Council of
Engineers

THAILAND

ACPE FORUM

2025

Some Recent Efforts on Earthquake Disaster Risk Reduction in Indonesia

Presented by:
Prof. I Wayan Sengara, IPU, ASEANEng.

(Prepared by: Wayan Sengara, Masyhur Irsyam, Dyah Kusumastuti, Erwin Lim, Udrekh)

27th of June, 2025 at 01:00 – 04:20 P.M. (GMT+7)

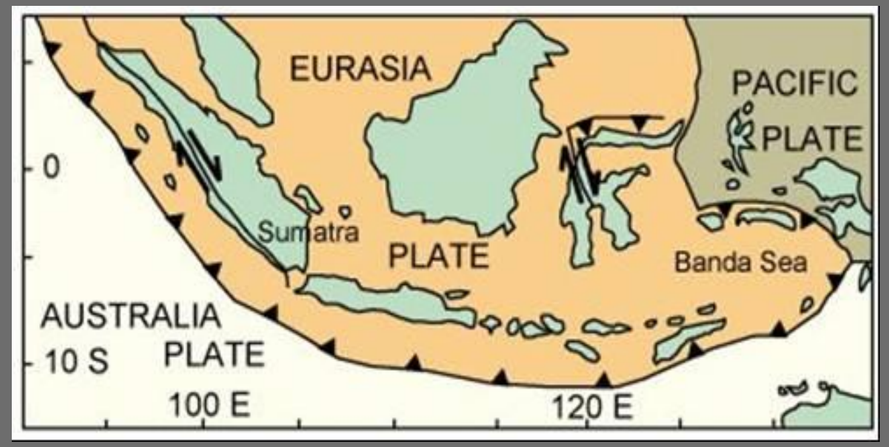
CONTENT

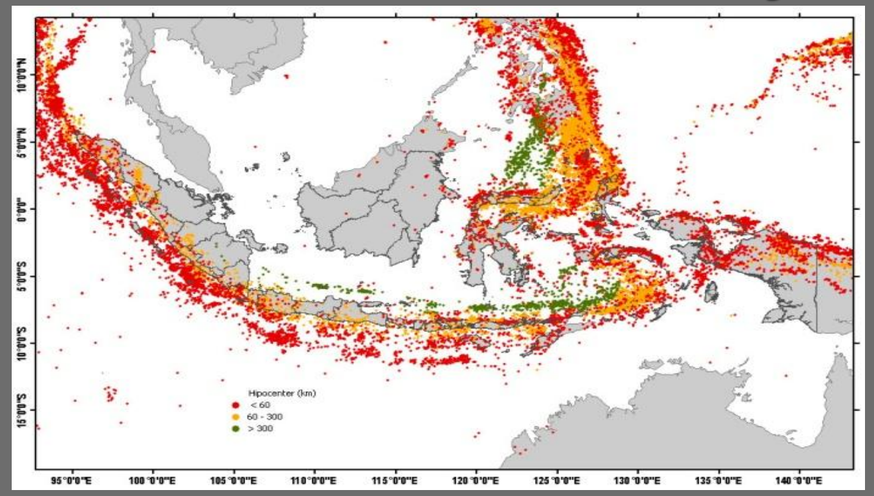
- **Highlight on Earthquake Disasters in Indonesia and Framework for DRR**

- **Seismic Hazard and Risk-Targeted Ground-Motions Mapping**
  - *2017 and 2024 Revision of Indonesian Seismic Hazard Maps*
  - *2019 Risk-targeted Ground Motion (RTGM, MCE_R)*
  - *Compliance and Enforcement of Building-Codes Process*
  - *Engineers Capacity Building*

- **Other Efforts for Resilient Community:**
  - *Post Earthquake Building Assessment Survey and Damage Modeling*
  - *Earthquake Reconnaissance Survey and Report After Earthquake*
  - *School Retrofitting*

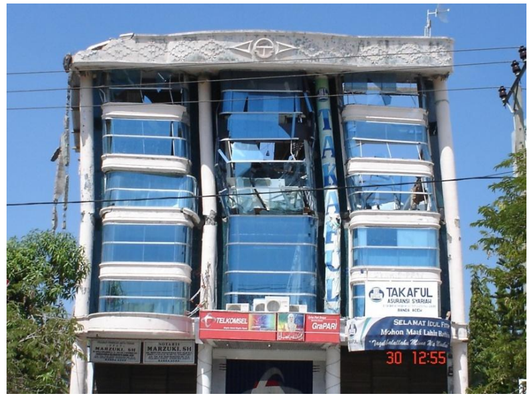
Earthquake Disasters in Indonesia for the last 33 years

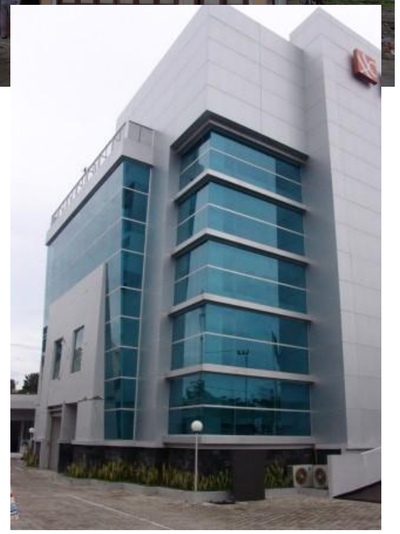




- Flores, (+Tsunami) Desember 1992 (M=6.8)
- Banyuwangi, (+Tsunami) 1994
- Liwa, Feb. 1994 (M = 6.5)
- Kerinci, 1995
- Jambi, October 1995
- Biak, February 1996
- Mangole, Maluku, 1998 (Mw=7.7)
- Bengkulu, June 4, 2000 (Mw=7.9)
- Banggai, Sulawesi, 2000
- Sukabumi, 2000
- Pandeglang, 2000 dan 2001
- Nabire, 2004; M=6.5
- Karangasem, Bali, 2004
- Nabire, 2004, M=6.5
- Karangasem, Bali, 2004
- Bengkulu, 2004, M=7.4
- Padang Panjang, 2004, M=6.0
- Alor-NTT, Nov 2004, M=6-7
- **Aceh, (+Tsunami) 26 Desember, 2004, Mw=9.2**
- Sulawesi, 19 Februari, 2005, M= 6.5
- **Nias, 28 Maret 2005, Mw=8.7**
- Padang (Mentawai), 10 April 2005, M=6.7
- Yogyakarta, 27 Mei 2006, Mw=6.3
- Pangandaran, (+Tsunami) 17 Juli 2006, Mw=7.2
- Ujung Kulon, 19 Juli 2006, ML=6.2
- Gorontalo, 23 Juli 2006, ML=6.6
- Sumatra Barat, Maret 2007
- Indramayu, 9 Agustus 2007, Mw=7.5
- Bengkulu, 12 September 2007, Mw=8.4
- West Java, 2 September 2009, Mw=7.0
- **WestSumatra, 30 September 2009, Mw=7.6**
- Sungai Penuh, 1 Oktober, 2009, M=7.0
- Mentawai, 25 October 2010, Mw=7.2
- Jawa Barat, 15 Desember 2017, Mw=6.9
- Lombok, 29 Juli 2018 Mw 6.4;
- Gempa Jawa Barat, 15 Desember 2017, Mw=6.9
- **Lombok, 5 dan 19 Agustus 2018, Mw=7.0**
- **Palu, 28 September 2018, Mw=7.4**
- South Bandung-West Java, 18 September 2024, M4.9

M9.2 Aceh, M8.7 Nias, 2005, M6.3 Yogyakarta, and M7.6 Padang EQs.





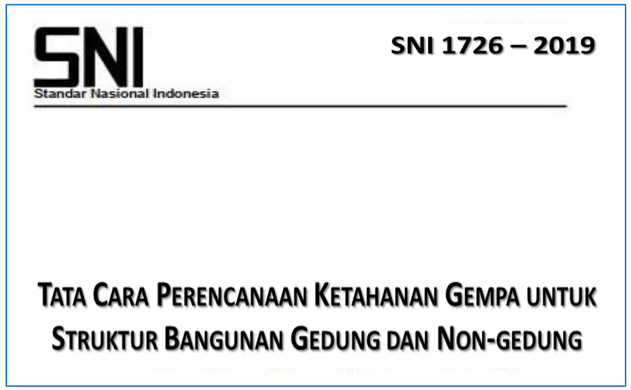
Framework: The ASEAN Vision on DRR 2025

1. The AADMER recognizes the increasing number and scale of intensity of both **natural** **and human-induced disasters**
2. ASEAN should look towards and plan for other disasters that include **human-induced disasters: such as trans-boundary haze pollution, emergencies in the waters, and the development of nuclear power plants** posing a significant risk to the region.
3. ASEAN need to expand and **build capacity** at all levels and to promote the development of **regulatory arrangements and preparedness strategies** to anticipate these risks.
4. Build more connections between **ASEAN** Socio-Cultural Community, ASEAN Economic Community and ASEAN Political Security Community to further **enhance disaster management and emergency response** at the regional level.

(**Source: ASEAN Vision 2025 Disaster Management**,
ASEAN Ministerial Meeting on Disaster Management AMMDM, 2015)

Indonesia State of Progress in Eq DRR

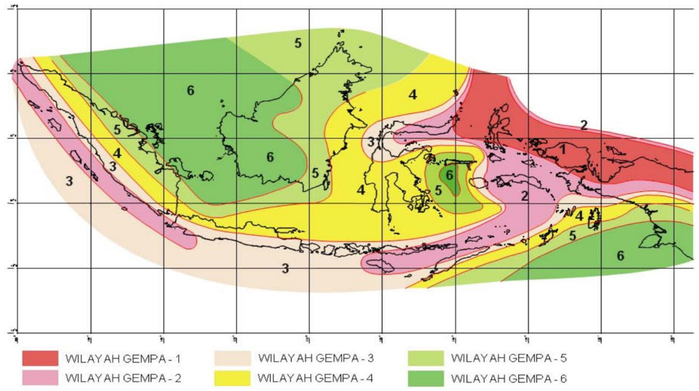
1. **Master Plan for Disaster Management 2020-2045** (Presidential Decree No. 87/2020)
2. **2017 and 2024 Update** on Indonesian earthquake sources and **Hazard Maps**
3. **SNI-1726:2019** , Revision of Indonesian Seismic Resistance of Structures Codes for Building and non-Building, as an update of SNI-1726:2012



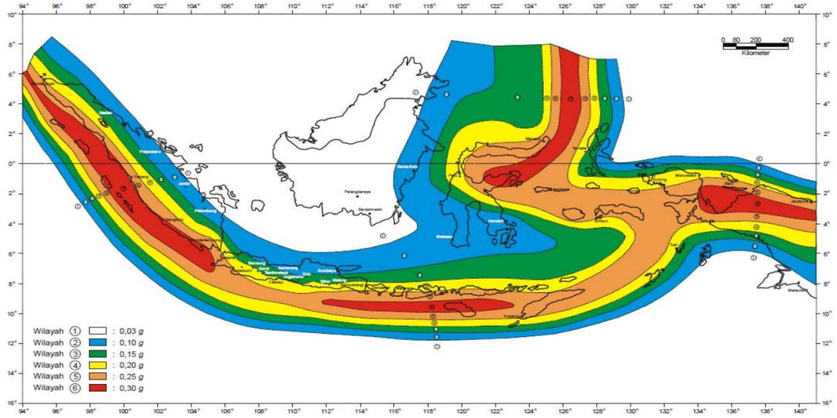
- **Seismic Hazards and Risk-Targeted Ground-Motions Mapping**
  - *2017/2024 Revision of Indonesian Seismic Hazard Maps*
  - *2019 Risk-targeted Ground-Motion Maps (RTGM, MCE_R)*
  - *Compliance and Enforcement of Building-Codes Process*
  - *Engineers Capacity Building*

• *Updates on Seismic Hazard Maps*

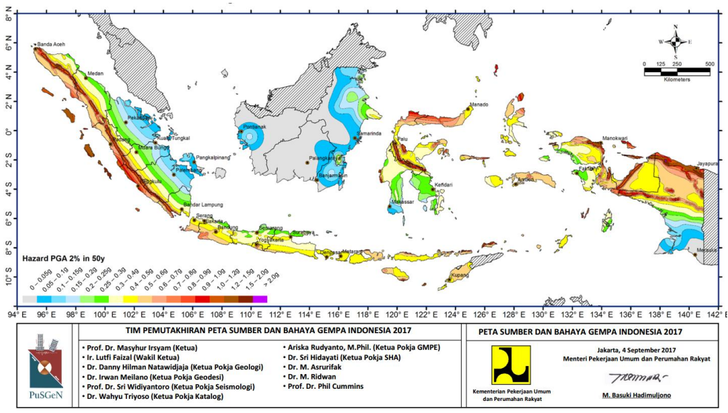
- First Indonesian hazard maps had been developed by Beca Carter through bilateral cooperation between Indonesia and New Zealand (1978), 200 years RP.
- 2002 development of Indonesian seismic hazard map particularly developed for building codes of 2002 (SNI-03-1726-2002), 500 years RP.
- Later in 2009, a National Team (Team-9) established for Revision of Seismic Hazard Maps of Indonesia. This team successfully developed 2010-Indonesian Hazard Maps, 2500 years RP.
- New 2017 Indonesian Seismic Hazard Maps have been produced.
- 2019 Risk-Targeted Ground-Motions (1% probability of building collapse in 50 years) mapping, for input to Indonesia building codes (SNI-1726-2019), with reference to ASCE-SEI-7-2016.
- 2024-2025 Update of Indonesian Seismic Hazard Maps, under completion.



1978 ISHM



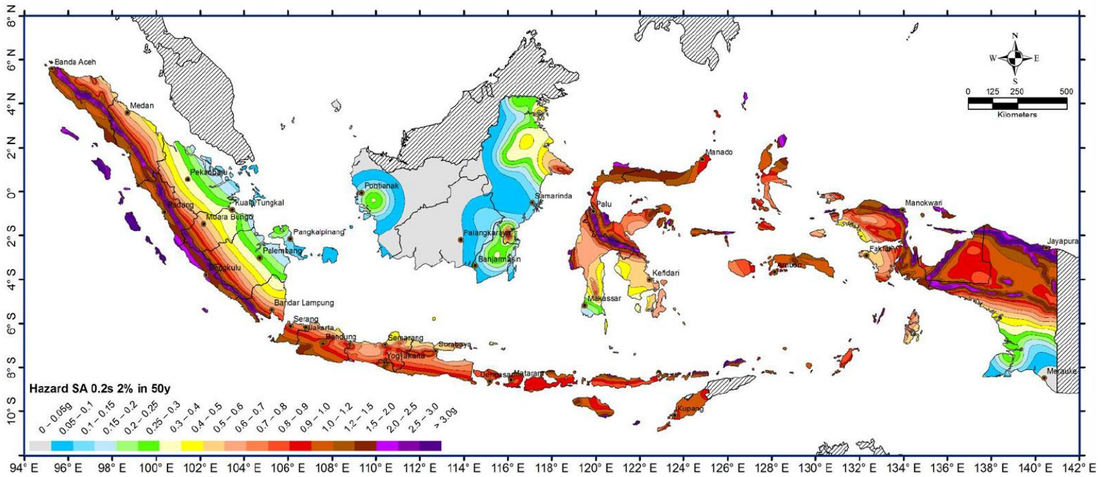
2010 ISHM



2017 ISHM

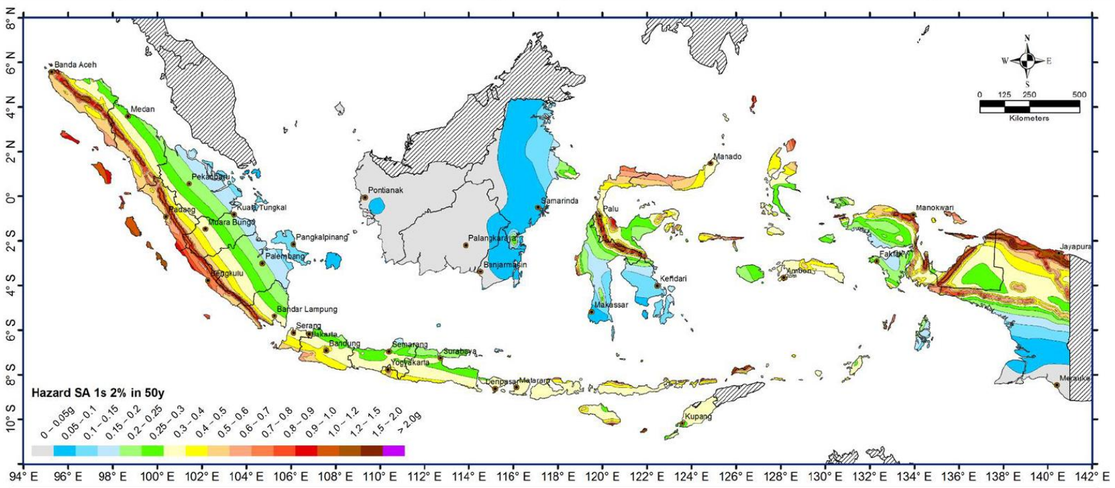
Update of Indonesian Seismic Hazard Map 2017 to 2024,
Currently under Completion

Peta hazard percepatan spektra 0.2 detik di batuan dasar (S_B) untuk probabilitas terlampaui 2% dalam 50 tahun (gempa 2.500 tahun)

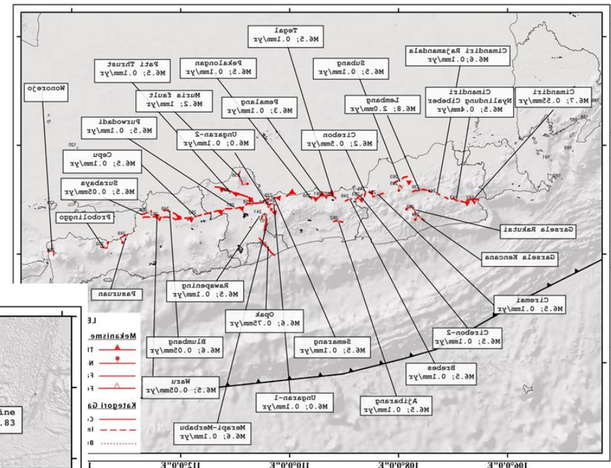


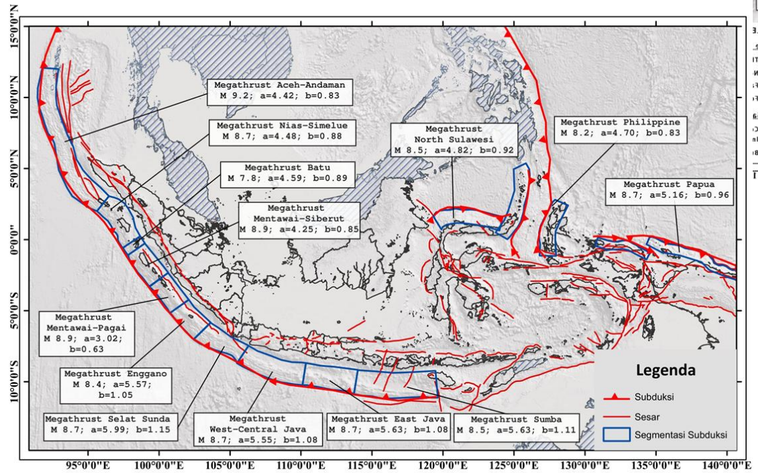
Sa, 0.2 second, 2475 yr RP

Peta hazard percepatan spektra 1 detik di batuan dasar (S_B) untuk probabilitas terlampaui 2% dalam 50 tahun (gempa 2.500 tahun)

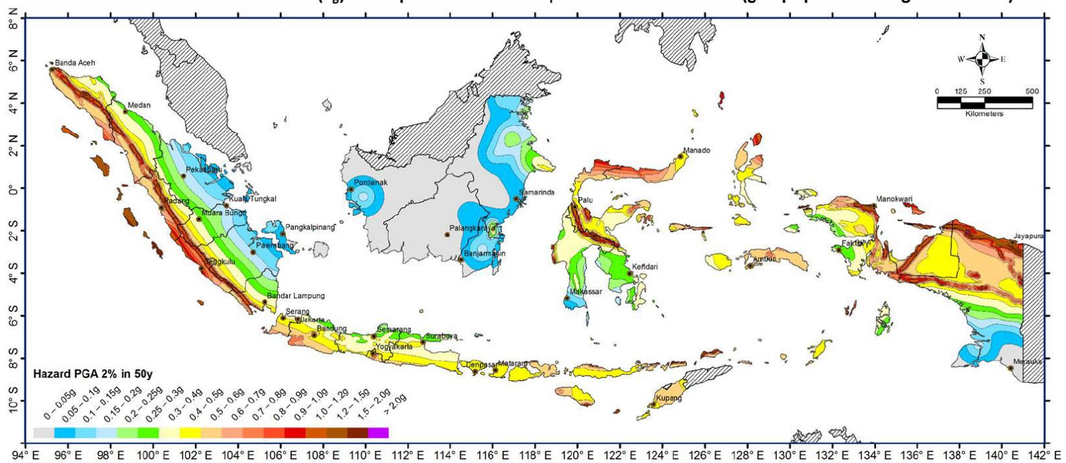


Sa, 1 second, 2475 yr RP





Peta hazard PGA di batuan dasar (S_B) untuk probabilitas terlampaui 2% dalam 50 tahun (gempa periode ulang 2.500 tahun)



PGA, 2475 yr RP

Kerja sama:

(Developed by: Indonesian Team for Revision of Seismic Hazard Map, 2017-2025)

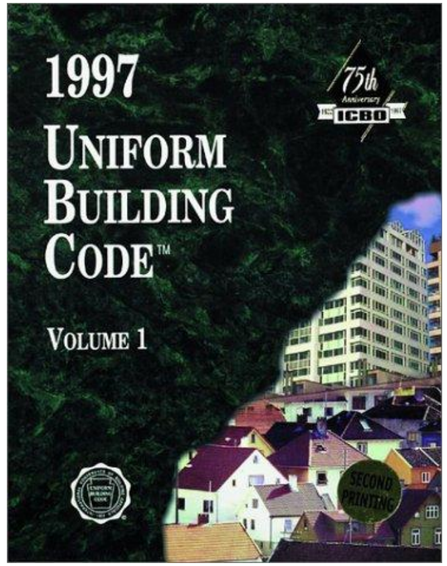
- ***Update on Seismic Codes***

1. **Buildings Structures**
2. **Bridge Structures**
3. **Dam Structures**

Development of SNI 1726-2012

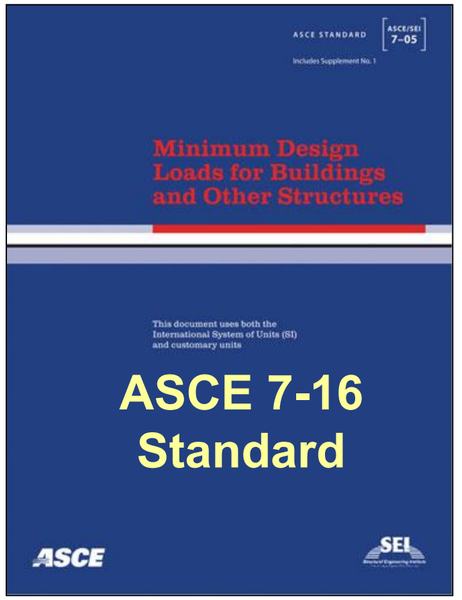
Transition from :

SNI-1726-2002 → SNI-1726-2012 → SNI-1726-2019



HAZARD-Based Spectra

RISK-Targeted Based Spectra



RISK-Targeted Based Spectra

Indonesia State of Progress in Update of Building Codes

Release of:

- New Indonesian Seismic Building Codes (SNI 1726-2019) and
- Requirements on Earthquake Ground-Motions Selection and Modifications for Buildings, (SNI-8899-2020)

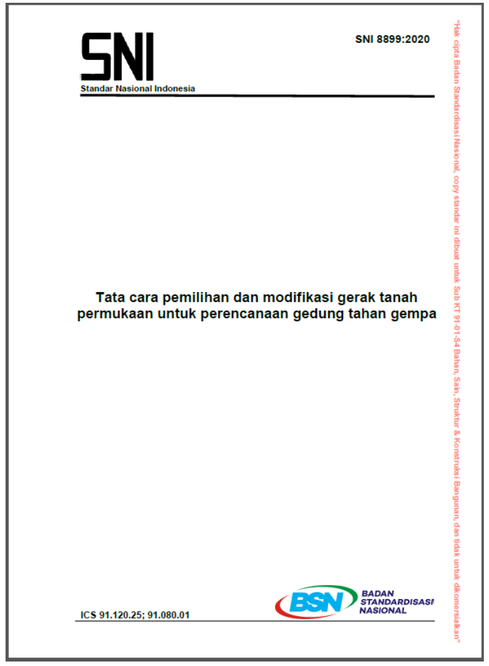
=> Proposed revision of SNI-1726-2019 with reference to ASCE-SEI-7-22

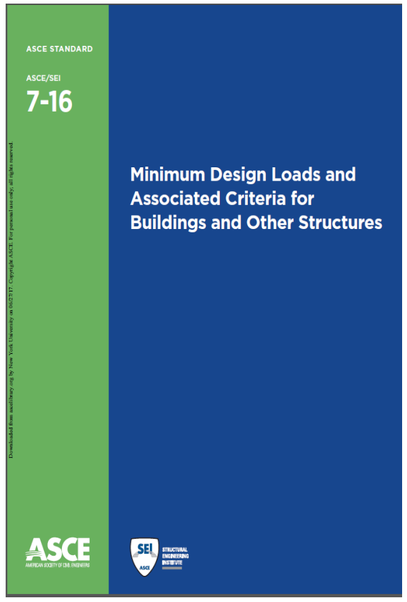
References:

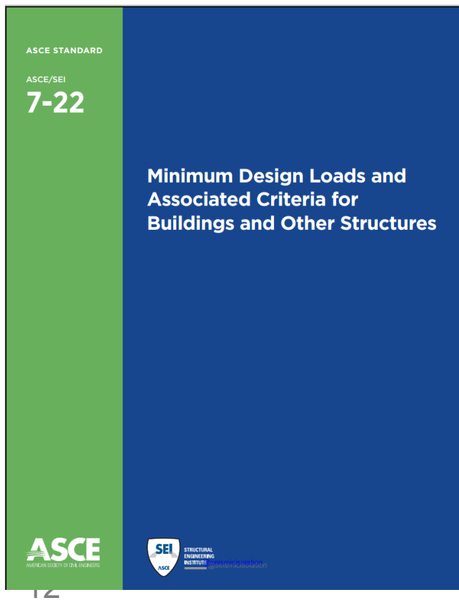
- *ASCE 7-16, Minimum Design Loads and Associated Criteria for Buildings and OtherStructures.*
- *TBI 2017, Guidelines for Performance-Based Seismic Design of Tall Buildings*
- *ASCE 7-22, Minimum Design Loads and Associated Criteria for Buildings and OtherStructures.*

SNI 1726:2019

SNI 8899:2020







- Compliance and Enforcement of Building-Codes Process

- Advisory Committee (TPKB) Establishment & Review Process
- Currently modified as Professional Engineer Expert (TPA) Reviewer

UU no. 28 - 2002

Clause 36 mentioned that the approval for technical design of public buildings or buildings with special function shall be issued by the authority after the review from expert team/member.

Pasal 36

(1) Pengesahan rencana teknis bangunan gedung untuk kepentingan umum ditetapkan oleh Pemerintah Daerah setelah mendapat pertimbangan teknis dari tim ahli.

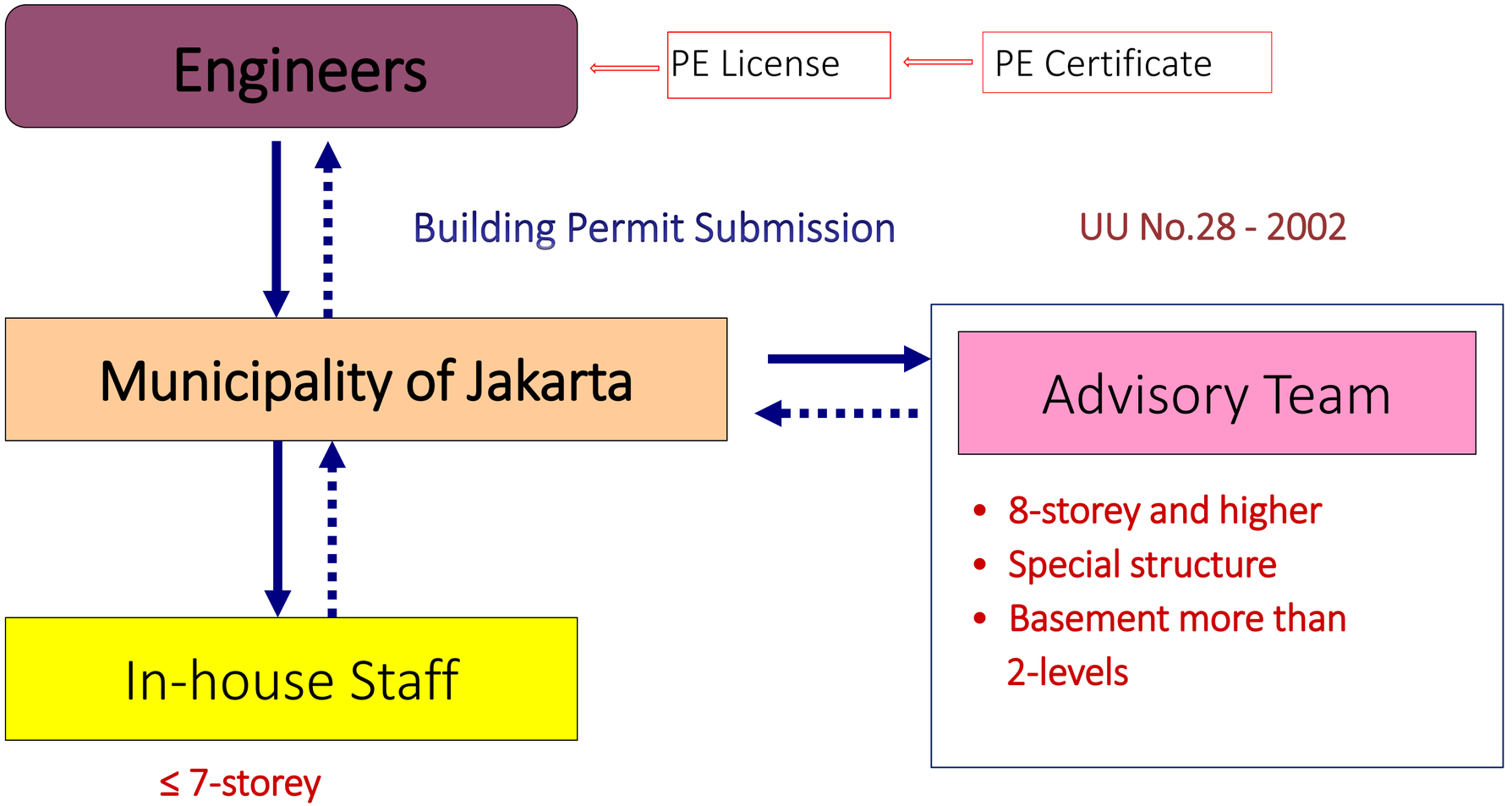
(2) Pengesahan rencana teknis bangunan gedung fungsi khusus ditetapkan oleh pemerintah setelah mendapat pertimbangan teknis tim ahli.

(3) Keanggotaan tim ahli bangunan gedung sebagaimana dimaksud dalam ayat (1) dan ayat (2) bersifat ad hoc terdiri atas para ahli yang diperlukan sesuai dengan kompleksitas bangunan gedung.

(4) Ketentuan mengenai tata cara pengesahan rencana teknis bangunan gedung sebagaimana dimaksud dalam ayat (1) dan ayat (2) dan keanggotaan tim ahli bangunan gedung sebagaimana dimaksud dalam ayat (3) diatur lebih lanjut dengan Peraturan Pemerintah.

- *Compliance and Enforcement of Building-Codes Process*

Peer review process on design requirement of building permit



- Engineers Capacity Building

15 members participate in the 18 World Conference on Earthquake Engineering

Milan-Italy, 30 June – 5 July 2024

Organized by International Association for Earthquake Engineering (IAEE)

18TH WORLD CONFERENCE ON EARTHQUAKE ENGINEERING
WCEE2024
MILAN

Various Topics:

- Seismic Hazards Mapping
- Seismic Building Codes
- Geotechnical Earthquake Engineering
- Structural Earthquake Engineering
- Seismic Disaster Mitigation and Management

- Engineers Capacity Building

International Conference hosted by
Indonesian Earthquake Engineers Association (IEEA)

AARGI
ASOSIASI AHLI REKAYASA GEMPA INDONESIA

- 1st ICEEDM 2008 (Jakarta)
- 2nd ICEEDM 2011 (Surabaya)
- 3rd ICEEDM 2016 (Bali)
- 4th ICEEDM 2019 (Padang)
- 5th ICEEDM 2022 (Yogyakarta)
- **6th ICEEDM 2026 (Jakarta)**

- Engineers Capacity Building

International Joint Workshop

- *2017: Advanced Technologies for Seismic Protection for Buildings (with Japanese Society of Seismic Isolation)*
- *2018 : Structural Design of High-Rise Buildings with Passive Control Devices (With NCREE, Taiwan)*
- *2019: Workshop on Geotechnical Engineering and Structural Engineering (with NCREE, Taiwan)*

- **Other Efforts for Resilient Community:**
  - ***Post Earthquake Building Assessment Survey and Damage Modeling***
  - ***Earthquake Reconnaissance Survey and Report After Earthquake***
  - ***School Retrofitting***

Post Earthquake Building Assessment Survey and Damage Modeling

Key Elements in Building Assessment:

- Reference:
  - **ATC 20 Procedures** for Post Earthquake Safety Evaluation of Buildings
  - Available building codes (SNI)
- **Safety-evaluation procedures**:
  - Rapid evaluation
  - Detailed evaluation
  - Engineering evaluation – should be conducted for essential facilities, e.g. hospitals
- **Inspectors:**
  - Qualified technical persons (at each level of evaluation)
  - Authorized
  - Use of engineering judgement

Post Earthquake Building Assessment Survey and Damage Modeling

Key Elements in Rapid Building Assessment:

Ref:

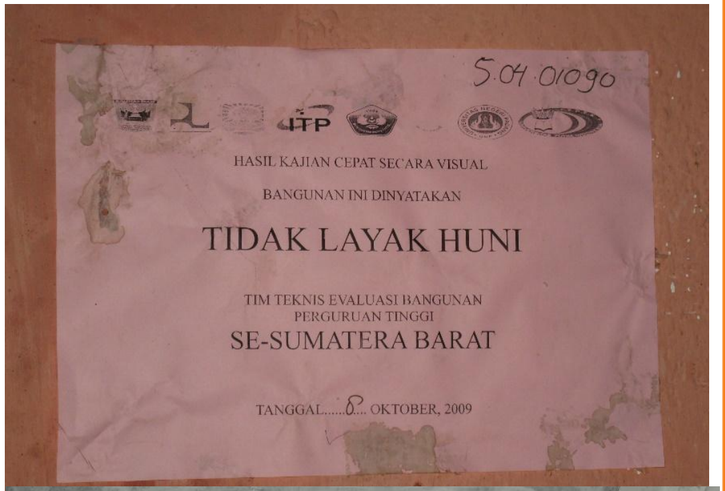
- ATC 20 Procedures for Post Earthquake Safety Evaluation of Buildings

- Available building codes (SNI)

- Provide form of assessment
- Appropriate posting system
- Notes of essential facilities – hospitals
- Aftershocks
- Locked buildings/unit
- Retrieval of possessions and salvage
- Changing of posting

Inspection of Essential Facilities

- Essential facilities (including hospitals)
- Evaluation of essential facilities
  - First Priority
  - Require Detailed Evaluation
  - Check Fixed Equipment
  - Check Fire Protection and Elevator Systems
  - Coordinate Damage Inspections



TAGGING

A red tag indicates **UNSAFE**: Extreme hazard, may collapse. Imminent danger of collapse from an aftershock. Unsafe for occupancy or entry, except by authorities.

A yellow tag indicates **LIMITED ENTRY**: Dangerous condition believed to be present. Entry by owner permitted only for emergency purposes and only at own risk. No usage on a continuous basis. Entry by public not permitted. Possible major aftershock hazard.

A green tag indicates **INSPECTED**: No apparent hazard found, although repairs may be required. Original lateral load capacity not significantly decreased. No restriction on use or occupancy.

(Source: Kusumastuti-AARGI, 2009)

Development of Damage Model – BNPB-ITB-IEEA-AusAid

Post-earthquake Survey of 2009 Padang Earthquake

- **Total of 3,896 buildings were surveyed in the Padang and Pariaman region.**
- **This comprised a range of types which included medical facilities (108), educational buildings (460), commercial buildings (479), and residential structures (2,268).**
- **The survey works also entailed 1,700 interviews with residents.**
- **Buildings of all age categories were damaged and nominally engineered structures also suffered significant damage.**
- **Observations revealed poor structural configurations, poor detailing of reinforcement, and the use of low-quality construction materials.**
- **Involving 70 Engineers and Researchers, Conducted by collaborative efforts of:**

BNPB-AusAID-ITB-AARGI, Supported by

University of Andalas

AARGI
ASOSIASI AHLI REKAYASA GEMPA INDONESIA

AUSTRALIA-INDONESIA FACILITY FOR DISASTER REDUCTION

INSTITUT TEKNOLOGI BANDUNG 1920

BADAN NASIONAL PENANGGULANGAN BENCANA BNPB

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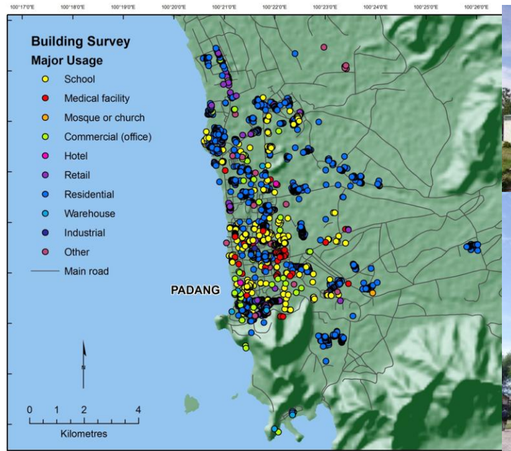
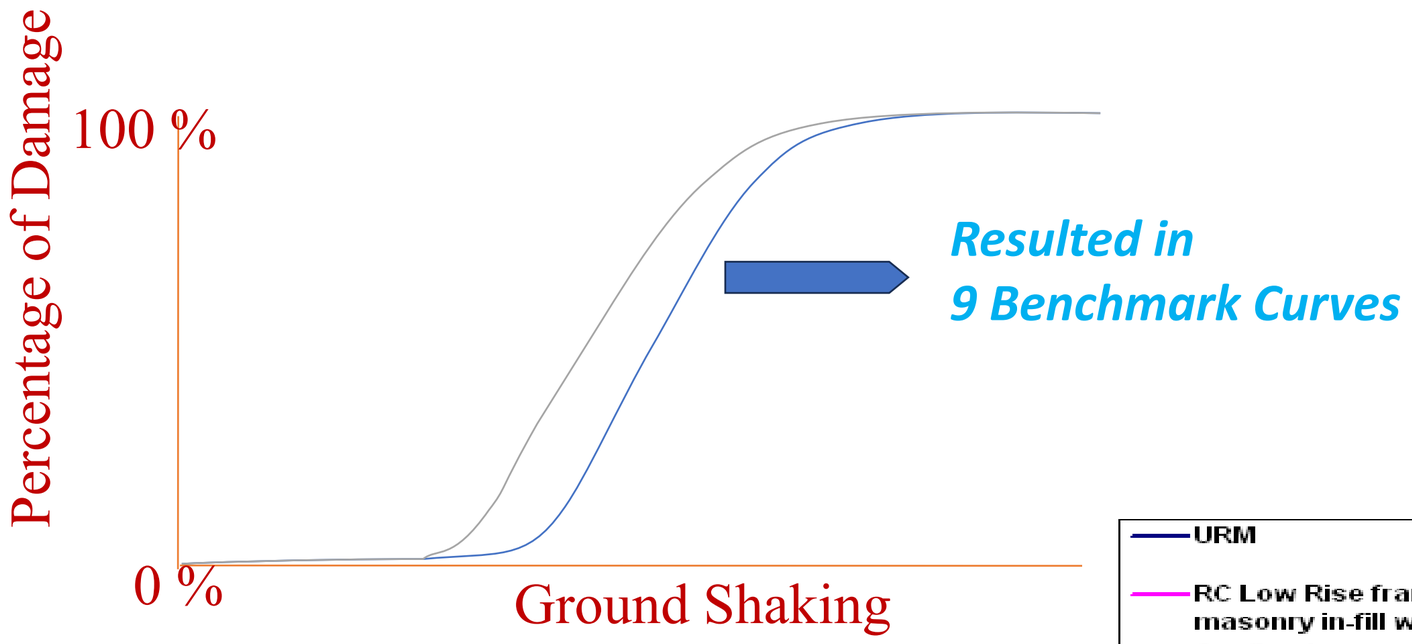
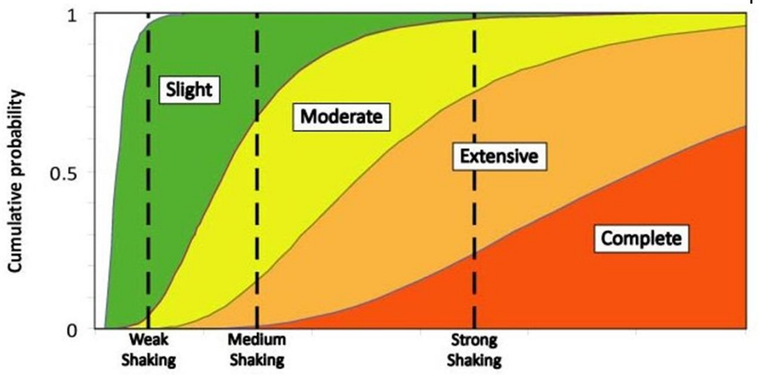
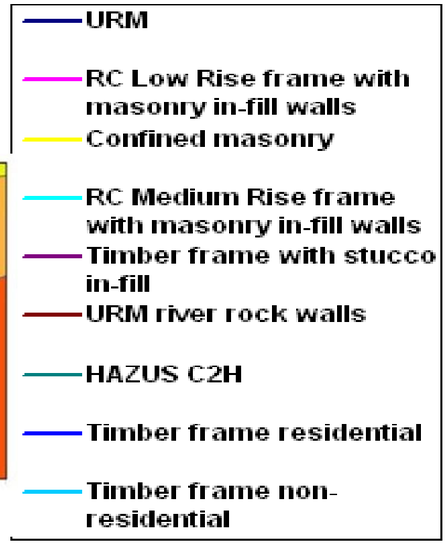


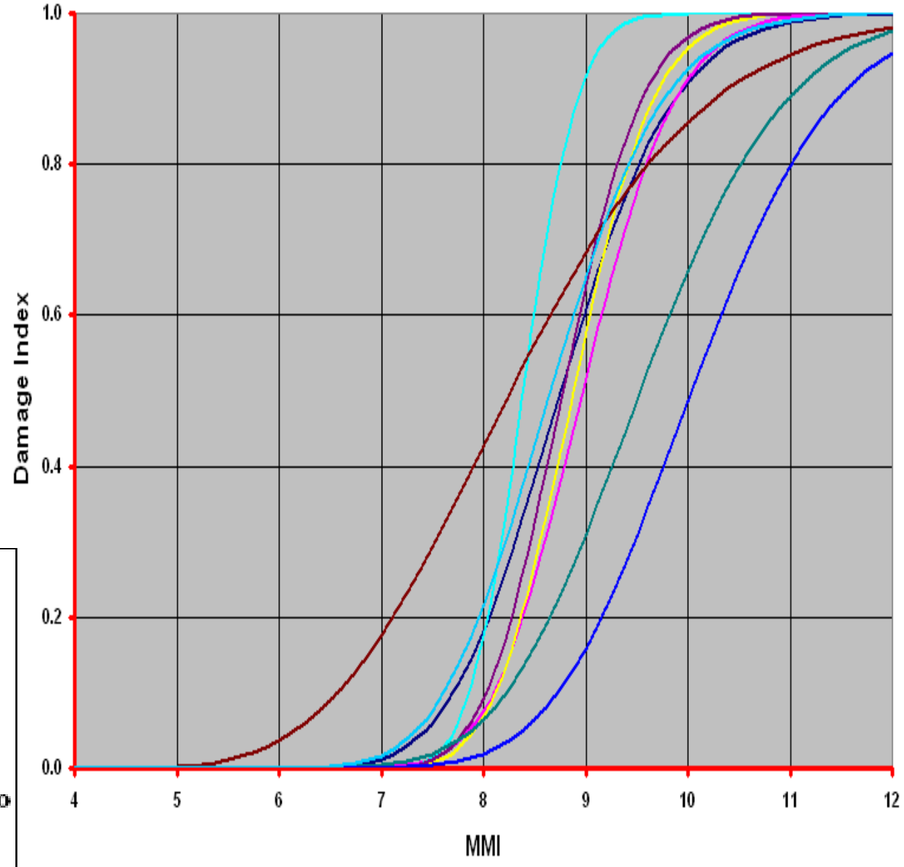
Development of Vulnerability (Damagae Model) Curves



Resulted in
9 Benchmark Curves







- Post Earthquake Disaster Survey Reports

Abstract
Earthquake Spectra
Volume 22: Pages 495-509, 2006 (https://doi.org/10.1193/1.2205199)

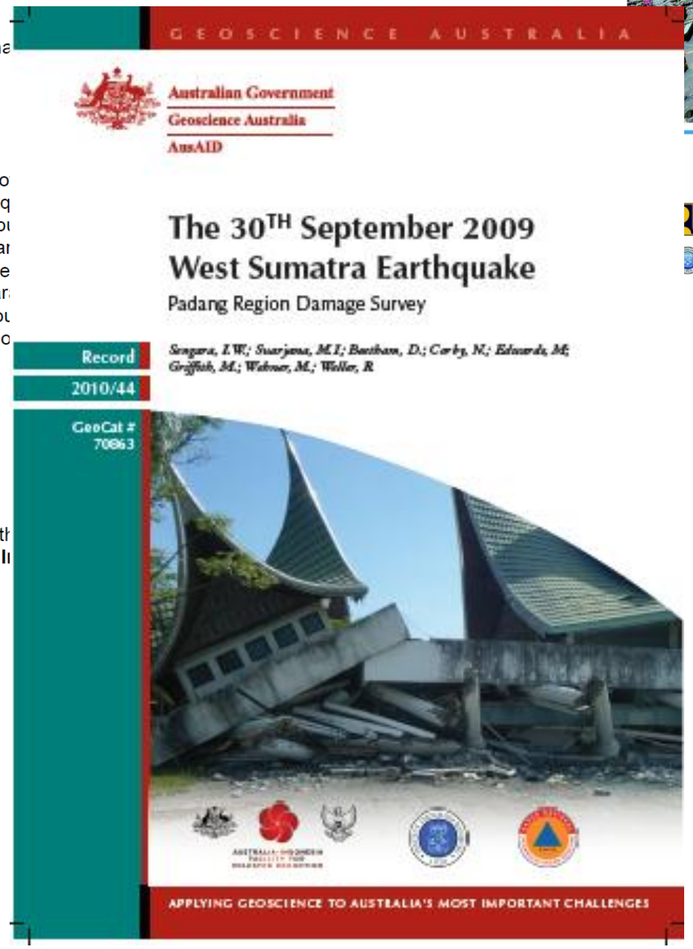
Survey of Geotechnical Engineering Aspects of the December 2004 Great Sumatra Earthquake and Indian Ocean Tsunami and the March 2005 Nias–Simeulue Earthquake

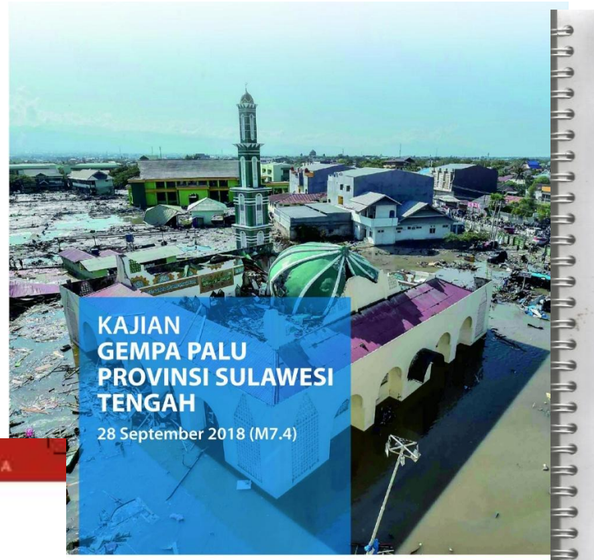
I. Wayan Sengara[1], Nanang Puspito[2], Engkon Kertapati[2], and Hendarto[2]
[1]Head, Center for Disaster Mitigation, Institute of Technology Bandung, Jl, Ganesha
[2]Member of Center for Disaster Mitigation, Institute of Technology Bandung

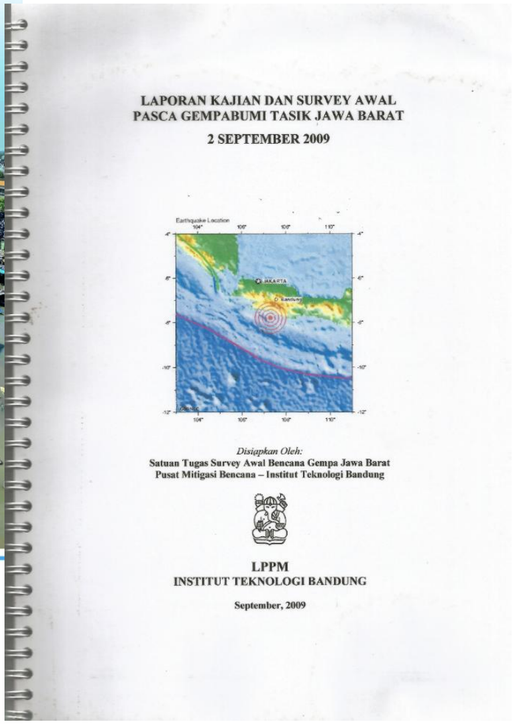
Abstract

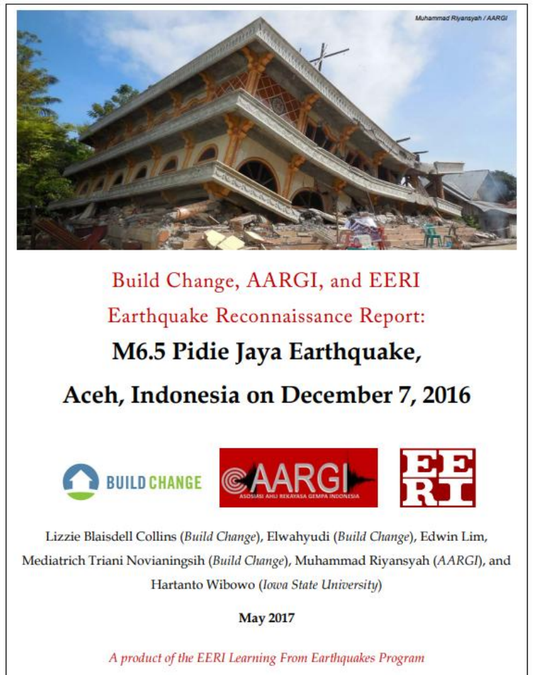
e damage related to geo
December 2004 earthq
ied many instances of bu
strong ground shaking ar
s suggest the need for e
heir ground motion char
nicrozonation study shou
purpose of reconstructio
Island.

Research Institute with
ngineering Research I









School Saftey in the Asia Pacific

Presented at

The 4th ICEEDM, Bali 2016

Global Alliance for
Disaster Risk Reduction & Resilience
in the Education Sector

Community Training – UNCRD (2008)

School Safety Training

Training for Masons

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INSTITUT TEKNOLOGI BANDUNG 1920

School Retrofit – UNCRD (2008)

Report on

Review of Seismic Retrofit Design of School Buildings

Under the Project

"Reducing Vulnerability of School Children to Earthquakes in Asia-Pacific Region" in

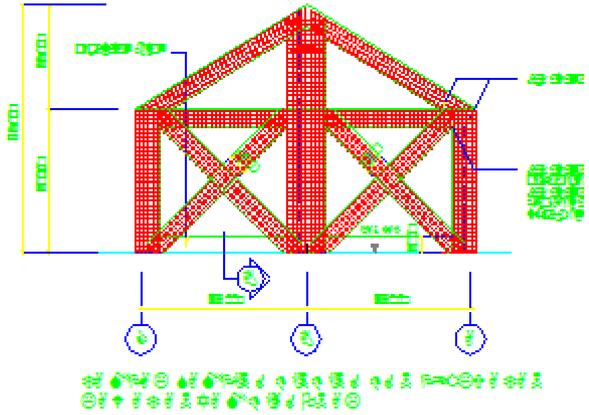
- **Indonesia**
- **India**
- **Uzbekistan**
- **The Fiji Islands**

Submitted to

United Nations Centre for Regional Development, Disaster Management Planning Hyogo Office, Kobe, Japan

By
Bishnu Pandey
Vancouver, Canada

December, 2008



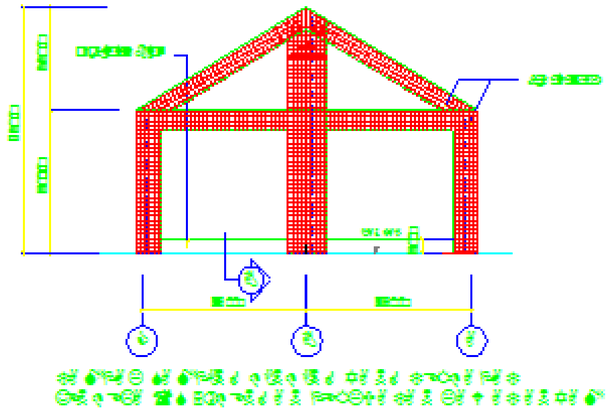
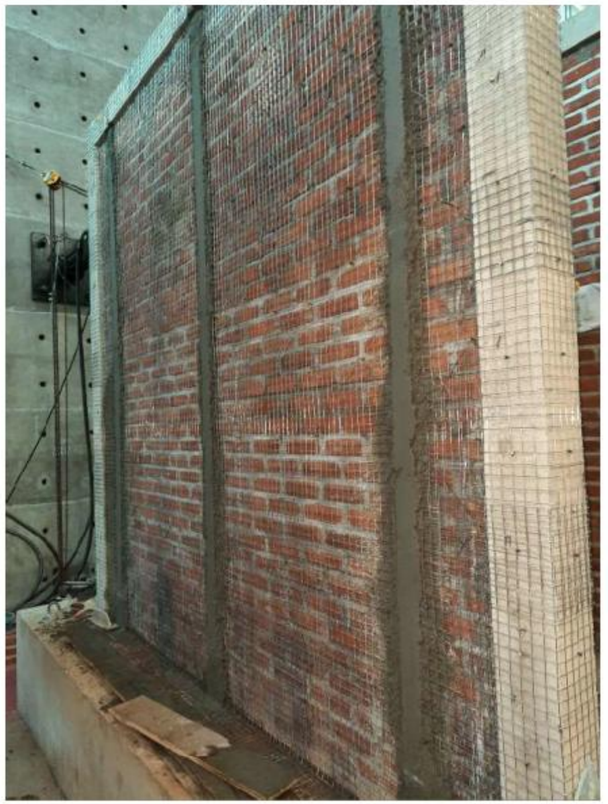


Figure 8 Various stages of retrofitting of SD Padasuka II

Dyah Kusumastuti, dkk. "Reducing earthquake vulnerability of non-engineered buildings: case study of retrofitting of school building in Indonesia," World Conference on Earthquake Engineering, 2008

Research Collaboration with NCREE, Taiwan (2023)

Topic: retrofit of confined masonry using ferrocement layer



Concluding Remarks

- *Seismic Hazard Maps, Building and Infrastructures Codes for Indonesia has evolved and revised over the last three decades.*
- *Recent seismic spectral design load requirements for buildings and infrastructures for new construction in Indonesia are in general directed toward in-line with many International Building Codes.*
- *An increase in spectral design loads requirements would tend to expose many existing buildings and infrastructures to be at a higher level of vulnerabilities and risks.*
- *Preliminary vulnerability building-damage models have been developed Post-Padang 2009 earthquake indicating, in general, high vulnerability of buildings in Indonesia. The models could be adopted as preliminary bases for the risk assessment process for many types of buildings.*
- *It has been highlighted that earthquake resistance design and construction of buildings and infrastructures in Indonesia needs to become a priority and it is a crucial factor for earthquake DRR. Professional Engineers play significant roles in this DRR.*

Concluding Remarks

- *It is essential to prevent or minimize building and infrastructure collapses or damages from future earthquakes through:*
  - *Provision of proper engineering design parameters.*
  - *Improvement and continuous update hazard maps and building +Infrastructure codes and guidelines.*
  - *The codes shall later be legally referred and embedded within the local regulations.*
  - *Proper design, good quality construction, and building and infrastructure design enforcements (Building Authority and Advisory Committee: TABG, TPA, etc.)*
  - *Systematic and good construction supervision.*
  - *Disaster RA of buildings and infrastructures demands development and continuous enhancement of building +Infrastructure vulnerability models.*
  - *Retrofit of Schools, Essential, and Vulnerable Buildings.*
  - Promotion on, enforcement of seismic building codes, trainings on, and community-based earthquake resistance constructions for buildings are vital to vulnerability and DRR.

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