ISOLATION/EXPANSION AND OTHER JOINTS SUBJECT TO MOVEMENT

WHY JOINTS ARE NEEDED

There is movement in concrete structures; regardless of size, height and width, the structure moves. To accommodate or cushion structural movement, there is need for elastic joints at strategic locations throughout the exterior and interior of the structure. The potential problems associated stress from torsional, seismic, or vibratory loads must be accommodated for. The dimension and location of joints are jointly are directly related to the movement tolerances required for various structural and aesthetic design elements.

Concrete is subject to changes in length, plane or volume caused by changes in its moisture content and/or temperature, reaction with atmospheric carbon dioxide, loads, (dynamic and/or static) and other forces. Joints are designed features, which are necessary to allow for changes in dimension in the concrete to take place. Properly designed and placed joints will minimize the concrete's exposure to deleterious stresses, thereby minimizing minor problems, such as, cracking and spalling, as well as potential major problems, such as structural failure.

Type of movement allow:

I. Contraction to occur

1. Drying Shrinkage
2. Carbonation
3. Irreversible creep

II. Cyclical Contraction

1. Environmental Differences (Humidity, Moisture Content and Temperature)
2. Application Loads (Deflection, Expansion and Contraction)

III. Abnormal Volume Changes

1. Permanent Expansion
   a. Sulfate Attack
   b. Alkali Reaction (between cement and certain aggregate)

The results of these changes are movement (permanent and/or transient) of the concrete.

Contraction: If contraction movement is restrained, cracking can occur within concrete when the tensile stresses exceed the strength of the concrete contracts (shrinks).

Expansion: If expansion movement is restrained it may result in distortion and cracking within the unit or crushing of its ends and transmission of unanticipated forced to abutting units. Joints and cracks will be closed and the forces may cause spalling if foreign objects preclude the closing.

Deflection: When deflection (torsional, flexural, etc.) movement stress is anticipated that may exceed the related structural design strength limitations of the unit isolation joint employed.

STRUCTURAL DESIGN REQUIRING JOINTS

I. Structures not under fluid pressure (most civil-engineered projects)
II. Containers subject to fluid pressure (dams, reservoirs, tanks, pipe lining, containment areas)
III. Pavement highway and airfield

TYPES OF JOINTS AND FUNCTIONS

I. CONTRACTIONS (CONTROL, RELIEF) JOINTS

Contraction joints are saw cut, tooled, placed or formed to provide a weakened plane. They are designed to regulate and control anticipated cracking that normally occurs in concrete segments. Since they are expected to control the location of cracks, contraction joints are often referred to as control or (stress) relief joints. Without the control joints, stress-relieving cracks would occur at unpredictable locations.

They are frequently used to divide large, relatively thin, structural units, for example pavement, floors, canal linings, retaining and other walls into small panels.

Contraction joints can form a complete break, between the floor slabs; can be designed to crack completely through the unit. Allowing each floor slab to function independent of the other. They also may be designed to allow for shrinkage contraction in the concrete during cure, while being tied to the adjoining element by reinforcing steel, keys or aggregate interlock.

Where greater continuity is desired from floor slab to floor slab dowel (usually slip bars), stepped or keyed joints may be employed.

To protect the floor slab contraction joint from the deleterious effect of hammer loads (impact from small wheeled carts or vehicles) it is necessary to fill the joint with a semi-rigid stress relieving epoxy material expressly designed to reinforce joint nosing to prevent spalling and raveling.

NOTE: Semi-rigid epoxy resin systems should comply with ACI 302-1R-15

II. EXPANSION (ISOLATION) JOINTS

Expansion joints (also referred to as expansion contraction joints) are used to isolate (the movement) of one structural element from another, thereby preventing crushing and distortion, such as displacement, buckling, spalling and warping. They are sometimes called isolation joints because they are used to isolate structural elements that behave in different manners. Example, they are used to isolate abutting concrete structural elements that might otherwise cause distress in one or both of the units due to transmission of compressive forces that develop during expansion, under applied loads or differential settlement.

Isolation joints are used primarily to isolate walls from floors or roofs, columns from floors or cladding, and pavement slabs and decks from bridge abutments - thus the name "isolation joints", etc.
Where greater continuity is desired from one structural unit to the next (floor slab to floor slab to stem wall) reinforcing bars or dowels, stepped or keyed joints may be employed.

To protect and fluid-proof the joints (prevent egress of fluids in or out of the structure) requires the use of joint filler. When movement will occur requires the use of a flexible joint filler (sealant or assemblage). Elastomeric (urethane, silicon, etc) joint sealants should comply with ACI 302. 1R-15 and ACI 504.

CONSTRUCTION (INTERUPTION) JOINTS

Construction joints may be planned or unplanned. Planned construction joints are incorporated into the structural units for several reasons, such as, precast elements length restriction or during a concrete pour due to configuration or restrictions or during a concrete pour due to configuration or "trick" form placement requirements. Planned construction joints can be called upon to function as expansion joints to accommodate the normal or even radical movement of a structure. Planned construction joints are usually treated in a similar fashion to expansion joints listed above.

Unplanned construction joints usually occur due to unforeseen concrete placement difficulties or forming restriction. In the case of unplanned and unwanted construction joints due to unforeseen interruption, a structural epoxy -bonding agent can be applied to the cured concrete and plastic concrete poured against it. If cured, a structural epoxy injection adhesive can be injected into the void, bonding the units together. Thereby, providing a monolithic structural unit as originally designed by permanently welding the unit together at the construction joint.

Epoxy bonding agents and injection adhesive should comply with ACI 503 and ASTM-C 88 1-87 Type IV and V.

A SEALANT SHOULD POSSESS THESE PROPERTIES AND FEATURES:

1. Long term adhesion to the faces of the joint
2. Resistance to creep, slump or cold flow
3. Resistance to shrinkage
4. Non-bleeding or non-staining properties
5. Adequate elastic properties to accommodate movement without splitting Resistance to specific chemicals
6. Compatibility with paint and protective coatings
7. Resistance to weathering and aging
8. Adequate hardness or abrasion resistance
9. Retention of physical properties
10. Stability in storage
11. Ease of mixing
12. Ease of application

PRIOR TO REPLACING A SEALANT, THE REASONS FOR FAILURE SHOULD BE DETERMINED:

1. Unsuitable sealant specified and installed
2. Joint dimensions that do not match specification and/or product capability
3. Joint movement that is greater than anticipated
4. Incorrect mixing of multi-component materials
5. Improper application for material
6. Omission of primer
7. Improper back-up material
8. Improper joint configuration

SEALANT TYPES - NINE BASIC CLASSIFICATIONS:

1. Hot-pour
2. Cold-pour, two part or three part, chemically cured
3. Non-sag, non-cured
4. Non-sag, one part, chemically cured
5. Non-sag, multi-part (two or three part), chemically cured
6. Heat-softened, non-sag sealants
7. Strip sealants - cold- applied mastic strips
8. Strip sealants - hot ironed, preformed strips
9. Compression seals
   a. Preformed cellular or compartmentalized compression seals (neoprene)
   b. Preformed open-cellular impregnated foam sealant
   c. Preformed non-impregnated closed cell foamed sealant

TYPE OF SEALANT (CHEMISTRY)

1. Polysulfides
2. Urethanes
3. Silicones
4. Acrylic
5. Acrylic Latex
6. Acoustical Sealant Butyl
7. Oil Based
8. Flexibilized Epoxy