



The I-ENG-A Report

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Building Science – Connecting the Dots Between Design and Investigative Engineering

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It has often been said that investigative or forensic engineering is an evaluation of a design process, in reverse. Many examples can be cited to illustrate this theory. Engineering reconstruction of a vehicular accident uses crash data developed from the vehicle design and crash tests to help determine the speed of a specific vehicle at impact. The evaluation of the cause of a structural collapse relies heavily on how the structure was designed and on what loads it was capable of withstanding. A product liability forensic investigation would focus on the intent and design of the product in determining if it did not perform as expected. Therefore, it is fair to say that in most investigative engineering cases, the element of design is either a direct or indirect part of the forensic process.

One of the most complex types of forensic investigation involves building science, in which many elements of a building system need to be considered to address a particular situation. During a recent assignment, Marshall Miller & Associates (I-ENG-A[®] Member Firm, Raleigh, NC) was asked to determine the cause of a moisture intrusion condition and the resulting mold development within the perimeter walls of a large, three-story commercial

building located in the southeastern region of the United States. After the environmental verification of the moisture and mold problem, the focus of Marshall Miller & Associate's investigation turned to potential causal factors. The key to investigating these types of conditions within a complex building environment lies in the understanding of the design and operation of four basic building science components, which include:

- 1) HVAC, or mechanical systems;
- 2) plumbing systems;
- 3) site drainage conditions; and
- 4) the building envelope, as well as their relationships with one another.

In this instance, the firm conducted a building science investigation of all four components of the building, both individually and as they were designed as an overall system. After elimination of the designs and operations of the site drainage and plumbing systems as potential direct causal factors, attention was turned to the evaluation of the building's mechanical/HVAC systems and the building envelope (roof, floor and wall systems). Monitoring and testing of the building by the I-ENG-A[®] Member Firm revealed an abnormal

negative/stack pressure condition within areas of the building, when certain HVAC units were operational. Further investigation of the mechanical systems revealed that design modifications had been made to certain areas of the building, without consideration of the potential adverse effects to the building's overall mechanical system and the building envelope. It was discovered that during hot weather periods (summer/fall), high humidity (moisture laden) air was being drawn into the perimeter wall system due to the negative pressure condition that existed within the building. Also, the condition was found to be exacerbated by the presence of vinyl wallpaper on most of the interior wall surfaces, which allowed moisture to be further trapped within the wall cavities (concealed condensation) and the development of mold in the wall cavities. While this case study serves to highlight the complexity of building science investigations and the importance of considering all design elements in the investigation of a building system's recognized problem, it should also alert all building owners/operators to maintain a watchful eye on their facility, even in the absence of a known problem.

Today, the engineering community is being called upon to investigate and identify the cause(s) of many types of problems within complex building systems. Present day building design, construction materials and techniques, coupled with complicated energy efficient HVAC systems being used in buildings seem to be compounding potential problems. Building contractors, building owners, designers, as well as code officials will hopefully begin to use building science information being gathered to minimize problems within both old and new buildings.

As with many I-ENG-A[®] member firms, this firm Marshall Miller & Associates, located in North Carolina, has a full compliment of environmental, design and investigative engineers that can assist clients in the building science community by helping to connect the dots between design issues and problematic forensic conditions within their building(s).

It is best to contact the local I-ENG-A[®] member firm for assistance on these types of issues as conditions may vary according to your local climate and building requirements.

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