Understanding Fire Resistant Expansion Joints

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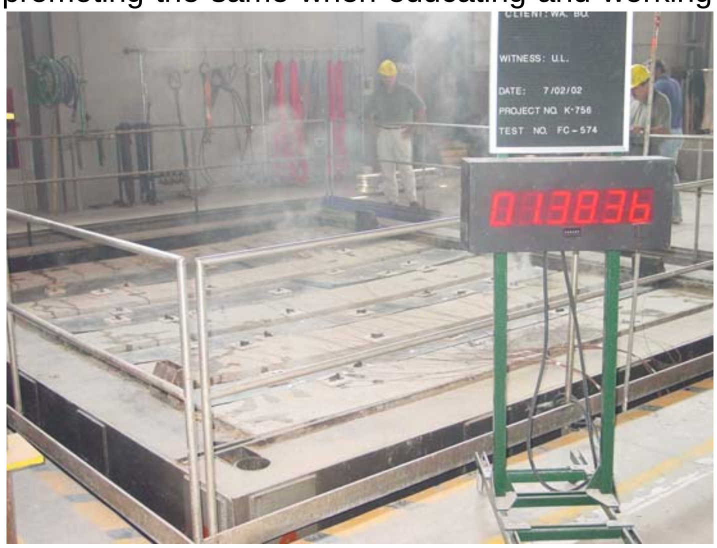
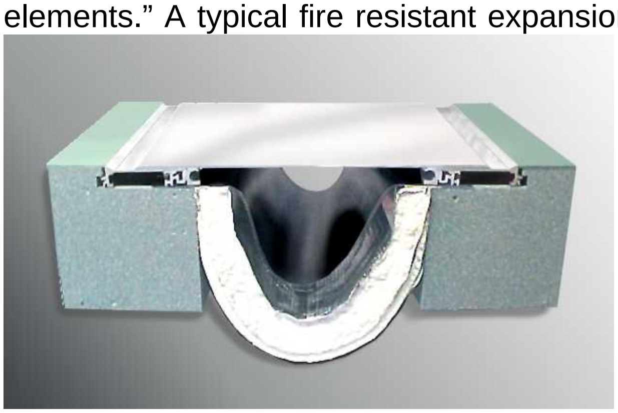
An expansion joint is a separation bordered by two opposing building elements such as floors, walls, ceilings and roofs. The specific purpose of the joint is to relieve building stresses by accommodating dynamic structural behavior otherwise commonly known as "building movement". There are several types of building movement that must be carefully considered by the design professional and product manufacturers during the evaluation and selection of expansion joint systems. The general types of building movement that must be considered are thermal cycling, seismic, wind, load transfer and concrete shrink, creep, and elastic shortening. These movements may occur independently of each other or simultaneously and may be measured perpendicular or parallel to the direction of the expansion joint. Under certain conditions load transfer may result in vertical displacement at the expansion joint. When these movements occur simultaneously expansion joint manufacturers will typically use the term "multidirectional movement". Providing the appropriate expansion joint system for these conditions must be carefully considered in order to accommodate the full expected range of building movement. In addition to building movement expansion joint systems must comply with ADA requirements, accommodate and accept various finish building materials, accommodate heavy loads in floor applications, be aesthetically pleasing and compliment the building interior and exterior design schemes, protect the building envelope against weather and moisture intrusion and most importantly provide the required fire rating as established by the adjacent rated construction. Expansion joint systems are a necessary component of almost every building. They take on many different styles and their choice of materials and colors are almost endless. These systems are manufactured by the assembly of multiple components with the intent to minimize the disruption of interior finishes and design schemes. In many cases expansion joint systems accept finish floor and wall inlay materials. In short they re-establish the transition between the opposing building elements and provide for efficient use of the building interior. They often measure several hundred feet in length and connect numerous building compartments and occupied areas.

Where expansion joint systems are located within rated construction they must include a secondary passive assembly that provides a protective barrier between potential areas of fire and those which are to be protected. They provide closure to what is understood as vulnerable areas in our buildings. The expansion joint system alone and it's immediate components are not capable in withstanding the extreme temperatures of fire, which can range from 704° to above 1093° Degrees C (1300° F to above 2000° F). The philosophy and practice of compartmentation is both recognized and practiced by our friends and colleagues in the firestopping industry as perhaps as our best defense and ability to protect life and property. The leaders in the expansion joint industry also share that philosophy and are promoting the same when educating and working with key influences.



Although expansion joint manufacturers are typically proactive in educating design professionals there remains much industry confusion and a lack of understanding on fire resistant expansion joint systems. The basic description of a fire resistant joint system as defined by the American Society for Testing and Materials (ASTM International) is a "device or designed feature that provides a fire separating function along continuous linear openings, including changes in direction, between or bounded by separating elements." A typical fire resistant expansion joint assembly is broken down into



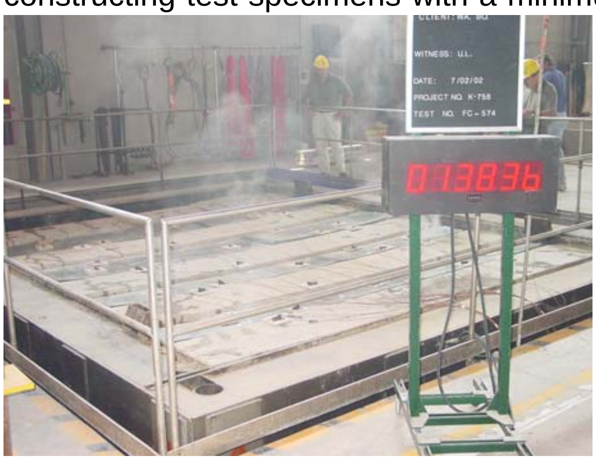
two key components - the expansion joint system as discussed earlier and the fire barrier system. Expansion joint systems or covers as referred to by various parties can be classified as elastomeric or hard cover. It should be noted that elastomeric covers may be comprised of poured sealants or extruded profiles. Their behavior characteristics and performance under extreme temperatures should be a consideration by the design professional when reviewing available systems for upcoming projects. Temperatures relatively low and in the area of 204° C (400° F) approach the melting point and state of a non-solid for thermoplastic materials and profiles. In comparison, systems that utilize metal alloys for their covers and profiles typically exhibit higher melting temperatures. Traditionally, aluminum expansion joint systems are the most widely promoted and utilized systems in the industry. With the melting point of aluminum being well above the maximum allowable temperatures permitted on the unexposed surface of the test assembly a higher level of confidence is achieved with the use of hard cover systems. They are capable of carrying higher live loads at elevated temperatures in comparison to elastomeric systems hence, during a fire emergency there is little concern for occupants safely exiting the structure if their means of egress takes them across an expansion joint system. This holds true as well for fire emergency personnel entering the building. During a fire condition and elevated temperatures a hard cover system on a vertical wall is structurally capable of better withstanding the impact of a hose stream in comparison to elastomeric covers.

Located below horizontal or behind vertical expansion joint systems is the secondary passive assembly or “fire barrier”. Generally, the fire barrier system consists of multiple layers of high temperature ceramic fiber or intumescent paper commonly known as fire blanket. Most ceramic fibers blankets are typically rated for continuous exposed temperatures upwards of 1926° C (3500° F). This is note worthy as a result that other industries use traditional mineral wool as their preferred choice of fire resistant materials. The expansion joint industry does not recognize mineral wool as a high temperature material as a result that it’s maximum continuous use limit is well below the typical temperatures experienced in during a fire endurance test. The number of and thickness of blanket layers is dictated by the targeted hourly rating and the desired opening that will define maximum outward movement. These layers may be encapsulated in a fabric reinforced aluminum scrim to reduce airborne fibers during installation. The scrim also provides limited moisture resistance during shipping and installation. The blanket layers may also receive an optional 2-mil stainless steel foil lamination. Use of the foil is determined by the

manufacturer and it's use is dictated by design. It's use however serves multiple roles in providing protection against smoke penetration and the reflectivity of intense heat during actual fire conditions. The blankets are traditionally attached to a preformed metal retainer that provides secure and positive attachment of the assembly to the building structure. Fire barrier assemblies are traditionally manufactured and shipped in standard 10 ft lengths and requires a third party recognized butt splice transition for installation.

As most design professionals and industry members acknowledge that all fire barrier assemblies need to be tested by an independent third party it has only been recently that fire-resistant joint systems received their dedicated test standards. The industry in earlier years originally tested fire barriers utilizing the standards set forth by ASTM E 814 and E 119. Both standards subjected the test specimen to a controlled fire exposure utilizing the widely recognized time-temperature curve. The primary difference between the standards relative to expansion joints was the size of the test assembly. Many manufacturers selected the E 814 standard as a result that testing could be performed on a small scale furnace that provided certain benefits in expediting research, reducing time and limiting cost. There was questions however if the tests were true representations of actual installations due to the continuous and lineal nature of expansion joints.

ASTM E 119 later became the preferred standard as a result that the size of the test specimen more closely reflected the lineal nature of expansion joints. For floor systems, the minimum length of the test specimen was recognized to be 12 feet and for verticals, the minimum recognized height for the test specimen was 9 feet. Most importantly earlier testing did not require cycling of the test specimen or dictate positive pressures inside the furnace chamber. The pass/fail criteria found in both standards typically were followed by the third party to qualify the test specimen at the end of the fire endurance test. Today the industry has made great improvements in recognizing the importance of fire resistant joint systems and how they contribute to total fire protection and life safety. Within the United States the industry has finally adopted two test standards dedicated to the fire testing of fire resistant joint systems. They have in addition, incorporated dedicated sections and requirements into the model building codes. Currently, fire resistant joint testing typically follows the UL 2079 and ASTM E 1966 test standards. In simplest of terms both standards are similar with the exception of guidelines relative to thermocouple placement and requirements. Generally speaking the standards require the test assembly to be subjected to the traditional time temperature curve where temperatures just 5 minutes into the fire endurance test reach 538° C, (1,000° F). After 120 minutes of fire exposure temperatures achieved can be upwards of 1010° C, (1,850° F). It should be noted and emphasized that stand alone expansion joint systems and their traditional elastomeric thermoplastic and metallic aluminum components will not survive beyond 5 or 10 minutes into the test as a result of their melting temperatures and flame propagation characteristics hence, the need for a secondary passive high temperature assembly. Within the current standards the same pass/fail criteria was adopted where the maximum allowable temperature rise above the initial recorded temperature is 163° C, (325° F) on any one thermocouple located on the unexposed surface of the test specimen and 121° C, (250° F) as an average on all thermocouples. While the standard of 163° C, (325° F) may seem arbitrary, it actually has established an industry benchmark to prevent the spread of fire to adjacent compartments. Closer examination will show that this value closely considers the flashpoint of common materials such as paper or newsprint. For instance, if a fire originates in a small office and the local newspaper is placed on a desk located near a common wall in an adjoining office with a room temperature of 24° C, (75° F) there is cause for concern. During the fire, heat radiating through the wall may raise the unexposed surface temperature on the wall to exceed the newspaper's approximate flashpoint of 232° C, (450° F) thereby permitting the spread of fire without flames ever breaking through the wall construction. To limit this possibility, a safety factor has been built into the test standard. It should be noted that if the allowable temperature rise was permitted to be higher, compartmentation and life safety as we promote and practice today would be difficult to achieve. Further requirements of the latest test standards include: testing all assemblies with a factory and/or field splice, constructing test specimens with a minimum exposure to fire - generally 12 ft for



horizontals and 9 ft for verticals, subjecting all test specimens to cycling prior to the fire test. This is of key importance and worthy of extended discussion here. Expansion joints are dynamic and not static in nature. It is generally an industry standard that expansion joints are designed for plus or minus 50 percent movement. In the case of a 4 inch expansion joint a system would be selected by the architect to accommodate 2 inches of outward movement and 2 inches of inward movement requiring a total of 4 inches of dynamic movement by design. Within the test standard the sponsor must select which movement classification they wish to qualify. Typically, most manufacturers select Class II (wind) and Class III (seismic). If these classifications are achieved Class I (thermal) is automatically granted by the third party. During the sponsor's test in the above example the test specimen would be mounted to a cycling apparatus (Photo 7) inclusive of the splice transition and cycled at a rate of 30 cpm with 50% extension and compression to qualify for Class III movement. After 100 complete cycles the apparatus is slowed to 10 cpm continuing the 50% extension and compression to qualify for Class II movement. After 400 complete cycles the test specimen is examined, documented and transferred to the test furnace. In an attempt to reduce costs many contractors attempt to install a traditional firestopping below or behind the expansion joint system. This would result in a compromised installation. Most firestop systems are not cycled at 30 cpm to meet Class III movement and do not provide plus or minus 50% movement capability. Approving their installation with a traditional expansion joint system will place life and property at high risk. In practice the fire barrier assembly must provide the same cyclic and movement capability as the expansion joint system above or in front of itself. Continued education and an increased awareness among fire marshals and code inspectors will slowly correct this growing issue.

Cycling before the fire test subjects the fire barrier to simulated movement that will occur over it's expected service life, including the possibility of seismic activity. It confirms what effect movement and fatigue have on the fire barrier's components and if the system is capable of protecting life and property long term in the event of real fire. This is a key component in the validation process to determine if the system is capable of protecting life and property.

An added requirement of the test standard is to subject all vertical specimens to a hose stream test. Water pressure and duration of the test varies according to hourly rating but for a typical 2-hr endurance test the test specimen would be subjected to 30 psi water pressure measured at the base of the hose nozzle for a duration of 1.5 seconds per square for of exposed area. With a traditional 9 ft tall specimen and a wall 12 ft wide this would equate to a duration of 2.7 minutes. Although the test standard allows the hose stream to be conducted on a duplicate test specimen many manufacturers conduct the test on the same specimen originally exposed to the fire for the desired rating. A significant change to the industry and a requirement of the latest test standards is to run the endurance test at positive pressure. There are particular requirements in the standards to determine how both vertical and horizontal test specimens are to be exposed to positive pressure and measured. Horizontal specimens must be exposed to a min. positive pressure of .01 inch of water over their entire length including splice. Pressure is measured 12 inches below the exposed horizontal surface of the test specimen. Vertical assemblies must be exposed to a min. positive pressure of .01 inch of water measured at their mid-height elevation. Pressures increase along with the height and can be significant at the top of wall causing results to fall short of manufacturer's expectations.

The above discussion has pertained to the UL 2079 and ASTM E 1966 test standards. In Canada, ULC-S115-05 test standard is utilized to list fire barriers. As we know this standard is the method of fire tests for firestop systems and legitimately allows design professionals and contractors to substitute firestop systems in lieu of the proper fire barrier for expansion joints. Model codes do not yet have specific sections relating to fire resistant joint systems causing concern among those who are active in the industry and who work on large public and key projects. In many cases project specifications will refer to the standards used on U.S. projects. Progress however was recently made by the recent release of ULC-S115-05 in November of 2005. In the updated standard Section 8 was added which specifies the requirements for evaluating Joint Firestop Systems. Review of this section will indicate that the standard now begins to address lineal Fire Resistant Expansion Joints as we know them however for the time being they will be referred to as Joint Firestop Systems.

A final discussion to address the current growth initiatives of our industry is the use of Factory Trained Applicators (Installers). This author compliments the FCIA in their effort and commitment to promote the use of FM 4991 Firestop Contractors. As with all life safety products there is no tolerance and room for error during installation. Lives depend on it. Finding the right contractor to install the fire resistant joint system is every bit as important as finding the right engineering firm to design the structure. Utilizing a Factory Trained Applicator must be of value to both the owner and the design team. Qualification requirements and calling for the use of a Factory Trained Applicator for the project must be specification driven. To achieve total life safety design it is critical that all systems for the project be purchased from a single source manufacturer and installed by the manufacturer's Factory Trained Applicator who has been trained on the proper selection and installation of their systems. Communication between the design team and the expansion joint manufacturer supplying the fire barrier is absolutely critical. It has become evident within our current industry that quality and workmanship has been compromised in recent years. The industry has become very competitive with manufacturers rushing to close orders and contractors attempting to regain profits by value engineering systems in an attempt to reduce costs and meet aggressive project schedules. Design professionals are being educated in this area. Factory Trained Applicators and the manufacturer work together as a team to ensure quality and an installation that meets the latest test standards and building codes. Their products and installed work receive a written performance warranty that exceeds industry standards. As a team they can offer design assistance, review of project and site conditions, proper product selection, preparation of proposal drawings and a willingness to meet with the design team to ensure that this area of the project receives proper and thorough attention. Post project and service related issues for the owner will be dramatically reduced. It should be noted that specialty contractors that express interest in receiving the training to become Factory Trained Applicators do so with the highest level of commitment and dedication. Typically, each company sends 2-3 key employees on an average to a 4 day intensive training program involving both classroom and hands-on product installation (Photos 8 and 9). Both design and the mechanics of proper installation is communicated. At the conclusion of the training all attendees are required to take a final exam.

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