White Paper

Expansion Joints 101
Let’s begin with a basic overview on expansion joints and expansion joint systems to define some of the terms, the types of systems and the criteria for determining the appropriate system for the application. An expansion joint is an opening within a structure, at a predetermined location, designed to absorb movement of the structure. Basically, an expansion joint slices a building vertically from roof to grade slab.

The types of expansion joint systems we will be discussing today are located in the interior and exterior of buildings and open-air structures such as parking garages.

If you have ever omitted an expansion joint from a structure by design or are thinking about trying it, think again. The forces of Mother Nature will put one in if you don’t and it will not be put there in a straight line.

**Expansion Joint defined**

An expansion joint system is a transition across an expansion joint opening between structural members of a building. In other words, it is a cover or an insert and the adjacent construction it is installed in. That construction is as important to the system as are the extrusion shapes, plates, seals or anchors.

In order to choose a particular expansion joint system for an application, the specifier must answer several questions such as:

- Type of movement that is anticipated
- The joint width
- Type of application and construction, is it…floor, wall, ceiling?
- Load requirements that have to be met?
- What are the floor finishes that will be used?
- Are there blockouts?
- What other items need to be considered such as a vapor or fire barrier or sound proofing?

When talking about the type of movement, there are different types of building movement that can be caused by temperature differentials, earth movement or wind.

Thermal movement is caused by temperature changes within the structure. Thermal movement is primarily horizontal.

Seismic movement is caused by earthquake activity. Seismic movement may be horizontal, vertical or shear, or a combination of all three.

Most people immediately think of California, but seismic movement extends beyond the “Golden State.” Although the US east of the Rocky Mountains historically has fewer and generally smaller earthquakes than the West, there are at least two factors that increase the risk in the East.

1. Due to geological differences, eastern earthquakes effect areas ten times larger than western areas of the same magnitude.
2. Also, the Eastern US is more densely populated.
You always have to design for thermal movement.

Thermal joints generally remain constant throughout the building, are typically 1 to 6 inches in width and have a movement of plus or minus 10-50%.

Seismic joints may change with floor level, are 2 to 24 inches and larger in width and have a movement of plus or minus 50 to 100%.

The nominal joint width is the design width of an opening at median temperature.

The expansion joint system selected needs to accommodate the minimum movement range and maximum dimensions of the movement range for the given nominal joint width.

The selection of joint system is dependent upon handling this movement range.

The Temperature Adjustment table concept has been used by the state departments of transportation (DOT) for years regarding setting of expansion joints on concrete bridge structures.

The concept relates temperature to the setting width of the expansion joint system. The numbers are derived from two design criteria:

1. Total design movement at the joint location and
2. Temperature range for area.

The concept is used successfully on bridges and some large parking deck structures. It is used rarely on architectural building structures, but it should be incorporated.

Typical interior application conditions of expansion joint systems are depicted here:

- Floor to floor
- Floor to wall
- Wall to wall
- Wall to corner
- Wall to ceiling
- Ceiling to ceiling

Exterior applications include roof, wall, soffit and concrete decks of open-air structures.

Don't forget the traffic loads!

When determining load requirements, consider what type of traffic will take place. Will it be pedestrian, equipment or heavy duty such as vehicular? And how much load, uniform and concentrated, will be applied? For instance in a hospital corridor, it may be the small hard-wheeled mobile x-ray machine that destroys the joint systems, not the pedestrian traffic. Typically the x-ray machine load type is ignored.

Blockouts are critical to joint fit and finish

The blockout is the recess in the concrete floor structure or constructed wall system that is formed by the specialty contractor. A blockout is one of the most important factors in that it increases the expansion joint system's strength because the system is recessed thus reducing the impact factor. Also a recessed system is safer for building occupants rather than a surface-mounted system which could be a trip-hazard. There can be issues with blockouts, which we will discuss shortly.

Other items to consider when selecting an expansion joint system include:

- Vapor barriers prevent penetration of moisture, water and debris into the structure. Vapor barriers are generally specified in floor, wall and roof joints.
- Sound barriers are becoming increasingly more important, especially with expansion joint systems, in security areas.
- Fire barrier systems are specified in floor and wall joints in fire-rated locations.

Earthquakes in Boston?
Boston Children's Hospital added a wing and specified 2102mm joints. Why did they do this? Because if an earthquake does occur, the owner did not want the two buildings hitting each other that could lead to catastrophic results.

Windload induced movement is caused by high winds forcing the structure to sway. Windload induced movement is normally perpendicular and/or parallel to the joint.

For the various types of building movement, there are specific expansion joint systems to accommodate these movements.
A primer on fire barriers

In 1980, 84 people died and 679 were injured as a result of a fire at the MGM Grand Hotel in Las Vegas. One reason, not the only reason, this fire spread rapidly from floor to floor was that there was limited fire protection at the expansion joints. This was insufficient and ineffective in preventing “chimney effect.”

Fire barriers are used to prevent fire and smoke from penetrating an expansion joint opening for the specified rating period.

In all cases, the fire barrier is designed to prevent the temperature on the cold side of an expansion joint opening from rising above a predetermined rate for the specified rating period. The cold side of an expansion joint opening refers to the area within a structure adjacent to or opposite the surface where a fire or smoke source is located.

This MGM fire caused major changes in fire code regulations for a number of structural building systems including expansion joints. As you will see shortly, buildings today are still not providing adequate fire safety.

There are four primary tests used to evaluate expansion joint and fire barrier systems:

- ASTM E119 – a test that measures the fire rating of materials, products, or assemblies. It does not incorporate movement.
- ASTM E1399 - a test to measure the minimum and maximum of joint widths of expansion joint systems. This test can test expansion joint limits without a fire barrier
- Both of these tests have been incorporated into ASTM E1966.
- ASTM E1966 - a test to determine performance of a joint after a cycle test (or movement) and fire-exposure test
- UL 2079 - a test for fire resistance of expansion joint systems and is similar to ASTM E1966.

What you really want to see are ASTM E1966 and/or UL 2079. The criteria for the Fire “Endurance” Testing of the products is controlled by the time-temperature curve shown. E119 states that the method “is intended to evaluate the duration for which the types of building elements contain a fire, retain their structural integrity or exhibit both properties during a predetermined test exposure.”

ASTM E1966 is the rating that determines if the system meets fire resistive properties as claimed by the manufacturer. In this fire endurance test, fire barriers are tested by placing a series of thermocouples on the cold side of the installed system, then applying flame as seen in the Time-Temperature Curve.

For fire barrier under 102mm, the fire rating is determined when any one of the thermocouples reaches 325 degrees above ambient temperature.

For fire barrier 102mm and above, the fire rating is determined when the average temperature of all thermocouples reaches 250 degrees above ambient temperature.

Something important to note. In 3 of the 4 tests mentioned, the word “system” includes:

1. Expansion joint system
2. Fire barrier and
3. Floor or wall construction.

Note that the listing detail shows the components.

The architect, general contractor or installer should make sure that the expansion joint system vendor has met the applicable standards. All major vendors meet this requirement, with the systems tested at an approved certifying agency. They are:

1. Underwriters Laboratories, Inc. in Northbrook, IL
2. Omega Point Laboratories in Elmendorf, TX (purchased by Intertek in April of 2005)
3. Intertek Testing Services in Antioch, CA and
4. Southwest Research Institute, San Antonio, TX

It is then the responsibility of everyone involved to verify proper substrate construction, and proper installation so that the expansion joint system can function as required.