9

MOVEMENT AND MOISTURE CONTROL

Masonry walls are relatively brittle and typically include thousands of linear feet of mortar joints along which cracks and bond line separations can occur. Thermal and moisture movements and dissimilar movements between adjacent materials should always be considered, and components selected and detailed accordingly. Concrete products shrink, clay products expand, and metals expand and contract reversibly. Such movement is accommodated through flexible anchorage and the installation of control joints in concrete masonry and expansion joints in clay masonry. Coefficients of thermal expansion and moisture movement coefficients can be used to estimate the expected movement of various materials, and movement joints sized and located accordingly. If details do not sufficiently accommodate wall movement, excessive moisture can penetrate through the resulting cracks.

9.1 MOVEMENT CHARACTERISTICS

One of the principal causes of cracking in masonry walls is differential movement. All materials expand and contract with temperature changes, but at very different rates. All materials change dimension due to stress, and some develop permanent deformations when subject to sustained loads. Masonry walls are much stronger than in the past because of high-strength units and portland cement mortars, but strength has come at the expense of flexibility. Using masonry as we do today with ductile steel and concrete skeleton frames requires careful consideration of the movement characteristics of each material. Clay masonry expands irreversibly after firing with the absorption of atmospheric moisture. Concrete masonry shrinks irreversibly with the loss of residual moisture from the manufacturing process. Clay masonry expands and concrete masonry shrinks until the units reach an equilibrium moisture content with the environment which surrounds them. Cracking in the masonry can result from restraining the natural expansion or contraction of the materials themselves, or from failure to allow for differential movement of adjoining or connected materials.

9.1.1 Temperature Movement

The thermal movement characteristics of most building materials are known, and a standard coefficient can be used to calculate expected movement for a given set of conditions. The table in *Fig. 9-1* shows that the potential for thermal expansion in masonry is relatively small compared to that of metals.

Average Coefficient of Linear Thermal Movement (T_c)	
Material	T_c (in./in/°F) (multiply by 10^{-6})
Brick	
clay or shale brick	3.6
clay or shale tile	3.3
fire clay brick or tile	2.5
Concrete Masonry	
normal weight	
sand and gravel aggregate	5.2
crushed stone aggregate	5.2
medium weight	
air-cooled slag	4.6
lightweight	
coal cinders	3.1
expanded slag	4.6
expanded shale	4.3
pumice	4.1
Stone	
granite	2.8–6.1
limestone	2.2–6.7
marble	3.7–12.3
sandstone	4.4–6.7
slate	4.4–5.6
travertine	3.3–5.6
Concrete	
calcareous aggregate	5.0
siliceous aggregate	6.0
quartzite aggregate	7.0
Glass	5.0
Metals	
aluminum	13.2
steel, carbon	6.7
steel, stainless	
300 series	8.9–9.6
400 series	5.8–6.1
brass	10.4
bronze	10.0–11.6
copper	9.4–9.8
zinc	
rolled	17.4
alloy, with grain	13.0
alloy, across grain	9.8
Wood	
parallel to fiber	
fir	2.1
maple	3.6
oak	2.7
pine	3.0
perpendicular to fiber	
fir	32.0
maple	27.0
oak	30.0
pine	19.0

Figure 9-1 Coefficients of linear thermal expansion for some building materials.