M7.7 Myanmar Earthquake
March 28, 2025

Released: 5/24/2025
NHERI DesignSafe Project ID: PRJ-5573

JOINT PRELIMINARY VIRTUAL RECONNAISSANCE REPORT (J-PVRR)

Joint Virtual Assessment Team (J-VAT) Lead:
Janise Rodgers, GeoHazards International

Joint Virtual Assessment Team (J-VAT) Contributing Authors:
(in order of section authored)

Selim Günay, University of California, Berkeley
Rinpuii Tlau, GHI
Jorge Archbold, Universidad del Norte
Hari Kumar, GHI
Carlos Arteta, Universidad del Norte
Jesús Caballero, Universidad del Norte
Danny Gho, P-Waver Inc.
Rachel Fields, Oregon State University
Erica Fischer, Oregon State University
Hnin Wai Lwin, AIT
Yeshey Lotay, GHI
Julian Carrillo, Universidad Militar Nueva Granada, UMNG, Colombia
Jeanine Engelbrecht, BGC Engineering
Caio Sringari, BGC Engineering
Scott Anderson, BGC Engineering
Julie Zou, Tonkin + Taylor, New Zealand
ZoMung Thawng, Independent Consultant, Myanmar
Ananth Balachandra, Tonkin + Taylor, New Zealand
Nick Rogers, Tonkin + Taylor, New Zealand
James Russell, Tonkin + Taylor, New Zealand
Danrong Zhang, Georgia Institute of Technology
J. David Frost, Georgia Institute of Technology
Giorgia Giardina, Delft University of Technology & EEFIT
Yasemin Didem Aktas, UCL & EEFIT
Albert Ortiz, Universidad del Valle, Colombia
Yvonne Merino-Peña, University of California, Berkeley
Xavier Romão, University of Porto
Federica Greco, Arup
Matthew Free, Arup & EEFIT
Sutat Leelataviwat, King Mongkut's University of Technology Thonburi
Ji-Eun Byun, University of Glasgow & EEFIT
Sean Wilkinson, Newcastle University & EEFIT
Laura Vargas, Universidad Industrial de Santander

Joint Virtual Assessment Team (J-VAT) Editors:
(in alphabetical order)
Mohammad S. Alam, University of Hawai'i at Manoa
Tracy Kijewski-Correa, University of Notre Dame
Khalid M. Mosalam, University of California, Berkeley
Ian Robertson, University of Hawai'i at Manoa

DEDICATION

This report is dedicated to the memory of all those who lost their lives in the M7.7 Myanmar Earthquake and in solidarity with those who were injured or displaced by this event. We also wish to honor those who labored tirelessly to rescue as many as possible under extremely challenging conditions. This report is a symbol of our ongoing commitment to learn from this disaster and work with colleagues in the region to build more resilient communities in the future.

PREFACE

The National Science Foundation (NSF) awarded an EAGER grant (CMMI 1841667) to a consortium of universities to form the **Structural Extreme Events Reconnaissance (StEER) Network** (see https://www.steer.network for more details). StEER was renewed through a second award (CMMI 2103550) to further enhance its operational model and develop new capabilities for more efficient and impactful post-event reconnaissance. StEER builds societal resilience by generating new knowledge on the performance of the built environment through impactful post-disaster reconnaissance disseminated to affected communities. StEER achieves this vision by: (1) deepening structural engineers' capacity for post-event reconnaissance by promoting community-driven standards, best practices, and training, as well as their understanding of the effect of natural hazards on society; (2) coordination leveraging its distributed network of members and partners for early, efficient and impactful responses to disasters; and (3) collaboration that broadly engages communities of research, practice and policy to accelerate learning from disasters.

The **Geotechnical Extreme Events Reconnaissance (GEER) Association** has been and continues to be the leading organization within the geotechnical engineering community focused on learning from natural hazards such as earthquakes, hurricanes, landslides, debris flows, and floods, amongst others. GEER field missions are designed to acquire perishable data of geotechnical nature in a timely manner, with the aim of developing information that forms the basis of new research activities and new knowledge. GEER teams typically include United States based personnel working collaboratively with local experts and individuals to accomplish data collection objectives. When circumstances prevent deployment of personnel from the United States, then GEER conducts virtual reconnaissance activities working collaboratively with in-country personnel who may not have the same limitations on travel or access.

GeoHazards International (GHI) is a non-profit organization that works to save lives by empowering at-risk communities worldwide to build resilience ahead of disasters and climate impacts. Since 1991, GHI has worked with communities and governments in over 30 countries. GHI strengthens local knowledge and capacities to protect people from the impacts of earthquakes, tsunamis, landslides, floods, tropical cyclones, extreme temperature, and other hazards, as well as a vulnerable built environment. Learning from hazard events allows GHI to better support disaster resilience in the communities they serve. For more information, please visit www.geohaz.org.

The **Earthquake Engineering Research Institute (EERI)** is the leading non-profit membership organization dedicated to understanding earthquake risk and increasing earthquake resilience in communities worldwide. Its multidisciplinary membership includes researchers, practitioners, and students in engineering, geoscience, social science, architecture, planning, government, emergency management, public health, and policy making. EERI has been bringing people and disciplines together since 1948. EERI provides members with the technical knowledge, leadership and advocacy skills, collaborative networks, and multidisciplinary context to achieve earthquake resilience in their communities worldwide. For more information about EERI, please visit: https://www.eeri.org/.

EEFIT

Earthquake Engineering Field Investigation Team

The Institution of Structural Engineers' (IStructE) Earthquake Engineering Field Investigation Team (EEFIT) is the UK's leading post-disaster reconnaissance group, studying, through field and remote deployments, the impact of major earthquakes and tsunamis on buildings, infrastructure and communities, and trajectory and efficacy of recovery since 1982. Among EEFIT's objectives are to train the next generation engineers and disaster risk management professionals through mission work, to stay embedded within the international post-disaster reconnaissance communities, to influence disaster resilience policy through reports, consultations and research output, and to use the groundwork and field data as a test bed for developing, piloting and verifying advanced technology.

Asian Institute of Technology (AIT) is an international not-for-profit English-speaking postgraduate institution, focusing on engineering, environment, and management studies. Founded in 1959, AIT is located on a green campus north of Bangkok, Thailand. The School of Engineering and Technology has a legacy of more than 60 years in offering engineering education, research, and outreach activities to develop qualified professionals who can provide solutions to global and societal challenges.

COPYRIGHT DISCLAIMER

This report was developed to contribute to the efforts of the international research community with the ultimate goal of understanding certain scientific aspects of the M7.7 Myanmar Earthquake. No resources included in this report are used for commercial purposes and none of the authors receive remuneration directly related to the publication of this research document.

All external resources in this report were utilized in line with the Berne Convention for the Protection of Literary and Artistic Works, Section 107 of the Copyright Act of 1976, and the practice of the courts in the United States.

All external resources in this report were used in good faith and in consideration of the possibility of 'fair use' which allows otherwise infringing resource usage to be exempted based on the criteria established by the aforementioned regulations and the practice of the courts.

Fair use is a doctrine in United States copyright law that allows limited use of copyrighted material without requiring licensing and permission from the rights holders, such as commentary, criticism, news reporting, research, teaching or scholarship. It provides for the legal, non-licensed citation or incorporation of copyrighted material in another author's work under a four-factor balancing test.

ATTRIBUTION GUIDANCE

Reference to J-PVRR Analyses, Discussions or Recommendations

Reference to the analyses, discussions or recommendations within this report should be cited using the full citation information and DOI from DesignSafe (these are available at https://www.steer.network/responses).

Citing Images from this J-PVRR

Some images in this report are taken from public sources. Each figure caption specifies the "Source" attributed to the owner of that image; re-use of the image should cite that source directly. Note that public sources might still have copyright issues and depending on the use case, the user may need to secure additional permissions/rights from the original copyright owner.

Other images in this report were acquired by members of one of the contributing organizations or their collaborators. Such images are denoted with "Credit" attributed to the individual in the caption. Thus, it is appropriate to use the report's full citation information and DOI from DesignSafe (these are available at https://www.steer.network/responses).

ACKNOWLEDGMENTS

This report was the product of multiple organizations and made possible by the funders of those organizations.

- This material is based upon work (in part) supported by the National Science Foundation under Grant Nos. CMMI 2103550 and CMMI-1826118 for StEER and GEER, respectively.
- GeoHazards International would like to recognize and thank the many donors who have supported their work and made their contributions to this report possible.
- The EERI Learning from Earthquakes (LFE) program is funded through the support of EERI members and the generous contributions of LFE Endowment Fund Donors.

All authors and editors listed on the cover page participate as volunteer professionals. Thus, any opinions, findings, and conclusions or recommendations expressed herein are those of the individual contributors and do not necessarily reflect the views of their employer or other institutions and organizations with which they affiliate. In addition, any opinions, findings, and conclusions or recommendations expressed in this material are those of the individuals listed on the cover page and do not necessarily reflect the views of the National Science Foundation.

The following J-VAT members were not authors of this report but did contribute to the corresponding Media Repository, published under a separate DOI. Their photographic evidence and analysis were vital to the production of this report:

- Heidi Stenner, GHI
- Hla Myat Shu, AIT
- Isabella Bruges, Universidad del Norte
- Zeyad Khalil, Imperial College London
- Marko Marinković, University of Belgrade
- Julide Yuzbasi, Cukurova University
- Borjan Petreski, Institute of Earthquake Engineering and Engineering Seismology in Skopje
- Burak Duran, University of New Hampshire
- María Mejía, Universidad del Norte
- Kristin Ulmer, Southwest Research Institute

Special thanks also go to StEER's Student Administrator, Kate Ancona for her assistance coordinating this virtual response. We also acknowledge Professor Jonathan D. Bray of UC Berkeley and Graduate Research Assistant Emre Duman of the Georgia Institute of Technology for their contributions to Section 4 in collaboration with the GEER authors. We further acknowledge Mandalay Business Capital City Development Ltd. for permitting discussion of their ongoing project in Section 4.

The authors acknowledge accessing strong-motion data through the Center for Engineering Strong Motion Data (CESMD), last visited on 3 May 2025. The networks or agencies providing the data used in this report are the Geofon Seismic Network.

The sharing of videos, damage reports and briefings via Slack by the entire NHERI community was tremendously helpful and much appreciated. The authors recognize the efforts of the DesignSafe CI team who continuously supported and responded to the team's emerging needs.

ACCESS THIS AND OTHER PRODUCTS
For a full listing of this report and all other StEER products (briefings, reports and datasets) with full citation information and DOIs, please visit the StEER website: https://www.steer.network/responses
The Learning from Earthquakes website provides access to this and other Virtual Earthquake Reconnaissance Team (VERT) reports, datasets, and publications from over 300 earthquakes in more than 50 countries: http://www.learningfromearthquakes.org/
For all GeoHazards International publications and resources to support disaster resilience, please visit the GeoHazards International website: https://www.geohaz.org/resources
All EEFIT mission reports, lecture recordings and other resources can be accessed EEFIT website: https://www.istructe.org/get-involved/supported-organisations/eefit/
For a full listing of GEER reports and products please visit the GEER website: https://geerassociation.org/reconnaissance-reports

COMMON TERMS & ACRONYMS

Acronym	General Terms	Brief Description
--	DesignSafe	Data Repository
--	DesignSafe-CI	Academic Organization within NHERI
AIT	Asian Institute of Technology	University
ASCE	American Society of Civil Engineers	Professional Organization
ASTM	American Society for Testing and Materials (now ASTM International)	Standards Body
ATC	Applied Technology Council	Professional Organization
BOCA	Building Officials and Code Administrators	Code Body
CC-BY	Creative Commons Attribution License	Code/Standard
CESMD	Center for Engineering Strong Motion Data	Governmental Agency
CI	Cyberinfrastructure	Research Asset
CLPE	Critical Load Path Elements	StEER Term
CMU	Concrete Masonry Unit	Building Material
CPIC	Center for Public Interest Communication	Research Support Organization within University of Florida to study, test and apply strategic communication for social change
CWA	Central Weather Administration	Taiwan Governmental Agency
DBE	Design Basis Earthquake	Design Terminology
DDM	Department of Disaster Management	Governmental authority (Myanmar)
DEQC	Data Enrichment and Quality Control	StEER Term
DMH-NEDC	Department of Meteorology and Hydrology – National Earthquake Data Center	Governmental authority (Myanmar)
DOI	Digital Object Identifier	Common Term
EARR	Early Access Reconnaissance Report	StEER Term
EERI	Earthquake Engineering Research Institute	Professional Organization
EEFIT	Earthquake Engineering Field Investigation Team	Professional Organization
EF	Enhanced Fujita Scale	Hazard Intensity Scale
EF	Equipment Facility	Academic Organization within NHERI
EIFS	Exterior Insulation Finish System	Building Component

Acronym	General Terms	Brief Description
FAA	Federal Aviation Administration	Governmental Agency
FAQ	Frequently Asked Questions	Common Term
FAST	Field Assessment Structural Team	StEER Term
FEMA	Federal Emergency Management Agency	Governmental Agency
FIRM	Flood Insurance Rate Maps	Regulatory Product
GEER	Geotechnical Extreme Events Reconnaissance	Academic Organization within NHERI
GHI	GeoHazards International	Non-profit Organization
GMPM	Ground Motion Prediction Model	Technical Term
GPS	Global Positioning System	Measurement Technology
GSA	Government Services Administration	Governmental Agency
HVAC	Heating, ventilation and air conditioning	Building System
HWM	High Water Mark	Intensity Measure
IBC	International Building Code	Code/Standard
ICC	International Code Council	Code Body
IRC	International Residential Code	Code/Standard
ISEEER	Interdisciplinary Science and Engineering Extreme Events Research	Academic Organization within NHERI
J-VAT	Joint Virtual Assessment Team	For multidisciplinary joint responses (i.e., GEER)
LiDAR	Light Detection and Ranging	Measurement Technology
MCE	Maximum Considered Earthquake	Design Terminology
ME&P	Mechanical, electrical and plumbing	Building System
MMI	Modified Mercalli Intensity	Hazard Intensity Scale
MNBC	Myanmar National Building Code	Code/Standard
NBC	National Building Code	Code/Standard
NEER	Nearshore Extreme Event Reconnaissance	Academic Organization within NHERI
NFIP	National Flood Insurance Program	Government Program
NHERI	Natural Hazards Engineering Research Infrastructure	Academic Organization within NHERI
NIST	National Institute of Standards and Technology	Governmental Agency

Acronym	General Terms	Brief Description
NOAA	National Oceanic and Atmospheric Administration	Governmental Agency
NSF	National Science Foundation	Governmental Agency
NWS	National Weather Service	Governmental Agency
OCHA	Office for the Coordination of Humanitarian Affairs	United Nations Agency
OSB	Oriented strand board	Construction Material
OSEEER	Operations and Systems Engineering Extreme Events Research	Academic Organization within NHERI
PAGER	Prompt Assessment of Global Earthquakes for Response	Government Agency (USGS) Knowledge Product
PEER	Pacific Earthquake Engineering Research center	Academic Organization (Earthquakes)
PGA	Peak Ground Acceleration	Intensity Measure
PGV	Peak Ground Velocity	Intensity Measure
PHEER	Public Health Extreme Events Research	Academic Organization within NHERI
PSHA	Probabilistic Seismic Hazard Analysis	Standard Technical Term
PVRR	Preliminary Virtual Reconnaissance Report	StEER Term
QC	Quality Control	Oversight process
RAPID	RAPID Grant	Funding Mechanism
RAPID-EF	RAPID Experimental Facility	Academic Organization within NHERI
RC	Reinforced Concrete	Building Material
SAR	Synthetic Aperture Radar	Standard Technical Terminology
SGI	Special Government Interest	FAA Process
SLP	Surface-Level Panoramas	Measurement Technology
SMS	Short Message Service	Communication Modality
SPC	Storm Prediction Center	Governmental Agency
SSEER	Social Science Extreme Events Research	Academic Organization within NHERI
StEER	Structural Extreme Events Reconnaissance network	Academic Organization within NHERI
SUMMEER	SUstainable Material Management Extreme Events Reconnaissance	Academic Organization within NHERI

Acronym	General Terms	Brief Description
TAS	Testing Application Standard	Technical Standard
USAR	Urban Search and Rescue	Standard Emergency Management Term
UAS/V	Unmanned Aerial Survey/System/Vehicle	Measurement Technology
USD	US Dollar	Standard Currency
USGS	United States Geological Survey	Governmental Agency

EXECUTIVE SUMMARY

The M7.7 March 28, 2025 Mandalay, Myanmar earthquake occurred at 12:50 PM local time (06:20 UTC), causing extensive damage and over 3500 fatalities[1] in central Myanmar, and isolated damage as far as Bangkok, Thailand, over 500 km from the southern end of the rupture. The M7.7 event appears to have ruptured approximately 460 km of the right-lateral strike-slip Sagaing Fault (Benz et al. 2025), the most active and seismically hazardous fault in Myanmar. Based on the single near-field strong motion recording (from the capital, Nay Pyi Taw) available at the time of this report, shaking along the rupture appears to have been quite strong (0.62g PGA and 161 cm/s PGV, horizontal), and at design levels for some period ranges.

Significant ground failure effects have been observed and documented throughout the area impacted by the earthquake. Examples of features from fault rupture, liquefaction and associated ejecta, lateral spreading, pavement distress, regional displacements and dam collapse were observed and documented. Good performance of earth retaining structures and the benefits of ground improvement were also noted.

Numerous buildings collapsed or experienced structural damage in Mandalay and Nay Pyi Taw, and in smaller cities such as Sagaing, Kyaukse, and Amarapura. In Myanmar, reinforced concrete buildings with collapsed weaker/more open ground and/or lower stories were one of the most frequently observed collapse types. Some residential and commercial buildings in Mandalay, Sagaing, and Nay Pyi Taw collapsed completely, including condominiums, a number of hotels, and other residential and mixed-use buildings. In Thailand, multiple buildings were damaged in Chiang Mai and in Bangkok, where a high-rise under construction collapsed, causing dozens of fatalities and triggering a government investigation. In Myanmar, vernacular brick-nogging, unreinforced masonry, and timber buildings collapsed in strongly shaken areas. Numerous important facilities, including 640 hospitals and clinics, over 2600 schools, and some fire stations were damaged (AHA Centre 2025). The General (government) hospitals in Mandalay, Sagaing, and Nay Pyi Taw experienced large surges of injured patients, and Mandalay General Hospital lost power and water. Religious and cultural heritage structures in Myanmar, including hundreds of monasteries, pagodas/stupas, over 50 mosques, and a few churches, experienced significant damage.

In Myanmar, widespread power outages occurred, though limited information on damage to power systems was available. Two major bridges and multiple smaller bridges collapsed, and ground failures of various types caused significant damage to roads, streets, and railways. However, the amount of infrastructure that is heavily dependent on subsurface conditions and thus vulnerable to major earthquakes is less than other countries. In Thailand, limited infrastructure damage was reported, though a portion of an elevated rail line under construction in Chiang Rai collapsed.

In response, StEER activated at Level 1 and joined a consortium of several organizations to form a Joint Virtual Assessment Team (J-VAT) that includes members of StEER, the Geotechnical Extreme Events Reconnaissance (GEER) Association, the Earthquake Engineering Research Institute (EERI) Learning from Earthquakes (LFE) Program, the UK's Earthquake Engineering

[1]Casualty figures from the Department of Disaster Management as of April. Opposition media reported a nationwide death toll of 4484 as of May 18, 2025 (DVB 2025a). The National Unity Government (government-in-exile) reported 4200 fatalities as of April 20, 2025 (NUG 2025). Other groups have reported higher death tolls, e.g., (Shahzada, Noor, and Xu 2025).

Field Investigation Team (EEFIT), GeoHazards International (GHI), and the Asian Institute of Technology (AIT) in Bangkok.

The J-VAT was charged with the production of the primary product of the joint response to this event: this **Joint Preliminary Virtual Reconnaissance Report (J-PVRR),** intended to: (1) provide an overview of the March 28, 2025 M7.7 Myanmar earthquake and it societal impacts; (2) overview the regulatory environment and construction practices in the affected areas; (3) document its geotechnical dimensions and impacts to the built environment by synthesizing insights from remote sensing and preliminary reports of geotechnical failures and damage to land, buildings and infrastructure; and (4) offer recommendations for continued study of this event. Note that observations in Myanmar were based primarily on images shared on social media by local residents and local media (foreign journalists were not allowed in the affected areas), satellite imagery, official damage figures from the military government, and reports by ASEAN and UN agencies. Observations in Thailand were based on local reports from the field, local and international media, social media, and official damage information from ASEAN and the government.

Recommendations for further study center on investigation of the (i) Impacts of surface fault rupture on infrastructure and urban areas in Myanmar, (ii) building and infrastructure performance near Nay Pyi Taw (NPW) strong motion station, which recorded the strongest motions for the event, (iii) impacts on distant soft-soil sites in Bangkok and Yangon, (iv) ground motion studies, particularly related to supershear rupture and soft soil conditions, (v) power system performance in Myanmar, and (vi) health system impacts due to direct damage, loss of utility services, evacuations, and patient surge.

TABLE OF CONTENTS

1. Introduction

The March 28, 2025 M7.7 Mandalay, Myanmar earthquake occurred at 12:50 PM local time (06:20 UTC), causing extensive damage and loss of life in central Myanmar and isolated damage as far as Bangkok, Thailand, over 500 km from the southern end of the rupture. Shaking was widely felt across Myanmar and Thailand, and in some neighboring areas of India and China (USGS 2025a). Over 7 million people were likely exposed to shaking of MMI VIII or higher, according to PAGER estimates (USGS 2025b). Figure 1.1 shows affected areas, with administrative jurisdictions. In Myanmar, the Mandalay administrative region was the most affected, with additional significant impacts in Sagaing, Nay Pyi Taw, and Bago regions and in Shan State. In Thailand, limited but significant damage was reported in Bangkok and Chiang Mai.

1.1. Societal Impact

The earthquake had major societal impacts, affecting a large percentage of the population. USGS PAGER estimated economic losses to be in the range of $1-$10B (20% probability), $10-$100B (35% probability), and $100B-$1,000B (40% probability) (Fig. 1.2b). It is noted that Myanmar's Gross Domestic Product (GDP) in 2023 was $66.8B (World Bank 2025), therefore, it is likely that this earthquake will have a major impact on Myanmar's economy.

However, before the earthquake, Myanmar was already coping with ongoing conflicts and political instability; a significant percentage of its population was displaced and in need of humanitarian assistance. Approximately one-third of the population needed humanitarian assistance (UN Women 2025), including more than 6.5 million children; one in three displaced people in the country was a child (UNICEF 2025a). These conditions were worsened by the earthquake. Considering the basic characterization of increased risk as a convergence of hazard, exposure, and vulnerability, this was an extreme earthquake that impacted a vast and vulnerable population and infrastructure. It is estimated that more than eight million people were affected and were in urgent need of assistance after the earthquake (Mizzima News 2025).

A large number of casualties were reported, with government estimates that more than 3500 people were killed[2] and thousands more injured. Homes, schools, hospitals, and infrastructure such as roads and bridges were damaged. Many families already surviving in fragile conditions now face even greater hardship, with limited access to safe water, healthcare, and shelter. In the days following the earthquake, heavy rains were reported across parts of Mandalay and Sagaing, damaging makeshift shelters, causing further misery for those sleeping in the open, and raising the risk of disease outbreaks (UNICEF 2025a). According to the Department of Disaster Management (DDM), Myanmar, in mid-April 198,623 people were displaced due to the earthquake. Of these, 41,733 people were staying in 145 temporary shelters (AHA Centre 2025).

Women and girls, already vulnerable due to ongoing conflict and economic instability, face heightened risks and unique challenges in the aftermath. With homes and infrastructure destroyed, women and girls are at increased risk of gender-based violence in overcrowded, makeshift shelters where they lack privacy and security, or outside in tents or with only blankets or sheets to separate spaces, and with limited lighting (UN Women 2025). Children separated from families and caregivers face increased risks of violence, trafficking, and unsafe migration.

[2]Various death tolls have been reported by state media, opposition media, and others, in the range of 3600 to over 5000 deaths. See Section 1.2 Loss of Life and Injuries for discussion.

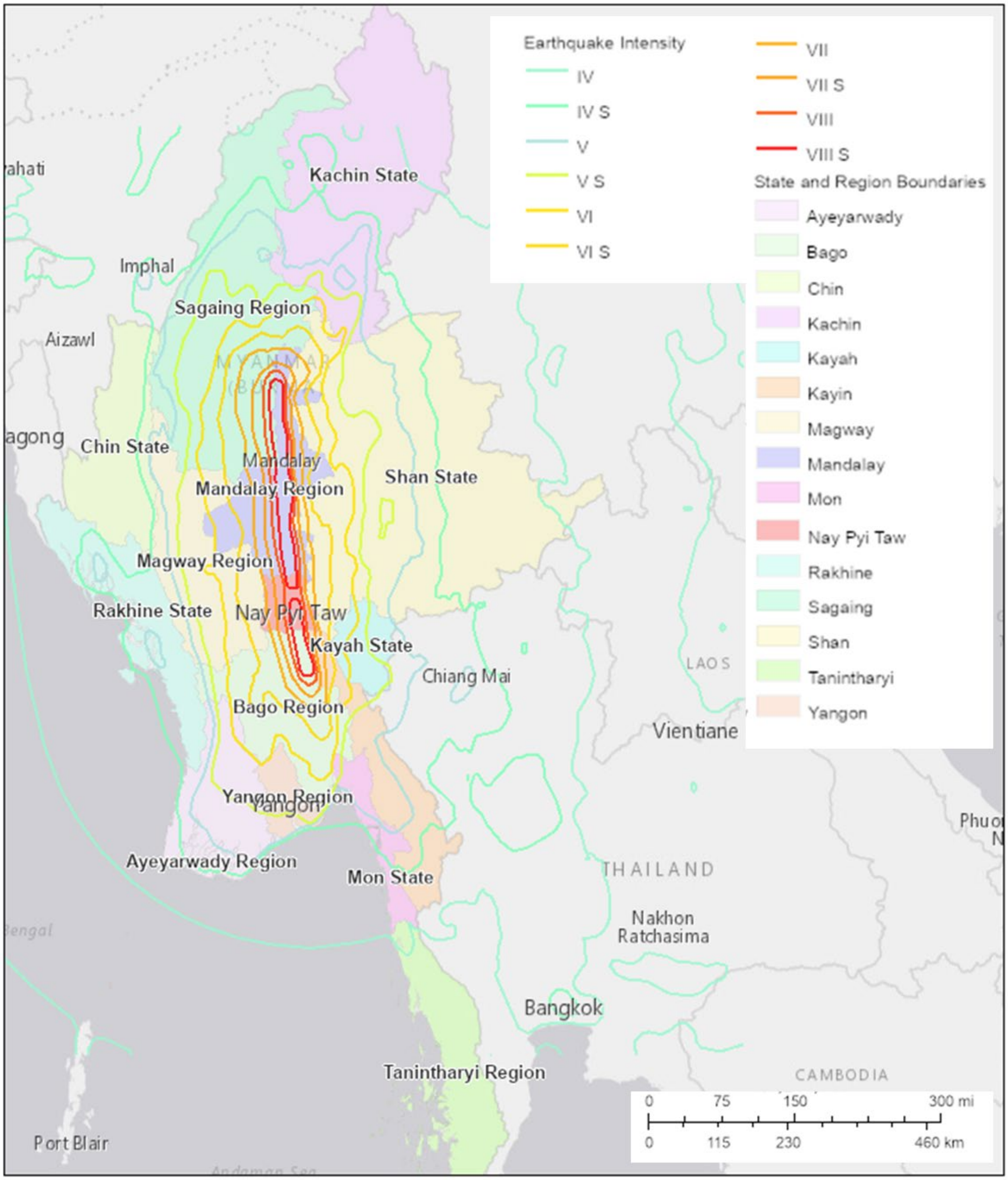
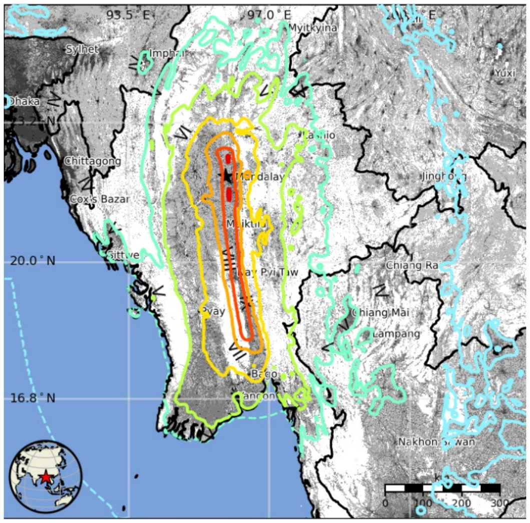


Figure 1.1. USGS ShakeMap and affected areas of Myanmar and Thailand, with administrative divisions (Source: USGS, ESRI; created with Myanmar Information Management Unit mapmaker).

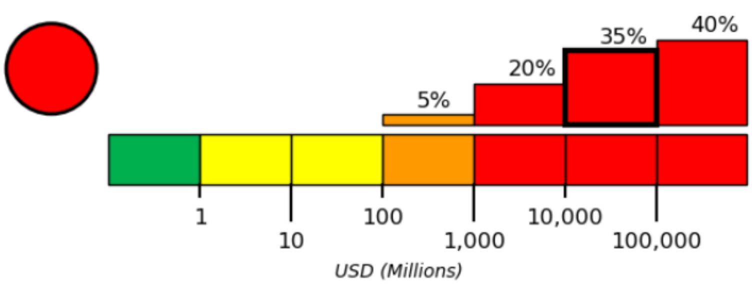


Population per ~1 sq. km. from LandScan

Population Exposure

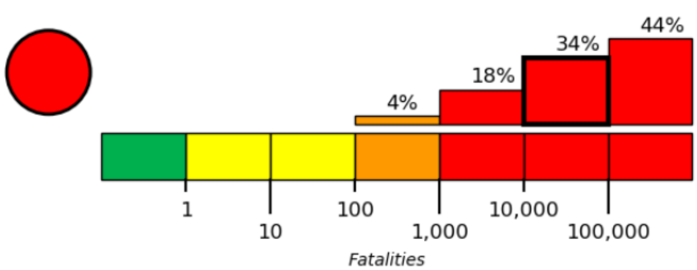
MMI	Shaking	Population
I	Not Felt	0 k*
II-III	Weak	32,989 k*
IV	Light	163,709 k*
V	Moderate	24,656 k
VI	Strong	20,277 k
VII	Very Strong	8,788 k
VIII	Severe	3,637 k
IX	Violent	5,801 k
X	Extreme	415 k

(a)



Estimated economic losses may exceed the GDP of Burma.

(b)



(c)

Figure 1.2. USGS PAGER Knowledge Products as of April 16, 2025: (a) isoseismals (curves of equal MMI) estimated for Mw 7.7 earthquake; (b) estimated economic losses; (c) number of estimated fatalities (USGS 2025b).

Disrupted healthcare further restricts access to care for childbirth, maternal health, and survivors of gender-based violence. Lack of clean water, and damage to WASH (water, sanitation, and hygiene) facilities impact the entire population with especially pronounced impacts on women of childbearing age (UN Women 2025). Women also face mental health impacts, and women-headed households are likely to face barriers in accessing aid (UN Women 2025).

Prior to the earthquake, Myanmar was facing a double burden of communicable and noncommunicable diseases. The interruption to healthcare has increased the risk of disease exacerbation or even death for people with chronic illnesses due to the shortage in medicines and supplies, and barriers to treatment and care (K. K. Zaw, Nwe, and Hlaing 2017). This is a significant concern due to the prevalence of chronic illness in the affected population (~10% diabetic, 20% prediabetic, 25-50% hypertense) (MDA, n.d.).

The earthquake's devastation has also disproportionately impacted persons with disabilities who face increased vulnerability due to physical injuries, displacement and disruption of essential services. According to a UN initial rapid assessment conducted with 15 organizations of persons with disabilities and special schools in Mandalay and Sagaing, 11 of them reported direct impacts (UNFPA 2025). The disaster has also led to a rise in newly acquired disabilities, further straining limited resources. Preliminary reports indicate families of persons with disabilities have suffered severe hardships, including the collapse of homes, destruction of critical infrastructure such as sanitation facilities and loss of livelihoods (Mishra 2025).

Moreover, as discussed later in Section 5.4, the earthquake resulted in the destruction of thousands of religious structures (AHA Centre 2025). In Myanmar, temples, mosques, monasteries, and nunneries serve not only as places of worship, but also play a vital role in safeguarding the nation's cultural heritage and supporting the welfare of its communities (National Geographic 2025).

1.2. Loss of Life and Injuries

The USGS PAGER tool estimated that approximately 32.9 million people felt the main event as *weak*, 163.7 million as *light*, 24.6 million as *moderate*, and 38.9 million felt the event as *strong* to *extreme* (Fig. 1.2a). This triggered a "red alert" by USGS PAGER due to its potentially high fatality rates. The number of fatalities was estimated to have a 18% probability of being 1,000 to 10,000, a 34% probability of being 10,000 to 100,000, and a 44% probability of more than 100,000 (Fig. 1.2c).

The main seismic event and its aftershocks resulted in a large number of fatalities and injuries, though markedly lower than the PAGER's most probable estimates. Fatalities were mostly concentrated in Myanmar, but also included a few in Thailand and other nearby countries. As of April 29, 2025, the total number of fatalities reported by state-run MRTV was 3,770[3], with 5,106 people injured and 106 still missing, according to the Associated Press (Peck 2025). These numbers may vary across different reports due to the ongoing challenges in data collection and reporting in the affected regions. It is possible that the actual number of fatalities and injuries is higher than official figures suggest, as independent sources have reported higher estimates (DVB 2025c; MSR 2025). In neighboring Thailand, about 100 deaths were confirmed at the site of a

[3] Casualty figures from the Department of Disaster Management as of April. Opposition media reported a nationwide death toll of 4484 as of May 18, 2025 (DVB 2025a). The National Unity Government (government-in-exile) reported 4200 fatalities as of April 20, 2025 (NUG 2025).

high-rise building under construction that collapsed in Bangkok; with a small number of people unaccounted for as of mid-May 2025, and seven deaths were reported elsewhere in the country (Reuters 2025, Saksornchai 2025). Furthermore, the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) also estimates that more than 17.2 million people in Myanmar are in need of humanitarian assistance as a result of the disaster (OCHA 2025).

1.3. Official Response

The official response unfolded between March 28 and April 10, 2025 and is detailed in Appendix A. The response initiated with the military government declaring a state of emergency in six regions: Nay Pyi Taw, Mandalay, Sagaing, Magway, Bago, and part of Shan state to facilitate a coordinated response (CDP 2025) and request for humanitarian assistance from the international community. Initial search and rescue efforts were limited near the epicenter, due to its remoteness and zones outside military government control, unlike the Mandalay region, where urban search and rescue (USAR) teams were immediately dispatched. Foreign assistance arrived in the affected areas, beginning on March 30, with Nay Pyi Taw becoming the central coordination node for foreign aid. The pace of relief to areas outside the military government's control was scrutinized in the early days of the response (HADR 2025).

Neighboring countries such as China and Thailand mobilized USAR teams and additional aid by April 1. While debris removal and assessment and repair of essential infrastructure was underway and continued throughout the first week of April, in Sagaing, the government still tightly controlled access to the affected areas, and conflict zones remained inaccessible to international agencies, hampering relief efforts (Butler 2025). While Mandalay International Airport resumed limited domestic flights on April 4 and Nay Pyi Taw Airport opened in a limited capacity on April 7, damaged roads continued to hinder the ground transport of relief supplies (Xinhua 2025), with the arrival of monsoon rains in the Sagaing region degrading conditions further.

Initial rapid needs assessments include 588,000 people across 31 townships in seven states and regions, including Nay Pyi Taw Union Territory, and identified urgent priorities as food, drinking water, healthcare, cash assistance, and emergency shelter. However, among those assessed, 47% had yet to receive any form of assistance as of April 7 (OCHA 2025). This underscored the government's fragmented response, prioritizing urban centers and infrastructure repairs while deprioritizing conflict-affected rural areas. While international organizations like WHO and ASEAN-ERAT filled critical gaps, systemic inefficiencies and ongoing conflict hindered recovery.

As of April 7, the government officially named the M7.7 event "the Mandalay Earthquake" to ensure consistency in documentation and referencing (AP 2025), though Myanmar's parallel National Unity Government and international organizations continued using the term "Sagaing Earthquake" as is consistent with norms in the seismic community (Kavi 2025).

1.4. Report Scope

StEER activated a Level 1 response to evaluate this event, inviting members to this effort beginning on March 29, 2025, given the strong potential to generate new knowledge, evidenced by achieving 67% of the Level 1 activation criteria (see Table 1.1). An official response page was then instituted at the StEER website. Given the scale and severity of this event, as well as the challenging context, in the days that followed activation, a consortium was developed combining the efforts of several organizations under the process normally executed for StEER Virtual Assessment Structural Teams (VASTs). This Joint Virtual Assessment Team (J-VAT) includes members of StEER, the Geotechnical Extreme Events Reconnaissance (GEER) Association, the Earthquake Engineering Research Institute (EERI) Learning from Earthquakes (LFE) Program, the UK's Earthquake Engineering Field Investigation Team (EEFIT), GeoHazards International (GHI), and the Asian Institute of Technology (AIT) in Bangkok.

The J-VAT was charged with the production of the primary product of the joint response to this event: this **Joint Preliminary Virtual Reconnaissance Report (J-PVRR),** intended to:

1. provide an overview of the March 28, 2025 M7.7 Myanmar earthquake and it societal impacts,
2. overview the regulatory environment and construction practices in the affected areas,
3. document its geotechnical dimensions and impacts to the built environment by synthesizing insights from remote sensing and preliminary reports of geotechnical failures and damage to land, buildings and infrastructure,
4. offer recommendations for continued study of this event by the participating organizations and the wider engineering reconnaissance and disaster resilience communities.

Observations in Myanmar were based primarily on images shared on social media by local residents and local media (foreign journalists were not allowed in the affected areas), satellite imagery, official damage figures from the military government, and reports by ASEAN and UN agencies. Observations in Thailand were based on local reports from the field, local and international media, social media, and official damage information from ASEAN and the government.

Table 1.1. Summary of Level 1 Activation Criteria.

Hazard	Exposure	Feasibility
● Major event	● Sufficiently populated areas to create measurable impact ● Communities with a history of recovery OR those rarely exposed ● Communities with unique vulnerability ● Noteworthy code or construction practices (e.g., test of revised codes, mitigation measures/ retrofits) ● Critical infrastructure ● Under-documented structure classes	● Availability/interest of members ● Sufficient media/social media coverage of the event, including the potential to automate the mining of information ● Bandwidth of StEER support team / not balancing multiple concurrent responses

2. Hazard Characteristics

2.1. Earthquake Features and Tectonic Summary

Myanmar occupies a key position at the eastern boundary of the Indian Plate, where it collides obliquely with the Sunda Plate and contributes to the extrusion of continental blocks around the eastern syntaxis of the Himalaya (Wang et al. 2014). The tectonic framework of the region is mainly defined by three principal systems: the Sunda megathrust, the Sagaing Fault, and the strike-slip fault network of the Shan Plateau (Wang et al. 2014). The convergence between the Indian Plate and Burma Plate (also called the Burma Sliver) forms the prominent Indo-Burman Range, characterized by active subduction, thrusting, and folding (Wang et al. 2014).

The Sagaing Fault is the most active and seismically hazardous in Myanmar. Six events ≥ M7 have been attributed to the Sagaing Fault since 1918 (Fig. 2.1) (Hurukawa and Maung Maung 2011). It is a right-lateral (dextral) strike-slip fault extending approximately 1,400 km from the Andaman Sea to northern Myanmar (Wang et al. 2014). This fault acts as a transform boundary between the Burma Plate and the Sunda Plate and accommodates about 18-20 mm/year of relative motion based on GPS measurements (Hurukawa and Maung Maung 2011). Historical records and relocated seismicity have revealed at least two major seismic gaps along this fault: one between 19.2°N and 21.5°N and another south of 16.6°N (Fig. 2.1) (Hurukawa and Maung Maung 2011).

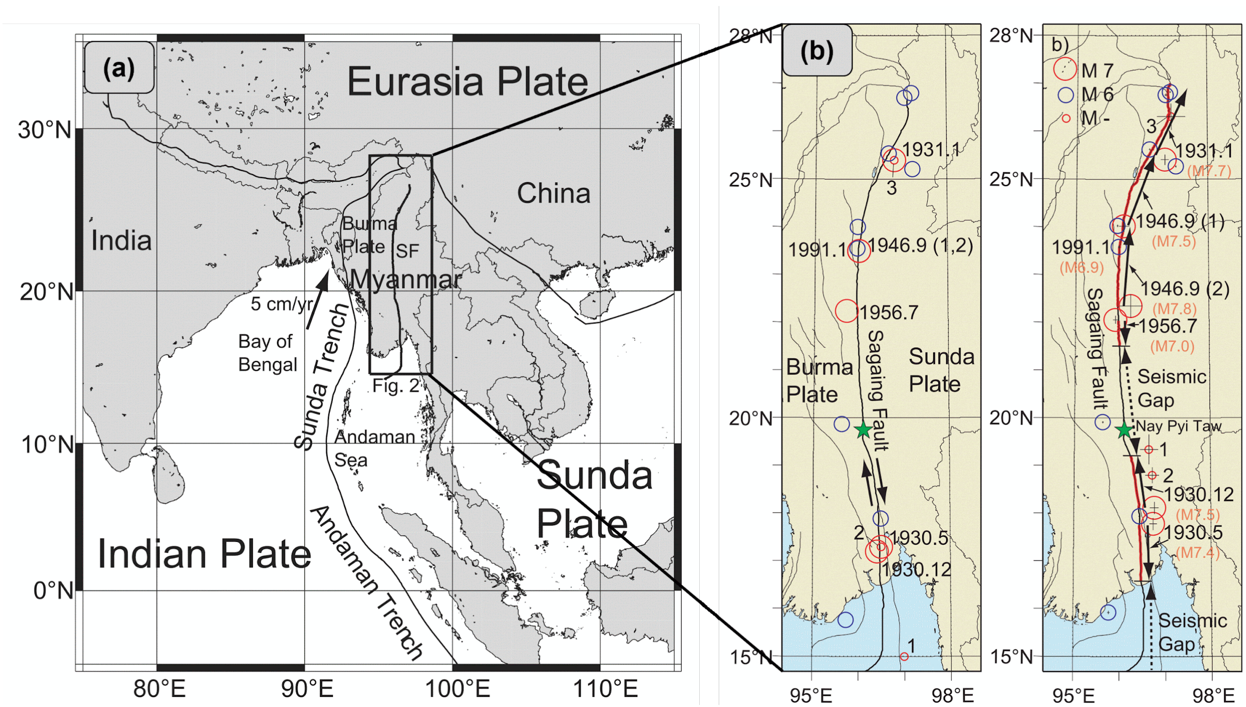


Figure 2.1. (a) Regional tectonic framework of Myanmar and its surroundings, showing the interaction of the Indian, Eurasian, Sunda, and Burma plates. The Sagaing Fault (SF) acts as a major transform boundary between the Burma and Sunda plates, while the Sunda Trench and Andaman Trench mark active subduction zones. Arrows indicate relative plate motions; (b) Detailed tectonic map of Myanmar highlighting the Sagaing Fault and distribution of major historical earthquakes (M ≥ 7.0) between 1918 and 2006. Epicenters are color-coded by magnitude. The figure also identifies two significant seismic gaps along the Sagaing Fault, one located south of 16.6°N and another between 19.2°N and 21.5°N. (Source: Hurukawa and Maung Maung 2011).

USGS focal mechanism solutions indicate that the earthquake rupture was consistent with either a near-vertical (82°) right-lateral strike-slip fault striking approximately North-South (1°). A summary of the nodal planes is presented in Table 2.1, along with the orientation and magnitude of the principal stress axes shown in Table 2.2. The nodal planes and axis orientation reveal that the earthquake was dominated by strike-slip faulting, as also observed in the characteristic four-quadrant distribution of compressional and tensional lobes in the fault plane solution (Fig. 2.2).

The mainshock focal mechanism, distribution of aftershocks and finite fault model (Fig. 2.3) indicate that the rupture occurred on the Sagaing Fault (USGS 2025a; Bentz et al. 2025), with maximum slip values along the fault plane of 6.4 m towards the south of the epicenter (USGS 2025a) (Fig. 2.3). The reported seismic moment estimate is M_0 = 4.4e+20 Nm. USGS Shakemap estimates an MMI of IX around the epicenter (Fig. 2.4), with estimated PGA of 0.5g and Sa(T=1s) of 1g - around the epicenter, while the estimated PGV is approximately 100 cm/s (Fig. 2.5).

Table 2.1. USGS-Reported Nodal Planes of Mainshock as of April 2, 2025 (USGS 2025a).

Plane	Strike	Dip	Rake
NP1	1°	82°	-174°
NP2	270°	84°	-8°

Table 2.2. USGS-Reported Principal Axes of Mainshock as of April 2, 2025 (USGS 2025a).

Axis	Value	Plunge	Azimuth
T	4.547e+20	1°	315°
N	0.169e+20	80°	52°
P	-4.716e+20	10°	225°

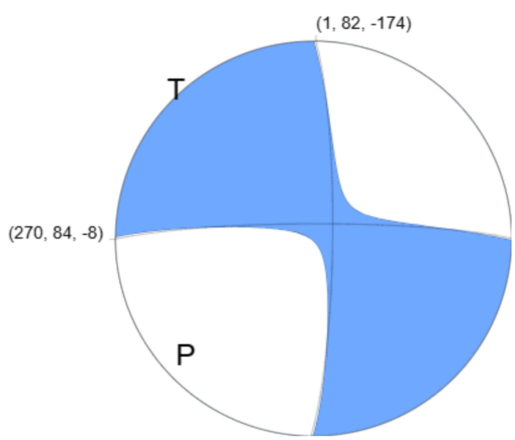


Figure 2.2. USGS-reported fault plane solutions of mainshock as of April 2, 2025 (USGS 2025a).

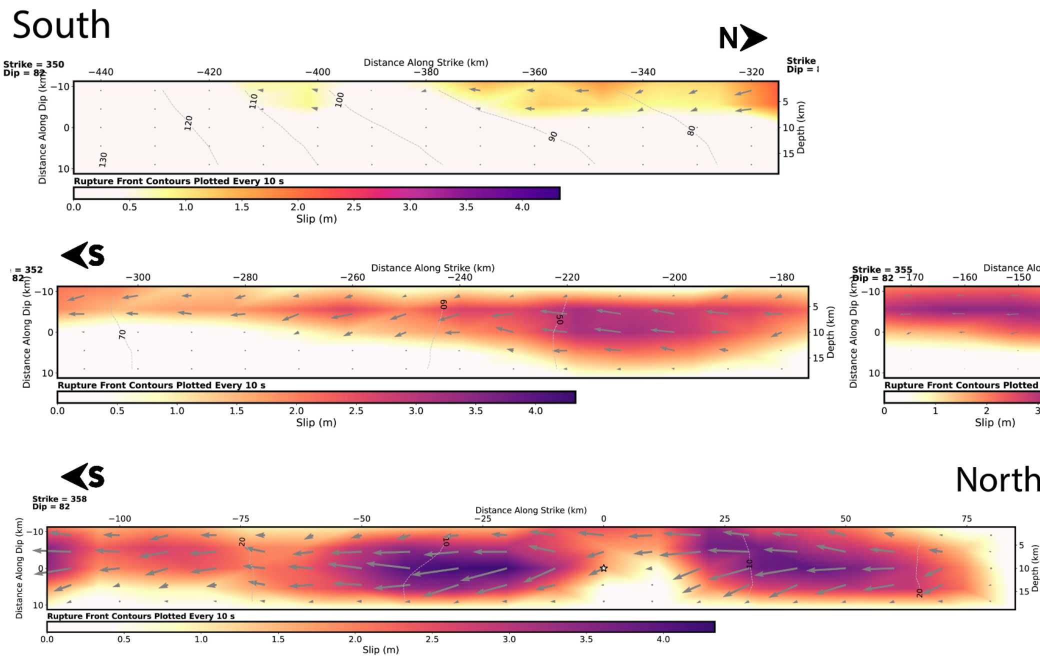
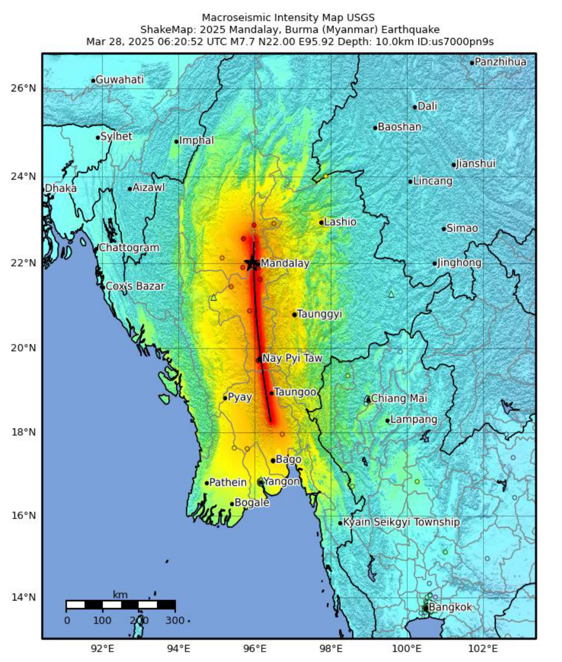


Figure 2.3. USGS-reported cross-section and surface projection of slip distribution of Mainshock as of April 2, 2025 USGS (USGS 2025a).



SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.0464	0.297	2.76	6.2	11.5	21.5	40.1	74.7	>139
PGV(cm/s)	<0.0215	0.135	1.41	4.65	9.64	20	41.4	85.8	>178
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based on Worden et al. (2012) Version 21: Processed 2025-04-16T05:13:29Z
△ Seismic Instrument ○ Reported Intensity ★ Epicenter ▭ Rupture

Figure 2.4. USGS-reported intensities (v. 21) estimated from ShakeMap for mainshock as of April 16, 2025 (USGS 2025a).

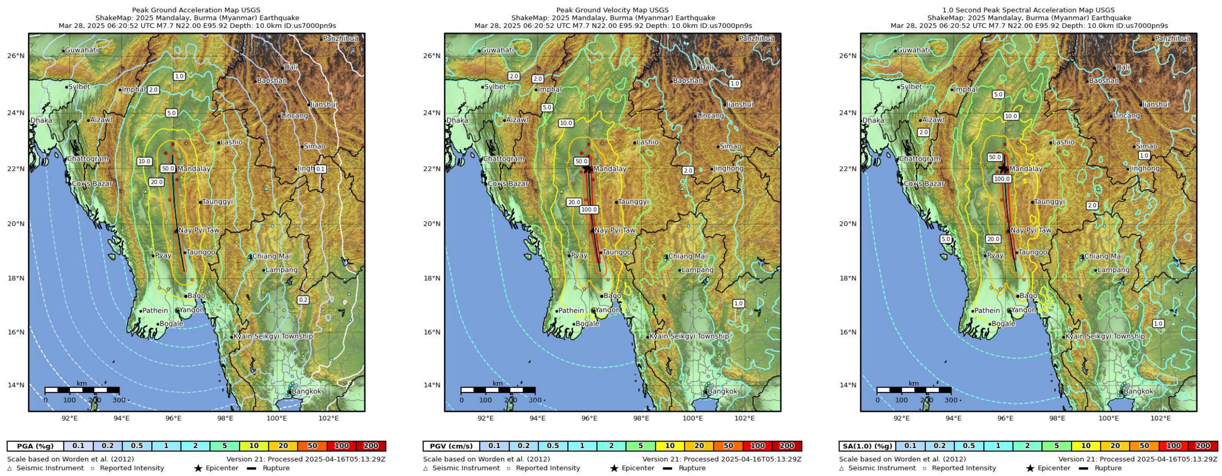


Figure 2.5. USGS-reported intensity maps (V. 21) from recorded PGAs, PGVs, and Spectral acceleration at T =1s estimated from ShakeMap for mainshock as of April 16, 2025 (USGS 2025a).

2.1.1 M 6.7 - Burma Aftershock

Only ten minutes after the M7.7 Mandalay earthquake, at approximately 06:32:04 (UTC), a M6.7 aftershock occurred 32 kilometers south of the mainshock. The focal mechanism solution indicates that the aftershock was associated either with a steeply dipping (82°) left-lateral strike-slip fault with an E-W orientation (strike = 81°) or with a moderately dipping (56°) fault striking nearly N-S (strike = 177°) with a dominant reverse component (rake = -170°) (Table 2.3). The distribution of the principal axes supports a strike-slip regime, where the T-axis trends towards the SE (azimuth = 134°) with a plunge of 17°, and the P-axis is oriented towards the NE (azimuth = 34°) with a plunge of 30° (Table 2.4). The fault plane solution shows a characteristic pattern of strike-slip faulting (Fig. 2.6), consistent with the regional kinematics dominated by the Sagaing Fault system. This aftershock represents a typical response to the redistribution of stress following the mainshock rupture.

Table 2.3. USGS-Reported Nodal Planes of Aftershock as of April 2, 2025 (USGS 2025a).

Plane	Strike	Dip	Rake
NP1	81°	82°	-34°
NP2	177°	56°	-170°

Table 2.4. USGS-Reported Principal Axes of Aftershock as of April 2, 2025 (USGS 2025a).

Axis	Value	Plunge	Azimuth
T	1.479e+19	17°	134°
N	-0.344e+19	55°	250°
P	-1.136e+19	30°	34°

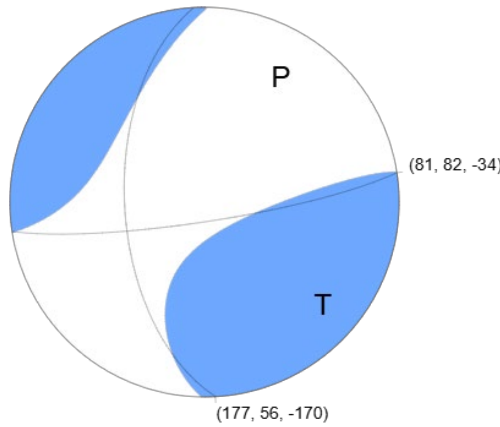


Figure 2.6. USGS-reported fault plane solutions of aftershock as of April 2, 2025 (USGS 2025a).

The USGS ShakeMap products for the M6.7 aftershock are presented in Figure 2.7 (MMI) and Figure 2.8 (PGA, PGV, and Sa(T=1s)). Although the energy released by this aftershock was considerably lower than that of the M7.7 mainshock and affected a narrow region, it still generated significant shaking intensity (estimated MMI around the epicentral region reached IX, while the region near the mainshock epicenter experienced MMI values around VII-VIII). Near the epicenter, the estimated PGA and Sa(T=1s) were both approximately 0.5g, while the PGV was around 50 cm/s. In contrast, near the mainshock epicenter, the estimated PGA decreased to about 0.2g, PGV reached 20 cm/s, and the Sa(T=1s) was around 0.2g.

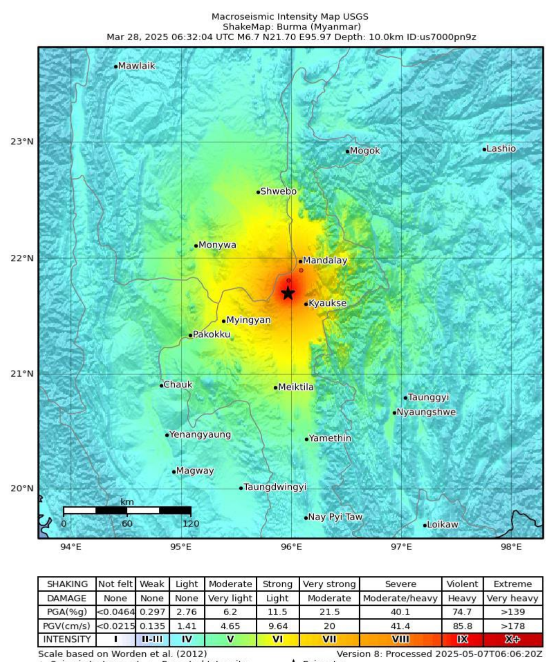


Figure 2.7. USGS-reported intensities (v. 8) estimated from ShakeMap of aftershock as of May 7, 2025 (USGS 2025a).

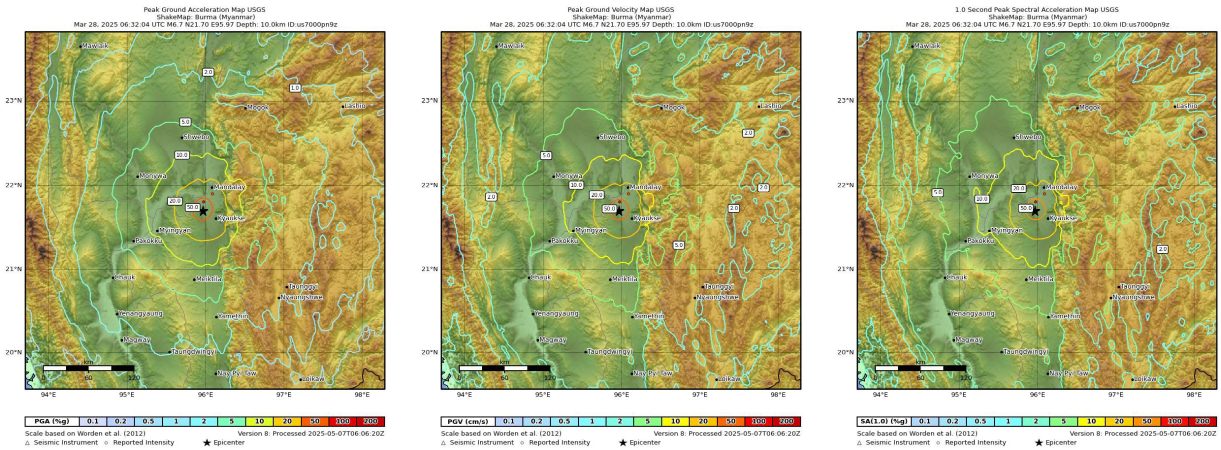


Figure 2.8. USGS-reported intensity map (v. 8) from recorded PGAs, PGVs, and Spectral acceleration at T =1s estimated from ShakeMap for aftershock as of May 7, 2025 (USGS 2025a).

2.2. Recorded Ground Motions

The Department of Meteorology and Hydrology – National Earthquake Data Center (DMH-NEDC) operates the Myanmar National Seismic Network, which consists of nine seismic stations distributed across the country. At the time this report was authored, response spectra data were available for only five stations, four of which are part of the Myanmar National Seismic Network. Table 2.5 summarizes key ground motion intensity measures, including PGA for the three-component recordings provided by DMH-NEDC and others and reported by the USGS. The spatial distribution of the geometric mean (geomean) of the two horizontal components for PGA and Sa(T=1s) is shown in Figure 2.9a and Figure 2.10a, respectively, for the mainshock. For comparison, the geographical distribution of the geomean of the horizontal components for PGA and Sa(T=1s) for the aftershock are presented in Figure 2.9b and Figure 2.10b, respectively.

The maximum PGA recorded during the mainshock was 0.623g at the NPW station, located just 2.75 km from the rupture. Figure 2.11 shows acceleration time histories for NPW. However, no spectral acceleration values were available for NPW from the USGS at the time of this report; similarly, response spectral data for the aftershock are available from only one station (CHTO).

Two stations in Bangkok, KMUA and BKSI, recorded the earthquake ground motion.

Table 2.5. USGS-reported recorded three-component ground motions during the M 7.7 mainshock as of April 19, 2025 (USGS 2025a).

Station	Channel	PGA [g]	T=0.3 [g]	T=1.0 [g]	T=3.0 [g]
YGN (R_{rup} = 157.1 km)	Z	0.0197	0.0223	0.0414	0.0174
	H1	0.0243	0.0271	0.0374	0.0578
	H2	0.0186	0.0222	0.0434	0.0563
KTN (R_{rup} = 360.6 km)	MM.HNZ	0.0085	0.0114	0.018	0.0066
	MM.HNN	0.0138	0.0325	0.0476	0.0207
	MM.HNE	0.0126	0.0303	0.0236	0.0146
CHTO (R_{rup} = 272.2 km)	IU.HNZ	0.0138	0.0226	0.028	0.0121
	IU.HN1	0.0113	0.0185	0.0153	0.0185
	IU.HN2	0.0092	0.0173	0.0212	0.0195
NPW (R_{rup} = 2.75 km)	Z	1.07	-	-	-
	H1	0.574	-	-	-
	H2	0.623	-	-	-
NGU (R_{rup} =113.9 km)	Z	0.0178	-	-	-
	H1	0.0427	-	-	-
	H2	0.0565	-	-	-

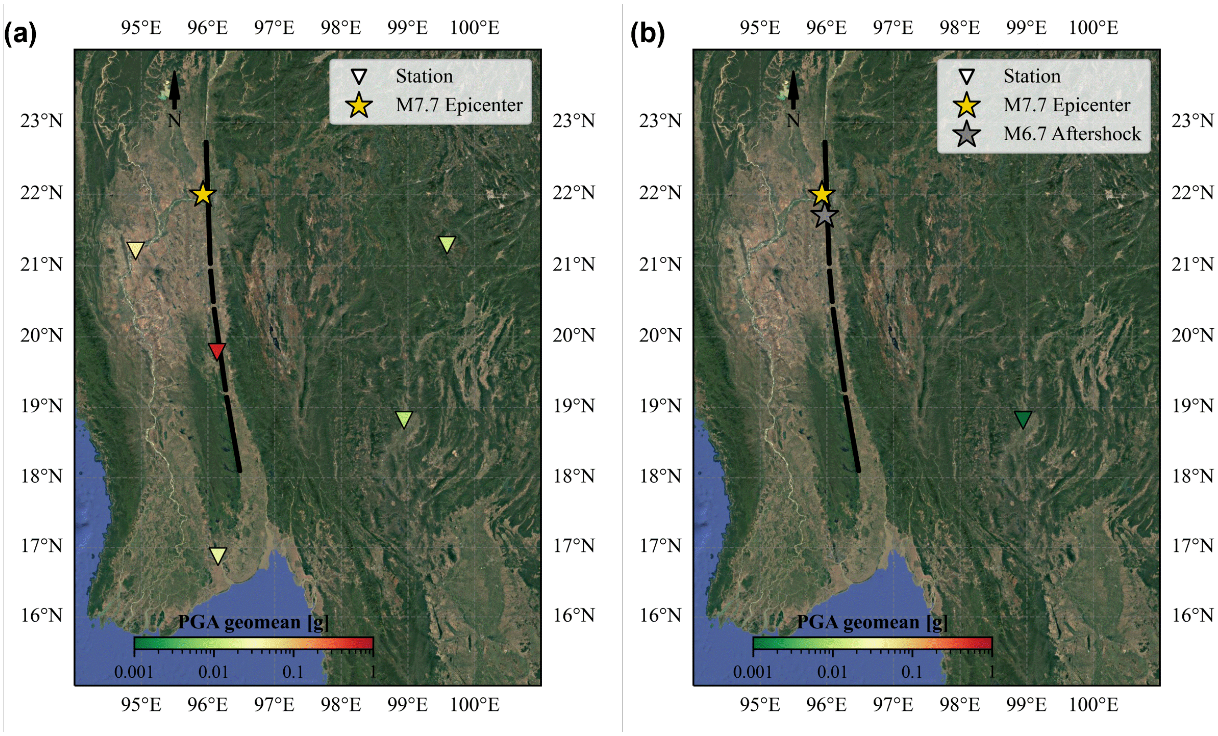


Figure 2.9 Geographical distribution of the geomean of PGA in the (a) mainshock and (b) aftershock.

Figure 2.10. Geographical distribution of the geomean of 5%-damped 1s spectral accelerations, Sa(T=1s), in the (a) mainshock and (b) aftershock.

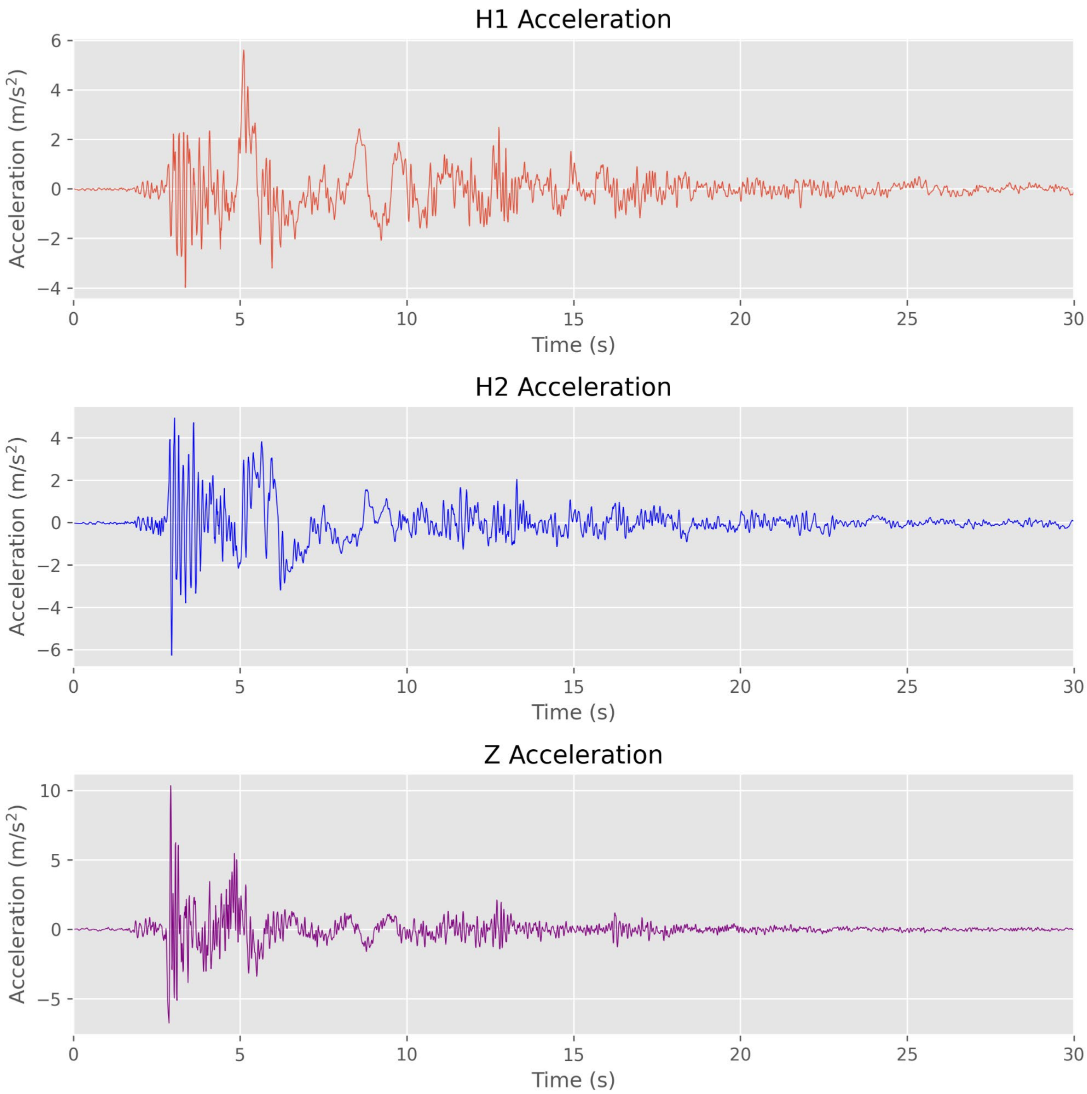


Figure 2.11. Acceleration time histories for Geoforschung Zentrum (GFZ) NPW station (Data Source: GEOFON Data Centre 1993).

2.2.1 Comparison with ground motion models

Figure 2.12 compares recorded ground motion intensities with the predictions of two ground motion prediction models (GMPMs) as a function of rupture distance for both PGA (Figures 2.12a-b) and Sa(T=1s) (Fig. 2.12c). Figure 2.12b shows a comparison with a local model (Si and Midorikawa 2000) for Vs30 = 400 m/s, while Figure 2.12a and Figure 2.12c present results for the geometric mean of the NGA-WEST2014 GMPMs: ASK 14 (Abrahamson, Silva, and Kamai 2014), CB14 (Campbell and Bozorgnia 2014), BSSA14 (Boore et al. 2014), and CY14 (Chiou and Youngs 2014)). The selected GMPMs adopt different definitions of the intensity measured component: the ASK14, CB14, BSSA14 and CY14 models estimate RotD50, whereas the local model provides estimates for the random (also referred to as arbitrary) horizontal component. Therefore, for each station, both recorded horizontal components were individually compared to the local model predictions. In contrast, the geometric mean of the recorded horizontal components was used as a proxy for RotD50 to compare with the NGA-WEST2014 models, given that acceleration time histories were not available at the time of analysis.

Note that Figure 2.12a shows PGA compared against the median predictions for rock and soil sites from the NGA-WEST2014 models, including ±1 standard deviation bounds. Only one recorded value exceeds the 84th percentile of the GMPM predictions for both rock and soil, while the remaining values fall within the expected percentile range (16th to 84th). Figure 2.12b presents PGA compared to the local model. In this case, at least six recorded values lie within the 16th to 84th percentile range, while the remaining ones fall either below the 16th or above the 84th percentile. Figure 2.12c displays the Sa(T=1s) compared to NGA-WEST2014 predictions. Two records exceed the 50th percentile of the rock-site prediction but fall below the 50th percentile of the soil-site model; both remain within ±1 standard deviation for both site conditions. The remaining record exceeds the upper bound of one standard deviation for both rock and soil models.

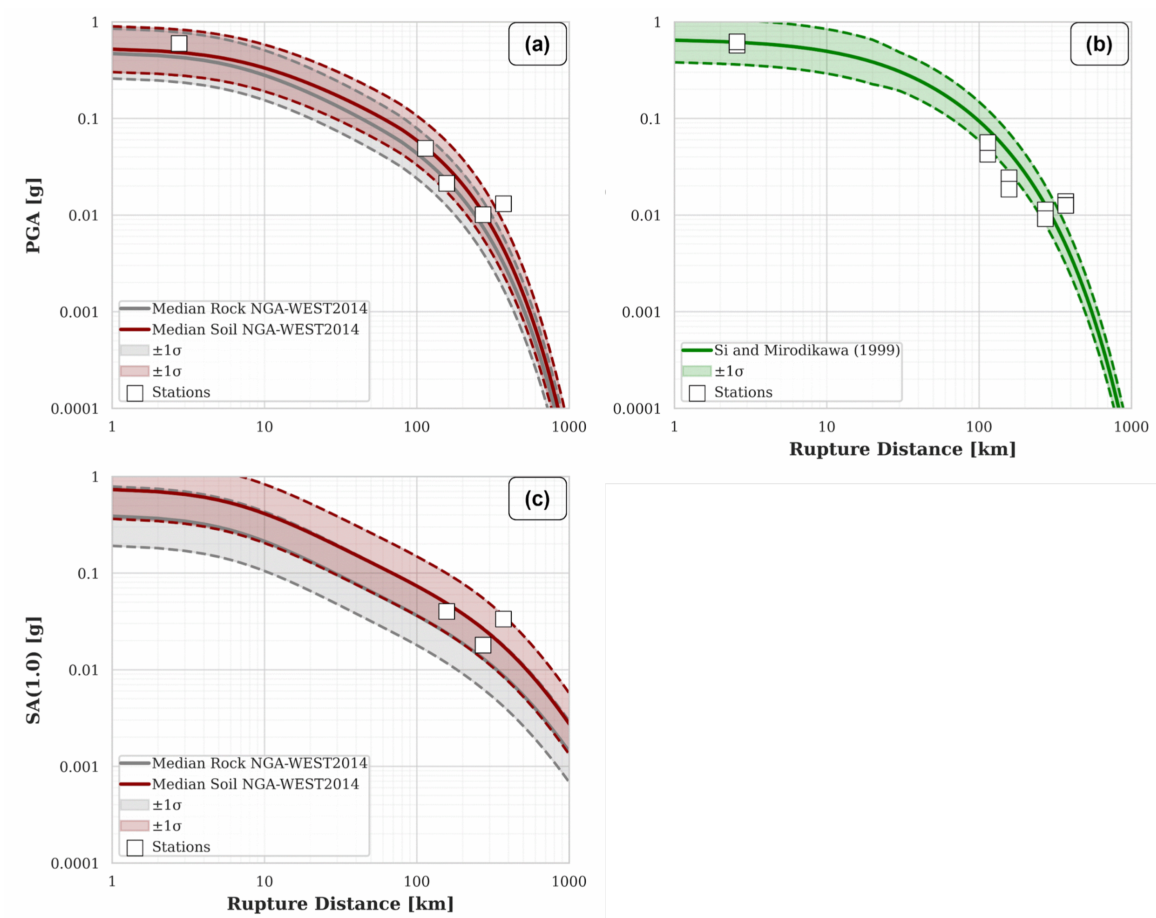


Figure 2.12. Comparison of pseudo-acceleration computed from recorded accelerations with estimates of local model and NGA-WEST2014 GMMs. Shaded regions represent 16/84th percentiles of GMMs.

2.3. Response Spectra

Response spectra for acceleration time histories recorded at Nay Pyi Taw station (California Geological Survey and U.S. Geological Survey 2005) are compared with design and MCE spectra from Myanmar National Building Code (2020) in Figure 2.13. Shaking at Nay Pyi Daw, very close to the fault rupture, was design-level (or above) for: (i) periods less than about 0.2 sec and (ii) from 0.8 sec to over 4 sec. Motions at very short periods and above ~1.5 sec exceed MCE level.

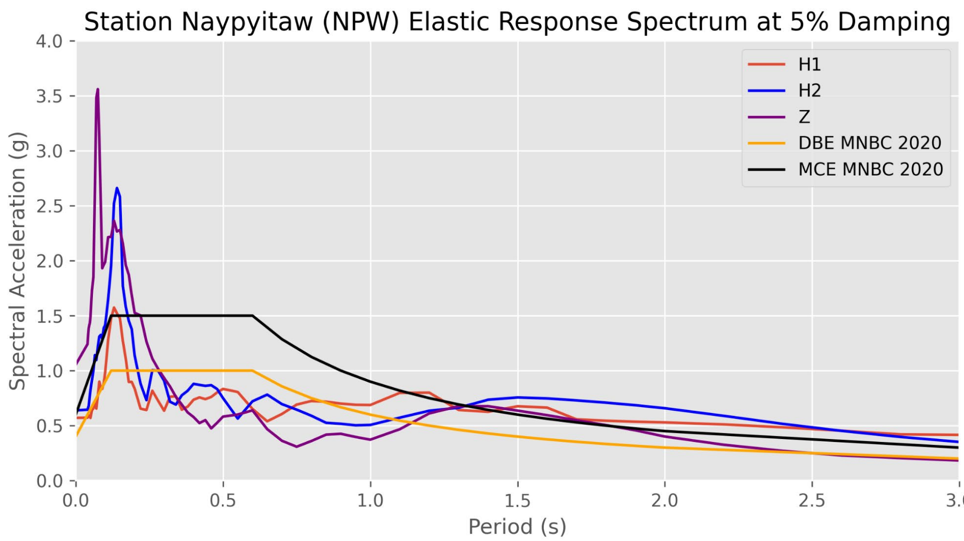


Figure 2.13. Elastic response spectra (5% damping) recorded accelerations at Nay Pyi Taw (NPW) station, compared with design and MCE spectra for Nay Pyi Taw per the Myanmar National Building Code (2020).

The acceleration response spectra for two local stations and the Bangkok basin Zone 5 DBE and MCE spectra are shown in Figure 2.14. While the earthquake response spectra are lower than DBE and MCE for short and intermediate periods, at longer periods the recorded earthquake spectra are larger than the MCE level.

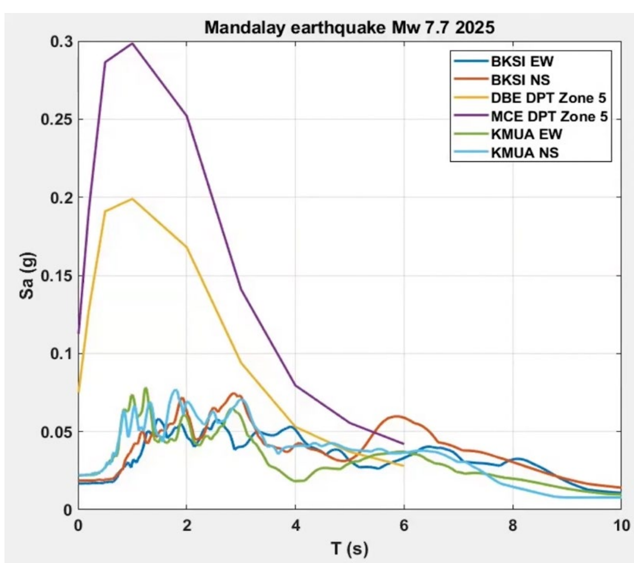


Figure 2.14. Response spectra from accelerations recorded at stations in Bangkok, compared with design and MCE spectra for Bangkok Basin (Source: Pennung Warnitchai presentation).

2.4. Surface Fault Rupture

Evidence from satellite and on-the-ground sources, including a notable security video, indicates that surface rupture was extensive throughout the region impacted by the earthquake. However, a key limitation of performing virtual reconnaissance is that it prevents experts from making critical contextual observations and conducting precise site-specific measurements to discern the specific cause of the observed surface fault rupture. For example, ground fissures resulting from strike-slip fault rupture may share many similar features with extension cracks resulting from lateral spreading and interpretation is challenging without the site-specific insights such as orientation, local slope conditions, vertical and horizontal offset measurements, presence (or not) of ejecta, whether ground is natural or human-made, and elevation of water table, amongst others. Therefore, interpretations of the origin of the surface fault rupture may be subjective.

Notwithstanding this, selected illustrative examples of suspected surface fault rupture resulting from the strike-slip event are included herein. These determinations are made in part based on the known general location of the Sagaing fault. For example, fault rupture was evident in images taken near the Hayetkon Railway Station, Pyinmana, Nay Pyi Taw (see Section 6.2.2). Similar lateral offsets of roadways were reported in urban areas (Fig. 2.15). Figure 2.16 shows a collage of the fault rupture offsets at the various locations relative to the Sagaing Fault. Readers can consult the imagery compiled in the accompanying Media Repository (Rodgers et al. 2025), curated with this report in DesignSafe, for additional georeferenced visual evidence of surface fault rupture.

Figure 2.15. Roadways with offset of several feet (21°52'49.27"N, 95°59'5.57"E) (Source: HMSon @heungburma on X).

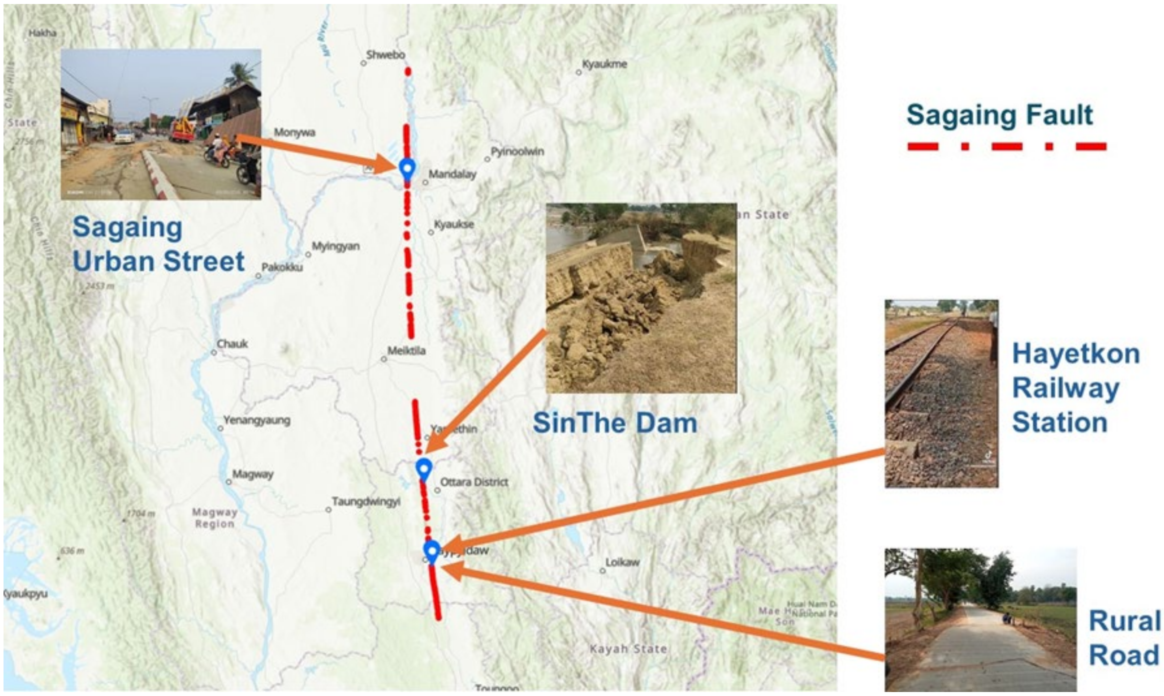


Figure 2.16. Map showing observed offsets of various structures along the Sagaing Fault.

2.5. Induced Hazards - Fire Following Earthquake

In Mandalay, two fires were reported following the earthquake: one on March 28th around 1 pm local time (GMT+6:30) at Mandalay University and another in the Thanlep Hmao West neighborhood in Mandalay City. The fire at Mandalay University started on the east side of campus in the main building and ignited additional structures, but was contained in the same day (DVB 2025b). Meanwhile, the fire in the Thanlep Hmao West neighborhood, in Mahaaungmyay, Mandalay township, consumed the dense informal settlement before the fire could be contained (DVB 2025b). The fire remained within the neighborhood without spreading to additional structures in adjacent blocks. Eye-witness accounts describe fire emerging from ground fissures, which could suggest there were gas leaks in the Thanlep Hmao West neighborhoods (Denby 2025).

3. Local Design Standards, Codes and Construction Practices

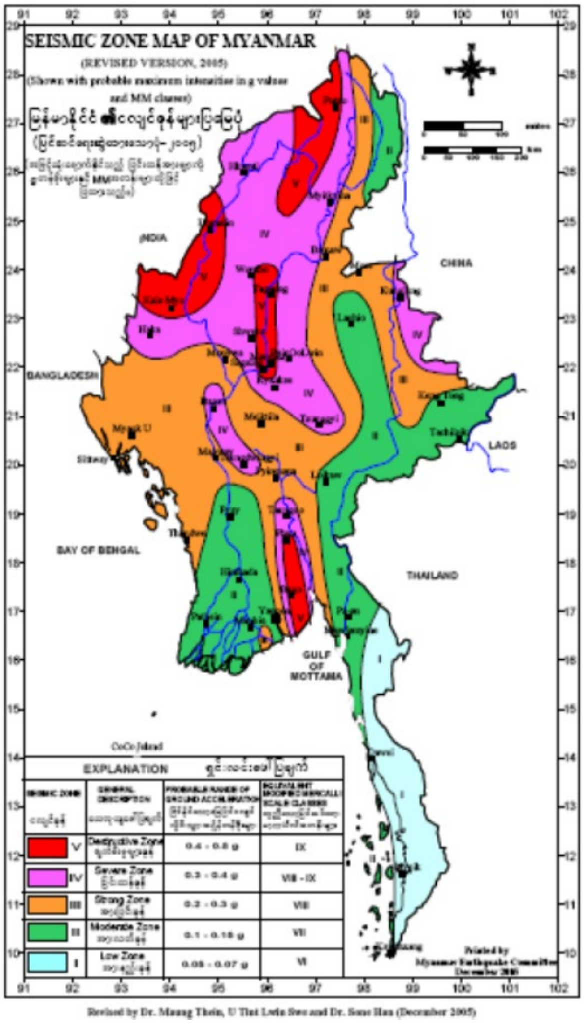
3.1. Myanmar

3.1.1 Building Codes

Myanmar has had a national building code with seismic provisions since the first version (MES 2012) was published 2013, with the Myanmar National Building Code 2020 as the current edition. Prior to this, other international codes, including British Standards, U.S. codes and standards (UBC, ACI), and Japanese standards were used for building design in major cities (MacRae, Myint, and Jain 2011). A first-generation national seismic hazard zone map based on historical seismicity and UBC97 zones has been available since 2006 (Thein, Swe, and Han 2006; MacRae, Myint, and Jain 2011). Prior to 1988, seismic resistance was optional, and most engineered buildings were designed and built by the government (MacRae, Myint, and Jain 2011). From 1988 to 2002, buildings taller than 8 stories followed Yangon City Development Committee (YCDC) regulations, and the private sector began providing most design services (MacRae, Myint, and Jain 2011). Additional regulations for shorter buildings and tall buildings also came into practice in Yangon particularly after 2003 (MacRae, Myint, and Jain 2011). Most buildings constructed prior to 2002 are unlikely to have been specifically designed to resist earthquakes. Moreover, code enforcement remains uneven, i.e., even post-2002, buildings may not have been designed for earthquake resistance.

In 2011, Technical Working Groups were formed for the development of the Myanmar National Building Code under the direction of the Ministry of Construction with the collaboration of Myanmar Engineering Societies (MES), UN-Habitat, authorities from relevant departments, and technical experts such as practicing engineers and architects. The resulting *Myanmar National Building Code* (*MNBC*)-*Provisional 2012* was published in 2013 (MES 2012) and used as the primary document guiding the construction practice across the nation. An updated version was issued in 2016. In 2018 and 2019, Technical Working Groups reviewed and modified some sections of MNBC 2016 (MES 2016) to align with international codes and standards, resulting in MNBC 2020 (MoC 2020).

The MNBC addresses a wide range of sectors, (i) Planning, Environment, Administration and Legislation, (ii) Architecture and Urban Design, (iii) Structural Design, (iv) Soil and Foundation, (v) Building Services, (vi) Material, and (vii) Constructional Practices and Safety. It establishes the standard for designing buildings that resist floods, cyclones, landslides, earthquakes, and other hazards. The seismic design criteria and design requirements for different types of buildings are described in Part 3 Structural Design (Section 3.4); seismic design provisions were patterned after ASCE 7-05. Figure 3.1 shows the Maximum Considered Earthquake (MCE) ground motion acceleration for the major cities mentioned in MNBC 2020. Some remaining cities will be included in the 2025 version. Figure 3.2 shows the probabilistic seismic hazard maps used to develop the tabular values in Figure 3.1. Design values of spectral response accelerations S_{DS} and S_{D1} are ⅔ of the MCE spectral parameters S_S and S_1.



Sr	City	Lat.	Lon.	S_S	S_1
1	Bagan	21.167	94.850	1.00	0.50
2	Bago	17.333	96.483	2.40	1.20
3	Bamaw	24.267	97.200	0.80	0.50
4	Coco Islands	14.117	93.367	0.80	0.30
5	Dawei	14.100	98.217	1.20	0.80
6	Hakha	22.650	93.617	1.00	0.70
7	Hpa-An (Pa-An)	16.750	97.667	0.20	0.20
8	Kengtung	21.300	99.617	0.70	0.20
9	Kyaukpyu	19.417	93.550	0.90	0.40
10	Labutta	16.147	94.761	0.70	0.50
11	Lashio	22.933	97.750	0.70	0.20
12	Loikaw	19.683	97.217	0.90	0.40
13	Magwe	20.150	94.167	1.00	0.60
14	Mandalay	21.933	96.100	1.20	0.70
15	Mawlamyine	16.500	97.617	0.30	0.20
16	Meiktila	20.833	95.833	0.80	0.50
17	Monywa	22.083	95.000	0.90	0.40
18	Myeik (Mergui)	12.433	98.600	0.60	0.30
19	Myitkyina	25.367	97.400	0.90	0.90
20	Naypyitaw	19.750	96.100	1.50	0.90
21	Pakokku	21.333	95.083	1.00	0.40
22	Pathein (Bassein)	16.783	94.733	0.70	0.30
23	Putao	27.333	97.417	0.90	1.00
24	Pyay	18.800	95.217	0.80	0.30
25	Pyinmana	19.733	96.217	1.50	0.90
26	Sagaing	21.867	95.983	1.80	1.20
27	Shwebo	22.567	95.700	0.70	0.40
28	Sittwe	20.133	92.883	0.80	0.70
29	Taungoo	18.933	96.433	1.50	0.90
30	Taunggyi	20.783	97.033	0.80	0.40
31	Thandwe (Sandoway)	18.467	94.350	0.60	0.20
32	Yangon	16.767	96.167	0.70	0.20

Figure 3.1. Seismic hazard zoning map used in the MNBC 2012 (left) and tabulated values in MNBC 2020 of MCE Ground Motion Accelerations at 2% Probability of Exceedance in 50 Years with 5% Critical Damping, Site Class B (Thein, Swe, and Han 2006; MoC 2020).

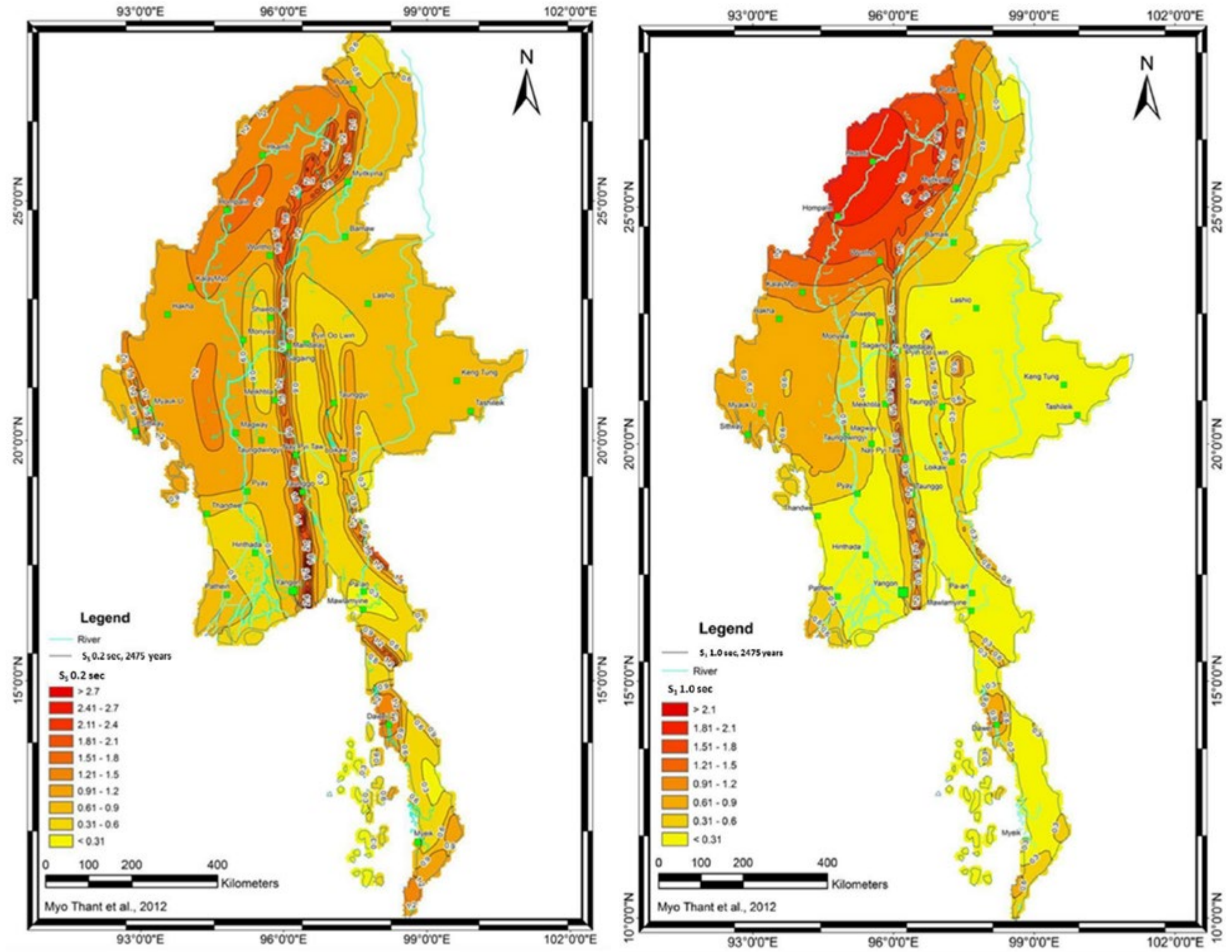


Figure 3.2. MNBC 2020 MCE Ground Motion for 0.2 sec (S_s) (left) and 1.0 sec (S_1) (right) Spectral Response Acceleration at 2% Probability in 50 Years with 5% Critical Damping, Site Class B ((MoC 2020).

3.1.2 Municipal Building Rules and Land Development Regulations

In addition to the building code, the construction sector in Myanmar must follow municipal jurisdictions' requirements and regulations for building construction and land use. Three major municipal governing boundaries are responsible for urban planning, construction regulation, and public infrastructure management in their respective cities: Yangon City Development Committee (YCDC), Mandalay City Development Committee (MCDC), and Nay Pyi Taw Development Committee (NPTDC). Yangon's building regulations date to 1988 (MacRae, Myint, and Jain 2011). Current regulations and procedures are discussed elsewhere, (e.g., World Bank 2020).

Specifically, Mandalay City Development Rules and Mandalay City Development Law are the legal principles that regulate urban planning standards, construction requirements, and development controls within the city's administrative boundaries. The standard procedures and requirements for obtaining a construction permit are different according to the regional requirements. Notably, structural design details considering the seismic design are not required to be submitted for low-rise buildings, and only the signature of a licensed engineer who will supervise the construction of the building is needed. Detailed structural drawings are required for buildings with 4 stories and above. Building permit applications for buildings of 5 stories and above require a copy of structural design calculations, the signature of the structural engineer who designed the building, and approval letters from the departments such as fire service department and electric power department.

3.1.3 Construction Practices

The construction methods and practices utilized in Myanmar include both traditional and modern techniques. Reinforced concrete structures are built using modern methods, while masonry, brick nogging (timber frame infilled with brick masonry), and timber are traditionally built without specific seismic design principles. Construction supervision for important buildings, such as hospitals, can be assumed in Yangon, Mandalay and Nay Pyi Taw beginning in 2009, and in the entire country beginning in 2017. However, seismic design is rarely practiced for the majority of reinforced concrete buildings, especially low- to medium-rise buildings in Myanmar.

3.2. Thailand

Thailand's seismic design regulations have gradually evolved over the past three decades, driven by increasing awareness of seismic hazards, and from lessons learned from previous seismic events. The first regulation, issued in 1997 (Ministerial Regulation No. 49), was based on the 1985 Uniform Building Code and focused only on basic force calculations using the equivalent static load method. A revised version in 2007 expanded slightly on this but still lacked detailing and site-specific provisions (Poovarodom et al. 2018).

A major improvement came in 2009 with the introduction of the DPT 1302-52 standard, modeled on ASCE 7-05, which provided modern procedures and seismic hazard maps. The standard incorporated soil amplification effects but still lacked structural detailing requirements. This gap became more evident following several damaging regional earthquakes (e.g., the 2011 Tarlay and 2014 Mae Lao earthquakes), which prompted a deeper reassessment of Thailand's seismic risk. The most recent version, DPT 1301/1302-61, adopted in 2021, introduced key updates: improved hazard maps, site-specific spectral acceleration data, especially for Bangkok, and expanded structural detailing requirements. These updates are informed by regional seismic studies and local site conditions, particularly by the amplification effects from deep soft soils in the Chao Phraya Basin. Bangkok, for instance, was divided into ten seismic microzones with distinct spectral shapes to better reflect these effects (Poovarodom et al. 2018).

Complementing these updates, recent microzonation research by the Thai Meteorological Department (TMD) has confirmed extremely soft soil conditions (Vs30 < 140 m/s) in Bangkok and surrounding provinces, corresponding to soil commonly categorized as Types E and Type F, based on the NEHRP classification (Fig. 3.3). These conditions can amplify seismic motions significantly beyond the assumptions of national design spectra (Pornsopin et al. 2024). Recent Probabilistic Seismic Hazard Analysis (PSHA) suggests that these site effects can amplify ground motion at periods of vibration close to 1 sec, which in certain regions of Thailand implies that code estimates for spectral acceleration can be underestimated by a factor of roughly five (Pornsopin et al. 2024).

Finally, while Thailand's seismic design framework has grown more sophisticated over time, implementation remains a challenge for local authorities. Enforcement outside major urban areas is inconsistent, and there is a recognized need for stronger inspection regimes, more widespread site characterization, and continued training for practitioners (Poovarodom et al. 2018).

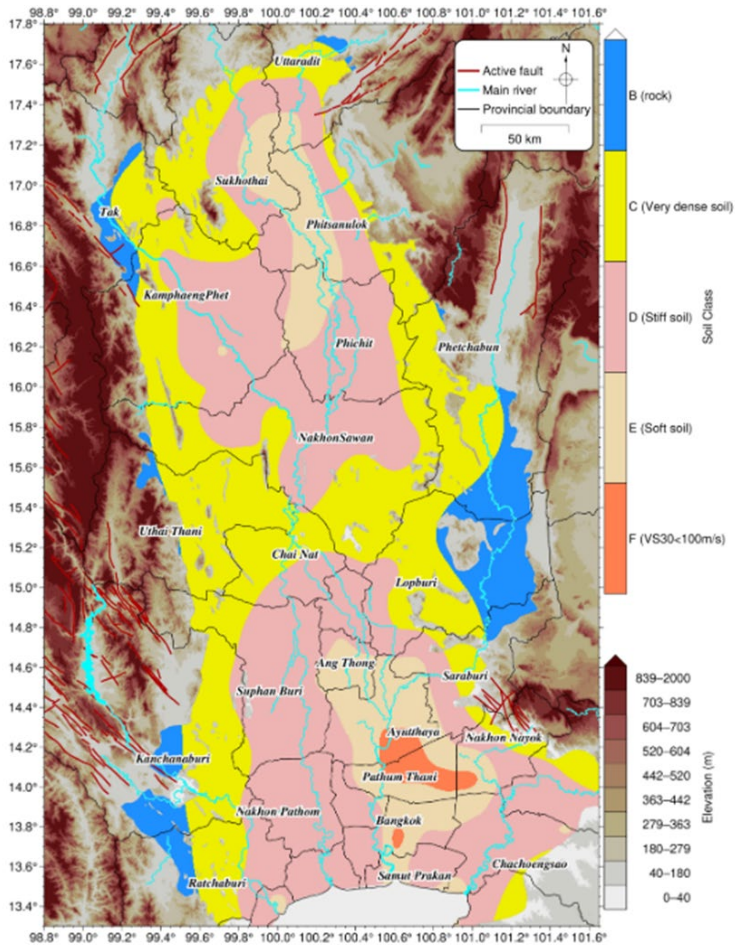


Figure 3.3. Soil classification map of Thailand (Pornsopin et al. 2024).

4. Geotechnical Performance

This section summarizes the primary geotechnical performance observations for the virtual reconnaissance of the M7.7 Myanmar earthquake. Against the backdrop of a regional remote sensing-based damage assessment summarized in Section 4.1, more specific observations from sub-regional and local perspectives are presented in Sections 4.2 through 4.7 on liquefaction, lateral spreading and ground failure, earth retaining structures, dam and levee performance, performance of improved ground, and other geotechnical observations, respectively. Readers may consult the imagery compiled in the accompanying Media Repository (Rodgers et al. 2025), curated with this report in DesignSafe, for additional georeferenced visual evidence.

4.1. Remote Sensing-based Damage Assessment

A series of remote sensing approaches were utilized to quantify the extent of damage resulting from the earthquake. These included developing a Damage Proxy Map derived from InSAR coherence (Fig. 4.1.1), assessment of floodplain extents and vegetation changes using Digital Elevation Model-based approaches (Fig. 4.1.2), evaluating surface disturbance (Fig. 4.1.3), and preliminary quantification of displacement fields using InSAR (Fig. 4.1.4). The specifics of how these various approaches were implemented are summarized in Appendix B. Given the aerial extent of the damage and the fact that the reconnaissance was conducted virtually, a decision was made (for the purposes of this J-PVRR) to focus on a sub-region of the damage area for more specific geotechnical evaluations. Figure 4.1.5 provides a base map showing the selected sub-region and a number of areas within that region where the following subsections focus on to highlight different performance and damage observations. Review of Maxar satellite and other sources confirmed that the observations in this base map area were representative of those throughout the impacted region.

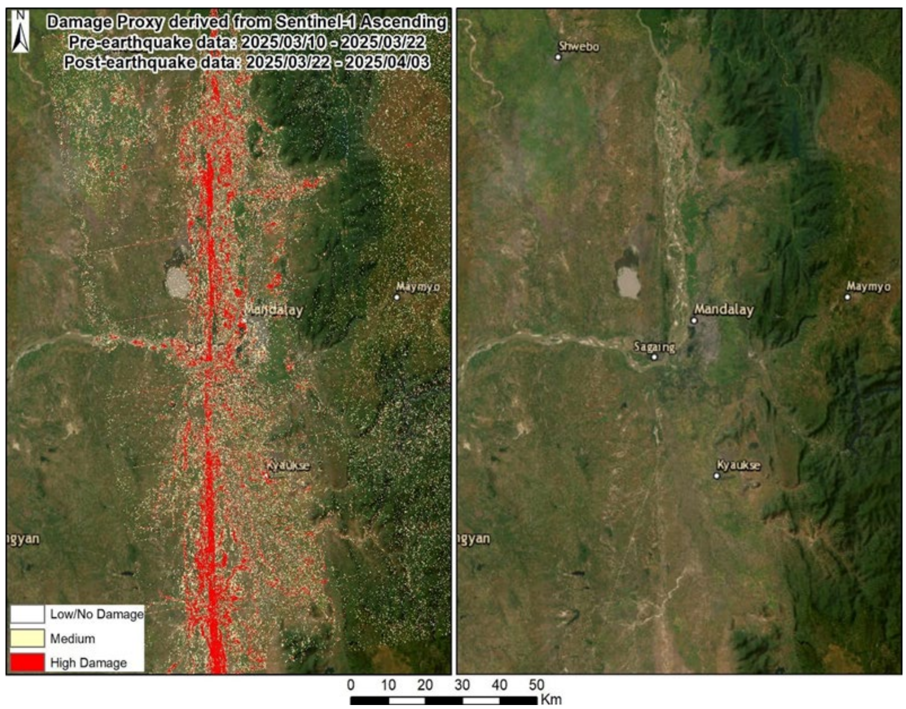


Figure 4.1.1. Damage Proxy Map derived from InSAR coherence using Appendix B (Credit: BGC).

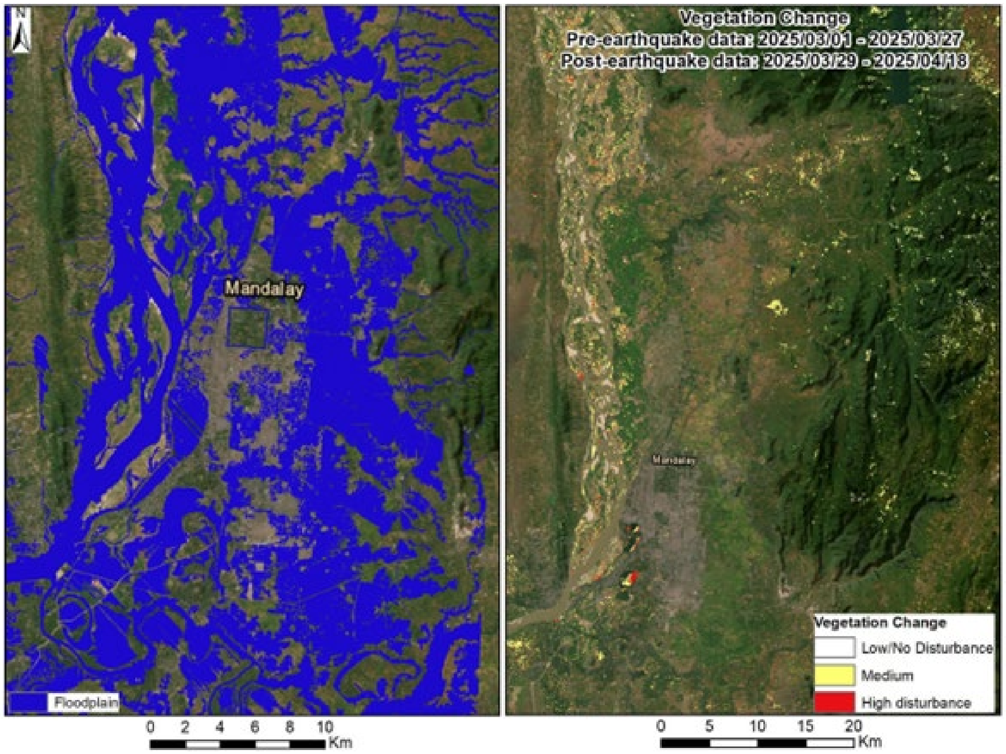


Figure 4.1.2. Flood plains and vegetation changes derived from DEM using Appendix B (Credit: BGC).

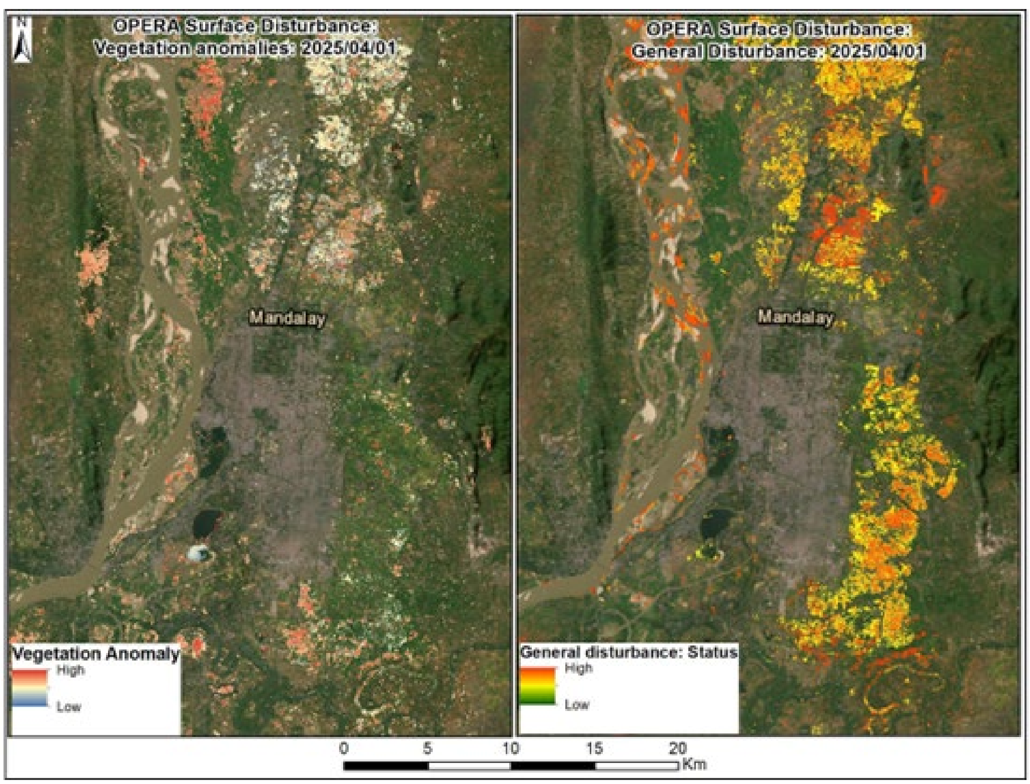


Figure 4.1.3. OPERA surface disturbance using Appendix B: vegetation anomaly (left) and general surface disturbance (right) (Credit: BGC).

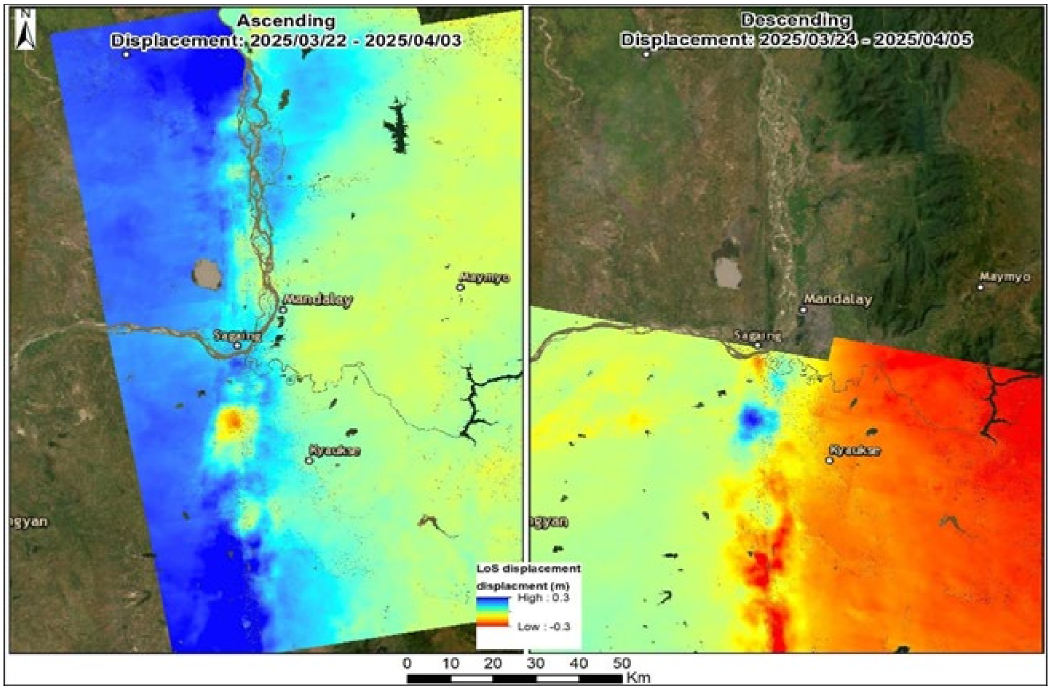


Figure 4.1.4. Preliminary InSAR displacement fields derived using [Appendix B](#) (Credit: BGC).

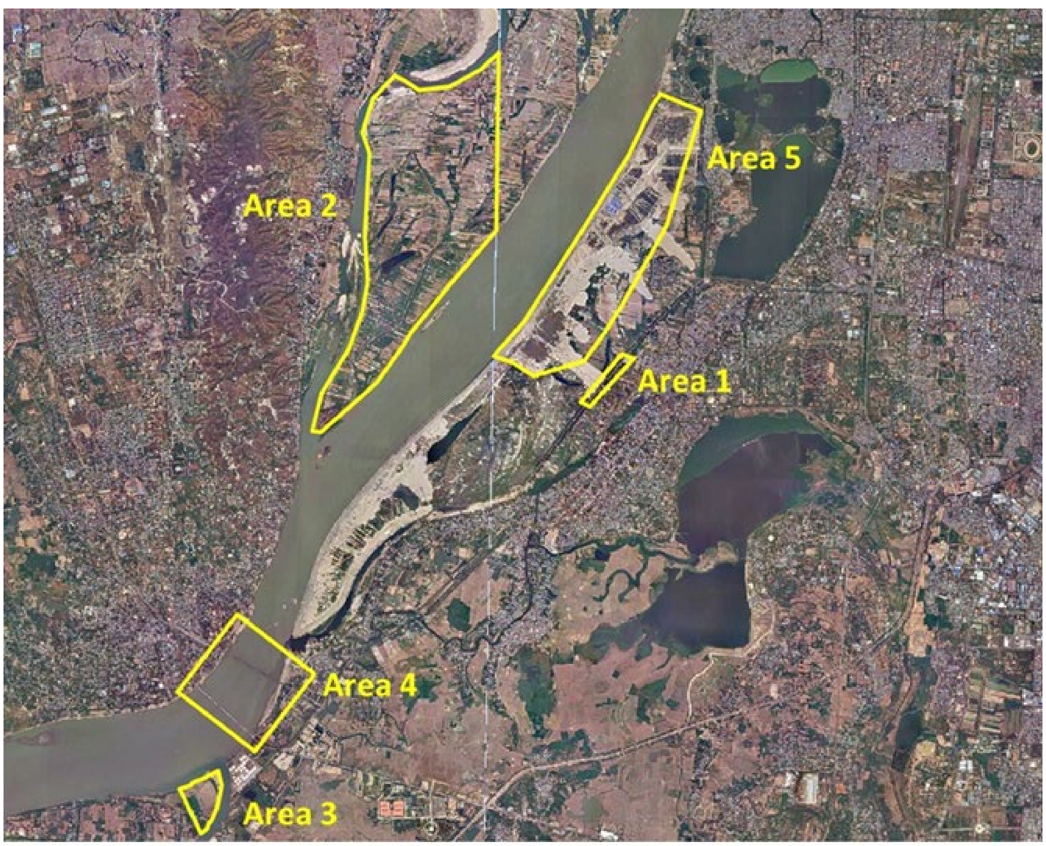


Figure 4.1.5. Base map showing regions for specific observation discussions [Approximate location of image center 21.93°N, 96.02°E].

4.2. Liquefaction

Maxar satellite images as well as photos taken locally in Areas 2 and 3 (although it is prevalent throughout the entire impacted area) show evidence of ejecta resulting from liquefaction, e.g., see example in Area 2 in Figure 4.2.1. The lowest magnification image to the left maps (in red) the locations of lateral spread fissures throughout the entire area. The pattern is consistent with the location of this sand bar between two river channels. The middle image shows a magnified view of a smaller portion of the area, also with the location of fissures indicated in red. Finally, the image on the right at the highest magnification shows that significant amounts of ejecta were expelled from the fissures.

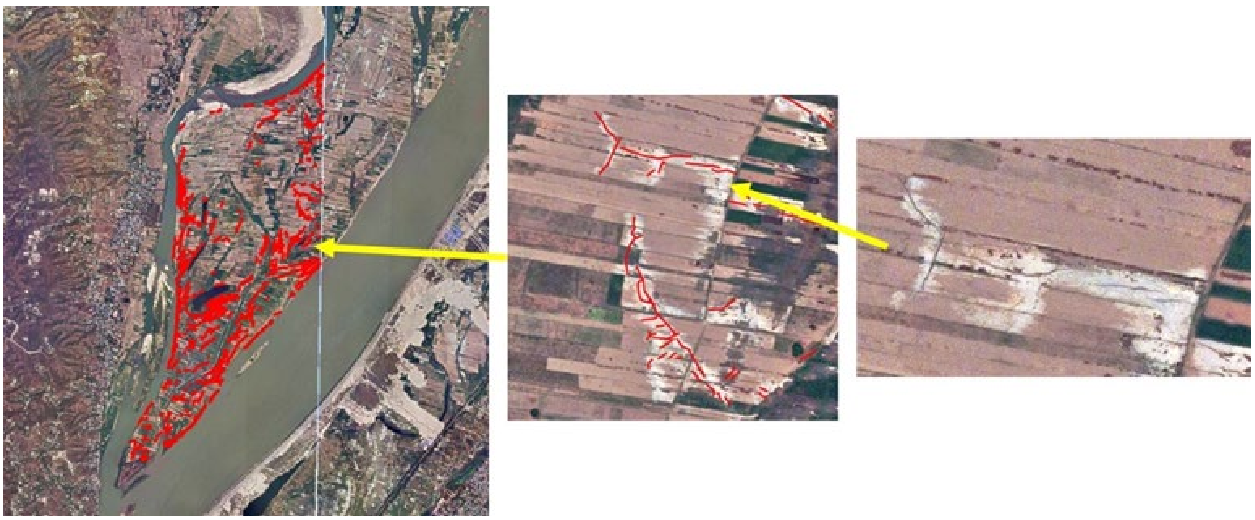


Figure 4.2.1. Mapping of lateral spread features in Area 2. Insets show increasing magnification of targeted subarea showing ejecta. Lateral spread fissures marked in red.

4.3. Lateral Spreading

A similar collage of images for Area 3 at different magnification levels is shown in Figure 4.3.1. The left-most image, at the lowest magnification, highlights (in red) the locations of lateral spread fissures throughout the entire area. The pattern is consistent with the location of this sand bar between two rivers. The middle pair of images show magnified views of two smaller portions of the overall area, while the same magnification images on the right show the location of a few fissures from lateral spreading and ejecta visible in the upper image but little ejecta in the lower image where lateral spreading appears to be more significant, likely reflecting differences in the initial local slopes and thus static shear stress conditions.

Figure 4.3.1. Mapping of lateral spread features showing differing fissure and ejecta patterns in Area 3. Inset images show magnified views of two subareas. Lateral spread fissures marked in red.

Further evidence of lateral spreading is evident in the photos shown in Figure 4.3.2, with fissures visible in the road at the crest of the slope (left image) and extension cracking near the toe of the slope (right image).

Figure 4.3.2. Evidence of lateral spreading along riverbank [Approximate location 21.9260, 96.0546]: fissures in the road at the crest of the slope (left) and extension cracking near the toe of slope (right) (Credit: ZoMung Thawng).

Lateral spreading and associated pavement cracking and fissuring was also reported in Area 1 along the Myo Patt Road as shown in Figure 4.3.3. Given the location of this highway and its proximity and orientation relative to the Sagaing Fault, it is possible that the observations in Figure 4.3.3 are a combination of several issues including failure of the pavement subgrade, lateral spreading due to local topographic variations, and fault rupture parallel to the highway alignment. Irrespective of the specific cause (which is difficult to determine in a virtual setting), the degree of damage is clearly significant as seen in the photos.

Figure 4.3.3. Extension in pavements along Myo Patt Road [Approximate Location 21.9260, 96.0546] (Credit: ZoMung Thawng).

4.4. Earthen Retaining Structure Performance

In general, many earth retaining structures tend to perform quite well even in relatively large earthquakes. While little is known about whether reinforced concrete gravity type retaining walls or some form of mechanically stabilized earth structures are now constructed in Myanmar, there were no reports of damage or failure of such structures during the earthquake.

4.5. Dam and Levee Performance

While a number of dams are located within the area impacted by the earthquake, the only report of dam impacts was at the SinThe Reservoir Dam near Dahatkone village (see Figure 4.5.1).

Figure 4.5.1. SinThe Dam aerial view (left) with images of post-earthquake damage. [Location 20.159054, 96.121426] (Sources: Google Earth (left) with still images extracted from video posted by [@heinwaisoe073 on TikTok](https://www.tiktok.com/@heinwaisoe073)).

4.6. Performance of Improved Ground

The Myanmar earthquake reinforced the importance of considering whether earthquake-prone and affected land should be strengthened to improve future resilience before any building and infrastructure reconstruction occurs. In 2017, Tonkin + Taylor International, a geotechnical specialist consultancy from New Zealand, was engaged to provide geotechnical earthquake engineering advice including the identification of ground improvement options for the Amarapura Urban Development Project (River City) to be established in Mandalay, Myanmar.

The Amarapura Urban Development Project, shown in Figure 4.6.1 and encompassing Area 5 in Figure 4.1.5 will be built on land composed of loose to medium dense sands, which are recent alluvial sediments deposited by the meandering, ancestral Ayeyarwady River. In its natural state, this soil is susceptible to liquefaction during strong earthquake shaking. Liquefaction results in a loss in strength and stiffness in the underlying sediments, leading to large vertical and lateral deformations, and may have a significant impact on buildings, roads, and underground infrastructure. Thus, ground improvement was proposed to help limit the amount of ground deformation, in particular lateral spreading, that is predicted to occur under earthquake shaking associated with a rupture along the nearby Sagaing Fault.

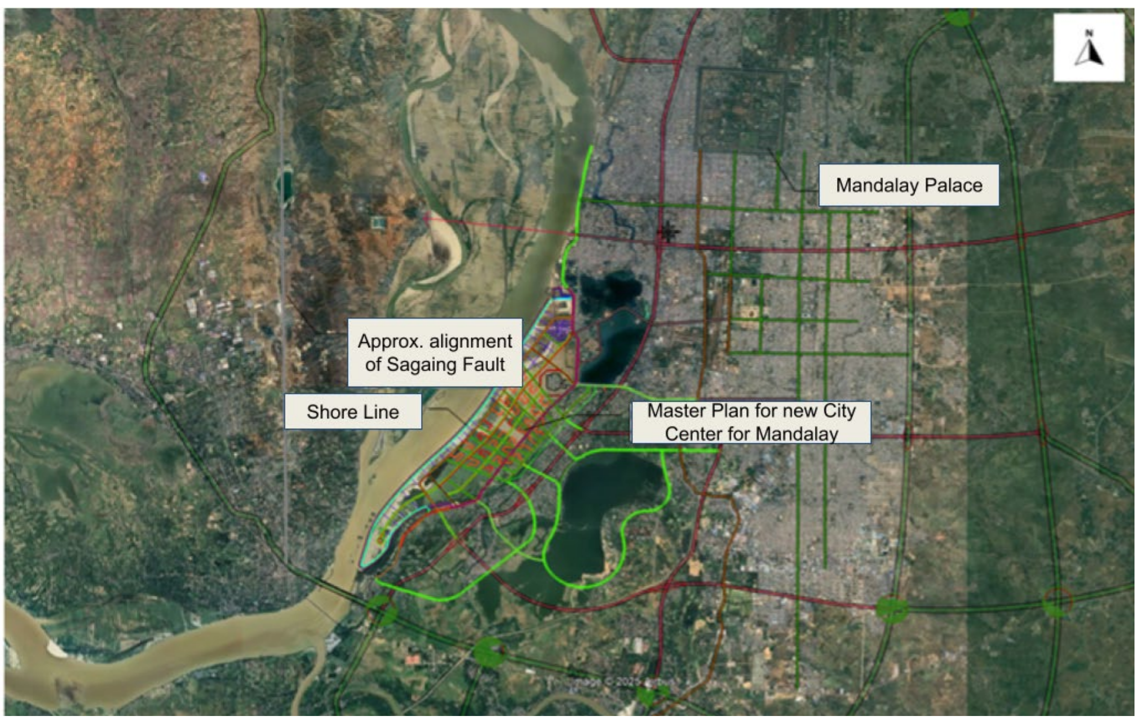


Figure 4.6.1. Master plan for Amarapura Urban Development Project (River City) (Credit: Mandalay Business Capital City Development Ltd).

In 2020, Tonkin + Taylor International developed shallow and deep ground improvement options to mitigate against effects of liquefaction (i.e., ground settlement and lateral spreading) to achieve the level of performance required for the Amarapura Urban Development Project. These have been progressively implemented using the vibro-flotation method to improve ground density. While ground deformation was observed throughout the Mandalay area (see Fig. 4.6.2), the project team undertaking the ground improvement work observed no appreciable ground deformation in areas improved using vibro-flotation; performance of this improved land was clearly better than areas where ground improvement has not yet been completed (Fig. 4.6.3).

Figure 4.6.2. Severe ground deformation along Myo Patt Road next to Amarapura Urban Development Project site (Credit: ZoMung Thawng).

Figure 4.6.3. Liquefaction ejecta post-earthquake in area where ground improvement work for Amarapura Urban Development Project had not yet been completed (Credit: ZoMung Thawng).

4.7. Other Geotechnical Observations

One anomalous observation was the development of a sinkhole in Demoso Township in Loikaw District of Kayah State. A photo of the post-earthquake sinkhole is shown in Figure 4.7.1, estimated to now be 100 feet deep.

Figure 4.7.1. View of sinkhole located in Demoso Township in Loikaw District of Kayah State [Location 20.159054, 96.121426] (Source: DVB TV Facebook).

5. Building Performance

Tables 5.1 and 5.2 provide a synthesis of the typical performance of buildings in this event, respectively organized by occupancy and geography. Geographic patterns of damage are informed by analysis of significant ground surface change, based on modified Copernicus Sentinel data processed by the European Space Agency and analyzed by the Earth Observatory of Singapore (Figures 5.1 and 5.2), which indicate that the most likely damaged urban areas are located in Myanmar's Mandalay, Sagaing, and Nay Pyi Taw regions (EOS 2025a), as well as in Thailand, particularly in Bangkok, Chiang Rai, and Chiang Mai (EOS 2025b). The subsections that follow present notable examples from these regions for the various structure classes in Table 5.1. Readers may consult the imagery compiled in the accompanying Media Repository (Rodgers et al. 2025), curated with this report in DesignSafe, to access a richer collection of georeferenced visual evidence cataloged by occupancy.

Table 5.1. Summary of Building Performance by Occupancy.

Single-Family Residential Buildings	Significant damage to traditional/vernacular (brick, brick-nogging, and timber) and reinforced concrete housing in Myanmar, including a full spectrum of damage up to and including complete collapse. Estimated 55,587 houses damaged (12,441 totally; 43,146 partially) in Myanmar.
Multi-Family Residential Buildings	In Myanmar, numerous reinforced concrete multi-story residential buildings with unreinforced masonry infill experienced lower-story damage or collapse due to weak/soft ground/lower stories. Other types of damage common in non-ductile reinforced concrete frames were observed. In Bangkok, some structural damage to tall buildings was reported.
Commercial Buildings	Similar to residential buildings, commercial reinforced concrete buildings in Myanmar experienced a range of damage; hotels and mixed-use buildings were observed to have lower-story collapses or severe damage due to weak/soft story conditions. Estimated 5,452 office buildings damaged in Myanmar.
Healthcare/Medical Facilities	Over 640 health facilities damaged in Myanmar, and 168 hospitals damaged in Thailand.
Schools	Damage to 2,565 schools in Myanmar; very few details available. Universities in Myanmar experienced damage from shaking; major fire at Mandalay University. 128 schools damaged in Thailand.
Government Facilities	Few observations available in Myanmar; Thailand reported damage to 83 government buildings.
Critical Facilities	In Myanmar, few observations were available; reported damage to fire stations.
Historical Buildings	Widespread and significant damage to cultural heritage buildings and structures, including collapses; at least one UNESCO World Heritage site and several sites on the tentative list damaged. 5,342 pagodas reported damaged in Myanmar.
Religious Institutions	Severe damage to temples, mosques, monasteries, nunneries and churches, including numerous collapses. 5,319 religious buildings reported damaged in Myanmar.
Debris estimates	3.3 million tons in Myanmar.
Notes: Totals of affected facilities in Myanmar are taken from (MIMU, n.d.). Totals of affected facilities in Thailand are taken from (AHA Centre 2025)).	

Table 5.2. Summary of Building Performance by Geography.

Myanmar	
North of Sagaing and Mandalay	Very limited information available.
Sagaing (city)	Very significant building damage and numerous collapses.
Mandalay (city)	Severe damage across the city, though performance was variable and many buildings had limited damage.
South of Mandalay to Myittha	Severe damage reported in Kyaukse and elsewhere.
Myittha to Meiktila	Less densely populated; little information available.
Meiktila to Nay Pyi Taw	Isolated areas of severe damage near the rupture are likely, based on satellite imagery, but few observations available.
Nay Pyi Taw	Severe damage was apparent in Nay Pyi Taw and nearby cities of Pyinmana and Ottara Thiri.
South of Nay Pyi Taw	Some damage reported in Bago region and the rupture terminus.
Thailand	
Bangkok	Nonstructural and limited structural damage; taller buildings experienced more damage due to deep, soft soil site conditions that amplified shaking; damage to reclining Buddha statue at Wat Pho.
Chiang Mai	Limited reports of damage to buildings.

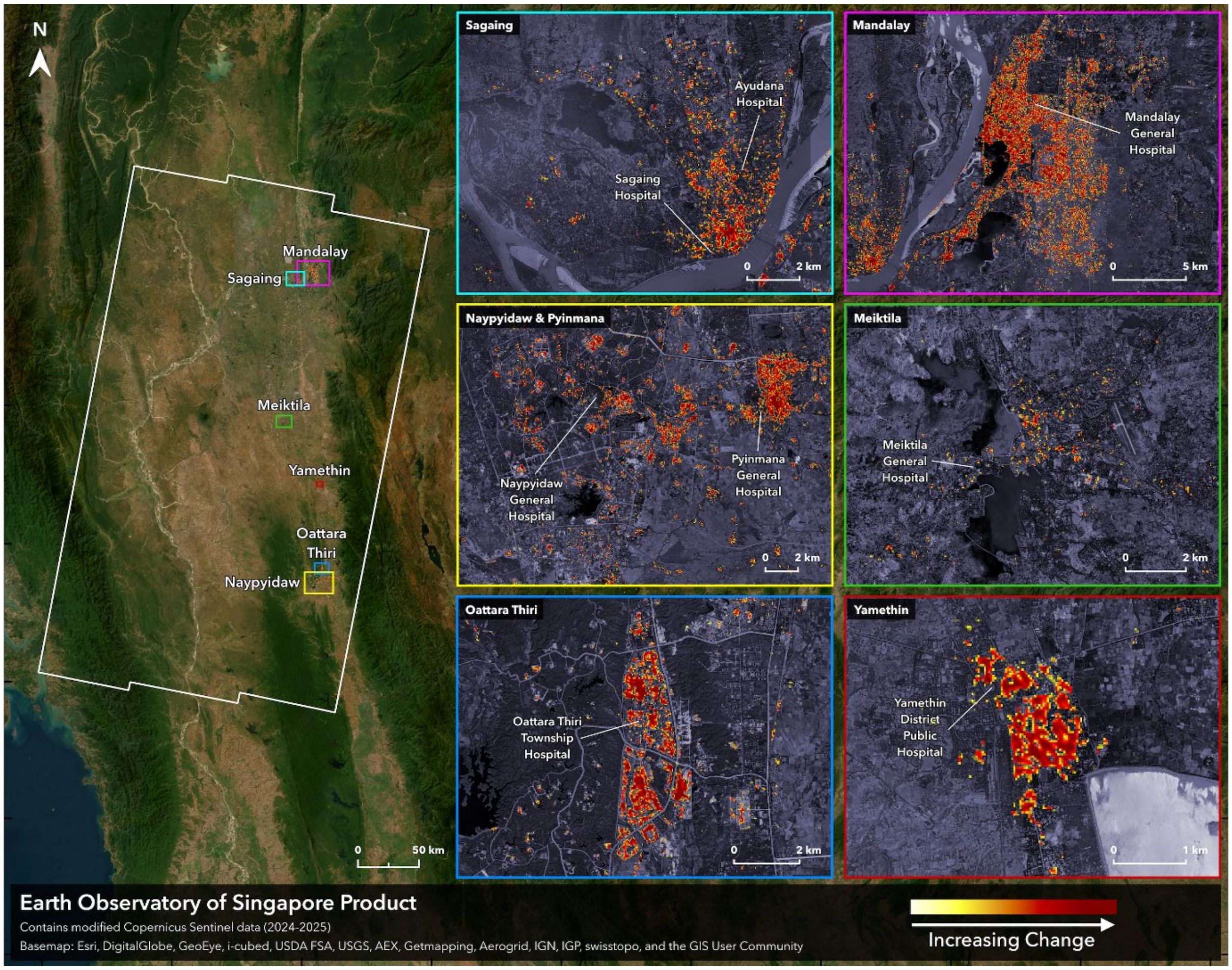


Figure 5.1. Damage Proxy Map for Myanmar (EOS 2025a). The red pixels indicate significant potential damage, based on the detection of ground surface change. Credits: Earth Observatory of Singapore Remote Sensing Lab (EOS-RS), contains modified Copernicus Sentinel data (2024-2025).

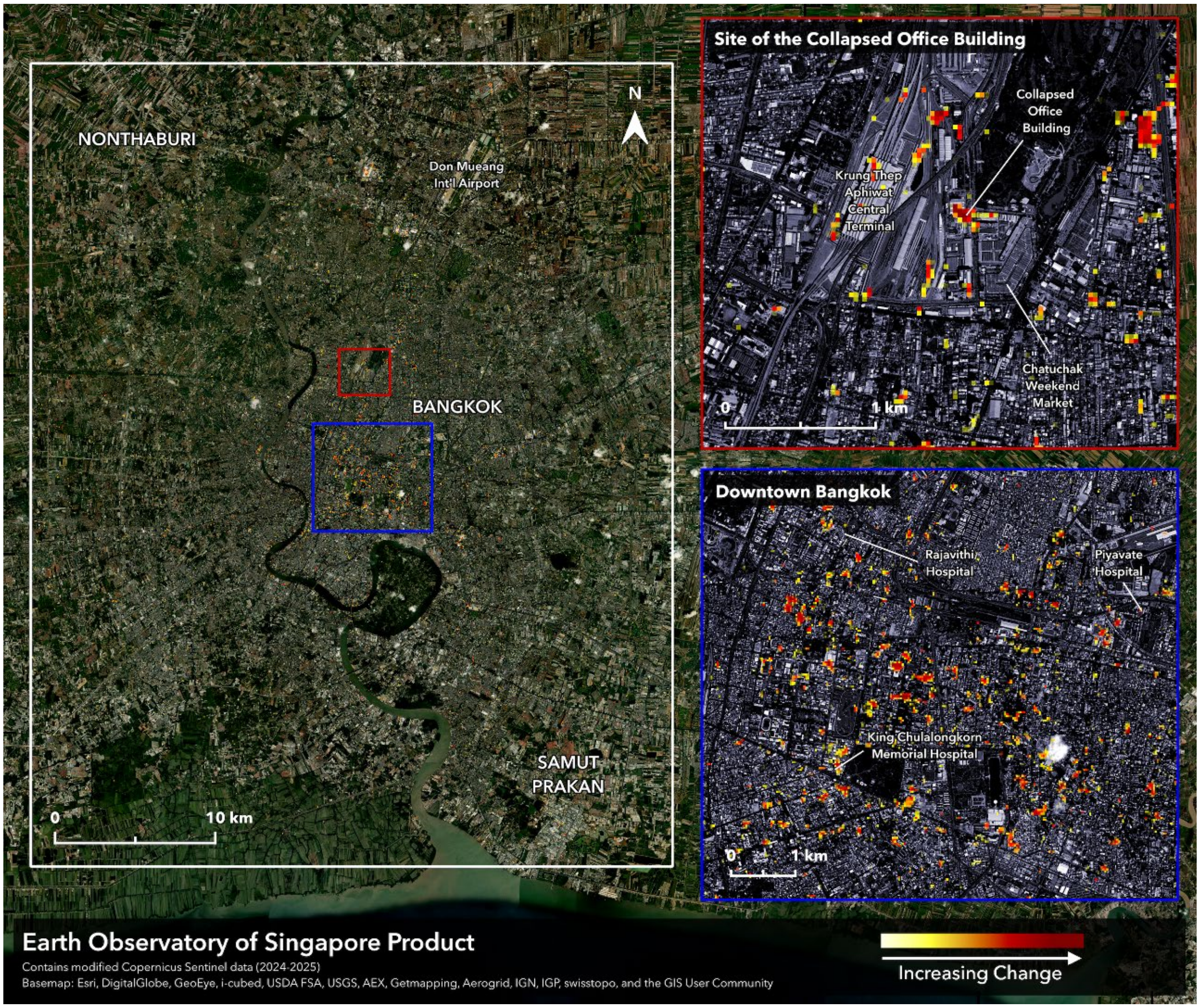


Figure 5.2. Damage Proxy Map for Bangkok, Thailand (EOS 2025b). The red pixels indicate significant potential damage, based on the detection of ground surface change. Credits: Earth Observatory of Singapore Remote Sensing Lab (EOS-RS), Contains modified Copernicus Sentinel data (2024-2025).

5.1. Residential and Commercial Buildings in Myanmar

5.1.1 Traditional/Vernacular Construction

Myanmar has rich vernacular/traditional building typologies (Oo et al. 2003). These include stilt houses built using locally sourced bamboo, wood (often teak) and rattan (WMF 2020; BillionBricks 2023), unreinforced masonry structures and wood-masonry composites, e.g., brick nogs (sometimes referred to as brick-nogging in the literature).

While many villages or other rural settlements were impacted by the earthquake (e.g., Meiktila village and many villages within the Chaung-U Township), it is unclear how much of the building stocks reflect the authentic characteristics of traditional/vernacular building technologies. Despite a number of failure examples from among shared visual material in social media (Fig. 5.1.1), we are yet to establish the overall performance of traditional/vernacular building technologies during the 2025 earthquakes.

Figure 5.1.1. (a) Partial collapse of a brick-nogging single family house in Pyinmana Township, Nay Pyi Taw, due to the failure of masonry infilled wall (Source: Pyinmana Update News Facebook); (b-d) traditional buildings around Inle Lake in Nyaungshwe Township (Source: The Irrawaddy News); (e) timber and masonry traditional type commercial building in Sagaing city with limited visible damage (shedding of bricks from narrow piers by doorway) (Source: Screengrab of @heungburma on X); (f) partially collapsed brick masonry commercial building in Sagaing City (Source: Screengrab of @heungburma on X).

5.1.2 Reinforced Concrete

Figure 5.1.2 overviews low-rise buildings with soft-story mechanisms at the ground floor. These primarily reinforced concrete frame structures with unreinforced brick infill walls are characterized by a relatively open ground story to accommodate parking, shops and large entrances, which creates a story weaker and more flexible than those above. Observed failures were not necessarily symmetrical, as shown in Figure 5.1.2 where one of the sides of the first story failed and caused collapse.

(a)

(b)

(c)

Figure 5.1.2. Low-rise buildings with soft-story mechanisms at the first floor (Sources: (a) @heungburma on X, (b) and (c) @TostevinM on X).

Figure 5.1.3 documents the collapse of the Sky Villa Condominiums. This complex appears to consist of three independent, but similar buildings immediately adjacent to each other. The front building in Figure 5.1.3a suffered collapse of the lower floors, while the middle and rear buildings suffered complete collapse. The buildings consisted of reinforced concrete frames with infill masonry walls in the upper stories. The first story, as seen in Figure 5.1.3a, had fewer structural elements and lacked infill and structural walls, which weakened the first story that collapsed (see Figure 5.1.3b). Video evidence (Fig. 5.1.3c) indicates that at least one building collapse did not occur immediately, but some minutes later.

(a) (b)

(c)

Figure 5.1.3. Sky Villa Condominium (a) before and (b-c) after the earthquake. (Sources: (a) screengrab from Eleven Broadcasting on YouTube, (b) @Myanmar38187592 on X (c) screengrab from NEWS9 Live on YouTube).

Figure 5.1.4 documents the collapse of Hotel Aung Ban, in the city of Aungpan, Myanmar, a reinforced concrete frame building with probable strong beams and weak columns, among other apparent vulnerabilities. The columns, which also appear to lack ductile detailing (damage is clearly concentrated at the column ends leading to a side-sway mechanism with little to no damage in the beams), were unable to resist the horizontal demands imposed by the floor system. While beams and slabs maintained their structural integrity, column failure ultimately led to failure of the building.

(a)

(b)

(c)

Figure 5.1.4. Hotel Aung Ban, Aungpan, Myanmar [Coordinates: 20.658, 96.632] (a) before and (b-c) after earthquake. (Sources: (a) Google Maps; (b) @IrrawaddyNews on X; (c) www.ludunwayoo.com).

Figure 5.1.5 shows the collapsed Jade City Hotel, Nay Pyi Taw, Myanmar. The pre-earthquake view (Fig. 5.1.5a) shows both vertical and plan irregularities. The earthquake possibly affected the building more in the longitudinal direction. The irregular front part of the building above the main entrance (Fig. 5.1.5a) has long columns, possibly just two in the short direction at the ground floor. Open space for the entry and lobby reduced lateral stiffness and strength, and potential torsional effects from the plan irregularity resulted in complete collapse of the front part of the building, as well as collapse of the lower three (apparently softer/weaker) stories of the building.

(a)

(b)

Figure 5.1.5. Jade City Hotel, Nay Pyi Taw, Myanmar [Coordinates: 19.88025,96.15184] (a) before and (b) after the earthquake (Sources: (a) Google Maps; (b) SiThu Maung on Facebook).

5.2. Health Facilities

5.2.1 Overview of Damage

Myanmar's health system contains both government and private hospitals. Government hospitals range from large, central referral hospitals in major cities, to district and township hospitals with 50 to 200 (or more) beds, to community-level station hospitals in smaller towns. Private hospitals are typically found in larger cities. This entire system was under significant stress well before the earthquake due to the ongoing conflict, with a reported 1500 attacks on healthcare since 2021 (Health Cluster 2025). Bangkok has a large healthcare system including a number of large hospitals.

As of April 14, 2025, 640 Myanmar hospitals or clinics were reportedly damaged (AHA Centre 2025), without a breakdown by location or facility type. Initial assessments of 103 health facilities as of May 2, 2025 by Health Cluster partners recorded 7 facilities not functioning, 56 partially functioning, and 40 fully functional (Health Cluster, 2025), an apparent improvement over April 2 when 86 facilities partially functional and 6 lost functionality completely (Fig. 5.2.1). Functional losses were attributed to power and water service interruptions caused by damage (Guadarrama 2025). In Nay Pyi Taw, the entrance canopies of the Emergency Department and Outpatient Department of the 1000-bed General Hospital suffered structural collapse (Fig. 5.2.2), and a 3-story 100-bed private hospital built in 2010 also experienced partial collapse in the ground story (Fig. 5.2.3).

Review of pre- and post-earthquake satellite imagery shows two potential collapses at private hospitals in Mandalay, with others reviewed not having damage severe enough to be visible on satellite imagery. Media reports, including that of a newly opened private hospital in Mandalay forced to cease operation (Soh 2025) and Wachat Jivitadana Sangha Hospital in Sagaing (Fig. 5.2.4), indicate damage significant enough to severely limit functionality even without visible damage from the satellite imagery.

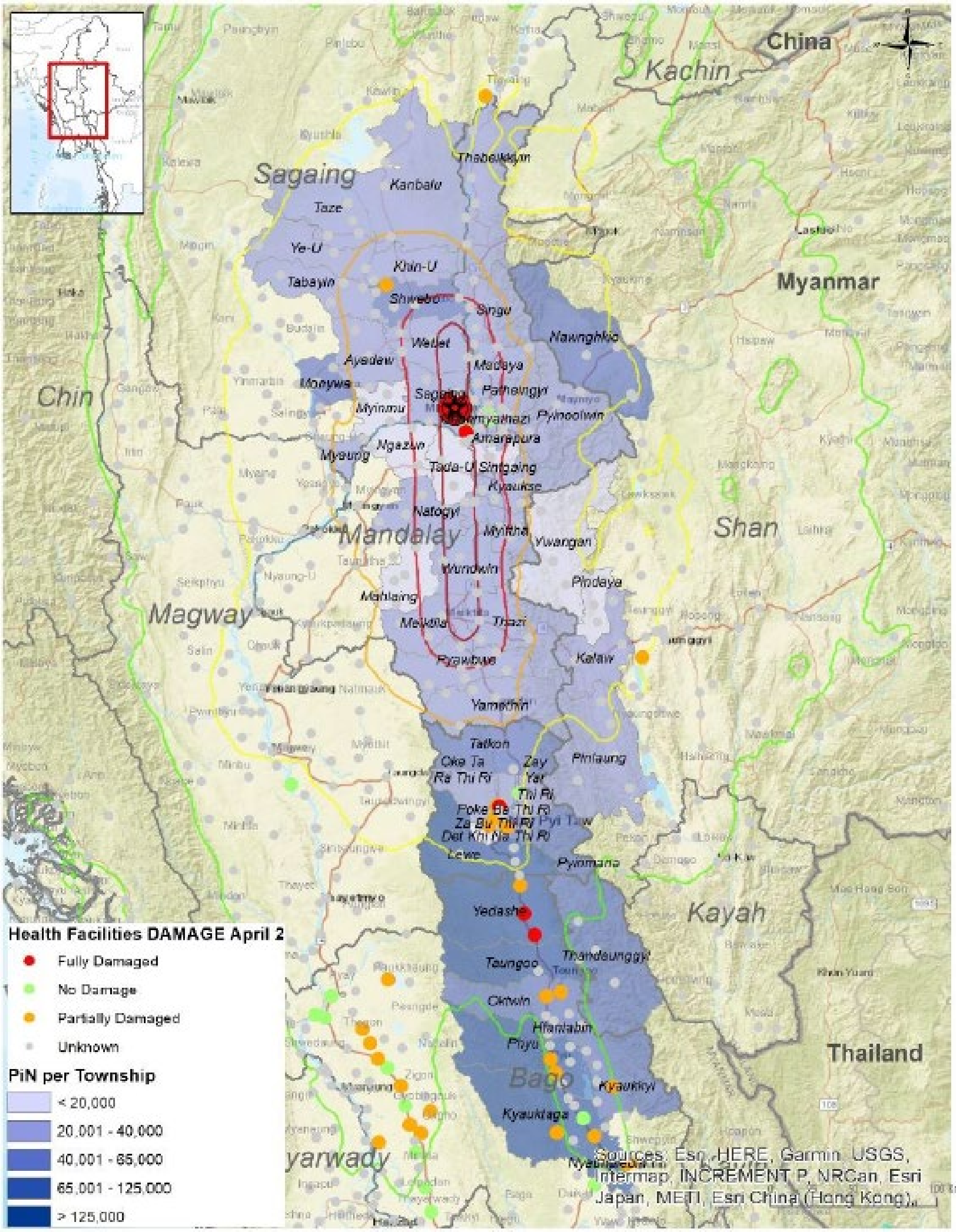


Figure 5.2.1. Location of damaged health facilities verified by health cluster partners as of April 2 (Health Cluster 2025).

(a) 

(b) 

Figure 5.2.2. Nay Pyi Taw General Hospital: (a) back view of the building shows one of the typical reinforced concrete entrance canopies before the earthquake; (b) canopy collapsed at the Emergency Department (Sources: (a) Wikimedia Commons, (b) Mazzina Myanmar, 2025).

(a) 

(b) 

Figure 5.2.3. Before (a) and after (b) images of the entrance frame at Ottara Thiri Private Hospital, which suffered structural collapse due to column failure (Sources: (a) Ottara Thiri Private Hospital Facebook Page; (b) MMKM Chinese Language Center on Facebook).

Figure 5.2.4. Wachat Jivitadana Sangha Hospital in Sagaing [Coordinates: 21.915215, 96.001606] was closed due to physical damage at the base of the structure (Source: Than Lwin Khet News on Facebook).

5.2.2 Hospital Response

Initial reports by the World Health Organization (WHO 2025a) indicate that Mandalay General Hospital and a 1000-bed hospital in Nay Pyi Taw were the main facilities treating injured people in the affected areas during the week after the earthquake.

As of March 29, people interviewed in Mandalay indicated that the victims mobilized to the hospitals were being treated in austere conditions outdoors on the hospital grounds, due to a large patient surge, and a lack of electricity and water supply (Volk 2025). This had notable effects on patients requiring dialysis treatments. A 2019 assessment of the hospital's utility systems and nonstructural components (GeoHazards International and UN-Habitat 2019) had identified significant vulnerabilities in the hospital's power and water systems. Limited available video of Mandalay General Hospital on April 1, 2025 showed power had been restored; available media showed patients receiving treatment inside and outside the hospital building.

In Nay Pyi Taw, victims waited for treatment outside hospitals (RNZ 2025). The expressway connecting Yangon with Nay Pyi Taw and Mandalay was also damaged, impeding the deployment of medical teams (MSF 2025). In Sagaing, one of the most affected cities, the main public hospital suffered moderate physical damage to nonstructural elements and column concrete cover (Fig. 5.2.5); however, the hospital continued seeing patients (Fig. 5.2.6), albeit with reduced treatment capacity due to power loss and lack of imaging capacity to diagnose fractures and other internal injuries. As hospitals were overwhelmed by the surge in demand for multiple days, it is unclear whether care was administered outside due to damage, need for natural light, or because patient loads required using the outdoors as an overflow space.

As of March 31, critical patients could not be transferred for advanced treatment such as amputations (MFP Facebook), with two bridges connecting Sangaing with Mandalay still closed on April 3 due to physical damage (MFP Facebook). Additionally, disruption of dialysis services in Mandalay required rerouting patients to Pyin Oo Lwin (Than Lwin Khet News Facebook).

(a) (b)

Figure 5.2.5. Evidence of physical damage in the interiors of a building at the Sagaing General Hospital: (a) non-structural damage in facade walls and (b) concrete cover detachment in reinforced concrete columns due to apparent pounding (Source: See Clearly via GoogleMaps).

Figure 5.2.6. Patients treated outdoors at Sagaing General Hospital; note no visible damage to the outside of the building shown. Identifiable faces are masked. (Source: DVB).

In Thailand, 168 hospitals reported earthquake damage (AHA Centre 2025), primarily to nonstructural systems. At least two hospitals reportedly experienced structural damage (AIT team, personal communication, April 7 2025). In Bangkok, several hospitals were evacuated to parking lots, canteens and sports halls on March 28 (BBC 2025). King Chulalongkorn Memorial Hospital, BNH Hospital, Phramongkutklao Hospital, and Rajavithi Hospital evacuated patients. The following day, patients were moved back or transferred to nearby facilities (France 24 2025). Hospital staff also indicated having performed medical procedures such as blood transfusions in the halls, which indicates the building likely had power supply after the earthquake.

5.3. Educational Facilities

As of April 7, government media were reporting 2661 schools damaged by the earthquake in Myanmar (AHA Centre 2025; UNICEF 2025b). A breakdown of the damage by severity or location was not made publicly available.

Myanmar has approximately 42,000 schools registered with the government, with 82% reopening after prolonged COVID-19 closures (Bhatta et al. 2023). Approximately 92% of enrolled K-12 students attend government schools, with the majority attending Basic Education schools at the primary, middle, or high school levels (Bhatta et al. 2023). Government schools were on break and therefore not in session when the earthquake occurred, meaning most students would not have been in school at the time of the earthquake. Government schools being closed may be one reason that less damage information is available.

Initial remote sensing observations indicate that some collapses of government school buildings likely occurred. Significant damage also reportedly occurred at religious/monastic schools, but very limited information was available. However, preschools and other childcare centers, and possibly some private schools, were open at the time of the earthquake.

Multiple private school collapses occurred, causing dozens of fatalities (Fig. 5.3.1). A private preschool in Kyaukse collapsed, killing two teachers and numerous students (H. N. Zaw 2025). The Myat private school in Sagaing suffered what appears to be a ground-story collapse that killed 8 students and 3 teachers. The 7-story Pynnyar San Eain private school collapsed in Paleik, killing an unknown number of people. A kindergarten in Amarapura experienced ground-story collapse but no injuries or fatalities occurred. Private schools may have been more vulnerable to earthquake damage due to being located in buildings that were originally built as residential or mixed-use buildings, and that have common vulnerabilities for these occupancies, such as weak/soft ground stories.


(a)

(b)

Figure 5.3.1. Collapsed reinforced concrete frames of private schools in Kyaukse (a) and Sagaing (b) (Source: Htet Naing Zaw, BBC Burmese (a); BBC Burmese (b)).

Universities in the region also experienced significant damage, including Mandalay University, Technological University Kyaukse, and Technological University Sagaing (Fig. 5.3.2). The post-earthquake fire in Mandalay University's historic main building reportedly destroyed matriculation exam papers of thousands of students that were being graded at the time of the earthquake (DVB 2025e).

 (b)  (b)

Figure 5.3.2. Earthquake and fire damage to Mandalay University (a) and collapsed ground story at Technological University Kyaukse (b) (Source: Popular News Journal (a); student group via Facebook (b)).

5.4. Religious Buildings and Cultural Heritage Structures

Myanmar is renowned for its rich cultural heritage and religious architecture, with thousands of Buddhist pagodas, temples, and monasteries scattered across the country. Myanmar's religious structures not only serve as places of worship but also play vital roles in education, healthcare, and community support. A large majority of the population (80 to 90%) practices Buddhism with Christians (7%), Muslims (3%) and practitioners of other religions being significant minorities. The majority of religious buildings and cultural heritage are therefore Buddhist. A diverse range of architectural typologies, reflecting influences from different religions and colonial traditions, is present including but not limited to:

- Pagodas and Stupas – The most iconic religious structures in Myanmar, often gilded and adorned with intricate carvings.
- Monasteries – Traditionally built with teak wood, monasteries serve as places of worship and education for monks.
- Temples – Found primarily in Bagan, these structures range from simple brick designs to elaborate multi-tiered temples with ornate stucco decorations.
- Colonial-Era Churches and Mosques – British colonial rule introduced Christian churches and mosques, many of which still stand in Yangon and Mandalay.

Myanmar has two UNESCO World Heritage Sites of outstanding universal value to cultural or natural heritage: the Pyu Ancient Cities (Hanlin, Beieithano and Sri Ksetra listed in 2014) and Bagan (listed in 2019 for being strikingly early and large urbanized settings). Bagan, located near Mandalay, is an ancient capital and comprises over 3000 monuments from the 10th to the 14th centuries, including stupas, temples and monasteries, which already suffered extensive damage during the country's last major earthquake in 2016 (Movius 2025; UNESCO 2016). Little is known on the impact of the 2025 earthquake on the world heritage sites, except for damage to the roof structures of the Sulamani Temple, That Bin Nyu Temple, Bagan Pagoda No. (1138), Pagoda No. (879), Pagoda No. (882), and Tuyin Taung Temple (Fig. 5.4.1).

Myanmar has another 15 sites on the UNESCO World Heritage tentative list, for which the following information is available:

- Wooden Monasteries of Konbaung Period: Ohn Don, Sala, Pakhangyi, Pakhannge, Legaing, Sagu, Shwe-Kyaung (Mandalay) - No confirmed reports of earthquake damage.
- Badah-lin (Padah-Lin) caves - No confirmed reports of earthquake damage.

- Ancient cities of Upper Myanmar: Innwa, Amarapura, Sagaing, Mingun, Mandalay - Damage was reported in several ancient cities of upper Myanmar:
    - Innwa (Ava): Several monasteries and pagodas suffered damage (PTI 2025).
    - Amarapura: Widespread destruction, with damaged monasteries (Rahaman Sarkar, Gregory, and Croft 2025).
    - Sagaing: Suffered immense destruction, including collapsed bridges, religious buildings, and schools (Lynch 2025).
    - Mingun: Damage includes Mingun Pahtodawgyi, an unfinished pagoda, along with other historic structures (Wikipedia 2025a).
    - Mandalay: The earthquake devastated Mandalay, causing hundreds of buildings to collapse, including century old buildings, religious buildings and residential areas (Rahaman Sarkar 2025).
- Mrauk-U: No confirmed reports of damage.
- Mon cities: Bago, Hanthawaddy - Significant damage in Bago and surrounding areas, including damage to historic structures (UN News 2025).
- Shwedagon Pagoda on Singuttara Hill in Yangon - Not damaged.

Figure 5.4.1. Examples of damage to the roof structures of the temples of the Bagan Ancient Cultural Heritage Zone (World Heritage Site) (Source: Mizzima-Burma).

Beyond these UNESCO sites, a large number of religious and cultural heritage structures in Myanmar were damaged, including 670 monasteries and 290 pagodas (Al Jazeera 2025a), as well as 95 pagodas/stupas and 50 mosques (National Unity Government Myanmar on X). Notable cases include the Mahamuni Pagoda in Mandalay (Fig. 5.4.2a), and the Four-Storied Monastery in Inwa (some 40 km from Mandalay), both Buddhist temples and pilgrimage sites. A non-exhaustive list of other damage to pagodas and cultural heritage structures is in Appendix C.

Other religious buildings affected by the ground shaking include newer churches and mosques. For example, the Sacred Heart Cathedral in Taungoo, some 380 km away from Mandalay, suffered from extensive non-structural damage (Monthienvichienchai 2025). Fifty mosques across the affected regions were damaged (Al Jazeera 2025a). The Myodaw and Moekya mosques' collapse killed a significant proportion of the Muslim population in the area, who were gathered for the Ramadan night (Taraweeh) prayer (Htun and Wong 2025).


(a)


(b)

Figure 5.4.2. Damage to religious sites in Myanmar: (a) Mahamuni Pagoda (Source: @SaadAbedine on X); (b) collapse of the Myatheindan Pagoda (or Hsinbyume Pagoda) (Source: Vietnam).

5.5. High-Rise Building Performance in Bangkok

The ground shaking recorded in Bangkok during the 2025 Mandalay earthquake was among the strongest ever experienced in the city in modern times. The ground shaking significantly affected high-rise buildings throughout Bangkok and its surrounding areas. One monitoring station recorded a Peak Ground Acceleration (PGA) of 0.023g. Although Bangkok is located nearly 1,000 km from the earthquake's epicenter, the city was still impacted due to local site effects. The Bangkok Basin is composed of deep alluvial sediments, which can amplify seismic waves by a factor of three to four, particularly at periods of one second or longer. This amplification greatly affected tall and high-rise buildings during the earthquake. Immediately after the earthquake, many public buildings and high-rises were evacuated, leading to severe traffic congestion across the city. Metro and light rail services were also temporarily suspended. The Bangkok Metropolitan Administration (BMA) has processed thousands of reports of building damage, declaring 34 buildings severely damaged (The Nation 2025a)

The 30-story State Audit Office Building in Bangkok's Chatuchak district, which was under construction at the time of the earthquake, collapsed (Fig. 5.5.1). Structural damage triggered a progressive collapse of the building, making it the only confirmed case of complete structural failure in Bangkok. As of May 4, the Bangkok Metropolitan Administration reports the death toll from the collapse as 109 (The Nation 2025b). Most high-rise buildings in the city, including the collapsed structure, are reinforced concrete buildings with structural walls serving as the primary lateral load-resisting system. The gravity load-resisting systems typically consist of post-tensioned flat slabs. While severe structural damage was still fairly limited, a few buildings suffered significant shear wall damage due to compression and bar buckling failure (Fig. 5.5.2). Isolated cases of column failure were also reported. In one instance, excessive displacement caused damage to a connecting bridge between two towers. Localized structural damage due to pounding between adjacent structures was also reported.

Figure 5.5.1 The site of 30-story building collapse showing debris pile next to an undamaged ground plus two-story concrete frame building also under construction (Source: [Thai Post News]).

Figure 5.5.2. Shear wall compression and bar buckling failure (Source: [CSI LA Facebook post]).

For the most part, the damage to high-rise buildings was limited to architectural and non-structural components, particularly masonry infill wall panels and ceilings. Unreinforced masonry infill walls in Thailand are usually plastered and constructed without separation from the bounding frames, making them sensitive to inter-story displacement. However, most of the buildings with only non-structural damage were cleared for immediate occupancy following post-earthquake inspection.

6. Infrastructure Performance

Table 6.1 provides a synthesis of the typical performance of other infrastructure classes in this event, organized by class. The subsections that follow present notable examples. Readers may consult the imagery compiled in the accompanying Media Repository (Rodgers et al. 2025), curated with this report in DesignSafe, to access a richer collection of georeferenced visual evidence cataloged by infrastructure class.

Table 6.1. Summary of Performance by Infrastructure Class.

Power and Telecommunications Infrastructure	In Myanmar, widespread power outages and national grid failure was reported, though limited information was available on damage to specific generation, transmission, and distribution assets.
Airports	Mandalay and Nay Pyi Taw airports are near the fault rupture; both were damaged and closed to commercial flights until April 4 for Mandalay and April 7 for Nay Pyi Taw.
Roads	407 roads damaged in Myanmar causing significant disruptions: 198 locations / 81 bridges along the Yangon-Mandalay Expressway damaged by various types of ground failure, hindering relief efforts. Roads and streets crossing the active trace of the Sagaing Fault were damaged by surface rupture.
Bridges	Damage reported to 95 bridges in Myanmar; two major bridges collapsed in the Mandalay-Sagaing area.
Railways	38 railways (over 70 segments of rail lines) damaged in Myanmar; concrete beam collapse at Den Chai-Chiang Rai-Chiang Khong (Thailand), currently under construction (Mail 2025).
Water Systems	Water system damage including pipe breaks reported in Mandalay City, notably affecting hospitals (see Section 5.2.2).
Other Lifelines	Limited damage and performance information available for other utility systems.
Port Facilities	No observations available for this class at time of this report.
Agricultural	No observations available for this class at time of this report.
Note: Totals of affected facilities in Myanmar taken from (MIMU, n.d.).	

6.1. Power Systems, Outages and Restoration

Historically, hydropower has been the dominant source of electricity in Myanmar, with the distribution of power sources in recent years baselined in the Outage and Restoration database curated with this report in DesignSafe. However, Myanmar's power sector has been severely affected by the ongoing political turmoil since 2021, with prolonged electricity blackouts throughout the country (Aliyev, Seong, and Myint 2023). The earthquake only compounded these vulnerabilities. Electricity outages were widespread as illustrated by the nighttime lights imagery shown in Figure 6.1.1, with light intensity analyses in Table 6.2 suggesting significant power losses in Mandalay, Mogoke, Wundwin, Yamethin, and Nay Pyi Taw (IRDR 2025). Media reports suggest that the most affected areas, such as Nay Pyi Taw and Mandalay, experienced complete power loss (Myanmar Now 2025b). Outages cascaded to affect other utilities, such as water, in locations like Pathein (DVB 2025d). Even relatively less affected areas like Yangon were experiencing significant power outages; even once power was restored, rolling blackouts for 2-4 hours per day persisted for days (Cho 2025). There was no information on the status of restoration efforts at the time this report was issued.

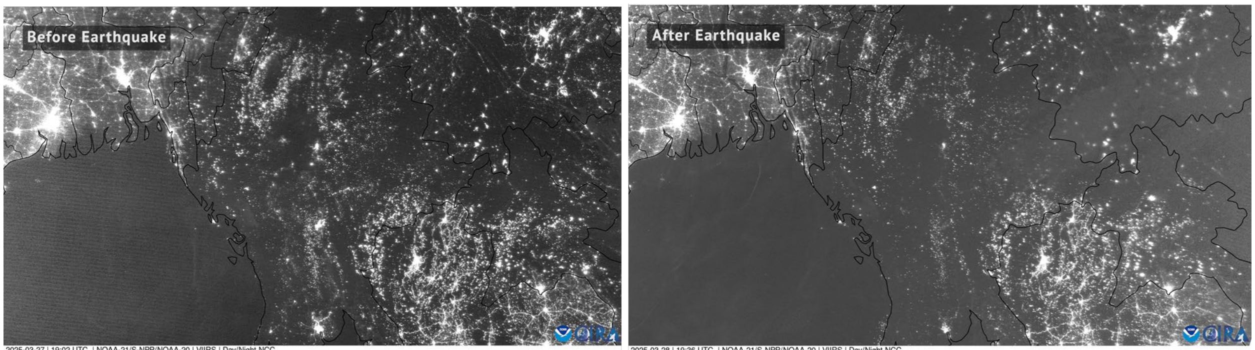


Figure 6.1.1. Nighttime lights over Myanmar before and after the earthquake; reduced illumination post-event (28 Mar 2025) indicates potential power or infrastructure impacts (Source: CIRA).

Table 6.2. Decrease in Power Supply Relative to December 7, 2024 Baseline Values (IRDR 2025).

Affected Area(s)	Light Intensity Change	Affected Area [km^2]	Affected Population
Mandalay	-82.88%	73.79	1,002,000
Mogoke, Wundwin, Yamethin	-85.81%	9.21	19,000
Nay Pyi Taw	-89.47%	150.20	100,000
Yangon	-38.42%	291.60	3,770,000

Impacted power infrastructure contributing to these outages are reported in Figure 6.1.2a, alongside locations of high-capacity hydroelectric power plants, which comprise the largest portion of Myanmar's power generation (Fig. 6.1.2b). The Thaketa Gas Engine Power Plant experienced a complete power outage due to national grid collapse, but was restored after 16 hours. As of April 2nd, 2025, this plant carried 30% of Yangon's emergency power load (PowerChina 2025). The Sembcorp Myingyan Power Plant was automatically shut down during grid failure but sustained no physical damage. As of April 6th, 2025, there was no confirmation that the plant had resumed operations (Lin 2025). The condition of other power plants, substations or transmission systems could not be confirmed.

Figure 6.1.2. (a) Geospatial distribution of impacts to power systems, and (b) location of hydroelectric power plants with capacity greater than 70.0 MW (Data Source: OpenStreetMap).

6.2. Transportation Systems

Sections 4.3 and 5.2.2 respectively discussed damage to some roads and expressways and their impacts on critical facilities. The following sections present additional evidence of impacts to transportation systems.

6.2.1. Bridges

In Myanmar, dozens of bridges were reportedly damaged, in addition to 81 bridges on the Yangon-Mandalay Expressway (AHA Centre 2025), some of which collapsed during the earthquake. Figure 6.2.1 maps locations of two major collapsed bridges together with the trace of the 460 km surface fault rupture characterized by USGS (USGS 2025c), illustrating their very close proximity to the fault rupture. One of these collapsed bridges is the historic Ava Bridge (also known as the Sagaing bridge), which was a 16-span truss simply supported bridge between Ava and Sagaing, crossing the Ayeyarwady River. Although largely bypassed by the newer Yadanabon Bridge for highway traffic, the Ava Bridge remained a key rail connection between Mandalay and the northwestern regions. Its collapse affected regional supply chains, forced detours via less efficient routes, and severed a passenger rail route, further compounding the post-event transportation challenges. The bridge decks in several spans were unseated from the bearing supports at the piers due to a combination of large displacement in the bridge's longitudinal direction, rotation of the deck, insufficient seat length, and possible damage to bearings (Fig. 6.2.2). Traffic now routes through the Yadanabon Bridge built in 2008 just to the north, which reopened to light traffic two days after the earthquake (Theint 2025).

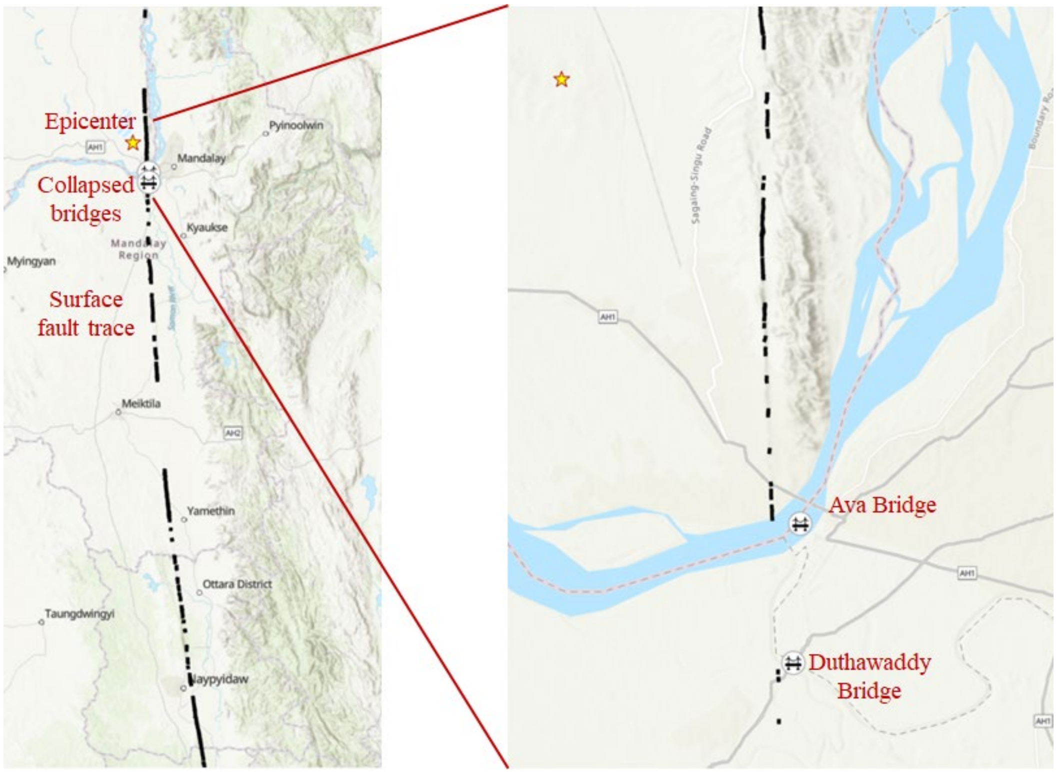
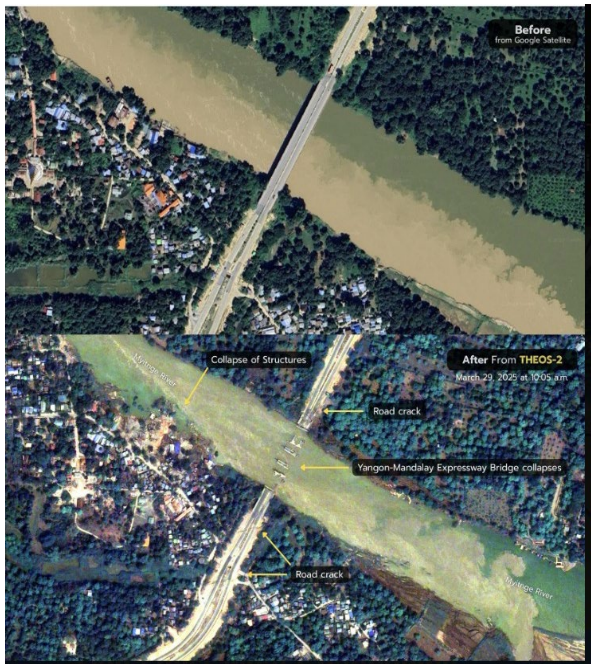


Figure 6.2.1. Collapsed bridges in epicentral region close to surface fault rupture (USGS 2025c).

Figure 6.2.2. Unseated bridge decks of the Ava Bridge, noting undamaged piers and fully intact bridge deck sections (Deliso 2025).

Located on the AH-1 (Yangon-Mandalay Expressway), the Dutthawaddy (U Man Lay) Bridge crossing the Myitnge River, served as a vital link along a major transportation corridor. As part of AH-1, the primary north-south transportation artery, this bridge was essential for mobility, emergency response, and logistics. Its collapse due to unseating of the bridge decks on all its spans (Fig. 6.2.3a) caused major transportation disruptions, delaying relief operations, and increasing travel times. Several of its piers also lifted off their foundations and overturned (Fig. 6.2.3b), with heavy damage to its abutment and ground failure at the approach and shoulder (Fig. 6.2.4).

The economic impact of the collapse of these bridges was significant. It led to supply chain delays, higher transportation costs, and congestion on lower-capacity roads, placing additional strain on Myanmar's already limited infrastructure. Major corridors for goods, fuel, and humanitarian aid were disrupted, exacerbating the post-disaster logistical and recovery challenges.



(a)


(b)

Figure 6.2.3. Dutthawaddy (U Man Lay) Bridge crossing Myitnge River: (a) satellite images before (top) and after (bottom) the earthquake (Credit: Gansu Data and Application Center for High-Resolution Earth Observation System); (b) unseated bridge decks and overturned piers (Source: [Khit Thit Media on Facebook]).

(a)


(b)


Figure 6.2.4. Dutthawaddy (U Man Lay) Bridge crossing Myitnge River: (a) roadway and abutment damage (Source: Extracted from video from @fri4800 on TikTok); (b) approach and shoulder road failure with wide separation (Source: Extracted from video from @aungsl1 on TikTok).

6.2.2. Railways

Myanmar's railway service was disrupted prior to the earthquake due to the ongoing conflict (The Nation 2024), with the last incident along the Yangon-Mandalay railway line reported on December 13, 2024 (Eleven 2024). The Yangon-Mandalay and Pyin Oo Lwin-Taung Twin Gyi were among the routes further affected by the earthquake (Table 6.3). Train services for passengers and freight were temporarily suspended on the Yangon–Mandalay and Pyin Oo Lwin–Taung Twin Gyi lines (MITV 2025). By April 5, passenger and cargo trains along the Yangon-Mandalay route resumed operations (Batrak 2025); regular train services on the Pyinmana-

Taungdwingyi-Pyinmana route resumed as of April 10 (Railly News 2025). Figure 6.2.5 shows track deformations at the Thayetkon Railway Station, an indicator of excessive ground movements.

Table 6.3. Number of Track Damage Reports, Listed by Route or Route Start/End Points with Inset Map of Affected Towns and Cities.

Kyaukdaga and Taungoo	23
Taungoo and Nay Pyi Taw	7
Thazi-Mandalay	30
Pyin Oo Lwin-Taung Twin Gyi	11

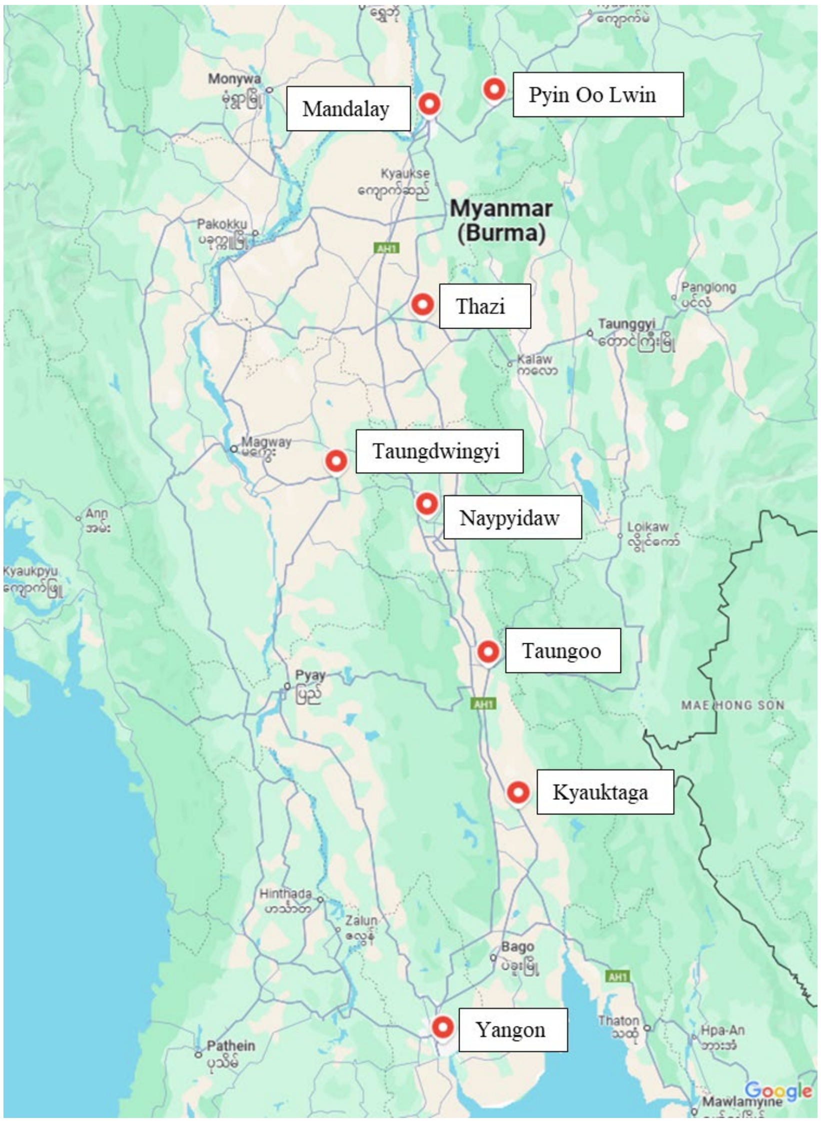


Figure 6.2.5. Track deformation at Thayetkon Railway Station (Source: Facebook).

On April 11, the Union Minister for Transport and Communications General reported that several restoration efforts were underway. The reinforcement works included the renewal of gravel fill, the readjustment of concrete sleepers (concrete ties), and the use of automatic lining, leveling and tamping machines to strengthen the railway lines. In addition, 18 tarpaulin tents were installed as temporary stations at several sites along the Nay Pyi Taw-Thazi, Thazi-Mandalay, and Thazi-Phaya Nga Su routes (MITV 2025).

6.2.3. Airports

Figure 6.2.6 maps locations of airports relative to the 460 km surface fault rupture from USGS (USGS 2025c), with Mandalay Airport near the epicenter and Nay Pyi Taw Airport along the fault rupture to the south. Immediately after the earthquake, the radar systems at both airports were not operating, halting flights. During this time, Yangon Airport was the only operational airport in Myanmar handling international aid (Myanmar Now 2025a). Despite nonstructural damage, including suspended ceiling failure (Fig. 6.2.6), experienced in the Mandalay Airport, the airport reopened for domestic flights on April 4. The airport was fully reopened on April 6 (Xinhua 2025).

In Nay Pyi Taw Airport, the main airport in Myanmar's capital, the airport control tower failed at its base (Fig. 6.2.7), killing at least five individuals and leading to the airport's temporary closure (@heungburma on X). There are no ground motion recordings nearby (NPW strong motion station is about 18 km north-northwest), however it is possible that the ground shaking at this location had a pulse-like nature due to rupture directivity. Such rupture directivity effects away from the epicenter along the fault rupture has been observed in other recent earthquakes, e.g., the 2023 Turkiye earthquake sequence (Dilsiz et al. 2023). There was also damage to runways and terminal buildings. Domestic flights partially resumed at Nay Pyi Taw Airport by April 7, following the necessary repairs.

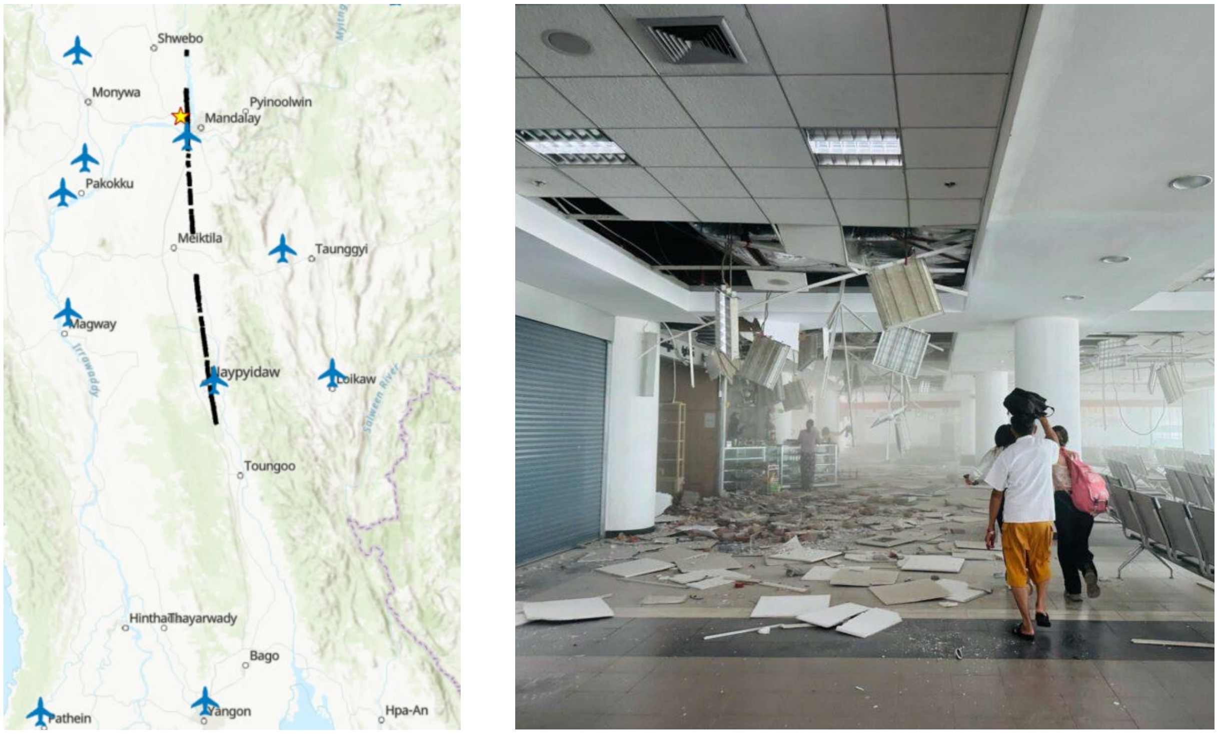


Figure 6.2.6. (left) Locations of major airports in Myanmar relevant to earthquake epicenter and the surface fault rupture trace from USGS (USGS 2025c); (right) suspended ceiling damage in a terminal building at the Mandalay Airport (Source: (Myanmar Now 2025a)).

Figure 6.2.7. Collapsed airport control tower of the Nay Pyi Taw airport due to biaxial bending resulting from combined effect of horizontal ground motion components (Source: [@heungburma on X]), with aerial imagery of condition before and after earthquake (Sources: before, Airbus, Maxar Technologies; after, Maxar Technologies).

7. Recommended Response Strategy

Based on the information gathered by this Joint Preliminary Virtual Reconnaissance Report (J-PVRR), StEER, GEER, EERI, EEFIT, GeoHazards International and AIT Bangkok offer the following topics and recommendations for future study.

TOPIC 1: Impacts of Surface Fault Rupture

Lengthy surface fault rupture was documented via satellite across hundreds of kilometers, with right-lateral offsets of a meter or more apparent in multiple locations based on available ground-level images. Initial virtual observations indicate the rupture passed through urban, peri-urban, and rural areas and affected infrastructure crossing the fault and buildings constructed across it. Follow-up studies could include:

- Remote sensing identification of infrastructure (including roads, railways, dams, bridges, airports, flood protection infrastructure, water infrastructure, and power infrastructure) built across the fault trace along the portions of the rupture identified by USGS as having likely surface rupture.
- Field documentation of surface fault rupture and its impacts on structures, where field reconnaissance is necessary in many cases to conclusively distinguish surface fault rupture from other causes of surface cracking.
- Study of (i) restoration of transportation infrastructure and services and affected urban environments, including temporary measures, (ii) decisions on rebuilding or relocating structures across the fault, and (iii) whether decisions have been made to restrict development in areas affected by surface rupture.

TOPIC 2: Building and Infrastructure Performance Near Nay Pyi Taw (NPW) Strong Motion Station

The Nay Pyi Taw strong motion station (19.779°N 96.138°E per USGS, 2.75 km from rupture) recorded design-level (or higher) shaking in some period ranges and pulse motions from what is thought to have been a supershear rupture. Documenting building, geotechnical, and possibly infrastructure performance (if sufficient assets of interest were present) near NPW station will allow relating the assets' performance to recorded ground motion. Limited damage information was available from the peri-urban area close to NPW station. Specific investigations could include:

- Documenting instances of ground failure within a certain radius from the station.
- Documenting damage (or lack thereof) to all buildings within a certain radius from the station.
- Investigating performance of recently constructed buildings near the station designed to MNBC 2016 or 2020, which has seismic provisions based on ASCE 7 (albeit an older version). Most buildings in this area are fairly new.
- Documenting damage and performance of relevant infrastructure (for example, power distribution assets) within a certain radius from the station.

TOPIC 3: Impacts on Distant Soft-Soil Sites

Notable damage occurred in Bangkok, approximately 500 km from the southern end of the rupture. Damage in Yangon appears limited. A strong motion recording is available for Yangon, and instruments in Bangkok apparently recorded the event, though the data were not made available at the time this report was prepared. Specific investigations could include:

- Performance and future vulnerabilities of tall buildings on very soft soil in Bangkok.

- Comparison of ground motions in Bangkok and Yangon.

TOPIC 4: Ground Motion Studies

Several important strong-motion records were obtained from this earthquake. Instrumentation in the strongly shaken area was unfortunately sparse, and the status of instruments in Mandalay was not known at the time this report was written. Potential topics for further investigation include:

- Placement and analysis of data from a temporary array of strong motion instruments, especially in the Mandalay region, to capture aftershock recordings.
- Implications of the supershear rupture in terms of ground motion characteristics and hazard.
- Incorporating new data from Bangkok in ground motion prediction models.

TOPIC 5: Power System Performance in Myanmar

Significant power outages were observed across much of Myanmar, and failure of the national grid was reported, though details of damage to generation, transmission, and distribution assets were sparse. Follow-up studies could include:

- Documenting damage to power system assets.
- Performance of the national grid and restoration.

TOPIC 6: Health System Impacts

In Myanmar, hospitals in the most affected areas experienced a large patient surge, while reportedly contending with loss of utilities and some facility damage, though limited information on facility performance was available. Follow up studies can examine:

- Damage to facilities and their impacts on medical care delivery and ability to handle patient surge
- Response of the healthcare system, including beneficial adaptations to austere conditions in Myanmar.
- Evacuation decision-making processes and impacts of evacuations on medical care delivery in Myanmar and Bangkok.
- Restoration of healthcare service delivery, primarily in Myanmar.
- Causes of injuries and deaths given varied construction.
- Impact on primary care services.
- Impacts to access to treatment and care for existing illnesses and lessons learned for future earthquakes and disasters.
- Recovery of the public health system and lessons learned.

Escalation Decision

Based on the magnitude of this event and the significant exposure of the building and infrastructure inventories documented by this J-PVRR, this event satisfies the majority (75%) of StEER's escalation criteria (see Table 7.1). This would normally prompt StEER to escalate to Level 2, commissioning a Field Assessment Structural Team (FAST) to begin rapid assessment of the affected region using car-mounted panoramic imaging systems and unmanned aerial systems. However, Myanmar currently has a US State Department Level 4 Travel Warning (Do Not Travel), due to ongoing conflict, which creates significant challenges for conducting field reconnaissance. Some of the organizations contributing to the report are not permitted (by their sponsors or organizational policies) from sending teams to locations with a Level 4 warning or its equivalent (for countries other than the US); for others, specific team safety measures would be necessary. It may be possible for a few individuals from some participating organizations to conduct fieldwork under United Nations auspices, through mechanisms such as post-disaster needs assessments.

While field travel to Thailand would not face restrictions, the limited damage is already well documented by the government, AIT Bangkok and other local universities, which significantly reduces the need for an international team to travel.

Based on the above, **StEER's response to this event will remain at Level 1 with no activation of a Field Assessment Structural Team (FAST).** As a result, this PVRR represents the extent of StEER's official response. StEER stands ready to make its mobile app available to any local organization who would like to conduct assessments and has the access and security measures necessary to do so. In lieu of such opportunities, the authors will continue to coordinate with other organizations responding to this event to encourage consideration of the above recommendations and will monitor their assessments. Should these ongoing efforts reveal new information that would satisfy one or more of StEER's escalation criteria, StEER may re-evaluate its decision and deploy a FAST.

Table 7.1. Summary of Escalation Criteria

Hazard	Exposure	Feasibility
● Unique Hazard Characteristics	● Infrastructure of interest ● Community Impacts ● Downtime or Recovery Issues	● Resources ● Collaboration Potential

Appendix A: Official Response Timeline

Day 1: 28 March 2025: The Military government responded in the affected regions and declared a state of emergency in six regions: Nay Pyi Taw, Mandalay, Sagaing, Magway, Bago, and part of Shan state to facilitate a coordinated response (CDP 2025). The military government requested humanitarian assistance from the international community to address the disaster's aftermath.

Heavy damage was reported in Sagaing, the closest major population center to the earthquake's epicenter. Still, search and rescue were limited due to its remoteness and zones outside military government control, unlike the Mandalay region, where urban search and rescue (USAR) teams were immediately dispatched. Emergency response teams from Ayeyarwady Region and Yangon were dispatched to Nay Pyi Taw to assist in search and rescue efforts. In all locations, the local community began self-organizing. In Nay Pyi Taw, the capital city, which was also affected by the earthquake, emergency meetings were held to assess the situation; military and civil hospitals began treating large numbers of casualties. Mandalay and Sagaing hospitals were also overwhelmed with injured patients.

Day 2: 29 March 2025: In Nay Pyi Taw, logistics coordination intensified, and the government began soliciting international assistance from India, China, and ASEAN. Senior General Min Aung Hlaing visited the Mandalay Region, surveying the earthquake damage by helicopter and assessing the ongoing relief efforts. However, in Sagaing, the military arrived in select towns but had limited access to People's Defense Forces (PDF)-controlled areas (Al Jazeera 2025b).

Day 3: 30th March 2025: The Ministry of Education ordered the closure of schools nationwide to assess structural integrity and ensure the safety of students and staff in an effort to prepare universities, colleges, and other schools for the upcoming academic year (Ministry of Information 2025). The World Health Organization (WHO) delivered nearly 3 tons of medical supplies, including trauma kits and multipurpose tents, to hospitals in Nay Pyi Taw and Mandalay to support the treatment of the injured (WHO 2025b). However, the WHO supplies could not reach interior towns, as roads remained damaged. Many civil society groups continued to attempt to deliver informal aid.

Day 4: 31 March 2025: Nay Pyi Taw becomes the central coordination node for foreign aid. India initiated "Operation Brahma," deploying medical teams, field hospitals, and naval ships carrying relief materials to assist Myanmar in its humanitarian efforts, mainly in Mandalay (UNI 2025). In Sagaing, the community was displaced further, and access to shelter and food remained erratic. In many areas, the Military government seems to have prioritized security over relief in areas outside their control, with reports of scrutiny of local civil society organizations providing relief (HDAR 2025). The education department began the structural assessments of educational facilities (UNICEF 2025b).

Day 5: 1 April 2025: Nay Pyi Taw continued to be the coordination hub, and the government-controlled media showcased aid deliveries. Additional aid and USAR teams arrived from neighboring countries, including China and Thailand. These teams focused on search and rescue operations and provided essential supplies. Several mobile clinics were established in Mandalay, and various agencies distributed shelter kits. The government initiated the repair of key roads, including the NPD eight-lane highway and the airport damaged by the earthquake (ReliefWeb 2025). However, in Sagaing, the government still tightly controlled access to the affected areas, and conflict zones remained inaccessible to international agencies.

Day 6: April 2nd, 2025: In Nay Pyi Taw, shelter planning for displaced families was started. The government initiated structural checks on government buildings. In Mandalay, hospitals continued to receive a large number of patients. Educational building assessments were started for schools that had been damaged. In Sagaing, the challenges in aid distribution continued to hamper aid agencies' efforts to reach the most affected areas, particularly in regions with ongoing conflict (Butler 2025). Reports indicated that the civil war even complicated the burial process for some Muslim victims in the region, as the Muslim cemetery in Sagaing has been closed to the public for several years due to the fighting, and the victims of mosque collapses had to be transported to Mandalay (Htun and Wong 2025).

Day 7 to Day 10: April 3-6-2025: WHO allocated 8 million USD to restore health services and prevent disease outbreaks in Sagaing and Mandalay. Nay Pyi Taw and Bago remained under a state of emergency, though repairs to critical infrastructure continued. Yangon primarily served as a logistics hub, with emergency teams deployed to Nay Pyi Taw first and then to the required locations. Mandalay International Airport resumed limited domestic flights by April 4, but damaged roads continued to hinder the ground transport of relief supplies (Xinhua 2025). Monsoon rains in the Sagaing region worsened conditions for all.

Day 11 to Day 14: April 7 to 10th, 2025: Domestic flights partially resumed at Nay Pyi Taw Airport by April 7, following repairs to runways and terminal buildings. The Ministry of Transport prioritized reopening key railway sections, including the Yangon-Bago-Taungoo-Nay Pyi Taw line, to facilitate aid transport. Meanwhile, in Nay Pyi Taw, military personnel assisted in clearing debris from public buildings and monasteries, though progress remained slow due to limited heavy machinery. The government collaborated with ASEAN-ERAT teams to assess needs in displaced communities.

In Sagaing, cleanup efforts started in earnest by April 6, with military units removing collapsed trusses from the Sagaing (Inwa) Bridge to restore river transport. Ferries operated free services between Mandalay and Sagaing ports. Despite the disaster, the Military government continued airstrikes in conflict zones like Chaung-U Township and Pauk Township, diverted resources, and hampered relief efforts on the ground (HRW 2025). Damaged roads and communication blackouts persisted, particularly in rural Sagaing and Shan State, delaying aid delivery.

According to UNOCHA, the initial rapid needs assessments covering 588,000 people across 31 townships in seven states and regions, including Nay Pyi Taw Union Territory, identified people’s urgent priorities as food, drinking water, health care, cash assistance, and emergency shelter. Among those assessed, 47 percent had yet to receive any form of assistance (OCHA 2025).

As of April 7, the government officially named the M7.7 event “the Mandalay Earthquake” to ensure consistency in documentation and referencing (AP 2025), though Myanmar’s parallel National Unity Government and international organizations continued using the term “Sagaing Earthquake” as is consistent with norms in the seismic community (Kavi 2025).

Appendix B: Geotechnical Analysis Details

B.1. Damage Proxy Maps derived from InSAR coherence

The Damage Proxy maps shown in Section 4.1 are derived from Sentinel-1 synthetic aperture radar (SAR) data as follows:

- Interferometric coherence is calculated for two image pairs:
  - Pre-earthquake pair: March 10, 2025 and March 22, 2025
  - Cross-earthquake pair: March 22, 2025 and April 3, 2025
- The damage proxy map is calculated as the difference between pre-earthquake coherence and cross-earthquake coherence.
- Interferometric coherence is used as an indicator of how similar the surface is between the two image acquisitions. Coherence has a value of between 0 and 1. High coherence values indicate that the areas remained the same, with minimal changes between two image acquisitions. Low coherence values indicate that the surface changed between two image acquisitions.
- In creating damage proxy maps, pre-earthquake coherence is assumed to be high for urban areas and areas with low vegetation where the surface is not expected to change between two acquisitions.
- When calculating coherence (cross-earthquake coherence) using one image captured before an earthquake and one image after the earthquake, damaged areas are expected to have low coherence.
- Since vegetation and natural surfaces can also be associated with low coherence values even in normal conditions, the damage proxy maps consider pre-earthquake coherence to assess where areas changed from high coherence before the earthquake to low coherence after the earthquake, which serves as a proxy for damages.
- A threshold value for a change in coherence was arbitrarily chosen, with a change in coherence of between 0.2 and 0.4 shown as 'Medium' change, and change in coherence > 0.4 as 'High Damage'.

B.2 Flood Plains and vegetation changes derived from DEM

The floodplains were derived from the Copernicus Global Digital Elevation Model (DEM) using an established methodology (Nardi et al. 2019). The method uses a scaling relationship between cumulative catchment area (calculated from the DEM) and flood depth to estimate the floodplain. The floodplains are calculated at a resolution of 30m. The product is a binary raster layer where 1 indicates a flooded cell.

- The vegetation change maps were derived from Sentinel-2 satellite data. Pre-earthquake satellite images were extracted for the period between March 1, 2025 to March 26, 2025. The mean Normalized Difference Vegetation Index (NDVI) was calculated over this period as a qualitative indicator of the presence and density of vegetation. NDVI had a value between -1 and 1, with NDVI < 0 indicating that vegetation is not present. Higher NDVI values indicate higher vegetation densities.
- The post-earthquake Sentinel-2 images were retrieved for the period between March 29, 2025 to April 18, 2025. The mean NDVI was calculated for this period to provide an indicator of vegetation densities after the earthquake.

- The change in vegetation was calculated, highlighting where the NDVI decreased by between 0.1 and 0.2 (classified as ‘Medium’ change), and where NDVI decreased by more than 0.4, the area was flagged as High disturbance.

B.3 OPERA surface disturbance

The NASA OPERA surface disturbance products were downloaded for the area. The product maps surface disturbance associated with changes detected on the image acquisition date (April 1, 2025 in this case) outside a historical norm.

B.4 Preliminary InSAR displacement fields

The preliminary InSAR displacement fields are generated from the Sentinel-1 satellite data using ascending (as the satellite travels from south to north) and descending (as the satellite travels from north to south) orbital directions.

- The displacement is measured in meters showing the displacement between the two acquisitions.
- In the ascending geometry, the data were captured between March 22, 2025 and April 3, 2025.
- In the descending geometry, the data were captured between March 24, 2025 and April 5, 2025.
- Note: The InSAR phase can be affected by atmospheric disturbances and other external sources of error. These errors sources have not been corrected for in this preliminary product.
- Note: the displacement represents the component of the displacement that occurs in the look direction of the satellite (the vector between the satellite and the ground); therefore, the real displacement magnitude may be underestimated.

Appendix C: Impacts to Monuments and Cultural Heritage Sites

Name	**Location**	**Age**	**Damage**
Ma Shi Khana Pagoda	Sagaing (~23 km from Mandalay)	From the 14th cc	Collapsed (O'Connell 2025)
Shwe Sar Yan Pagoda	Shwe Sar Yan Village in the south-east Mandalay	From the 9th-13th cc	The golden spire on top collapsed (O'Connell 2025)
Sakyadhita Nunnery	About 8 km west of Mandalay	From 1998	Three buildings collapsed (O'Connell 2025)
Me Nu Brick Monastery (or Maha Aungmye Bonzan Monastery)	Inwa, around 40 km southwest of Mandalay	From the mid-19th cc	Severe damage (O'Connell 2025)
Maha Myat Muni Pagoda	Mandalay	From the 18th cc	Collapse (New York Times 2025)
Pindaya Monastery	Pindaya, around 200 km southeast of Mandalay	Over 170 years old	Stupas toppled (Browne 2025)
Mandalay Palace	Mandalay	From the 19th cc	Part of structure toppled to side (NPR 2025)
ZayTiGyi Pagoda	Pindaya, Shan State		Spire failure (Sim 2025)
Mandalay Palace	Mandalay	1850s, rebuilt in 1990s	Parts of palace damaged, including damage to one of tower-gates (Wikipedia 2025b)
Mahamuni Buddha Temple	Mandalay	1785, rebuilt after 1884 fire	Severe damage (Times of India 2025)
U Bein Bridge, longest teakwood bridge in the world	Amarapura Township, Mandalay	1849(One News 2025)	Temporarily closed due to minor damage
Myatheindan Pagoda (or Hsinbyume Pagoda)	Mingun	1816	Severe damage (Yangon Khit Thit News Agency 2025)
New Masoyein Monastery or Masoeyein Monastery	Mandalay	20th century	Collapse
Myat Saw Ye Naung pagoda	Taung Ngu, Bago Region	From mid-19th cc	Spire failure

Name	Location	Age	Damage
Wat Chaiwatthanaram	Ayutthaya, just north of Bangkok	From the 17th cc	Safe (Movius, 2025)
Wat Pho temple	Bangkok	From the 18th cc	Cracking at the reclining Buddha (Movius 2025)

References

Abrahamson, Norman A., Walter J. Silva, and Ronnie Kamai. 2014. “Summary of the ASK14 Ground Motion Relation for Active Crustal Regions.” *Earthquake Spectra* 30 (3): 1025–55. https://doi.org/10.1193/070913EQS198M.

AHA Centre. 2025. “Situation Update No. 9 - M7.7 Mandalay Earthquake (Monday, 14 April 2025, 2000 HRS (UTC+7)) - Myanmar | ReliefWeb.” April 15, 2025. https://reliefweb.int/report/myanmar/situation-update-no-9-m77-mandalay-earthquake-monday-14-april-2025-2000-hrs-utc7.

Al Jazeera. 2025a. “Hundreds of Muslims Feared Dead in Myanmar Earthquake, Mosques Destroyed.” Al Jazeera. March 29, 2025. https://www.aljazeera.com/news/2025/3/29/myanmar-quake-muslims-feared-dead-destroyed-mosques.

———. 2025b. “Rains Add to Misery in Quake-Hit Myanmar as Death Toll Rises to 3,471.” Al Jazeera. April 6, 2025. https://www.aljazeera.com/news/2025/4/6/rains-add-to-misery-in-quake-hit-myanmar-as-death-toll-rises-to-3471.

Aliyev, Sadig, Joonkyung Seong, and Myoe Myint. 2023. “In The Dark: Power Sector Challenges in Myanmar.” https://thedocs.worldbank.org/en/doc/6bd0c527c8469333b119d88cc0b8b410-0070062023/in-the-dark-power-sector-challenges-in-myanmar-august-2023.

AP. 2025. “Rescue Efforts from Myanmar’s Deadly Earthquake Wind down as Death Toll Hits 3,600.” AP News. April 7, 2025. https://apnews.com/article/myanmar-ceasefire-military-resistance-earthquake-disaster-05329d5a2448d0afd9d7c09e55a1c759.

Batrak, Oleksandr. 2025. “Myanma Railways Enhances Railway Infrastructure After Earthquake.” *Railway Supply* (blog). April 12, 2025. https://www.railway.supply/en/myanma-railways-enhances-railway-infrastructure-after-earthquake/.

BBC. 2025. “Watch: Moment Baby Is Born on Bangkok Street after Quake Evacuation.” March 28, 2025. https://www.bbc.com/news/videos/c7898myzxvpo.

Benz, H., K. Furlong, M. Herman, K. McKenzie, R. Schmitt, N. Reitman, E. Thompson, Barnhart, W. Yeck, and P. Pananont. 2025. “2025 M7.7 Mandalay, Burma (Myanmar) Earthquake.” ArcGIS StoryMaps. April 28, 2025. https://storymaps.arcgis.com/stories/5f3e33e35c5247c9bf5204fa0d6e56e5.

Bhatta, S. D., S. Katwal, S. Sinha Roy, R. Van der Weide, U. Sharma, A. P. Kyaw, and M. M. Thwin. 2023. “Education in Myanmar: Where Are We Now?” Washington, DC: The World Bank. https://thedocs.worldbank.org/en/doc/716418bac40878ce262f57dfbd4eca05-0070012023/state-of-education-in-myanmar-july-2023.

BillionBricks. 2023. “Traditional Myanmar Stilt Houses: An Eco-Friendly Legacy - BillionBricks | Net-Zero Homes.” September 27, 2023. https://billionbricks.org/blog/traditional-myanmar-stilt-houses-an-eco-friendly-legacy/.

Boore, David M., Jonathan P. Stewart, Emel Seyhan, and Gail M. Atkinson. 2014. “NGA-West2 Equations for Predicting PGA, PGV, and 5% Damped PSA for Shallow Crustal Earthquakes.” *Earthquake Spectra* 30 (3): 1057–85. https://doi.org/10.1193/070113EQS184M.

Browne, Malachy. 2025. “Earthquake Devastates Myanmar’s Cultural Sites.” *The New York Times*, March 29, 2025, sec. World. https://www.nytimes.com/2025/03/29/world/asia/earthquake-devastates-myanmars-cultural-sites.html.

Butler, Gavin. 2025. “How Aid Becomes a Weapon in Myanmar’s War Zone.” BBC News. April

2, 2025. https://www.bbc.com/news/articles/cp8je14g2eno.
California Geological Survey, and U.S. Geological Survey. 2005. “Center for Engineering Strong Motion Data (CESMD).” U.S. Geological Survey. https://doi.org/10.5066/P13HTZQS.
Campbell, Kenneth W., and Yousef Bozorgnia. 2014. “NGA-West2 Ground Motion Model for the Average Horizontal Components of PGA, PGV, and 5% Damped Linear Acceleration Response Spectra.” *Earthquake Spectra* 30 (3): 1087–1115. https://doi.org/10.1193/062913EQS175M.
CDP. 2025. “2025 Myanmar and Thailand Earthquake.” Center for Disaster Philanthropy. April 15, 2025. https://disasterphilanthropy.org/disasters/2025-myanmar-and-thailand-earthquake/.
Chiou, Brian S.-J., and Robert R. Youngs. 2014. “Update of the Chiou and Youngs NGA Model for the Average Horizontal Component of Peak Ground Motion and Response Spectra.” *Earthquake Spectra* 30 (3): 1117–53. https://doi.org/10.1193/072813EQS219M.
Cho, Ko. 2025. “Junta Forces Retreat as Escalating Clashes with Arakan Army Continue across Ayeyarwady Region.” Myanmar Now. May 1, 2025. https://myanmar-now.org/en/news/junta-forces-retreat-as-escalating-clashes-with-arakan-army-continue-across-ayeyarwady-region/.
Deliso, Meredith. 2025. “PHOTOS: See the Destruction in Myanmar, Thailand from 7.7 Magnitude Earthquake.” ABC News. March 31, 2025. https://abcnews.go.com/International/myanmar-thailand-earthquake-photos/story?id=120260363.
Denby, Kenneth. 2025. “‘Fire Leapt from the Ground’ as the Myanmar Earthquake Struck.” The Times. April 5, 2025. https://www.thetimes.com/world/asia/article/myanmar-earthquake-struck-mandalay-homes-02z8smht9.
Dilsiz, Abdullah, Selim Gunay, Khalid Mosalam, Eduardo Miranda, Carlos Arteta, Halil Sezen, Erica Fischer, et al. 2023. “StEER: 2023 Mw 7.8 Kahramanmaras, Türkiye Earthquake Sequence Preliminary Virtual Reconnaissance Report (PVRR).” Designsafe-CI. https://doi.org/10.17603/DS2-7RY2-GV66.
DVB. 2025a. “Https://English.Dvb.No/Live-Burma-Earthquake/.” Democratic Voice of Burma. May 18, 2025. https://english.dvb.no/live-burma-earthquake/.
———. 2025b. “Mandalay University Main Building and Seinpan Neighborhood Caught Fire after Earthquake (in Burmese).” Democratic Voice of Burma. March 29, 2025. https://burmese.dvb.no/post/697295.
———. 2025c. “Regime Blocks Aid Groups from Providing Relief to Earthquake Survivors in Central Myanmar.” Democratic Voice of Burma. April 7, 2025. https://english.dvb.no/regime-blocks-aid-groups-from-providing-relief-to-earthquake-survivors-in-central-myanmar/.
———. 2025d. “ပုသိမ်တွင် လျှပ်စစ်မီးမရသဖြင့် ရေရရှိရန် ခက်ခဲနေ.” Democratic Voice of Burma. March 31, 2025. https://burmese.dvb.no/post/697819.
DVB, English. 2025e. “Death Toll from Myanmar Earthquake Nears 3,000; Ninety Percent of Sagaing Town Destroyed, Say Residents.” Democratic Voice of Burma. March 30, 2025. https://english.dvb.no/death-toll-from-myanmar-earthquake-nears-3000-ninety-percent-of-sagaing-town-destroyed-say-residents/.
Eleven. 2024. “Explosion on Yangon-Mandalay Railway Causes Delays and Disruptions.” Eleven Media Group Co., Ltd. December 15, 2024. https://elevenmyanmar.com/news/explosion-on-yangon-mandalay-railway-causes-delays-and-disruptions.
EOS. 2025a. “Location: /EOS-RS_202503_Myanmar_Earthquakes/.” Earth Obsevatory of Singapore - Remote Sensing (EOS-RS) & Advanced Rapid Imaging and Analysis

Singapore (ARIA-SG) Products Repository. 2025. https://eos-rs-products.earthobservatory.sg/EOS-RS_202503_Myanmar_Earthquakes/.
———. 2025b. “Location: /EOS-RS_202503_Thailand_Earthquakes/.” Earth Obsevatory of Singapore - Remote Sensing (EOS-RS) & Advanced Rapid Imaging and Analysis Singapore (ARIA-SG) Products Repository. 2025. https://eos-rs-products.earthobservatory.sg/EOS-RS_202503_Thailand_Earthquakes/.
France 24. 2025. “Deadly Earthquake Forces Thai Patients into Sports Hall.” France 24. March 29, 2025. https://www.france24.com/en/live-news/20250329-deadly-earthquake-forces-thai-patients-into-sports-hall.
GEOFON Data Centre. 1993. “GEOFON Seismic Network.” GFZ Data Services. https://doi.org/10.14470/TR560404.
GeoHazards International, and UN-Habitat. 2019. “Non-Structural Risk Assessment of Mandalay General Hospital, Mandalay, Myanmar.” Nairobi, Kenya: United Nations Human Settlements Programme (UN-Habitat).
Guadarrama, Adrian. 2025. “Myanmar Earthquake Update: The Healthcare System Has Been Severely Impacted.” April 5, 2025. https://www.msf.hk/en/latest/news-and-stories/news/myanmar-earthquake-update-the-healthcare-system-has-been-severely-impacted.
HADR. 2025. “Myanmar Earthquake & Conflict: Reaching Underserved Communities with Deepening Vulnerabilities (08 April 2025) - Myanmar | ReliefWeb.” ReliefWeb. April 8, 2025. https://reliefweb.int/report/myanmar/myanmar-earthquake-conflict-reaching-underserved-communities-deepening-vulnerabilities-08-april-2025.
HDAR. 2025. “Myanmar Earthquake & Conflict: Reaching Underserved Communities with Deepening Vulnerabilities (08 April 2025) - Myanmar | ReliefWeb.” ReliefWeb. April 8, 2025. https://reliefweb.int/report/myanmar/myanmar-earthquake-conflict-reaching-underserved-communities-deepening-vulnerabilities-08-april-2025.
Health Cluster. 2025. “Myanmar Health Cluster Sagaing Earthquake Situation Report #3, 6 April 2025 - Myanmar | ReliefWeb.” April 7, 2025. https://reliefweb.int/report/myanmar/myanmar-health-cluster-sagaing-earthquake-situation-report-3-6-april-2025.
HRW. 2025. “Myanmar: Allow Immediate Aid to Quake-Stricken Areas | Human Rights Watch.” Human Rights Watch. April 1, 2025. https://www.hrw.org/news/2025/04/01/myanmar-allow-immediate-aid-quake-stricken-areas.
Htun, Zeyar, and Tessa Wong. 2025. “Myanmar Quake: Imam’s Grief for 170 Killed as They Prayed in Sagaing.” BBC News. April 1, 2025. https://www.bbc.com/news/articles/cm2e98xep10o.
Hurukawa, Nobuo, and Phyo Maung Maung. 2011. “Two Seismic Gaps on the Sagaing Fault, Myanmar, Derived from Relocation of Historical Earthquakes since 1918.” *Geophysical Research Letters* 38 (1). https://doi.org/10.1029/2010GL046099.
IRDR. 2025. “SDGSAT-1 Image for Myanmar Earthquake 28 March (Report 2) - Myanmar | ReliefWeb.” March 30, 2025. https://reliefweb.int/report/myanmar/sdgsat-1-image-myanmar-earthquake-28-march-report-2.
Kavi, Maung. 2025. “Don’t Call It the ‘Sagaing Quake’! Warns Superstitious Myanmar Junta.” *The Irrawaddy* (blog). April 9, 2025. https://www.irrawaddy.com/news/burma/dont-call-it-the-sagaing-quake-warns-superstitious-myanmar-junta.html.
Lin, Bo-yu. 2025. “Myanmar Earthquake Triggers Widespread Power Outages, Fuel Shortages | NEWS.” Reccessary. March 31, 2025. https://www.reccessary.com/en/news/asean-environment/massive-earthquake-in-myanmar-triggers-power-outages-fuel-shortages.
Lynch, Cordelia. 2025. “A Gruelling Search for Bodies in the City at the Myanmar Earthquake’s

Epicentre.” MSN. April 2, 2025. https://www.msn.com/en-gb/news/world/a-gruelling-search-for-bodies-in-the-city-at-the-myanmar-earthquakes-epicentre/ar-AA1CaCbx.
MacRae, G. A., U. T. Myint, and S. K. Jain. 2011. “Steps in Earthquake Proofing a Country: A Case Study of Myanmar.” *Bulletin of the New Zealand Society for Earthquake Engineering* 44 (2): 87–98. https://doi.org/10.5459/bnzsee.44.2.87-98.
Mail, Pattaya. 2025. “Myanmar Earthquake Causes Concrete Beam Collapse on Den Chai-Chiang Khong Railway Project.” *Pattaya Mail* (blog). March 28, 2025. https://www.pattayamail.com/thailandnews/myanmar-earthquake-causes-concrete-beam-collapse-on-den-chai-chiang-khong-railway-project-495621.
MDA. n.d. “About Us.” Myanmar Diabetes Association. Accessed May 22, 2025. https://myanmardiabetes.org.mm/about-us/.
MES. 2012. “Myanmar National Building Code – Provisional 2012.” Myanmar Engineering Societies. https://www.mes.org.mm/content/myanmar-national-building-code.
———. 2016. “Myanmar National Building Code MES – 2016.” Myanmar Engineering Societies. https://www.mes.org.mm/content/myanmar-national-building-code.
MIMU. n.d. “Updates on Sagaing Earthquake.” Myanmar Information Management Unit. Accessed May 22, 2025. https://www.themimu.info/news/updates-sagaing-earthquake.
Ministry of Information. 2025. “MoE Prepares for Upcoming Academic Year Following Earthquake Impact | Ministry Of Information.” April 21, 2025. https://www.moi.gov.mm/moi:eng/news/17535.
Mishra. 2025. “Myanmar Quake: ‘I Constantly Worry – What If Another Earthquake Happens?’ | UN News.” April 7, 2025. https://news.un.org/en/story/2025/04/1161986.
MITV. 2025. “Rail Transportation: Damaged Rail Tracks under Repair for Transportation.” Myanmar International TV. April 2, 2025. https://www.myanmaritv.com/news/rail-transportation-damaged-rail-tracks-under-repair-transportation.
Mizzima News. 2025. “Price of Construction Materials and Medicines Soar after Earthquake (in Burmese).” BUR.MIZZIMA.COM. April 2, 2025. https://bur.mizzima.com/2025/04/02/51932.
MoC. 2020. “Myanmar National Building Code - 2020.” Ministry of Construction.
Monthienvichienchai, Chainarong. 2025. “Bangkok Declares Disaster Zone after Myanmar Earthquake Shakes City - Vatican News.” Vatican News. March 28, 2025. https://www.vaticannews.va/en/world/news/2025-03/thailand-myanmar-southeast-asia-quake-humanitarian-disaster.html.
Movius, Lisa. 2025. “Myanmar Heritage Sites Severely Damaged by Deadly Earthquake.” The Art Newspaper. March 31, 2025. https://www.theartnewspaper.com/2025/03/31/myanmar-heritage-sites-severely-damaged-deadly-earthquake.
MSF. 2025. “MSF Ready to Assist in Myanmar Following Powerful Earthquake | Doctors Without Borders - USA.” Medecins Sanns Frontieres. March 28, 2025. https://www.doctorswithoutborders.org/latest/msf-ready-assist-myanmar-following-powerful-earthquake.
MSR. 2025. “Rapid Impact Assessment Report (2025).” Yangon, Myanmar: Myanmar Survey Research. https://www.msr-research.com/en/knowledge-events/rapid-impact-assessment-report-2025.
Myanmar Now. 2025a. “Collapse of Control Tower Closes Airport in Myanmar Capital.” Myanmar Now. March 29, 2025. https://myanmar-now.org/en/news/collapse-of-control-tower-closes-airport-in-myanmar-capital/.
———. 2025b. “Myanmar Earthquake Causes Havoc, Blackouts, and Infrastructure Collapse.” Myanmar Now. April 1, 2025. https://myanmar-now.org/en/news/myanmar-earthquake-

causes-havoc-blackouts-and-infrastructure-collapse/.
Nardi, F., A. Annis, G. Di Baldassarre, E. R. Vivoni, and S. Grimaldi. 2019. “GFPLAIN250m, a Global High-Resolution Dataset of Earth’s Floodplains.” *Scientific Data* 6 (1): 180309. https://doi.org/10.1038/sdata.2018.309.
National Geographic. 2025. “Centuries of History and Culture Reduced to Rubble after Myanmar Earthquake.” History. April 26, 2025. https://www.nationalgeographic.com/history/article/myanmar-earthquake-religious-cultural-sites.
New York Times. 2025. “An Earthquake and Its Aftermath.” *The New York Times*, March 28, 2025, sec. World. https://www.nytimes.com/2025/03/28/world/asia/myanmar-thailand-earthquake-photos.html.
NPR. 2025. “Photos: See the Aftermath of the Earthquake in Myanmar and Thailand.” *National Public Radio*, March 30, 2025, sec. World. https://www.npr.org/2025/03/29/g-s1-57186/photos-see-the-aftermath-of-the-earthquake-in-myanmar-and-thailand.
NUG. 2025. “Earthquake Emergency – National Unity Government of Myanmar.” National Unity Government. April 20, 2025. https://nugmyanmar.org/earthquake-emergency/.
OCHA. 2025. “Myanmar: Earthquake Response Situation Report No. 1 (As of 7 April 2025) | OCHA.” April 7, 2025. https://www.unocha.org/publications/report/myanmar/myanmar-earthquake-response-situation-report-no-1-7-april-2025.
O’Connell, Ryan. 2025. “Centuries of History and Culture Reduced to Rubble after Myanmar Earthquake.” National Geographic. April 26, 2025. https://www.nationalgeographic.com/history/article/myanmar-earthquake-religious-cultural-sites.
One News. 2025. “U Bein Bridge Temporarily Closed Due to Damage.” *One News Myanmar* (blog). April 5, 2025. https://onenewstvchannel.com/en/the-weather/u-bein-bridge-temporarily-closed-due-to-damage/.
Oo, Cho, Saburo Murakawa, Kyosuke Sakaue, Daisaku Nishina, Yasuo Koshikawa, and Atsushi Yakushijin. 2003. “Study on the Indigenous Building Materials of Traditional Houses in Myanmar.” *Journal of Asian Architecture and Building Engineering - J ASIAN ARCHIT BUILD ENG* 2 (May):161–68. https://doi.org/10.3130/jaabe.2.161.
Peck, Grant. 2025. “Humanitarian Needs Remain Pressing a Month after Myanmar’s Deadly Quake.” AP News. April 28, 2025. https://apnews.com/article/myanmar-quake-humanitarian-red-cross-un-civil-war-2c1f6af0f36df1332647185b42ae2e2d.
Poovarodom, N., P. Warnitchai, S. Leelataviwat, C. Chintanapakdee, P. Panyakapo, P. Lukkunaprasit, T. Ornthammarath, and A. Pimanmas. 2018. “A New Earthquake Resistant Design Standard for Buildings in Thailand.” In *7th Asia Conference on Earthquake Engineering*. Bangkok, Thailand. https://www.academia.edu/96985759/A_New_Earthquake_Resistant_Design_Standard_for_Buildings_in_Thailand.
Pornsopin, Patinya, Sophon Chaila, Chutimon Promsuk, Chirawat Kamjudpai, Passakorn Pananont, Khomphet Phetkongsakul, Wanatchaporn Rungjaeng, and Nuttarinee Boonchu. 2024. “Seismic Hazard Microzonation Map for the Central Plain of Thailand.” *Progress in Applied Science and Technology* 14 (1): 42–53. https://doi.org/10.60101/past.2024.251551.
PowerChina. 2025. “POWERCHINA’s Swift Response Restores Power for Myanmar Earthquake Relief.” April 2, 2025. https://en.powerchina.cn/2025-04/02/c_828904.htm.
PTI. 2025. “Isro Releases Satellite Images of Myanmar Earthquake Damage.” Deccan Chronicle. April 1, 2025. https://www.deccanchronicle.com/nation/isro-releases-satellite-images-of-myanmar-earthquake-damage-1870156.

Rahaman Sarkar, Alisha. 2025. “Before and after Satellite Images Show Extent of Devastation Left by 7.7 Earthquake in Myanmar.” April 1, 2025. https://www.msn.com/en-gb/news/world/before-and-after-satellite-images-show-extent-of-devastation-left-by-77-earthquake-in-myanmar/ar-AA1C3wrW.

Rahaman Sarkar, Alisha, Andy Gregory, and Alex Croft. 2025. “Mapped: The Regions Hit Worst by 7.7-Magnitude Earthquake in Myanmar and Thailand.” MSN. March 30, 2025. https://www.msn.com/en-us/news/world/mapped-the-regions-hit-worst-by-77-magnitude-earthquake-in-myanmar-and-thailand/ar-AA1BPAfC.

Railly News. 2025. “Myanmar Railways Recover Quickly After Earthquake.” RayHaber. April 13, 2025. https://raillynews.com/2025/04/Myanmar-Railways-Recovered-Quickly-After-Earthquake/.

ReliefWeb. 2025. “Myanmar: Earthquake - Mar 2025 | ReliefWeb.” April 11, 2025. https://reliefweb.int/disaster/eq-2025-000043-mmr.

Reuters. 2025. “Rains Add to Challenge for Myanmar Quake Relief, Toll at 3,471 | Reuters.” April 5, 2025. https://www.reuters.com/sustainability/society-equity/rains-add-challenge-myanmar-quake-relief-toll-3471-2025-04-06/.

RNZ. 2025. “Myanmar Earthquake: Rescuers Race against Clock as Monsoon Season Looms.” RNZ. April 2, 2025. https://www.rnz.co.nz/news/world/556952/myanmar-earthquake-rescuers-race-against-clock-as-monsoon-season-looms.

Rodgers, Janise, Tracy Kijewski-Correa, Hnin Wai Lwin, Yeshey Lotay, Heidi Stenner, Jorge Archbold, Hla Myat Shu, et al. 2025. “StEER: M7.7 Myanmar Earthquake Annotated Media Repository.” Designsafe-CI. https://www.designsafe-ci.org/data/browser/public/designsafe.storage.published/PRJ-5573/#detail-9f367152-f03c-4284-af93-64fc1b348f59.

Saksornchai, Jintamas. 2025. Thai construction magnate facing charge over Bangkok tower collapse surrenders to police, AP News, May 14, 2025. https://apnews.com/article/bangkok-building-collapse-thailand-myanmar-earthquake-ee56ec5b47304c771d38c5998e587a5e.

Shahzada, Khan, Umar Ahmad Noor, and Zhao-Dong Xu. 2025. “In the Wake of the March 28, 2025 Myanmar Earthquake: A Detailed Examination.” *Journal of Dynamic Disasters* 1 (2): 100017. https://doi.org/10.1016/j.jdd.2025.100017.

Si, Hongjun, and Saburoh Midorikawa. 2000. “New Attenuation Relations for Peak Ground Acceleration and Velocity Considering Effects of Fault Type and Site Condition.” In *Proceedings of 12th World Conference on Earthquake Engineering*. https://doi.org/No. 0532.

Sim, Kakada. 2025. “Mandalay’s Earthquake-Damaged Temple Mistakenly Identified as in Yangon.” *Fact Crescendo Cambodia English* (blog). April 8, 2025. https://cambodia.factcrescendo.com/english/mandalays-earthquake-damaged-temple-mistakenly-identified-as-in-yangon/.

Soh, Therese. 2025. “OUE Healthcare Says Mandalay Hospital Building in Which It Has a Stake Damaged by Earthquake - The Business Times.” Business Times. April 1, 2025. https://www.businesstimes.com.sg/companies-markets/oue-healthcare-says-mandalay-hospital-building-which-it-has-stake-damaged-earthquake.

The Nation. 2024. “Myanmar Railways Reports Hundreds of Attacks on Railroads, Bridges, Stations.” Nationthailand. May 24, 2024. https://www.nationthailand.com/news/asean/40038299.

———. 2025a. “Over 3,000 Govt Buildings Affected by Earthquake, 34 Severely Damaged.” Nationthailand. April 2, 2025. https://www.nationthailand.com/news/general/40048232.

———. 2025b. “SAO Building Collapse Victim Count Rises to 109 with Six New Reports.”

Nationthailand. May 4, 2025. https://www.nationthailand.com/news/general/40049571.
Thein, Maung, Tint Lwin Swe, and Sone Han. 2006. “The Seismic Zone Map of Myanmar (Revised Version 2005).” Myanmar Earthquake Committee, Myanmar Engineering Society.
Theint, Nandi. 2025. “Smell of Death ‘Fills the Air’ near Epicentre of Myanmar Earthquake.” Earthquakes News | Al Jazeera. March 30, 2025. https://www.aljazeera.com/news/2025/3/30/smell-of-death-fills-the-air-near-epicentre-of-myanmar-earthquake.
Times of India. 2025. “Myanmar Earthquake: Photos, Video Show Devastation as Mosque and Mahamuni Pagoda Collapse after Strong Tremors.” *The Times of India*, March 28, 2025. https://timesofindia.indiatimes.com/world/south-asia/myanmar-earthquake-at-least-three-dead-after-mosque-collapse-photos-and-video-emerge/articleshow/119646222.cms.
UN News. 2025. “Myanmar Earthquake Tragedy ‘Compounds Already Dire Crisis’ | UN News.” March 31, 2025. https://news.un.org/en/story/2025/03/1161726.
UN Women. 2025. “Myanmar Earthquake 2025: What It Means for Women and Girls.” UN Women – Headquarters. April 3, 2025. https://www.unwomen.org/en/articles/explainer/myanmar-earthquake-2025-what-it-means-for-women-and-girls.
UNESCO. 2016. “Director-General of UNESCO Expresses Solidarity with the People of Myanmar after Earthquake in Bagan.” UNESCO World Heritage Centre. August 26, 2016. https://whc.unesco.org/en/news/1547/.
UNFPA. 2025. “Situation Analysis Report: Impact of the Earthquake on Organizations of Persons with Disabilities in Mandalay and Sagaing Regions, Myanmar - Myanmar | ReliefWeb.” April 7, 2025. https://reliefweb.int/report/myanmar/situation-analysis-report-impact-earthquake-organizations-persons-disabilities-mandalay-and-sagaing-regions-myanmar.
UNI. 2025. “Op Brahma: India Sends Relief Assistance, Search & Rescue Teams, Field Hospital with Specialists to Quake-Hit Myanmar.” United News of India. March 29, 2025. https://www.uniindia.com/news/india/lead-op-brahma-myanmar/3426188.html.
UNICEF. 2025a. “Devastating Earthquake Leaves Families in Myanmar Reeling | UNICEF.” 2025. https://www.unicef.org/emergencies/powerful-earthquake-rocks-myanmar.
———. 2025b. “UNICEF Myanmar Earthquake Flash Update No. 6 - 09 April 2025 - Myanmar | ReliefWeb.” April 9, 2025. https://reliefweb.int/report/myanmar/unicef-myanmar-earthquake-flash-update-no-6-09-april-2025.
USGS. 2025a. “M 7.7 - 2025 Mandalay, Burma (Myanmar) Earthquake.” 2025. https://earthquake.usgs.gov/earthquakes/eventpage/us7000pn9s/map?dyfi-responses-10km=true&shakemap-intensity=false.
———. 2025b. “M 7.7 - 2025 Mandalay, Burma (Myanmar) Earthquake (PAGER).” 2025. https://earthquake.usgs.gov/earthquakes/eventpage/us7000pn9s/pager.
———. 2025c. “M7.7 Mandalay, Burma (Myanmar) Earthquake.” U.S. Geological Survey. April 3, 2025. https://www.usgs.gov/news/featured-story/m77-mandalay-burma-myanmar-earthquake.
Volk, Kristina. 2025. “‘Even If We Bring Them to Hospital, They Can’t Treat Them,’ Says Rescuer in Myanmar.” BBC News. March 29, 2025. https://www.bbc.com/news/live/c4gex01m7n5t.
Wang, Yu, Kerry Sieh, Soe Thura Tun, Kuang-Yin Lai, and Than Myint. 2014. “Active Tectonics and Earthquake Potential of the Myanmar Region.” *Journal of Geophysical Research: Solid Earth* 119 (4): 3767–3822. https://doi.org/10.1002/2013JB010762.
WHO. 2025a. “WHO Medical Supplies Reach Hospitals in Earthquake Hit Areas.” March 30,

2025. https://www.who.int/southeastasia/news/detail/30-03-2025-who-medical-supplies-reach-hospitals-in-earthquake-hit-areas.
———. 2025b. “WHO Scales up Emergency Response in Earthquake–Hit Myanmar, Provides 100 Tonnes of Medicines and Supplies, Coordination of Emergency Medical Teams on the Ground.” World Health Organization. April 4, 2025. https://www.who.int/southeastasia/news/detail/04-04-2025-who-scales-up-emergency-response-in-earthquake-hit-myanmar--provides-100-tons-of-medicines-and-supplies--coordination-of-emergency-medical-teams-on-the-ground.
Wikipedia. 2025a. “List of Populated Places Affected by the 2025 Myanmar Earthquake.” In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=List_of_populated_places_affected_by_the_2025_Myanmar_earthquake&oldid=1285891655.
———. 2025b. “Mandalay Palace.” In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=Mandalay_Palace&oldid=1283668643.
WMF. 2020. “Traditional Burmese Teak Farmhouses.” World Monuments Fund. 2020. https://www.wmf.org/projects/traditional-burmese-teak-farmhouses.
World Bank. 2020. “Review of Disaster Risks and Structural Vulnerability Assessments in Myanmar: VOLUME 1 – Overview of Yangon’s Disaster Risk Profile.” https://understandrisk.org/wp-content/uploads/WB_Myanmar01_Report_FA03.pdf.
Xinhua. 2025. “Myanmar’s Nay Pyi Taw, Mandalay Airports Set to Resume Local Operations.” April 3, 2025. https://english.news.cn/asiapacific/20250403/98824a1574544453bc75d388884c8f5b/c.html.
Yangon Khit Thit News Agency. 2025. “မင်းကွန်းမြို့တွင် ငလျင်ဒဏ်ကြောင့် ထိခိုက်သေဆုံးသူများထဲတွင် စစ်ကောင်စီ တပ်သားများလည်းပါဝင်ပြီး ကယ်ဆယ်ရေးများ ဆက်လက် လုပ်ဆောင်နေဆဲဟု ဒေသခံများ ပြောဆို.” *Khit Thit Media* (blog). March 29, 2025. https://yktnews.com/2025/03/209449/.
Zaw, Htet Naing. 2025. “Heartbroken Parents Call out Children’s Names at Earthquake-Hit Pre-School.” March 31, 2025. https://www.bbc.com/news/articles/c4g90ldvjexo.
Zaw, Ko Ko, Nwe Nwe, and Su Su Hlaing. 2017. “Prevalence of Cardiovascular Morbidities in Myanmar.” *BMC Research Notes* 10 (1): 99. https://doi.org/10.1186/s13104-017-2422-2.