

THE REPUBLIC OF THE UNION OF MYANMAR

MINISTRY OF CONSTRUCTION



MYANMAR
NATIONAL
BUILDING
CODE
2025

PART 3 - STRUCTURAL DESIGN
PART 4 - SOIL AND FOUNDATION

လျှင်ဘေးအလွန် တည်ဆောက်ပြုပြင်ရေးလုပ်ငန်းများအတွက် နည်းပညာဆိုင်ရာ
ပြန်လည်သုံးသပ်ခြင်းနှင့် အနာဂတ်တွင် ကြုံတွေ့လာနိုင်သည့် နည်းပညာဆိုင်ရာ
စိန်ခေါ်မှုများအတွက် ကြိုတင်ပြင်ဆင်ခြင်းဆွေးနွေးပွဲ

၃။ လျှင်ဒဏ်ခံအဆောက်အအုံများ တည်ဆောက်ခြင်းနှင့် MNBC-2025 ပါ ပြဋ္ဌာန်းချက်များ

PART-4

SOIL AND FOUNDATION, MNBC-2025

- Review on the Damage Evaluation of Past earthquakes, 7.7 Mw, 28-3-2025
- Previous and Current Technology for Foundation Design, MNBC-2025

Presented by:

Dr. Yu Maung

PE-0038 (Geo), ACPE-00564 (Civil), AE-9221 (ASEAN Engineer)

Consultative of HPBC, Fed. MES, EC of MNCOLD

Date: 28-7-2025, Monday

Introduction

Current Regulatory Environment

All building works in Myanmar must comply with the MNBC-2025 recently is established by Ministry of Construction with advice and assistance from various sectors to develop and publish the Myanmar National Building Code-2025.

Following the Mandalay earthquake struck on 28th March, 2025, the Myanmar Earthquake Committee and the Myanmar Geoscience Association have undertaken the necessary preparations to build earthquake-resistant buildings.

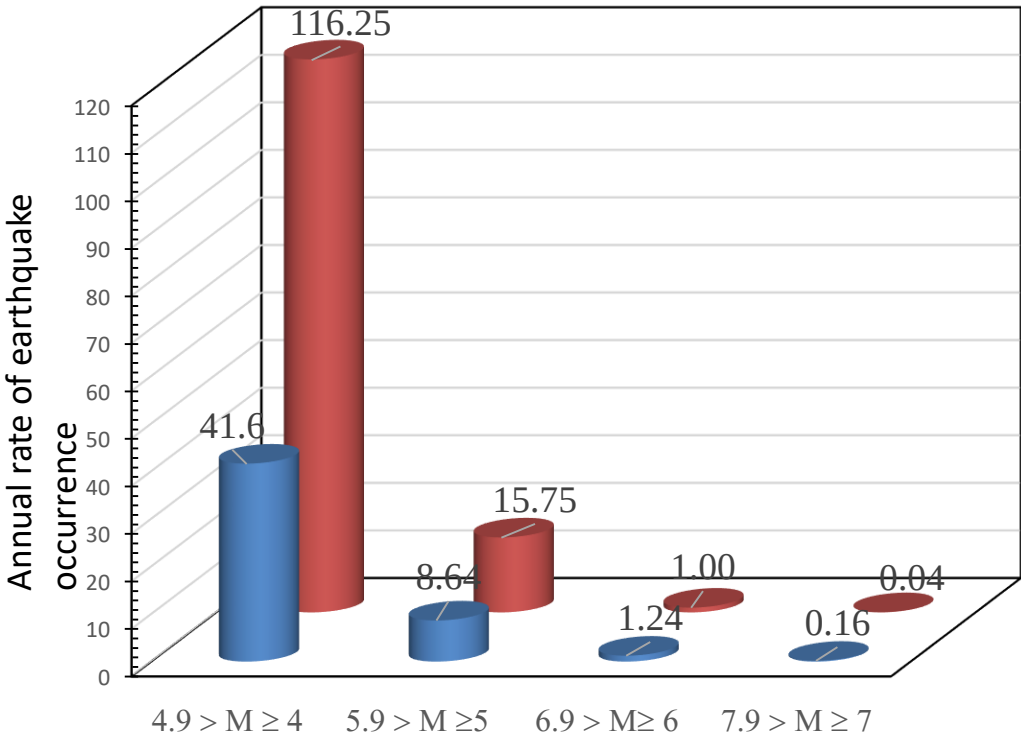
Therefore, the Ministry of Construction acknowledged the contributions of the Ministries, the Myanmar Engineering Council, the Myanmar Architect Council, the High-rise and Public Building Projects Committee, the Federation of Myanmar Engineering Societies and partner organizations, the Myanmar Earthquake Committee, the Myanmar Geoscience Association and to those who have provided advice and assistance from various sectors to develop and publish the Myanmar National Building Code - 2025.

Myanmar Wakes Up to Grave Earthquake Threat

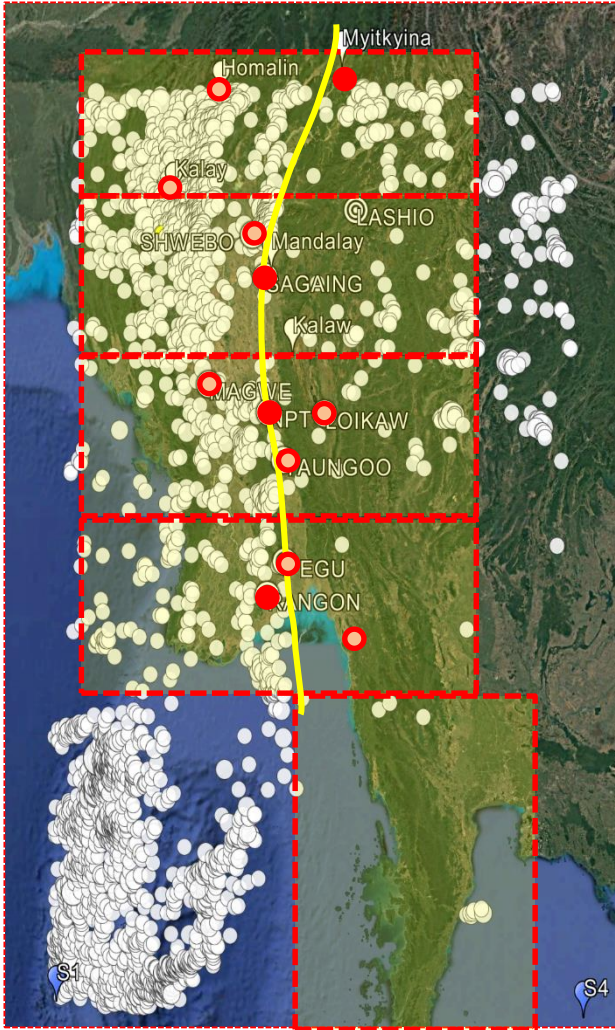
Myanmar's key cities, Yangon, Naypyidaw, Mandalay, and Myitkyina all sit close to the Sagaing Fault, which bisects Myanmar from northern Kachin State, through the central dry zone, and into the Andaman Sea.

Comparison of Numbers of Earthquake between periods of last 124 years and last 24 years

4.9 > M ≥ 4	5.9 > M ≥ 5	6.9 > M ≥ 6	7.9 > M ≥ 7	Total no.	Period, years	Period
Light	Moderate	Strong	Major			
5159	1071	154	20	6404	124	Jan, 1900- Dec, 2024
2790	378	24	1	3193	24	Jan, 2001- Dec, 2024

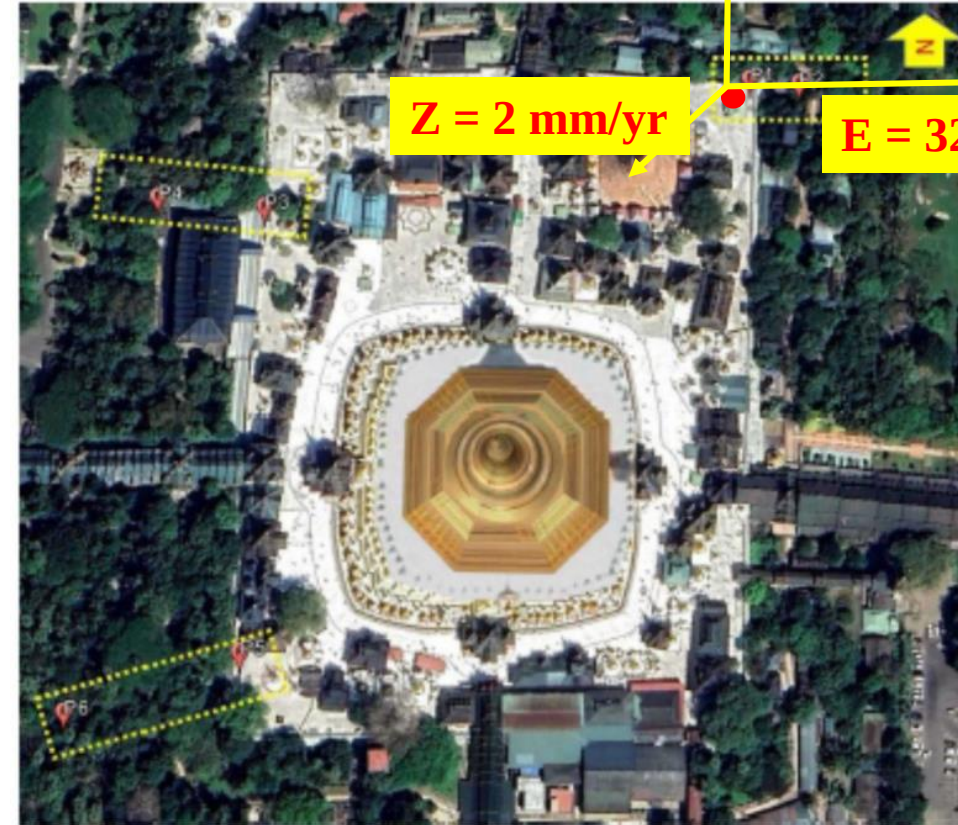
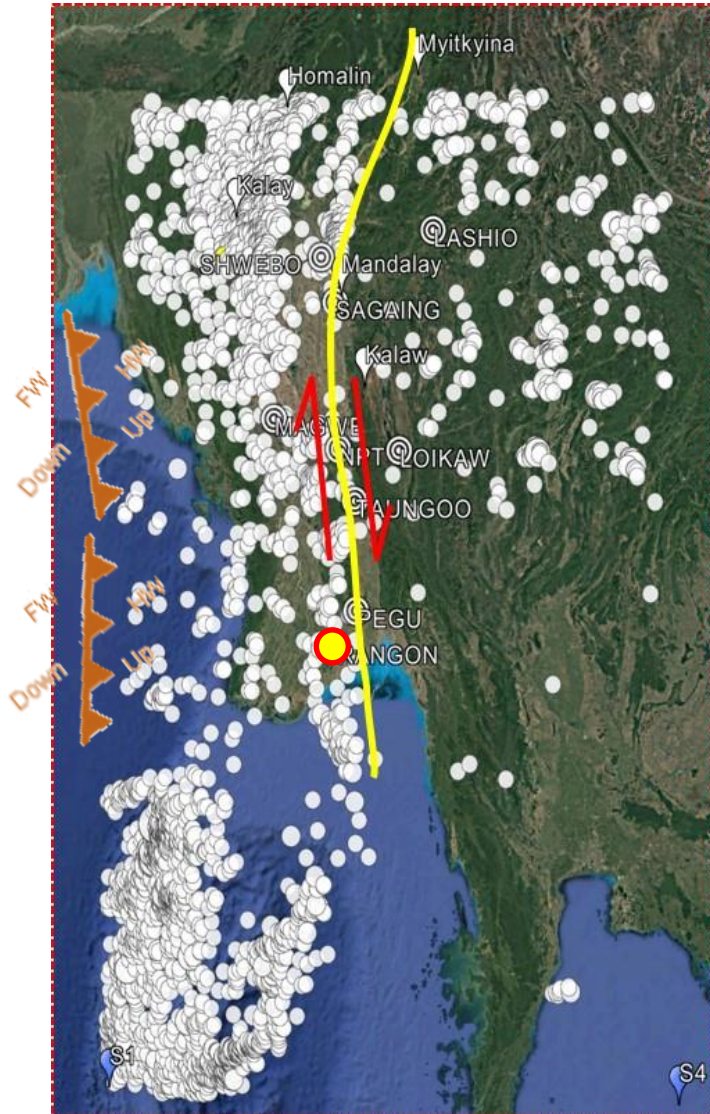


- Annual rate of earthquake occurrence within 124 years
- Annual rate of earthquake occurrence within 24 years



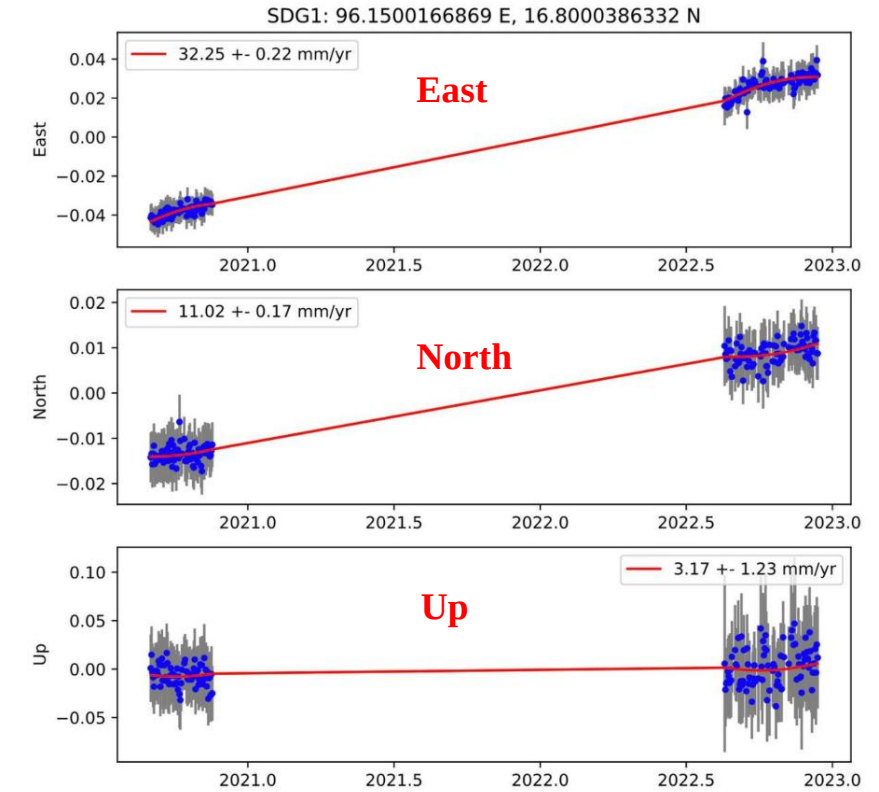
Numbers of earthquake within the effected area, which effect on populated cities of Myanmar

Real Time Displacement Monitoring 2020-2022, Two years

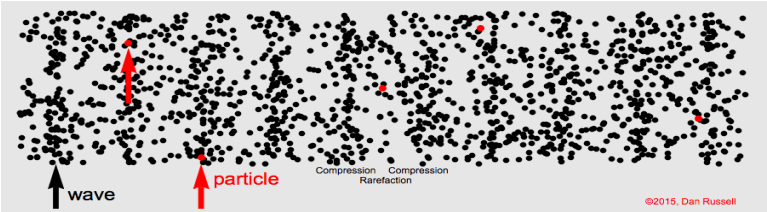
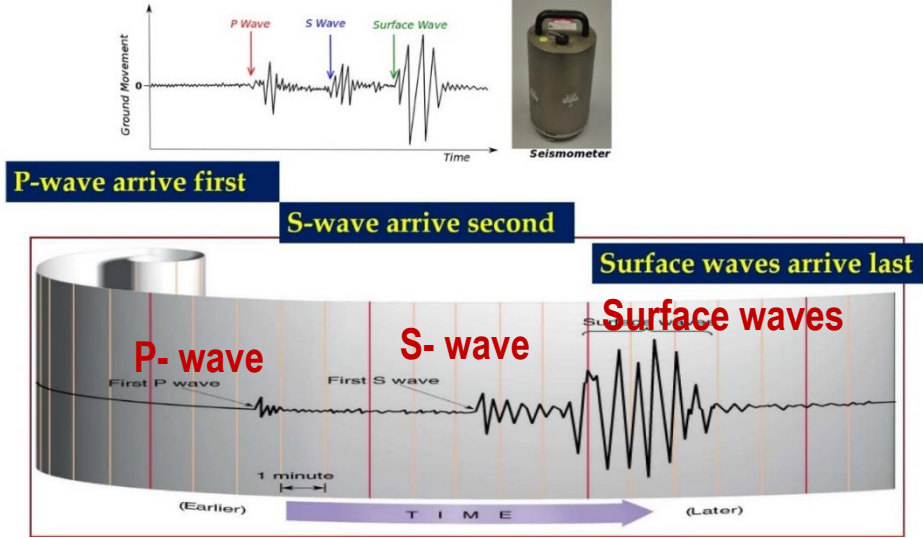


ပုံ-၆ - ရွှေတိဂုံစေတီတော်မြတ် တောင်တော်ကြီး ရေရှည်တည်တံ့ခိုင်မြဲရေးအတွက် မြေသား ရွေ့လျားမှုစဉ်ဆက်မပြတ်တိုင်းတာမှုစနစ် (Real-time Monitoring System) တပ်ဆင်ခြင်း

Verified by InSAR, (Interferometric Synthetic Aperture Radar)
NTU, Singapore.
InSAR data processing for digital elevation model generation

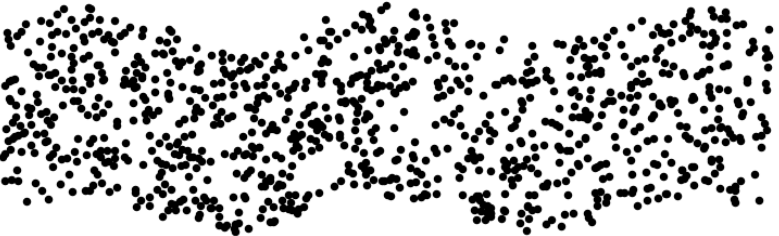


Building Damages and Collapse due to Recent Major Earthquake နည်းပညာဆိုင်ရာ ပြန်လည်သုံးသပ်ခြင်း



Body waves

- P- wave
- S- wave



Surface waves

High Pseudo load for buildings;

1. Major earthquake to great earthquake and/or
2. Very near earthquake source

Wave type	Average velocity, km/s	Remark
P-wave	6.0–7.0	5.0–7.0 km/s (oceanic)
S-wave	3.5–4.0	
Surface wave	2.5	Love waves and Rayleigh waves.

City	Wave travel time, sec				Distance to famous Pagoda, km	
	P- wave	S- wave	Surface wave	Max. time difference		
Sagaing	1.3	2.2	3.5	2.2	8.77	Kaungmudaw
Mandalay	2.4	4.3	6.8	4.4	17	Maha Myat Muni
Naypyidaw	35.9	62.8	100.4	64.5	251	Uppatasanti
Yangon	82.9	145.0	232.0	149.0	580	Shwedagon

နည်းပညာဆိုင်ရာ ပြန်လည်သုံးသပ်ခြင်း

■ Review on the Damage Evaluation of Past earthquakes

1. Past experiences of foundation failure in the world

Japan Earthquake
Foundation Failure



7.5 magnitude earthquake on
New Year's Day, [Jan. 1, 2024](#)



နည်းပညာဆိုင်ရာ ပြန်လည်သုံးသပ်ခြင်း

1. Past experiences of foundation failure in the world

Foundation Failure

Taiwan Earthquake

Magnitude-6.4 quake struck at 11:50 p.m. Tuesday and was centered 14 miles northeast of the coastal city of Hualien. [Feb 07, 2016 5:42 AM](#)

Taiwan's 30-year major earthquake cycle will come due in 10 years

6.4 magnitude quake hit the eastern Taiwanese city of Hualien

Foundation Failure

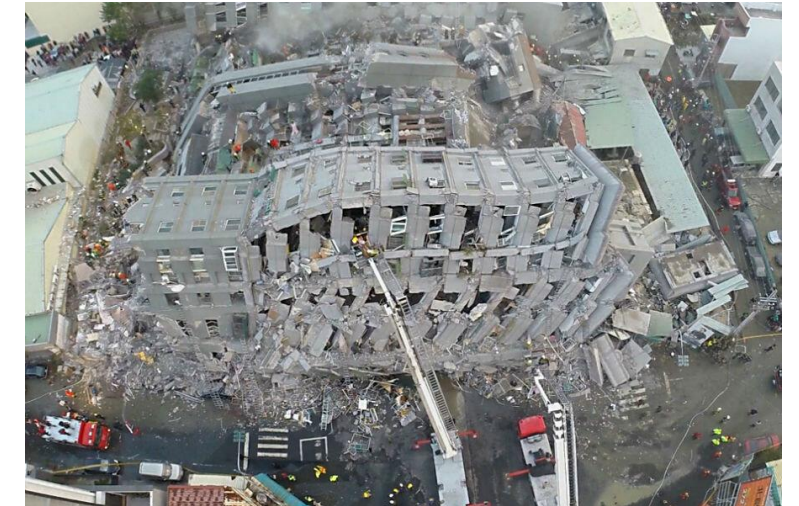


Rescue workers block off the area outside a building that tilted to one side after its foundation collapsed in Hualien, Taiwan.

Foundation Failure



High-rise residential building (Structure collapse)



Foundation Failure



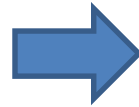
နည်းပညာဆိုင်ရာ ပြန်လည်သုံးသပ်ခြင်း

Significant ground failure due to geological and geotechnical conditions:

1. **Liquefaction (sand boiling),**
2. **Ground Softening, and**
3. **Lateral Spreading** occurred in Wufeng.

Taiwan during the [*1999 Chi-Chi earthquake*](#) ($M^w = 7.6$).

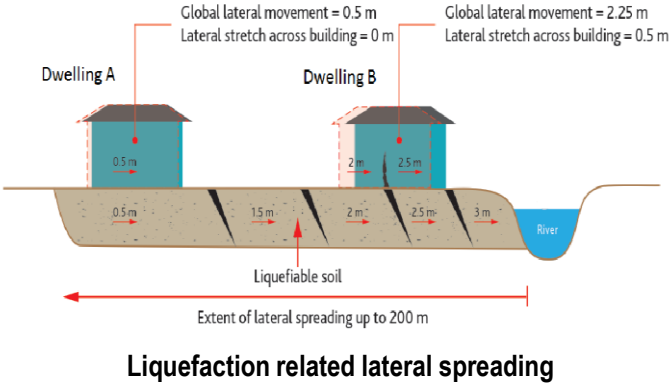
Experienced peak accelerations ~ 0.7 g.



နည်းပညာဆိုင်ရာ ပြန်လည်သုံးသပ်ခြင်း

2. Foundation Failure in Myanmar

28-3-2025, 7.7 magnitude quake hit the Mandalay City, Myanmar



Foundation Soil Failure



လမ်း ၃၀၊ ၇၀ လမ်းနှင့် ၇၀ လမ်းကြား၊ ချမ်းအေးသာစံမြို့နယ်။



Foundation Soil Failure



နည်းပညာဆိုင်ရာ ပြန်လည်သုံးသပ်ခြင်း

Building Damages or Collapse are due to:

1. Failure or collapse of superstructure itself
2. Consequences of foundation (substructure) failure;
 - due to foundation *soil failure* (Liquefaction; sand boil, cyclic softening, and ground spreading)
 - due to foundation *structure failure*
 - due to changes of *foundation resisting system* (horizontal and vertical displacements, changes of foundation resistance), which will cause harmful distortion on superstructure.

နည်းပညာဆိုင်ရာ ပြန်လည်သုံးသပ်ခြင်းနှင့် နည်းပညာဆိုင်ရာကြိုတင်ပြင်ဆင်ခြင်း

MNBC-2025

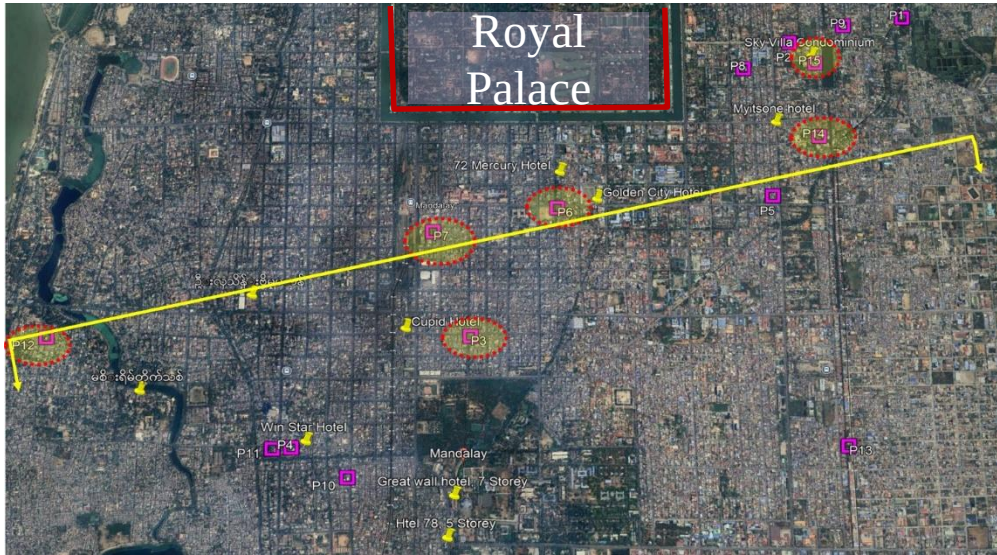
Summary of Probable Causes of Foundation Failure

Damages of Buildings due to Recent Major Earthquake in Myanmar

1. Liquefaction (soil boiling, cyclic softening and then foundation punching failure)
 2. Ground spreading (back fill soil, near slope or water front building)
 3. Pounding effects between building foundations/other non-structures
 4. Different side restraints of foundation
 5. Weak foundation (bearing capacity to resist the seismic load)
 6. *Less of consideration for foundation design*
 7. *Less of construction quality control*
 8. *Less of consideration for quality control by owner*
- Geologic hazards, which shall be managed by **designer**.
- Technical and management issues, which shall be managed by **authority, owner and designer**.
- Mostly old building

1. Foundation soil failure related to geological and geotechnical conditions of building sites in Mandalay city

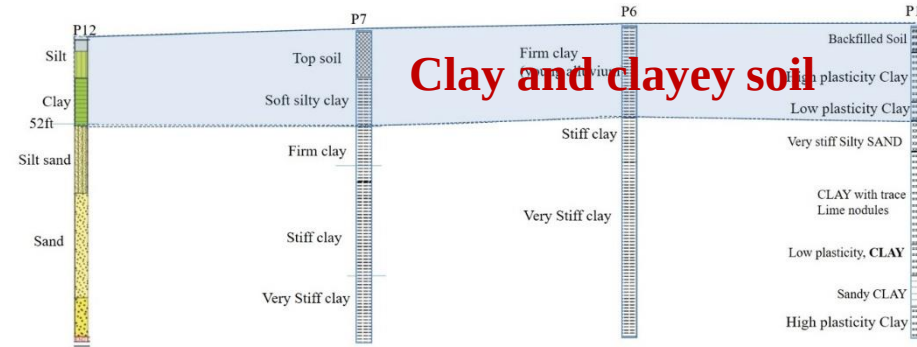
Note : Low potential Liquefaction (low potential Sand boil)



Possibly: Cyclic softening of Silt and clay

Different Types of Soil Liquefaction:

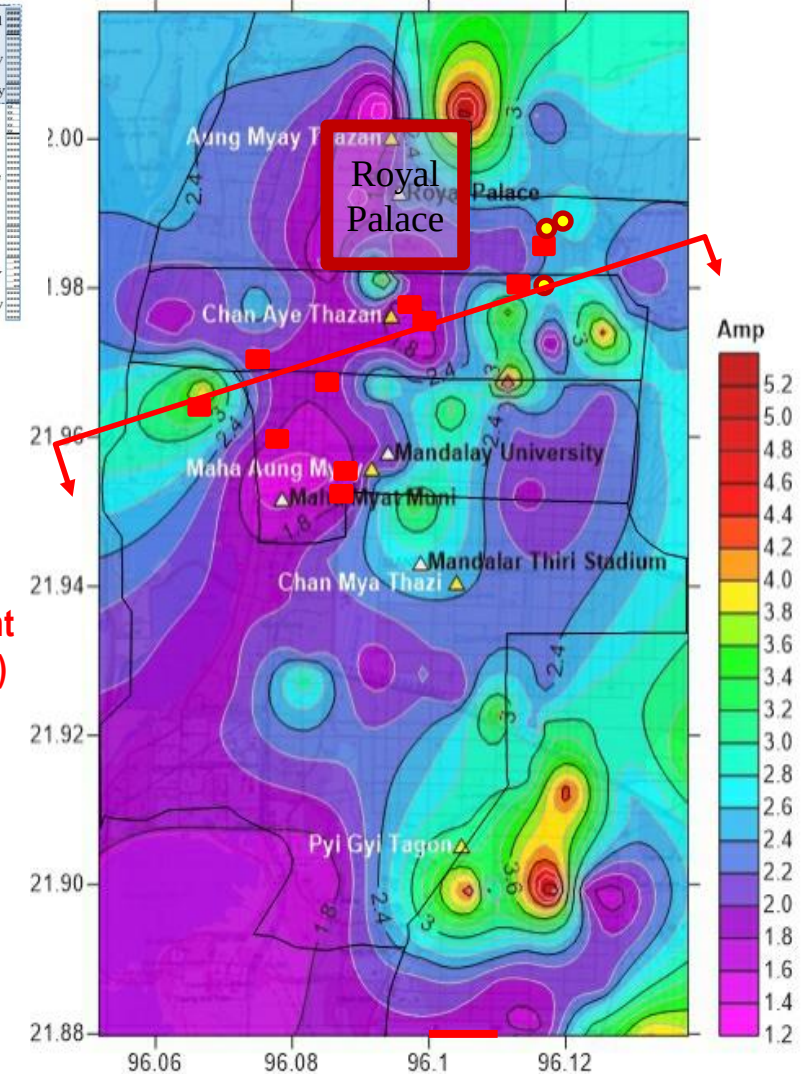
1. Cyclic liquefaction (sand boil)
2. Cyclic softening (low plasticity clayey soils, peat, organic soil)
3. Cyclic mobility (saturated granular soils lose strength and behave like a liquid by a progressive softening under cyclic loading)
4. Flow Liquefaction (static liquefaction; landslides or flow slides, especially on slopes or near embankments)



Geological soil profiles NE-SW

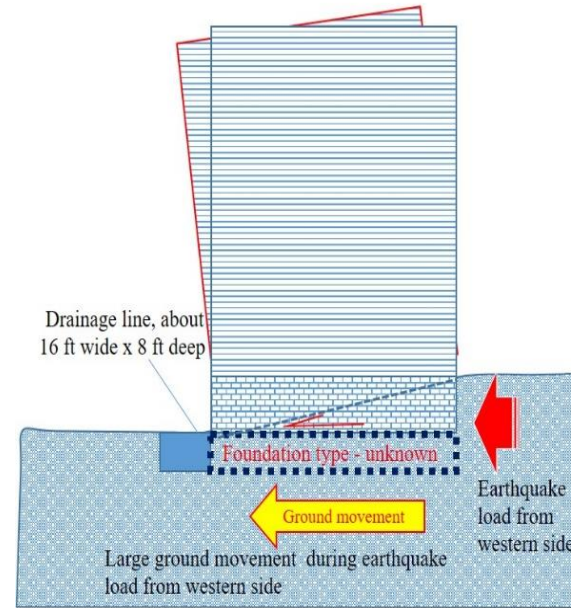
**Earthquake Risk Assessment
based on Geotechnical (Soil)
Conditions**

Mandalay city

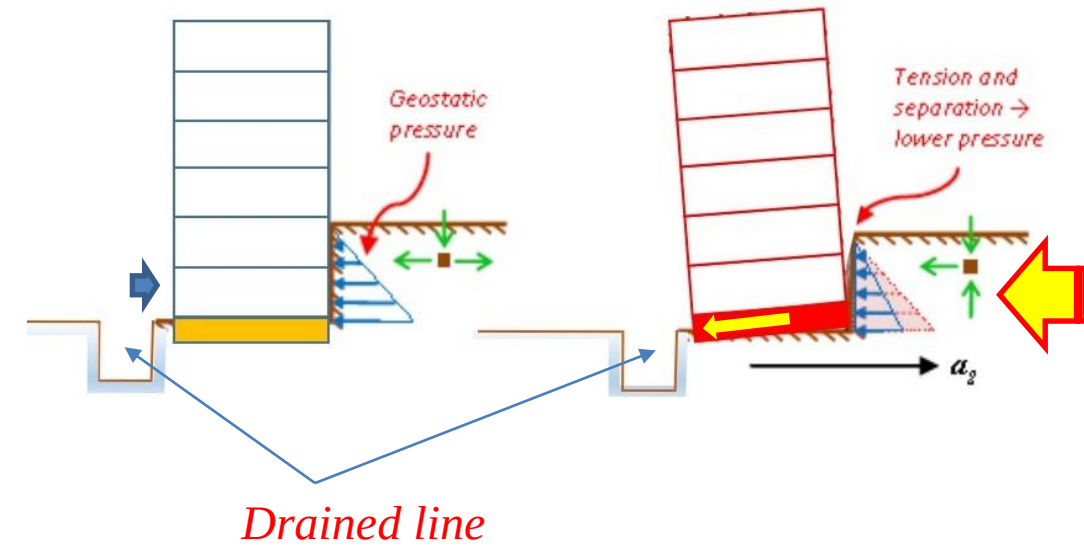


Different Side Resistant Foundations

- Due to different side resistant/movements of foundation system
- Foundation design standard/mistakes/errors
- Poor Construction practice/method
- Material deficiencies



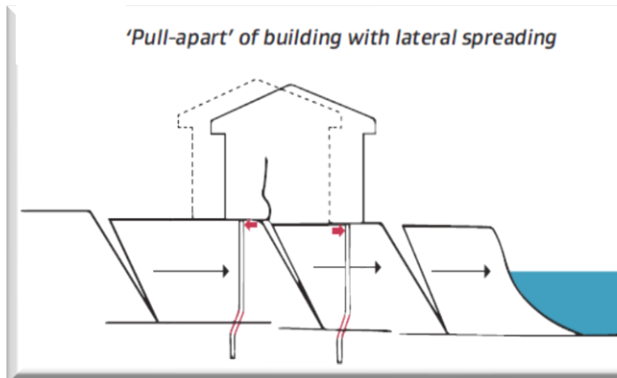
Foundation sliding



Experiences from 7.7 M_w, Mandalay city

Ground spreading

- The horizontal foundation ground movement often near waterways or slopes, as the liquefied soil loses its strength and flows outward. This can cause significant damage to structures.



Pounding effects between building foundations /other non-structures

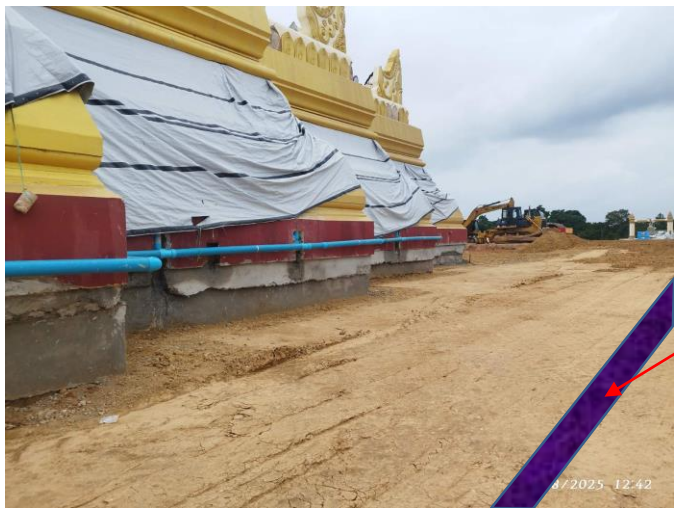
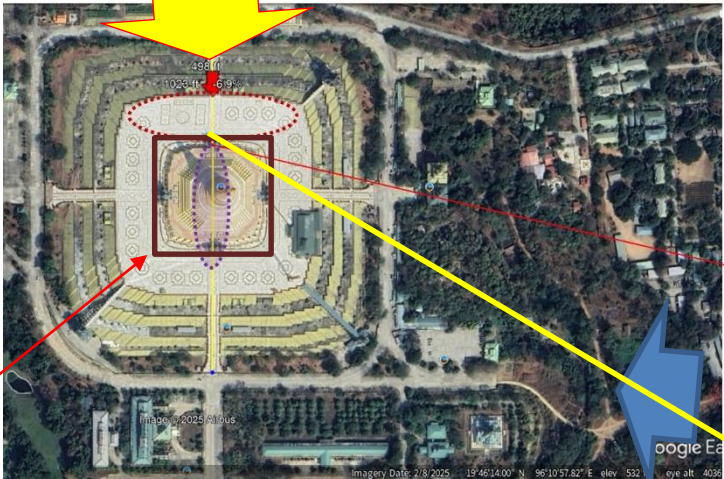
- Pounding between adjacent building foundations during earthquakes occurs *when inadequate separation gaps lead to collisions during seismic shaking*. This can cause significant damage, *especially to non-structural elements and can even lead to structural failure*.

Comparison of horizontal movement during earthquake shaking;

Surface slab movement >> Pagoda foundation movement

Low grade concrete strength (200 mm) between pagoda foundation and plinth slab (375 mm thick)

Earthquake force



7. Poor Construction Practice/method/quality control

- Poor design quality/mistakes/errors
- Poor Construction practice/method
- Material deficiencies
- Machine/equipment
- Poor workmanship
- Owner management



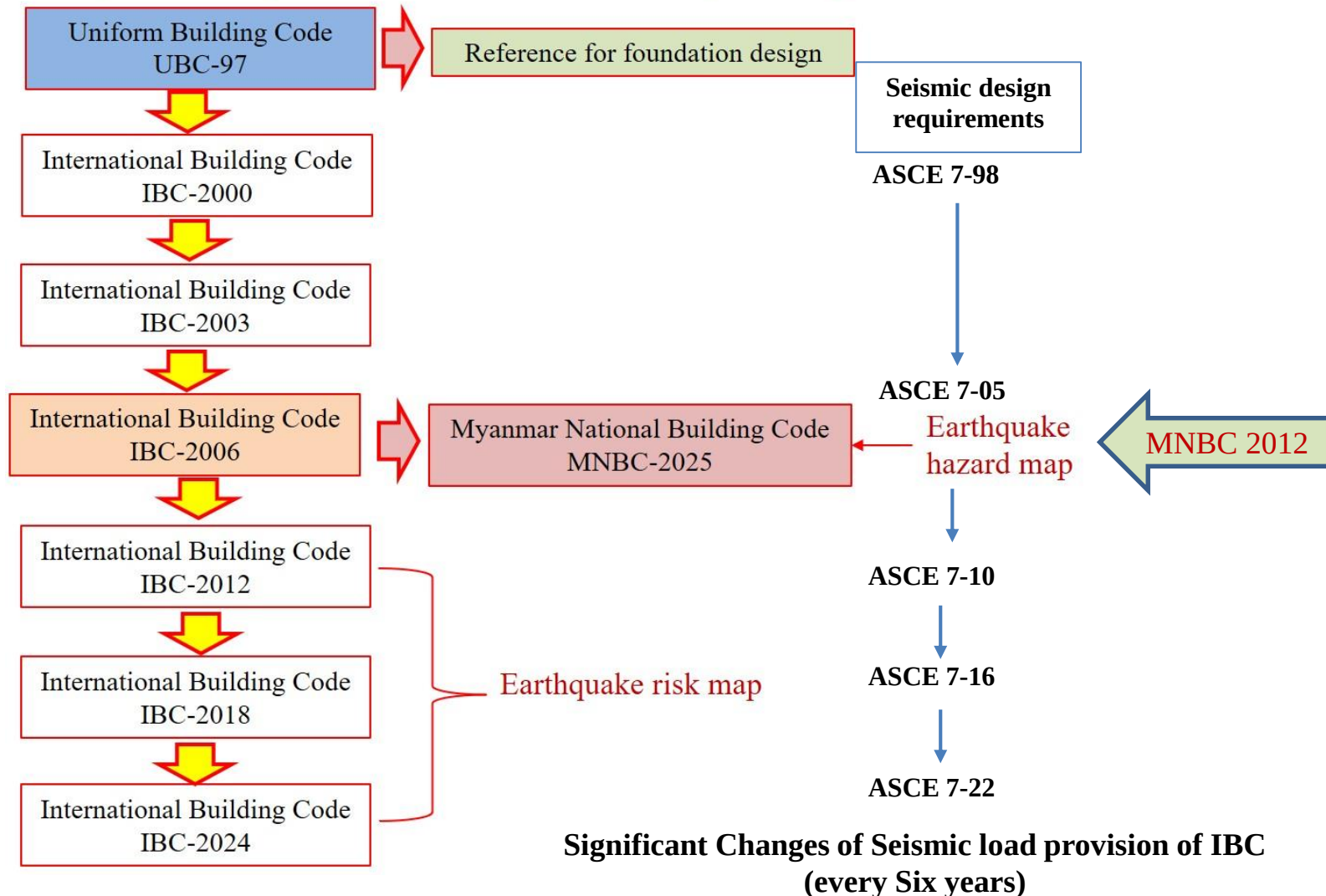
Experiences from 7.7 M_w , Mandalay city

▪ Previous and current technology for foundation design, part-4, MNBC-2025

Significant Changes of Foundation Design Concept

1. Design (Technology and Techniques) to follow the MNBC-2025
2. IBC-2006 significantly revised foundation design compared to the 1997 Uniform Building Code (UBC), particularly in *seismic design provisions*.
3. IBC 2006 introduced changes to seismic zoning, response spectra analysis, and detailing requirements, *impacting how structures are designed to withstand earthquakes*. (ASD but, performance-based approach can be incorporated to some extent, *especially in seismic design*)
4. Designing the overall structural behavior by analyses of superstructure and foundation

Changes of Earthquake Resistant Foundation Design Concept



Limitations of Seismic Resistant Design

According to the Structural Engineers Association of California (SEAOC) Commentary, the aim of the Probabilistic Seismic Hazard Analysis (Earthquake loads from PSHA map):

1. To resist a minor earthquake ($3 \leq M_w < 3.9$) ground motion without damage.
2. To resist a moderate earthquake ($5 \leq M_w < 5.9$) ground motion without structural damage, but possibly experience some nonstructural damage.
3. To resist a major earthquake ($7 \leq M_w < 7.9$) ground motion having an intensity equal to the strongest either experienced or forecast at the building site, *without collapse, but possibly with some structural as well as nonstructural damage.*

Note: This recommendations is *the general description for understanding of earthquake resistant design.*

Earthquake Hazard Map and Requirement of MNBC-2025

Mercalli I scale used to evaluate ground shaking and damage.

M_L = Local magnitude (Charles Richter, 1935)

M_b = Body wave magnitude

M_S = Surface wave magnitude

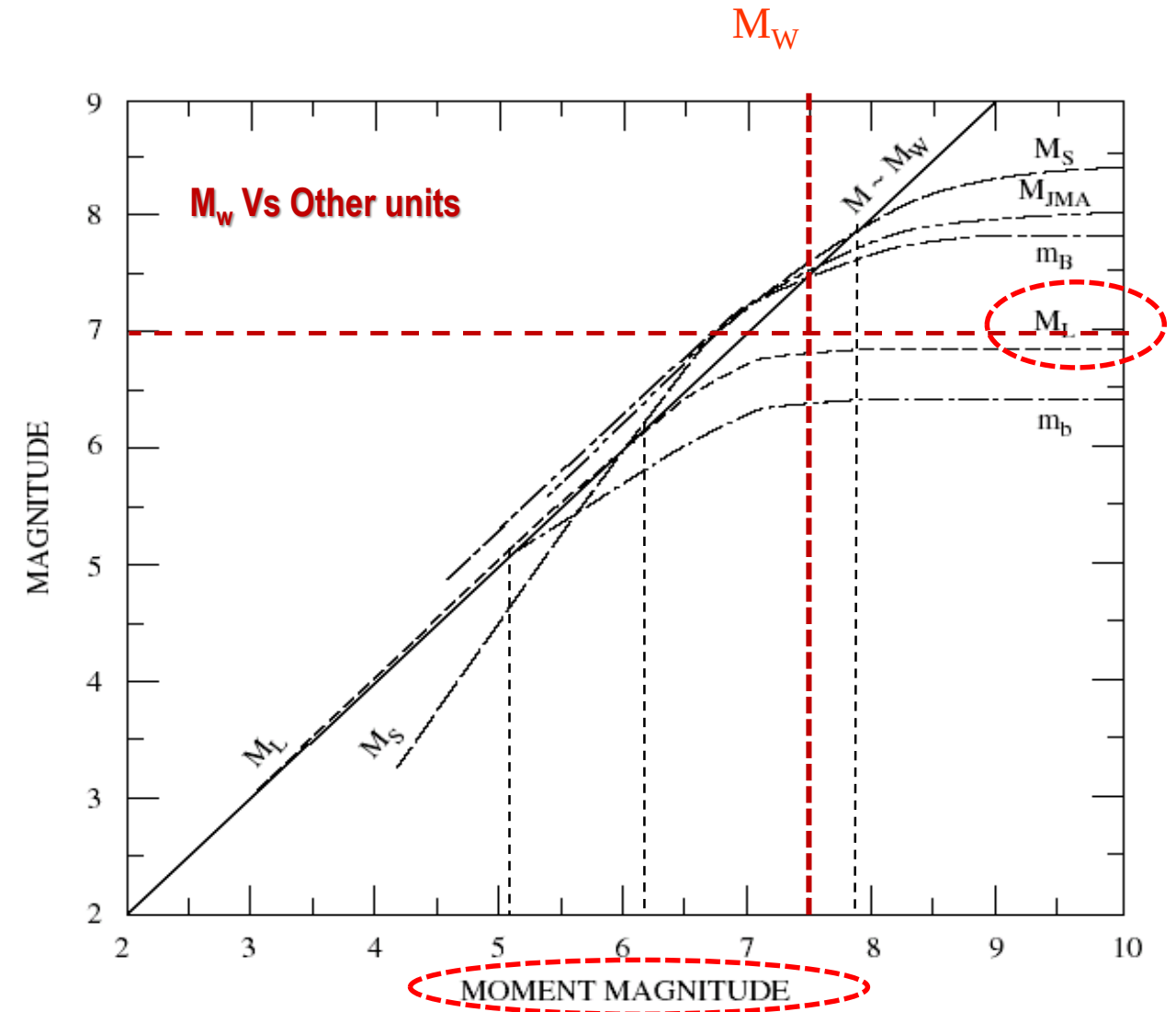
M_W = Moment magnitude

□ Bolt (1989) suggested that

1. M_L and m_b be used for shallow earthquakes of magnitude 3 to 7
2. M_S be used for magnitude 5 to 7.5,
3. M_W be used for magnitude greater 7.5

Remark: M_W shall be used for all earthquake engineering design codes.

- Richter scale measures the magnitude of the earthquake (meaning the force of the earthquake),
- Mercalli scale measures the *physical impact of the earthquake within a given location*.



Earthquake Load Consideration Concept of MNBC 2025

🌿 Earthquake Resistant Design:

- ✓ To resist ground motion
- ✓ Not earthquake magnitude

Geotechnical Parameters of Earthquake Hazard on buildings

Ground Motion Parameters of Code of practice;

1. Amplitude (S_a (S_s , S_1) or **PGA**, PGV, PGD)
2. Frequency content
3. Duration of ground motion

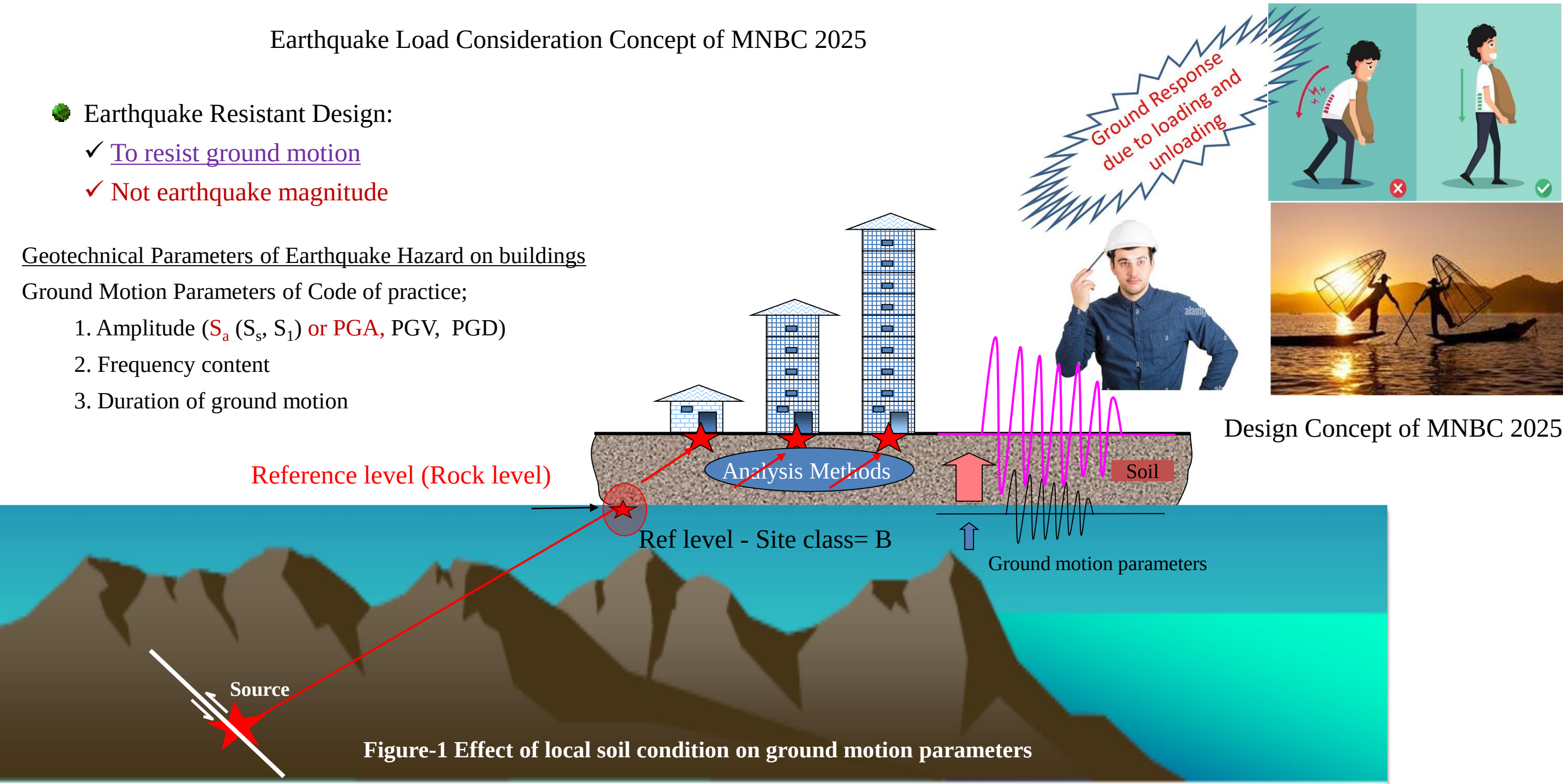
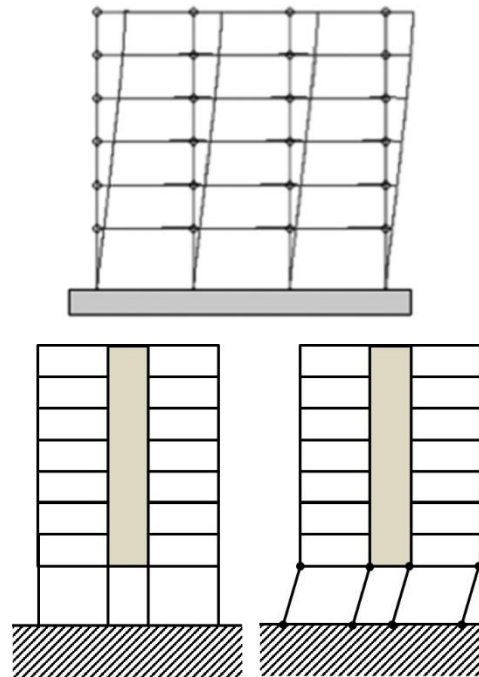


Figure-1 Effect of local soil condition on ground motion parameters

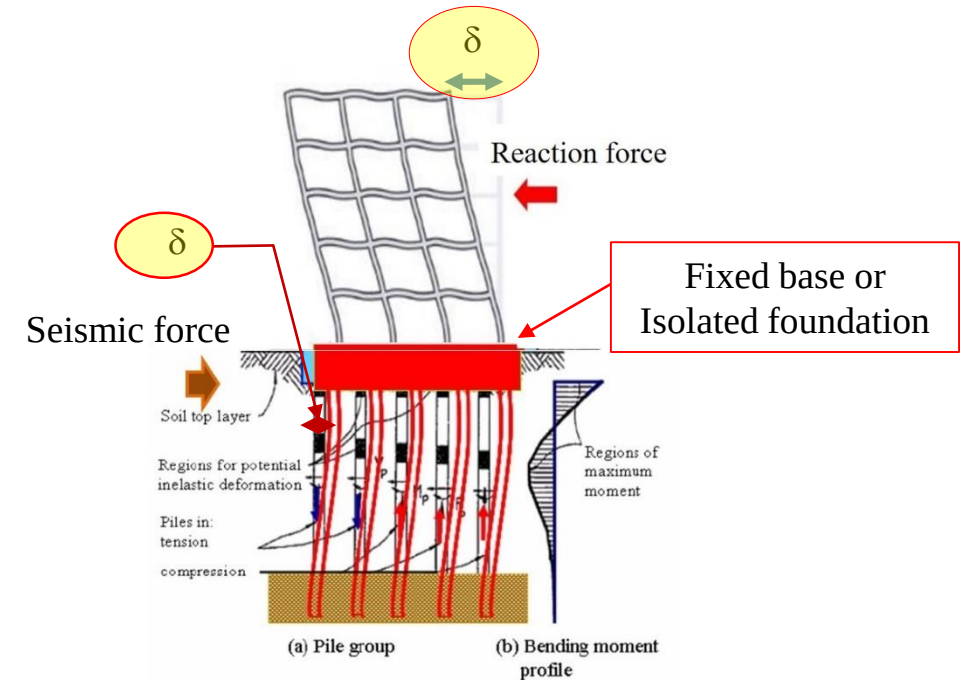
Significantly changes of foundation design compared to the 1997 Uniform Building Code (UBC),
particularly in seismic design provisions as per Part-4, MNBC-2025 (ref: IBC 2006)

Seismic Loads on Foundation and Superstructure



Capacity based Design,
Designed based on superstructure reaction
and conditional stability of foundation for
the geotechnical capacity (mostly considered
qualitatively, only pile load test)

Old concept (UBC 97)



Ground Response Foundation Design
Design based on compactible for the
reaction of superstructure design
analysis and foundation structure
analysis, MNBC-2025

Current concept (IBC 2006 or MNBC-2025)

Foundation design concept according to requirement of MNBC-2025

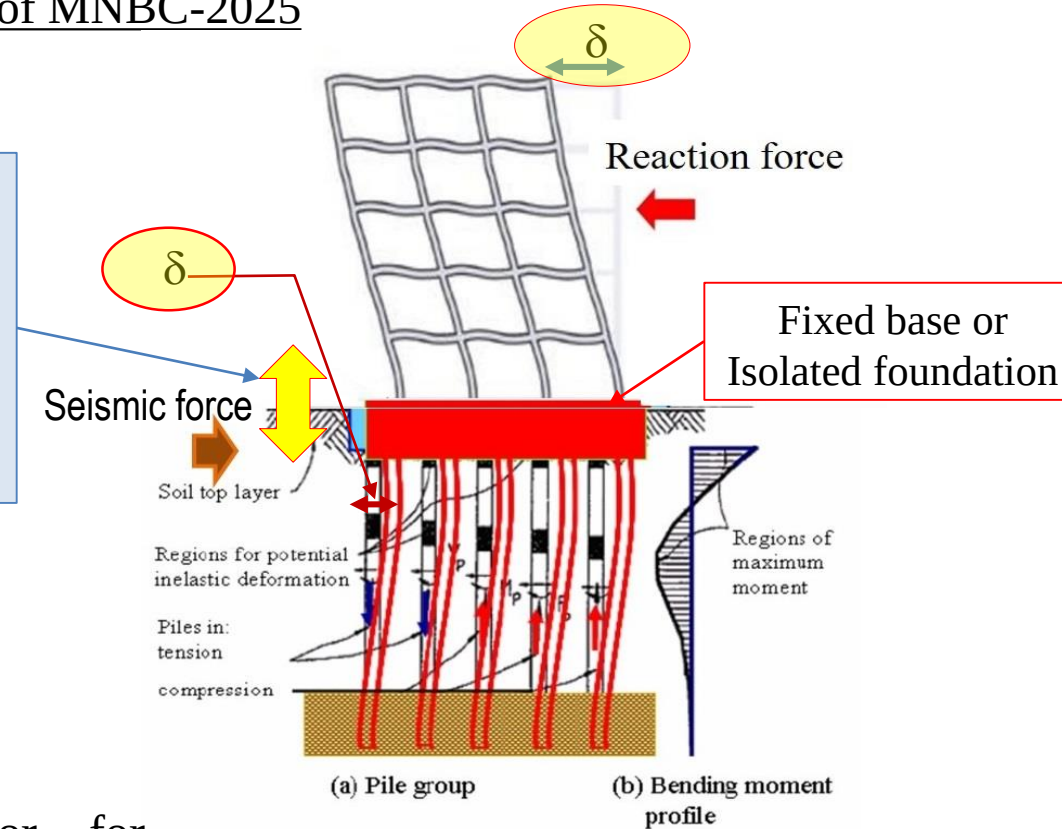
4.1.3 DESIGN (MNBC-2025)

Allowable bearing pressures, allowable stresses and design formulae provided in this section *shall be used with the allowable stress design load combinations* specified in Structural **Design Section 3.2.1.**

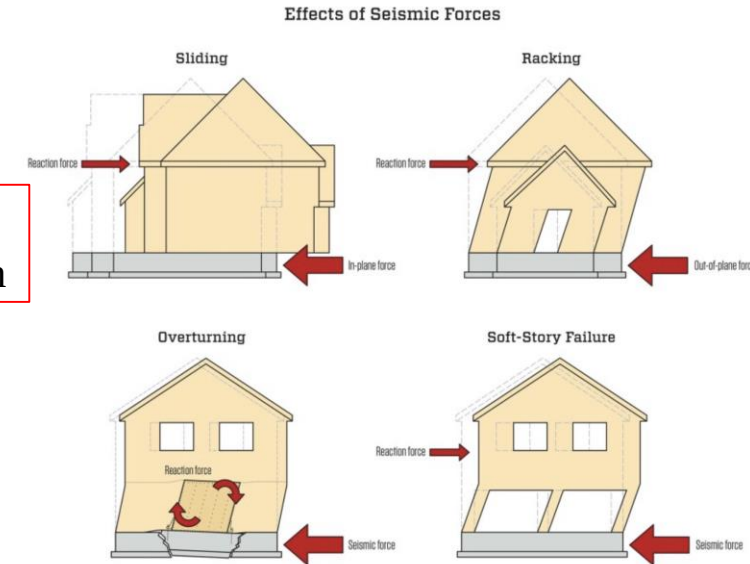
3.2.1.5 Special Seismic Load Combinations

Conclusion Remark:

1. Designing the overall structural behavior for superstructure and foundation.
2. Performance-based approach to Allowable Stress Design, *especially in seismic design (ref; ASCE 7-05).*



(Deep foundation)



(Shallow foundation)

END



Thank for your attention

