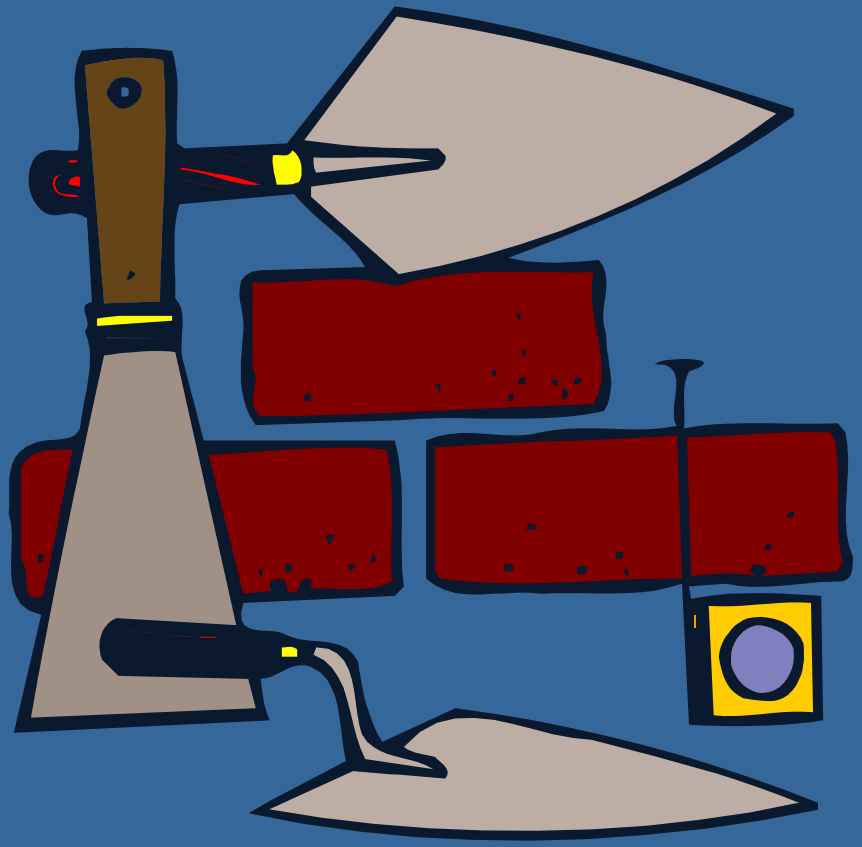
CONSTRUCTION QUALITY: MATERIALS and WORKMANSHIP

FIRED BRICK MASONRY WALL



Many Factors Affect Strength of Masonry Wall

Masonry Unit (Brick)

- Compressive, bending, rupture, tensile strength
- Dimensions and variations in dimensions
- Rate of absorption of water

Mortar

- Compressive, bending, rupture, tensile strength
- Type of cement and cement: sand mix
- Rate of drying

Workmanship and Curing

- Wetting bricks prior to laying
- Curing the wall
- Joint thickness and variation in joint thickness
- Filling and raking out of joints
- Plumb, level, straight, and true to a line

Masonry Panel

- Shear, bending, rupture strength of bricks and mortar combined

Wall Shape and Size

- Width, height, length, slenderness ratio

Plaster

- Increases the thickness and shear strength of the wall

Clean Water for Masonry and Concrete

- Salty water can reduce the strength of concrete by ~20% and corrode steel faster
- Use water that is at least clean enough to wash and bathe with
- Do not use swamp, tidal pond or ditch water →

Clean Sand for Masonry and Concrete

- Avoid beach sand
- Make sure sand is clean from dirt (fines), leaves, tree roots

  →Take a handful of sand, pour some water on it, if the water runs out dirty, reject it

→ Good Quality Bricks

- ❑ No cracks or chips
- ❑ No visible unmixed portions or divits
- ❑ Brick is square, not warped or curved
- ❑ Dimensions are consistent among sample of 10-20 bricks → they do not vary by more than 1 cm in long direction and 5mm in width and height
- ❑ When two bricks are hit together, the sound is a metallic clink not a dull thud
- ❑ When left out in the rain or soaked for 24 hours, bricks do not crumble

→ Use Only Fully Fired Bricks

- *Bad practice → weak (not fully fired) bricks used and eroding in the rain*

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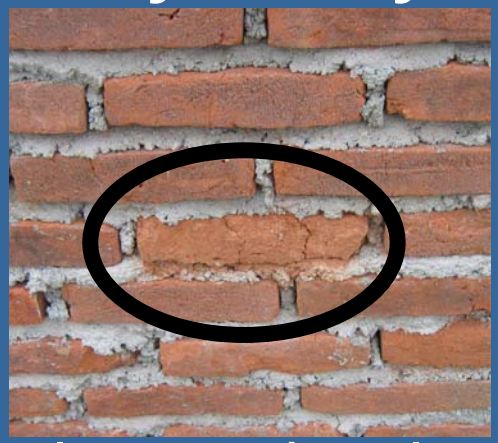

Bad Practice – chisel out and replace →

Three-point bending: a non-quantitative, simple test → 80% pass with an average size Indonesian male, no bouncing

Mortar Mix

- 1:2 for WC (kamar mandi) and damp proof course on bottom 40 cm (approximately 7 courses) of exterior walls



- 1:3 above damp proof course and interior walls




- Use clean water (clean enough for washing and bathing)
- Use enough water to be loose and flowable but not weep out of joints

- Use up the mix within 90 minutes of mixing with water

→Soak Bricks in Clean Water Prior to Laying

Good Practice (Baik)

Bricks soaked prior to laying

Bad Practice (Buruk)

Bricks laid dry

Typical Aceh bricks are too porous: they absorb water from the mortar. This dries out the mortar before the cement has time to hydrate and create a strong bond between the bricks.

If Bricks Are Laid Dry…

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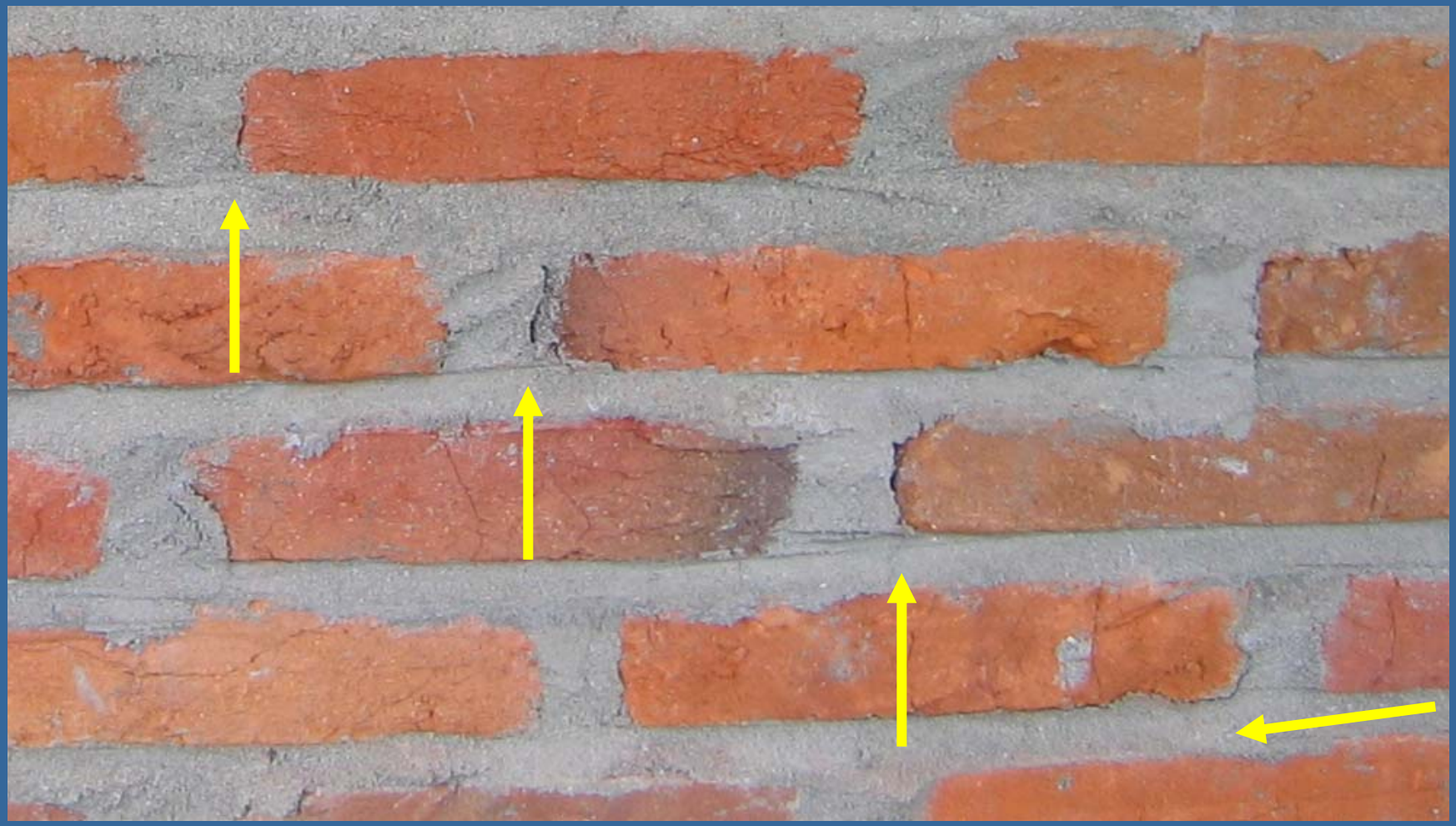

Bad Practice (Buruk)

Hairline shrinkage cracks

Soaking Bricks in Clean Water Prior to Laying

is one of the most important steps you can take to improve the strength of masonry walls built in Aceh, and their performance during earthquakes

→Lay Bricks Horizontally (One Course at a Time)

Good Practice (Baik)

→ *Bricks laid horizontally one course at a time*

→ *Use a line and deadman*

Bad Practice (Buruk)

→ *Difficult to maintain horizontal continuity, plumb and level when bricks are laid several courses at a time*

→ Maintain Uniform Joint Thickness

Good Practice (Baik)

- → *Bricks laid horizontal*
- → *Joint thickness maximum 15 mm*
- → *Joint thickness varies by less than 4mm*

Bad Practice (Buruk)

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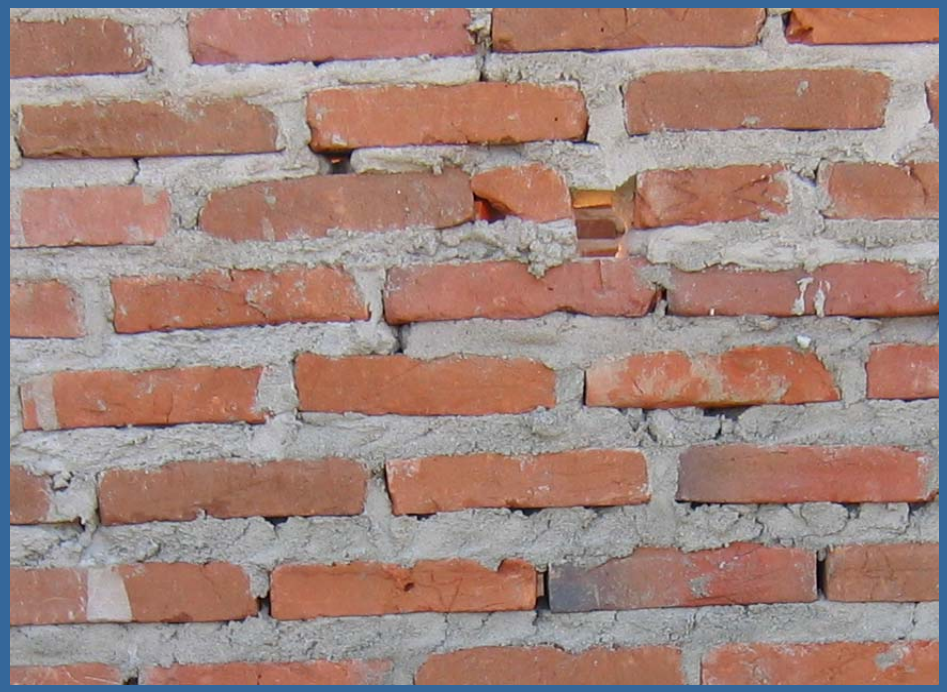
→ Fill Joints Completely



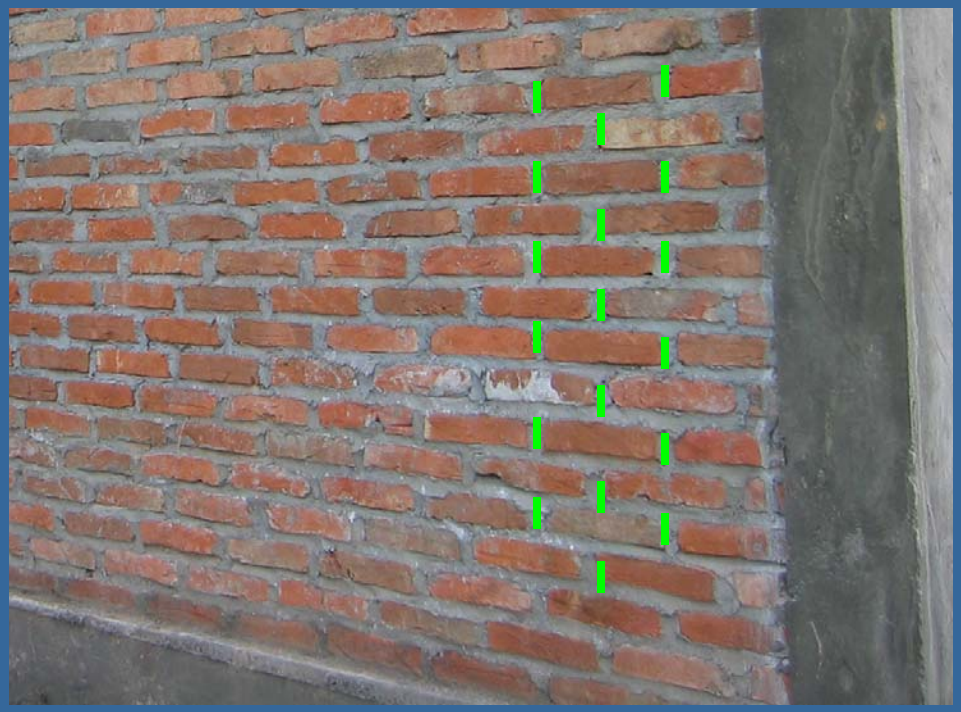
Good Practice (Baik)

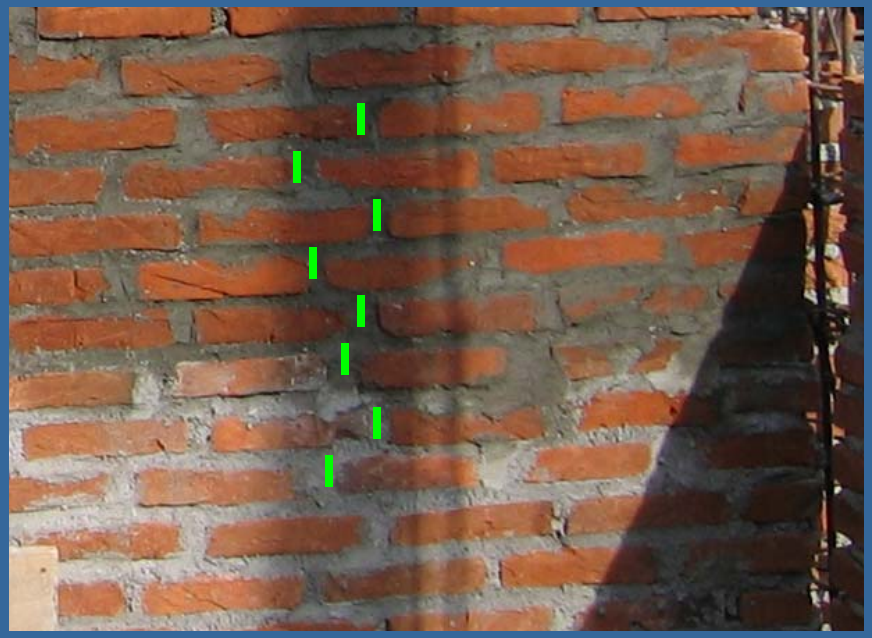
→ *Joints filled*

Bad Practice (Buruk)

→ *Joints not fully filled with mortar (some head joints don't have any mortar; it is possible to see through the wall)*

→ Stagger Vertical Joints





Good Practice (Baik)

→ *Bricks laid end-to-end*

→ *Bond staggered*

Bad Practice (Buruk)

→ *Bond inconsistent*

→ Maintain Consistent Spacing Between Bricks and Column Steel

2 – 3 cm depending on size of column

Bad Practice (Buruk)

Gap between bricks and steel too large - check steel remains plumb

Gap between bricks and steel too large at bottom, too small at top – no space for concrete cover over steel

→ Avoid Bond Discontinuities
Avoid Small Panels

Photo **Courtesy R. Willison, UNDP**

Bad Practice (Buruk)

→ *Discontinuous bond between column and window frame*

→ *Small masonry panels between column and window frame*

→ Avoid Patterned Bonding Over Frames

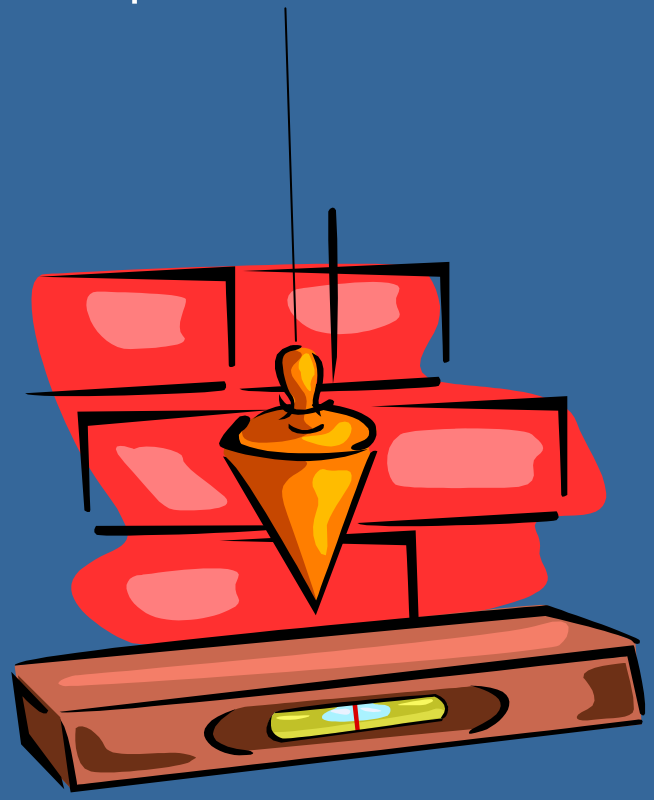
WHY? No arch effect in practice

Better to use horizontal steel reinforcement (tied into adjacent columns) and running bond

→ Regularly Check Plumb

If the variation from plumb is more than 2 cm over 3m height, tear down and rebuild (bonkar)

Use a plumb bob or level



→ Cure the Wall

Sprinkle water on the wall for at least three days (depending on the type of cement and weather)

→ Plaster the Wall

Good quality, cement-based plaster will increase the strength and thickness of a fired brick masonry wall