# 2nd ICST 2017

## THE EMERGENCE OF SCIENCE FOR HUMAN PROSPERITY AND HEALTH

**Joint International Conference on Science and Technology in The Tropic**

Organized by:
University of Mataram, Indonesia and University of Malaya, Malaysia

# PROCEEDINGS

AUGUST 23rd-24th 2017
UNIVERSITY OF MATARAM

ISBN : 978-602-61265-1-1

UNIVERSITI MALAYA
KUALA LUMPUR


# PROCEEDINGS

## The 2nd International Conference on Science and Technology 2017

**"Joint International Conference on Science and Technology in The Tropic"**

**Mataram, August, 23th-24th 2017**

**PUBLISHED BY :**

**Universitas Mataram**

**Jl. Majapahit, No 62 Mataram West Nusa Tenggara, Indonesia 83125**

**Telp: +62-0370-633007**

**Fax: +62-0370-636041**

# PROCEEDINGS

## The 2nd International Conference on Science and Technology 2017

**"Joint International Conference on Science and Technology in The Tropic"**

## Mataram, August, 23th-24th 2017

**Person In Charge :** Dr.ret.net. Lalu Rudyat Telly Savalas

**Council Committee :** Prof. Dr. Ir. H. Lalu Wiresapta Karyadi, M.Si

**Head of Steering Committee** : Prof. Ir Sunarpi, Ph.D

**Deputy of Steering Committee :** Prof. Dr. Dato' Azizan Abu Samah

**Peer Reviewer :**

Prof. James Gannon, Ph.D
Prof. Dr. Mohammad F.R. Hassanien
Prof. Dr. Lim Phaik Eem
Prof. Yong Hoi Sen
Prof. Helmut Erdman
Prof. Ir. Sunarpi., Ph.D
Prof. Ir. Sri Widuastuti, Ph.D
Prof. I Made Sudarma
Prof. I Komang Damar Jaya., Ph.D
Dr. Islamul Hadi
Dr. rer.nat. Teti Zubaidah, ST., MT
I Wayan Sudiarta,.Ph.D
Dr. Imam Bachtiar
Dr. Syahrul
Aluh Nikmatullah., Ph.D

**Editor and layout:**

Dr.ret.net. Lalu Rudyat Telly Savalas
Cahyo Mustiko, ST.,M.Sc., Ph.D
Ir. Aluh Nikmatullah, Ph.D
Nanda Diniarti, S.Pi., M.Si
Dewi Nur'aeni Setyowati, S.Pi, M.Biotech

**ISBN : 978 - 602 - 61265 - 1 - 1**

Cetakan pertama : Agustus 2017

**Published by :**

Universitas Mataram
Jl. Majapahit, No 62 Mataram West Nusa Tenggara, Indonesia 83125
Telp: +62-0370-633007 / Fax: +62-0370-636041

## KEYNOTE SPEAKERS

| Keynote Speaker | Name and Institution | Country |
|---|---|---|
| Keynote Speaker 1 | **Prof. Ir.H. Sunarpi,Ph.D** (University of Mataram,) | **Indonesia** |
| Keynote Speaker 2 | **Prof. Dr. Dato' Azizan Abu Samah** (University of Malaya,) | **Malaysia** |
| Keynote Speaker 3 | **Prof. Franl Lavigne** (Universite Paris) | **France** |
| Keynote Speaker 4 | **Prof. Lim Phaikeem** (University of Malaya) | **Malaysia** |
| Keynote Speaker 5 | **Dr. Weiwei Yu** (Third Institute of Oceanography) | **China** |
| Keynote Speaker 6 | **Prof. Dato'Asbi Ali, Ph.D** (Management and Science University) | **Malaysia** |
| Keynote Speaker 7 | **Prof. Dr. Akihiro Hazama, MD** (Fukushima Medical University) | **Japan** |
| Keynote Speaker 8 | **Dr. Wenjia Hu** (Third Institute of Oceanigraphy) | **China** |
| Keynote Speaker 9 | **Prof. Julian Heyes** (Massey University) | **New Zealand** |

**Joint international Conference University of Mataram, Indonesia, and University of Malaya, Malaysia**
**INTERNATIONAL CONFERENCE OF SCIENCE AND TECHNOLOGY (The 2nd ICST)**
**UNIVERSITY OF MATARAM**
**Mataram, August 23rd to August 25th, 2017**

## THE CONFERENCE PROGRAMME

| TIME | AGENDA | MODERATOR | PLACE AND PIC |
|---|---|---|---|
| DAY : WEDNESDAY,AUGUST 23 RD TO AUGUST 25, 2017 | | | |
| 08.00-09.00 | REGISTRATION | University of Mataram Dome (Prof. Sunarpi Building) | |
| **09.00-10.00** | **Opening Ceremony Location University of Mataram Dome (Prof. Sunarpi Building) Jl. Majapahit 62 Mataram** | | MC Nizar |
| 09.00-09.05 | Doa | Ir. H. Rasidy, M.Si | |
| 09.05-09.10 | Indonesian Anthem | University of Mataram Choir | |
| 09.10-09.20 | Welcome Speech | The Chair of Organizing Committee Dr.rer.net Telly Savalas | |
| 09.20-09.30 | Opening Speech | Rector University of Mataram Prof. Ir.H. Sunarpi,Ph.D | |
| 09.30-09.40 | Opening dances and songs | Students of Mataram University | |
| 09.40-10.30 | MORNING TEA BREAK & POSTER SESSION | | BPPU |
| **10.30-12.00** | **Keynote Speakers Plenary-1 Location University of Mataram Dome (Prof. Sunarpi Building) Jl. Majapahit 62 Mataram** | **Moderator: Muhammad Ali, S.Pt., M.Si., Ph.D** | |
| 10.30-11.00 | **Keynote Speaker-1** Science | **Prof. Ir.H. Sunarpi,Ph.D** (University of Mataram, **Indonesia**) | |
| 11.00-11.30 | **Keynote Speaker-2** Physics | **Prof. Dr. Dato' Azizan Abu Samah** (University of Malaya, **Malaysia**) | |
| 11.30-12.00 | **Keynote Speaker-3** Physical Geography | **Prof. Franl Lavigne** (Universite Paris, **France**) Long-term impact of the 1257 CE eruption of Samalas volcano in Lombok Island | |
| | | | |
| **12.05-13.05** | **Keynote Speakers Plenary-2 Location University of Mataram Dome (Prof. Sunarpi Building) Jl. Majapahit 62 Mataram** | **Moderator: Prof. Sri Widyastuti** | |
| 12.05-12.35 | **Keynote Speaker-4** Marine Biology | **Prof. Lim Phaikeem** (University of Malaya, **Malaysia**) The Use of "OMIC" Technologies in Understanding the Response of Microalgae towards Various Abiotic Stressors | |
| 12.35-13.05 | **Keynote Speaker-5** Oceanography | **Dr. Weiwei Yu** (Third Institute of Oceanography, **China**) The Distribution Patterns and Reference Conditions of Marine Species Richness in chinese Coastal Waters | |

| | |
|---|---|
| 13.05-14.00 | LUNCH BREAK & POSTER SESSION |

| 14.00-16.25 | **PARALEL SESSION Location. Prof Sunarpi Lecture Building** | | | | | |
|---|---|---|---|---|---|---|
| | **ROOM 1** | **ROOM2** | **ROOM 3** | **ROOM 4** | **ROOM 5** | **ROOM 6** |
| | **AGRICULUTER** | **MARINE SCIENCE** | **NATURAL SCIENCES** | **HEALT** | **TECH. & ENGINEERING** | **FOOD SCI. & TECH** |
| | **Moderator: Dr. Herman Suheri** | **Moderator: Dr. Aluh Nikmatullah** | **Moderator: Dr. Telly Savalas** | **Moderator: Dr. Yunita Sabrina** | **Moderator: Dr. Syahrul** | **Moderator: Dr. Rien Handayani** |
| 14.00-14.10 | 001_Zainuri | 032_Karnan | 142_Wildan | 129_Parnomangan M | 101_M. Ramdhan O | 039_Sukmawaty |
| 14.10-14.20 | 011_IKD Jaya | 033_Imam Bachtiar | 007_Aris Doyan | 013_Hamsu Kardiyan | 010_Alex Laplaza | 066_Dedy Rahmad |
| 14.20-14.30 | 119_Hiryana W | 045_Zaenal Abidin | 009_Norma Ikrama | 016_Lina Nurbaiti | 110_Buan Anshari | 086_Satrijo Saloko |
| 14.30-14.40 | 047_Eka Widiastuti | 051_Muh Risnain | 021_Rosalina | 018_Idiani Darmawati | 027_N. Kencanawati | 091_Dian Hasni |
| 14.40-14.50 | 028_Lyli Ishak | 069_Faturrahman | 132_Imam S | 029_Sujono | 047_Akmaluddin | 092_Murna |
| 14.50-15.10 | Discussion | Discussion | Discussion | Discussion | Discussion | Discussion |
| | | | | | | |
| | **ROOM 1** | **ROOM2** | **ROOM 3** | **ROOM 4** | **ROOM 5** | **ROOM 6** |
| | **AGRICULUTER** | **MARINE SCIENCE** | **NATURAL SCIENCES** | **HEALT** | **TECH. & ENGINEERING** | **FOOD SCI. & TECH** |
| | **Moderarot: Dr. Herman Suheri** | **Moderarot: Dr. Aluh Nikmatullah** | **Moderarot: Dr. Telly Savalas** | **Moderarot: Dr. Yunita Sabrina** | **Moderarot: Dr. Syahrul** | **Moderarot: Dr. Herman Duheri** |
| 15.15-15.25 | 002_Taslim Sjah | 075_Edi Sulman | 008_Susilawati | 022_Mitrayana | 054_Rudi Walujo | 115_Ismed |
| 15.25-15.35 | 025_Mulyati | 099_Abdul Syukur | 020_Hikmawati | 030_Sti Idawati | 058_Marenda Dwi J | 121_Cesar W Refdi |
| 15.35-15.45 | 031_Kusnarta,IGM | 114_M Fadlillah | 026_Erin Ryantin G | 037_Handa Muliasari | 113_Ngudiyono | 141_Murad |
| 15.45-15.55 | 040_Rizki Amalia N | 122_Novita HN | 035_Saprizal H | 041_Ardiana Ekawanti | 080_Gunawan | 124_Wahid Y |
| 15.55-16.05 | 044_BH Kusumo | 123_Wiharyani W | 036_Zhilal Shadiq | 042_Elizabeth CS | 120_Buan Anshari | 093_Yusya' Abu Bakar |
| 16.05-16.25 | Discussion | Discussion | Discussion | Discussion | Discussion | Discussion |
| 16.25-17.00 | AFTERNOON BREAK & POSTER SESSION | | | | | |
| END OF DAY 1 | | | | | | |

| DAY : THURSDAY, AUGUST 24th, 2017 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 08.00-09.00 | REGISTRATION | University of Mataram Dome (Prof. Sunarpi Building) | | | | | |
| **09.00-10.00** | **Keynote/Invited Speakers Plenary-3 Location. University of Mataram Dome (Prof. Sunarpi Building), Jalan Majapahit 62 Mataram** | **Moderator: Prof. Ir. I Komang DamarJaya, M.Sc.Agr., Ph.D** | | | | | |
| 09.00-09.30 | **Keynote Speaker-6** Science | **Prof. Dato'Asbi Ali, Ph.D** (Management and Science University, **Malaysia**) | | | | | |
| 09.30-10.00 | **Keynote Speaker-7** Health | **Prof. Dr. Akihiro Hazama, MD** (Fukushima Medical University, **Japan**) | | | | | |
| **10.00-10.30** | **MORNING TEA BREAK & POSTER SESSION** | | | | | | |
| **10.30-11.30** | **Keynote/Invited Speakers Plenary-4 Location. University of Mataram Dome (Prof. Sunarpi Building), Jalan Majapahit 62 Mataram** | **Moderator: Prof. Ir. M. TaufikFauzi, Ph.D** | | | | | |
| 10.30.11.00 | **Keynote Speaker-8** Marine Biology | **Dr. Wenjia Hu** (Third Institute of Oceanigraphy, **China**) | | | | | |
| 11.00-11.30 | **Keynote Speaker-9** Post-Harvest Technology | **Prof. Julian Heyes** (Massey University, **New Zealand**) | | | | | |
| **11.30-13.00** | **LUNCH BREAK AND POSTER SESSION** | | | | | | |
| **13.00-15.35** | **PARALEL SESSION Location. Prof Sunarpi Lecture Building** | | | | | | |
| | ROOM 1 | ROOM2 | ROOM 3 | ROOM 4 | ROOM 5 | ROOM 6 | ROOM 7 |
| | AGRICULTURE | AGRICULTURE | NATURAL SCIENCES | HEALT | TECH. & ENGINEERING | MIXED TOPICS | MIXED TOPICS |
| | Moderator: Prof. Taslim Sjah | Moderator: Ir. Bambang HK | Moderator: Dr.Imam Bachtiar | Moderator: Made Sriasih | Moderator: | Moderator: Dr. Ihsanawati | Moderator: Dr. L. Zulkifli |
| 13.00-13.10 | 046_Fitria Z | 079_M Sudantha | 065_Syamsuddin | 050_IA Eka W | 056_Warsa | 043_Niniek Fp | 063_Muhammad Ali |
| 13.10-13.20 | 017_Liana S | 053_Dika S | 073_Sri Seno H | 060_Mashur | 136_CahyoMustiko | 057_ Ahmad S | 064_Muhammad Ali |
| 13.20-13.30 | 052_Theresia E | 082_ Lolita E S | 085_Siti Rabiatulb F | 061_Hamsu K | 059_Shafwam A | 084_Sitti Latifah | 143_Syamsul Bahri |
| 13.30-13.40 | 076_M. T. Fauzi | 107_Jauhar F | 089_Moh Liwa | 062_ Purkan | 034_Ahmad Fauzi | 067_Indra KS | 145_Muji Wahyu |
| 13.40-13.50 | 078_M Sudantha | 012_Suwardji | 105_Ira Purnawati | 072_Nurhidayati | 081_Suryawan M | 106_Suharti | 146_Saprini |
| 13.50-14.10 | Discussion | Discussion | Discussion | Discussion | Discussion | Discussion | Discussion |

| | ROOM 1 | ROOM2 | ROOM 3 | ROOM 4 | ROOM 5 | ROOM 6 | ROOM 7 |
|---|---|---|---|---|---|---|---|
| | **AGRICULTURE** | **NATURAL SCIENCE** | **NATURAL SCIENCES** | **HEALT** | **TECH. & ENGINEERING** | **TECH. & ENGINEERING** | **MIXED TOPICS** |
| | **Moderator: Prof. Taslim Sjah** | **Moderator: Dr. L. Zulkifli** | **Moderator: Dr.Imam Bachtiar** | **Moderator: Made Sriasih** | **Moderator:** | **Moderator: Dr. CahyoMustiko** | **Moderator:** |
| 14.15-14.25 | 108_Nani H | 126_Abdul S | 097_Sri Wahyuni | 083_Yunita S | 014_Ahmad Fauzi | 006_Sirajuddin HA | 024_Husni |
| 14.25-14.35 | 125_I W Sutresna | 131_Seto P | 098_Mustika H | 095_Ermina | 055_Warsa | 068_ IW Joniarta | 150_Made sriasih |
| 14.35-14.45 | 128_Kisman | 140_PraptiS | 104_Munira | 096_Yusra | 088_Maria AH | 102_Andreas S | |
| 14.45-14.55 | 134_Ni Md Dini | 023-Veni Rori S | 049_Fitriah | 103_Madelina A | 094_Amrullah | 127_Yumna Cici O | |
| 14.55-15.05 | 138_B. Tri Ratna | 015_Muh.Taufik | 111_LelyK | 004_Telly Savalas | 100_Syahrul | 137_Hasdi A | |
| 15.05-15.15 | 149_ Merry W | 148_Ihsanawati | 117_ IM. Sudarma | | | 112_I WynYasa | |
| 15.15-15.35 | Discussion | Discussion | Discussion | Discussion | Discussion | Discussion | Discussion |
| 15.35-16.00 | CLOSING CEREMONY OF | | | | | | |
| | 2nd ICST Recommendation | | | | Chairman of 2st ICST | | |
| | Presentation of Best Oral and Poster Prizes | | | | | | |
| | Closing Speech | | | | University of Malaya | | |
| | | END OF DAY 2 | | | | | |

| **DAY 3: FRIDAY, AUGUST 25TH, 2017** | | |
|---|---|---|
| 08.00-12.00 | Workshop on cell culture and analysis of cell death by fluorescence microscopy | Dr. Masao Miyake<br>Fukushima Medical University, Japan |
| 08.00-17.00 | Field Trip | |
| END OF DAY 3 | | |
| END OF 2ND ICST PROGRAMME | | |

# PREFACE

Bismillaahirrahmaanirrahiim
Assalaamu'alaikumwarahmatullaahwabarakaatuh.
Peace be upon us.

Praise always we pray to God Almighty for giving us the abundance of grace, guidance and inayah, so that we all can meet here in the "2nd International Conference on Science and Technology (ICST) 2017". The theme of this conference is "The Emergence of Science for Human Prosperity and Health" where this conference is joint international conference between Mataram and Malaya University.

First of all, I would like to welcome you all to West Nusa Tenggara Province specially Lombok Island, "the Island of Thousand Mosques", which is famous to its many natural resource and beautiful tourism destinations where you can enjoy them while attending the conference. This conference will be held for two days, from 23rd to 24th August 2017, and took place in campus of the University of Mataram.

So far, we received one hundred fifty papers from various universities and research institutions in Indonesia and from overseas. The paper have been selected and grouped based on the similarity of the research field, which then are presented and discussed. Presentation of the papers will be held in seven parallel classes and poster presentation. The Selected papers will be published in Malaysian Journal of Science (Special Issue) which index by Scopus, and the rest will be published in the Conference Proceedings. Additionally, selected paper in aquaculture have the opportunity to be published in Jurnal Akuakultur Indonesia.

At this moment, the organizing committee would like to express our gratitude to all of you for your participation on this conference, especially to the all keynote speakers, presenters who have submitted for both oral and posters presentations and also to all participants. Our special gratitude also goes to the Rector of the University of Mataram and Vice Chancellor of Malaya University, who have been highly supporting this conference. Critics and suggestions on the implementation of this conference will be appreciated and as much as possible we will improve the next ICST. Last but not least, the organizing committee would like to thank to all of you who have supported this conference.

Have an enjoyable conference.
Wassalamu'alaikum warohmatullahi wabarakatuh.

Chairman of 2nd ICST 2017

Dr.rer.nat. Lalu Rudyat Telly Savalas, M.Si.

# OPENING SPEECH - RECTOR THE UNIVERSITY OF MATARAM
# The 2nd International Conference on Science and Technology 2017

Joint International Conference on Science and Technology in The Tropic Beetwen Mataram and Malaya Universiti

Respected Guests,
Keynote speakers,
Conference participants,
and all other participants.

On Behalf of all staffs of the University of Mataram, I welcome you all to Lombok, a beautiful island in West Nusa Tenggara Province, where the University of Mataram is located. Lombok is known for its natural and cultural diversity where you can enjoy traditional cuisines, beaches, waterfalls, mountain, traditional villages and handicraft of many ethnics including Sasak, Samawa, Mbojo, Balinese, Chinese, Arabic, and many others.

As the Rector of the University of Mataram, it is a great honour for me to address the opening of "The 2nd International Conference on Science and Technology" here at the University of Mataram, which will be held from 23rd to 24th August 2017, with a theme "The Emergence of Science for Human Prosperity and Health". The main aim of this seminar is to gather scientist from all over the world to share their ideas, knowledge and experiences and to build network for possible future collaboration.

As we are aware that sharing knowledge and experiences from speakers are extremely valuable in a conference, therefore I would like to express my high appreciation, first, to the keynote speakers from overseas and from Indonesia for their willingness to come to Lombok to share their acknowledged works. Your effort and contribution to this conference are absolutely valuable. Second, my high appreciation also goes to the national speakers and all other participants, including the speakers from University of Mataram and local universities in West Nusa Tenggara Province, your participation in this conference not only will give incredible share of ideas, skills and knowledge that you have, but also will improve the academic environment that we are developing in this university. I hope this conference will be a good forum, not only for communicating and sharing ideas, knowledge and experiences, but also for building networking for future collaboration.

I would also like to take this opportunity to express my appreciation to the sponsors which have given some contribution to this conference. Last but not least, I would like to thank the organizing committee as well as all other supporters and participants, without their effort, commitment and hard work, this conference will not run well.

Finally, I wish you most successful conference, enjoy Lombok Island and hope to see you again in other forum here at the University of Mataram.

Rector of the University of Mataram

**Prof. Ir. Sunarpi, Ph.D**

**TABLE OF CONTENTS**

# Structural Behaviour of Spherical Hollow Reinforced Concrete Beam under Flexural Loading

Suryawan Murtiadi[1*], Akmaluddin[1], Maskimi[1]

[1]Mataram University,Mataram, Indonesia,
[*]Corresponding Author: s.murtiadi@unram.ac.id

## Abstract

This research was conducted with aims to determine and understand the behaviour of spherical hollow reinforced concrete beam. Five hollow reinforced concrete beams were tested with variations of 1, 3, 5, 7 and 9 spheres resulted the volume ratios of 99%, 98%, 97%, 95% and 94%, respectively. Beams dimension were 200 x 300 mm with effective length of 3000 mm. Steel reinforcements were 3D13 in tension and 2D10 in compression linked together with D10-20 stirrups. The concrete strength of 22 MPa and steel yield-strength of 390 MPawas considered. In addition, one solid beam was also tested as a standard beam. Flexural static loads were applied according to SNI testing standardmethod with two points of loading. Test results indicated that the fracture pattern of all specimens was classified as bending cracks. The presence of spherical hollow has insignificant effect to the structural behaviour of reinforced concrete beam. Cracking moments has 83% decreased and the ultimate moment has only95% decreased. Ductility of the hollow beams was also decreased but it is still acceptable since the ductility ≥2. Therefore, in order to reduce self-weight of reinforced concrete, the use of spherical hollow beam is highly recommended.

**Keywords:** Concrete beam, hollow sphere, structural behaviour, moment capacity, ductility

## 1. Introduction

Concrete is a very popular building material in the construction industry because of its strength to withstand high compressive forces. However, the concrete has a weakness with low tensile strength and its need to be combined with other materials such as steel reinforcement. Another weakness is its heavy self-weights which is necessary to have an innovation to the structure by reducing its own weight. The reinforced concrete structural element with the hollow is a structure that is effective enough to reduce its own weight. This research was conducted in the laboratory of Materials and Building Department of Civil Engineering University of Mataram. This study aims to determine and understand the behavior ofspericalhollow reinforced concrete beam structure. While the specific purpose of this study is to obtain the form of geometry modeling hollow cross section that supports the ductility of an element of reinforced concrete structure.

The world consumption for concrete is about 8.8 million tons annually. This consuming material will continues to increase from year to year in line with the increasing needs of basic human facilities and infrastructure. From the increasing use of concrete materials, there are two important aspects to note i.e durability of the concrete material itself and the environmental disturbance caused by Portland cement production. Besides abrasion and landslide by the use of coarse aggregate material, excess sand is also a problem to be prevented. Therefore, the optimization and limitation of the use of concrete materials is essential.

Concrete slab with Bubble Deck system developed by Netherlands (1997) is an innovation of hollow concrete plate elements with no beam (flat plate) and column head (drop panel). This system can be used as floor slab, roof and floor plate. One of the structural advantages of this system is to have a load-bearing capacity that is as good as a massive plate, but with a smaller thickness. This brings the advantages of saving plate construction materials up to 40% to 50%. With the reduction of the plate's own weight, other structural elements will also retain less weight of the plate, and will reduce the required column and foundation dimensions, resulting in a 50% overall material saving for the whole building.

Rahadyanto (2013) conducted experimental hollow beam with the utilization of PET bottle waste. The experimental test was divided into three types, solid beam K-400, K-400 hollow beam and K-300 hollow block. The reasonably stable maximum loads occur in solid beam K-400 with K-300 hollow beam of 77.33 kN and maximum holding moment of 46.40 kN.m. The solid strength ratio of K-400 and the K-300 hollow to the K-400 hollow beam is 1.017. While Ali and Wahid (2008) state that massive blocks reach cracks at higher loads than hollow blocks. The hollow beam has a failure of press with the plan load while the massive block is able to withstand the load greater than the load of the plan.

Canonica (2013) divides the structural form in two levels i.e. global-form (whole form) and local-form (element form/component detail structure). At the global level-form structural efficiency is produced by a form-active structure while at local-form level structural efficiency is obtained by forming a cross-sectional configuration of structural components formed to produce the moment of inertia (I) as large as possible with the least amount of material possible. For structural receiving moment of efficiency can be done by placing the most material on the outermost side of the cross section of the structural component in order to obtain maximum inertia. Correspondingly, Canonica (2013) has also thought to pierce the cross section of the beam in order to reduce its own weight without reducing its flexural strength.

## 2. Materials and Methods

### 2.1. Materials

All beams have dimension of 200 mm x 300 mm x 3200 mm and placed on a simple supported position with a clean span of 3000 mm. The beam is planned to fail to carry the load through flexural failure. Three types of modelling are used on beam test specimens with under reinforced reinforcement ratios. Concrete cover between reinforcement is 22.5 mm for all surfaces. The three types of the beam and detail of steel reinforcement shown in the Figure 1.

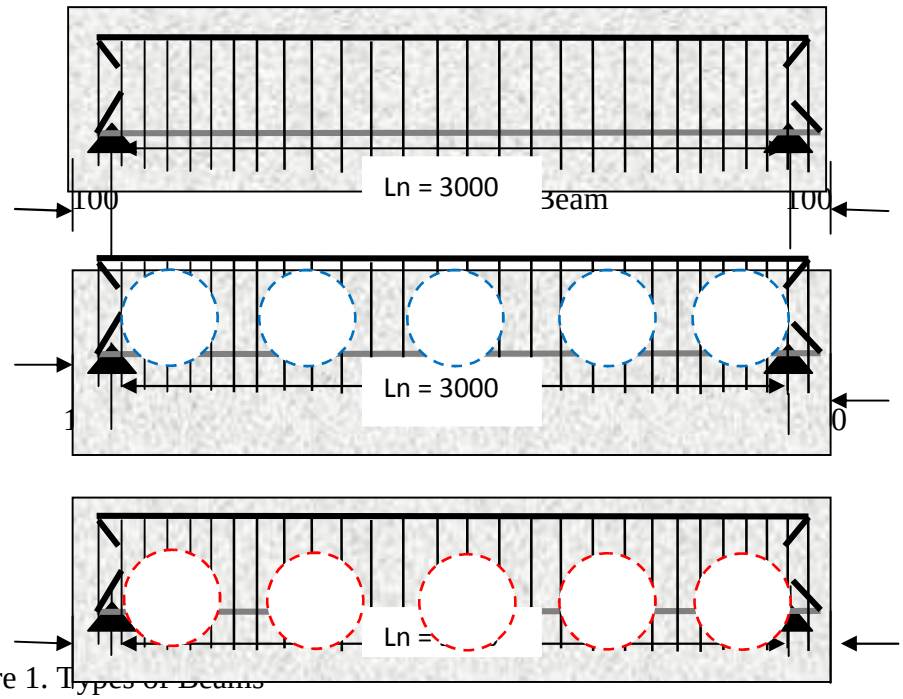


Figure 1. Types of Beams

### 2.2. Methods

Ten hollow concrete beams were tested by varying the number of balls and the position of the ball in a reinforced concrete beam section. The number of spheres consisted five

variations of 1, 3, 5, 7, and 9 balls resulted the beam volume ratios of 99%, 98%, 97%, 95% and 94%, respectively. The cross section of the beam is rectangular with width b = 200 mm and height h = 300 mm with effective span L = 3000 mm. Two tensile reinforcements type of 3D13 and 2D10 were applied with Ø10-20 mm stirrups. The quality of concrete is fc'22 MPa while steel reinforcement isfy = 390 MPa. For comparison, a solid beam of the same size and reinforcement is also tested as a standard beam. The static bending load is carried out following the SNI testing standard with two points of loading. The load cell is placed in the middle of the span and distributed to two points through the steel profile. Hydraulic jack capacity of 50 tons as a load source connected with load cell. Vertical deflection measurements in the center of the landscape are recorded with LVDT.Load-deflection relationships were recorded until the test specimens collapse. The position of loading beam at the experimental test is shown in Figure 2.

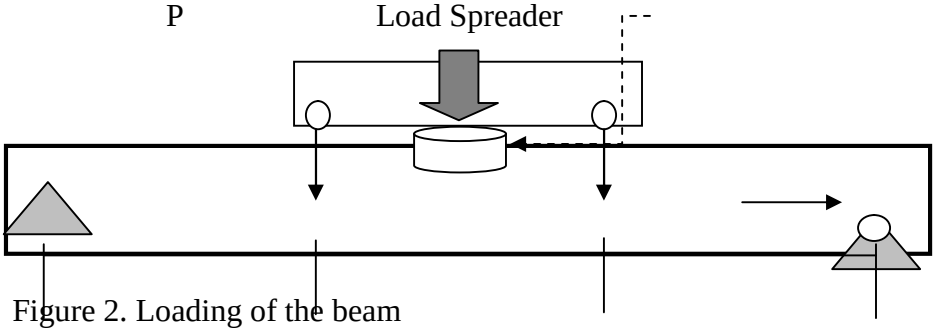


Figure 2. Loading of the beam

## 3. Results and Discussions

### 3.1 Flexural Behavior

Behavior of the beam when given a load indicates that when the load is still small the beam is relatively strong to withstand the load marked by the small deflection of the beam. The increased load is increased resulting in cracks starting to appear on the extreme part of the concrete beam. The cracks continue to propagate in the vertical direction as the load increases. Over time, the number of cracks that occur also increases which not only the old cracks become larger and longer but also new cracks are shifted from the initial crack position towards the outside. Pattern of crack that happened also is characteristic of crack bending that is direction of crack perpendicular axis cross section. Finally after the crack appears more and more then the beam loses its strength to withstand the outside load or be said the beam has experienced failure.

### 3.2 Load-Deflection Relationship

It is seen in the Load-Deflection diagram in the laboratory tests that all test specimens have structural behaviour and capacities of not much different. It is also seen that solid beams (without cavities) have the ability to withstand the best load. The upward curve at the start of the test indicates a slope which is the stiffness of the beam before the first crack occurs. Hence the first crack value greatly determines the behaviour of the bending test object. In addition to obtaining cracked moment values, service moments and ultimate moments, this diagram is also useful for determining ductility of the beam.

The test result values for all specimens are shown in Table 2 showing the load and deflection at the service load and the collapsed load (ultimate) of each specimen.Seen from Table 2 the ductility of the beam with the cavity decreased compared to the less hollow block. However, this decline is considered insignificant. The lowest ductility experienced by the beam with the cavity occurred on the specimen with 9 (nine) hollows of 2.28. Compared to the solid beam with the ductility of 2.78, the ductility of the hollow beam decreased to 82%.

### 3.3 Structural Behaviour

The magnitude of the first cracking moment (Mr), the service moment (My) and the ultimate moment (Mu) of the experimental results are shown in Table 2. It is seen in the table that the experimental results are larger than the theoretical calculations. This is because in the theoretical calculations the ability of concrete is considered zero when the concrete starts to crack. Also shown in the table, there is a decrease in the strength of a hollow block rather than a cavity beam. Compared to cavity blocks, the hollow beam ability with 9 balls in carrying loads decreased by 94%, 95%, and 95% respectively for Mr, My, and Mu. The magnitude of this decline is considered insignificant so that the use of this hollow ball beam can be recommended for application in the field.

**Table 2. Structural Capacity**

| Series | Beam | Fc' (MPa) | Mr (kN.m) | My (kN.m) | Mu (kN.m) | Δy (mm) | Δu (mm) | Ductility Δu/Δy |
|---|---|---|---|---|---|---|---|---|
| 1 | V-0AB | 22,43 | 10,085 | 45,04 | 47,25 | 14,04 | 38,98 | 2,78 |
| 2 | V-2A | 21,57 | 8,628 | 42,78 | 45,41 | 14,36 | 35,80 | 2,49 |
| 3 | V-3A | 23,21 | 10,415 | 44,60 | 46,78 | 15,36 | 37,76 | 2,46 |
| 4 | V-5A | 22,08 | 8,970 | 39,56 | 46,36 | 15,14 | 36,76 | 2,41 |
| 5 | V-7A | 22,42 | 9,210 | 42,84 | 45,36 | 15,74 | 36,50 | 2,32 |
| 6 | V-9A | 22,68 | 9,785 | 42,19 | 45,75 | 16,50 | 37,68 | 2,28 |
| 7 | V-2B | 22,31 | 9,165 | 42,95 | 46,90 | 12,08 | 31,23 | 2,58 |
| 8 | V-3B | 21,95 | 8,783 | 43,47 | 45,34 | 12,42 | 30,06 | 2,42 |
| 9 | V-5B | 22,91 | 9,915 | 42,63 | 45,62 | 12,32 | 31,36 | 2,55 |
| 10 | V-7B | 21,11 | 8,424 | 42,87 | 46,36 | 12,65 | 33,05 | 2,61 |
| 11 | V-9B | 22,49 | 9,51 | 42,99 | 44,78 | 13,50 | 34,40 | 2,55 |

## 4. Conclusions

Based on the results of the analysis, several points can be concluded in the following:

1. Test results indicated that the fracture pattern of all specimens was classified as bending cracks.
2. The presence of spherical hollow has insignificant effect to the structural behavior of reinforced concrete beam. Cracking moments has 83% decreased and the ultimate moment has only 95% decreased.
3. Ductility of the hollow beams was also decreased but since the ductility ≥ 2 it is still acceptable for structural element.
4. Therefore, in order to reduce its self-weight of reinforced concrete beam, the use of spherical hollow beam is highly recommended.

## References


[1] Andriono and Kesuma (1993).Desain Rangka Beton Bertulang di Daerah Rawan Gempa, Second Edition, Erlangga, Ciracas, Jakarta.

[2] Ali, K. and Wahid, A. (2008).Studi Daktilitas balok *massive K-400* dengan Balok Berongga K-400 dan K-300, Second Edition, Erlangga, Ciracas, Jakarta.

[3] Andriono and Kesuma (1993).Desain Rangka Beton Bertulang di Daerah Rawan Gempa , Second Edition, Erlangga, Ciracas, Jakarta.

[4] Caronica (2013).Memahami Beton Bertulang, Revision Edition, Rekayasa Sain Bandung.

[5] Netherlands, B.V. (1997). Inovasi Struktur Sistem Bubble Deck untuk Elemen Pelat Beton Berongga Bola Plastik, http://www.afgruppen.com/Building-Servives/Methods/Bubbel-Deck-/http://en-wikipedia.org/wiki/Voided

[6] SNI 03-2847-2002 (2002).Tatacara Perencanaan Struktur Beton untuk Bangunan Gedung, Standar Nasional Indonesia, Departemen Kimpraswil, Jakarta.

[7] Rahadyanto (2013).Studi Eksperimental Balok Berongga dengan Pemanfaatan Limbah Botol, PET, Universitas Indonesia, Jakarta.

9 786026 126511

Penerbit
Universitas Mataram
Jl. Majapahit, No 62 Mataram West Nusa Tenggara,
Indonesia 83125
Telp: +62-0370-633007 / Fax: +62-0370-636041