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Architechnics is the architectural technology journal of McGinnis Chen Associates, Inc.

Architechnics is published to inform our clients and colleagues of issues and problems addressed in our practice. By publication of technical articles and case studies, we hope to circulate information that will be helpful to practicing architects, building managers and others in the building trade and related professions.

Due to the unique nature of our practice, McGinnis Chen Associates, Inc. (MCA) is often the beneficiary of hindsight. That is, we are often asked to examine, analyze and repair failed building systems principally regarding the building envelope.

Having done this type of work for over forty years, our office has accumulated a wealth of insight into the causes of many different types of building failures and how they might be rectified or avoided. We routinely work on buildings ranging from residences to high-rises, commercial to governmental, and old to new.

A RECONSTRUCTION OF ELEVATED ENTRY WALKWAYS

A Case Study

by Majid Azadeh, PE

One of the most overlooked challenges facing design professionals today is addressing durability of materials and assemblies in the design process. Budgetary and scheduling constraints limit most considerations for long-term performance. Lack of coordination between design disciplines and evolution of construction materials has also had a negative impact with respect to durability. All this can result in premature deterioration of structural appendages such as balconies and elevated walkways.

As remedial architects and engineers, we are commonly faced with remedial design or reconstruction of deteriorated assemblies, where consideration of durability is paramount. Following is a case study of a recent remedial project where MCA utilized architectural, engineering and material science expertise to provide an elegant yet durable solution while minimizing overall maintenance requirements.

The Project

Our office was recently called upon to address deteriorating elevated walkways and stairs at a condominium complex in Sunnyvale, California. The complex had previously gone through post-litigation reconstruction covering defective building envelope problems prior to our involvement with the project.

The complex consists of 102 dwellings within 9 buildings - with Group R occupancy and Type V construction - ranging from two to four stories in height. All buildings are situated over a concrete podium slab elevated over a communal parking garage. A complex system of stairs, elevated walkways and private entry bridges provide access and egress to buildings and individual units. Additional circulation between the upper levels of the buildings is provided by bridge walkways.

Since completion of construction in the late 1980s, the exterior walkways and stairs have experienced extensive deterioration due to wood decay.

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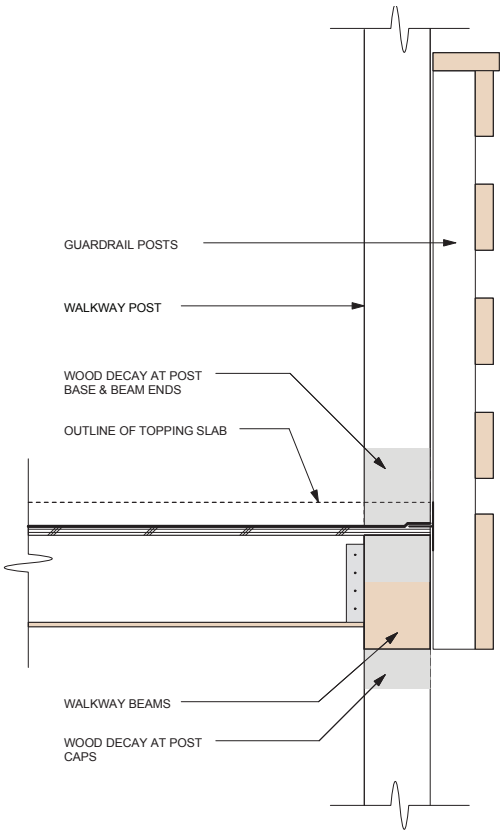

Original Elevated Walkway

VAPOR DRIVE CHALLENGES ADDRESSED USING COMPUTER SOFTWARE

by Jon Barratt

When designing or evaluating a building envelope assembly, it is important not only to consider the possibility of liquid water penetration, but also moisture accumulation caused by vapor drive. One tool that can assist with the investigation and analysis of potential vapor drive problems within a specific assembly is *Hygrothermal Simulation Software* (HSS).

HSS programs allow the user to "build" the cross section of interest by selecting materials from a list and assigning a thickness to each layer. MCA utilizes WUFI Pro, which includes a database that contains all relevant properties for each material: Permeability, Equilibrium Moisture Content, Bulk Density, Porosity, Specific Heat Capacity, and Thermal Conductivity. The user is then able to specify properties of the exterior and interior surfaces, such as finish type and color. The interior temperature and relative humidity must also be specified.

After the compass orientation, surface inclination, and building height are input, the user must then identify the geographic location of the building. To enable the user to simulate a wide range of climate conditions, WUFI Pro contains climate data for almost one hundred cities throughout North America, Europe, and Japan. For locations not listed, weather files may be generated through software included with the program. This process creates WUFI-compatible climate files from externally obtained sets of historical weather data.

Once all required data has been entered, the HSS program can then simulate exposure of the assembly to weather for a predefined length of time, usually three or more years. The program does this by continuously solving an iterative set of equations to determine the temperature, relative humidity and moisture content in each layer. Time-history plots of these values are generated as output.

Alternative cross-sectional configurations can be analyzed by modifying the current assembly and running additional analyses. This can be especially useful when multiple options are being considered for construction, since the conditions within the various assemblies can be easily compared over identical periods of time. It is also helpful when attempting to determine the effect of changing, adding or removing specific components of an assembly.

While HSS programs can provide valuable information to the design professional, it is also important to be aware of the limitations of this software. Since WUFI Pro is a one-dimensional simulation, conditions are only evaluated at a single point. This means that another analysis must be run at each location where the assembly changes. Another by-product of the one-dimensional approach is that the software cannot be used to predict leak locations, since the interface between two components in the plane of the envelope surface cannot be modeled one-dimensionally.

The use of an HSS program provides valuable feedback regarding the likelihood of water accumulation in a particular assembly due to vapor drive. It should be stressed that these results are best used in conjunction with other investigative techniques, not in place of them. Information obtained through testing, on-site observations, and the review of existing documentation is also vitally important when evaluating an assembly. Incorporating the conclusions generated by an HSS program can provide building professionals with useful information to help them solve design challenges.

MAKING THE OLD WORK LIKE NEW

by Jessica Walitt, AIA

Converting a Historic San Francisco Landmark into a modern luxury residence generates no end of challenges to its owners, designers, and builders. The vision is born out of the historic property itself and grows into a mixed-use collage of high-end retail, fine dining, art galleries, and of course residences. But through that growth the project team is faced with the inherent construction conflicts that exist between the early 20th century construction and today. Structural designs and seismic requirements have changed, codes and standards have modernized, and new materials may or may not be as durable as the historic ones they resemble.

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At the time of our involvement, sections of walkways and three out of eight stair stacks had been closed to pedestrian traffic due to life safety concerns. Multi-level temporary shoring was noticeable throughout the complex.

MCA was retained to provide a reconstruction scheme that would be least disruptive to continuous occupancy, while emphasizing durability and serviceability.

The Problem

The existing walkways and stairs were constructed of heavy timber post and beam framing of untreated Douglas Fir. End grains were exposed to weather at column tops and beam ends. Guardrail posts and railings were also fabricated from untreated Douglas Fir framing elements. All exposed framing elements were painted after construction with no application of primer at concealed joints.

The walkways were paved with a concrete topping slab cast over self-adhered sheet membrane applied directly over the plywood sub-floor. The existing membrane was punctuated by numerous post penetrations with inadequate and/or maintenance intensive flashing. Membrane delamination and waterproofing discontinuities were noted at nearly all penetrations and terminations. Lack of adequate drainage further exacerbated the overall distress to the structural elements.

Membrane flashing failures had occurred at nearly all post penetrations, resulting in severe deterioration of posts, beams and plywood sub-floors. Further deterioration of post bases had occurred at connections to podium slabs. Wood decay was also noted at the concealed joints between top rails and caps of the guardrails.

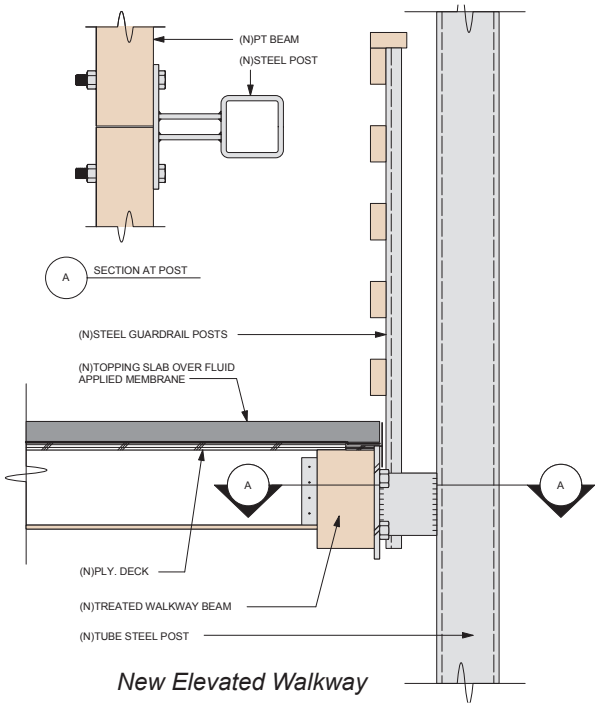
The Solution

The primary objective of the remedial work was to repair and waterproof elevated walkways and stairs using serviceable materials and assemblies while maintaining continuous access to the units. Initially, the project was envisioned as a reconstruction project where all deteriorated framing elements would be replaced with a species of lumber appropriate for exterior applications. The existing membrane would be replaced with a fluid-applied membrane to protect the walkway assembly. The project would be phased to allow continuous access to individual units during construction. However, this scheme would include reconstruction of post penetrations into the new membrane, presenting a maintenance intensive solution with potential for future failures and distress.

The final remedial approach was conceived with foremost considerations for waterproofing and durability. Post locations were shifted beyond the walkway edges, eliminating all membrane penetrations, and allowing uninterrupted sheet drainage for runoff. The new continuous posts were shop fabricated from structural tube steel with welded brackets and base plates. New posts were fastened to the sides of the walkway beams, reducing shoring requirements and facilitating continuous use of dwellings during construction. To avoid cutting the reinforcing steel, the podium slab was x-rayed at base-plate locations to allow for anchor bolt installation. New guardrails were fabricated from steel channels, and were also side mounted for enhanced drainage. Steel posts were coated with intumescent fireproofing. All exposed framing lumber - including guardrail runners and walkway beams - were specified of naturally durable or preservative-treated species. All fasteners were specified to be stainless steel.

Walkway sub-floors were coated with a fluid-applied membrane, ensuring adequate coverage and adhesion to wood and metal substrates. Sheet membrane was used extensively to protect the exterior face of walkway beams. Caulking was used at all fastener penetrations. All waterproofing materials were single-sourced to eliminate potential compatibility issues. The walkway assembly was paved with a light-weight concrete topping slab to protect the membrane and provide a pedestrian traffic bearing surface.

Alteration of the framing design required engineering not initially anticipated. Steel posts were analyzed to check for eccentric loading from multiple walkway levels. Guardrails were designed to meet the height requirements of the current building code. The existing podium slab was analyzed to check for capacity at new post locations. The costs associated with the unanticipated engineering were offset by savings due to reduction in shoring requirements and shortened construction schedule.



New Elevated Walkway

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The Ghirardelli Square Rehabilitation Project presented all these challenges and more. MCA was retained as the architect's waterproofing consultant, with efforts focused on the roofs and the exterior plaza. As questions began to arise from the architect and the contractor during the early stages of construction, two themes became apparent throughout the many challenges.

The first challenge was working with design elements on a historic building. Aesthetic changes are not allowed by the Planning and Landmarks Commissions in the interest of the historic intent of the design. Thus anything that was removed had to be put back fully and in kind, and new materials or building assemblies could not alter the overall appearance. Profiles of cornices and placement of handrails had to completely maintain their aesthetic.

The second major challenge was detailing around the historic elements themselves. Those in the construction industry regularly use the term "typical condition" or "typical detail" to indicate a sort of industry standard that may be followed at a certain type of assembly on any building. However, there is nothing typical about the "Ghirardelli" sign that stretches across the roofs of two of the buildings, nor is there any way to avoid the intersection of a steel angle post, a wood curb, and the peak of a sloped roof that were installed a hundred years ago. The designer cannot standardize or modernize that which is historic without destroying the overall aesthetic.

So in order to avoid a circular design and problem-solving process, modern materials often have to be used in a creative manner to meet historic needs. MCA specified a number of custom-fabricated metal pieces to serve as flashing around unique surfaces and interfaces. Where metal fabrication would have been too expensive or too complex, fluid-applied waterproofing membranes were applied due to their self-flashing capabilities and easy-to-install components. Although some abatement of hazardous materials was necessary (particularly for the removal of lead paint), some coal tar compatible sheet membranes were researched and installed directly over a residual coal tar membrane rather than fully removing it.

With restoration work come design challenges, unknown or unique conditions, and frequent changes to the construction, the materials, and of course the cost. In order to maintain its status as a Landmark property with high-end objectives, protection of the building envelope is paramount to its success.

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The new walkways utilize architectural, engineering and material science expertise to provide an elegant yet durable solution to a problem commonly encountered in elevated walkway design. As constructed, the new walkways maintain waterproofing continuity, facilitate drainage, and tolerate long-term environmental effects with minimal maintenance requirements.

Comments? Suggestions? Questions?
What would you like to see in future issues of this newsletter?
Contact Jessica Walitt
jwalitt@mcaia.com
(415) 986-3873

McGinnis Chen Associates, Inc. has been providing specialized architectural and engineering consulting to private, institutional and public property owners since 1963. Over this period we have provided pre-construction, diagnostic and remedial design for many of the San Francisco Bay Area's most prestigious commercial and civic properties as well as hundreds of residential properties. Our clients have included the most experienced property owners, developers, builders, architects, and attorneys as well as single-family and multi-family residential property owners and homeowner associations.