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Indonesian Architecture and Planning

“Inclusive Space, Enriching Culture”

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Faculty of Engineering, Gadjah Mada University.



3rd Biennale

ICIAP

International Conference on Indonesian Architecture and Planning

Inclusive Space, Enriching Culture

Yogyakarta, Indonesia

August 11-12, 2016

**The 3rd BIENNALE INTERNATIONAL CONFERENCE ON
INDONESIAN ARCHITECTURE AND PLANNING**

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Organizing Committee

East Wing Building Department of Architecture and Planning

Jalan Grafika No.2 Kampus UGM Yogyakarta 55281 INDONESIA

Phone : +62 274 580092

Fax : +62 274 580583

Email : iciap-ugm@archiplan.ugm.ac.id

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International Conference on Indonesian Architecture and Planning

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FOREWORD

It is with deep satisfaction that I write this Foreword to the Proceedings of the 3rd Biennale ICIAP 2016 (International Conference on Indonesian Architecture and Planning), held in Yogyakarta, Indonesia, 11-12 August 2016.

The high quality of the papers represent the thinking and experience of men and women experts in their particular fields. Their contributions helped to make the Conference as very important scientific event as it has been. The papers contributed the most recent scientific knowledge known in the field of Indonesian architecture and planning. I trust that this will be an impetus to stimulate further study and research in this area.

Thanks to the hard work in preparation and publicity on the part of the organizing committee, we have received over 100 submissions from Indonesia and other countries, such as Japan, India, Austria, and Australia. Manuscripts selected for presentation and publication in the ICIAP 2016 are subjected to a blind review by ICIAP Reviewer Board with the expertise in the field of architecture and planning. As readers may discover, the submissions covers wide array of architecture and planning subjects, in conjunction with the theme of ICIAP 2016, “Inclusive Space, Enriching Culture”. I believe that this Proceedings will provide and stimulate further study and research in Indonesian architecture and planning.

Finally, I would like to take this opportunity to say my gratitude to all reviewers, as well as great numbers of staffs, faculties, and student volunteers at the Department of Architecture and Planning, Faculty of Engineering, Universitas Gadjah Mada – Indonesia, for the invaluable efforts, continuous assistance and support.

Dr. Ir. Ahmad Sarwadi, M.Eng
Head of Department Architecture and Planning, Faculty of Engineering,
Universitas Gadjah Mada

INTRODUCTION

This third International Conference on Indonesia Architecture and Planning (ICIAP) is part of a biennale international program at the Department of Architecture and Planning, Faculty of Engineering, Universitas Gadjah Mada. With the focus on the field of architecture and planning subject/discourse in Indonesia, the conference is expected to be able to capture ideas, concepts, methods, or practices that evolve continuously in this field.

We have had two Conferences before, the first ICIAP in 2012 was bringing the theme of "Better Space Better Living", while the second ICIAP in 2014 with theme "Space for The Next Generation". After the successful biennale holds in 2012 and 2014, ICIAP 2016 comes with the main theme of "Inclusive Space, Enriching Culture". Space is believed to be inclusive for all living beings and therefore, in designing and creating space, we need a holistic and dialectic understanding on how culture and pluralism shapes space. ICIAP 2016 aims at bringing together science, research, and practice of how to integrate inclusive idea and culture in Indonesian architecture and planning. It has a specific goal in finding the amalgamation of how to define, design, plan, and create an inclusive space for all, thus enriching the very diverse of Indonesian culture and heritage.

In this third ICIAP, the conference offers main plenary session, panel discussions, and excursion to various architectural and heritage sites. We also had the opportunity to invite ten keynote speakers coming from diverse cultural background that come to share their specialties and experience from broader multi-dimensional aspects of these issues. This year, we had received over 100 abstracts or full papers that have been submitted to the conference. After the screening process, there are 53 papers that have been reviewed and eligible to participate in this event. From various perspectives, these papers have been grouped in several contexts, such as design, urban, traditional and contemporary architecture, educational, socio-cultural, history-heritage, disaster resilient, and green environment contexts.

Finally on behalf of the organizing committee, I would like to thank everyone, especially all the faculties, staffs, students, as well as the study programs at the Department of Architecture and Planning Faculty of Engineering, Universitas Gadjah Mada for supporting our efforts in many ways and with positive participations. And also the members of the scientific and all organizing committee colleagues of the Conference for all the hard works and supports. We are also indebted to all of speakers who have dedicated time to share their invaluable knowledge in this forum and to the entire participants of ICIAP, from the authors, the presenters, as well as the observers who have been during two days conference gave a positive academic atmosphere through related discussions.

Syam Rachma Marcillia, S.T., M.Eng., PhD
Chairperson Organizing Committee of ICIAP 2016

CONTENTS

Foreword

Dr. Ir. Ahmad Sarwadi, M.Eng Head of Department Architecture and Planning, Faculty of Engineering, Universitas Gadjah Mada	iv
--	----

Introduction

Syam Rachma Marcilia, S.T., M.Eng., Ph.D Chairperson Organizing Committee of ICIAP 2016	v
--	---

SPEAKERS

A Tale of Two Chinatowns: Expressing Spatial Identity of Ethnic Clusters in Greater Tokyo Shahed Khan	2
Plenary Session 1 Note	13
The Architecture of the Affandi Museum: Approaches to a Piece of Art Ulrike Herbig	18
Plenary Session 2 Note	28
Plenary Session 3 Note	31

URBAN CONTEXT

Water Bodies in the Urban Environment: a Scale Model Experimental Study Nedyomukti Imam Syafii, Masayuki Ichinose, Wong Nyuk Hien, Steve Kardinal Jusuf, Eiko Kumakura, Kohei Chigusa	36
The Usage of Urban Spaces in the Musi Riverside Settlement: Interaction between People Activities and Physical Environment Tutur Lussetyowati, Edy Sutriyono, Ridhah Taqwa, Widya Fransiska FA	42
The Formation of Urban Identity of Seturan, Yogyakarta Hana Afifah, Retno Widodo D. Pramono	47
Islamic Boarding School District And Its Spatial Interactions in Yogyakarta Urban Fringe Area Renindya Azizza Kartikakirana, M. Sani Roychansyah, Didik Kristiadi	54

The Optimal Growth of Shopping Mall in Yogyakarta Risya Putri, Retno Widodo D. Pramono	61
Combining the Activity-Space Pattern with Dwellers Perception to Explore the Sense of Place of an Urban Kampung Irsyad Adhi Waskita Utama	66
Parallel Session 1 Note Urban Context	80

ENVIRONMENTAL AND GREEN CONTEXT

Urban Farming for Housing Middle and High in the City, is Accurate as the Element Eco Green Settlement ,Today? W Uniek Praptiningrum	86
Placemaking Approach to Vitalize Urban Parks in North Bandung Saiful Anwar, Annisa Safira Riska, Indah Widiastuti	93
The Potential of Urban Vacant Land for Producing Fresh Vegetables in the City of Maribyrnong, Victoria, Australia Sri Tuntung Pandangwati, Ole Fryd	98
The Landscape Open Space Arrangement of Industrial Estates in Gresik Deasy Tuffahati, Bambang Soemardiono, Haryo Sulistyarso	110
Characteristic of Livable Campus Open Space Case Study: Gadjah Mada University Dwiyani Kumala Hapsari, Ardhya Nareswari, Ismudiyanto	115
Potential Assessment of Coastal Tourism Area Based on Integrated Coastal Zone Management (ICZM) Approach, Case Study: <i>Sendang Biru</i> Beach Arina Marta Setya Putri, Bambang Soemardiono, Haryo Sulistyarso	126
Parallel Session 1 Note Environmental and Green Context	131
Green Assessment of IEQ for Healthcare Facility in Tropic Region: A Case of Thai Hospital Sutida Sattayakorn, Masayuki Ichinose	135
Recurring Embodied Energy in Life Cycle Building (Case Study: Wall Component in Apartment Building) Sri Novianthi Pratiwi	143
Light Environment and Actual Energy Consumption due to Color Temperature of LED Lighting with Daylighting System Fuga Iketani, Masayuki Ichinose, Akihiro Yoshizawa, Daisuke Kuboi, Syoko Arakawa	148

Thermal Environment of the Marathon Course Area at the 2020 Tokyo Olympics Eiko Kumakura, Saeka Yamada, Nobuyuki Sunaga, Kazuaki Nakaohkubo	154
Observational Study on TSV and Thermal Comfort in Office Building of Vietnam Eriko Tokuda, Masayuki Ichinose, Nguyen Dong Giang, Rumiko Sasaki	160
The role of openings in the Balai Padang House in Loksado, South Kalimantan Rahmayanti, Ima Defiana, I Gusti Ngurah Antaryama	165
Parallel Session 2 Note Environmental and Green Context	170

ENVIRONMENTAL BEHAVIOUR

Is Teras Cikapundung an Inclusive Space? Nurtati Soewarno, Eka Virdianti	174
The Usage of Retail dan Circulation Spaces in Pasar Beringharjo, Yogyakarta Emmelia Tricia Herliana	178
Street Space and Informality: Towards an Inclusive Community Jimly Al Faraby	191
Study of Pedestrian-friendly Environment in Indonesia Ristya Arinta Safitri	199
Urban Compactness Effects to the Inefficiency Trips in Yogyakarta City, Case Study: Danurejan and Umbulharjo District Lanthika Atianta, M. Sani Roychansyah	205
Parallel Session 1 Note Environmental Behaviour	211

DISASTER RESILIENT

Coping Capacity Index in the Concept of Indonesia Disaster Resilient City: Yogyakarta and Banda Aceh M.A. Marfai, F.K. Shafarani, M.N. Malawani, Suriadi	216
Inclusive Space Interventions to Built Health Environment by Modular Design Ergonomics in Urban Pedestrian focusing on Digital Games as driven Simulation-Walk, A Case of Business District Sudirman until Railways Station Dukuh, Jakarta – Indonesia Nur Istifarini Handayani	221

Community Preparedness on Flood Disaster Prevention in Yogyakarta Ardhya Nareswari	228
Globalization, Growth, Resilience Doddy Aditya Iskandar	235
Instant Home Packages in Case of Emergency Medy Krisnany S	245
Parallel Session 2 Note Disaster Resilient	253

SOCIO CULTURAL

Study On The Possibility Of Organizational Cooperation Among Building Technical Stakeholders In Bangladesh Rumiko Sasaki, Tsuyoshi Seike, Yongsun Kim	258
Profile of Scavenger Settlement in Lebak Bulus- South Jakarta Tin Budi Utami, Budi Susetyo	262
Public Housing as a Common Space for Its Surrounding: Case of Walk-up Flats in Bantul Regency Deva Fosterharoldas Swasto	270
Parallel Session 3 Note Socio Cultural	278

TRADITIONAL AND CONTEMPORARY ARCHITECTURE

Nahdlatul Ulama's Principle of Dynamic Tradition and Pluralistic Formal Expressions of Nahdliyyin Mosques in Malang, East Java Yulia Eka Putrie	282
A Characteristic Study on the Designs and Materials of Talang Mamak Tribe Gun Faisal, Dimas Wihardiyanto	289
Reconstructing Local Architecture: A Field of Today's Contestation in Architecture Yohannes Firzal	296
Behavior and Process of Settling of Kaili Da'a Ethnic At Hamlet of Lekatu, Palu City, Central Sulawesi Zulfitriah Masiming, Soegiono Soetomo, Titien Woro Murtini	301
Omah Dudur in Urut Sewu Region, Grabag, Purworejo, Indonesia Satrio HB Wibowo, Sudaryono, E. Pradipto	308
Parallel Session 3 Note Traditional and Contemporary Architecture	317

HISTORICAL AND HERITAGE CONTEXT

Karsten's Work in Architectural Conservation of Semarang Albertus Sidharta Muljadinata	322
Coastal City of Semarang; From Maritime City into Sustainable City Krisprantono	329
The Meaning of Representation in Local Architectural Elements: The Case of Kraton Yogyakarta Ami Arfianti, Josef Prijotomo, Purwanita Setijanti	335
Implementation Quality Improvement Program in Urban Settlement (P2KP) in Kota Tua Conservation Sub-Area, Kampung Luar Batang Harfa Iskandaria, Karya Subagya	340
The Influence Activities of Traditional Market 'Gang Baru' in the Use of Public Space in Semarang Chinatown Rina Kurniati, Fiton Dwi Setiawan	347
Pathok Negara Yogyakarta as a Cultural Landscape Dwita Hadi Rahmi	356
Parallel Session 3 Note Historical and Heritage Context	362

EDUCATIONAL CONTEXT

The Application of Rapid Visual Analysis (RVS) in the Architectural Design Process as Support Disaster Resilient in Indonesia Livian Teddy, Gagoek Hardiman, Nuroji	368
The Cost and Benefits of Public Open Space (POS): an Evaluation on Yogyakarta's POS Investment Program Pramudita Kumala Ardianti, Retno Widodo D. Pramono	374
The Uncertainty of Interest Rate Variation in Mixed-Use Building NPV Valuation Analysis Eva Evita Chatharina Josephine, Irawan Tani	382
Inter-Actor Collaboration and Innovation Policy for Low Tech Industry: the Case of Batik Industry in Pekalongan Nimas Maninggar, Delik Hudalah	391

Study on Criteria of Essential Facilities in an Alternative Workplace using Factor Analysis Fauzan Alfi Agirachman	399
--	-----

Parallel Session 3 Note Educational Context	403
---	-----

UNPRESENTED PAPER

Alun-alun Yogyakarta: A Representative of Sustainable 'Local South' Public Space Which Is Influenced by Westernization` Wahidah Kurniawati	406
--	-----

The Prospect of Rumah Dome Rural Tourism as Disaster Edutourism Safira Aulia, Widiasari Her Nugrahandika	412
---	-----

Art and Tourism Role on Kampung Kreatif (Creative Village) Case Study: Kampung Kreatif Dago Pojok, Bandung Stefani Natalia Sabatini, Indah Widiastuti	420
---	-----

Urban Design Guidelines for Traditional Settlement on Swampy Area A Case Study of Asmat Regency Capital Masterplan, Papua, Indonesia Adi Utomo Hatmoko	426
--	-----

Changes of Local Settlement Areas based on Local Community Activities Pingkan Peggy Egam, Michael M. Rengkung	432
--	-----

The Concept of Preservation of Traditional Settlement in Benteng Keraton Wolio Area (Subdistrict of Murhum, Baubau City) Mimi Arifin, Shirly Wunas, Wa Ode Ramlah Rilani	438
--	-----

The Application Of Rapid Visual Analysis (RVS) in the Architectural Design Process as Support Disaster Resilient in Indonesia

Livian Teddy^{*1}, Gagoek Hardiman², Nuroji³

¹Lecturer, Department of Architecture, Sriwijaya University, Indonesia

²Lecturer, Doctoral Program of Architecture and Urban, Diponegoro University, Indonesia

³Lecturer, Doctoral Program of Civil Engineering, Diponegoro University, Indonesia

Abstract

As an earthquake-prone region should all stakeholders should be prepared to deal with it so that it can support better to disaster resilience. Architects as one of the pioneers of physical development should contribute it with in creating the design of earthquake-resistant buildings. So when an earthquake damaged building is not very severe or collapsed that can cause fatalities. But the evaluation method of building vulnerability to earthquakes is fast, easy, scalable and relatively accurate for the purpose of building design process procedure has not been developed by researchers. There are other ways to a much simpler method for evaluating the vulnerability of buildings to earthquakes that Rapid Visual Screening (RVS). But RVS is used to evaluate the vulnerability of existing buildings against earthquakes in a region for the purpose of disaster management. RVS is 'evaluating as you go along' that do not involve structural calculations, simple and easy to use. The question: is quite feasible to use an architect to evaluate the vulnerability of buildings in the design process and how to accuracy?

Based on these things, the interesting problems to be studied and will be described in this paper are: use RVS procedure for evaluating seismic vulnerability of the buildings in the architectural design process and testing the validity by using static analysis pushover.

From the results of research using 6 models building and quantitative method of research with strategy research simulation experiments. The comparison between procedure of RVS FEMA 2015 and pushover static simulation result indicates that the procedure is quite feasible to be applied in evaluating building's vulnerability to earthquakes in the design process.

Keywords: Earthquake; regularity; irregularity; architectural design, RVS

INTRODUCTION

In designing a building, the relationship between configuration of buildings and structures can be equated with the relationship between meat and bones; they are inseparable. Configuration errors would generate structural failure. There has been a lot of evidence in structural failure, for example: the earthquake in Yogyakarta in 2006, the 2007's earthquake in Bengkulu and Padang Earthquake of 2009, with most casualties caused by the collapse of the building. Some studies express that the fatal damage of buildings caused by earthquake in Indonesia takes place not only in "non-engineered" buildings but also in many "engineered" buildings (Boen, 2006; Boen, 2007a; Boen, 2007b; Pawirodikromo, 2007; Ismail et al., 2011). This phenomenon occurs in the world including Indonesia due to an ongoing debate that earthquake-resistant

building is not the domain of architects; it is the domain of structural engineers. This dichotomy causes the development of structural engineering in Indonesia is not well integrated into the architectural development of Indonesia (Wangsadinata, 2009).

Architects and structural engineers are supposed to establish good cooperation. Architects must understand the basic knowledge of seismic engineering such as acceleration, amplification, shear force base, brittle failure, damping and other seismic terms and also concepts of earthquake-resistant structures such as shear walls, bracing, moment frames, seismic isolators and the like. On the other hand structural engineers must understand the functional needs and aspirations of architects. A good collaboration between the two would yield earthquake architecture (Arnold, 1996).

The initial step of actualizing earthquake architecture in the architect's design process is able to identify and evaluate the vulnerability of buildings to earthquakes (slak & Kilar, 2012). By knowing the vulnerability of buildings being designed to

*Corresponding author: Livian Teddy
Student Doctoral Program of Architecture and Urban,
Diponegoro University, Indonesia.
e-mail: livianteddy@gmail.com

earthquakes, there will be two possible solutions that an architect can consider; first is to re-design so that the architect acquires configuration having a relatively small risk to earthquakes. Second, to leave entirely to structural engineers to handle as well as to prepare for the consequences such as the building's high cost.

The evaluation method of building's vulnerability to earthquakes which is quick, easy, measurable and relatively accurate for the purpose of building design process has not been deeply developed by researchers. There is other way to use a much simpler method to evaluate the vulnerability of buildings to earthquakes, that is Rapid Visual Screening (RVS). RVS is applied to evaluate the vulnerability of existing buildings against earthquake. RVS is 'casual evaluation' that does not involve structural calculations. This method exercises a scoring system to assess the reliability of building's main structure against seismic lateral loads (FEMA, 2002a). The other buildings' attributes that can affect the reliability of the building in response to earthquake loads are taken into account as factors that can modify the final score. In the beginning, this RVS method was created by the US Federal Emergency Management Agency (FEMA) by issuing FEMA 154 (1988a) and FEMA 155 (1988b). Then it was revised by issuing FEMA 154 (2002a) and FEMA 155 (2002b), the last ones were FEMA 154 (2015a) and FEMA 155 (2015b). With a simple method, RVS can be exercised by anyone interested and trained for it. The main purpose of RVS is for disaster management and not for architectural design thus its reliability should be investigated if it is to be applied in evaluating the vulnerability of building design result to earthquakes.

RVS AND REGULAR/IRREGULAR CONFIGURATION

Scoring list of RVS 2015 consists of two parts. Part one : scoring level 1 (SL1) which consists of basic score, modifier score (vertical irregular configuration-VL1 and horizontal-PL1 as well as soil type) and minimum score. The sum of basic score and modifier score must be greater than minimum score :

$$SL1 = \text{basicscore} + VL1 + PL1 > 0.3 \quad (1)$$

In part two : scoring level 2 (SL2) consists of adaptation of basic score :

$$S' = SL1 - VL1 - PL1 \quad (2)$$

and modifier score. Its structural description is more detail than vertical irregular configuration-VL2 (sloping site, weak/soft story, setback, short column, split level and other vertical irregularities), horizontal irregular configuration-PL2 (irregular torsional, non-parallel system, re-entrant corner, diaphragm opening, out-of-plane offset and other horizontal irregularities) and M part (redundancy, pounding and floor plate as beam). Final score (SL2) consists of the sum of S', VL2, PL2 and M which must be greater than minimum score :

$$SL2 = S' + VL2 + PL2 > 0.3 \quad (3)$$

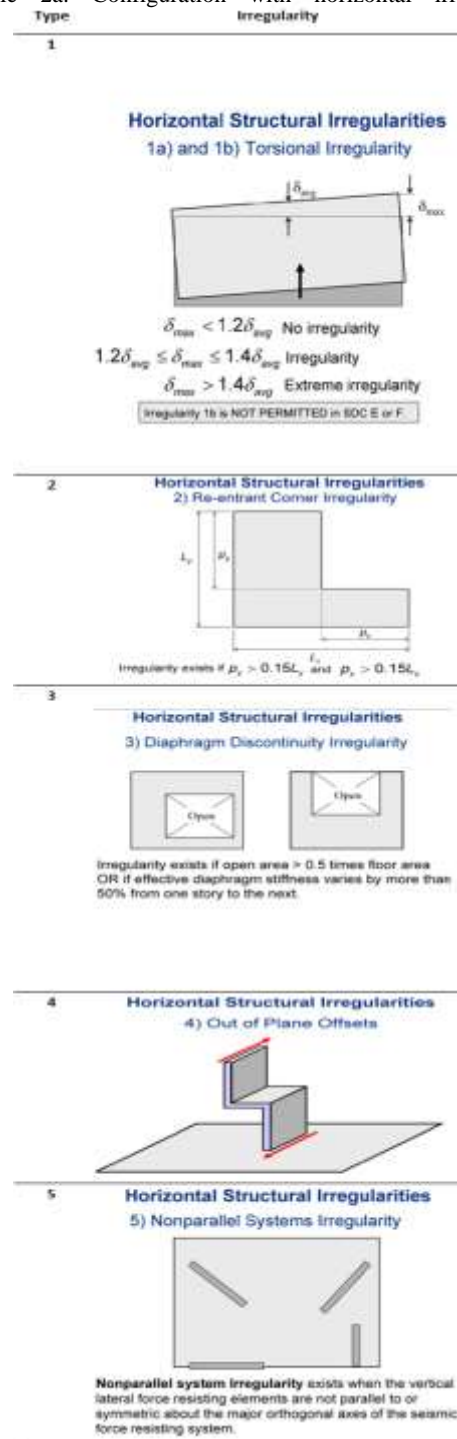
Score 0.3 is used to prevent overestimate due to multiple sum of modifier. While cut-off score from $SL2 = 2$ or medium damage is as shown in table 1 below :

Table 1. The relation between the scores, the probability of damage and prediction of the degree of damage

Score	Damage Probability	Damage Level	Seismic Performance-FEMA 273 (FEMA 1997)
4	0.01%	Least/Ignored Damage	< IO
3	0.10%	Light damage	IO (Immediate Occupancy)
2	1%	Medium damage	LS (Life Safety)
1	10%	Severe damage	CP (Collapse Prevention)
0	100%	Collapse	> CP

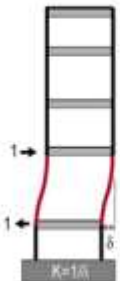

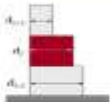
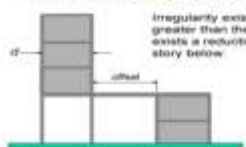
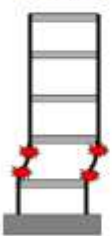
Source: Idham, 2011

Table 2a. Configuration with horizontal irregular



Source: FEMA, 2010

Table 2b. Configuration with vertical irregular

Type	Irregularity
1	<p>Vertical Structural Irregularities 1a, 1b) Stiffness (Soft Story) Irregularity</p>  <p>Irregularity (1a) exists if stiffness of any story is less than 70% of the stiffness of the story above or less than 80% of the average stiffness of the three stories above.</p> <p>An extreme irregularity (1b) exists if stiffness of any story is less than 50% of the stiffness of the story above or less than 70% of the average stiffness of the three stories above.</p> <p>Exception: Irregularity does not exist if no story drift ratio is greater than 1.3 times drift ratio of story above.</p> <p>Irregularity 1b is NOT PERMITTED in SDC E or F.</p>
2	<p>Vertical Structural Irregularities 2) Weight (Mass) Irregularity</p>  <p>Irregularity exists if the effective mass of any story is more than 150% of the effective mass of an adjacent story.</p> <p>Exception: Irregularity does not exist if no story drift ratio is greater than 1.3 times drift ratio of story above.</p>
3	<p>Vertical Structural Irregularities 3) Vertical Geometric Irregularity</p>  <p>Irregularity exists if the dimension of the lateral force resisting system at any story is more than 150% of that for any adjacent story.</p>
4	<p>Vertical Structural Irregularities 4) In-Plane Discontinuity Irregularity</p>  <p>Irregularity exists if the offset is greater than the width (d) or there exists a reduction in stiffness of the story below.</p>
5	<p>Vertical Structural Irregularities 5a, 5b) Strength (Weak Story) Irregularity</p>  <p>Irregularity (5a) exists if the lateral strength of any story is less than 80% of the strength of the story above.</p> <p>An extreme irregularity (5b) exists if the lateral strength of any story is less than 65% of the strength of the story above.</p> <p>Irregularities 5a and 5b are NOT PERMITTED in SDC E or F. Irregularity 5b not permitted in SDC D.</p>

Source: FEMA, 2010

The scoring coefficient of every seismic zone can be different. Earthquake zones used in scoring are : low, medium/moderate, moderately high, high and very high earthquake zones. To better understand the rules of regular or irregular configurations, FEMA issued FEMA 749 guidelines (FEMA 2010) (see table 2a & 2b).

MODELS AND RESEARCH METHOD

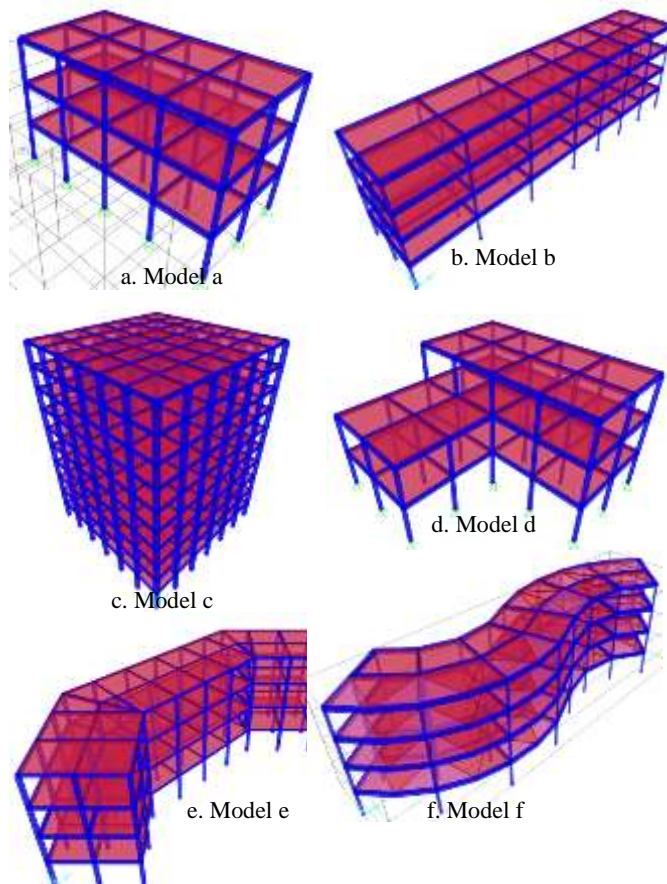


Fig. 1. Models of building with regular and irregular configurations

Source: Author data, 2016

To make it easier to understand the behavior of buildings against earthquakes, this study used 6 building models (Figure 1) with structure property as shown in table 3.

Earthquake zone used is high zone with spectra score $S_S = 0.97$ and $S_1 = 0.328$ with medium soil condition (D).

This study utilizes a quantitative method with research strategy of simulation experiments. Building structure models above are inputted in software and analyzed with the method of pushover static seismic analysis. The Nonlinear Static Procedure, often called “pushover analysis,” is an incremental static analysis used to determine the force-displacement relationship, or the capacity curve, for a structure or structural element (ATC, 1996). Then the numerical results are tabulated and compared with the results of scoring calculations FEMA 2015.

Table 3. Properties of structure models 'a' to 'f'

Models	Number of floors	Dimension of beams (cm)	Dimension of columns (cm)	Thickness of slabs (cm)	Moduls (m)	Quality		
						Concrete (Kg/cm2)	Longitudinal rebars (Kg/cm2)	Transversal rebars (Kg/cm2)
a	3	25X40	30X30	12	5X5	300	3000	2400
b	4	30X60	40	12	5X6 ; 5X9	300	3000	2400
c	10	25X50	70X70	12	5X5	300	4000	2400
d	3	25X40	30X30	12	5X5	300	3000	2400
e	4	25X40	40X40	12	5X5	300	3000	2400
f	4	30X60	40	12	5, 6, 7, 10	300	3000	2400

Source: Author data, 2016

RESULTS

Table 4. Concrete moment-resisting frame structure : basic score, modifiers, and final level 1 score, SL1.

No	Basic score and modifiers	Coefficient	Model a	Model b	Model c	Model d	Model e	Model f
1	Basic score	1.5	1.5	1.5	1.5	1.5	1.5	1.5
2	Severe Vertical Irregularity (VL1)	-0.9	-	-	-	-	-	-
3	Moderate Vertical Irregularity (VL1)	-0.5	-	-	-	-0.5	-	-
4	Plan Irregularity (PL1)	-0.6	-	-0.6	-	-0.6	-0.6	-0.6
5	Soil Type A or B	0.4	-	-	-	-	-	-
6	Soil Type E (1-3 stories)	0.0	0.0	-	-	0.0	-	-
7	Soil Type E (> 3 stories)	-0.5	-	-0.5	-0.5	-	-0.5	-0.5
	SL1 = 1+2/3+4+5/6/7 ≥ 0.3		1.5	0.4	1	0.4	0.4	0.4
	S' = (SL1-VL1-PL1)		1.5	2.1	1.5	2.6	2.1	2.1

Source: Author analysis, 2016

Table 5. Structural modifiers to add to adjusted baseline score.

Code	Topic	Statements	Coefficient	Model a	Model b	Model c	Model d	Model e	Model f
VL2	Vertical Irregularity	Sloping Site There is at least a full story grade change from one side of the building to the other.	-1.2	-	-	-	-	-	-
		Length of lateral system at any story is less than 50% of that at story above or height of any story is more than 2.0 times the height of the story above.	-0.9	-	-	-	-	-	-
		Weak and/or Soft Story (circle one maximum) Length of lateral system at any story is between 50% and 75% of that at story above or height of any story is between 1.3 and 2.0 times the height of the story above.	-0.5	-	-	-	-	-	-
		Vertical elements of the lateral system at an upper story are outboard of those at the story below causing the diaphragm to cantilever at the offset.	-1.0	-	-	-	-	-	-
		Vertical elements of the lateral system at upper stories are inboard of those at lower stories.	-0.5	-	-	-	-0.5	-	-
		There is an in-plane offset of the lateral elements that is greater than the length of the elements.	-0.3	-	-	-	-	-	-
		At least 20% of columns (or piers) along a column line in the lateral system have height/depth ratios less than 50% of the nominal height/depth ratio at that level.	-0.5	-	-	-	-	-	-
		Short column The column depth (or pier width) is less than one half of the depth of the spandrel, or there are infill walls or adjacent floors that shorten the column.	-0.5	-	-	-	-	-	-
		Split level There is a split level at one of the floor levels or at the roof.	-0.5	-	-	-	-	-	-
		Other Irregularity There is another observable severe vertical irregularity that obviously affects the building's seismic performance.	-1.0	-	-	-	-	-	-
	There is another observable moderate vertical irregularity that may affect the building's seismic performance.	-0.5	-	-	-	-	-	-	
	ΣVL2	0	0	0	-0.5	0	0		
PL2	Plan Irregularity	Torsional irregularity: Lateral system does not appear relatively well distributed in plan in either or both directions.	-0.7	-	-0.7	-	-0.7	-0.7	-0.7
		Non-parallel system: There are one or more major vertical elements of the lateral system that are not orthogonal to each other.	-0.4	-	-	-	-	-0.4	-0.4
		Reentrant corner: Both projections from an interior corner exceed 25% of the overall plan dimension in that direction.	-0.4	-	-	-	-0.4	-0.4	-
		Diaphragm opening: There is an opening in the diaphragm with a width over 50% of the total diaphragm width at that level.	-0.2	-	-	-	-	-	-
		Building out-of-plane offset: The exterior beams do not align with the columns in plan.	-0.4	-	-	-	-	-	-
		Other irregularity: There is another observable plan irregularity that obviously affects the building's seismic performance.	-0.7	-	-	-	-	-	-
		ΣPL2	0	-0.7	0	-1.1	-1.5	-1.1	
Redundancy	The building has at least two bays of lateral elements on each side of the building in each direction.	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
M	Pounding	Building is separated from an adjacent structure by less than 1% of the height of the shorter of the building and adjacent structure and: The floors do not align vertically within 60 cm.	-1.0	-	-	-	-	-	
		One building is 2 or more stories taller than the other.	-1.0	-	-	-	-	-	
		The building is at the end of the block.	-0.5	-	-	-	-	-	
Concrete moment-resisting frame	Flat plate serves as the beam in the moment frame.	-0.4	-	-	-	-	-		
	ΣM	0.3	0.3	0.3	0.3	0.3	0.3		
	Σ(VL2 + PL2 + M)	0.3	-0.4	0.3	-1.3	-1.2	-0.8		
	Final skor level 2, SL2 = (S' + VL2 + PL2 + M) ≥ 0.3	1.8	1.7	1.8	1.3	0.9	1.3		

Source: Author analysis, 2016

DISCUSSION

Model a and c are 2-axis symmetrical configurations, model b and e are 1-axis symmetrical configurations, and model d and f are asymmetrical configurations. The irregularity configurations are as follow: model a and c are of regular categories; model b, e and f are of horizontal irregular categories; and model d is of vertical and horizontal irregular category. The manual calculation results of seismic performance model a-f by FEMA RVS 2015 are displayed in Table 4 and 5. In Table 4 there is no soil type D (medium) so it is assumed that it is the same as soil type E (soft).

Based on calculation results of RVS FEMA 2015 in Table 5, the score of SL2, model a=1.8, model b=1.7, model c=1.8, model d=1.3, model e=0.9 and model f=1.3. If compared with Table 1 it is concluded that model a, b, and c=2 or LS seismic performance and model d, e and f=1 or CP performance. This implies that if there is an earthquake with high intensity and magnitude, building a, b, and c will suffer moderate damage, while building d, e and f will be severely damaged.

Simulation results of model a-f in SAP2000 structure software (Table 6) indicate that model a is of CP seismic performance, model b on X-axis is of LS seismic performance and on Y-axis is of CP seismic performance. Model c, d, e and f are of LS seismic performance. With a simple configuration of model a and b with CP seismic performance it is concluded that the column shear capacity of both models is inadequate or its dimension is too small. On the other hand, a simple configuration of model c which is symmetrical 2-axis with LS seismic performance or 0.98% and quite far from the limit score of 1.5%, indicates that it is very safe. In model d, e and f even though the seismic performance is of LS category, its score is 1.23%- 1.49% which is very close to the limit score of 1.5%. The models above are configurations whose irregularities are set. In reality, the actual building may carry several irregular combinations of both horizontal and vertical and the scores may exceed the limit score. In other words, the configuration of such model d, e and f are prone to earthquakes.

If compared between the manual calculation results of RVS FEMA 2015 and SAP2000 on model a and b, manual calculations of RVS FEMA 2015 does not take into account the shear capacity of a building structure so that the seismic performance is different. On the contrary, model c with a configuration that is relatively the same as model a owns an unproblematic shear capacity therefore the seismic performance results of RVS FEMA 2015 and SAP2000 are similar. The seismic performances of RVS FEMA 2015 and SAP2000 in model d, e and f appear to be different when viewed in a glance, but when it is observed from the seismic performance score of SAP2000 which is

1.23%- 1.49%, it is very close to the limit score which is 1.5%. Thus RVS FEMA 2015 detects that configurations of model d, e and f are vulnerable to an earthquake so that its seismic performance is CP.

CONCLUSIONS

From discussions above, it can be concluded that :

- Based on calculations of RVS FEMA 2015, model a, b, and c possess LS seismic performance and model d, e and f possess CP seismic performance.
- Based on calculations of SAP2000, model a is of CP seismic performance, model b on X- axis is of LS seismic performance and on Y-axis is of CP seismic performance, model c is of LS seismic performance and model d, e and f are of LS seismic performance.

From both calculations being applied, FEMA 2015's manual calculations can predict quite well the seismic performance of a building configuration, but its weakness is unable to predict a seismic performance of a configuration with inadequate shear capacity structures. The comparison of these calculation methods exhibits that manual calculations of RVS FEMA 2015 is fairly moderate in predicting the vulnerability of buildings to earthquakes with the result that it is feasible to evaluate the vulnerability of buildings to earthquakes in the process of architectural design. The flaw of this method is recently being corrected by the author who is currently doing dissertation research to create a procedure to evaluate the vulnerability of a building in the design process from shear capacity's capabilities and its configurations.

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