

Mandalay Earthquake Review

- Damage Assessment
- Structural Review
- Damage and Fault Zone Mapping

Saw htwe zaw

Myanmar Earthquake Clinics

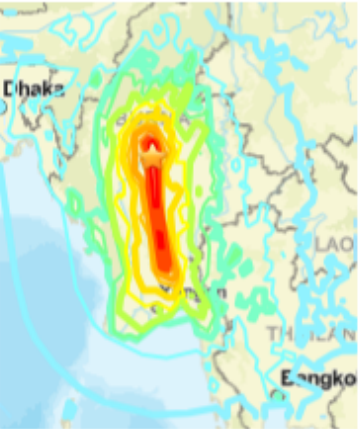
Naypyitaw

250728

M 7.7 - 2025 Mandalay, Burma (Myanmar) Earthquake

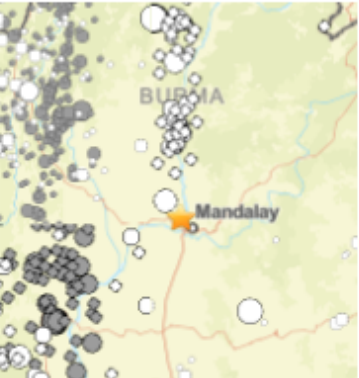
2025-03-28 06:20:52 (UTC) | 22.011°N 95.936°E | 10.0 km depth

Interactive Map



Contributed by [US](#)

Regional Information



Felt Report - Tell Us!

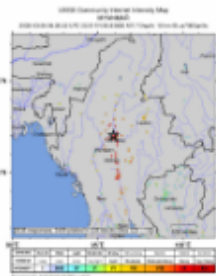
0 0 2 5 3 5

Responses

Contribute to citizen science.
Please [tell us](#) about your experience.

Did You Feel It?

IX

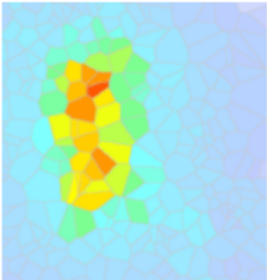


Community Internet Intensity Map

Contributed by [US](#)

ShakeMap

X

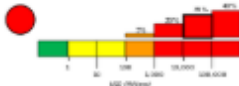


Estimated Intensity Map

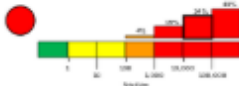
Contributed by [US](#)

PAGER

RED



Estimated Economic Losses

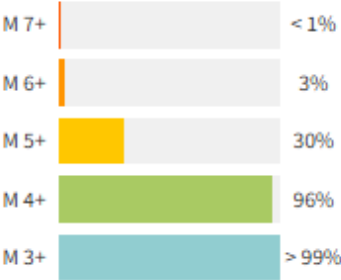


Estimated Fatalities

Contributed by [US](#)

Aftershock Forecast

According to our forecast, the chance of at least one aftershock within the next **month**:



Contributed by [US](#)

Mag	Depth km	Day	Time UTC	Lat	Lon	Dist km
7.7	10	2025-03-28	06:20:52.709Z	22	95.92	0
6.7	10	2025-03-28	06:32:04.777Z	21.7	95.97	34

Closest 10 (of 2) quakes shown. [Zoom to this vicinity](#)

Finite Fault



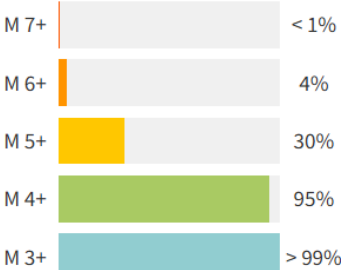
Fault Plane Solution

Contributed by [US](#)

View Nearby Seismicity

Aftershock Forecast

According to our forecast, the chance of at least one aftershock within the next **week**:



Contributors

US



USGS National Earthquake Information Center, PDE

Authoritative Network

Myanmar Earthquake Clinics Response

Federation of Myanmar Engineering Societies (Fed.MES)

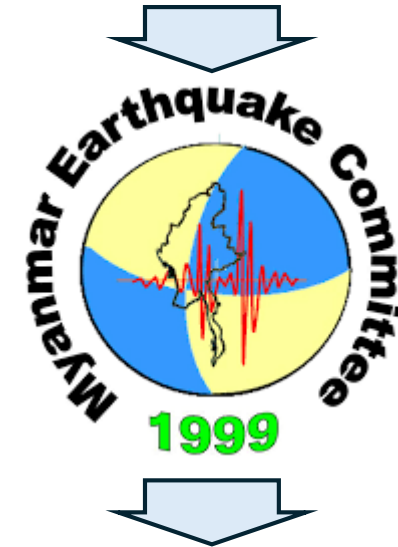
- Since 1946, started as “Association of Engineers in Burma”
- 68,000+ members, 360+ corporate members
- 40+ Committees and 30+ Technical Divisions
- Nation-wide networks

Myanmar Earthquake Committee

- Established in 1999 as a technical committee under Fed. MES
- Seismologists, Geologist, Engineers
- Universities, Government Officers, Private Practitioners, Enthusiasts

Earthquake Clinics

- A network of volunteer engineers
- Leveraged the networks of the following institutions for coordination and support.
 - Federation of Myanmar Engineering Societies (Fed. MES)
 - Myanmar Engineering Council networks (MEngg.C)
 - Highrise and Public Building Committee (HPBC)



Earthquake Clinics

Life is not something we can download later

Myanmar Earthquake Clinics Response

Clinics Response

1. PDRA

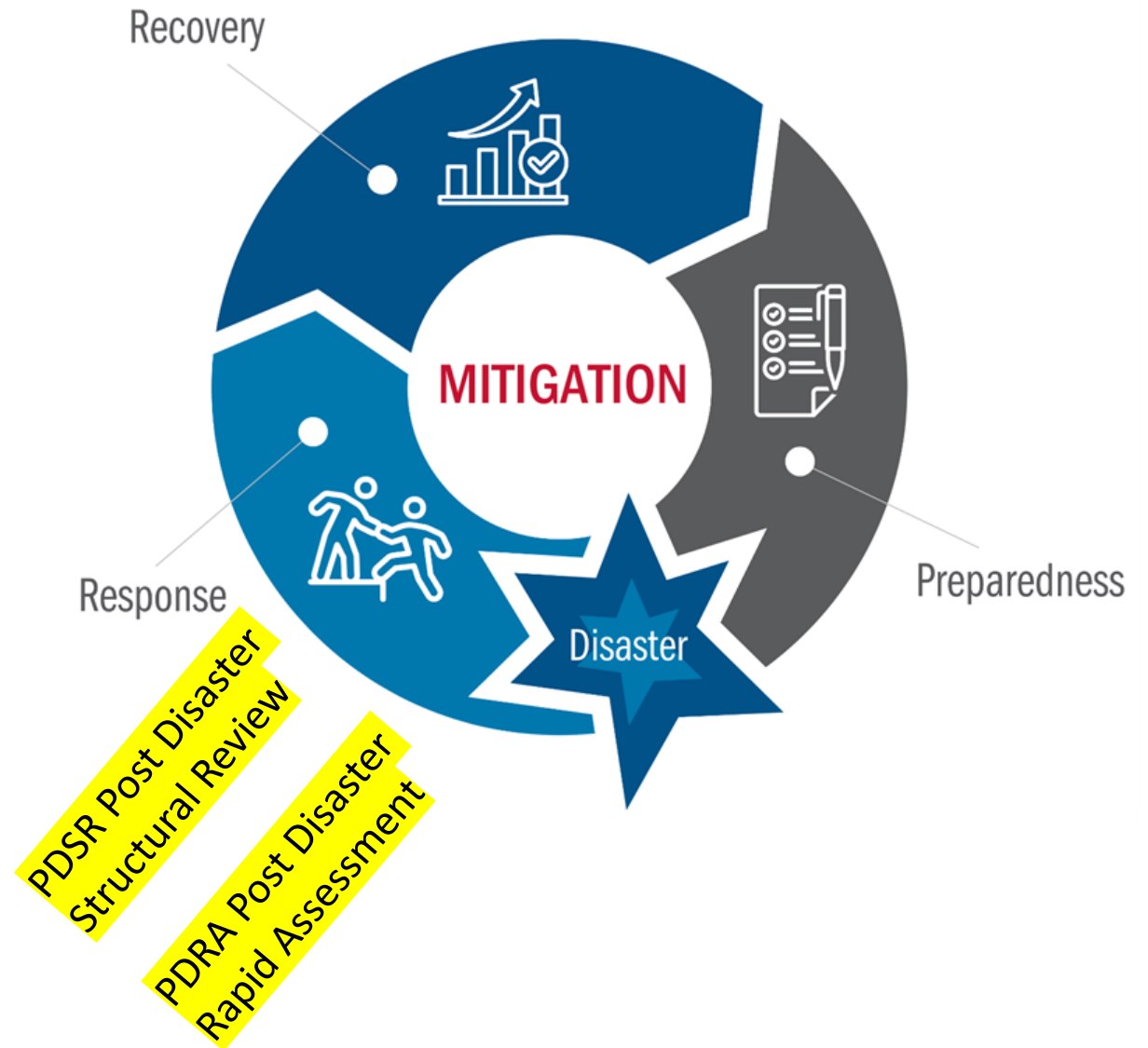
- Ref: PDRA, ATC20, FEMA P2055
- Prioritize Buildings (Green/Yellow/Red)
- Build Database

2. PDSR

- Ref: ASCE41, FEMA P2335
- Training and Retrofit Design

3. Mapping

- Damage Zone Map
- Fault Zone Map



Part 1: Post Disaster Rapid Assessment

- FEMA P-2055
 - Post-Disaster Building Safety Evaluation Guidance

- Green (Blue)
 - Few Repair
 - Owner and Engineers (RE)

- Yellow (Orange)
 - Minor Repair
 - Owner and Engineers (RSE)
 - Major Repair
 - Owner, Engineers (PE), Authority (City Councils)

- Red
 - Retrofit
 - Owner, Engineers (PE), Authority (City Councils)
 - Demolish
 - Owner, Engineers (PE), Authority (City Councils)

PDRA	Damage State	Stakeholder					Repair Strategy
		Owner	Authority	Engineer			
				RE	RSE	PE	
Blue/ Green	Few Repair						Repair with general guidelines
Orange/ Yellow	Minor Repair						
	Major Repair						Retrofit Design and Repair
Red	Retrofit						
	Demolish						Demolishing with Damage Control



Post-disaster Building Safety Evaluation Guidance

Report on the Current State of Practice, including Recommendations Related to Structural and Nonstructural Safety and Habitability

FEMA P-2055 / November 2019



RESTRICTED USE

Caution: This structure has been inspected and found to be damaged as described below:

Date _____
Time _____

(Caution: Aftershocks since inspection may increase damage and risk.)

Entry, occupancy, and lawful use are restricted as indicated below:

This facility was inspected under emergency conditions for: _____
(Jurisdiction) _____

Inspector ID / Agency _____

Facility Name and Address: _____

UNSAFE

DO NOT ENTER OR OCCUPY (THIS PLACARD IS NOT A DEMOLITION ORDER)

This structure has been inspected, found to be seriously damaged and is unsafe to occupy, as described below:

Date _____
Time _____

This facility was inspected under emergency conditions for: _____
(Jurisdiction) _____

Inspector ID / Agency _____

Facility Name and Address: _____

Do Not enter, except as specifically authorized in writing by jurisdiction. Entry may result in death or injury.

Do Not Remove, Alter, or Cover this Placard until Authorized by Governing Authority

INSPECTED

LAWFUL OCCUPANCY PERMITTED

This structure has been inspected (as per) and no apparent structural damage has been found.

Date _____
Time _____

(Caution: Aftershocks since inspection may increase damage and risk.)

This facility was inspected under emergency conditions for: _____
(Jurisdiction) _____

Inspector ID / Agency _____

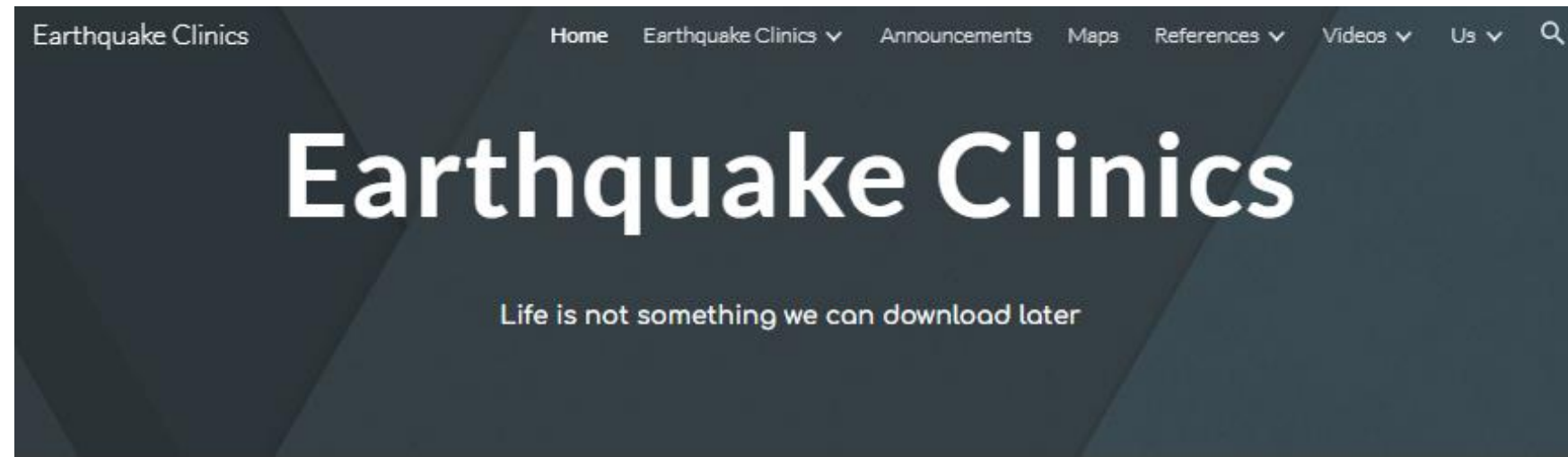
Facility Name and Address: _____

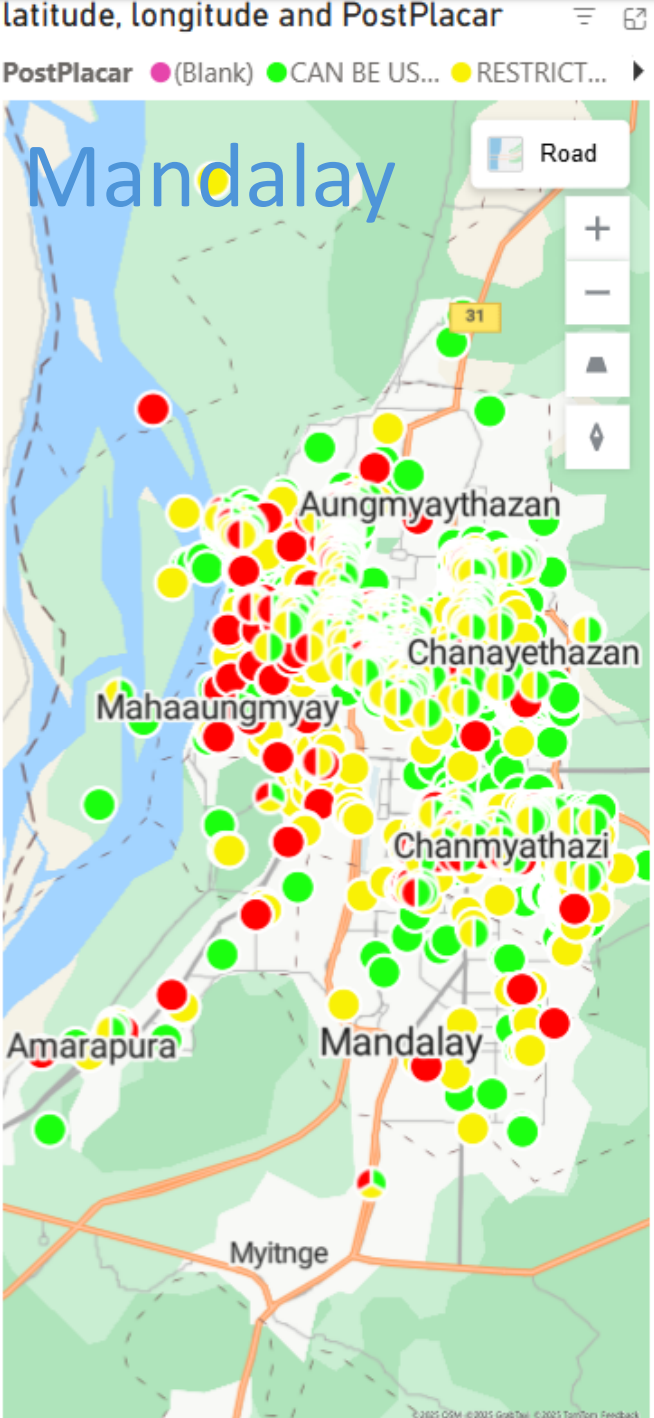
Inspector Comments: _____

Do Not Remove, Alter, or Cover this Placard until Authorized by Governing Authority

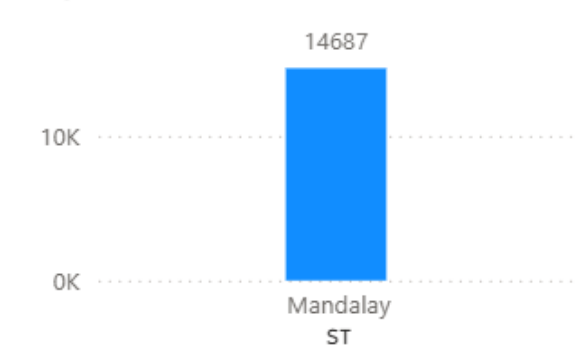
Earthquake Clinics Web site

<https://sites.google.com/view/earthquakeclinics>

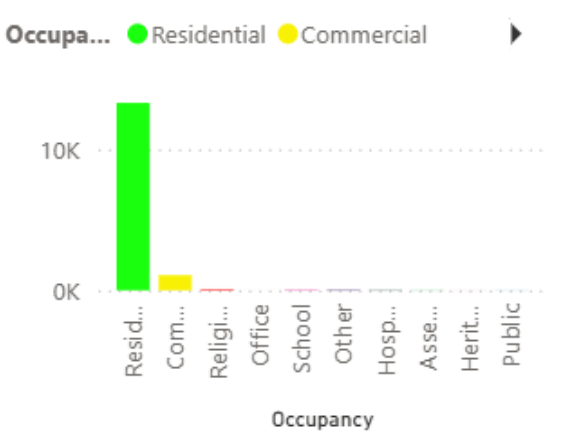




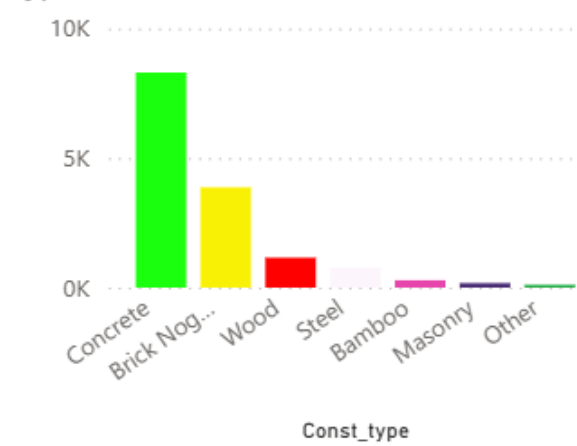
Daily Data



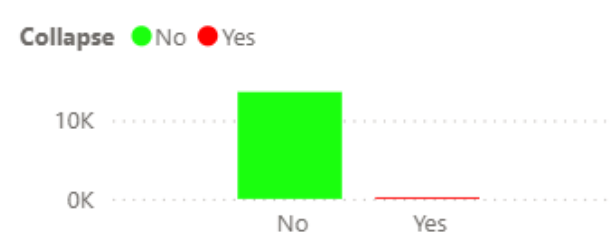
Occupancy



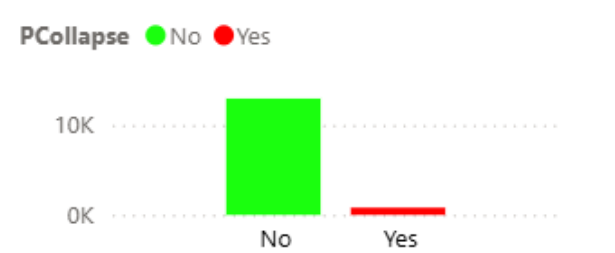
Type of Construction



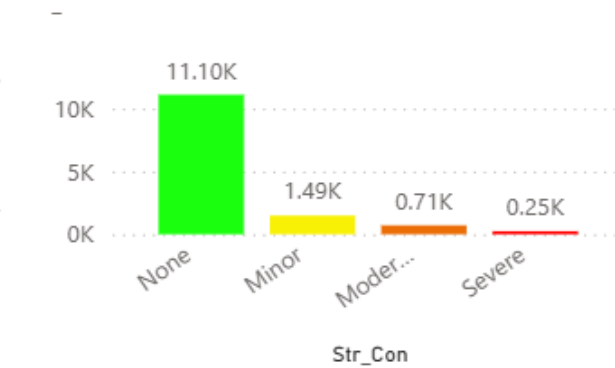
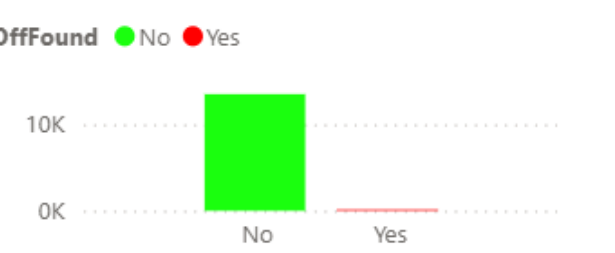
Overall Condition (Collapse)



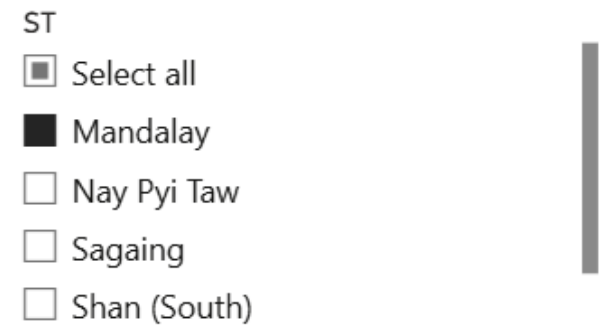
Overall Condition (Partially Collapse)



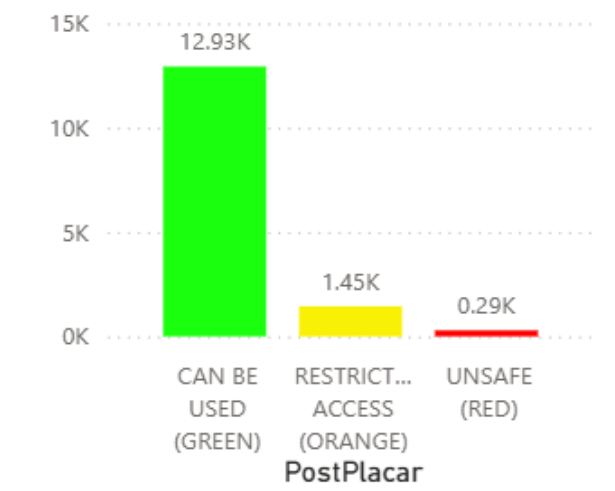
Overall Condition (Off Foundation)



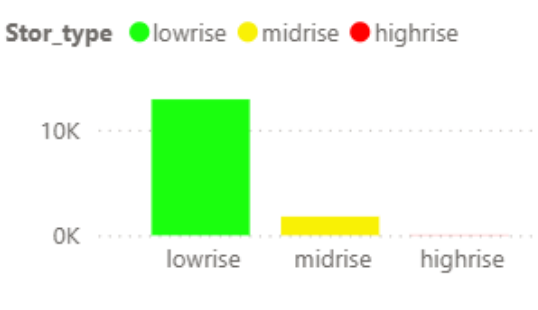
ST/ Region



PostPlacar

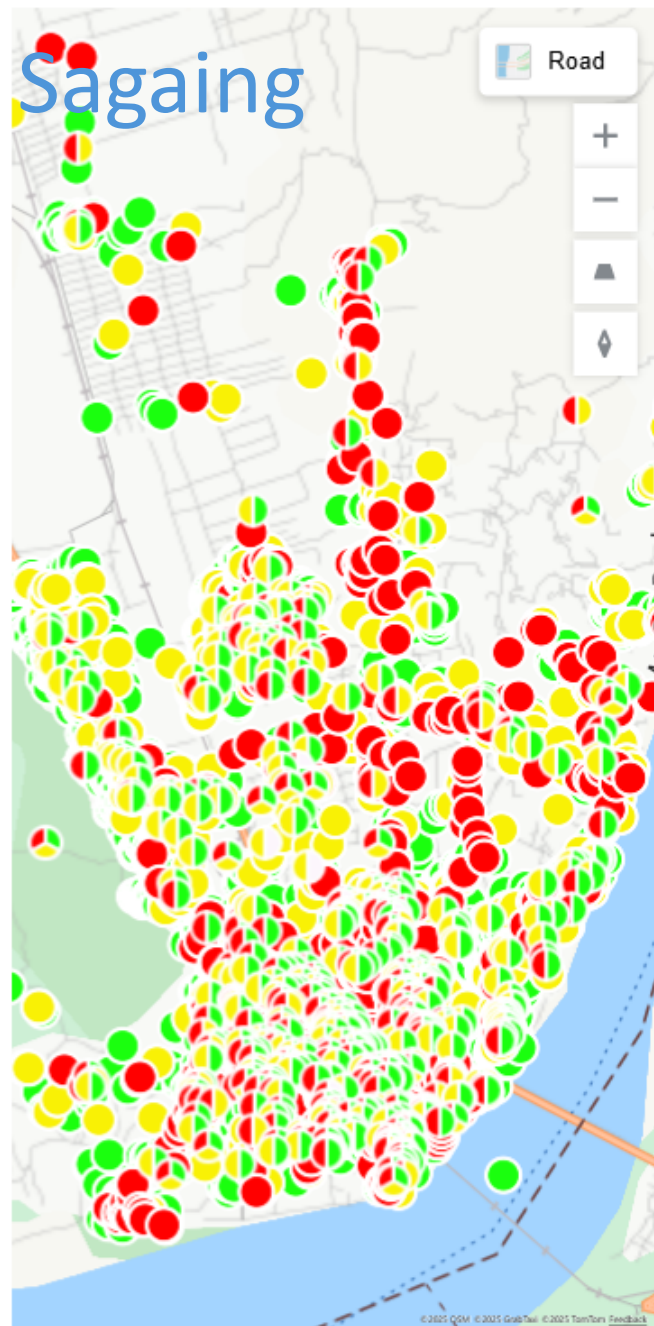


Storey Type

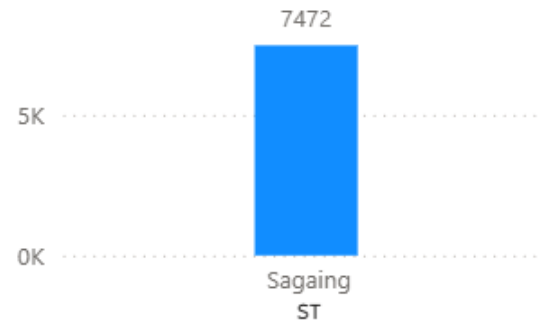


latitude, longitude and PostPlacar

PostPlacar (Blank) CAN BE US... RESTRICT...

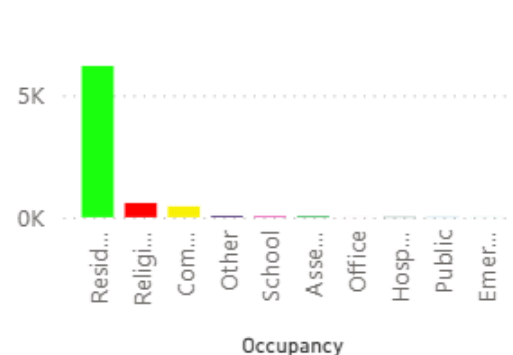


Daily Data

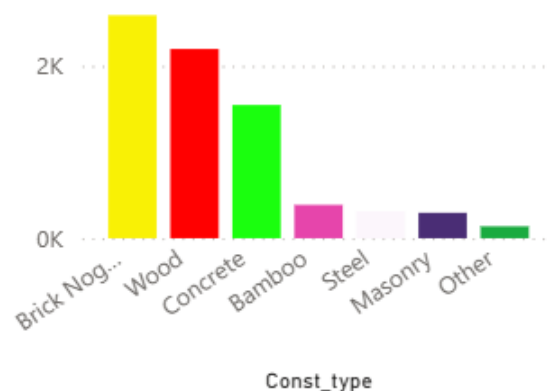


Occupancy

Occupancy (Residential, Religion)



Type of Construction



Overall Condition (Collapse)

Collapse (No, Yes)



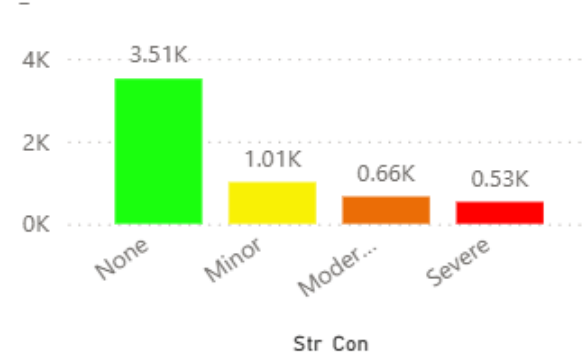
Overall Condition (Partially Collapse)

PCollapse (No, Yes)



Overall Condition (Off Foundation)

OffFound (No, Yes)

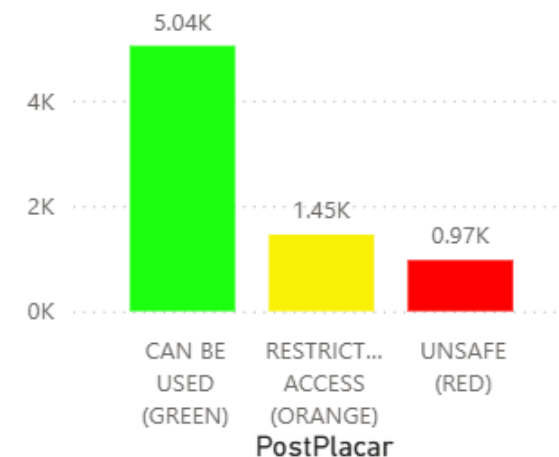


ST/ Region

ST

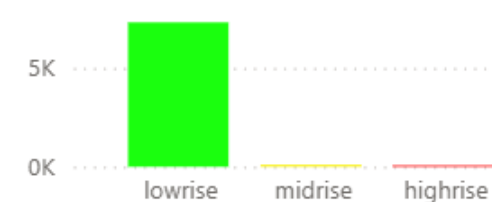
- Select all
- Mandalay
- Nay Pyi Taw
- Sagaing
- Shan (South)

PostPlacar



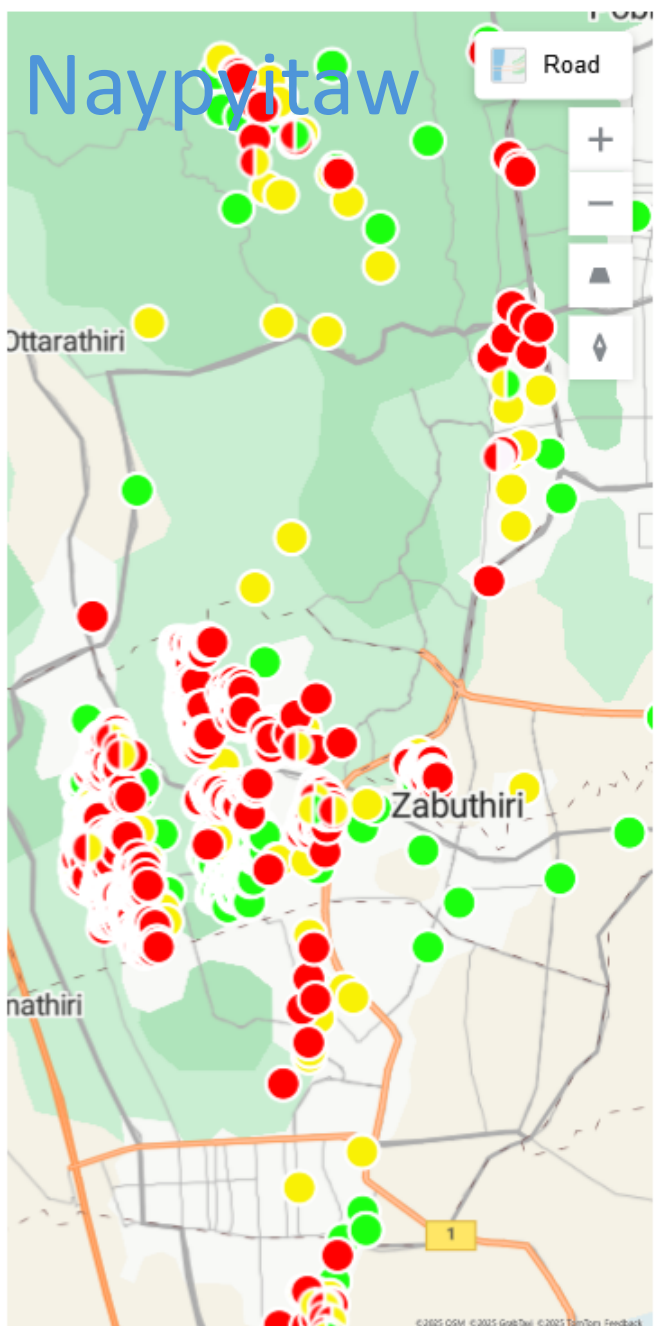
Storey Type

Stor_type (lowrise, midrise, highrise)

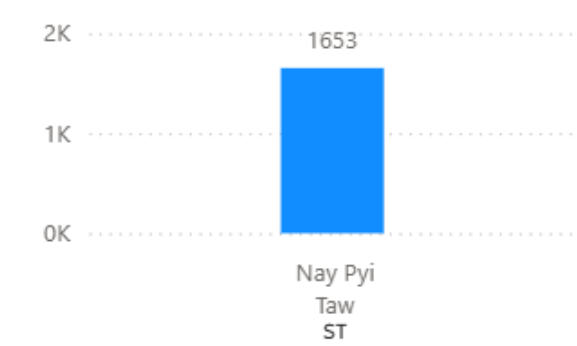


latitude, longitude and PostPlacar

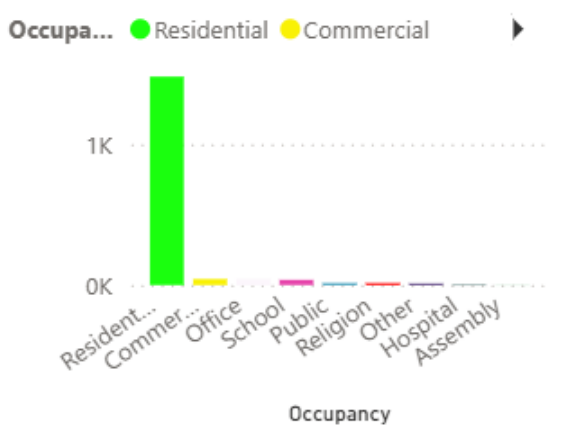
PostPlacar (Blank) CAN BE US... RESTRICT...



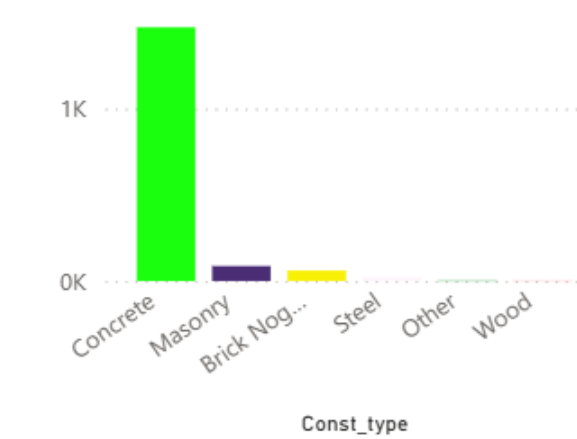
Daily Data



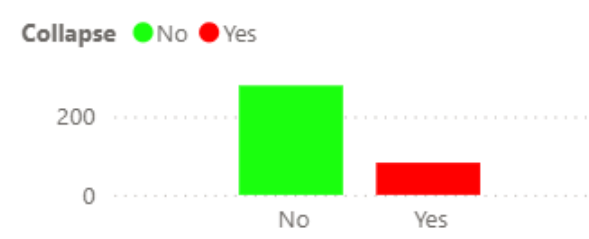
Occupancy



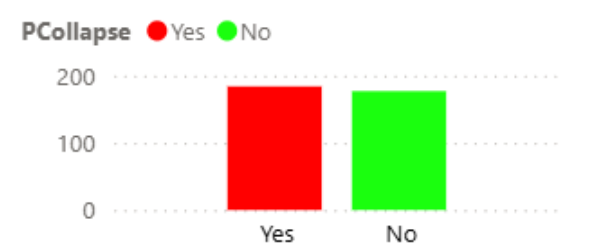
Type of Construction



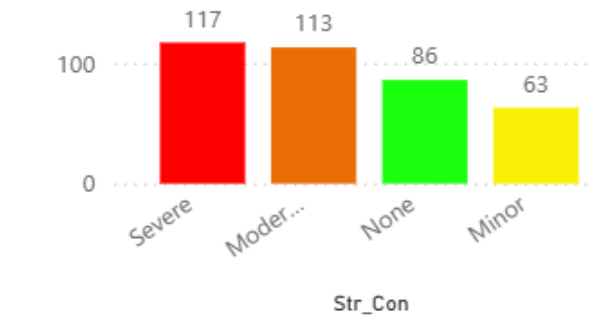
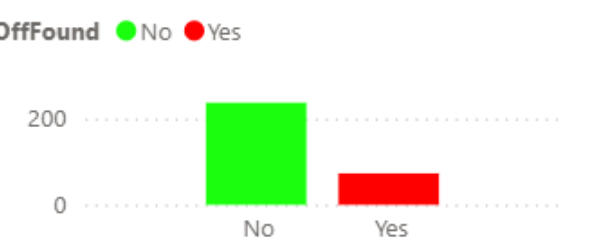
Overall Condition (Collapse)



Overall Condition (Partially Collapse)



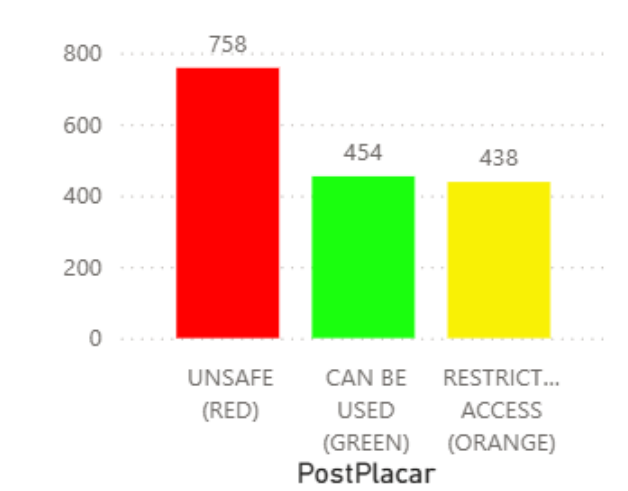
Overall Condition (Off Foundation)



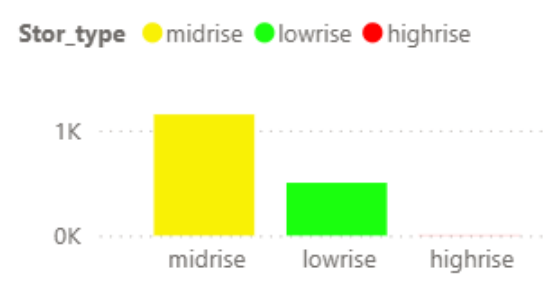
ST/ Region

- ST
- Select all
 - Mandalay
 - Nay Pyi Taw
 - Sagaing
 - Shan (South)

PostPlacar

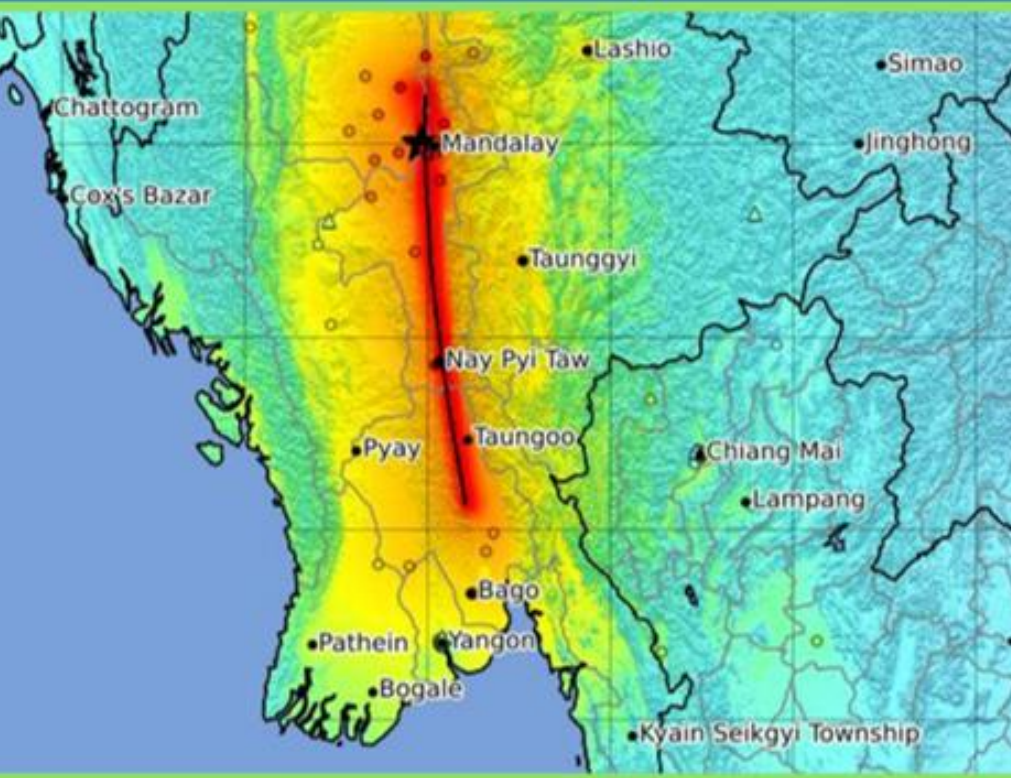


Storey Type



Post Disaster Rapid Damage Assessment (PDRA) Report

7.7 Mandalay Earthquake 2025 Engineering Response & Recovery



PDRA Report

- PDRA report has been published in June 2025.

- End of Part 1



Earthquake Clinics

Life is not something we can understand

Part 2: Post-Disaster Structural Review (PDSR)

PDRA

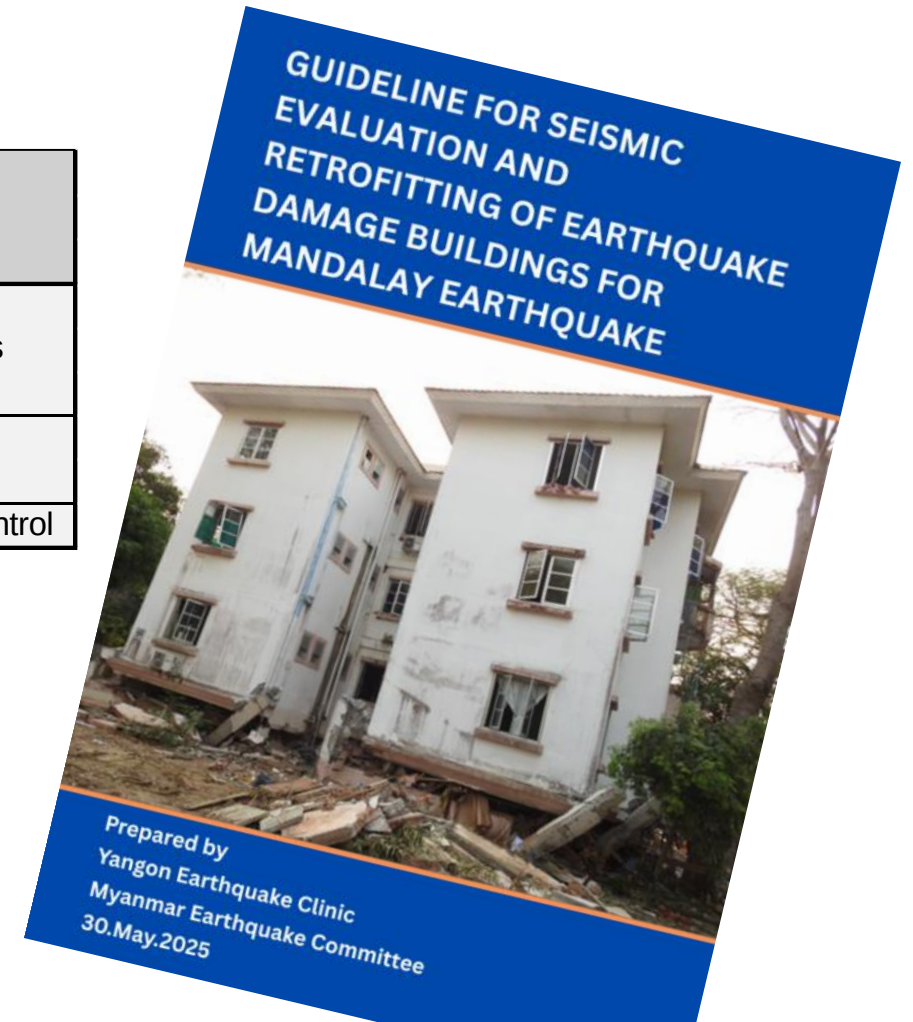


PDRA	Damage State	Stakeholder					Repair Strategy
		Owner	Authority	Engineer			
				RE	RSE	PE	
Blue/ Green	Few Repair						Repair with general guidelines
Orange/ Yellow	Minor Repair						
	Major Repair						Retrofit Design and Repair
Red	Retrofit						Demolishing with Damage Control
	Demolish						

Major Repair + Retrofit



PDSR





Guidelines for Post-Earthquake Repair and Retrofit of Buildings Based on Assessment of Performance-Critical Damage

FEMA P-2335 / May 2025



Structural Review Training and Retrofit Design Training

- Structural Review Training and Retrofit Design Training sessions have been conducted **every Wednesday since the first week of May.**
- The structural assessment and retrofit guidelines has been prepared based on **ASCE 41-17** and **FEMA P-2335**

ASCE/SEI
41-17

**Seismic Evaluation
and Retrofit of
Existing Buildings**

PDSR Scheme

ASCE41-17

- Existing buildings
- Before Earthquake
- Deficiency based
- All building types

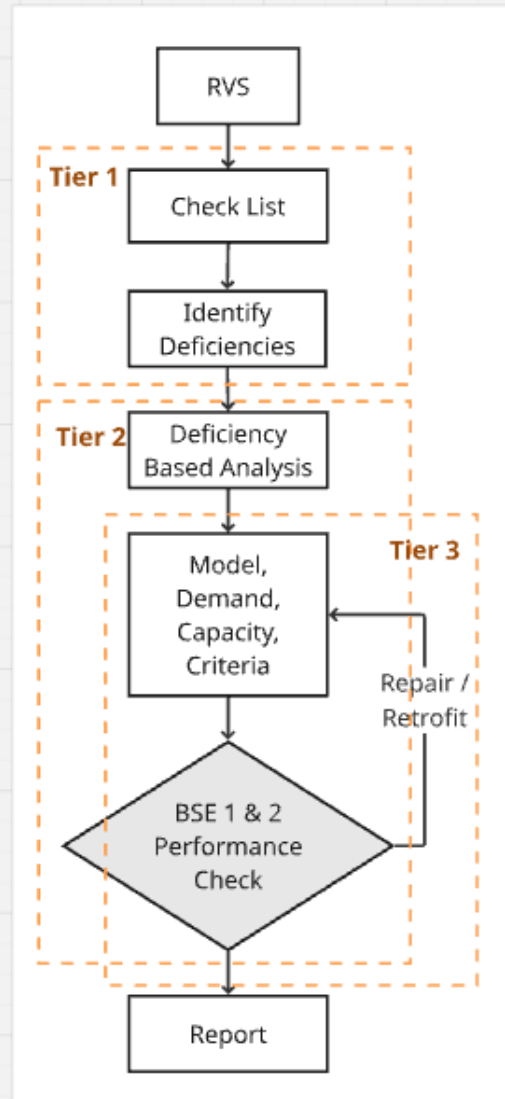
FEMA P2335-25

- Damaged buildings
- After Earthquake
- Damage based
- Concrete buildings only

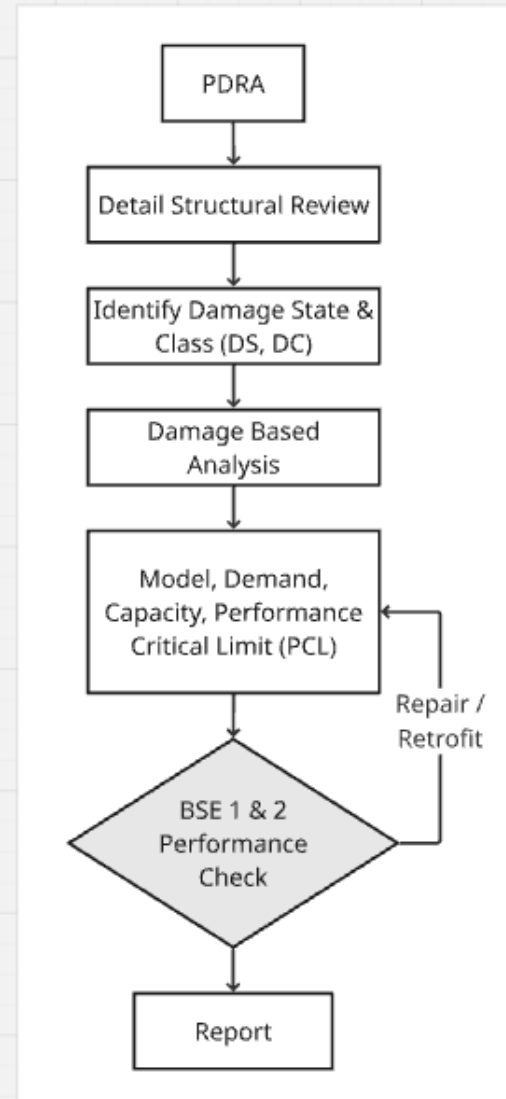
PDSR

- PDRA base
- Apply to all building types

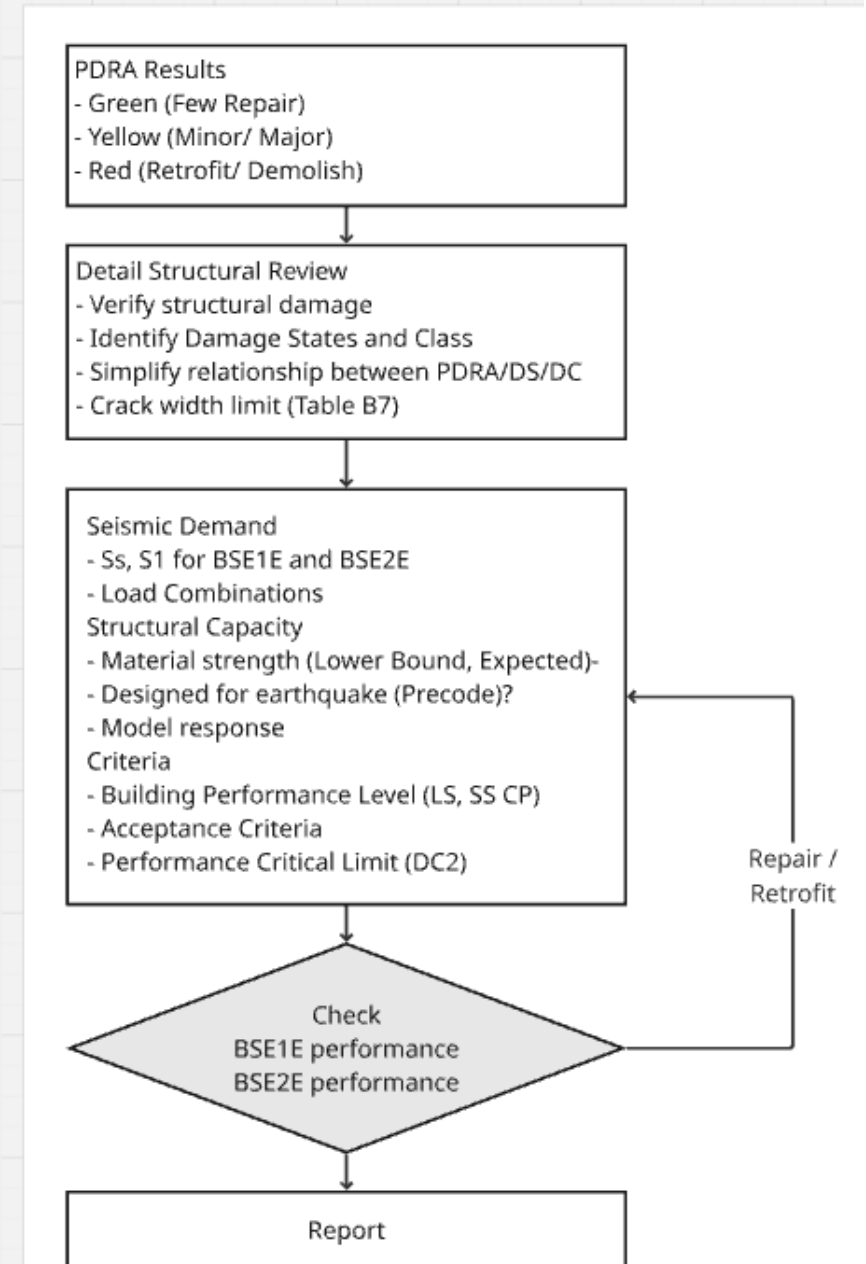
Deficiency Based Evaluation- ASCE41-17



Damage Based Evaluation- FEMA P2335



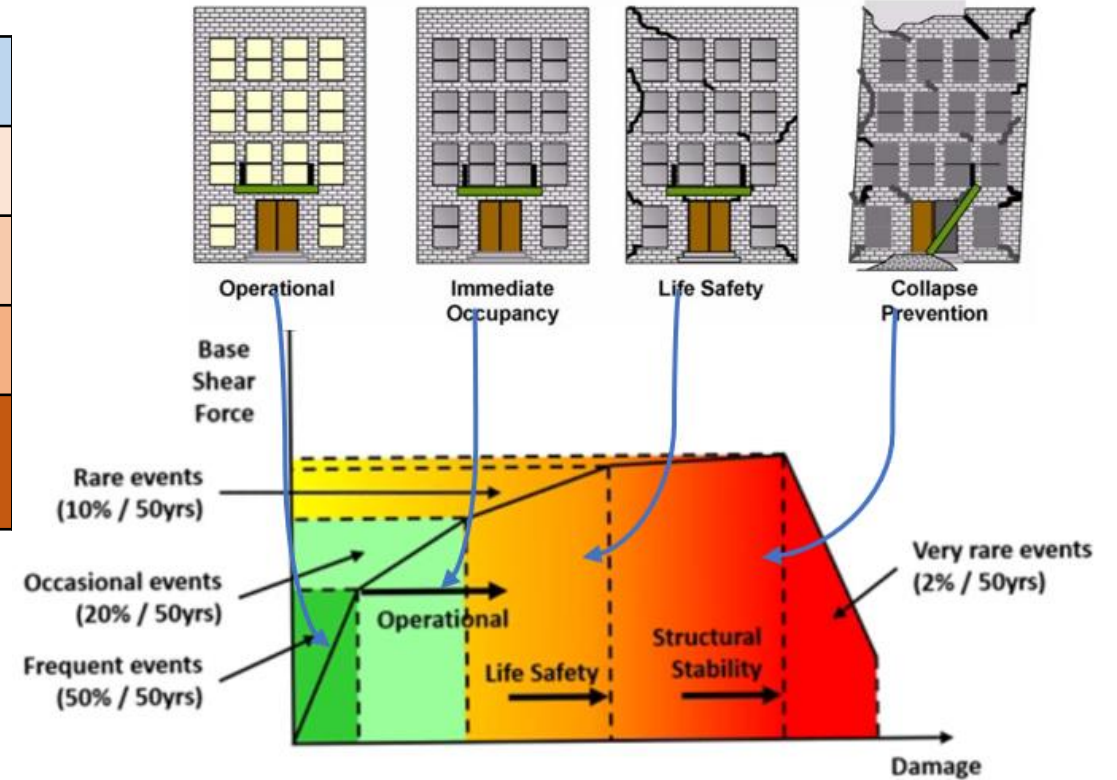
Post Disaster Structural Review (PDSR)



Risk Categories and Performance Objectives

Risk Category	Description	Example
I	Temporary Structures	Garages, working sheds, temporary shelters, temporary structures, etc.
II	Facilities not included in I, III and IV	Normal buildings, small shops, single family houses, etc.
III	Facilities with large number of people	Airport, theater, cinema hall, convention centers, building with more than 5000 people, etc.
IV	Essential Facilities	Hospital, police stations, parliament, government administrative buildings, army headquarters, etc.

Event Category	Return Period	Operational OP	Immediate Occupancy IO	Life Safety LS	Collapse Prevention CP
Frequent	72	I			
Occasional	225	II	I		
Rare	475	III	II	I	
Very Rare	975	IV	III	II	I
Extreme	2475		IV	III	II



Risk Category	BSE-1E	BSE-2E
I and II	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Collapse Prevention Structural Performance Hazards Reduced Nonstructural Performance (5-D)
III	Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)	Limited Safety Structural Performance Hazards Reduced Nonstructural Performance (4-D)
IV	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)	Life Safety Structural Performance Hazards Reduced Nonstructural Performance (3-D)

Factors and Load Combinations

Event Category	Description	Return Period	Exceedance in 50 years	Basic Safety Earthquake	Conversion Factor	Etabs Acceleration Factor
Occasional	Level 1 Earthquake for Existing Building	225	20%	BSE1E, (DBE-E)	1/2	0.75
Rare	Level 1 Earthquake for New Building	475	10%	BSE1N, (DBE-N)	2/3	1
Very Rare	Level 2 Earthquake for Existing Building	975	5%	BSE2E, (MCE-E)	3/4	1.125
Extreme	Level 2 Earthquake for New Building	2475	2%	BSE2N, (MCE-N)	1	1.5

Table 8: Expected material strength with respect to construction year./

Period	Concrete f'_c , (ksi)	Reinforcing Steel f_y , (ksi)	Structural Steel f_y , (ksi)
1900-1919	1	33	18
1920-1949	1	33	24
1950-1989	1	40	24
1990-2001	2.5	50	36
2002-Present	3 to 4	40 to 50	50

Table 20 Factors to Convert Lower-Bound Material Properties to Expected Strength

Material Property	Factor
Concrete compressive strength	1.50
Reinforcing steel tensile and yield strength	1.25
Connector steel yield strength	1.50

Following seismic force combinations shall be used.

$$Q_{UD} = Q_G + Q_E \quad \text{for deformation-controlled action}$$

$$Q_G = 1.1 (Q_D + Q_L)$$

$$Q_G = 0.9Q_D$$

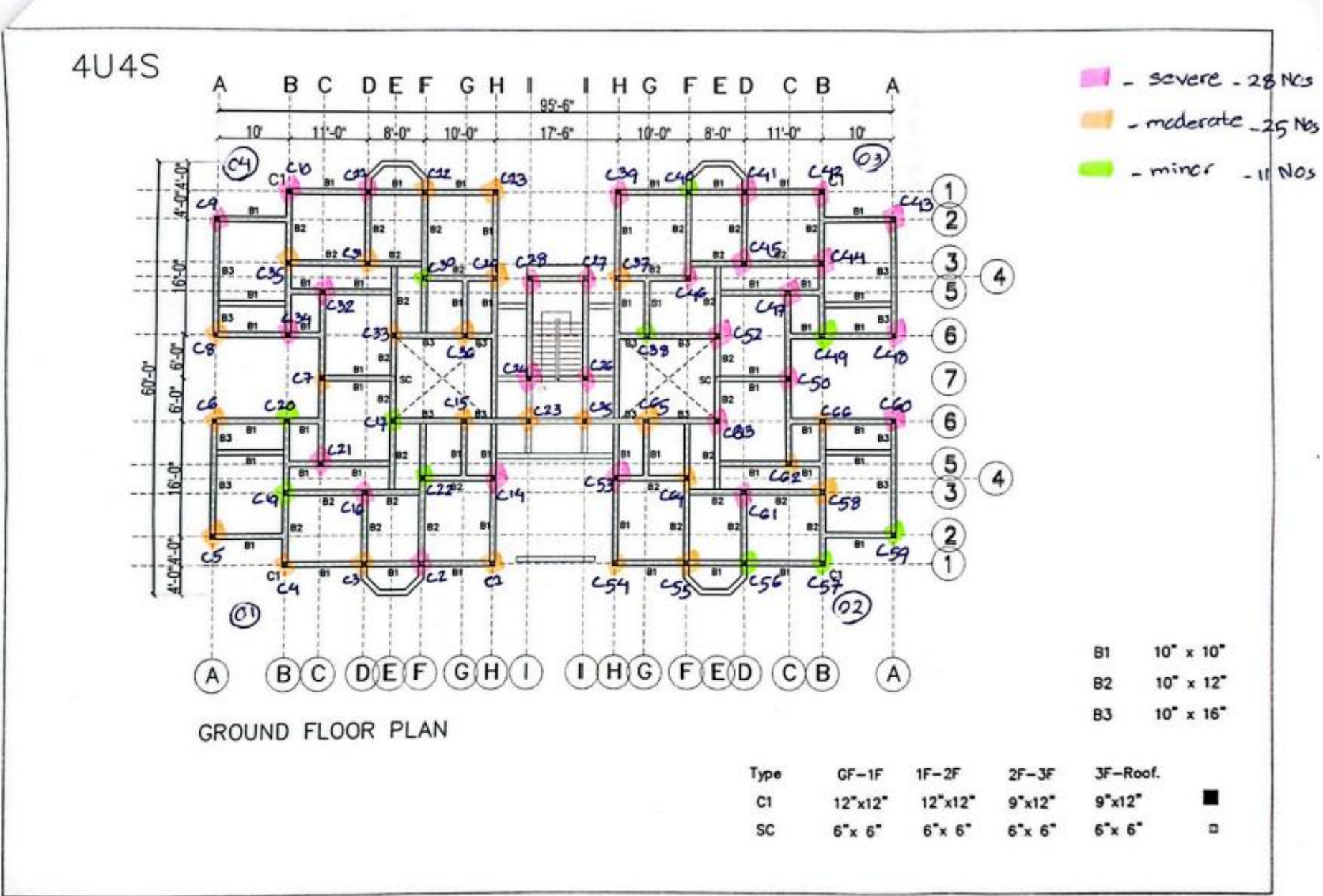
Where Q_{UD} = Deformation controlled action

Q_G = Gravity load action

Q_D = Dead load action

Q_L = Live load action, equal to 25% of the unreduced live load

Field Observation: PDRA Summary



Field Observation: PDRA Damages



GF - C10 (Severe)



GF - C13 (Severe)



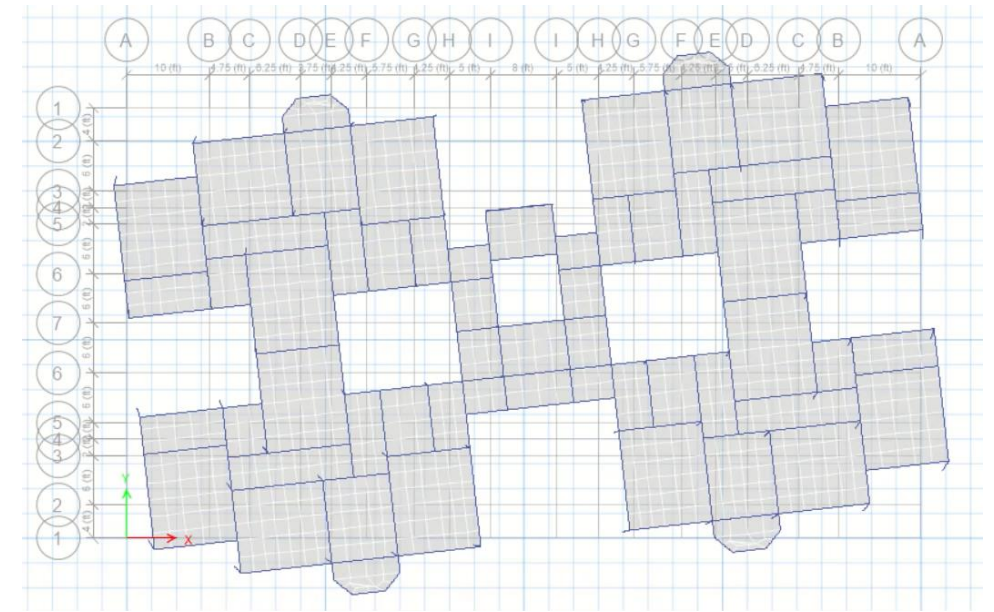
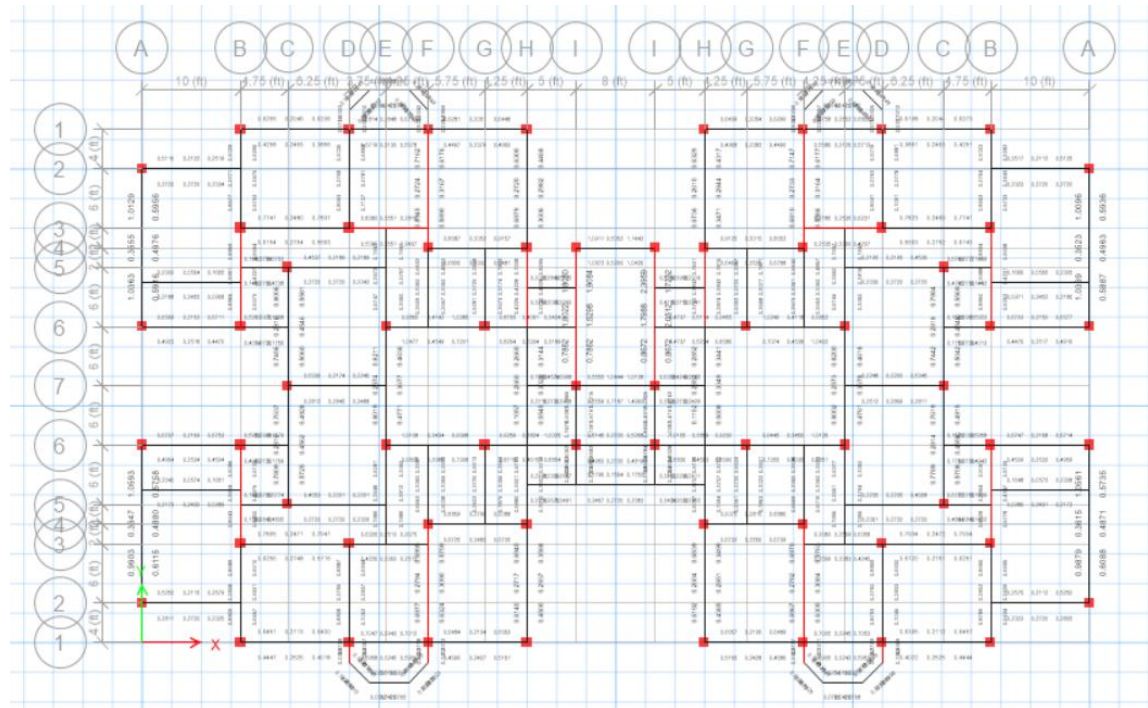
GF - C2 (Moderate)



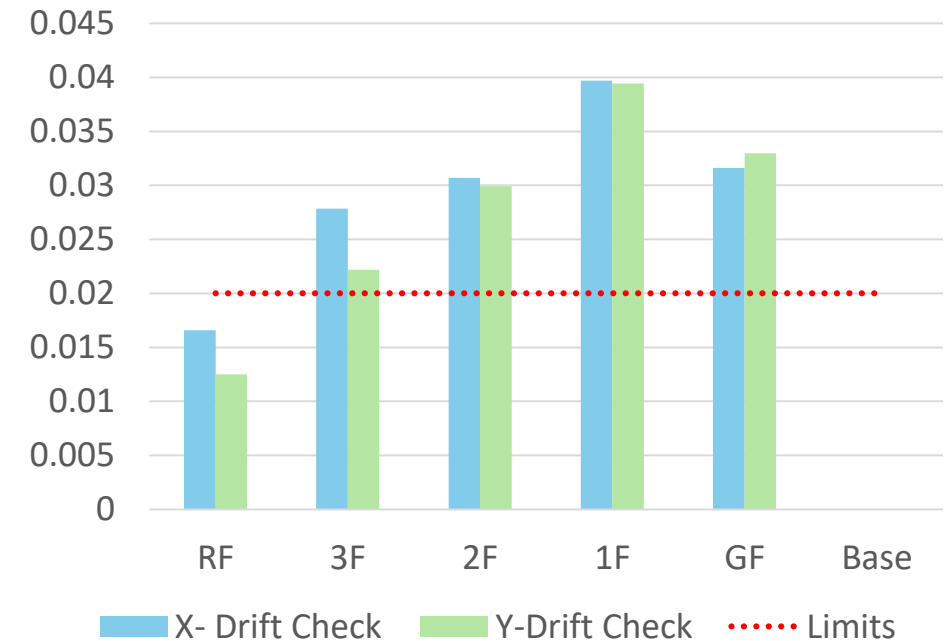
GF - C3 (Moderate)

Existing Model Performances

- First mode in rotation
- Drift limit exceed
- Many concrete columns are failed in design check.

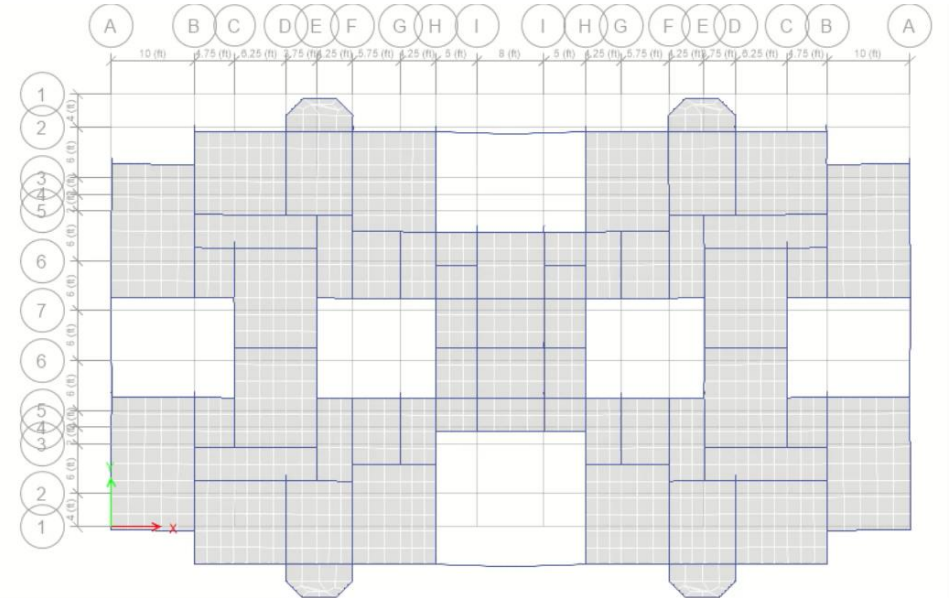
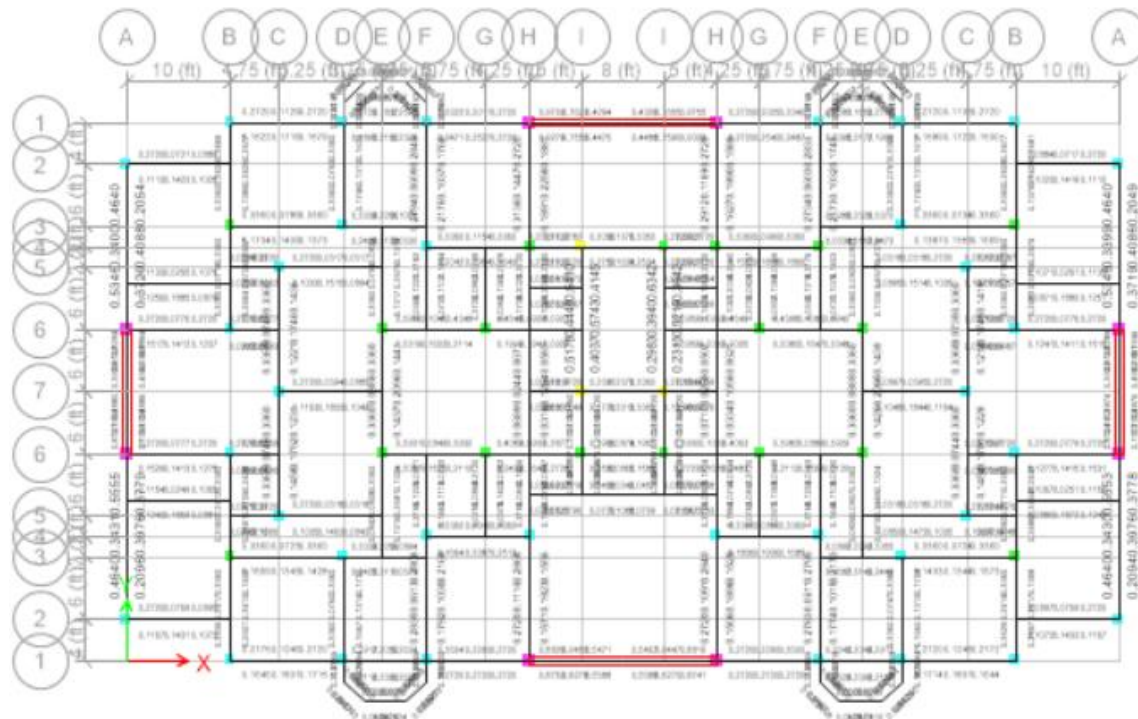


Existing Model Story Drift

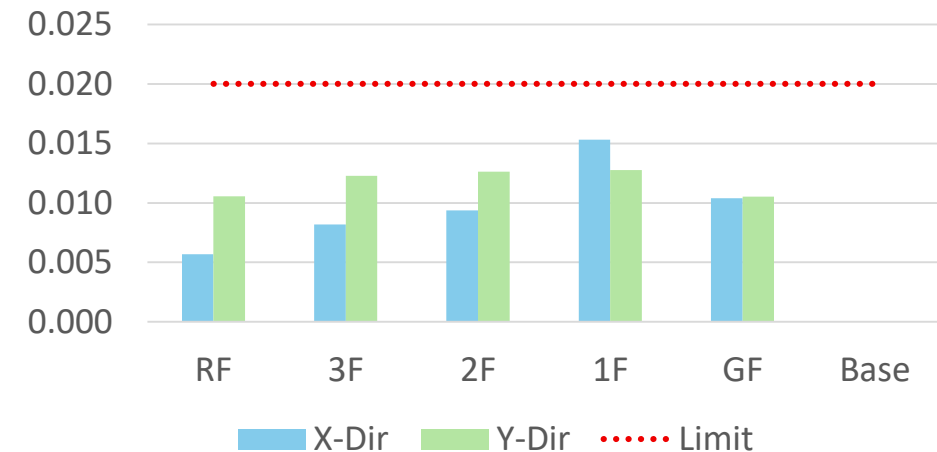


Retrofit Model Performances

- System Improvement:
 - Add lateral force resisting frames in re-entrant corners
- First and second modes in translation
- Drift within limit
- All structural members passed in design check.



Retrofit Model Story Drift



GUIDELINE FOR SEISMIC EVALUATION AND RETROFITTING OF EARTHQUAKE DAMAGE BUILDINGS FOR MANDALAY EARTHQUAKE



Prepared by
Yangon Earthquake Clinic
Myanmar Earthquake Committee
30.May.2025

Summary of PDSR Guideline

- Check performance in **Two Earthquake Levels** with respected **Performance Objectives**.
 - Structural components **failed more than 25%** of total in a story, system improvement is recommended.
 - Identify **system deficiencies** and improve if necessary.
 - **Repair all damages.**
-
- End of Part 2

Damage Zone and Fault Zone Maps

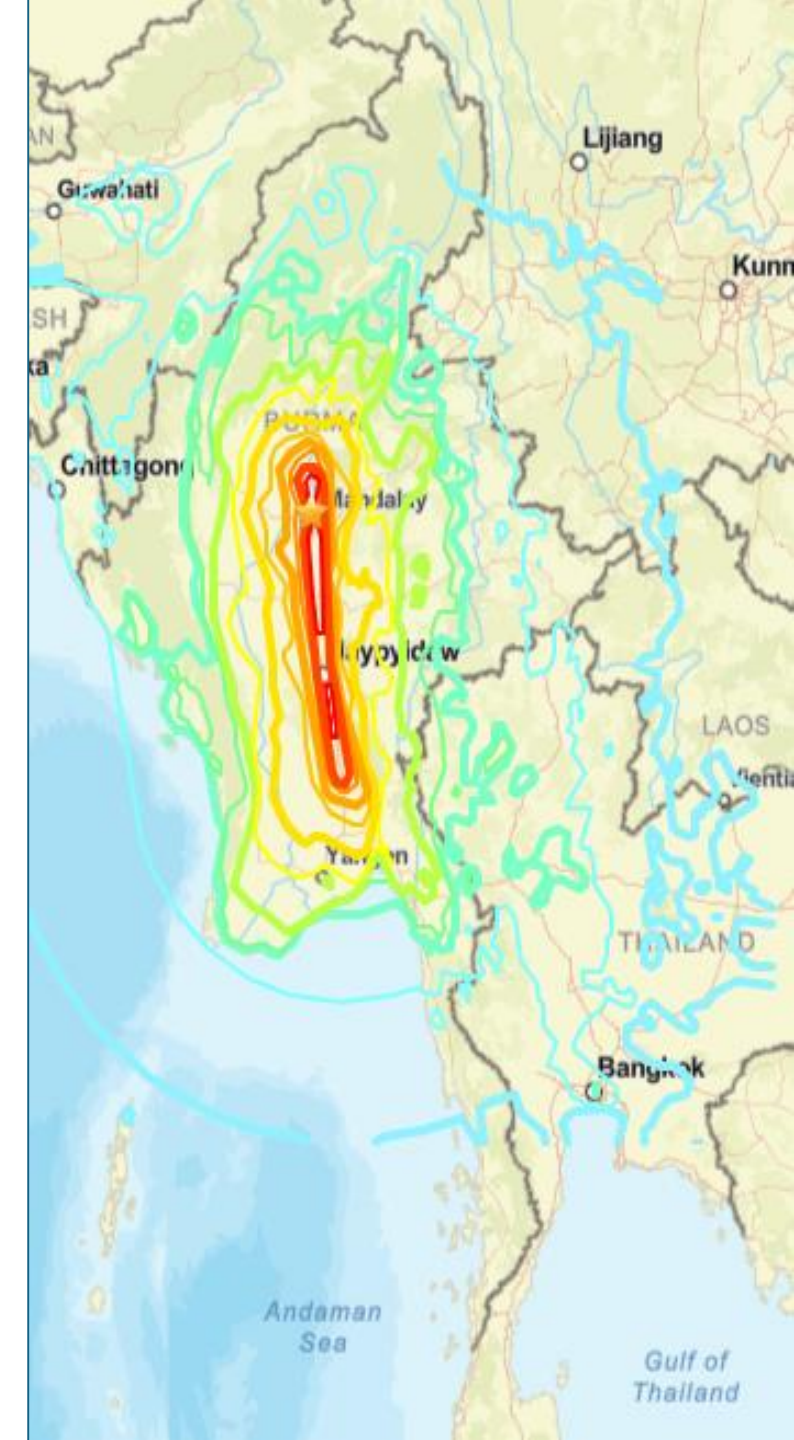
Structural Assessments

- Post Disaster Rapid Assessment (PDRA)
- Post Disaster Structural Review (PDSR)

Damage and Fault Zone Maps

Based on damage assessment data and ground studies from field collaborations and other on-line sources, following maps were prepared.

- Damage Zone Map
 - To prioritize areas and reconstruction activities
 - Efficient resource allocation and coordination
- Fault Zone Map
 - To develop risk base land use planning
 - To setup regulatory compliance system
 - To enhance mitigation, early warning and monitoring system



Damage Zone Map

Based Maps

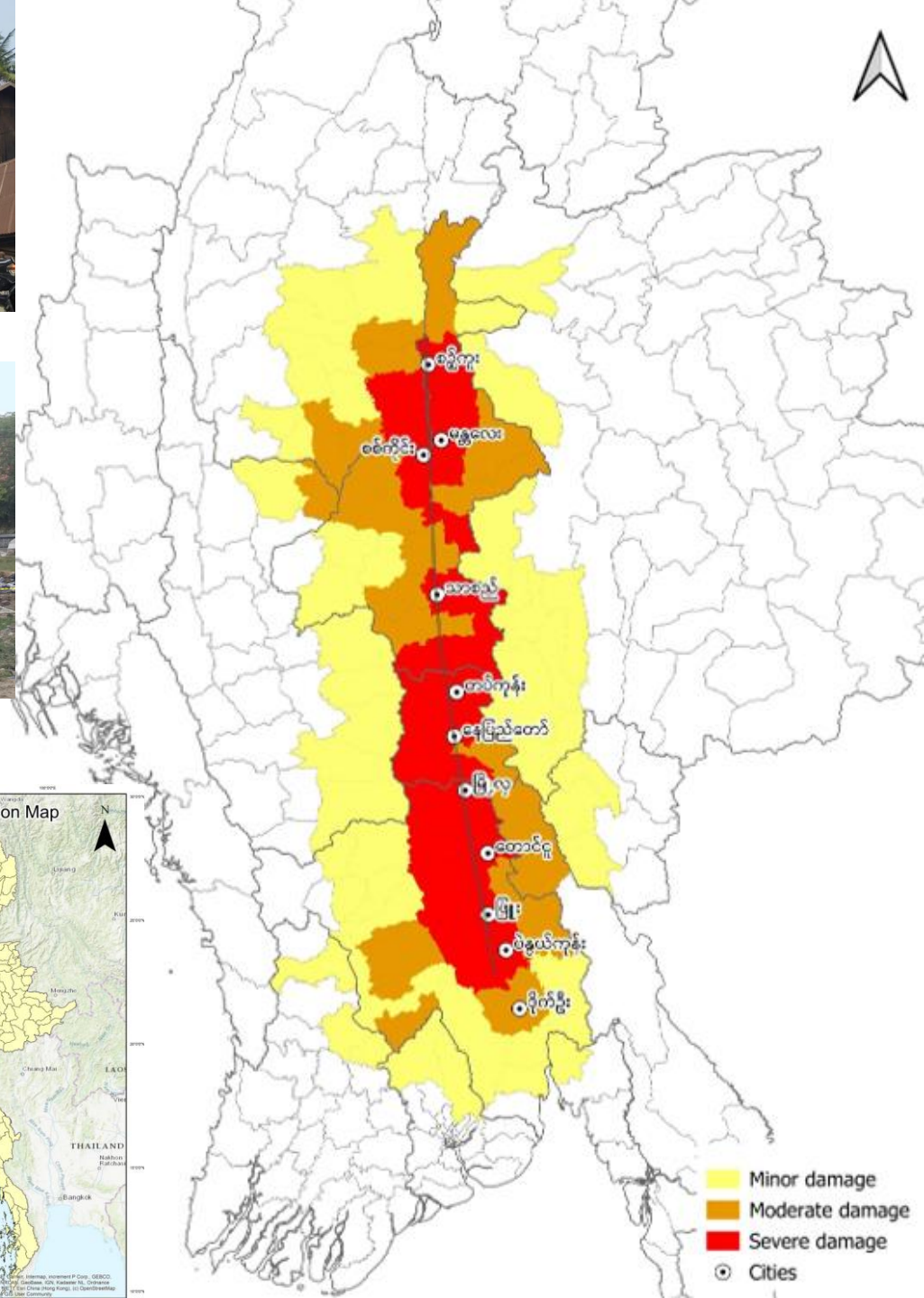
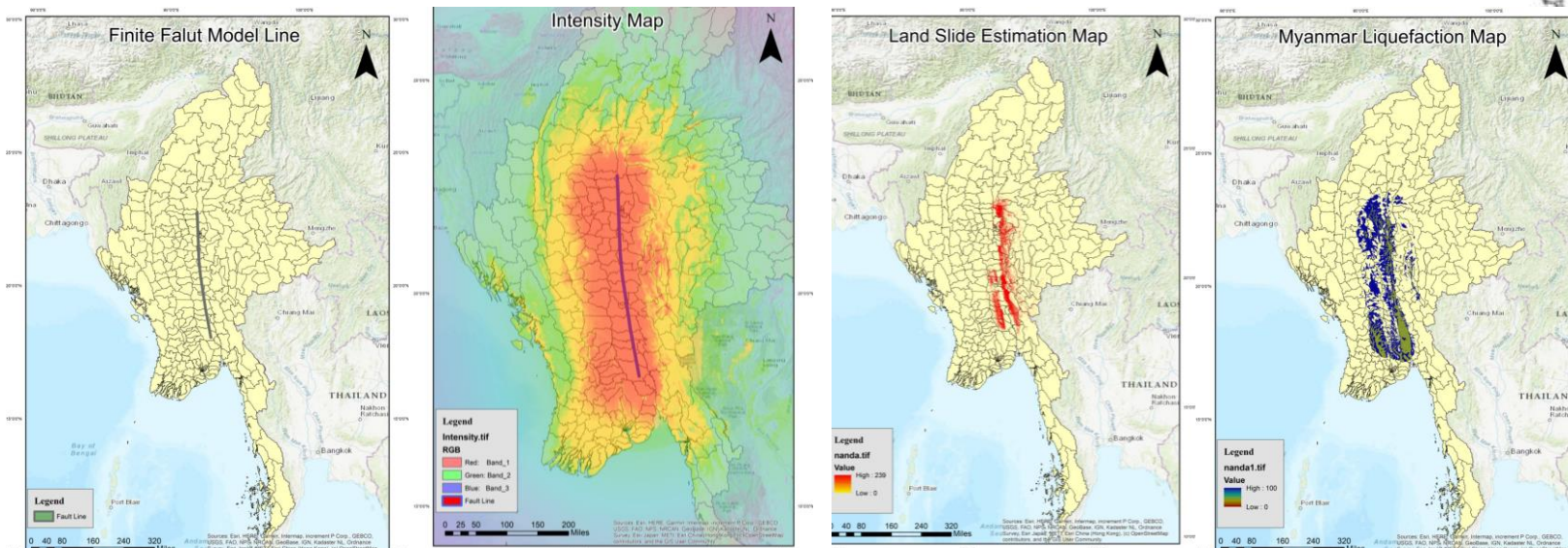
- Fault Model Rupture Line Map
- Intensity Map
- Landslide Risk Map
- Liquefaction Risk Map

Damaged Zone Map

- Field ground verifications
- Based on Township boundary
- Classified into Severe (Red), Moderate (Brown), Minor (Yellow) zones.



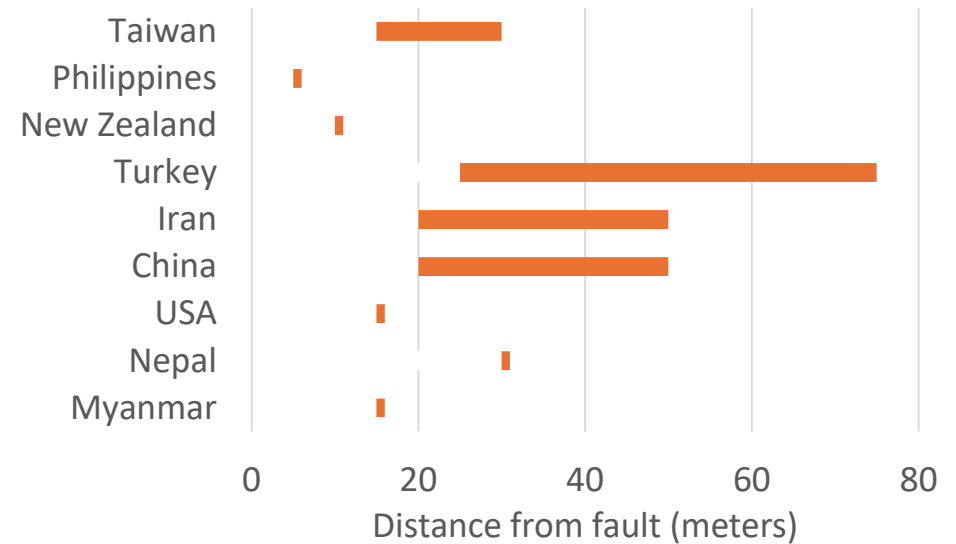
Sagaing Buddha Museum Road



- Minor damage
- Moderate damage
- Severe damage
- Cities

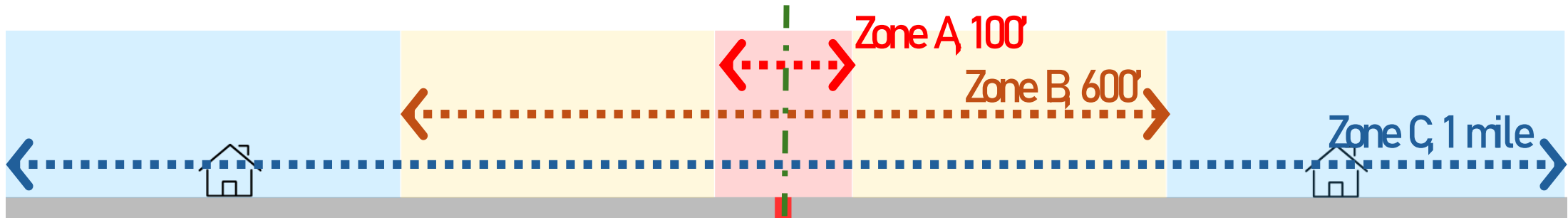
Fault Zone Map

Country specific practices on fault zone



Country	Red Zone (A)	Yellow Zone (B)	Blue Zone (C)
Taiwan	30 meters	30 - 60 meters	>60 meters
Philippines	5 meters (each side Of fault)	5 - 10 meters	>10 meters
New Zealand	~20 meters	meters	>50 meters
Turkey	25 - 30 meters	30 - 75 meters (where applied)	>75 meters
Iran	20 - 30 meters	30-50 meters (local codes)	>50 meters
Japan	Not legally defined	Determined case by case	General seismic risk areas
China	20 meters	meters (local guidelines)	>50 meters
USA (California)	15 meters (50 feet)	Case-by-case (fault investigation zone)	Outside fault rupture hazard zone
Nepal	Not standardized	~ 30 meters (recommended)	>30 meters
Chile	Not legally defined	Case-by-case (based on hazard	General seismic code area
Myanmar	50 ft (15 m) each side	600 ft (200 m) each side	0.5 miles (0.8 km) each side

Fault Zones



Red Zone – High-Risk Fault Zone

Location: 50 ft (15m) each side

Restrictions:

- **No permanent structures** allowed
- **Critical infrastructure** must be relocated or specially designed.
- **Land-use limitations** include bans on underground utilities and pipelines.
- **Review and strengthen existing** buildings.

Purpose: Avoid surface rupture and ensure life safety.

Buffer Zone

Location: 3000 ft (100 m) each side

Restrictions:

- **Conditional construction** allowed with enhanced seismic design.
- **Geotechnical investigations** required.
- **Allow low-rise, light-weight** buildings.
- **Review and strengthen existing** buildings.

Purpose: Mitigate shaking and secondary fault effects

Observation Zone

Location: 0.5 miles (0.8 km) each side

Restrictions:

- **Standard seismic codes** apply.
- **No special land-use bans**, avoid large developments.
- **No Public or Essential** buildings.
- **Review and strengthen existing** buildings.

Purpose: Maintain awareness and future hazard updates.

Yellow Zone – Moderate-Risk

Blue Zone – Low-Risk

Sagaing Innwa Area



Sunn Oo Ponnya Shin

- Badly damaged
- Now under heavy retrofitting work

Sagaing Myoma Market

- Main building badly damaged
- Now under heavy retrofitting work



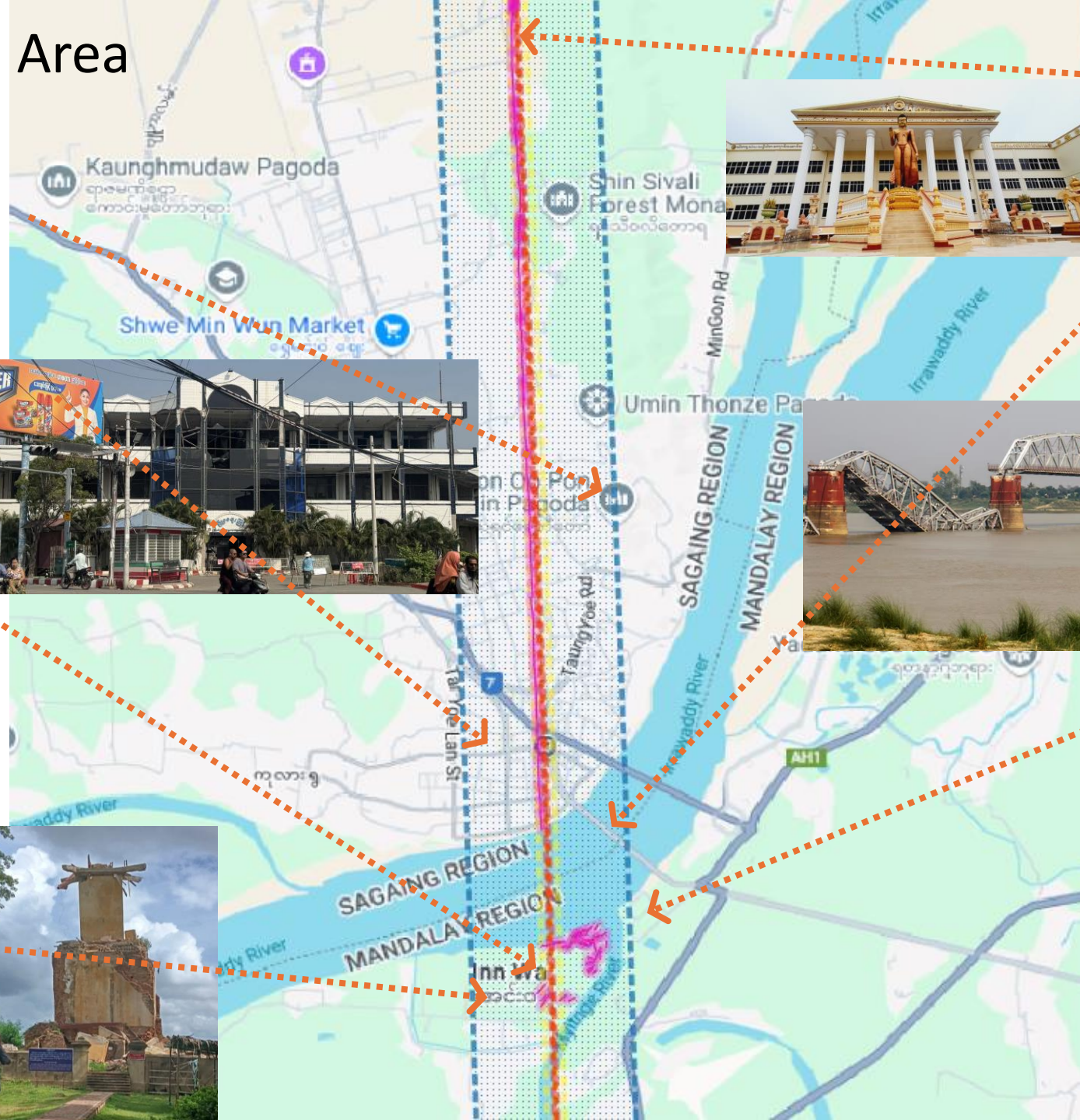
Mae Nu Oakkyang

- Badly damaged
- Debris clearing work completed



Watch Tower

- Badly damaged
- Debris clearing work



Sitagu Sangga Hall

- Most of ground floor columns damaged
- Waiting for retrofitting design



Mandalay Railway Bridge Collapse

- Several segment collapsed
- Clearing work completed



MESDP Innwa Terminal

- No damage report
- Hazardous material storage facility



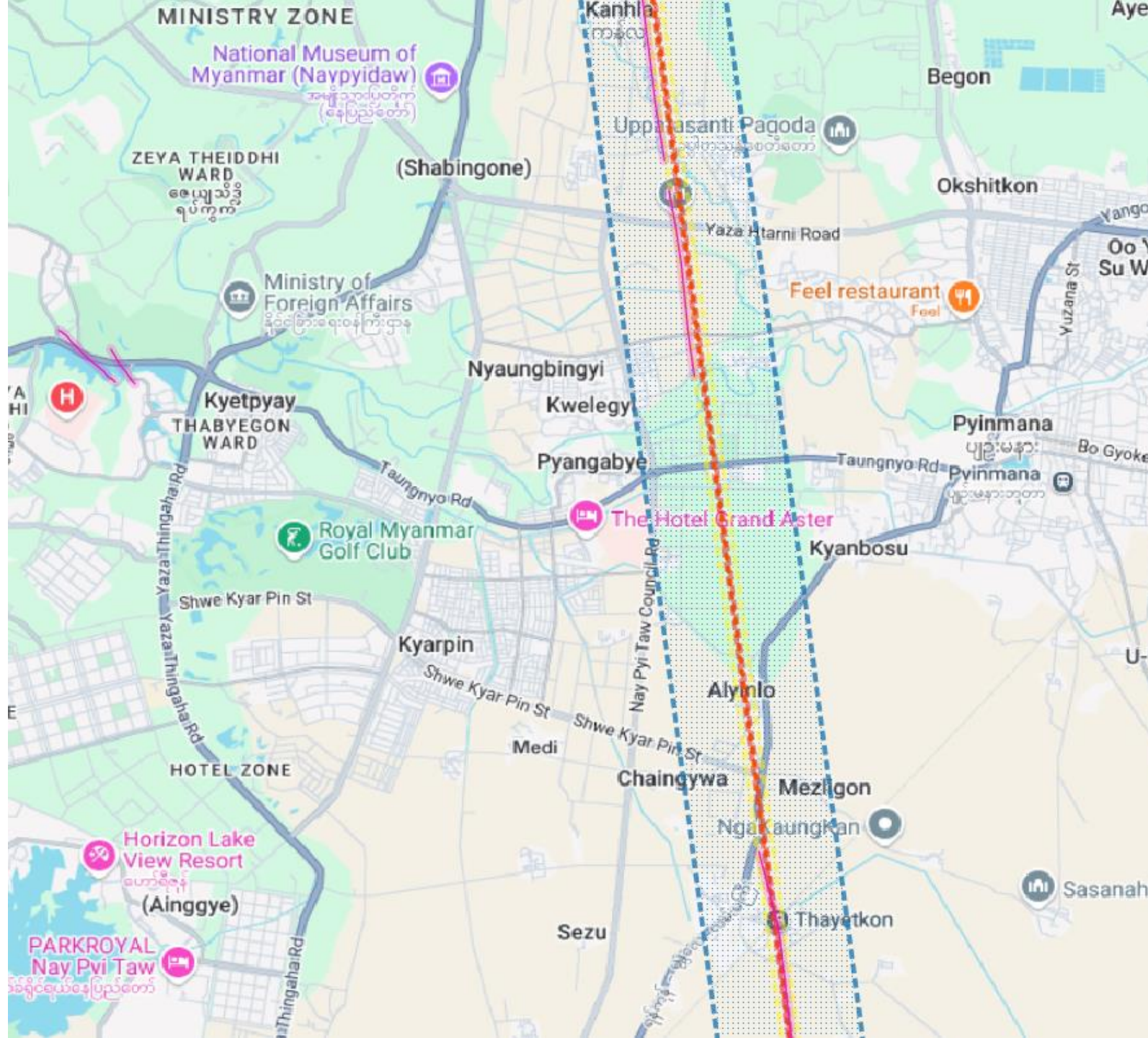
TadaU Area

Mandalay International Airport

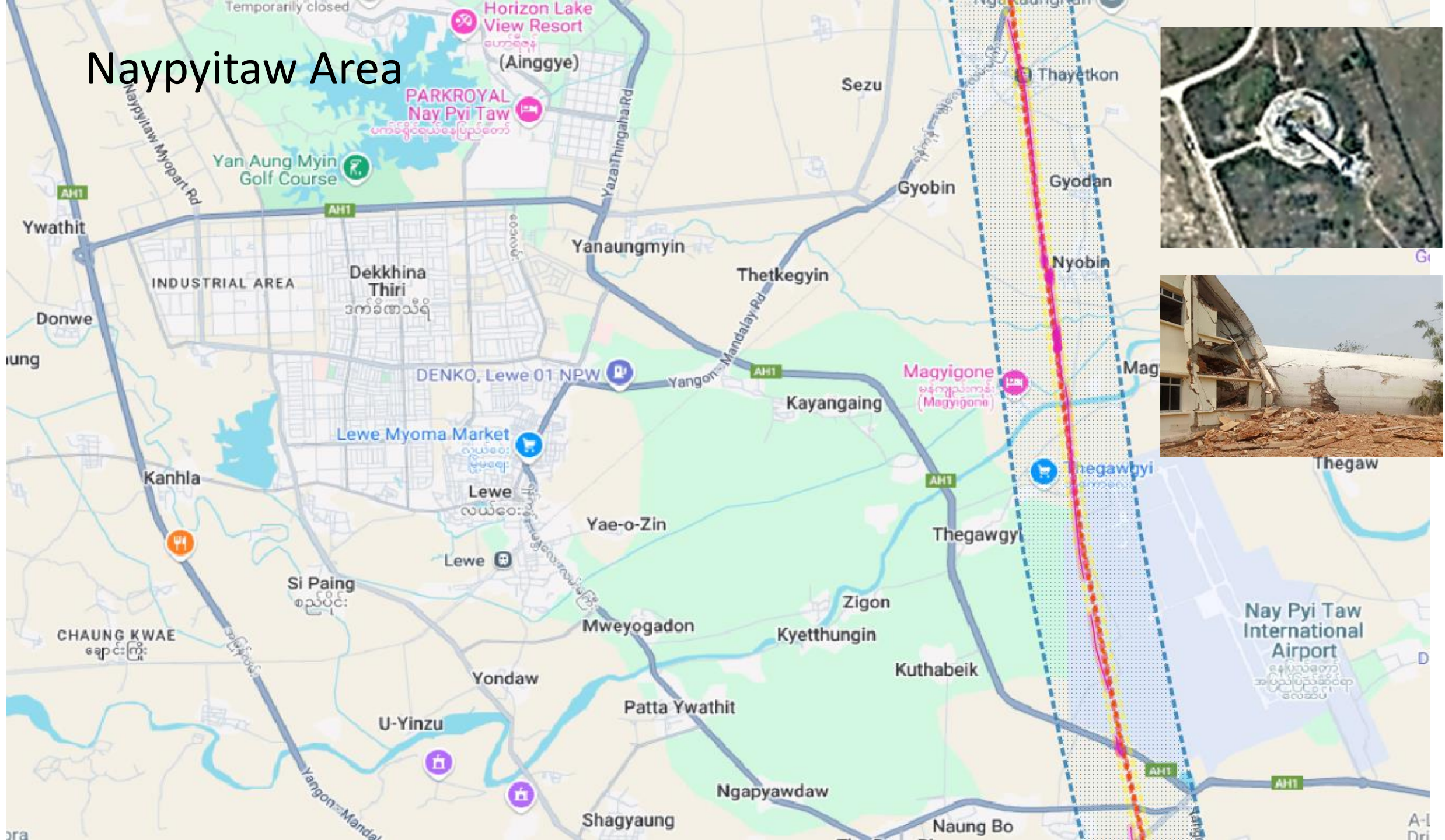
- Close to rupture zone
- Part of runway is in the observation zone



Naypyitaw Area



Naypyitaw Area

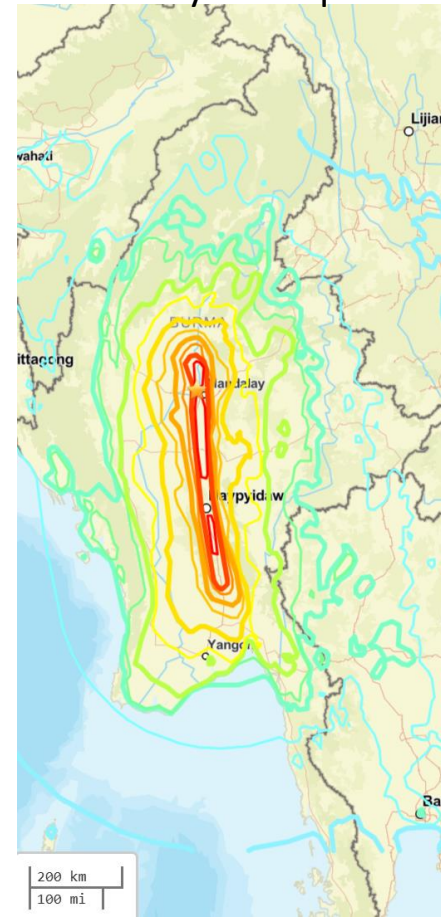


MNBC Code and 2025 updates

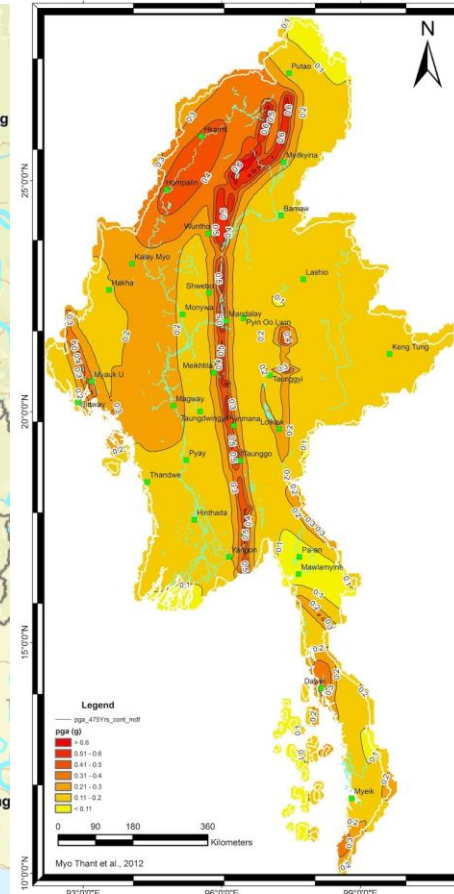
- Hazard map based on major seismic sources such as Sagaing fault, Kabaw fault, Kyauk Kyan fault etc. including 1839 Great Ava Earthquake of 8.3 magnitude.
- Mandalay Earthquake Intensity is relevant to MNBC2020 and MNBC2025 intensity map data.
- In MNBC2025 update, seismic safety has been enhanced by-
 - Seismic Force Increment to all Ground Floor Columns
 - Compulsory Ductile Detailing



Mandalay Earthquake

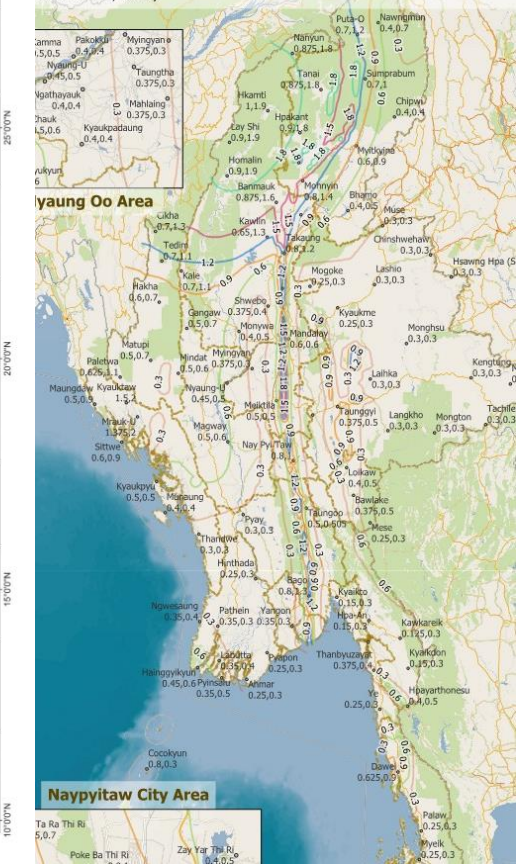


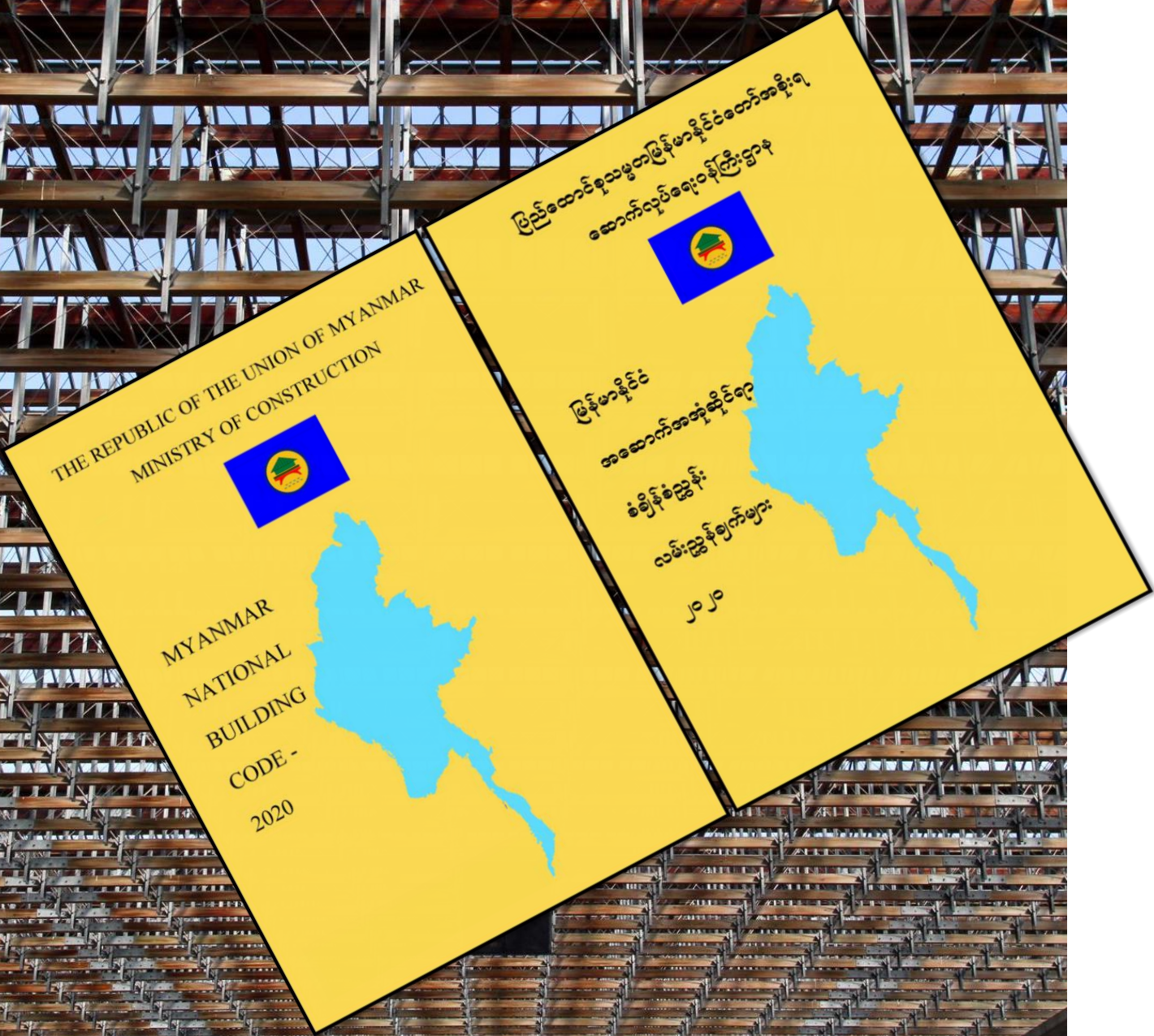
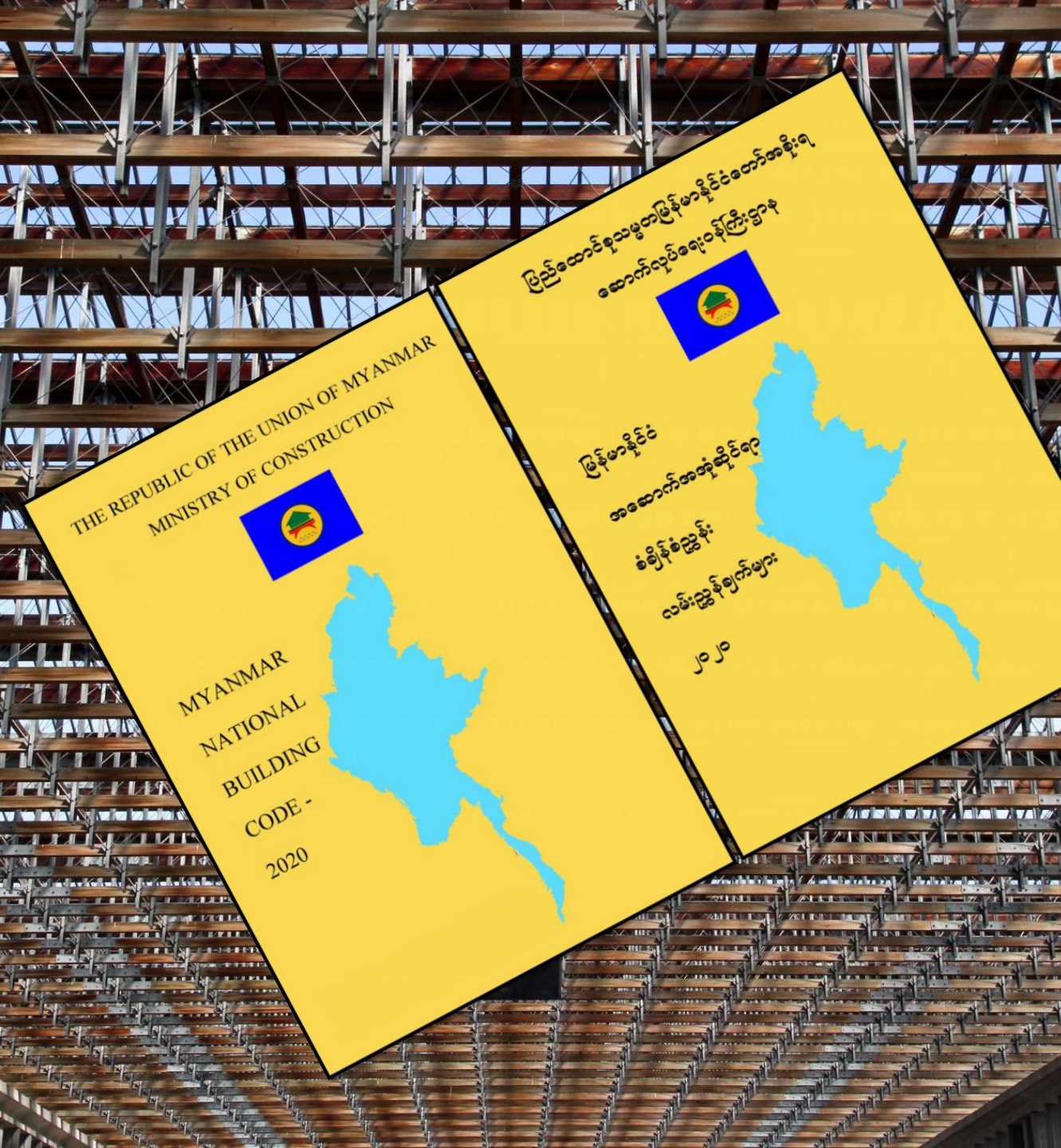
MNBC2020



MNBC2025

num Considered Earthquake Ground Motion for 1.0 Sec Spectral Response
eration at 2% in 50 Years with 5% Critical Damping for Site Class B
Thant et al., 2016)





Recommendations for Future Seismic Resilience

- Implement seismic design and seismic resistant construction practices.
- Implement Fault Zone restrictions for land use planning and earthquake mitigation.
- Enhance training for engineers and emergency responders.
- Promote public awareness and community preparedness.

Thanks for your attention

Myanmar Earthquake Clinics