joint failure. Although normal tolerances for different materials vary considerably (see Chapter 15), a reasonable estimate must be made of the combined or net effect on the joint. Once that allowance is determined, it must be added to the previously calculated joint width requirements in the formula

$$W = W_t + W_m + W_c \tag{9.6}$$

where W = total calculated joint width, in.
W_t = minimum joint width for thermal movement, in.
W_m = minimum joint width for moisture movement, in.
W_c = minimum joint width for construction tolerances, in.

The sealant joint width calculation process is summarized in *Fig. 9-15*. If the calculated joint is too wide for aesthetic considerations, the assumed spacing or panel length can be decreased and the width recalculated.

In order for the sealant to function properly, most sealant industry sources recommend that for butt joints up to ½ in. wide, joint depth should be less than or equal to the width, with 2:1 a preferred ratio. Sealant depth should be constant along the length of the joint, and should never be less than ¼ in.

9.3.2 Joint Locations

The calculations for joint width and spacing apply to continuous walls with constant height and thickness. Joint locations may be adjusted, or additional joints may be required for other conditions. The exact location of control and expansion joints will be affected by design features such as openings. Rule-of-thumb movement joint locations for brick and block construction include

- Changes in wall height (*see Fig. 9-16*)
- Changes in wall thickness (such as pilasters)
- Offsets in parallel walls (*see Fig. 9-17*)
- One side of openings 6 ft or less in width (*see Fig. 9-18*)
- Both sides of openings more than 6 ft wide
- Near corners in clay masonry constructin (*see Fig. 9-19*)

Movement joints should always be located at points of weakness or high stress concentration such as these, and coincidentally with movement joints in floors, roofs, foundations, or backing walls. Joints should be located at the calculated spacing along walls or sections of walls which are not interrupted by such elements.

In brick walls, expansion joints should be located near the external corners of buildings, particularly when the masonry is resting on a concrete foundation. The shrinkage of the concrete, combined with the expansion of the brick, can cause the wall to slip beyond the edge of the foundation or to crack the concrete (*see Fig. 9-20*). The opposing push of the intersecting veneer wythes can also crack the brick itself (*see Fig. 9-21*).

Brick parapet walls experience differential movement from the walls below caused by a variation in exposures. Even in a light rain, the tops and corners of a building will always get wet, but the rest of the walls may stay dry, resulting in more wet–dry cycles at the parapet. The temperature of the building enclosure walls is also moderated by interior heat and air conditioning, so the parapet is exposed to higher and lower extremes. As a result of these

JOINT WIDTH	THERMAL MOVEMENT	MOISTURE MOVEMENT
$W = W_T + W_M + W_C$ where: W = design joint width W_T = thermal movement W_M = moisture movement W_C = construction tolerance (varies with type of material)	$W_T = (T_c)(\Delta T)(L)$ where: T_c = thermal expansion coefficient (from Table 1) ΔT = Ts - Tw Ts = summer air temp. (°F) plus heat capacity constant (H from Table 2) x solar absorption coefficient (A from Table 3) Tw = winter air temperature (°F)	$W_M = (M_c/100)(L)$ where: M_c = moisture movement coefficient (Table 4) L = panel length or joint spacing, inches

TABLE 1 Thermal Movement Coefficient (T_c)

Material	T_c
Brick	
clay or shale	3.6
fire clay	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

TABLE 2 Constant for Heat Capacity (H)

Type of Material	(H)
Low heat capacity materials§	100
	or
Solar radiation reflected on low heat capacity materials±	130
High heat capacity materials§	75
	or
Solar radiation reflected on high heat capacity materials±	100

§ Materials such as EIFS and well-insulated metal panel curtain walls have low thermal storage capacity. Materials such as concrete and masonry have high thermal storage capacity.

± If the wall surface receives reflected as well as direct solar radiation, use the larger coefficient. Reflected radiation may be from adjacent wall surfaces, roofs, and paving.

TABLE 3 Solar Absorption Coefficient (A)

Material	A
Brick, light buff	0.50-0.70
Brick, red	0.65-0.85
Brick, white	0.25-0.50
Concrete, natural	0.65
Marble, white	0.58
Surface color	
black	0.95
dark gray	0.80
light gray	0.65
white	0.45

TABLE 4 Moisture Movement Coefficient (M_c)

Material	M_c	Type of Movement
Concrete, gravel aggregate	–0.03 to –0.08	shrinkage
Concrete, limestone aggregate	–0.03 to –0.04	shrinkage
Concrete, lightweight aggregate	–0.03 to –0.09	shrinkage
Concrete block, dense aggregate	–0.02 to –0.06	shrinkage
Concrete block, lightweight aggregate	–0.02 to –0.06	shrinkage
Brick, clay face	+0.03 to +0.08	expansion

Figure 9-15 Summary of method for calculating required sealant joint width. (Based on ASTM C1472, Standard Guide for Calculating Movement and Other Effects When Establishing Sealant Joint Width. *Copyright ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428.*)