TECHNICAL NOTE #20

Clay Brick vs Concrete: Movement of Masonry

All building materials change in volume in response to changes in temperature or moisture. Changes in volume, elastic deformations, creep and other factors result in movement that can cause stresses within building elements, resulting in cracks and crazing of surface plaster and paint. It is therefore important to understand the intrinsic properties of construction materials.

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EXECUTIVE SUMMARY

All building materials change in volume in response to changes in temperature or moisture. Changes in volume, elastic deformations due to loads, creep and other factors result in movement. This movement causes stress within the structure and often results in unsightly cracks and plaster crazing, as well as potential integrity issues.

The amount of movement depends on the material, the climatic zone and rainfall. By knowing the factors that influence masonry movement, architects and contractors can minimise damage and reduce maintenance costs over the life of the building. *SANS 10249: Masonry Walling* provides important information on movement in masonry, as well as methods of mitigation.

Figure 1 Typical cracks in masonry due to thermal and moisture expansion and contraction.

MOVEMENT OF MASONRY DUE TO MOISTURE

Masonry materials expand and contract due to changes in moisture levels during wet weather (reversible moisture movement). Clay bricks rarely exhibit movements in excess of 1mm per 10 metres of walling.

Because concrete is more porous, concrete bricks exhibit reversible expansion and contraction in the range of 3-6mm per 10m of walling.

Clay bricks have a once off, permanent expansion after manufacture due to the firing process that extracts all moisture from the brick. This expansion is between 0 and 0.2%.

The bulk of a clay brick's expansion takes place in the first six months after manufacture and is typically accommodated during construction with vertical movement joints.

The risk of cracking can be reduced by:

- Avoiding the use of clay and concrete units in the same wall
- Incorporating a cavity in a double leaf wall if different materials are used in the exterior and interior wall.
- Incorporating movement joints in the brickwork

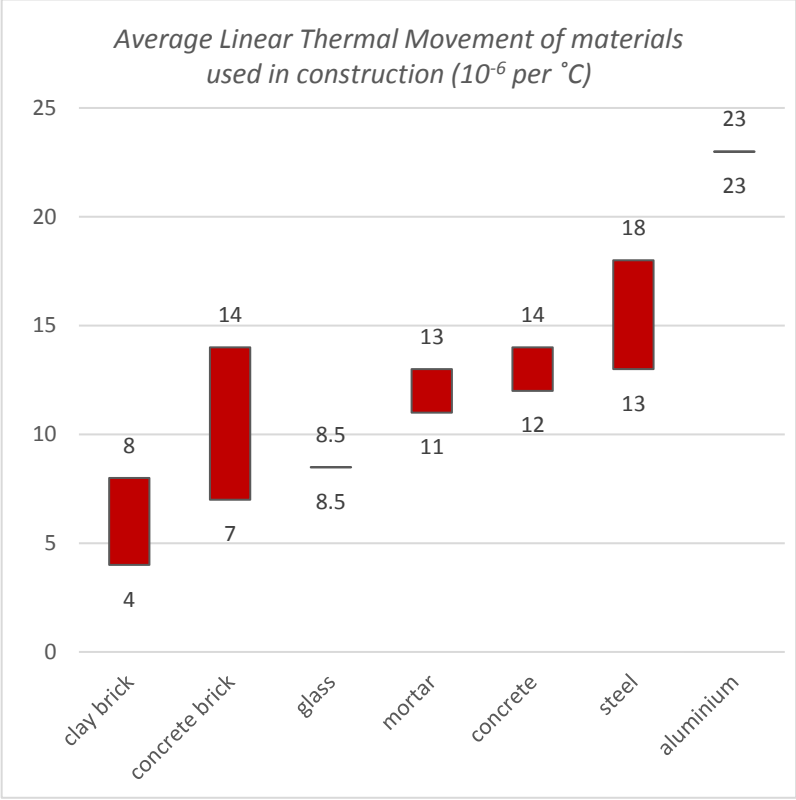
Clay bricks are fired in a kiln at extremely high temperatures. Concrete bricks are dried in the sun.

Movement of Masonry due to Temperature

All building materials also undergo daily thermal expansion and contraction and these daily temperature swings can result in stress cracks over time. Cracking is likely where two different material meet, and therefore structures that combine different material are particularly at risk.

South Africa experiences daily temperature swings of about 20˚C during both winter and summer. We have extremes of heat, compared with the extremes of cold experienced in the northern hemisphere.

Architects need to consider factors beyond the walling material. Movement of the adjoining structural steel frames, aluminium, timber, and concrete floor or roof slabs can all cause distress in either supported or infill masonry of every type.



DAILY AND SEASONAL TEMPERATURE FLUCTUATIONS

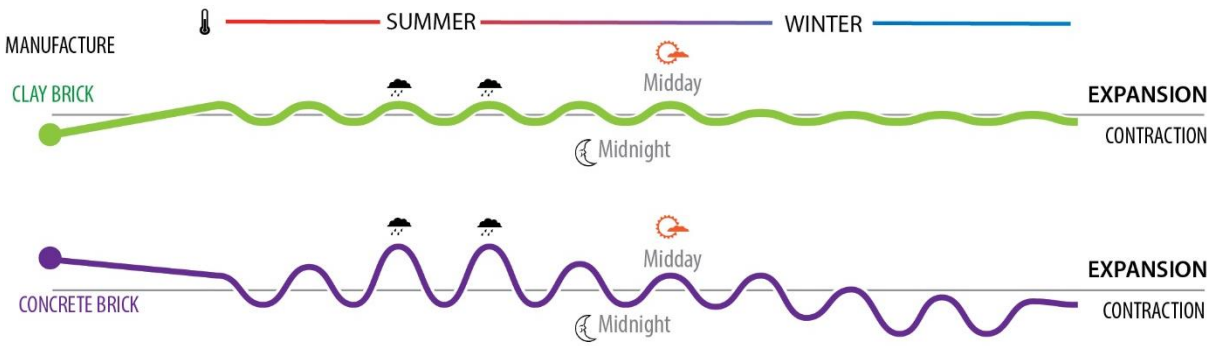


Figure 2 Expansion & contraction of masonry materials based on combined thermal and moisture coefficients.

CLAY BRICK: Thermal expansion and contraction is minimal throughout the year. Depending on the clay mixture and firing process, the coefficient of linear thermal movement is 4-8.

CONCRETE BRICK: Moisture movement is exacerbated by a daily cycle of thermal expansion and contraction. Depending on the type of aggregate and proportions, the coefficient of linear thermal movement is 7-14.

CONCRETE BLOCK: The movement coefficient of concrete blocks is similar to concrete bricks, but because blocks are larger the magnitude of movement is greater. Large blocks show cracks and plaster crazing more than smaller concrete units.

When concrete masonry walls are plastered and painted, the continuous cycle of reversible movement that takes place in concrete masonry means that these types of walls must be restored, replastered and repainted more often to preserve the exterior finish.

Plaster Crazing

Non-structural Crack

STRUCTURAL INSTABILITY DUE TO MASONRY MOVEMENT

Masonry movement due to shifts in foundations and soil compaction are serious and require a professional engineer to assess their impact on structural stability.

When evaluating unreinforced concrete block walls, the characteristic of the crack and the location of the crack need to be considered. Structural stability can be affected when there is a notable loss of contact between blocks.

ACCOMMODATING MOVEMENT IN MASONRY

In terms of clay brick construction, there is a significant body of knowledge available to contractors and architects during specification, design, construction and maintenance.

Clay brick and concrete masonry should be given special attention with regard to movement joint placement (vertical, and horizontal in the context of framed structures) and their detailing, in order to reduce unsightly cracks. Movement in masonry can be accommodated by separating walls into discrete panels through the provision of control (movement) joints that reduce stress build-up.

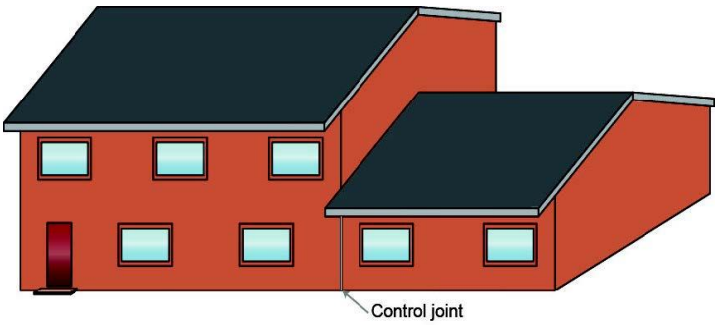


Figure 3 A Control Joint at a change in an external wall separates a long wall into separate panels that reduce stress.

The design and positioning of control joints should accommodate movement but should not impair the stability of the wall or any of its functions such as impermeability, sound insulation and fire resistance.

Long masonry walls can accommodate expansion and construction with vertical movement joints:

	Moisture Expansion (%)	Spacing of vertical joints 1cm wide.			
		Unreinforced		Reinforced Bed Joint #	
		Wall*	Building	Wall*	Building
Clay Brick Category 1	<0.05	16	18	16	18
Clay Brick Category 2	0.05 – 1.0	10	14	12	16
Clay Brick Category 3	0.1 – 0.2	6	10	8	12
Concrete brick/ block	0.03 - 0.06	5	8	10	12

* Free Standing wall
# Masonry with bed joint reinforcement at vertical centres that do not exceed 450mm

PRE-FABRICATED CONCRETE PANELS

Due to their large size and low density, many pre-manufactured concrete panels experience extreme expansion and contraction as do the steel structures that support them.

Joints in these structures will need special attention if they are to remain waterproof and air-tight.

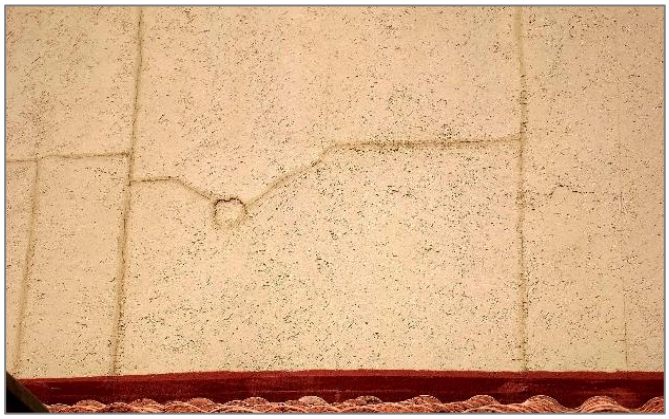


Figure 4 Cracking between pre-fabricated concrete panels and the steel frame due to thermal, moisture and foundation movement.

Please see the Clay Brick Association website for our Technical Guide and Bricklaying Made Easy, as well as numerous Technical Notes on accommodating the lesser movement associated with clay brick masonry walls.

For further information:
The Clay Brick Association of Southern Africa
Website: www.claybrick.org