Joint Design

1. Joints in Constructions

Bigger, wider and taller structures started to be constructed with developing modern construction sector. Therefore dimensional changes of the material due to temperature and the stresses occur as a result of that, wind pressure, the own weight of the construction, loads carried by the constructions have increased and gained more importance. One of the most important parameters to be considered carefully is the design of the joints between units, components and elements constituting a structure.

Movements cannot be completely prevented, for example in case of 25 degrees temperature difference on a 4 km concrete runway, pavement can get 60 to 120 cm longer or shorter in total depending on the type of concrete. Well designed joints are those allowing limited individual movements of the joined parts or the systems without adversely affecting their functions.
Summer – winter temperature difference exceeds 50°C in Turkey. Also without necessary precautions, stresses due to the temperature differences between day and night and between the surface and underground parts of the concrete deck will cause significant damages. Dimensional change due to these temperature differences and other reasons can predictably cause damage to runways and other wide area pavements. Similarly, dimensional change must be considered at structures such as tall buildings, long bridges, roads, industrial facilities, pipelines, canals, dams and tunnels.

Consequently, joint design is extremely important in construction, utilization and management of a structure without problems.

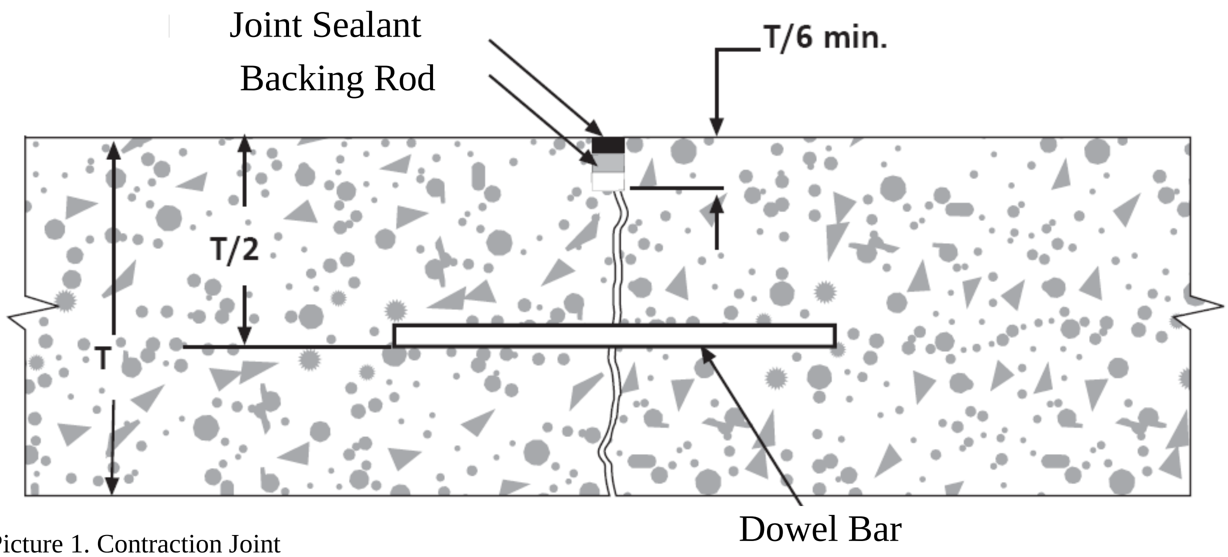
For a good design, applicable joint sealant properties must be considered as well as static and dynamic factors and substrate properties. A proper application is possible only with that information and suitable material selection.

2. Joint Design

Joints can be divided into two groups in terms of their functions:Contraction JointsDilation / Expansion Joints

a. Control joints (contraction joints) These are joints made to limit damages to the construction due to system movements that occur at unpredictable locations and times.
Especially coatings at wide concrete pavements are under risk with the effects of upper loads or floor infrastructure or with the effect of the contraction that occurs during curing of the fresh concrete. In order to prevent the concrete to be damaged, coatings on wide areas are separated into regular parts (decks) by joints cut at certain distances. This process is carried out by cutting the coating down to a certain depth or by means of separation strips. Generally accepted depth for these joints is 15 – 30 % of the coating thickness.
Although the concrete pavement divided into regular decks with contraction joints, will be broken along these joints forming the weakest line against the loads it cannot bear, it will be able

to continue its function or the damage occurred will be corrected by repairing only certain parts. Too shallow, low depth joints cannot provide desired functions.

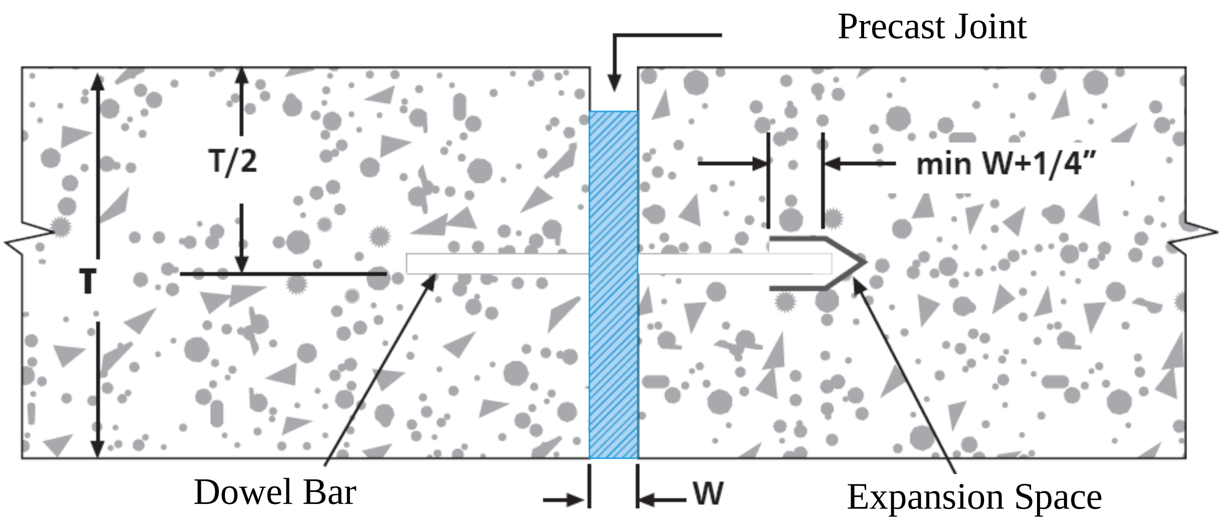


Picture 1. Contraction Joint

b. Expansion (dilation) joints

These are joints left to control the damages of foreseeable system movements and various factors on the structure. These factors are temperature change, wind load and traffic load.
Here, calculation of dimensional change due to temperature change and by using that value calculation of the width and number of joints will be explained briefly and just for concrete pavements. It is possible to make similar calculations for various materials by using the values in the tables provided.

Expansion joints at the concrete pavements form along the entire thickness of the pavement. These joints are generally formed while casting the concrete.



Picture 2. Expansion Joint

CALCULATION OF THE DIMENSIONS OF EXPANSION JOINTSΔT (°C) : Lowest and highest ambient temperatures. Values determined depending on meteorological statistics are used.A : Thermal expansion coefficient of the coating material. It refers to the linear dimensional change in the material per 1°C temperature change.L (m) : Linear dimension of the structure perpendicular to the joint; in meters.N : Foreseen number of joints.E : Elasticity of the joint sealant.W (m) : Joint widthW=L (m)*A (m/m °C)*° T (°C) /E %*N

Calculation Example:

ΔT= 50°C	Let's assume that a 100 meter long concrete pavement is divided into anos of 5x5 m with joints, therefore there will form 19 lengthwise joints, temperature difference is 50 degrees and movement capability of the sealant to be used is 25 %; and let's calculate the width of the joints.
L= 100 m	
A= 10.10-6 m/m °C	
N= 19	
E= 0.25	
W=?	
W= (100m)x(10.10-6 m/m °C)x (50°C)/(0.25)x19=0.01 m=1 cm	

Note: In case calculated width does not seen fit, number of joints may be changed according to the desired width. If a more elastic material is selected joints can be narrower or number of joints can be decreased.

Table 1. Linear thermal change coefficients of construction materials

Material	Change range m/m °C (1/°C)	General m/m °C (1/°C)
CONCRETE	6×10^{-6} -12×10^{-6}	10×10^{-6}
BRICK	4×10^{-6} -6×10^{-6}	6×10^{-6}
MARBLE	6×10^{-6} -8×10^{-6}	6×10^{-6}
GLASS	5 x 10-6 -10×10^{-6}	9×10^{-6}
CONSTRUCTION STEELS	12×10^{-6}	12×10^{-6}
ALUMINUM	$23{,}5 \times 10^{-6}$	$23{,}5 \times 10^{-6}$
PVC	70×10^{-6}	23.5×10^{-6}

Table 2. Approximate temperature change for construction materials

White and almost white surfaces	70°C
Concrete pavements	70°C
Earthenware surfaces	80°C
Aluminum surfaces	100°C
Dark color surfaces	100°C

Table 3. Expected movement ratios in joints for various materials

Brick	12.5%
Glass	15%
Concrete	25%
Aluminum	50%