WHEN BUILDINGS FAIL: DETERMINING WHAT CAUSED THE FAILURE

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When a building or the components within a building fails, the failure is often not the result of just one singular cause. Because of building system complexity and environmental exposure variability, the structural element conditions vary, and the loads affecting them are numerous. In turn, the resulting structure performance and potential failure modes are also numerous.

Examining each potential failure mode is an integral part of any forensic investigation. A thorough evaluation must be performed to determine whether a potential cause played a role in the failure. However, when a failure has multiple causes, how does a forensic engineer answer our client's fundamental question, "what caused the failure?"

Answering this seemingly fundamental question can be loaded with pitfalls. As forensic engineers, we must ensure we are providing our clients all the information and opinions needed to evaluate the claim. While engineers are inherently not claims adjusters, nor do they interpret insurance policies, two fundamental doctrines of claim adjustments are nevertheless critical to an engineer's understanding of multiple causations, hence, how causations are evaluated. These two doctrines are concurrent causation and efficient proximate cause.

The use of these two doctrines across the United States is not consistent, as differing state laws and court precedents have affected which causation doctrine may or may not be utilized. This paper is based upon a forensic engineer's perspective and understanding of these two doctrines and their role when investigating failures. The rationale for this discussion and citation of these two doctrines is solely for background information. These doctrines are not cited in an opinion report as forensic engineers are not experts in claims adjusting or legal issues.

Fundamental Doctrines in Building Failures

Concurrent Causation

The doctrine of concurrent causation is fundamentally based on whether a given identified contributing cause is covered or excluded. Assuming multiple causation mechanisms, if any one of the causation mechanisms is covered by the policy, then that loss may be significant to the client's analysis.

For instance, assume that a rotted roof joist capable of only supporting its self-weight is subjected to snow loads and collapses. In this scenario, the concurrent failure causes would either be the rotted and degraded condition of the roof joist and the weight of ice and snow. Presuming that the insurance policy provides coverage for the weight of ice and snow, coverage may be extended under the doctrine of concurrent causation.

Efficient Proximate Cause

The doctrine of efficient proximate cause utilizes an evaluation that considers all causations. After evaluating all the causations, the efficient proximate cause is the predominant cause and not necessarily the triggering cause. With the example of a rotted and degraded roof joist, the weight of light snow may have triggered the failure. Still, the efficient proximate cause would be the long-term rot and degradation, as the roof joist was only capable of supporting itself and should have been capable of supporting the light snow loading. In contrast, if the roof joist had suffered from minor surface degradations and was exposed to a snow loading that exceeded that established by the building code, then under the doctrine of efficient proximate cause, the failure could result from the weight of ice and snow.

Bounds of Causes

An alternative way of examining the conundrum of these two doctrines is by studying the bounds of causes. To illustrate this, assume a scenario where a barn is exposed to two different load mechanisms, representing upper and lower bounds on the magnitude of loads. The barn is barely standing with sagging ridge members, bulging walls, rotted members, and a partial collapse at one end. To illustrate the lower bound load regimen, assume that a flock of sparrows lands on the barn ridge, but the barn does not collapse. Then, another sparrow alights on the barn ridge, and collapse ensues.

In the case of efficient proximate cause, it would be inappropriate to assign the cause of the collapse to the weight of a two-ounce sparrow. In the lower bounding case, it is obvious that a maintained barn could carry the weight of the sparrows. Therefore, had it not been for the deterioration, the barn would not have failed, and the efficient proximate cause would be the deterioration of the structure.

At the opposite upper bound of load mechanisms, imagine the same barn impacted directly by a tornado that collapses the barn. In this case, the tornadic winds far exceed a reasonable load on a non-deteriorated barn (rendering it nearly impossible to determine if the deterioration would have made any difference). The efficient proximate cause would be attributable to the tornadic winds.

While these scenarios are extreme examples, they provide a framework for discussion. A forensic engineer's responsibility is to discern the factors involved in the failure within the gray area between these two extreme examples and determine causation. This gray area is often defined by the difficulty in determining the actual strength of a deteriorated/defective structure or element that is subjected to day-to-day loads or moderate weather events.

Utilizing the concurrent causation doctrine, the failure cause would be either the sparrow's weight and/or the degradation. In many respects, the concurrent causation doctrine is much more black-and-white. If an action contributed to the cause, it should be reported to the client for consideration. In contrast, under the efficient proximate cause, each contributing cause must be compared and evaluated to identify the predominate cause.

Forensic Analysis

As forensic engineers, we do not know, nor should we know, the specifics of a given policy. We won't know whether the loss should be examined under concurrent causation or efficient proximate cause by not knowing the specifics of a given policy. This allows for an unbiased approach. The boundary between policy interpretation and a forensic engineer is a necessity in remaining an impartial third party.

How can we answer our client's fundamental question if we don't know whether the policy is based on a concurrent causation doctrine or an efficient proximate cause doctrine? Does it matter? If we provide our client with all the details and the logic and reasoning behind our conclusions, have we provided our client sufficient information to evaluate the loss under either doctrine? Likely, the answer to this last question is yes.

We need to consider the reasonable potential failure mechanisms and identify the prospective triggering event, as well as the underlying conditions that led to the event. That triggering event should be considered when evaluating all potential causes, and these evaluations must be clearly discussed within the engineering report.

That said, we must be careful to avoid both speculation and analysis paralysis in determining causes (both triggering events and underlying causes). Unfortunately, these evaluations are often convoluted and can take many directions, rendering it difficult to provide forensic engineers one-size-fits-all recommendations on how to conduct the analysis. Over time, training, education, experience, and engineering judgment aid in identifying reasonable causes.

As a starting point in many cases, it is acceptable to infer the presence of some underlying issue based on documented weather data and/or reported loading conditions at the time of failure. For example, if a roof structure failed under a documented snow loading that was only 30% of code level snow weight, it would be reasonable to infer that an underlying structural issue existed that deserved closer analysis.

Another example would be if a roof membrane tore off a warehouse in documented 50 mile-per-hour (mph) wind gusts, it would be reasonable to infer that some underlying condition weakened the anchorage of the membrane as roofing systems must be installed to meet code prescribed loads above those generated by a 50-mph wind.

In many cases, rendering a reasonable conclusion regarding the precise nature of an underlying cause requires a destructive investigation and/or an analysis. We can certainly advise the client that a building should not have failed from a documented weather or loading event, but that additional work is required if they would like to know the precise underlying cause.

Building Failure While Under Construction

Envista Forensics investigated an incomplete, under-construction structure subjected to wind gusts blowing to the east and at approximately 55 mph. The structure collapsed to the east during the wind gusts, as illustrated in the photograph. While engineering standards for incomplete structures under construction are not required to carry the full code-prescribed load, the standards require the buildings to carry a portion of the full design load. As such, temporary bracing to supplement the incomplete building's capacity must be installed.

In this structure's case, the temporary bracing should have been capable of supporting wind loads 1.7 times that imposed by the actual 55 mph wind. Therefore, while wind forces were a clear trigger of the failure given the structure's displacement to the east, it was reasonable to initially infer that an underlying issue in the structure's capacity to resist wind forces contributed to the failure.

So, what went wrong? The temporary bracing installed by the contractor was insufficient. Calculations determined that the bracing method utilized by the contractor (one nail into a 2x4 brace through a steel pin shallowly driven into the gravel fill soil) required over 50 temporary braces along the 120-foot length of the subject building solely to resist the 55 mph wind gust. This bracing method assumed that the shallowly driven pin in granular soil would not pull out.

The contractor provided 12 braces. Given the bracing and the 55-mph wind, Envista concluded that wind forces triggered the failure. However, Envista also concluded that the root cause was deficiently installed bracing during construction. By acknowledging that wind triggered the loss but that the root cause, or the efficient proximate cause, was defective construction, the client was provided sufficient information to evaluate the loss under either the concurrent causation doctrine or the efficient proximate cause doctrine.

Envista did not opine on which doctrine pertained to our conclusions, and we did not analyze our conclusions under either doctrine. However, we did recognize that each doctrine may have different informational needs. Simply put, Envista provided the necessary information required for others to evaluate the insurance and legal issues associated with the failure.

This transparent approach to the conclusions, logic and reasoning provides our clients with the information necessary to evaluate a given failure. Forensic engineers are not adjusters or attorneys, but our conclusions must be correct, supportable in a court of law, and sufficiently complete to satisfy our client's needs. Without full disclosure of the logic and reasoning, an improper resolution can result. In this case, the carrier extended coverage for the building and subsequently subrogated against the contractor who installed the deficient bracing. Envista ultimately testified in this case, assisting in the final resolution.

Determining causation can be a complicated analysis. Forensic engineers are impartial, third-party experts that do not interpret insurance policies. However, as forensic engineers, we must strive to provide the most complete picture possible to our clients. Clear communication with the client is essential in understanding what question the client needs to have answered. Through communication and a firm understanding of our client's needs, we can provide exceptional expert service.