CONFINED MASONRY vs. RC FRAME WITH MASONRY INFILL
This Guideline is for Single Story Confined Masonry Houses with Lightweight (Flexible) Roofs

- Well-designed and built confined masonry buildings can perform well in earthquakes.
- However, if they are designed and built poorly, they can be deadly.
- Even a well built confined masonry building will probably have cracks in a strong earthquake.
**Which structural system are you using?**

<table>
<thead>
<tr>
<th>Structural System</th>
<th>RC</th>
<th>Frame with Masonry Infill</th>
<th>Confined Masonry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gravity Load</strong></td>
<td>FRAME (columns and beams)</td>
<td>Load bearing confined MASONRY WALL</td>
<td></td>
</tr>
<tr>
<td><strong>Seismic Load</strong></td>
<td>FRAME (columns and beams)</td>
<td>Confined MASONRY WALL (shear wall)</td>
<td></td>
</tr>
<tr>
<td>Beam and Column Design</td>
<td>RC Frame with Masonry Infill</td>
<td>RC Confined Masonry</td>
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<tr>
<td>Ductile detailing and design required in columns and beams (larger sections, larger diameter steel bars, more stirrups at closer spacing)</td>
<td>Ductile detailing NOT REQUIRED in columns and beams, usually done empirically (smaller sections, smaller bar diameters, fewer stirrups) Beams and columns are confining elements acting in tension but CONNECTIONS are CRITICAL</td>
<td></td>
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</tr>
</tbody>
</table>
Which structural system are you using?

<table>
<thead>
<tr>
<th>Process</th>
<th>RC Frame with Masonry Infill</th>
<th>RC Confined Masonry Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRMGE (columns and beams)</td>
<td>FRAME (columns and beams) constructed first</td>
<td>MASONRY WALL constructed first</td>
</tr>
<tr>
<td>Infill / Wall</td>
<td>NONSTRUCTURAL – for space partitioning, generally not attached to frame, but should be restrained from falling out (lightweight material best – masonry infill can have a negative effect on frame)</td>
<td>STRUCTURAL SHEAR WALL – quality workmanship is critical, as is attachment to the tie columns and bond beams</td>
</tr>
</tbody>
</table>
In Confined Masonry, “Bond Beams” are Not True Beams – they are uniformly supported by strip footing or masonry wall.
Be Careful – These Beams Are Beams and Require Ductile Detailing

Build Earthquake Resistant Houses
Change Construction Practice Permanently
This Guideline Does Not Apply to RC Frame and RC Stilt Structures

- FRAME structures must be engineered, designed, detailed, and are beyond the scope of this guideline.
- If you are building a frame structure, consider replacing the heavy brick masonry infill with a lighter weight material and restrain it from falling in an earthquake.
- Reinforced concrete stilt-type structures with heavy mass above the plinth beam, and those with open first floor and heavy second floor, should be avoided in earthquake-prone regions, especially where soft/loose soil conditions exist.
Build Change’s Philosophy

Design/Build Houses which are

1. Safe (earthquake-resistant)
2. Satisfactory (culturally appropriate and comfortable for homeowners)
3. Sustainable (built with locally available materials, tools and skills, affordable)

→ “the three S’s”
<table>
<thead>
<tr>
<th>Uses in Indonesia</th>
<th>RC Frame with Masonry Infill</th>
<th>RC Confined Masonry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Multistory commercial buildings, schools, mosques, 2-story houses for wealthier residents</td>
<td>Single story houses and small shops</td>
</tr>
<tr>
<td>Cost</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Engineering Input Required</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Skill of Workers</td>
<td>Higher</td>
<td>Lower</td>
</tr>
</tbody>
</table>
Build Change’s Philosophy

Make low or no-cost improvements to existing, common ways of building

→ Confined masonry is the most common method currently being used by homeowners to build single story homes in Sumatra and Java
Basic Concept of Confined Masonry

- Masonry walls confined on all four sides by reinforced concrete members – bond beams (sloof – ring balok) and tie columns (kolom utama – kolom praktis)
- Reinforced concrete members are interconnected – connection is critical
- Masonry walls constructed first, tie columns and bond beams cast around masonry walls
- Walls assumed to carry all vertical and lateral loads.
- Contribution of tie column and bond beam to the strength and load resistance is not taken into account.
This is a GUIDELINE because no building code adequately addresses confined masonry specific to Acehnese materials and architectural preferences

→ Single story: most codes and guidelines deal with multiple stories with heavy roof and floors so are overconservative for single story structures with lightweight roofs

→ Tall, slender wall: most building codes recommend a lower height to thickness ratio

→ Large, tall openings: most building codes recommend smaller openings

→ Timber truss roof: acts as a flexible diaphragm, potential for out-of-plane failure must be mitigated in other ways
The Most Important Factors for Good Performance of Confined Masonry Buildings in Earthquakes Are

1. Configuration

2. Connections

3. Construction Quality (Materials and Workmanship)

→ “the three C’s”