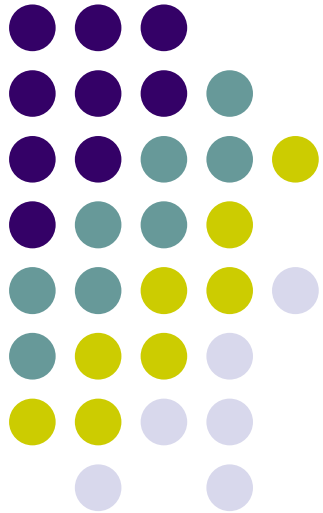
ITB Contributions for Collaborative Research in Feasible and Affordable Seismic Construction



Dyah Kusumastuti

Center for Disaster Mitigation

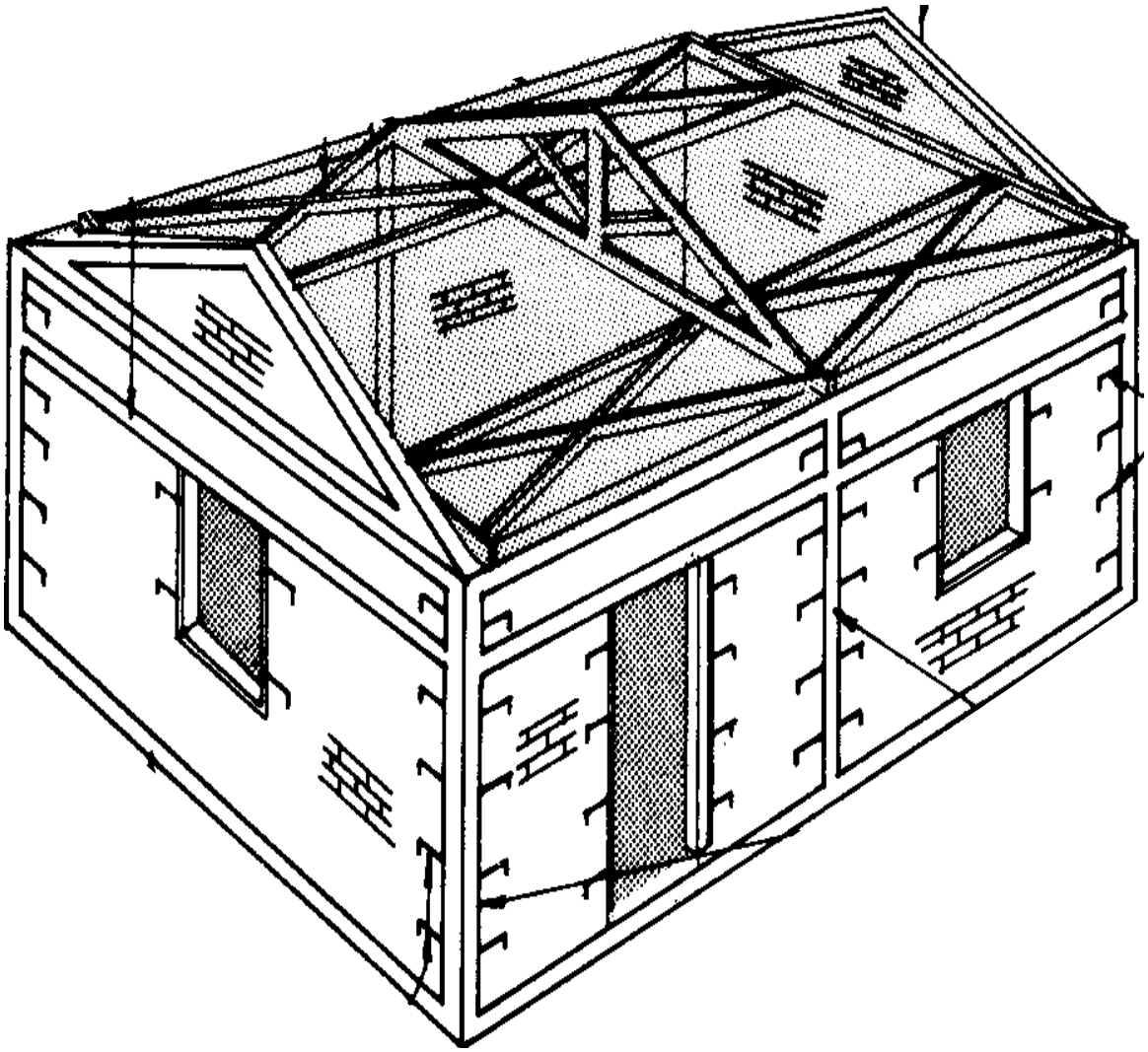
Institut Teknologi Bandung (CDM-ITB)

Expected ITB Contributions

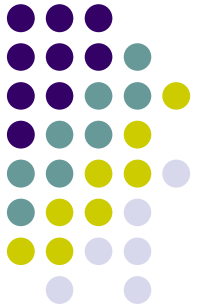
- 2007: study of characteristics of brick and mortar joint material (Southeast Asian region)
- 2008: detailed analysis, simplified evaluation method (model wall structure, test specimen)

Typical Housing in Indonesia

- “Confined masonry” type of structure
- RC columns and beams
- Un-reinforced brick walls



Types of Mechanism and Failure Modes of Walls



- Sliding shear failure
  - Low vertical load and poor quality of mortar
  - Shearing wall in two parts and sliding of the upper part on mortar joint

- Shear failure:
  - Combination of vertical and lateral loads exceeds strength of bricks
  - Diagonal cracks on walls

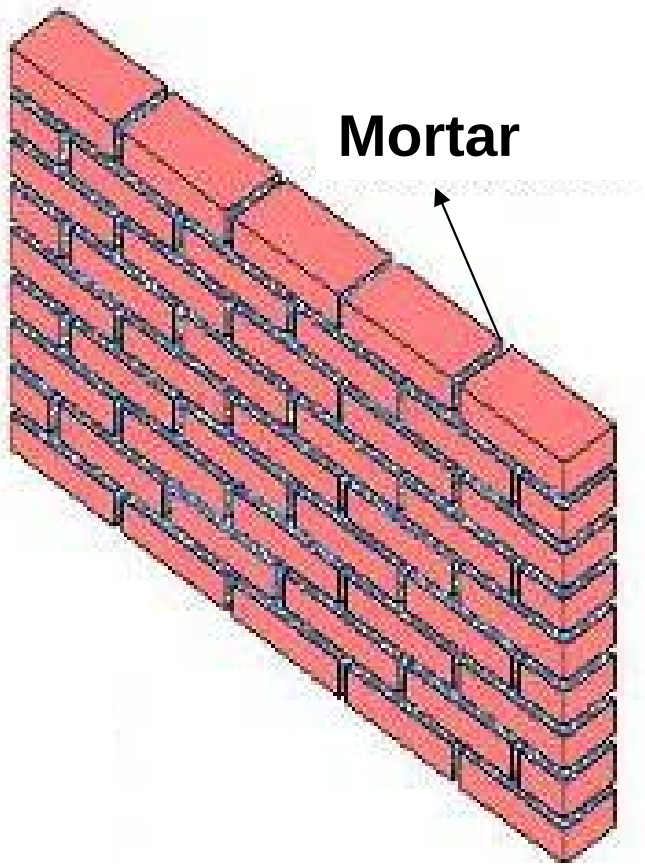
Damage on Wall Elements

- No connection of walls to the structural frame
- Inadequate capacity of frame elements
- Inadequate capacity of wall elements

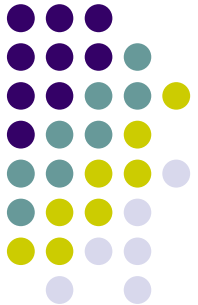
Damage on Wall Elements

Confined Masonry

- Seismic resistance verification:
  - Shear resistance
  - Flexural resistance
  - Out-of-plane behavior
- Quality of masonry walls depend on:
  - Quality of materials (bricks and mortar)
  - Spacing and brick laying

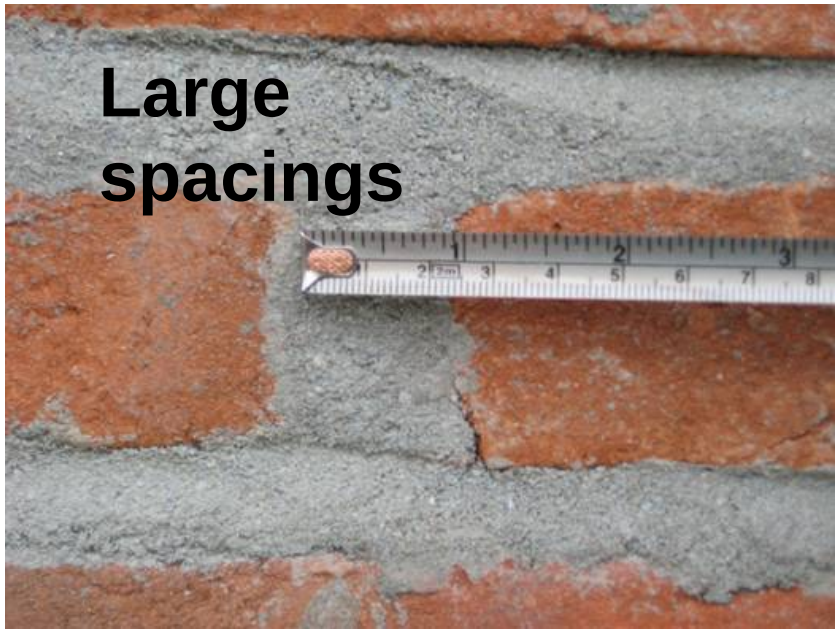


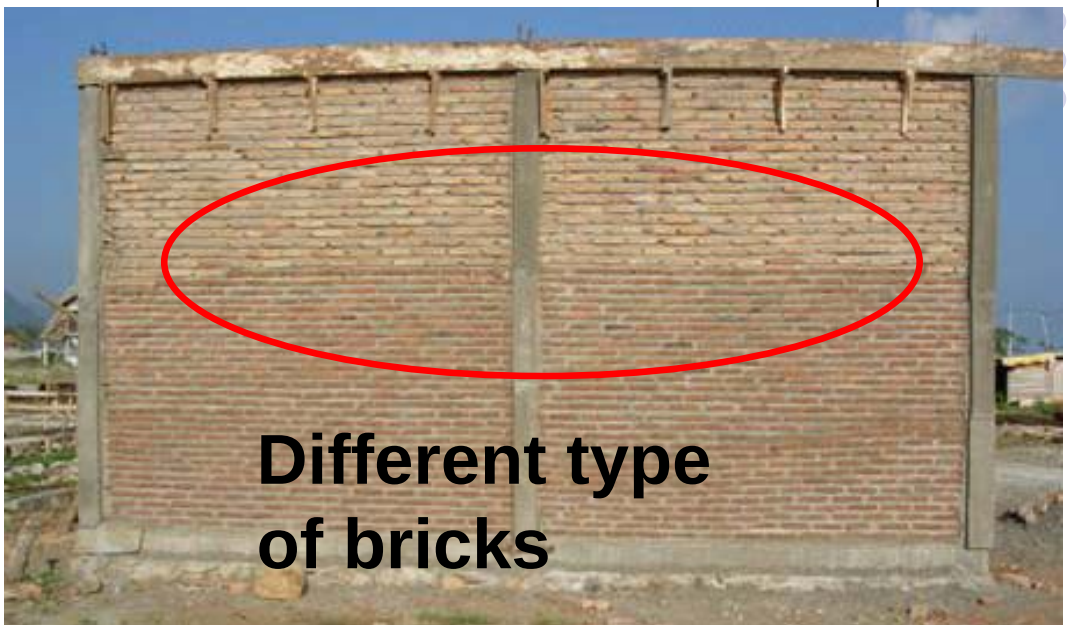
Codes vs Common Practice



- Quality of brick material:
  - Code: good quality (Minimum Class III)
  - Common practice: lower strength (sometimes poor, identified from cracked and melt prior to construction)
- Quality of mortar:
  - Code: Minimum 1 PC : 4 sand (volume ratio)
  - Common practice: 1 PC : 6 sand (volume ratio)
- Spacing:
  - Code: 8 -15 mm
  - Common practice: 15 – 30 mm
- Anchorage
  - Code: frame-wall connection
  - Common practice: no frame-wall connection

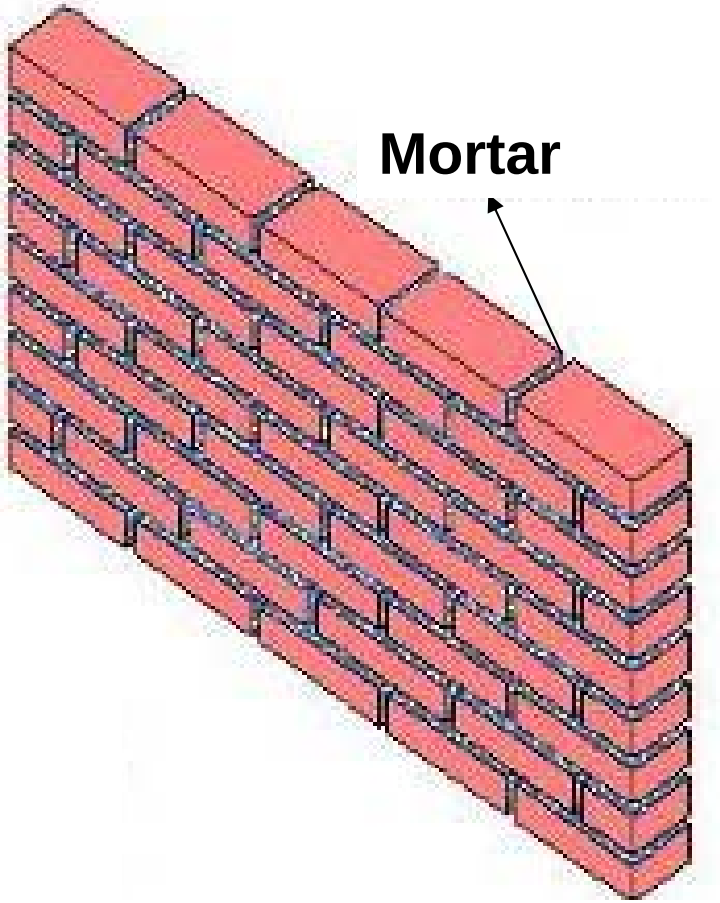
Common Practice for Brick Walls



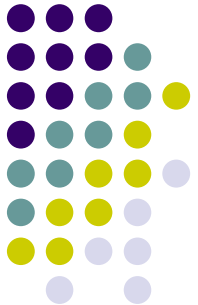


Confined Masonry

- No specific guidelines on modeling the “confined masonry”
- Results for numerical analysis may vary depending on the model
- Experimental approach is necessary to verify numerical analysis



Experimental Simulation



- Full scale tests on brick walls
- Variation of material quality and spacing
- Monotonic and cyclic loading (displacement control)
- Obtained results:
  - Envelope of seismic resistance
  - Hysteretic loop and cyclic behavior
  - Ultimate strength and displacement
  - Damage state (cracks and failures)

Experimental Simulation

- Proposed tests:
  - 2 types of brick quality (good and poor)
  - 2 types of mortar quality (1:4 and 1:6 of PC:sand volume ratio)
  - 4 types of mortar spacing (10 mm, 15 mm, 20 mm, 30 mm)
- Benchmark model:
  - good brick quality
  - 1:4 PC:sand volume ratio
  - 15 mm of mortar spacing
- Total number of specimen: 7

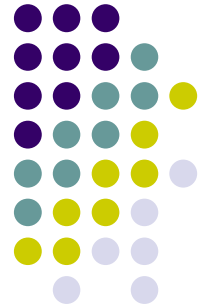
Experimental Simulation

- Geometry of specimen:
  - 1m x 1m unconfined masonry (brick wall)
  - Top and bottom cap for support and gravity load application
- Mechanical quantities to be determined:
  - Compressive strength
  - Shear or tensile strength
  - Modulus of Elasticity
  - Shear modulus
  - Ductility factor

Numerical Analysis

- Setting of basic requirements
  - Performance Based Design Concept
  - Damage limitation
  - Collapse prevention
- Development of wall structural models
- Verification of experimental results
- Assembly of complete structural models
- Calculation of structural response

Expected Research Accomplishment



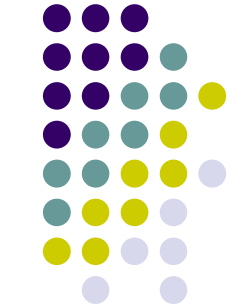
- Seismic resistance verification for typical Indonesian housing
  - Seismic load
  - Lateral resistance
  - Effect of walls on structural stiffness and rigidity
- Development of retrofitting/strengthening strategy for existing structure

2007 Tentative Schedule

Activity	2007				2008		
	9	10	11	12	1	2	3
Study on Materials (Material and Structural Element Test)							
Detailed Analysis (Prediction and Correlation)							
Simplified Evaluation							
Assist on Shake Table Test (Data Organization)							

Other Important Issues

- “Codes vs Common Practice” type of problems
  - Insufficient development length for joint (beam-column connection)
  - Plain rebars used for longitudinal reinforcement
- Numerical analysis may exclude the effects of these problems
- Experimental works are necessary to verify the structural adequacy



Thank you