# A Structural Performance Evaluation of Vertical Housing Model due to the Increased Seismic Loads in Semarang, Indonesia Using A Pushover Analysis

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# Introduction

- Earthquake is an event that often occurs in Indonesia with the intensity and scale that continues to increase. Because of its seismicity, Indonesia has made major changes on the earthquake of Indonesian National Standards: SNI 03-1726-2002 to SNI 1726:2012.

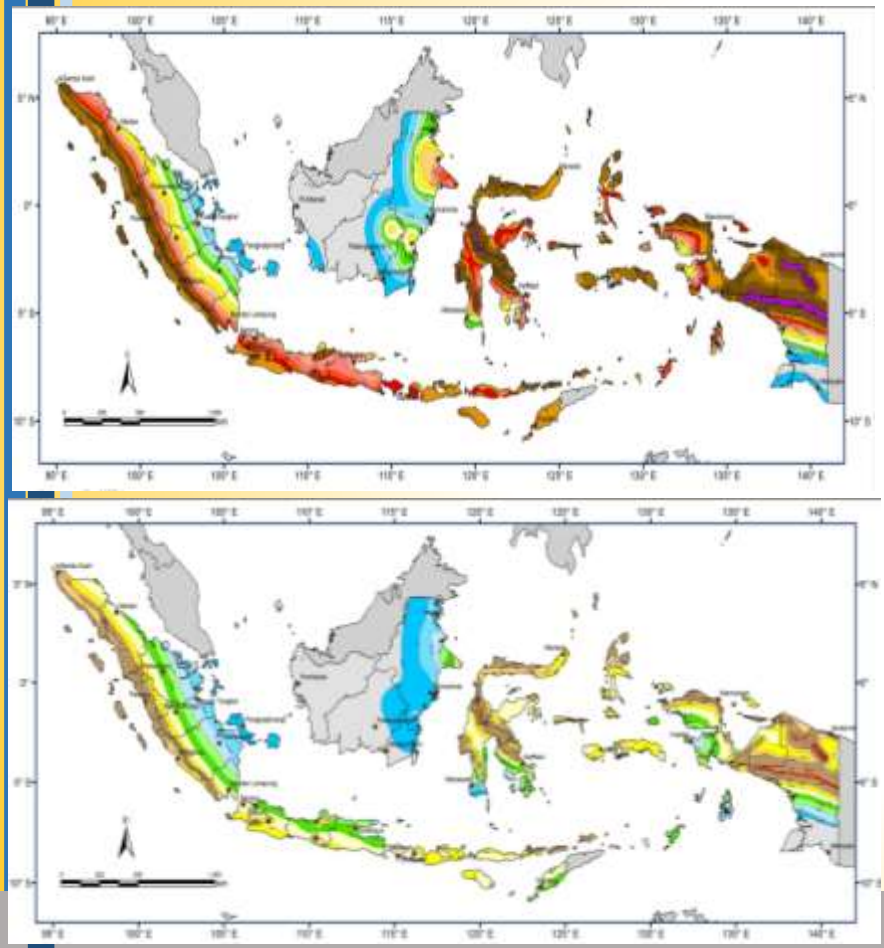

- Taken from : https://www.google.co.id/

- Semarang is the capital city of Central Java, Indonesia, which is one of the densely populated cities. The vertical housing building commonly known as apartement are develop to overcome housing need.


- Taken from : https://www.google.co.id/

# Seismicity of Semarang Region

- Semarang has a site-particular estimation of spectral acceleration response for short period (Ss ) is 1.1g and one-second (S1 ) is 0.2g (SNI 1726:2012)

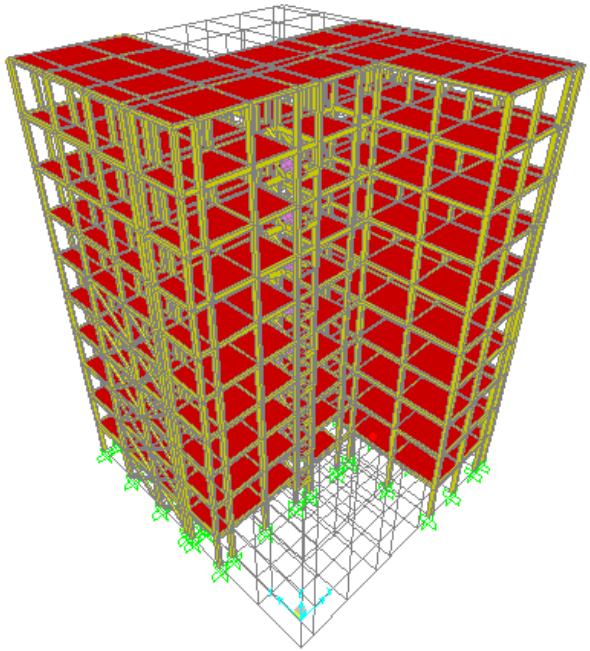


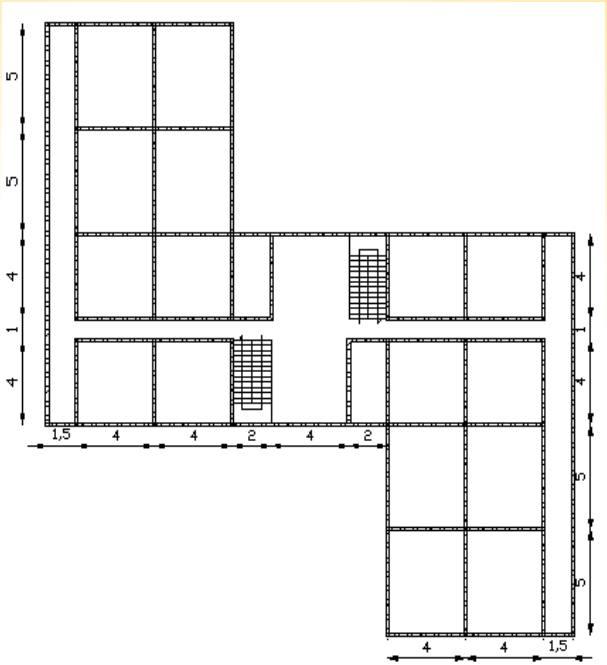
| Seismicity Region | Spectral Acceleration Response, $S_s$ (short-period, or 0.2 seconds) | Spectral Acceleration Response, $S_1$ (long-period, or 1.0 second) |
|---|---|---|
| Low | less than 0.250g | less than 0.100g |
| Moderate | greater than or equal to 0.250g but less than 0.500g | greater than or equal to 0.100g but less than 0.200g |
| High | greater than or equal to 1.000g but less than 1.500g | greater than or equal to 0.400g but less than 0.600g |
| Very High | greater than or equal to 1.500g | greater than or equal to 0.600g |

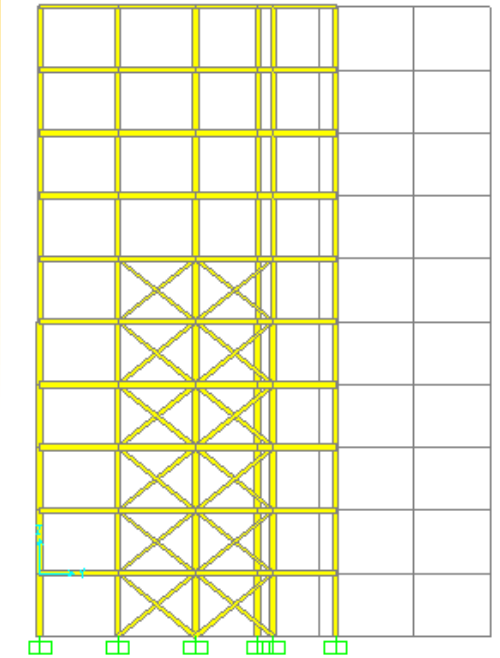
Notes: g = acceleration of gravity in horizontal direction

**Based on this conditions, the performance of vertical housing building model in Semarang needs to be evaluated due to increasing earthquake load.**

# Structural Modelling





The column of IWF 400.400.16.24 profile for floors 1-5 and IWF 350.350.14.22 profile for floors 6-10, beam element use IWF 400.200.8.13 profile with 64 shear connectors which are installed 2 pcs per 18.75 cm of length for floors 1-9, and IWF 250.250.14.14 profile with 58 shear connectors which are installed 2 pcs per 20.69 cm of length for roofbeam. Bracing uses IWF 200.200.12.12 profile, and stair design results in calculation of optrede of 20 cm, antrede 25 cm and angle 38$^{o}$ with a total of 19 steps. Floor plate uses 12 cm thick reinforced concrete.

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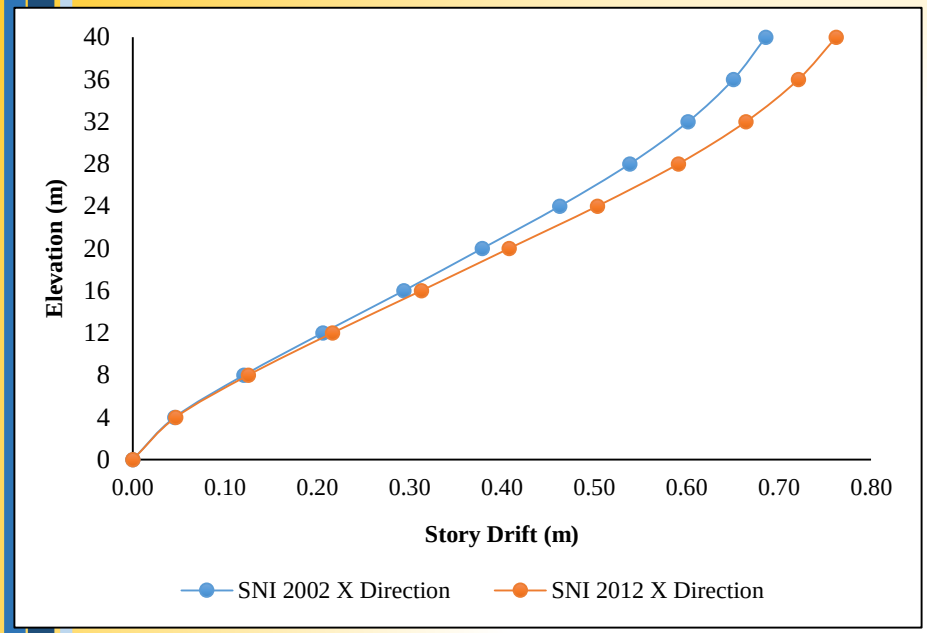
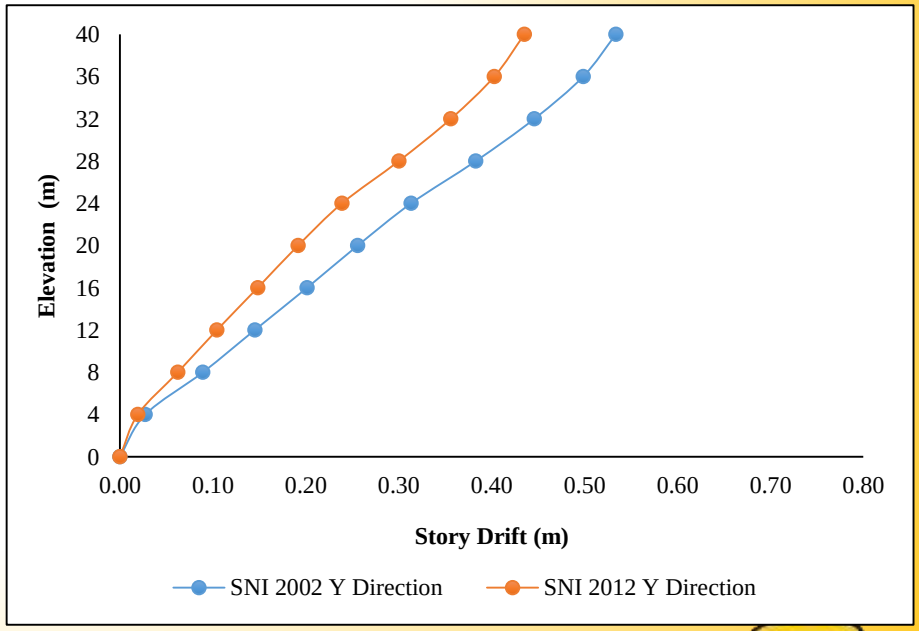
# Result of Pushover Analysis (1)

- The base shear force for X and Y directions have increased by 68.96% and 66.63% respectively for vertical housing building model in Semarang while the performance point was reached.
- The existing drift ratio for seismic load of SNI 1726-2002 is 0.40% and 0.29% respectively in X and Y directions, and the existing drift ratio for seismic load of SNI 1726-2012 is 0.73% and 0.66% respectively in X and Y directions.

| SNI | Direction | V (kN) | D (m) | Dt (m) | Drift Ratio (%) | Performance |
|---|---|---|---|---|---|---|
| 2002 | X | 7058.659 | 0.16 | 0.16 | 0.4 | IO |
| | Y | 12339.8 | 0.144 | 0.29 | 0.29 | IO |
| 2012 | X | 11926.5 | 0.29 | 0.144 | 0.73 | IO |
| | Y | 20561.54 | 0.17 | 0.263 | 0.66 | IO |

# Result of Pushover Analysis (2)

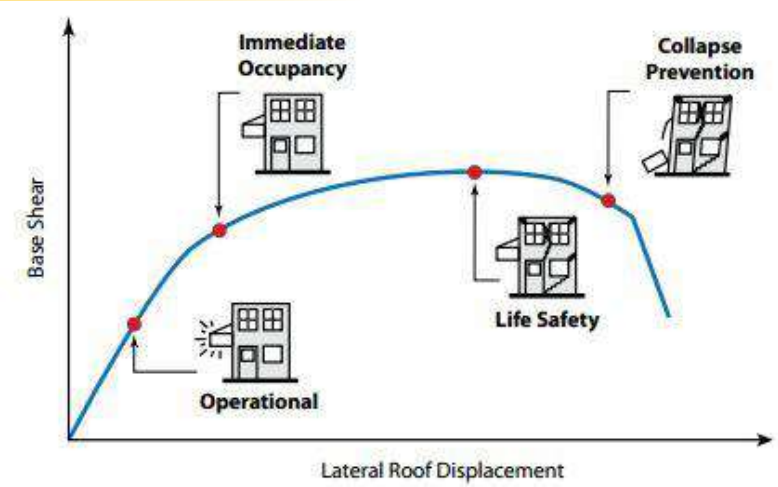



**Immediate Occupancy**

# Conclusions

- Since the existing drift ratio is less than 1%, the structural performance remains at Immediate Occupancy (IO), which refers to a condition of post-earthquake damage where the building is still regarded as safe to live in.
- The possibility of having fatal injury due to structural damage is very small. Even though it may be suitable to have some minor restorations of structural damage, these may normally not be needed prior to re-occupancy.




Performance Level


Thanks!