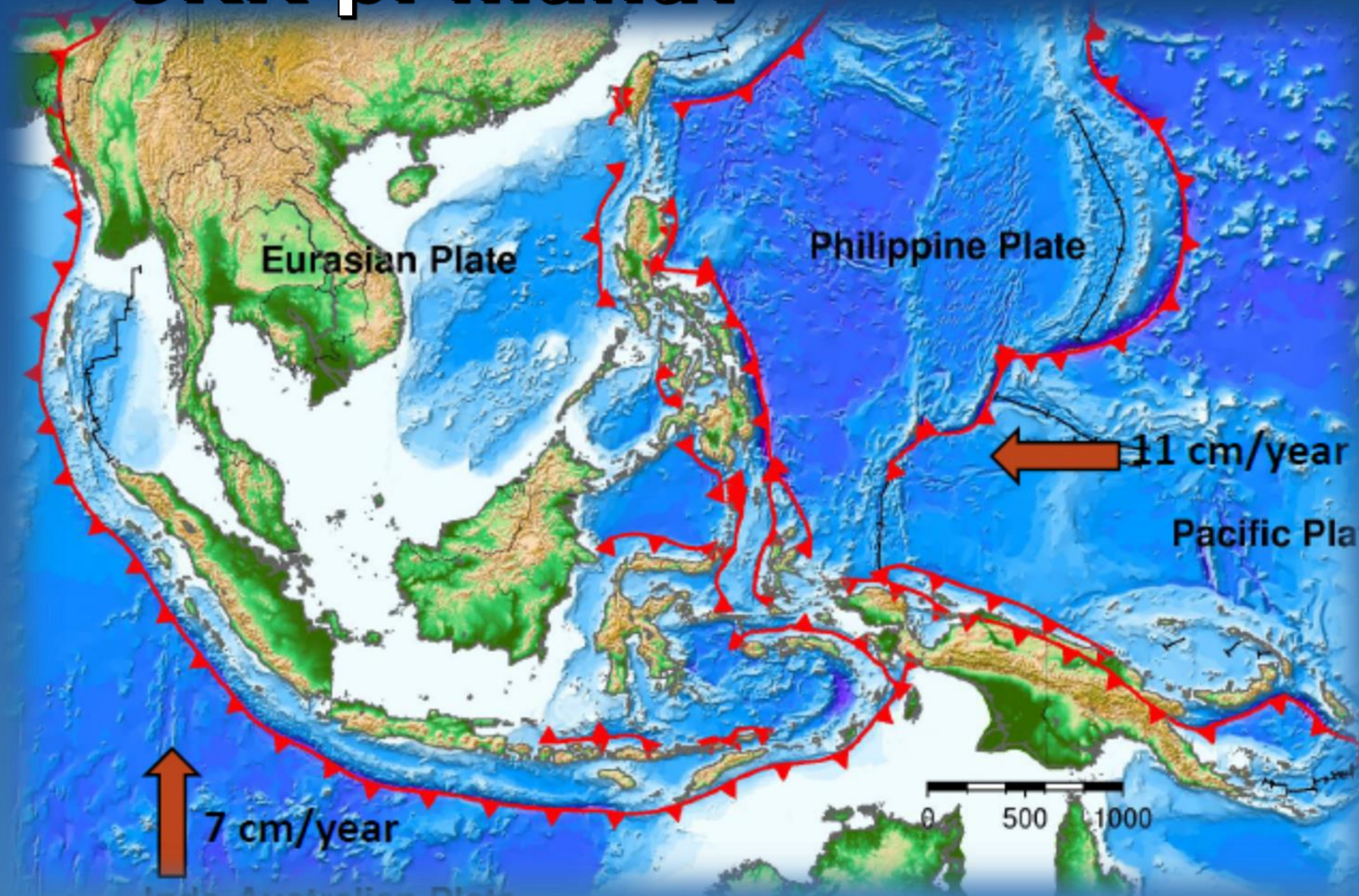
Earthquake Engineering In Malaysia –
JKR pi mana?



Cawangan Kejuruteraan Awam dan Struktur
Jabatan Kerja Raya Malaysia
Kuala Lumpur

Ir. Mohd Noor Azudin b Hj Mansor
Pengarah Kejuruteraan Pakar (Struktur)
23 September 2016

INTRODUCTION

- In 26 December 2004, an 9.1 Richter scale earthquake occured in Acheh and inducing the Indian Ocean tsunami which struck Malaysia by affecting Penang and Kedah states and to a lesser degree Perlis and Perak.
- The tsunami is the worst natural disaster in history and claimed 69 lives and left an additional 8,700 Malaysians (mainly women and children) from the coastal fishing inlets in Kedah (including Langkawi) and Penang without homes and livelihoods.
- Subsequent from that disaster Malaysian Government formed the Inter-Agency Committee on Earthquake and Tsunami Risk Management on 5th September 2005.

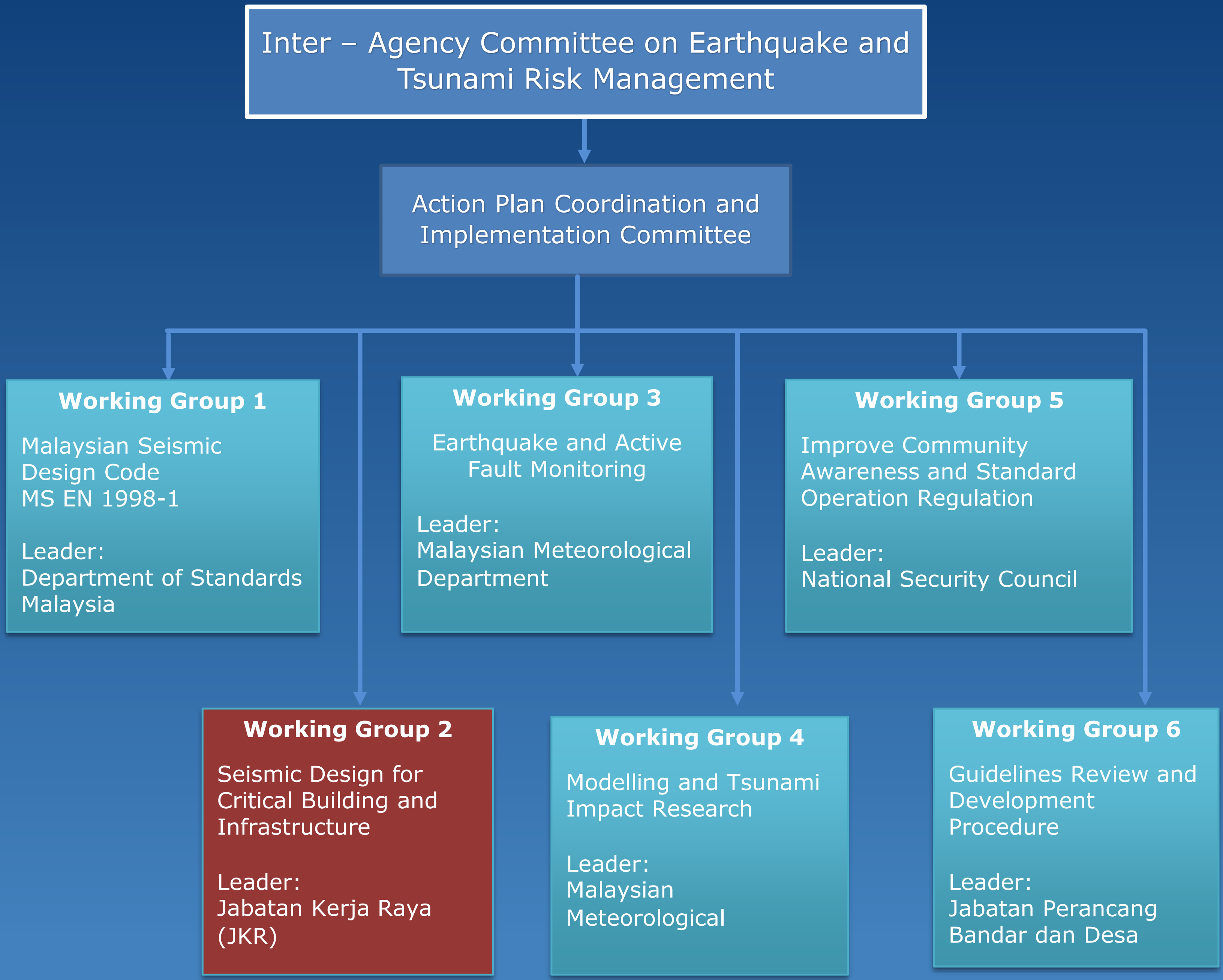
picture courtesy of BBC

picture courtesy of The Star

picture courtesy of The Star

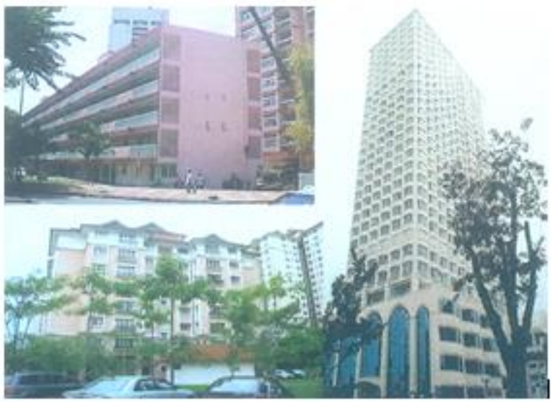
INTRODUCTION

- Inter-Agency Committee on Earthquake and Tsunami Risk Management has identified 6 Major action plans within the strategy groups.
- Jabatan Kerja Raya (JKR) has been involved with Working Group 2, which is to provide seismic inputs for building design and critical infrastructures
- JKR hosted the National Seminar on Earthquakes in PWTC Kuala Lumpur on 15 May 2007.
- 31 March 2010 - JKR proposed the “Seismic Design Guideline For Concrete Building In Malaysia” which was to be used departmentally.
- 11 August 2015 - Department of Standards Malaysia (SIRIM) published MS EN 1995-1:2015 Design of structures for earthquake resistance - Part 1 “General rules seismic actions and rules for buildings” albeit without the related National Annex. The standard was developed under Technical Committee 4 headed by Institute of Engineers Malaysia as the Standard Writing Organization.


Inter – Agency Committee on Earthquake and Tsunami Risk Management
Action Plan Coordination and Implementation Committee
Working Group 1
Malaysian Seismic Design Code MS EN 1998-1
Leader: Department of Standards Malaysia
Working Group 2
Seismic Design for Critical Building and Infrastructure
Leader: Jabatan Kerja Raya (JKR)
Working Group 3
Earthquake and Active Fault Monitoring
Leader: Malaysian Meteorological Department
Working Group 4
Modelling and Tsunami Impact Research
Leader: Malaysian Meteorological
Working Group 5
Improve Community Awareness and Standard Operation Regulation
Leader: National Security Council
Working Group 6
Guidelines Review and Development Procedure
Leader: Jabatan Perancang Bandar dan Desa

JKR 20601-0184-09

JABATAN KERJA RAYA MALAYSIA



SEISMIC DESIGN GUIDELINE FOR CONCRETE BUILDING IN MALAYSIA

TABLE OF CONTENT

Macrozonation Maps Used in the Guideline

APPENDICES

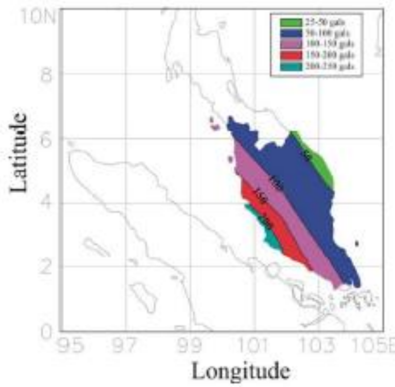


Figure 1. Macrozonation Map for 500 years return period at T=0.2 sec.

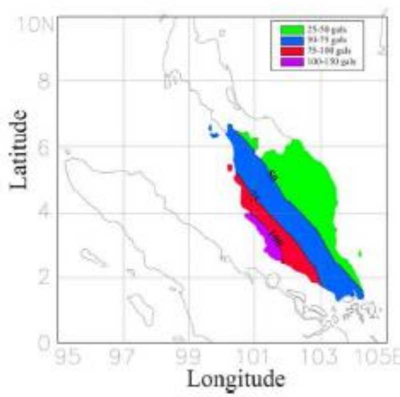


Figure 2. Macrozonation Map for 500 years return period at T=1.0 sec.

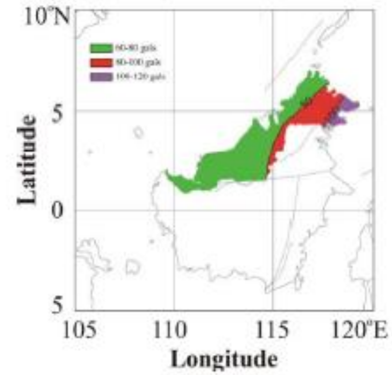


Figure 5. Peak ground acceleration (PGA) maps for 500 year

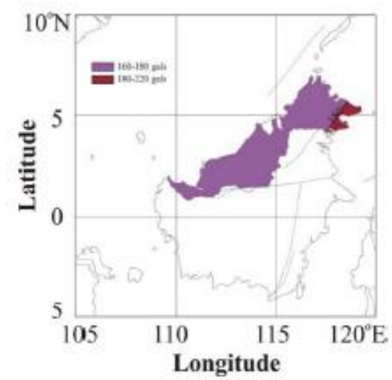
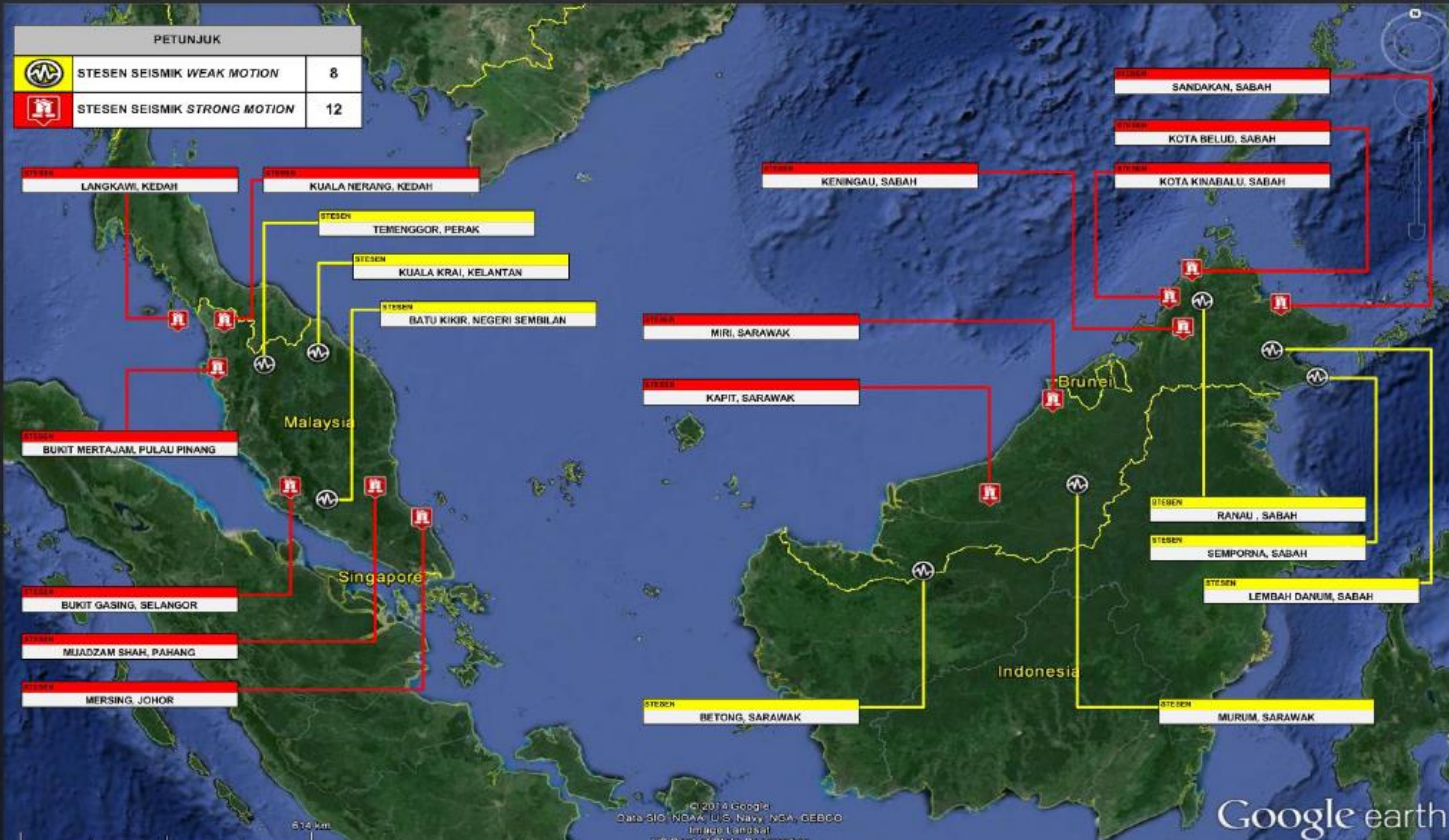


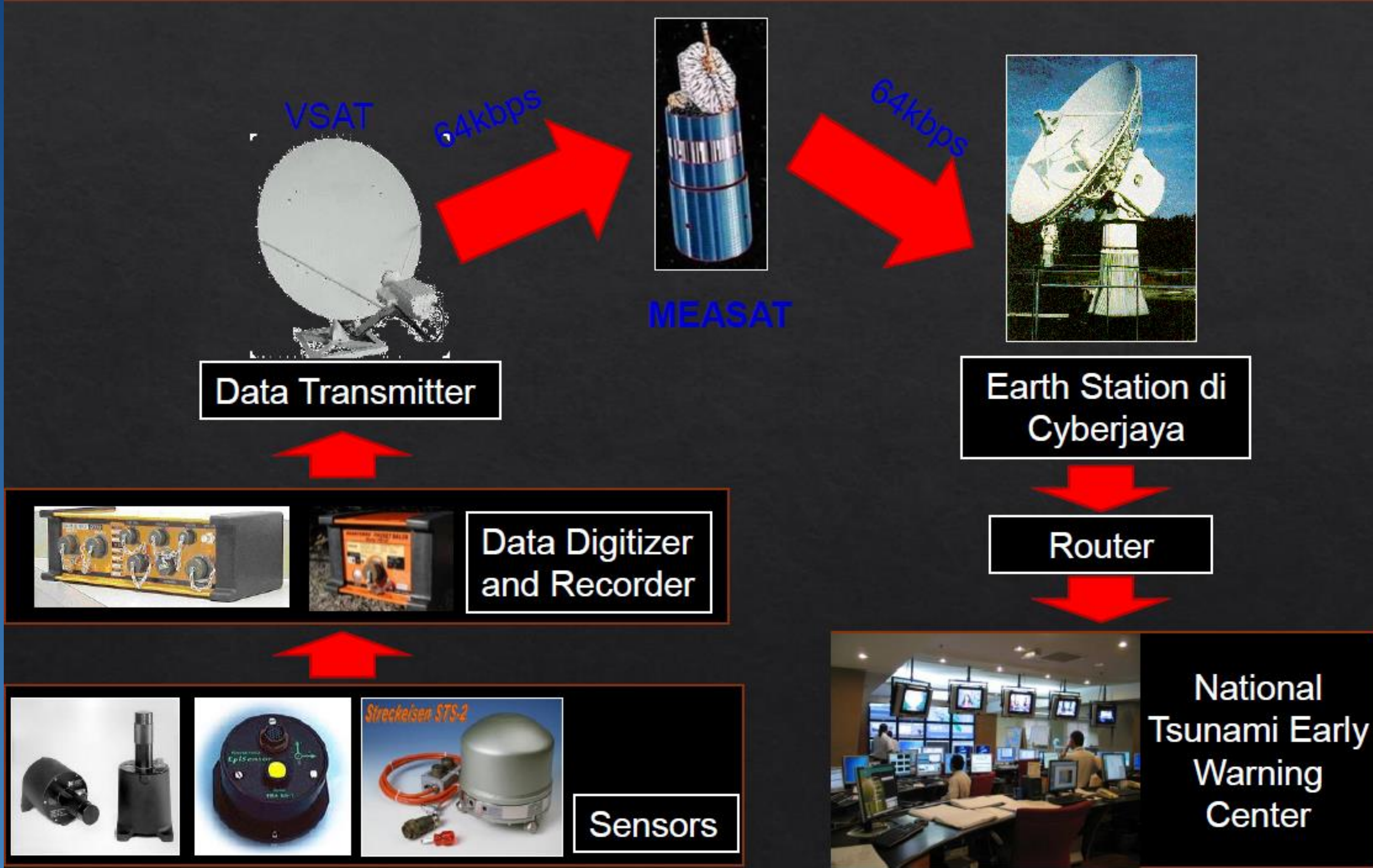
Figure 6. Peak ground acceleration (PGA) maps for 2,500 year

SEISMOLOGICAL STATION (OPERATED IN 2015)



Source: Dr. Chai Mui Fatt, Malaysian Meteorological Department

METHOD AND SYSTEM FOR TRANSMITTING SEISMIC DATA



Source: Dr. Chai, Malaysian Meteorological Department

MALAYSIAN STANDARD

MS EN 1998-1:2015

Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings

ICS: 91.120.25; 93.040

Descriptors: eurocode, seismic action, imposed loads, earthquake, structure, design, building

FOR SALE WITHIN MALAYSIA ONLY

DEPARTMENT OF STANDARDS MALAYSIA

The new MS EN 1998-1 published 11 August 2015

Draft NA to MS EN 1998

- The Department of Standards Malaysia published the draft copy of National Annex to MS EN 1998-1: 2015-15D005R0q in February 2016 for public comment
- A period of two(2) months was given for public comments from 1st Feb till 01 April 2016.
- Due to overwhelming public comments not agreeing to the proposed National Annex, SIRIM conducted a National Consultation meeting to obtain consensus from major stakeholders, namely: the local consultants, government agencies, local university researchers and other stakeholders, which also includes JKR on 23rd August 2016.


DRAFT MALAYSIAN STANDARD

15D005R0 q

STAGE : PUBLIC COMMENT (40.20)
DATE : 01/02/2016 - 01/04/2016

For Public Comment

Malaysia National Annex to MS EN 1998-1: 2015, Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings

OFFICER/SUPPORT STAFF: (NM /)

ICS: 91.120.25

Descriptors: Earthquake, Seismic Design of Structure, PGA, Site Natural Period, Hybrid Response Spectrum, Return Period

© Copyright

DEPARTMENT OF STANDARDS MALAYSIA

Drafting Committee Members

Acknowledgements

Members of Technical Committee on Earthquake

Ir. Prof. Dr. Jeffrey Chiang Choong Luin (Chairman)	The Institution of Engineers, Malaysia
Ir. Adjunct. Prof. MC Hee	The Institution of Engineers, Malaysia
Ir. Mun Kwai Peng (IEM–SWO Coordinator)	The Institution of Engineers, Malaysia
Ir. Lee Weng Onn	The Institution of Engineers, Malaysia
Ir. Dr. Ooi Teik Aun	The Institution of Engineers, Malaysia (GETD)
Ir. Dr. Ooi Heong Beng	Institute of Structural Engineers (Malaysia Regional Group)
Ir. P C Augustin	Association of Consulting Engineers Malaysia
Ir. Tu Yong Eng	YL Design Consultancy Services
Ir. Chen Wai Peng	HSS Engineering Sdn. Bhd
Ar. Andy Gan Khai Fatt	Pertubuhan Arkitek Malaysia
Mr. Ong Ka Thiam	Master Builders Association Malaysia
En. Syed Hazni Syed Abd. Ghani	Construction Industry Development Board, Malaysia
Dr. Wan Azli bin Wan Hassan	Malaysia Meteorological Department/ Ministry of Science Technology & Innovation
Dr. Nazirah Ahmad	Malaysian Rubber Board
Ir. Prof. Dr. Mohd. Zamin bin Jumaat	University Malaya
Dr. Lau Tze Liang	Universiti Sains Malaysia
Prof. Dr. Azlan Adnan	Universiti Teknologi Malaysia
Prof. Dr. Azmi Ibrahim	Universiti Teknologi MARA

Members of Working Group 1 (WG1) on Earthquake Actions

Ir. Adjunct. Prof. MC Hee (Chairman)	The Institution of Engineers, Malaysia
Reader Dr. Nelson Lam	University of Melbourne, Australia
Dr. Tsang Hing-Ho	Swinburne University of Technology, Australia
Engr. Daniel Looi Ting Wee	The Institution of Engineers, Malaysia (University of Hong Kong)
Ir. E P Lim	Hashim & Neh Sdn Bhd
Mr. Ahmed Zuhal Zaeem	University of Malaya

Members of Working Group 2 (WG2) on Vulnerability of Concrete Structures

Ir. Lee Weng Onn (Chairman)	The Institution of Engineers, Malaysia
Ir. Prof. Dr. Jeffrey Chiang Choong Luin	The Institution of Engineers, Malaysia

Members of Working Group 3 (WG3) on Geotechnical

Ir. Mun Kwai Peng (Chairman)	The Institution of Engineers, Malaysia
Ir. Dr. Ooi Teik Aun	The Institution of Engineers, Malaysia
Ir. Liew Shaw Shong	The Institution of Engineers, Malaysia

Members of Working Group 4 (WG4) on Non Structural Elements

Ar. Andy Gan Khai Fatt (Chairman)	Pertubuhan Arkitek Malaysia
Ir. Dr. Ooi Heong Beng	Institute of Structural Engineers (Malaysia Regional Group)

Members of Working Group 5 (WG5) on Base Isolations

Dr. Nazirah Ahmad (Chairman)	Malaysian Rubber Board
Prof. Dr. Azlan Adnan	Universiti Teknologi Malaysia
Engr. Muhammad Umar Zulkefli	Malaysian Rubber Board
Ir. Che Kob bin Ismail	IRC Jurutera Perunding Sdn Bhd
Mr. Or Tan Teng	Doshin Rubber
Ir. Cheng Hung Lim	Minconsult Sdn Bhd
Prof. Dr. Azmi Ibrahim	Universiti Teknologi MARA

Members of Working Group 6 (WG6) on Task Force on National Annex

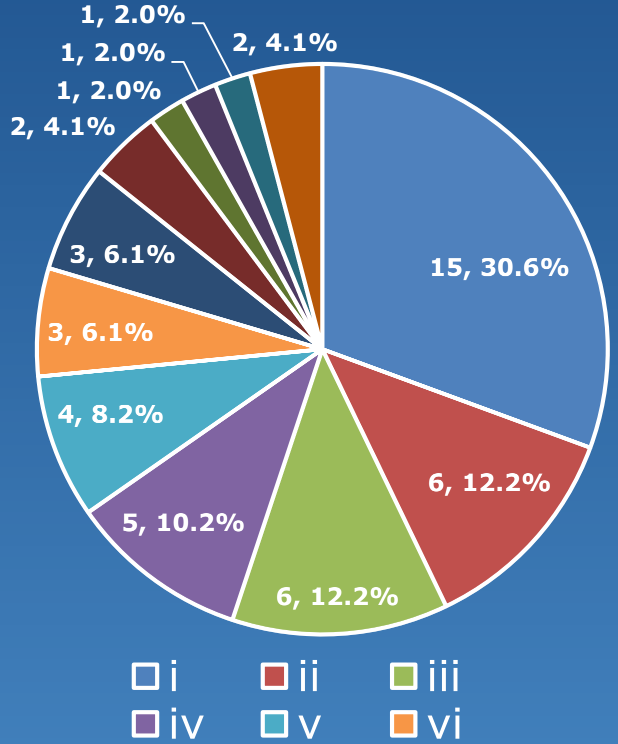
Ir. Mun Kwai Peng (Chairman)	The Institution of Engineers, Malaysia
Ir. Adjunct. Prof. MC Hee	The Institution of Engineers, Malaysia
Ir. Dr. Ooi Heong Beng	Institute of Structural Engineers (Malaysia Regional Group)
Ir. David Ng	The Institution of Engineers, Malaysia
Prof. Dr. Azlan Adnan	Universiti Teknologi Malaysia

Draft NA to MS EN 1998

- Comments by public consists of:

i. Probabilistic Seismic Hazard Analysis(PSHA) & need of seismic hazard map (31%)
ii. Response Spectrum Shape (12.2%)
iii. Site factor provisions (12.2%)
iv. Classification of Buildings Importance factor(10.2%)
v. Return period (8.2%)
vi. Vertical elastic response spectrum(6.1%)
vii. Exclusion of very low seismicity zone in Malaysia(6.1%)
viii. Modified Mercalli Intensity (MMI) Map Malaysia(4.1%)
ix. New term introduced as "Notional return period"(2%)
x. Displacement principles introduced (2%)
xi. Request for background data(2%)
xii. Cost escalation(4.1%)

Commented Subjects



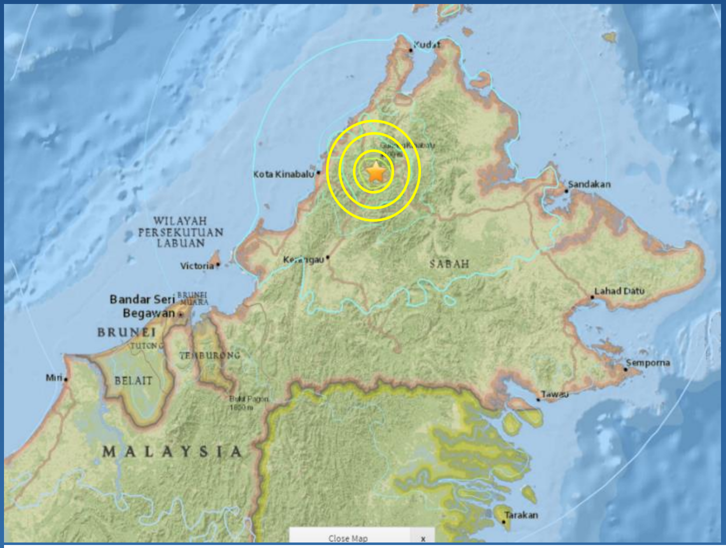
- It was agreed in the National Consultation meeting that the proposed National Annex shall obtain consensus from all stake holders.

Draft NA to MS EN 1998

- Initially JKR was not involved in the TC in drafting the NA.
- JKR was called in to represent the Government's interest after the outcome of the public comment.
- A National Consultation meeting was called in August 2016 and JKR was represented.
- A study group to restudy the proposed methodology, PGA values and the response spectrum and is expected to complete in November 2016. JKR is also represented in this study.

Ranau Earthquake

- Ranau, Sabah Magnitude of 6.0 earthquake took 18 lives on 05 June 2016.
- The dead were mainly climbers on the way down from Mount Kinabalu.
- The earthquake also resulted damages to buildings and infrastructures.
- The last strongest quakes recorded was in Lahad Datu 1976 with Magnitude 6.2, a coastal city about 211km away from Ranau
- On 26 August 2016, another earthquake with a magnitude of 4 was recorded with the epicenter located 16km north west of Ranau city



Magnitude	6.0 mww
Location uncertainty	5.987°N 116.541°E ± 5.1 km
Depth uncertainty	10.0 km ± 1.6
Origin Time	2015-06-04 23:15:43.910 UTC

Source : USGS

picture courtesy of Dr Sophia

picture courtesy of Prof Felix

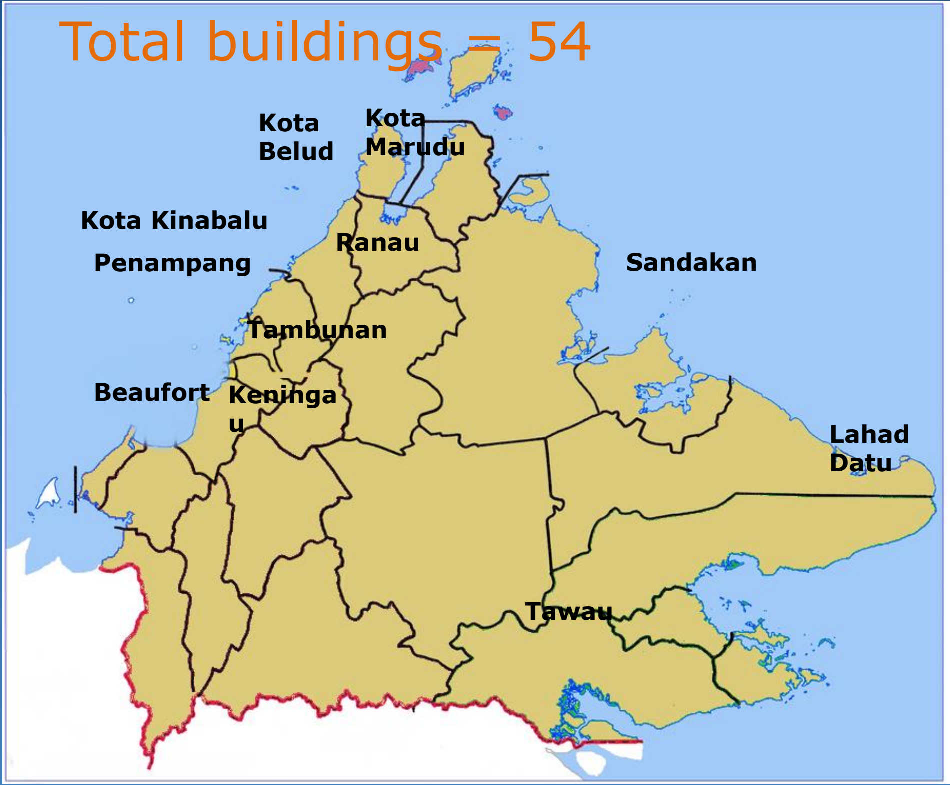
Current Earthquake Studies Funded by The Malaysia Government

- Subsequent from the Ranau earthquake, on 19 Jun 2015, The Malaysian Government initiated a study to identify the vulnerability of the existing structure in Sabah due to seismic activities.
- The study is being conducted by JKR Malaysia and in collaboration with JKR Sabah.
- Due to complete by end of November 2016

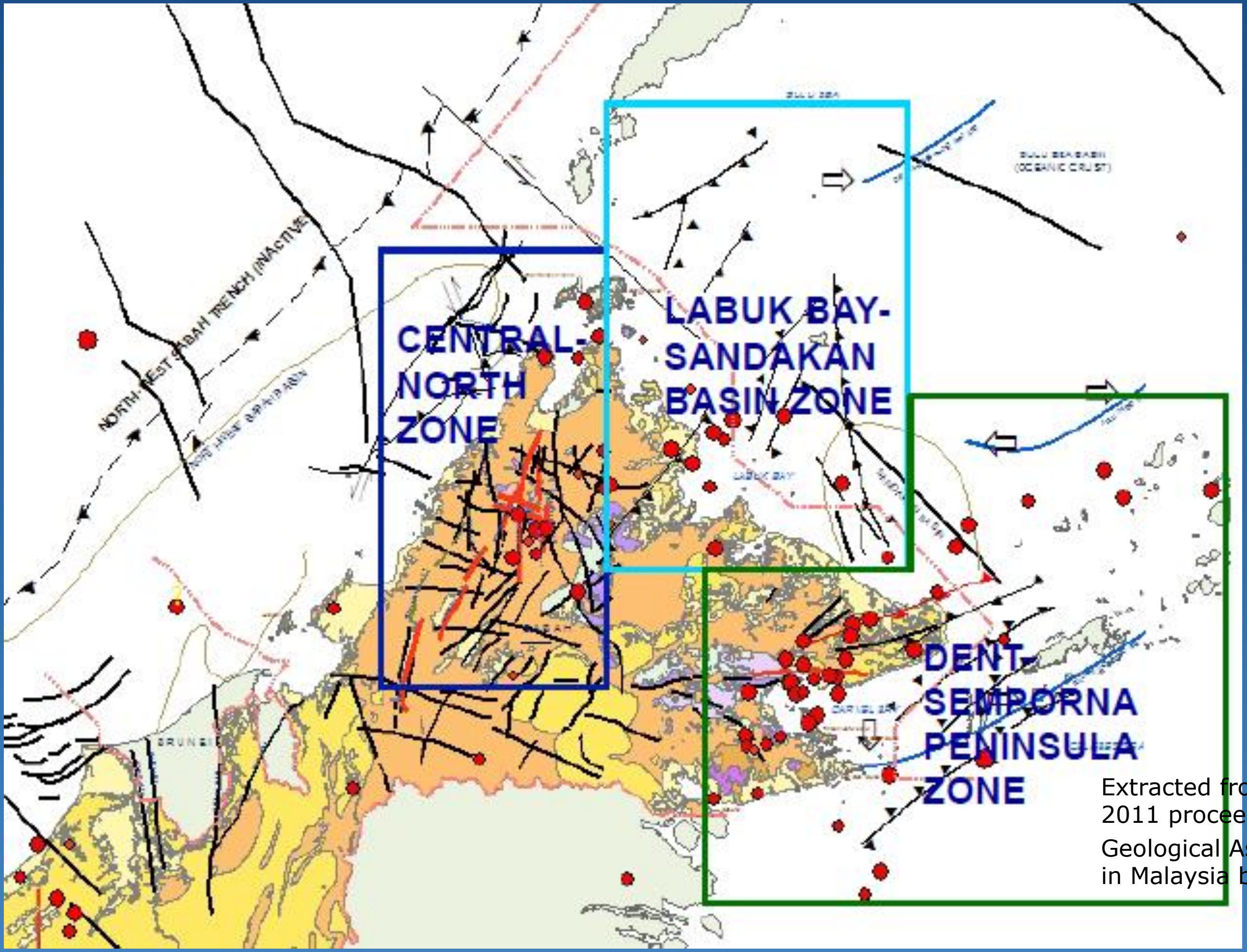
The Study

Regions Involved

NO.	DAERAH	NOS. OF BUILDING
1	KOTA KINABALU	3
2	PENAMPANG	3
3	RANAU	4
4	BEAUFORT	2
5	KUDAT	6
6	KOTA MARUDU	3
7	KENINGAU	9
8	TAMBUNAN	3
9	SANDAKAN	6
10	SEMPORNA	6
11	TAWAU	3
12	LAHAD DATU	6



The Study

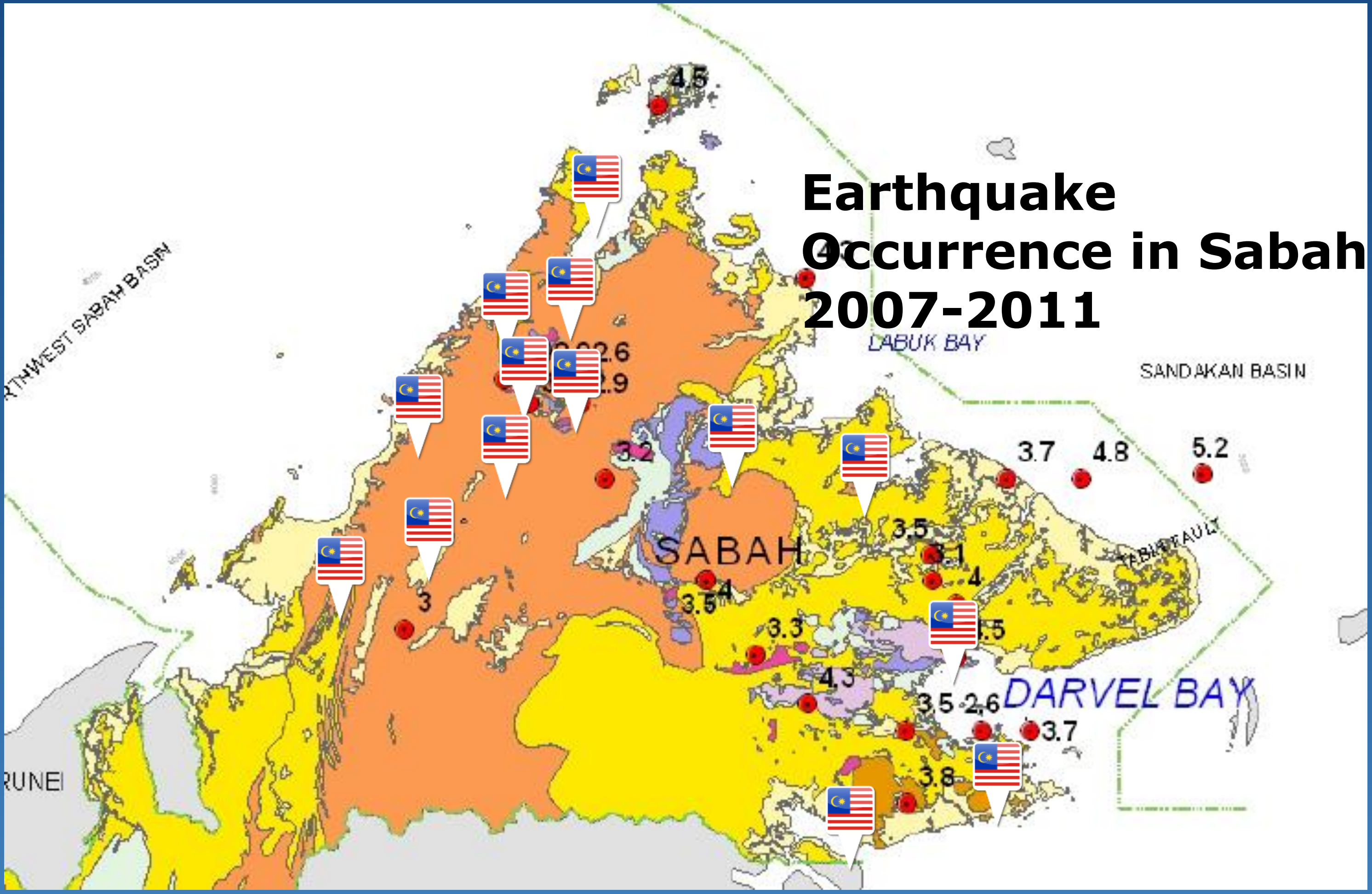


Seismic Zones in Sabah

Extracted from Seminar Teknikal Gempabumi JMM, 20 Dec 2011 proceeding's.

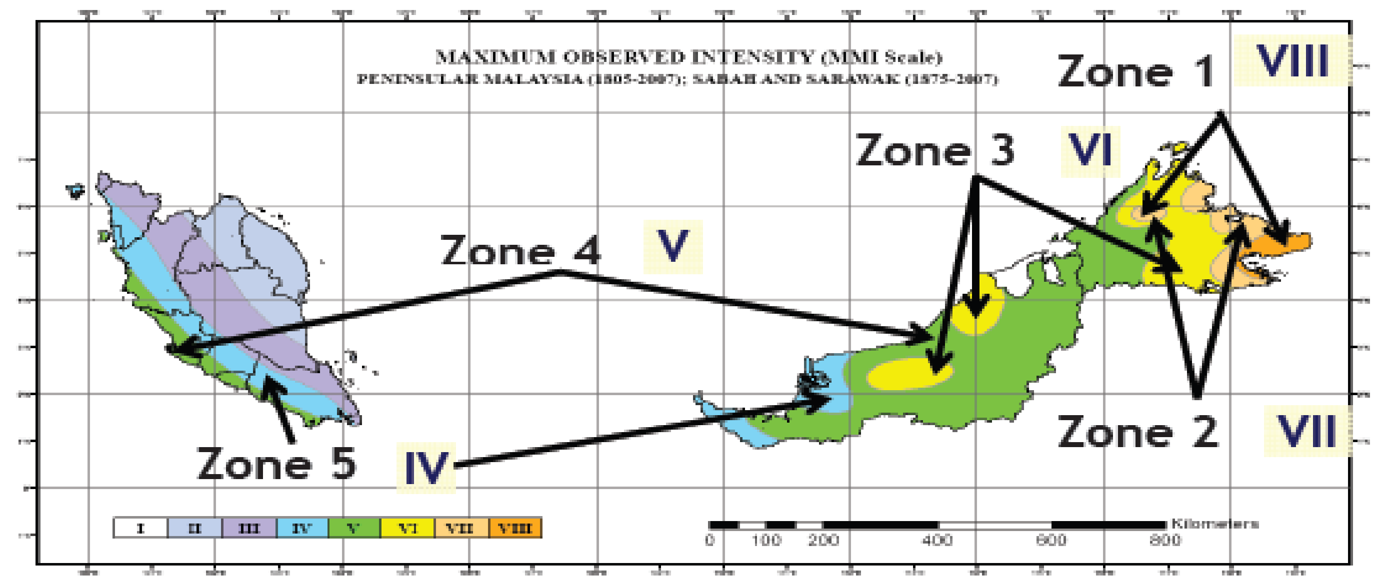
Geological Assesment of the Earthquake Sources and Hazard in Malaysia by Alexander Yan Sze Wah- JMG Sabah

The Study



- Extracted from Seminar Teknikal Gempabumi JMM, 20 Dec 2011 proceeding's.
- Geological Assesment of the Earthquake Sources and Hazard in Malaysia by Alexander Yan Sze Wah- JMG Sabah

The Study

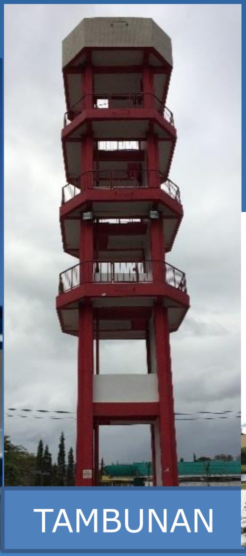


Earthquake Risk Zone Based On Mercalli Observed Intensities

The Study

Building Types Involved

- Government Schools
- Government Hospitals
- Quarters
- Government Office
- Elevated Water Structure
- Training Tower
- Police and Fire Department Stations



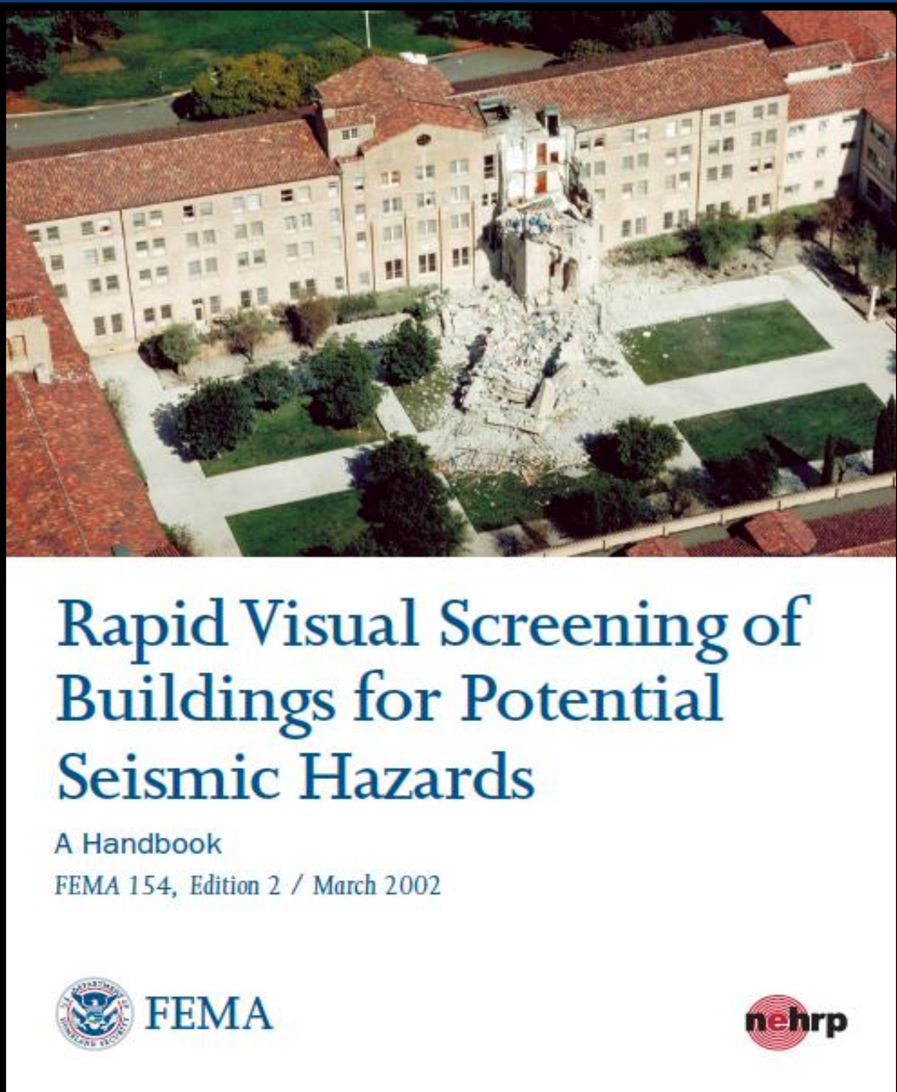
The Study

- Stakeholders
  - Ministry of Works Malaysia
  - JKR Malaysia
  - JKR Sabah
  - Sabah Government

The Study

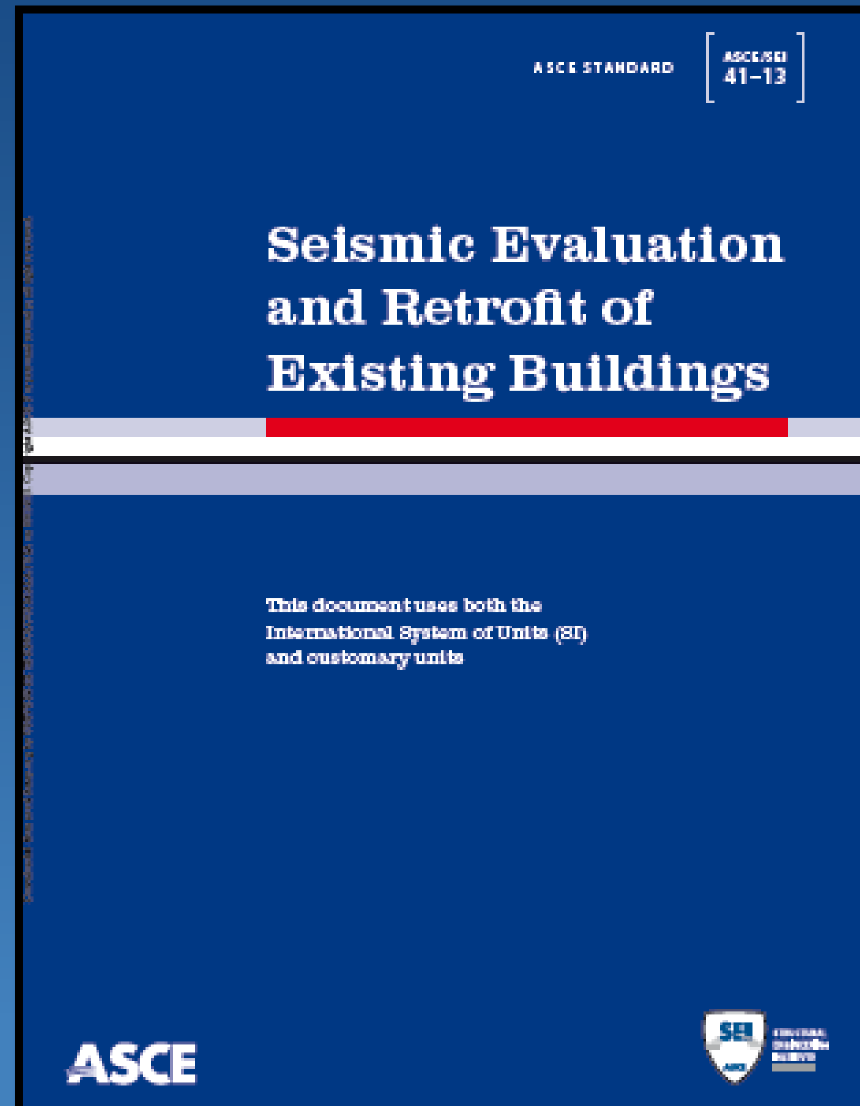
Proposed Methodology

- Data Collection
  - Soil investigation (8 boreholes, 10 M.Probe)
  - As-built/remeasured drawing
- Evaluation
  - Rapid Visual Screening (FEMA 154)
  - Evaluating Seismic Resisting Capacity (ASCE43-12)
  - Detailed Dynamic Analysis
- Demand/Capacity Analysis (DCA) and Fragility Evaluation
- Proposed Retrofitting on Some Critical Building as Identified



Rapid Visual Screening (FEMA 154)

ASCE 41-13 (Formerly FEMA 310)



FEMA 154: DATA COLLECTION FORM

RAPID VISUAL SCREENING OF BUILDINGS FOR POTENTIAL SEISMIC HAZARDS HANDBOOK (FEMA 154, EDITION 2 / MARCH 2002)

Form divided into 3 categories:

a) Low Seismicity (strong)
- < 0.167g (in horizontal direction)

b) Moderate Seismicity (very strong)
- ≥ 0.167g but less than 0.500g (in horizontal direction)

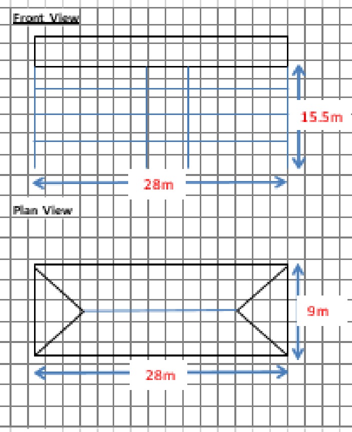
c) High Seismicity (severe)
- ≥ 0.500g (in horizontal direction)

TIER 1 : RAPID SCREENING PROCESS

FEMA-154 DATA COLLECTION FORM

Rapid Visual Screening of Buildings for Potential Seismic Hazards
FEMA-154 Data Collection Form

Seismicity Level: LOW



Scale:

Address : Flat Guru SK Kibabaig
89500 Penampang, Sabah

Postcode : 89500 Year Built:
Screener: Syarina Binti Badrulzaman
Floor Area: (5 Tingkat) 252 (m^2) Date: 27/1/2016
Building Name: Flat Guru SK Kibabaig
Use/Purpose: School
GPS Coordinate: N 05°55'02.416" E 116°06'33.063"

OCCUPANCY					SOIL TYPE						FALLING HAZARDS		
Assembly	Gov.	Office	Number of persons		A	B	C	D	E	F	Unreinforced	Parapet	Cladding
Commercial	Historic	Residential	0-10	11-100	Hard	Avg.	Dense	Stiff	Soft	Poor	Structures	Glass panels	
Emergency Serv.	Industrial	School	101-1000	1000+	Rock	Rock	Soil	Soil	Soil	Soil	Others:		

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	W1	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (MRF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM
Basic Score	7.4	6.0	4.6	4.8	4.6	4.8	5.0	4.4	4.8	4.4	4.4	4.6	4.8	4.6	4.6
Mid Rise (4 to 7 Stories)	N/A	N/A	+0.2	+0.4	N/A	+0.2	-0.2	+0.4	-0.2	-0.4	N/A	-0.2	-0.4	-0.2	-0.6
High Rise (> 7 Stories)	N/A	N/A	+1.0	+1.0	N/A	+1.0	+1.2	+1.0	0.0	-0.4	N/A	-0.2	N/A	0.0	N/A
Vertical Irregularity	-4.0	-3.0	-2.0	-2.0	N/A	-2.0	-2.0	-1.5	-2.0	-2.0	N/A	-1.5	-2.0	-1.5	-1.5
Plan Irregularity	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Pre-code	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Post Benchmark	0.0	+0.2	+0.4	+0.6	N/A	+0.6	N/A	+0.6	+0.4	N/A	+0.2	N/A	+0.2	+0.4	+0.4
Soil Type C	-0.4	-0.4	-0.8	-0.4	-0.4	-0.4	-0.4	-0.6	-0.4	-0.4	-0.4	-0.2	-0.4	-0.2	-0.4
Soil Type D	-1.0	-0.8	-1.4	-1.2	-1.0	-1.4	-0.8	-1.4	-0.8	-0.8	-0.8	-1.0	-0.8	-0.8	-0.8
Soil Type E	-1.8	-2.0	-2.0	-2.0	-2.0	-2.2	-2.0	-2.0	-2.0	-2.0	-1.8	-2.0	-1.4	-1.6	-1.4
FINAL SCORE, S										2.0					

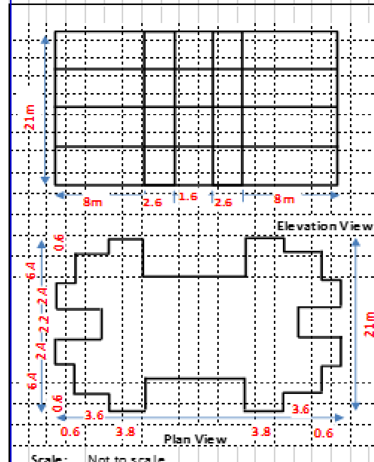
COMMENTS

Detailed Evaluation Required
YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know
BR = Braced frame
FD = Flexible diaphragm
LM = Light metal
MRF = Moment-resisting frame
RC = Reinforced concrete
RD = Rigid diaphragm
SW = Shear wall
TU = Tilt up
URM INF = Unreinforced masonry infill

Rapid Visual Screening of Buildings for Potential Seismic Hazards
FEMA-154 Data Collection Form

Seismicity Level: LOW



Scale: Not to scale

Address : Kuarters Ibu Pejabat Polis Daerah Kudat

Postcode : 89057 Year Built: 2002
Screener: Elya, Illyani, Syarina & JKR Kudat
Floor Area: 478.8 m^2 (sq.ft) Date: 23/2/2016
Building Name: Kuarters Ibu Pejabat Polis Daerah Kudat
Use/Purpose: Residential
GPS Coordinate: 6°54'23" N 116°50'32" E

OCCUPANCY					SOIL TYPE						FALLING HAZARDS		
Assembly	Gov.	Office	Number of persons		A	B	C	D	E	F	Unreinforced	Parapet	Claddings
Commercial	Historic	Residential	0-10	11-100	Hard	Avg.	Dense	Stiff	Soft	Poor	Structures	Glass panels	
Emergency Serv.	Industrial	School	101-1000	1000+	Rock	Rock	Soil	Soil	Soil	Soil	Others:		

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	W1	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (MRF)	C1 (MRF)	C2 (SW)	C3 (URMINF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM
Basic Score	7.4	6.0	4.6	4.8	4.6	4.8	5.0	4.4	4.8	4.4	4.4	4.6	4.8	4.6	4.6
Mid Rise (4 to 7 Stories)	N/A	N/A	+0.2	+0.4	N/A	+0.2	-0.2	+0.4	-0.2	-0.4	N/A	-0.2	-0.4	-0.2	-0.6
High Rise (> 7 Stories)	N/A	N/A	+1.0	+1.0	N/A	+1.0	+1.2	+1.0	0.0	-0.4	N/A	-0.2	N/A	0.0	N/A
Vertical Irregularity	-4.0	-3.0	-2.0	-2.0	N/A	-2.0	-2.0	-1.5	-2.0	-2.0	N/A	-1.5	-2.0	-1.5	-1.5
Plan Irregularity	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Pre-code	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Post Benchmark	0.0	+0.2	+0.4	+0.6	N/A	+0.6	N/A	+0.6	+0.4	N/A	+0.2	N/A	+0.2	+0.4	+0.4
Soil Type C	-0.4	-0.4	-0.8	-0.4	-0.4	-0.4	-0.4	-0.6	-0.4	-0.4	-0.4	-0.2	-0.4	-0.2	-0.4
Soil Type D	-1.0	-0.8	-1.4	-1.2	-1.0	-1.4	-0.8	-1.4	-0.8	-0.8	-0.8	-1.0	-0.8	-0.8	-0.8
Soil Type E	-1.8	-2.0	-2.0	-2.0	-2.0	-2.2	-2.0	-2.0	-2.0	-2.0	-1.8	-2.0	-1.4	-1.6	-1.4
FINAL SCORE, S										0					

COMMENTS

Soil type E was assumed on worse condition because of insufficient data to classify the soil type. Soil type to be confirmed with SI / Probe.

Detailed Evaluation Required
YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know
BR = Braced frame
FD = Flexible diaphragm
LM = Light metal
MRF = Moment-resisting frame
RC = Reinforced concrete
RD = Rigid diaphragm
SW = Shear wall
TU = Tilt up
URMINF = Unreinforced masonry infill

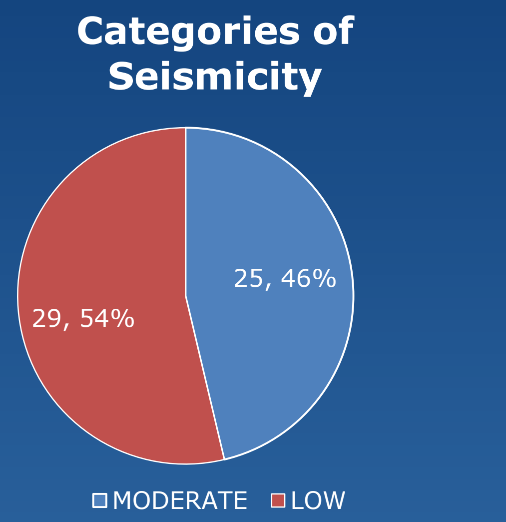
LIST OF FEDERAL & STATE BUILDINGS FOR 2 STORIES AND ABOVE FOR REGIONS IN SABAH;

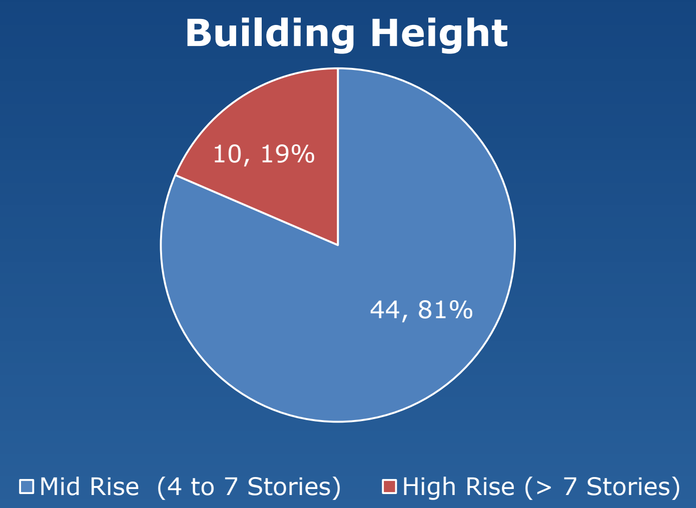
SUMMARY OF FINDINGS FROM FEMA-154 DATA COLLECTION FORM

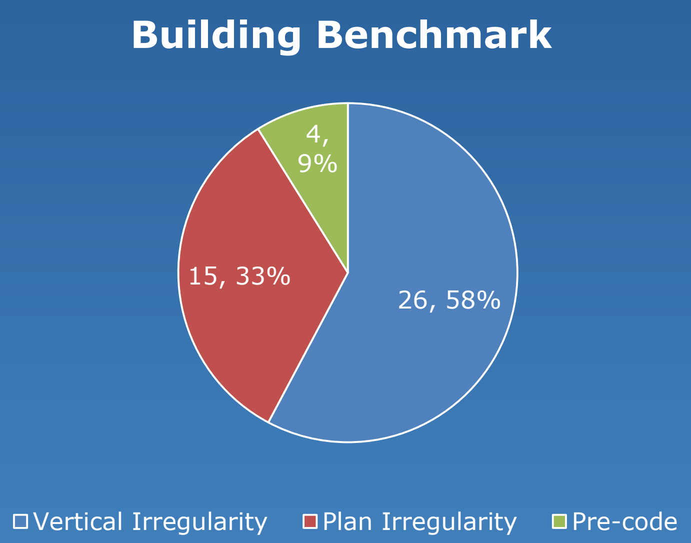
NO.	DAERAH	BANGUNAN PERSEKUTUAN	BANGUNAN NEGERI	BILANGAN BLOK BANGUNAN	BILANGAN TINGKAT	SEISMICITY	JENIS TANAH	BASIC SCORE	Mid Rise (4 to 7 Stories)	High Rise (> 7 Stories)	Vertical Irregularity	Plan Irregularity	Pre-code	Soil	SKOR AKHIR, S	LULUS/ TIDAK
1	KOTA KINABALU	i) Rumah Persekutuan Negeri Sabah - > 3 tingkat		3	8	LOW	D	4.4	-	-0.4	-	-	-	-0.8	3.2	√
			i) Kementerian Pembangunan Infrastruktur JKR Sabah		8	LOW	E	4.4	-	-0.4	-	-	-	-2.0	2.0	√
			ii) Dewan Undangan Negeri Sabah		4	LOW	D	4.4	-0.4	-	-2.0	-0.8	-	-0.8	0.4	x
2	PENAMPANG	i) Kuarters Bomba Penampang - 4 tingkat		3	4	LOW	D	4.4	-0.4	-	-2.0	-0.8	-	-0.8	0.4	x
		ii) Flat Guru SK Kibabaig - 4 tingkat			5	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
		iii) SMK Bahang, Penampang -2 BLOK			4	LOW	D	4.4	-0.4	-	-	-	-	-0.8	3.2	√
3	RANAU	i) Kompleks Kerajaan Persekutuan		4	4	MODERATE	D	3.2	0.2	-	-2.0	-0.5	-1.0	-1.0	-1.1	x
			i) Bangunan Asrama Pusat Latihan Islam Kundasang		2	MODERATE	D	3.2	-	-	-	-	-	-1.0	2.2	√
		ii) Bangunan Asrama SMK Mat Salleh - Asrama Perempuan			3	MODERATE	D	3.2	-	-	-	-0.5	-1.0	-1.0	0.7	x
		iii) Bangunan Asrama SMK Mat Salleh - Asrama Lelaki			4	MODERATE	D	3.2	0.2	-	-	-0.5	-1.0	-1.0	0.9	x
4	BEAUFORT	i) Kuarters Jabatan Bomba & Penyelamat Beaufort		2	5	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
			i) Pejabat Urusetia Beaufort (JKR8200)		3	LOW	D	4.4	-	-	-2.0	-0.8	-	-0.8	0.8	x
5	KUDAT	i) Federal Flat / Quarters 1 Blok (5 tingkat)		6	5	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
		ii) Kuarters Bomba & Penyelamat Kudat			5	LOW	D	4.4	-0.4	-	-	-0.8	-	-2.0	1.2	x
		iii) Menara Latihan Balai Bomba			5	LOW	E	4.4	-0.4	-	-	-	-	-2.0	2.0	√
		iv) Kuarters Ibu Pejabat Polis Kudat			4	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
		v) Bangunan Utama IPD Kudat			5	LOW	D	4.4	-0.4	-	-2.0	-0.8	-	-0.8	0.4	x
			i) Bangunan Urusetia - 2 Blok (4 tingkat)		4	LOW	D	4.4	-0.4	-	-	-	-	-0.8	3.2	√

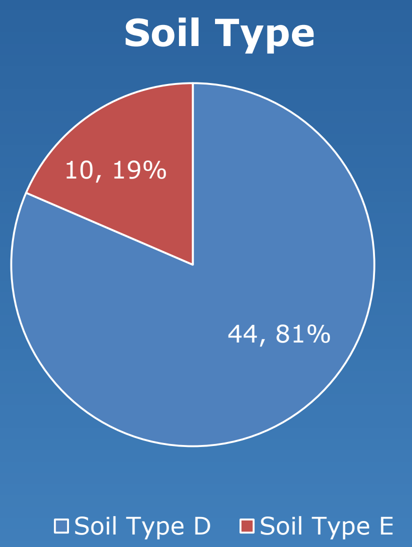
6	KOTA MARUDU	i) Berek Polis Kota Marudu		3	5	LOW	E	4.4	-0.4	-	-	-	-	-2.0	2.0	√
		ii) Menara Latihan Balai Bomba			5	LOW	D	4.4	-0.4	-	-	-	-	-0.8	3.2	√
		iii) Kuarters Bomba & Penyelamat Kota Marudu			5	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
7	KENINGAU		i) Bangunan Jabatan Tanah Dan Ukur	9	3	LOW	D	4.4	-	-	-	-	-	-0.8	3.6	√
		i) SMK Bingkor - Blok A & B			4	LOW	D	4.4	-0.4	-	-	-	-	-0.8	3.2	√
		ii) SMK Bingkor - Blok C			3	LOW	D	4.4	-	-	-	-0.8	-	-0.8	2.8	√
		iii) SMK Bingkor - Kuarters guru			5	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
		iv) Institut Pendidikan Guru Keningau - Blok Pentadbiran			3	LOW	D	4.4	-	-	-	-	-	-0.8	3.6	√
		v) Institut Pendidikan Guru Keningau - Blok C,B & D			5	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
		vi) Institut Pendidikan Guru Keningau - Flat A			5	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
		vii) Institut Pendidikan Guru Keningau - Kediaman Agatis			4	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
		viii) Institut Pendidikan Guru Keningau - Kuarters G & H			4	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
8	TAMBUNAN	i) Kuarters Balai Bomba - 4 blok		3	5	LOW	D	4.4	-0.4	-	-2.0	-0.8	-	-0.8	0.4	x
		ii) Menara Latihan Balai Bomba			5	LOW	D	4.4	0.4	-	-	-	-	-1.4	3.4	√
		ii) Berek Balai Polis Tambunan			5	LOW	D	4.4	-0.4	-	-2.0	-	-	-0.8	1.2	x
9	SANDAKAN		i) Perpustakaan Wilayah Sandakan	6	4	MODERATE	D	3.2	0.2	-	-2.0	-0.5	-	-1.0	-0.1	x
		i) Hospital Duchess of Kent - Bangunan Pakar/ Kecemasan 4 tingkat,			4	MODERATE	D	3.2	0.2	-	-2.0	-0.5	-	-1.0	-0.1	x
		ii) Hospital Duchess of Kent - ICU Operation Room, etc.			5	MODERATE	D	3.2	0.2	-	-	-0.5	-	-1.0	1.9	x
		iii) Kolej Kejururawatan -Asrama 4 tingkat			4	MODERATE	E	3.2	0.2	-	-	-	-	-1.6	1.8	x
		iv) UMS Sandakan			4	MODERATE	D	3.2	-	-	-	-	-	-1.0	2.2	√
		v) Wisma Kastam - Pejabat Pentadbiran 4 tingkat			4	MODERATE	D	3.2	0.2	-	-2.0	-0.5	-	-1.0	-0.1	x
10	SEMPORNA	i) Jabatan Penerangan		6	2	MODERATE	D	3.2	-	-	-	-	-	-1.0	2.2	√
		ii) Hospital Semporna			3	MODERATE	D	3.2	0.2	-	-2.0	-0.5	-	-1.0	-0.1	x
		iii) Kuarters Pejabat Kesihatan Semporna			5	MODERATE	D	3.2	0.2	-	-	-	-	-1.0	2.4	√
		iv) SMK Datuk Panglima Abdullah - Kuarters			5	MODERATE	D	3.2	0.2	-	-2.0	-	-	-1.0	0.4	x
		v) SMK Datuk Panglima Abdullah - Elevated Water Tank			6	MODERATE	D	3.6	0.4	-	-	-	-	-1.2	2.8	√
		vi) Kuarters Kompleks TLDM			5	MODERATE	E	3.2	0.2	-	-	-	-	-1.6	1.8	x
11	TAWAU	i) Wisma Persekutuan		3	8	MODERATE	E	3.2	-	0.4	-	-	-	-1.6	2.0	√
		ii) Hospital Tawau - Kolej Jururawat			4	MODERATE	D	3.2	0.2	-	-	-	-	-1	2.4	√
		iii) Hospital Tawau			6	MODERATE	D	3.2	0.2	-	-2.0	-0.5	-	-1.0	-0.1	x
12	LAHAD DATU		i) Kuarters Kerajaan Negeri - 4 tingkat.	6	4	MODERATE	E	3.2	0.2	-	-	-	-	-1.6	1.8	x
		i) Kuarters Balai Polis Lahad Datu - 6 tingkat.			6	MODERATE	E	3.2	0.2	-	-2.0	-	-	-1.6	-0.2	x
		ii) Hospital Lahad Datu - 5 tingkat.			5	MODERATE	D	3.2	0.2	-	-	-	-	-1.0	2.4	√
		iii) Kuarters B, Hospital Lahad Datu - 5 tingkat.			5	MODERATE	D	3.2	0.2	-	-2.0	-	-	-1	0.4	x
		iv) Kolej Vokasional Lahad Datu - 3 tingkat.			3	MODERATE	E	3.2	-	-	-	-	-	-1.6	1.6	x
		v) Kuarters Kolej Vokasional Lahad Datu - 5 tingkat.			5	MODERATE		3.2	0.2	-	-2.0	-	-	-1.6	-0.2	x

SUMMARY OF FINDINGS CONTINUE…









DETERMINING THE FINAL SCORE

S Score of 2 is suggested as "cut off" based on present seismic design criteria.

Interpretation of RVS Score

Estimates of the score are based on limited observed and analytical data, and the probability of collapse. For example,

A final score of S = 3 implies there is a chance of 1 in 10^3, or 1 in 1000, that the building will collapse if such ground motions occur.

A final score of S =2 implies there is a chance of 1 in 10^2, or 1 in 100.

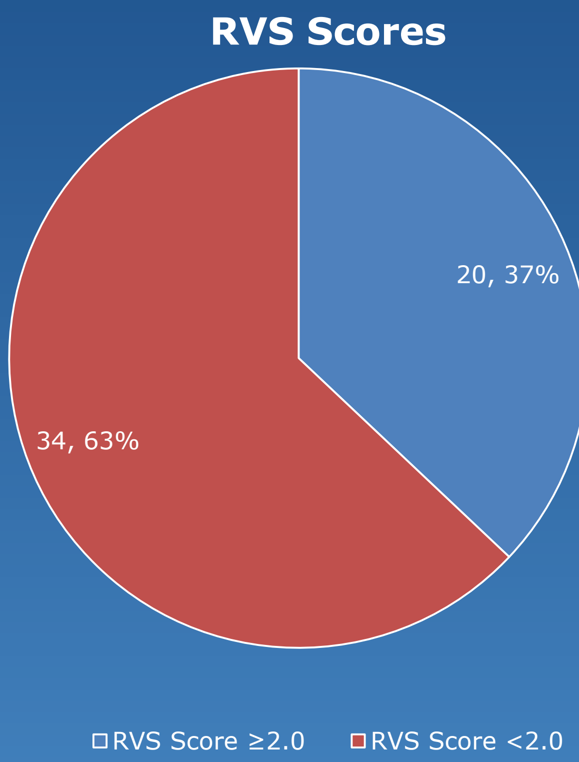
Note:

-Use of a higher cut-off S value implies greater desired safety but increased community-wide costs for evaluations and rehabilitation.

SUMMARY OF FINDINGS

Total buildings for rapid screening process (FEMA-154) = 54

Nos of building having RVS Score ≥2.0 : 20
Nos of building having RVS Score <2.0 : 34 (to proceed with Tier 1 analysis using ASCE checklist)



Category of building :

i. School
ii. Hospital
iii. Quarters

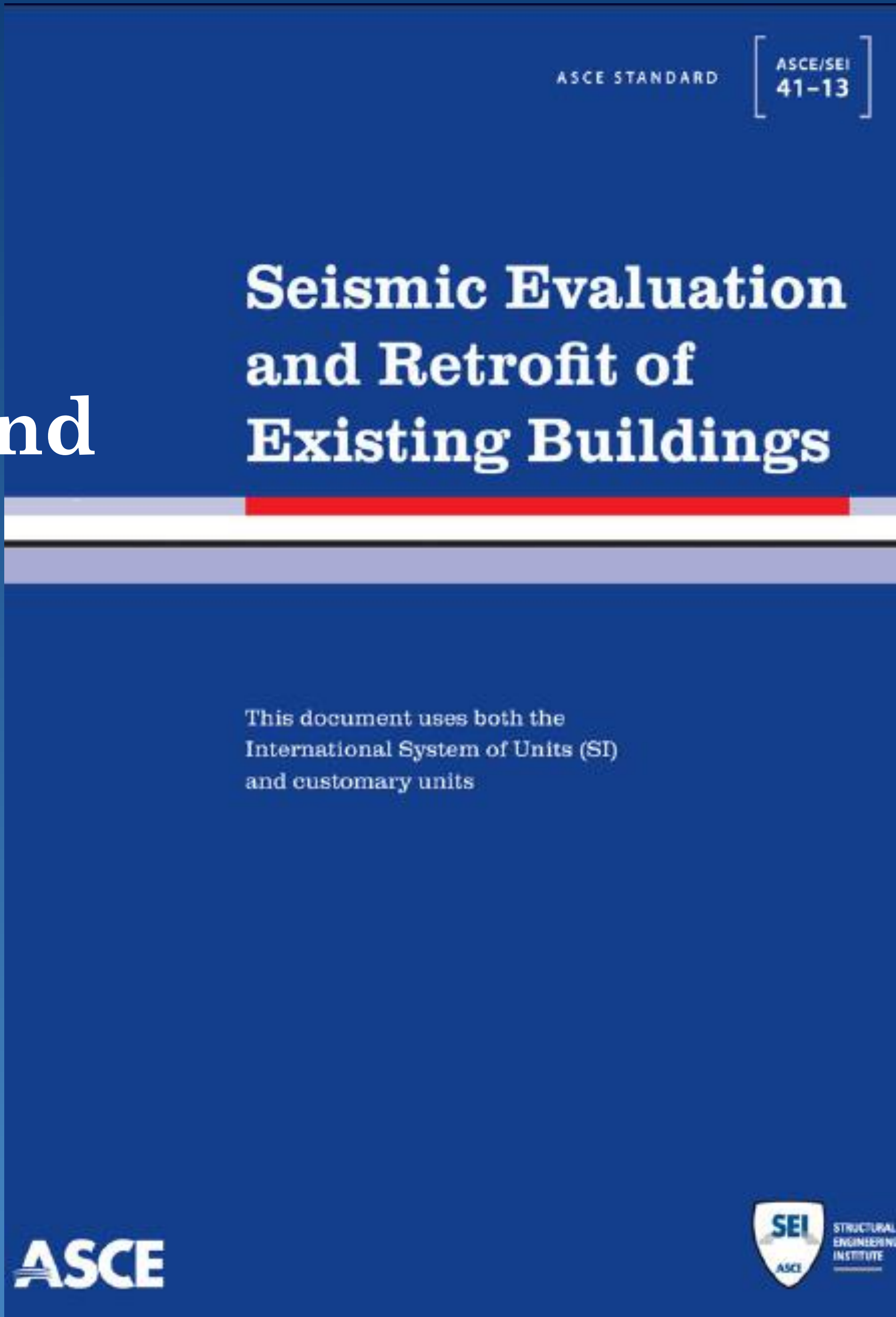
Tier 1 : Screening process using ASCE Checklist

Vertical Irregularity

Soft Story

ASCE 41-13

Seismic Evaluation and Retrofit of Existing Buildings



TIER 1 ANALYSIS

SCOPE OF WORKS

- Preparing computer models to represent the building main frames according to the structural drawings and material properties.
- Applying the earthquake loads statically combined with the dead and life loads to estimate the structural adequacy of the structure.
- Implementing response spectrum analysis to study the performance of the building dynamically.
- Analysing non-linear model by applying a series of seismic loadings to determine the failure mechanism and to determine the critical components for retrofitting purpose.
- Develop demand-capacity curve for buildings. Evaluation of the capacity curve by any suitable nonlinear analysis software for the investigated buildings are to be derived in term of acceleration capacity, performance points and expected damage of building.
- Develop fragility curve for buildings. The capacity spectrum parameters obtained from above analysis is then used in fragility evaluation for the development of fragility curves.

Basic Performance Objective for Existing Buildings (BPOE)

BPOE- The Basic Performance Objective for Existing Buildings is a specified performance objective that varies with Risk Category (Ref. Table 2.1)

BSE - Basic Safety Earthquake for use with the Basic Performance Objective for <u>Existing</u> Buildings.

Structural Performance Levels and Ranges

- (S-1)- Immediate Occupancy Structural Performance Level
- (S-2)- Damage Control Structural Performance Level
- (S-3)- Life Safety Structural Performance Level
- (S-4)- Limited Safety Structural Performance Level
- (S-5)- Collapse Prevention Structural Performance Level
- (S-6)- Structural Performance Not Considered

- is defined as the post-earthquake damage state in which a structure remains safe to occupy and essentially retains its pre-earthquake strength and stiffness. A structure in compliance with the acceptance criteria of this standard for Immediate Occupancy is expected to achieve this post-earthquake state.
- is defined as the post-earthquake damage state in which a structure has damaged components but retains a margin against the onset of partial or total collapse. A structure in compliance with acceptance criteria specified in this standard for this Structural Performance Level is expected to achieve this state.

Performance Objectives

Table C2-1. Probabililty of Exceedance and Mean Return Period

Probability of Exceedance	Mean Return Period (years)
50%/30 years	43
50%/50 years	72
20%/50 years	225
10%/50 years	475
5%/50 years	975
2%/50 years	2,475

Table C2-2. Performance Objectives

Target Building Performance Levels				
Seismic Hazard Level	Operational Performance Level (1-A)	Immediate Occupancy Performance Level (1-B)	Life Safety Performance Level (3-C) Collapse	Prevention Performance Level (5-D)
50%/50 yrs	a	b	c	d
BSE-1E (20%/50yr)	e	f	g	h
BSE-2E (5%/50yr)	i	j	k	l
BSE-2N (ASCE 7 MCER)	m	n	o	p

Table 2-1. Basic Performance Objective for Existing Buildings (BPOE)

	Tier 1a	Tier 2a	Tier 3	
Risk Category	**BSE-1E**	**BSE-1E**	**BSE-1E**	**BSE-2E**
I & II	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Collapse Prevention Structural Performance Nonstructural Performance Not Considered (5-D)
III	Structural Performance Position Retention Nonstructural Performance (2-B)	Structural Performance Position Retention Nonstructural Performance (2-B)	Structural Performance Position Retention Nonstructural Performance (2-B)	Limited Safety Structural Performance Nonstructural Performance Not Considered (4-D)
IV	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)	Life Safety Structural Performance Nonstructural Performance Not Considered (3-D)
I & II	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Collapse Prevention Structural Performance Nonstructural Performance Not Considered (5-D)

Proposed Tier 1 Screening

Basic Checklist
- LS- Life Safety
- IO- Immediate Occupancy

16.1 Basic Checklist .
16.1.2 LS Life Safety Basic Configuration Checklist
16.1.2 IO Immediate Occupancy Basic Configuration Checklist

No.	Code	Building Types
1.	C1	Concrete Moment Frames
2.	C2 C2a	Concrete Shear Walls with Stiff Diaphragms Concrete Shear Walls with Flexible Diaphragms
3.	C3 C3a	Concrete Frames with Infill Masonry Shear Walls and Concrete Frames with Infill Masonry Shear Walls and Flexible Diaphragms
4.	PC1 PC1a	Precast or Tilt-Up Concrete Shear Walls with Flexible Diaphragms and Precast or Tilt-Up Concrete Shear Walls with Stiff Diaphragms
5.	PC2	Precast Concrete Frames With Shear walls
6.	PC2a	Precast Concrete Frames without Shear Walls

Level of Seismicity - SDs,SD1

Table 2-5. Level of Seismicity Definitions

Level of Seismicity	***SDS***	***SD1***
Very low	< 0.167 g	< 0.067 g
Low	≥ 0.167 g < 0.33 g	≥ 0.067 g < 0.133 g
Moderate	≥ 0.33 g < 0.50 g	≥ 0.133 g < 0.20 g
High	≥ 0.50g	≥ 0.20 g

**The higher level of seismicity defined by SDS or SD1 shall govern*

$$SDS = 2/3\ F_a S_S$$

$$SD1 = 2/3\ F_v S_1$$

Where:

S_s=response spectrum ordinates for short (0.2 s) and
S_1=long (1 s) periods, in the direction of maximum horizontal response.

Site Classes

1. **Site Class A:** Hard rock with average shear wave velocity,

   v_s > 5,000 ft/s ;

2. **Site Class B:** Rock with 2,500 ft/s < v_s <5,000 ft/s ;

3. **Site Class C:** Very dense soil and soft rock with 1,200 ft/s<v_s≤2,500 ft/s or with either standard blow count N > 50 or undrained shear strength s_u > 2,000 lb/ft^2 ;

4. **Site Class D:** Stiff soil with 600 ft/s<v_s≤1,200 ft/s or with 15<N≤50 or 1,000 lb/ft^2≤s_u<2,000 lb/ft^2 ;

5. **Site Class E:** Any profile with more than 10 ft of soft clay defined as soil with plasticity index PI > 20, or water content w > 40%, and s_u < 500 lb/ft^2 or a soil profile with v_s < 600 ft/s ; and

6. **Site Class F:** Soils requiring site-specific evaluations:

   A. Soils vulnerable to potential failure or collapse under seismic loading, such as liquefiable soils, quick and highly sensitive clays, or collapsible weakly cemented soils;

   B. Peats or highly organic clays (H > 10 ft of peat or highly organic clay, where H = thickness of soil);

   C. Very high plasticity clays (H > 25 ft with PI > 75); or

   D. Very thick soft or medium-stiff clays (H > 120ft).

TIER 1 : SCREENING PROCESS (ASCE Checklist)

- COMPLETE THE BASIC CONFIGURATION CHECKLIST (Quick Check)
  - LIFE SAFETY (LS)
  - IMMEDIATE OCCUPANCY (IO)

- COMPLETE THE BUILDING SYSTEM STRUCTURAL CHECKLIST (Quick Check) FOR TYPES C3
  - LIFE SAFETY (LS)
  - IMMEDIATE OCCUPANCY (IO)

Note:
✓ School & Hospital need to proceed both LS & IO

Project: Flat Guru SK Kibabaig Location: Penampang
Completed by: ________ Date: ________

TIER 1 CHECKLISTS

16.1 BASIC CHECKLIST
Very Low Seismicity
Structural Components

C NC N/A U LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)

C NC N/A U WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel … dowels, or straps that are developed into the diaphragm. Connections shall have a… resist the connection force calculated in the Quick Check procedure of Section 4.5… Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)

Project: ________ Location: ________
Completed by: ________ Date: ________

16.1.2LS LIFE SAFETY BASIC CONFIGURATION CHECKLIST
Low Seismicity
Building System

General

C NC N/A U LOAD PATH: The structure shall contain a complete, well defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)

C NC N/A U ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 4% of the height of the shorter building. This statement shall not apply for the following building types: W1, W1a, and W2. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)

C NC N/A U MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)

Building Configuration

C NC N/A U WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1)

C NC N/A U SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)

C NC N/A U VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)

C NC N/A U GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)

C NC N/A U MASS: There is no change in effective mass more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)

C NC N/A U TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)

Moderate Seismicity: Complete the Following Items in Addition to the Items for Low Seismicity.
Geologic Site Hazards

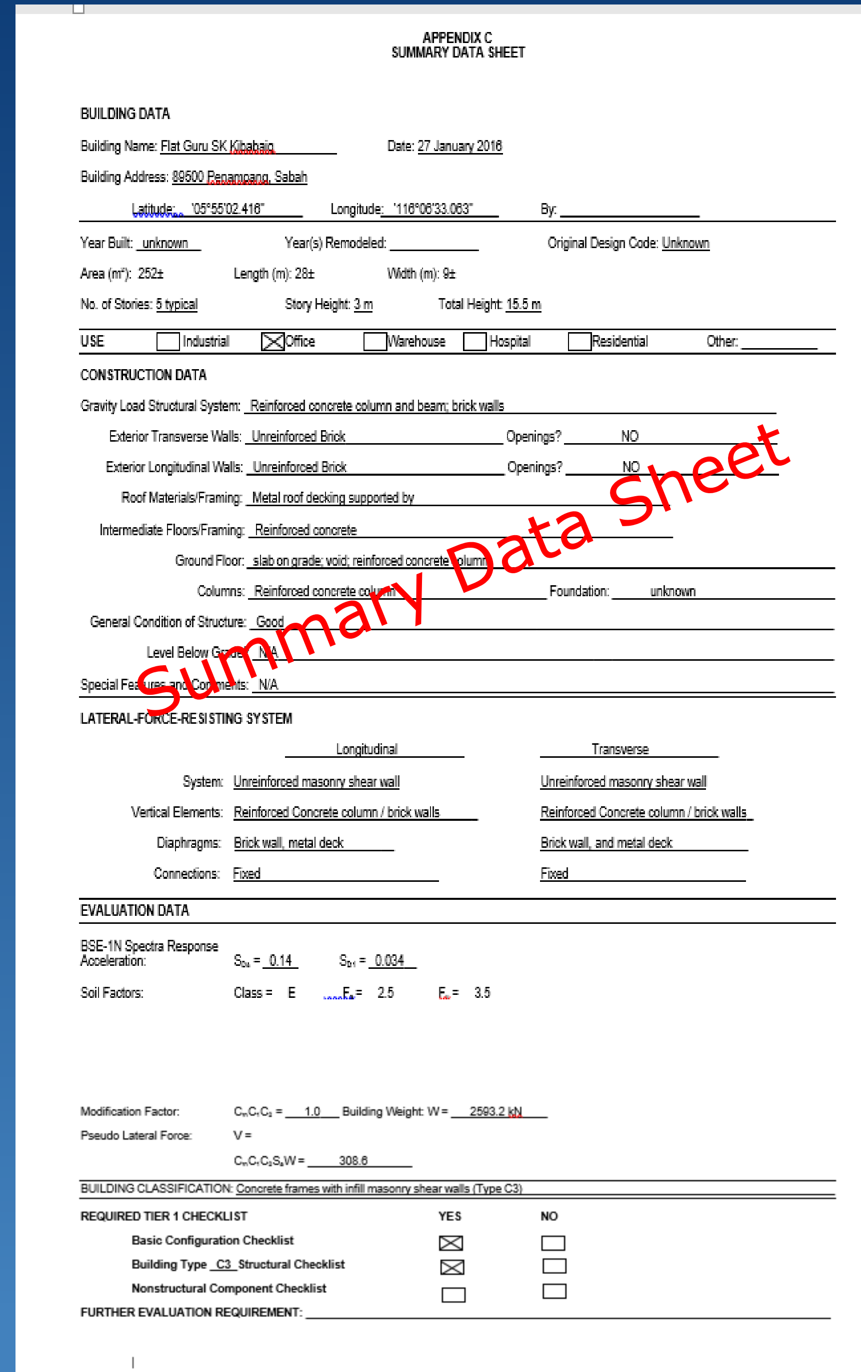
C NC N/A U LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building 's seismic performance shall not exist in the foundation soils at depths within 50 ft under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1)

C NC N/A U SLOPE FAILURE: The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1)

C NC N/A U SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not

TIER 1 : SCREENING PROCESS

- From ASCE Checklist & Summary Data Sheet will give a conclusion which building need to proceed with Dynamic Analysis



APPENDIX C
SUMMARY DATA SHEET

BUILDING DATA

Building Name: Flat Guru SK Kibabaig   Date: 27 January 2016

Building Address: 89500 Penampang, Sabah

Latitude: 05°55'02.416"   Longitude: 116°06'33.063"   By: ______

Year Built: unknown   Year(s) Remodeled: ______   Original Design Code: Unknown

Area (m^2): 252±   Length (m): 28±   Width (m): 9±

No. of Stories: 5 typical   Story Height: 3 m   Total Height: 15.5 m

USE: ☐ Industrial ☒ Office ☐ Warehouse ☐ Hospital ☐ Residential   Other: ______

CONSTRUCTION DATA

Gravity Load Structural System: Reinforced concrete column and beam; brick walls

Exterior Transverse Walls: Unreinforced Brick   Openings? NO

Exterior Longitudinal Walls: Unreinforced Brick   Openings? NO

Roof Materials/Framing: Metal roof decking supported by

Intermediate Floors/Framing: Reinforced concrete

Ground Floor: slab on grade; void; reinforced concrete column

Columns: Reinforced concrete column   Foundation: unknown

General Condition of Structure: Good

Level Below Grade: N/A

Special Features and Comments: N/A

LATERAL-FORCE-RESISTING SYSTEM

	Longitudinal	Transverse
System:	Unreinforced masonry shear wall	Unreinforced masonry shear wall
Vertical Elements:	Reinforced Concrete column / brick walls	Reinforced Concrete column / brick walls
Diaphragms:	Brick wall, metal deck	Brick wall, and metal deck
Connections:	Fixed	Fixed

EVALUATION DATA

BSE-1N Spectra Response Acceleration: S_{DS} = 0.14 S_{D1} = 0.034

Soil Factors: Class = E F_a = 2.5 F_v = 3.5

Modification Factor: $C_mC_1C_2$ = 1.0   Building Weight: W = 2593.2 kN

Pseudo Lateral Force: V =

$C_mC_1C_2S_aW$ = 308.6

BUILDING CLASSIFICATION: Concrete frames with infill masonry shear walls (Type C3)

REQUIRED TIER 1 CHECKLIST	YES	NO
Basic Configuration Checklist	☒	☐
Building Type C3 Structural Checklist	☒	☐
Nonstructural Component Checklist	☐	☐

FURTHER EVALUATION REQUIREMENT: ______

APPENDIX C
SUMMARY DATA SHEET

BUILDING DATA

Building Name: ______________________ Date: __________

Building Address: ______________________

Latitude: __________ Longitude: __________ By: __________

Year Built: __________ Year(s) Remodeled: __________ Original Design Code: __________

Area (sf): __________ Length (ft): __________ Width (ft): __________

No. of Stories: __________ Story Height: __________ Total Height: __________

USE ☐ Industrial ☐ Office ☐ Warehouse ☐ Hospital ☐ Residential ☐ Educational ☐ Other: __________

CONSTRUCTION DATA

Gravity Load Structural System: ______________________

Exterior Transverse Walls: ______________________ Openings? __________

Exterior Longitudinal Walls: ______________________ Openings? __________

Roof Materials/Framing: ______________________

Intermediate Floors/Framing: ______________________

Ground Floor: ______________________

Columns: ______________________ Foundation: __________

General Condition of Structure: ______________________

Levels Below Grade? ______________________

Special Features and Comments: ______________________

LATERAL-FORCE-RESISTING SYSTEM

	Longitudinal	Transverse
System:		
Vertical Elements:		
Diaphragms:		
Connections:		

EVALUATION DATA

BSE-1N Spectral Response Accelerations: S_{Ds} = __________ S_{D1} = __________

Soil Factors: Class = __________ F_a = __________ F_v = __________

BSE-1E Spectral Response Accelerations: S_{XS} = __________ S_{X1} = __________

Level of Seismicity: __________ Performance Level: __________

Building Period: T = __________

Spectral Acceleration: S_a = __________

Modification Factor: $C_m C_1 C_2$ = __________ Building Weight: W = __________

Pseudo Lateral Force: V= $C_m C_1 C_2 S_a W$= __________

BUILDING CLASSIFICATION: ______________________

REQUIRED TIER 1 CHECKLISTS	**Yes**	**No**
Basic Configuration Checklist	☐	☐
Building Type _____ Structural Checklist	☐	☐
Nonstructural Component Checklist	☐	☐

FURTHER EVALUATION REQUIREMENT: ______________________

Project: ______________________________________ Location: ______________________________________

Completed by: _________________________________ Date: ____

TIER 1 CHECKLISTS

16.1 BASIC CHECKLIST

Very Low Seismicity

Structural Components

C NC N/A U LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)

C NC N/A U WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)

16.1.2LS LIFE SAFETY BASIC CONFIGURATION CHECKLIST

Low Seismicity

Building System

General

C NC N/A U LOAD PATH: The structure shall contain a complete, well defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)

C NC N/A U ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 4% of the height of the shorter building. This statement shall not apply for the following building types: W1, W1a, and W2. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)

C NC N/A U MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)

Building Configuration

C NC N/A U WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1)

C NC N/A U SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)

C NC N/A U VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)

C NC N/A U GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)

C NC N/A U MASS: There is no change in effective mass more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)

C NC N/A U TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)

Moderate Seismicity: Complete the Following Items in Addition to the Items for Low Seismicity.

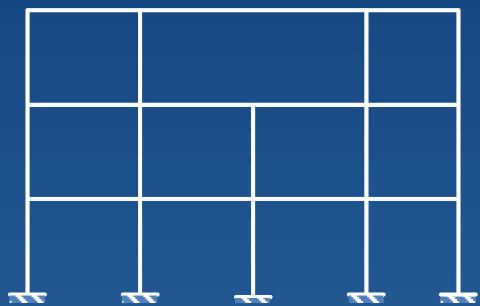
Geologic Site Hazards

C NC N/A U LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 ft under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1)

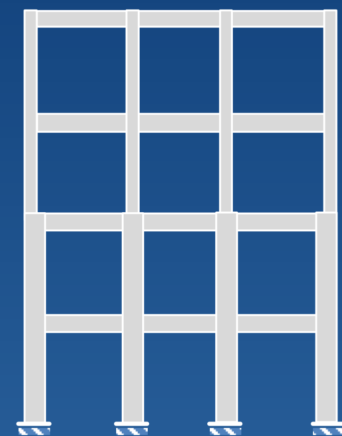
C NC N/A U SLOPE FAILURE: The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1)

C NC N/A U SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1)

WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above.



Reduced number of columns at upper floors

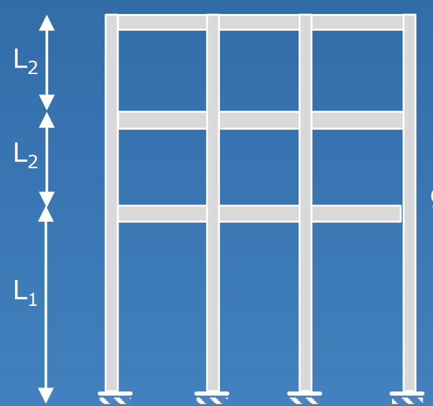


Reduction of column sizes at upper floors

Assuming all columns having same concrete strength, generally can be calculated by

$$\frac{\sum A_{col}\,Upper\ floor}{\sum A_{col}\,Lower\ floor}\text{x}100\%$$

SOFT STORY: The stiffness of the seismic-force resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above.

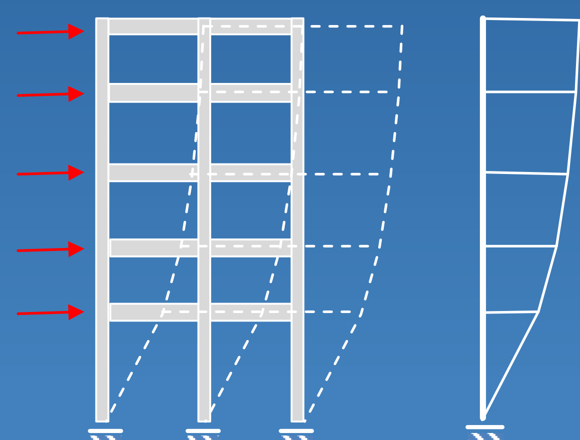


$L_1 > L_2$

Assuming all columns having same concrete strength, generally can be calculated by

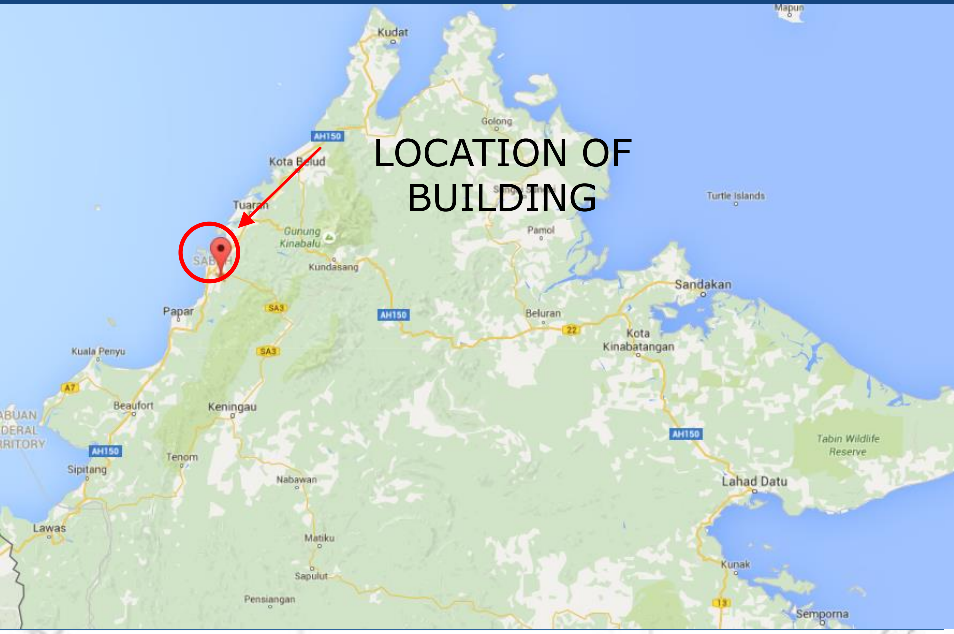
$$\frac{\sum \frac{EI}{L}\,Upper\ Floor}{\sum \frac{EI}{L}\,Lower\ floor}\text{x}100\%$$

Or by examination of story drift if detail analysis are available



EXAMPLE OF BUILDING :
FLAT GURU SK KIBABAIG PENAMPANG SABAH.

LOCATION OF BUILDING & MICROZONING MAP

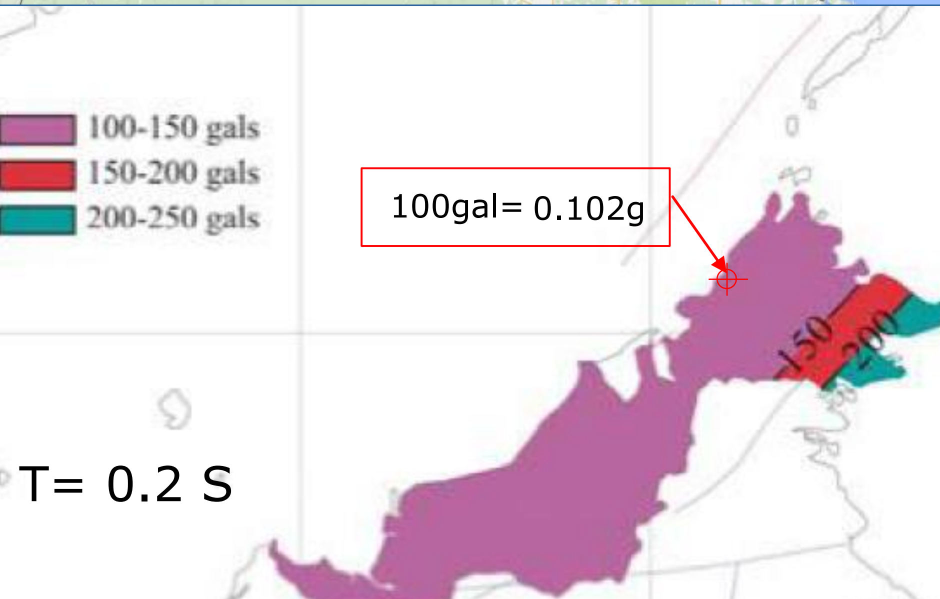


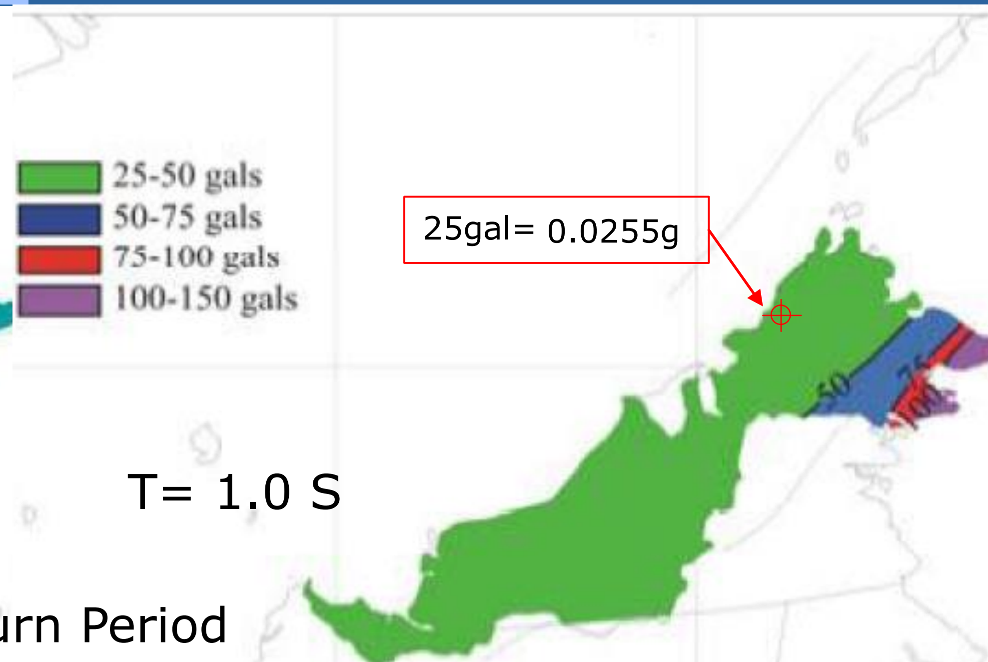
Common units of acceleration
-Standard gravity, g
-Gal or cm/s²

Conversions

Base value	m/s²	Gal
1 g	9.80665	980.665

Base value	m/s²	Standard gravity, g
1 Gal, or cm/s²	≈0.0102	0.00101972



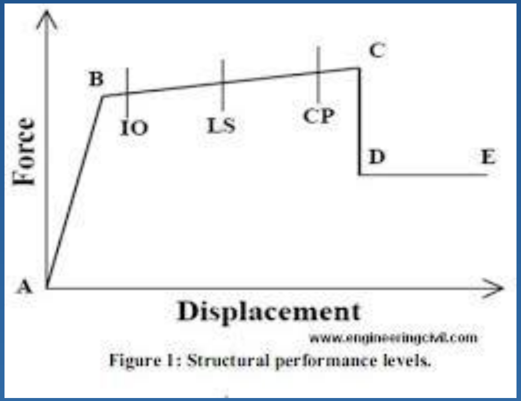


Microzoning Map For 500 years Return Period

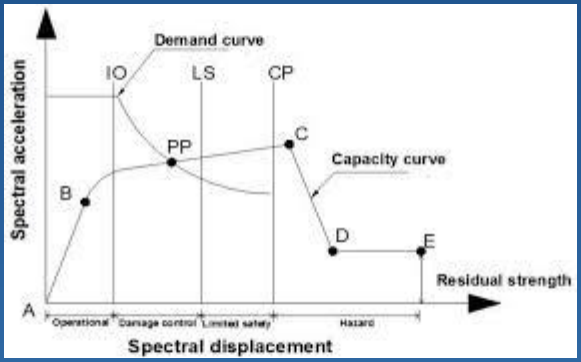
Demand-Capacity Analysis

- Demand Curves based on
  - Response Spectra – based on Akedemi Sains Malaysia Study 2007
  - Response Spectra based on recent study between UTM-MOSTI 2015
  - Response Spectra based on draft NA MS EN 1998
- Capacity Curves are calculated using Pushover Analysis (Non-linear Static)

Demand-Capacity Analysis

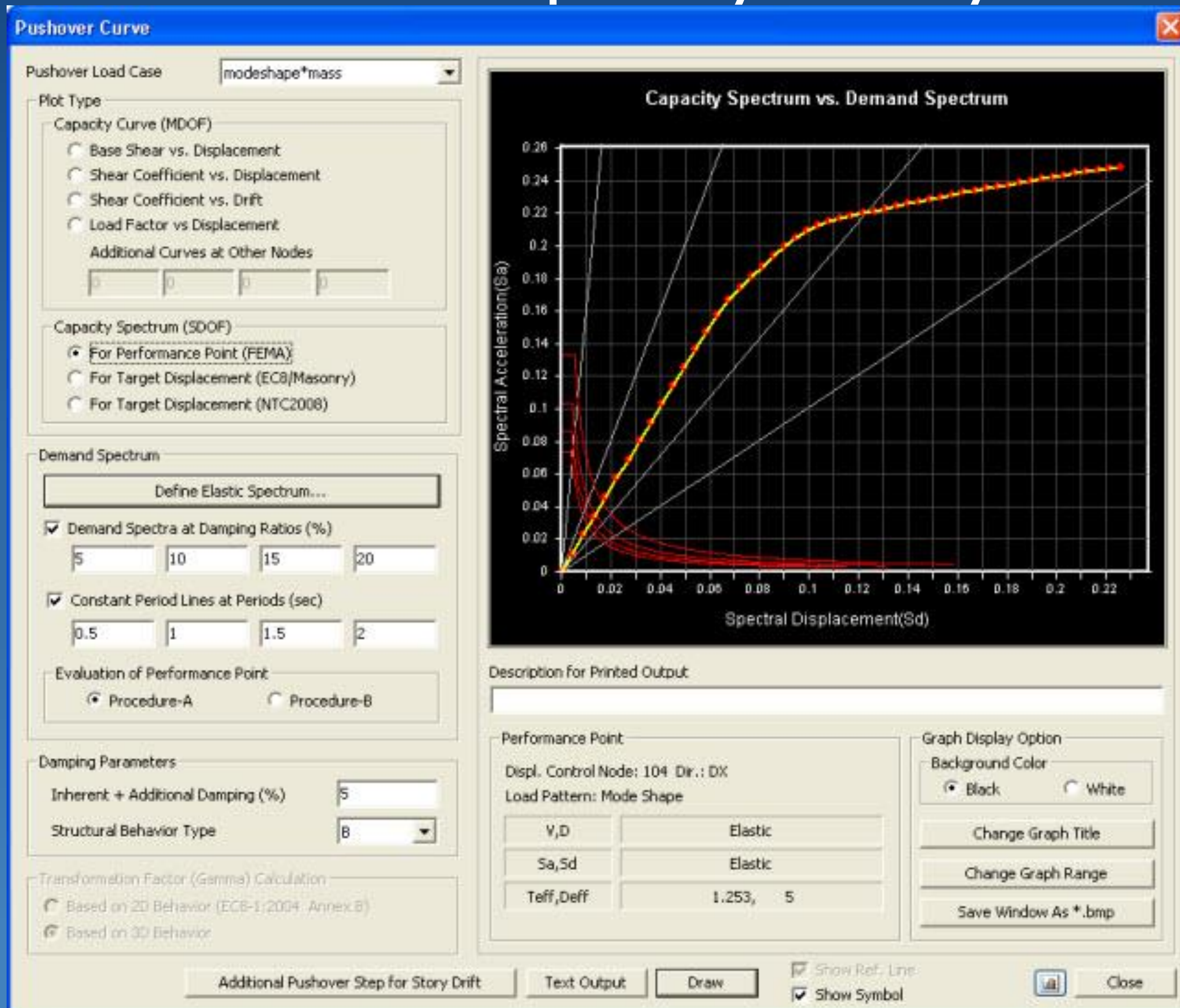


Capacity Curve by Pushover Analysis
IO- Immediate Occupancy
LS- Life Safety
CP- Collapse Prevention



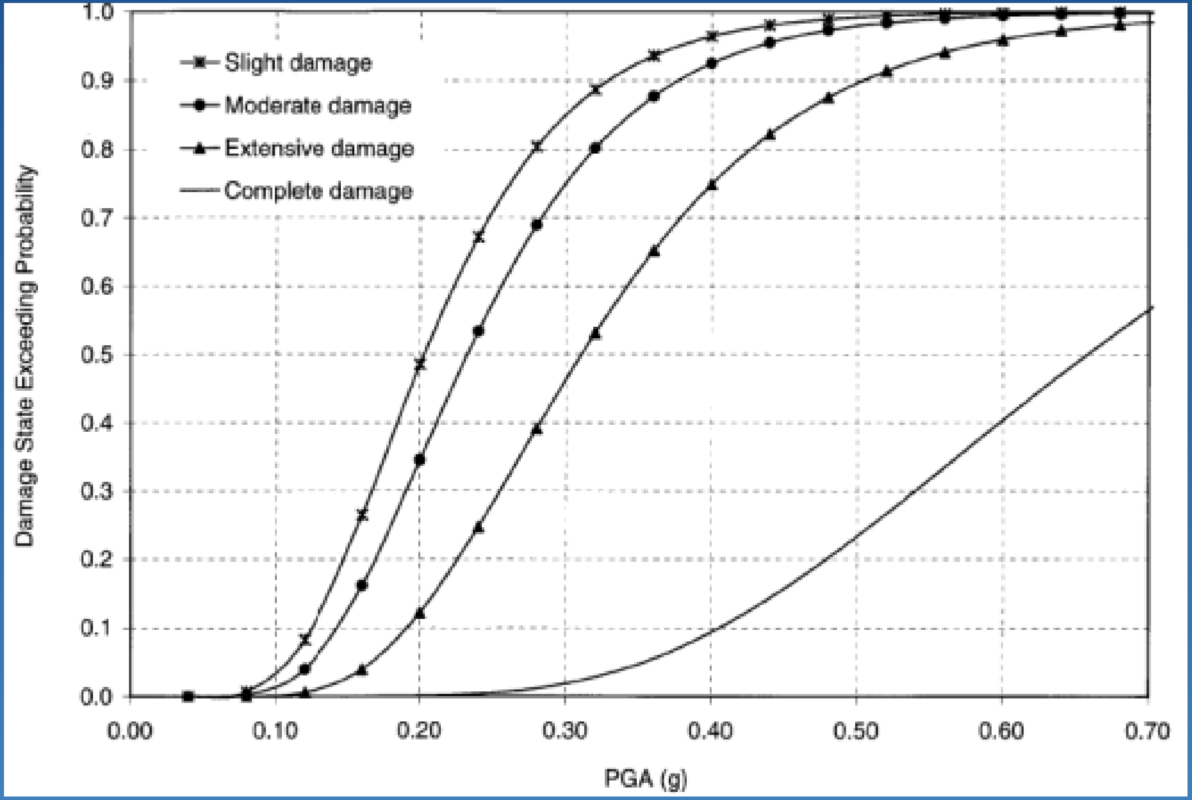
Capacity and Demand Curve

Demand-Capacity Analysis



Develop Fragility Curves

- To determine the probability of failure of a structure



Future Developement

- JKR will also be actively involve with the remaining parts of MS EN 1998. Namely the National Annex for the MS EN 1998 Part 3 – Assessment and Retrofitting of Buildings.
- Looking into easier and faster assessment of standard buildings based on future studies based on fragility curves.
- Looking into retrofitting engineering.

Concluding Remarks

- What is Structural Engineer?
- What is Software Operator?

- Di manakah saya berada?

Product of a software operator!!!

Terima kasih