 mmx6 mm Connection tools: aluminum plat with bolt diameter 1,5 mm Model height: 14 floors Structural model: beam

and column with bracing pattern shaped upside down triangle pyramid/like V	and column with portal system, this model is made without bracing	and column with bracing pattern shaped triangle pyramid/ like A

b. Sample making

First step of sample making process was preparing material according to design determined before, that was aluminum profile and tools that will use in model making process. Next, after material and tools prepared, it would continue with cutting aluminum profile bars according to size needed. After cutting process was finished, bars were connected one by one with strengthening system bolt joining construction with diameter 1,5 mm, till formed 3 models structural system hoped.

c. Testing method

Before doing testing method, design diagram formation of testing method was one. This meant to give rules in accomplishment when testing processed. This methods is description testing system of formation testing tools hardware, software and structural model with bracing patter. Before the real testing was done, system was tested to know if system formed working well through diagram of testing system designed.

Hardware that was used in testing models were: shaker which had function to give dynamic load (tremble) into model, force transducer has function to detect frequency got by model, amplifier with force transducer is detecting frequency got by model, amplifier has function arrange vibration in shaker, signal generator has function to connect model with amplifier, accelerator has function to connect vibration wave to measuring amplifier 2 to detect deviation occurred in model, signal analyzer has function to write vibration frequency and deviation in model, LVDT has function as variant from accelerator to detect deviation in model. While software used to record vibration result is computer with MATLAP program and structural model which will be tested. This is design of testing system diagram with bracing pattern as rules in testing structure reliability of high rise building with bracing pattern.

d. Process of testing model 1,2 and 3

Testing structural model of high rise building with bracing pattern is done step by step with some method. Testing is done through process of preparation loads in model, laying down of model in hard iron flat and construction testing tools connected to structural model. In testing model, all system of testing tools were connected according to scheme prepared, each tools has function

- shaker has function to give dynamic load (tremble) into model,
- force transducer has function to detect frequency got by model,
- amplifier has function arrange vibration in shaker,
- signal generator has function to connect model with amplifier,
- accelerator has function to connect vibration wave to measuring amplifier 2 to detect deviation occurred in model,
- signal analyzer has function to write vibration frequency and deviation in model,

- LVDT has function as variant from accelerator to detect deviation in model

4.1 Discussion result of research

The discussion is an interpretation from result of research. Researchers try to interpret product of acceleration wave frequency record to become comparison of structural model strength and value of deviation, occurred in wave frequency record, it is marked by wave frequency pattern according to time from 0 till 30 seconds and change of pressure produced by shaker with strength unit kg/s. From result research of testing model, it will be discussed result from model 1,2,3.

a. Result of testing model 1

No.	Deviation pattern produced by accelerator	Discussion
1		Result of recording pattern accelerator frequency represents frequency between value of vibration and time produces value of deviation structural model. Testing pattern of model is same each other. Testing model is given to two jerks, first jerk tests value of beginning deviation if model still able to get second jerk after first jerk that is second jerk as critical jerk of reliability structural model to lateral force. Pattern of picture from accelerator record located above model 1 shows two times deviation jerk, first jerk about 2, 5 meter and second jerk which is critical jerk about 1, 3 meter.
	Accelerator position above model	
		Result of recording pattern accelerator frequency represents frequency between value of vibration and time and produces value of deviation structural model. Testing pattern of model is same each other. Testing model is given two jerks, first jerk tests value of beginning deviation, is model still able to get second jerk after first jerk that is second jerk as critical jerk of reliability structural model to lateral force. Pattern of picture from accelerator record which is located in the middle of model 1 shows once deviation jerk, about 1,5 meter
	Accelerator position in the middle of model	
		Result of recording pattern accelerator

		frequency represents frequency between value of vibration and time and produces value of deviation structural model. Testing pattern of model is same with each other. Testing model is given two jerks, first jerk tests value of beginning deviation, if model is still able to get second jerk after first jerk that is second jerk as critical jerk of reliability structural model to lateral force. Pattern of picture from accelerator record which is located above model 1 shows two times deviation jerk, first jerk about 2, 5 meter and second jerk which is critical jerk about 1, 3 meter.
	Accelerator position below model	

b. Result of testing model 2

No.	Deviation pattern produced by accelerator	Discussion
1		Result of recording pattern accelerator frequency represents frequency between value of vibration and time and produces value of deviation structural model. Testing pattern of model is same with each other. Testing model is given two jerks, first jerk tests value of beginning deviation, if model is still able to get second jerk after first jerk that is second jerk as critical jerk of reliability structural model to lateral force. Pattern of picture from accelerator record which is located above model 2 shows two times deviation jerk, first jerk about 2, 7 meter and second jerk which is critical jerk about 1, 5 meter.
	Accelerator position above model	
		Result of recording pattern accelerator frequency represents frequency between value of vibration and time and produces value of deviation structural model. Testing pattern of model is same each other. Testing model is given two jerks, first jerk tests value of beginning deviation, is model still able to get second jerk after first jerk

		that is second jerk as critic jerk of reliability structural model to lateral force. Pattern of picture from accelerator record which is located in the middle of model 2 shows once deviation jerk, about 3 meter.
	Accelerator position in the middle of model	
		Result of recording pattern accelerator frequency represents frequency between value of vibration and time and produces value of deviation structural model. Testing pattern of model is same with each other. Testing model is given two jerks, first jerk tests value of beginning deviation if model is still able to get second jerk after first jerk that is second jerk as critical jerk of reliability structural model to lateral force. Pattern of picture from accelerator record which is located above model 2 shows two times deviation jerk, first jerk about 1,75 meter and second jerk is critical jerk about 1,5 meter.
	Accelerator position below model	

c. Result of testing model 3

No.	Deviation pattern produced by accelerator	Discussion
1		Result of recording pattern accelerator frequency represents frequency between value of vibration and time and produces value of deviation structural model. Testing pattern of model is same with each other. Testing model is given two jerks, first jerk tests value of beginning deviation, if model is still able to get second jerk after first jerk that is second jerk as critical jerk of reliability structural model to lateral force. Pattern of picture from accelerator record which is located above model 3 shows two times deviation jerk, first jerk about 4 meter and second jerk which is critical jerk about 1, 5 meter.
	Accelerator position above model	
		Result of recording pattern accelerator

		frequency represents frequency between value of vibration and time and produces value of deviation structural model. Testing pattern of model is same each other. Testing model is given two jerks, first jerk tests value of beginning deviation, if model is still able to get second jerk after first jerk that is second jerk as critical jerk of reliability structural model to lateral force. Pattern of picture from accelerator record which is located in the middle of model 3 shows once deviation jerk, about 2,8 meter
	Accelerator position in the middle of model	
		Result of recording pattern accelerator frequency represents frequency between value of vibration and time and produces value of deviation structural model. Testing pattern of model is same with each other. Testing model is given two jerks, first jerk tests value of beginning deviation, if model is still able to get second jerk after first jerk that is second jerk as critical jerk of reliability structural model to lateral force. Pattern of picture from accelerator record which is located above model 3 shows two times deviation jerk, first jerk about 1,5 meter and second jerk which is critical jerk about 1,6 meter.
	Accelerator position below model	

From analysis above, we can explain:

1. when accelerator located above model, model gets two times maximum deviation wave occurred between 0 till 30 second. From three models above, each model has different characteristic of deviation. According to comparison of deviation value, model 1 gets smaller deviation than model 2 and model 3.
2. when accelerator located in the middle of model, model gets once maximum deviation wave occurred between 0 till 30 second. From three models above, each model has different characteristic of deviation. According to comparison of deviation value, model 1 gets smaller deviation than model 2 and model 3.
3. when accelerator located below model, model gets two times maximum deviation wave occurred between 0 till 30 second. From three models

above, each model has different characteristic of deviation. According to the comparison of deviation value, model 1 gets smaller deviation than model 2 and model 3.

Although every models gets ductility to resist lateral force, generally we can say that model 1 compared with model 2 and model 3 has good ductility to resist lateral force because being based on points located of recording accelerator wave which is located above model, in the middle of model, and below model, the result shows smaller deviation, so we can conclude that model 1 with upside down pyramid bracing pattern is or like V is more reliable to resist lateral force.

E. CONCLUSION

From research of discussion of model reliability to high rise building with bracing pattern to lateral force which has been done, we can conclude:

1. every model has different characteristic of bracing pattern and so does the deviation. On model 1, critical jerk about 1,2 meter, On model 2 about 1,5 meter, On model 3 about 1,7 meter.
2. from three of models tested explains that every model has advantage point to lateral force, generally structural model getting smallest deviation is model 1 with upside down pyramid bracing pattern is or like V is more reliable to resist lateral force.
3. from three of different models tested the characteristics in every deviation are:

- when accelerator located above model, model gets two times maximum deviation wave occurred between 0 till 30 second. From three models above, each model has different characteristic of deviation. According to comparison of deviation value, model 1 gets smaller deviation than model 2 and model 3.
- when accelerator located in the middle of model, model gets once maximum deviation wave occurred between 0 till 30 second. From three models above, each model has different characteristic of deviation. According to comparison of deviation value, model 1 gets smaller deviation than model 2 and model 3.
- when accelerator located below model, model gets two times maximum deviation wave occurred between 0 till 30 second. From three models above, each model has different characteristic of deviation. According to comparison of deviation value, model 1 gets smaller deviation than model 2 and model 3.

F. RECOMMENDATION

From this research, researchers tell some recommendation which is purposed to learning activity connected with structure and construction design of high rise building, architecture's practitioners.

The recommendations are;

1. every structural design activity is better if it begins with reliability tests especially to the influence of lateral forces or earthquake. Because nothing building place which is safe from earthquake causing destruction and victims
2. using material technology such as steel as construction structure to high rise building like model 1. Structural model with V model is recommended to anticipate big deviation because of lateral forces.
3. every structural model with different pattern has different characteristic and ductility to resist lateral force, therefore structural design is better to know deviation pattern characteristic first.