The Confined Masonry Initiative

International Disaster and Risk Conference, Davos, Switzerland, may 30 – June 3, 2010

The Confined Masonry Initiative

presented by

Sahar Safaie, Consultant, Vancouver, Canada

Svetlana Brzev, British Columbia Institute of Technology, Vancouver, Canada

Marjorie Greene, EERI, Oakland, California

Marcial Blondet, Catholic University of Peru, Lima, Peru

Roberto Meli, National Autonomous University of Mexico, Mexico D.F., Mexico

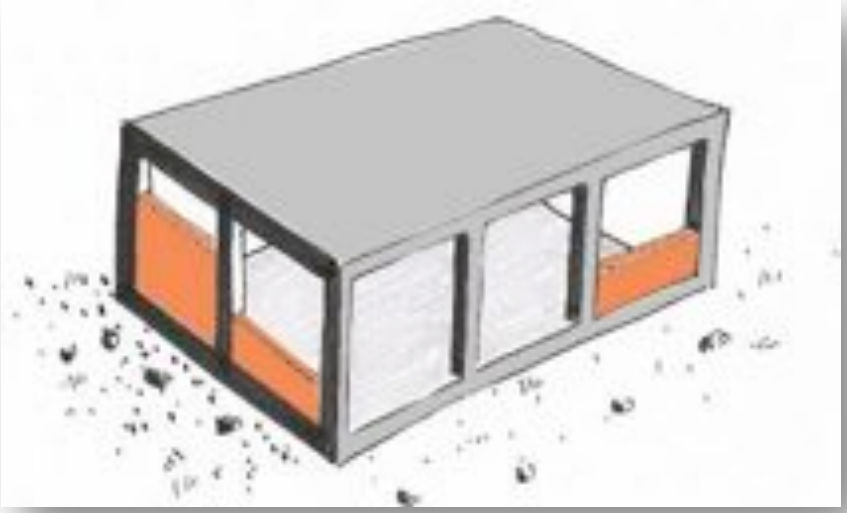
Jonathan Galindo, Catholic University of Peru, Lima, Peru

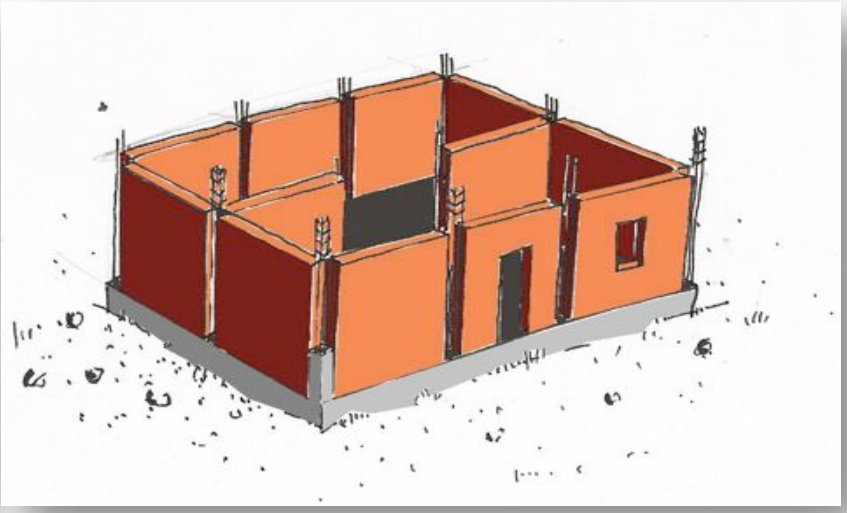
Sudhir Jain, Indian Institute of Technology Gandhinagar, Ahmedabad, India

Tom Schacher, Swiss Agency for Development and Cooperation, Switzerland (presenter)

International Disaster and Risk Conference, Davos, Switzerland, may 30 – June 3, 2010

RC moment frames vs Confined Masonry

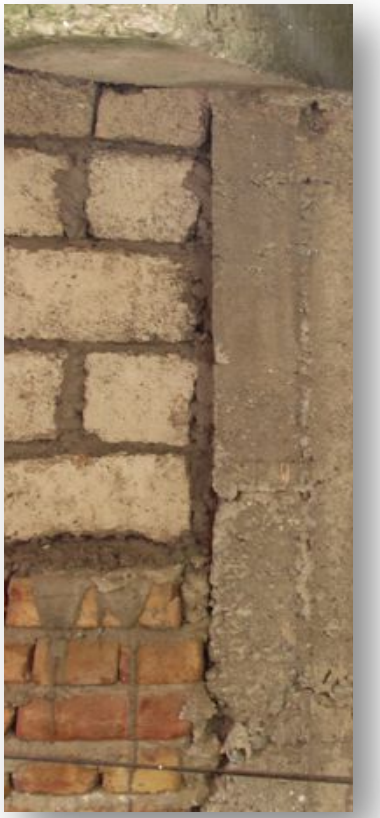




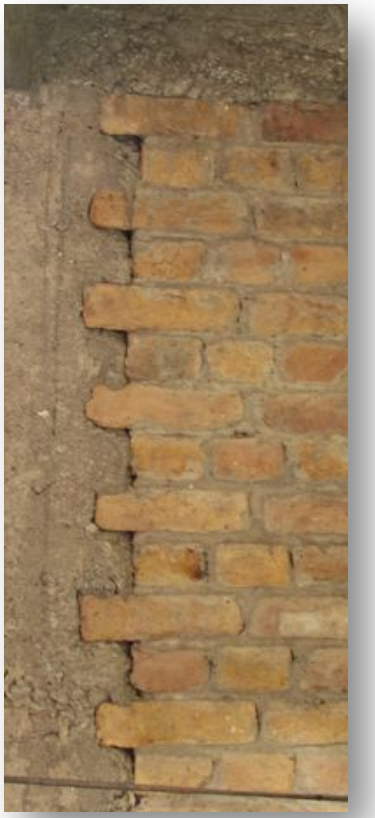
RC
columns first,
walls later

CM
walls first,
columns later

RC moment frames vs Confined Masonry



RC
columns first,
walls later



CM
walls first,
columns later

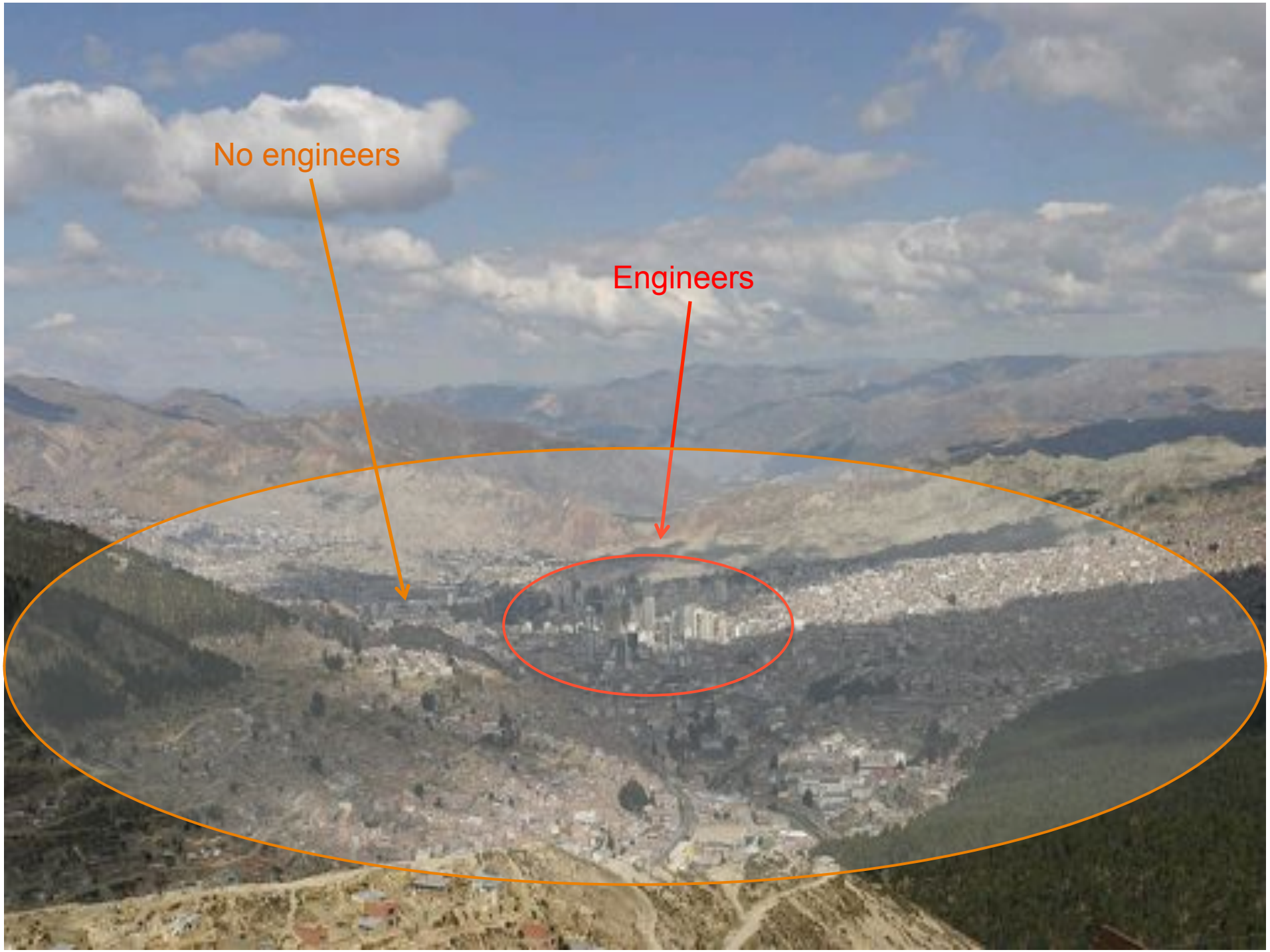
RC frames are 'hi-tech' systems

(because ALL of these conditions must be respected)

- *Steel must be:*
  - In the right place
  - With the right connections
  - Of the right quality and diameter
  - Properly tied
  - With the right embedding
- *Concrete must be:*
  - Of the right mix
  - Poured and vibrated properly
  - Cured properly
- *Formwork must be:*
  - Watertight
  - Properly braced

And

- *Structural concept must be*
  - *Right*
- *Walls must be*
  - Anchored properly or
  - Detached properly


No engineers
Engineers

RC frames in low-tech environments

(Several or all of these conditions apply)

- *Steel is not:*
  - ~~In the right place~~
  - ~~With the right connections~~
  - ~~Of the right quality and diameter~~
  - ~~Properly tied~~
  - ~~With the right embedding~~
- *Concrete is not:*
  - ~~Of the right mix~~
  - ~~Poured and vibrated properly~~
  - ~~Cured properly~~
- *Formwork is not:*
  - ~~Watertight~~
  - ~~Properly braced~~

And

- *Structural concept isn't*
  - ~~*Right*~~
- *Walls are not*
  - ~~Anchored properly or~~
  - ~~Detached properly~~

Typical problems with concrete works

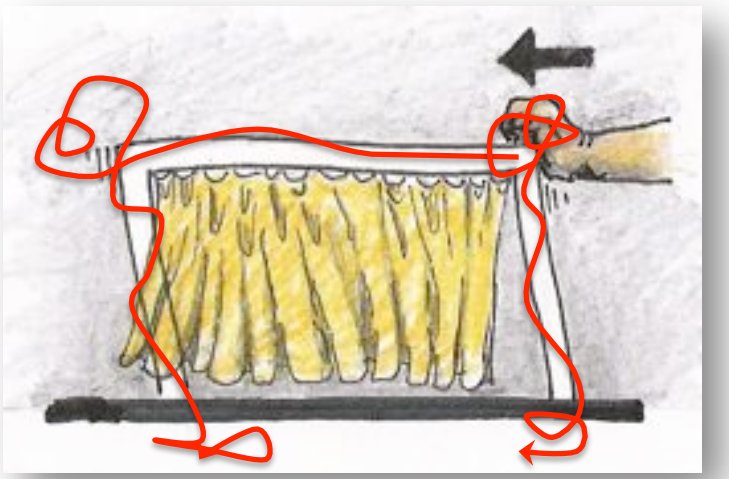
RC frames are too complex

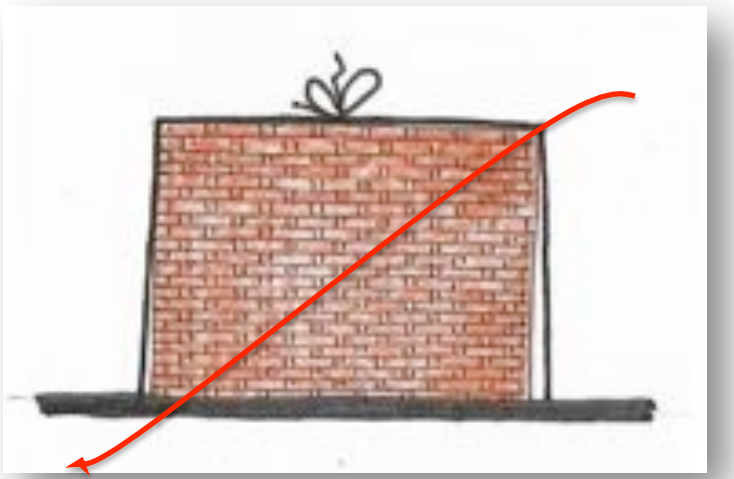
For safe construction
simpler systems are needed

Confined Masonry
is one of them

RC moment frames vs Confined masonry

Load paths (poetically speaking…)



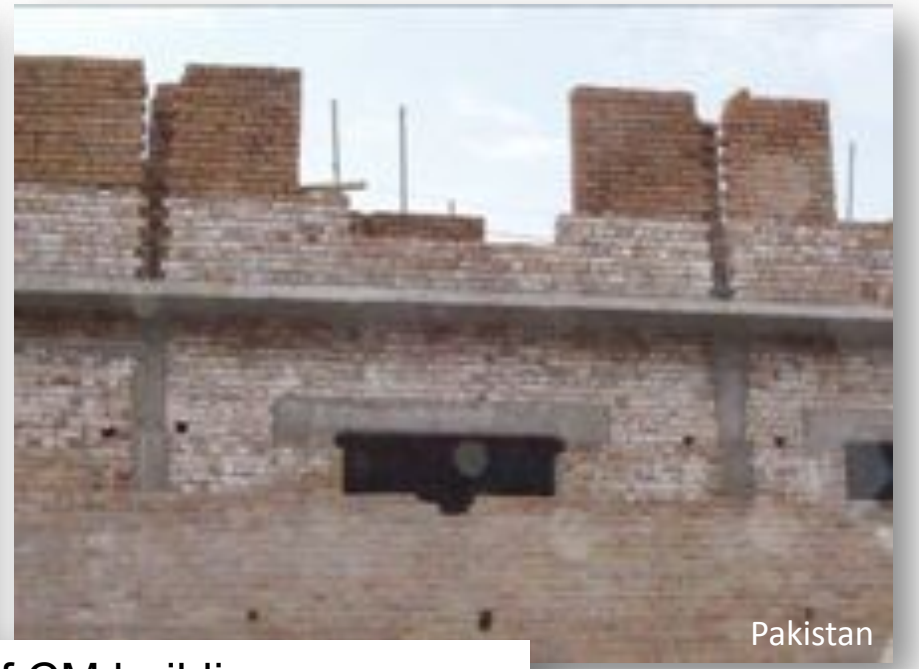


RC
Complex

CM
Simple

Construction of CM buildings

Pakistan


Pakistan

Pakistan

Indonesia

Low rise CM buildings

Pakistan

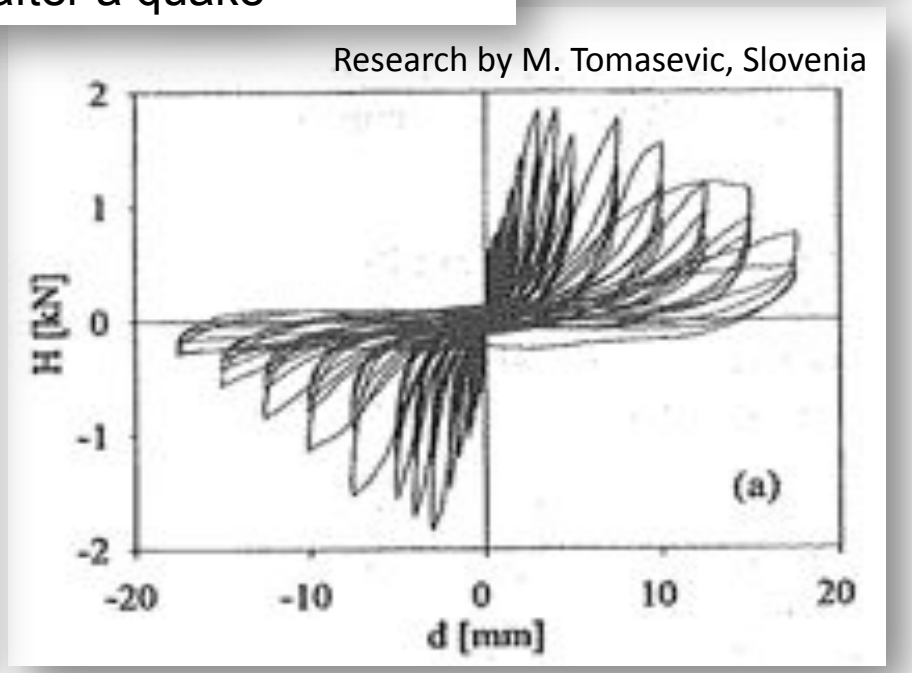
Slovenia

Indonesia

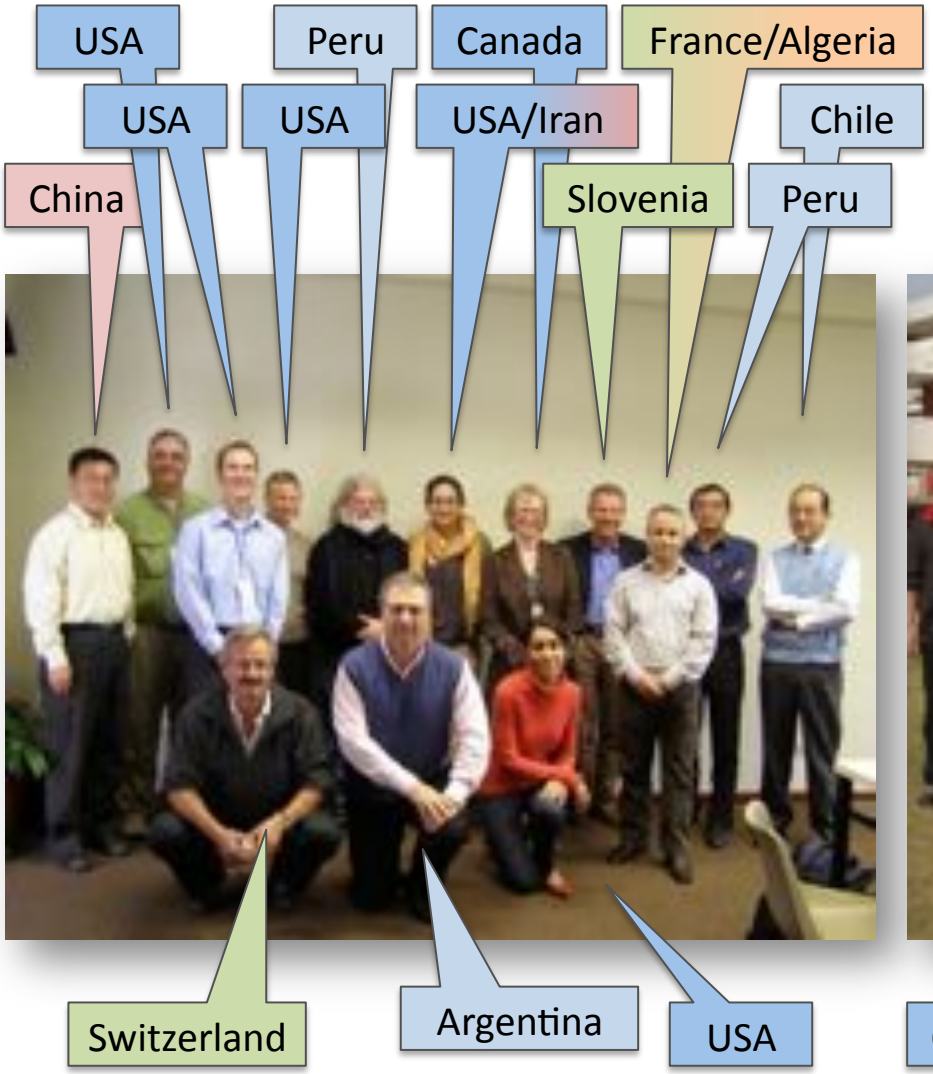
Pakistan

CM buildings after a quake

Research by M. Tomasevic, Slovenia



Medium rise buildings



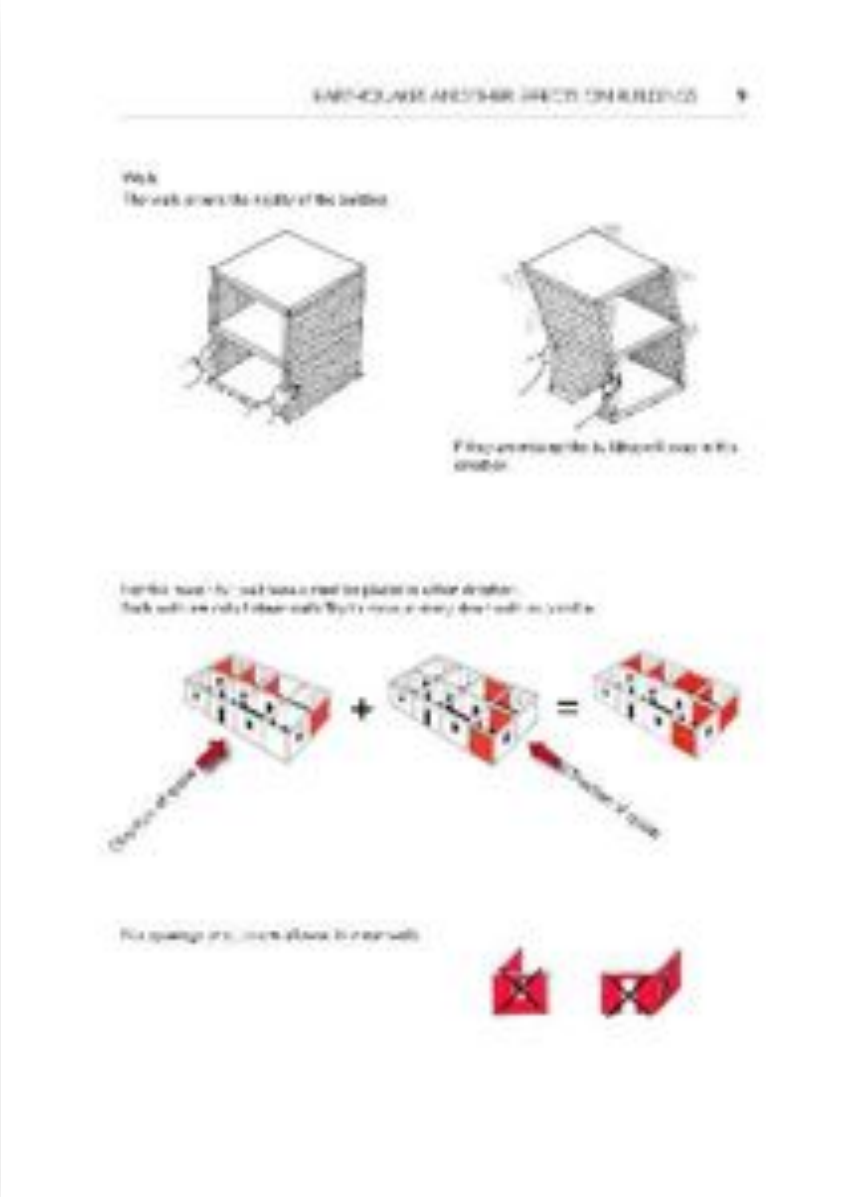
2nd CM Network meeting Peru 2009

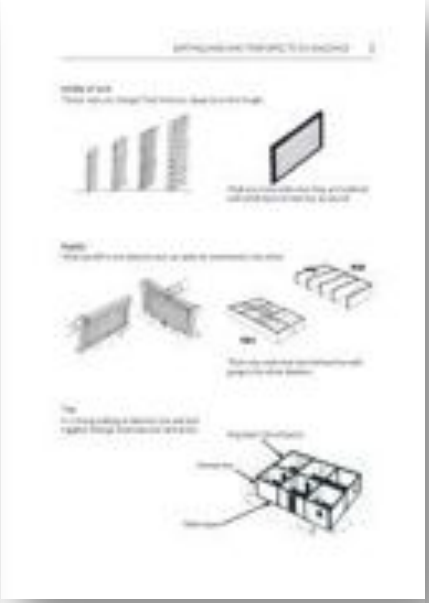
1st CM Network meeting India 2008

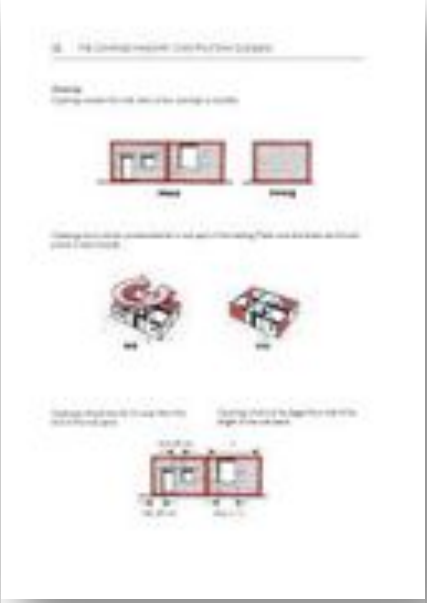
Compilation and analysis of existing material

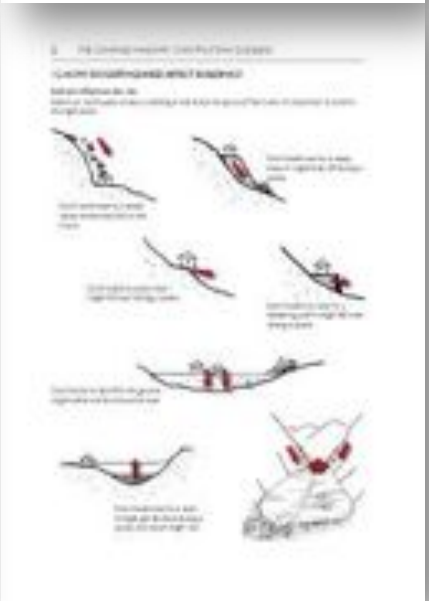
Downloadable at **www.confinedmasonry.org**

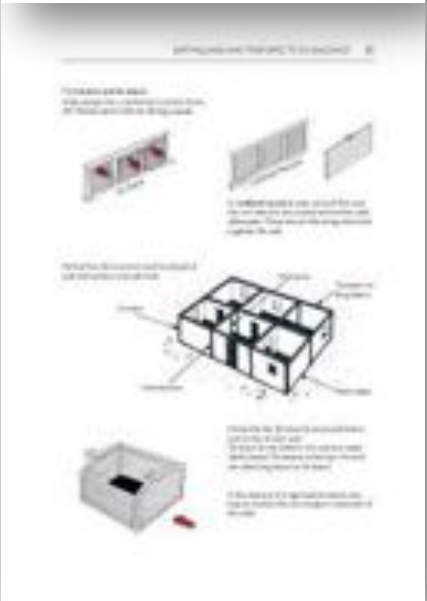
Confined Masonry DESIGN Guideline, Draft



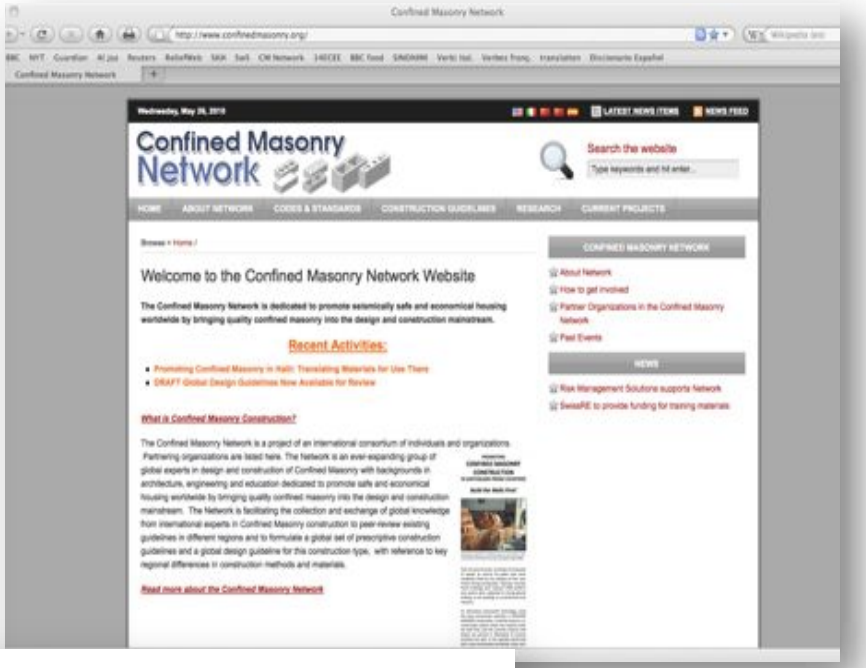








Confined Masonry CONSTRUCTION Guideline, ‘under construction’



Promotion through the internet

Post EQ opportunities: Practical training

Demo building

Full scale training models

On the job training

Training of inspectors

CM training necessary even where already in use

Research Needs for Confined Masonry

Research inputs are primarily needed to characterize the structural action and load-sharing mechanisms of confined masonry (CM) systems under in-plane as well as out-of-plane seismic loads, requiring both experimental as well analytical studies. Several serious research efforts have been made to address many aspects of confined masonry behaviour, especially in Central and South American. It appears that a collaborative and concerted effort will help resolve many issues more conclusively. In the following, research areas have been listed which need further investigation along with those which require fresh initiative:

I. Analysis Aspects of Confined Masonry

- Modeling issues
  - Idealization of CM systems (modeling) for the analysis procedure for both in-plane and out-of-plane response (*e.g., system of strut and tie; wide frame-column model for coupling beams, micro-modeling as assemblages of rigid blocks, FEM, etc.*)
  - Simplified analysis procedure
    - Qualifying criteria, such as limitations on building size, layout of openings in walls, expected seismic loading, etc.
    - Leads to prescriptive design and detailing of CM components
- Capacity and fragility curves
  - Structural behaviour of CM in terms of "generic" load-deformation response (pushover curve) and failure pattern/mechanisms
  - Fragility curves for comparison with other structural systems and for loss estimation studies

II. Structural Design Aspects for Confined Masonry

- Response reduction (or behavior) factor
  - Rational estimate based on key CM parameters which control its seismic performance (*e.g., wall density, building characteristics, seismic zone, site soils, etc.*)
- Primary structural requirement in terms of strength/stiffness for various components/elements of CM
  - Out-of-plane resistance and height/thickness ratio (*Current limits appear to be conservative. Is it true even if the wall is damaged due to in-plane action?*)
  - Maximum size of tie-columns (*usually controlled by wall thickness*)
  - Frame vs. wall lateral stiffness (*Is it a controlling factor? Does it distinguish CM from infilled frames? Should there be a limit on lateral stiffness of confining elements?*)
  - Openings – restrictions on size and spacing/location of openings, tie-columns around openings (*Should they be different from main tie-columns at wall ends?*)

Confined Masonry RESEARCH NEEDS

Research example: need for seismic bands ?

www.confinedmasonry.org

Thank you

and