The GOOD the BAD and the INEVITABLE Structural Condition Assessments

In this month's feature, STRUCTURE® magazine presents an overview of Structural Condition Assessments. From a maintenance or proactive assessment (the "good")… to a disaster or reactive assessment (the "bad")… and the "inevitable" (like death and taxes!) legal aspects of assessments in general… Structural Condition Assessments tap in to the entire structural engineering knowledge base. Presented here are the experiences and insights of structural engineers who perform these assessments and, in the case of the "inevitable", protect the performers contractually.

Pictured above — Philip (a.k.a. "Plumb Lucky") Blinderman is a member of the Single Action Shooting Society and participates in Cowboy Action Shooting and Western Re-enactment events in the Midwest. (Photo courtesy of Pat Campion)

The GOOD Structural Condition Assessment

By Robert T. Ratay, Ph.D., P.E.

Structures, like people, can maintain their good health with age, if properly cared for, examined, and treated when needed. Structures, like people, need periodic check-ups as part of their preventive care to ensure their fitness; and need examination when exhibiting signs of illness. Interestingly, structural condition is sometimes referred to as fitness-for-service.

It may be said that a structure that has withstood the combined effects of use, abuse, loads and environmental conditions over time has, in effect, proven itself. However, all structures do deteriorate with time as the result of repeated loadings, exposure to the elements, aging of materials, wear-and-tear from normal use, abuse, inadequate maintenance and other reasons. The deterioration may progress to the point—or one or more events may have the consequence—of compromising the structure's strength, stability, serviceability, or appearance. Structures may also be unwell due to errors in their original design, shortcomings in their construction, or imperfections in their materials.

What Is It?

"Structural condition assessment", as the phrase implies, is the physical examination and diagnosis of the "health" of a structure. It may include one, several, or all of the activities of visual observation, measuring, photographing, probing and sampling, field and laboratory testing, numerical analyses, record keeping, documentation, and report preparation. It is not to be confused with forensic investigation of structures, which is the determination of the causes and modes of non-performance and failure.

Assessing the condition of structures has become an area of professional practice within the field of structural engineering. It is an active business driven by various factors, such as the sale and purchase of buildings; the need for maintenance, repair and rehabilitation of buildings, bridges and other deteriorating infrastructure; the choice of adaptive reuse of facilities; the necessity of retrofitting for ever-changing code compliance; and, more recently, by the desire for increased physical security of corporate and public buildings, transportation structures and industrial facilities.

Defect, Deterioration, Damage

In diagnosing a structure's condition it is necessary to understand and recognize the possible origins of that condition. There are distinctions among *defect*, *deterioration*, and *damage*.

Defect in a structure may be the result of errors in design, poor construction, or defective materials. They are present from the beginning of the life of the structure, and may manifest themselves as early as during construction, or as late as years into the service life of the structure. ***Deterioration*** is the degradation in performance with time which may be normal under the particular use and exposure, or may be accelerated on account of defects in the design, construction or materials, or as the result of inadequate maintenance. ***Damage*** is the result of a natural, deliberate or accidental event that leaves a condition that is detrimental to the performance of the structure.

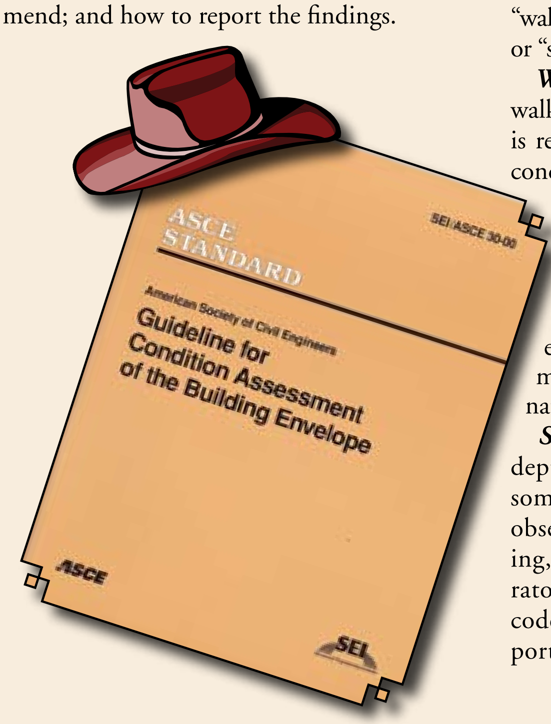
Identifying correctly the actual origin of a problem is particularly important for evaluating the existing safety and reliability, for predicting future performance, and, last but not least, for prescribing the proper methods and materials of repair, if any.

Qualifications

Understandings of structural behavior, and a working knowledge of structural analysis and design, are indispensable for the engineer doing structural condition assessment, but experience in field observation of structural problems is the most valuable background. Engineering judgment plays an important part in the assessment.

Thoroughness and accuracy of the field measurements, testing and analyses are important, but the reliability of the condition assessment is planted deeply in the interpretation of these data and in the judgments converting them into accurate conclusions and recommendations.

The engineer who undertakes the condition assessment of a structure needs to know, of course, how to plan and organize the assessment; how to inspect the structure; what to look for; how to recognize various conditions; what methods of field examination, laboratory testing, and analytical evaluations are available as well as feasible and useful; what to recommend; and how to report the findings.



SEI/ASCE 11/99 (Reference 2)

"A structure is a structure," but each is unique in the combination of its design, construction, history of use and abuse, and quality of its maintenance. Therefore, while there are "typical" signs that may indicate "obvious" conditions, one has to be aware that some unrecognized or hidden details may distort one's conclusions. For example, one may judge a vertical crack near the corner of a brick or stone facade to be the obvious result of movements caused by temperature variations; but it may turn out to be caused by corrosion of the corner steel column bursting the masonry.

It often happens with structures built years or decades ago that they do not meet the current codes, standards and specifications. One needs to obtain, understand and examine the codes, standards, specifications and practices in use at the time of the design and construction of the structure in order to understand its behavior and evaluate its adequacy. For this reason, the engineer doing condition assessments is well advised to have a library of all old codes and design specifications that he/she can acquire.

The cost of condition assessment, i.e. the fees received by the consultant, are usually disproportionately small in comparison to the possible financial consequences of the findings. This makes condition assessment rather high risk work because the liability of the consultant can be far greater than his/her fee for the work.

Types of Condition Assessment

One may classify the types (extent) of structural condition assessment into three groups: "walk-through", "due-diligence", and "in-depth" or "structural integrity" evaluations.

Walk-through is essentially what it says: walking through the facility, observing what is readily visible, and opining on the general condition of the facility.

Due-diligence assessment is, in essence, a cursory visual inspection of the facility, looking for and identifying clearly visible deficiencies, and reporting on the overall condition with a list of the obvious existing and potential problems, if any. It may be followed by a more thorough examination of parts or all of the structure.

Structural integrity assessment is an in-depth examination of the facility including some or all of the following activities: visual observation, field measuring, photographing, probing and sampling, field and laboratory testing, numerical analyses, checking code-compliance, documentation, and report preparation.

What to Look For?

The most common types of defects, deterioration, and damage to look for in structures of the four major construction materials are briefly outlined below.

In Concrete

Low strength, cracking, delamination, popouts, scaling, dusting, and extensive wear-and-tear are the common problems with concrete in service. Except for the low strength, they are visible on the surface. <u>Low strength</u> is not visible, so it has to be tested in-place by impact hammer or in the laboratory by compression testing of cores removed from the structure.

Checking verticality of a cracked retaining wall

The causes of low strength, as of other defects, can be determined by petrographic examination. <u>Cracking</u> is perhaps the most common problem. Crack mapping will document the locations and extent of the cracking, and the pattern of cracking may point to the possible cause(s). The cracks may be due to drying shrinkage, caused by reduction in volume of the concrete owing to water loss as the concrete dries; plastic shrinkage, that occurred while the concrete was still plastic and there was rapid moisture loss at the surface by evaporation; or due to overstress under load.

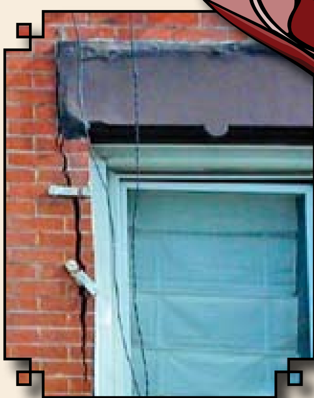
<u>Delamination</u>, when it occurs, is in the upper ⅛- to ½-inch of a slab, caused usually by premature finishing before bleed water had a chance to reach the surface. <u>Popout</u> is where a shallow, roughly conical-shaped pit occurs in the surface with a fractured aggregate particle at its base. Popouts range in size from a fraction of an inch to 3-to-4 inches in diameter. One of the causes of popouts is highly porous aggregate located near the surface that absorb moisture and expand outward on freezing. <u>Scaling</u> is probably the most common surface distress observed in exterior concrete that is exposed to moisture and freezing conditions. There are several causes of scaling – all originating from construction – including high water content, ineffective air entrainment, overfinishing, and improper curing. In appearance, it is the breaking up of a thin layer of surface into very small pieces; sometimes referred to as low durability.

continued on next page

Dusting refers to a powdery residue on the surface left by the concrete placement. The top surface of the concrete is relatively soft and friable owing to a chemical reaction that occurred during curing in the early hours after placement. Extensive wear-and-tear may not be an abnormality but just the result of use and old age.

In Steel

General corrosion, ductile overstress, brittle fracture, buckling, fatigue are among the common problems with steel in service. Except for low levels of ductile overstress, the others are visible conditions. General corrosion is the formation of an oxide (rust) over the surface and the resulting thinning of the parent metal. Rusting due to exposure to weather and moisture are prime examples of general corrosion. The thickness of rust is 6-to-9 times that of the material from which it formed, and can create very large bursting forces when its expansion is restrained.



Crack monitoring during a condition assessment

Ductile overstress may result in excessive deformations that impact the serviceability of the structure but is seldom the cause of unheralded failure. Ductile overstress, if beyond the yield stress, can sometimes be identified by the cracked or crazed appearance of the painted surface or mill scale. Brittle fracture is a sudden break characterized by flat fractures with little or no inelastic deformation, hence with little or no warning, prior to failure. Most brittle fractures initiate from locations of stress concentrations, such as weld flaws, and sudden changes of geometry or thickness in steels with low fracture toughness.

Buckling is easily recognized by the out-of-line or out-of-plane deformation of an originally straight line or plane. It occurs suddenly, usually without warning. If it is localized, such as a short wave in a beam or column flange, it should be a warning of possible impending collapse of the member. Fatigue is the result of repeated or cyclic loading that generates microscopic inelastic damage at regions of local stress concentration. It may be recognized by the initiation and growth of a crack or cracks due to the repeated loading. Frequently, fatigue crack growth will continue until the crack attains a critical size resulting in the failure of the entire member. Fatigue damage is a progressive mechanism which can often be identified before significant damage happens.

In Masonry

Cracking, reduced moisture resistance, freeze-and-thaw damage, and mortar deterioration are common problems in masonry walls. All of these are visible upon inspection. Cracking can be the result of differential foundation settlement; excessive deflection of supports, such as lintel beams over openings; overload; stress concentration such as at the seating on shelf angles; restrained shrinkage and temperature movements, such as at anchorages to the building's structural frame.

Although most masonry cracks are benign, all wall failures begin with a crack. Structural problems in masonry can originate with both the design and the construction. Reduced moisture resistance, freeze-and-thaw damage, and mortar deterioration are mostly material quality problems.

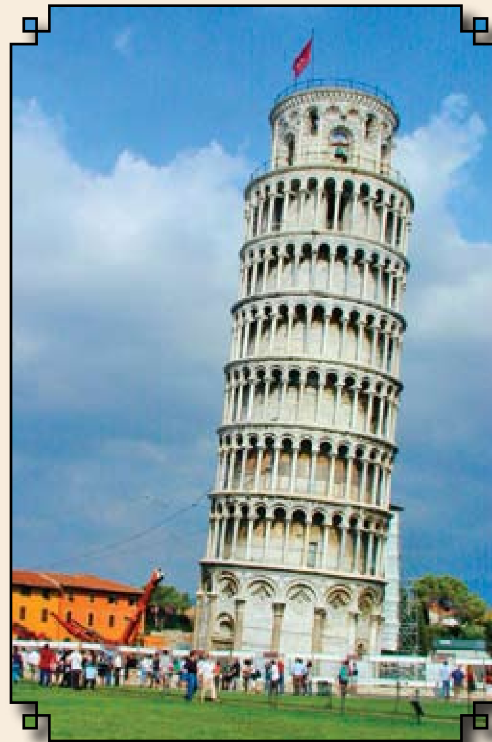
In Wood

Overstress and decay are two of the most common problems with wood structures. Overstress occurs most frequently at connections where small and hard metal connecting elements create stress concentration in the weaker and softer wood. Unless hidden by covering, serious overstresses can be seen. Decay occurs when, in conditions favorable to their growth, wood-destroying fungi will use wood as their food source. Decay is a potential hazard in wood structural members and should be arrested when noticed. It may take an expert in wood material to recognize early stages of decay and predict its progress and consequences.

Reporting

Structural condition assessment is incomplete and is of questionable value without a written report. Depending on the assignment, it may be a simple one-or-two-page letter or it may be a multi-volume set of documents — consistent with the scope and extent of the project. It is advisable to agree with the client, preferably before but at least during the project, on the extent of the report.

For a walk-through, and even for a ***due-diligence*** project a letter report is often adequate and appropriate. However, even a simple letter report should be organized in sections with subtitles so that a reader can easily locate the part(s) he/she is interested in. ***A large project with an in-depth investigation*** may warrant a large, possibly even multi-volume report. It may be advisable to deliver it in phases — or first as a preliminary report, and later as a final report — so as not to overwhelm the client and to give him/her the opportunity to see that it addresses all of his/her needs. Public agencies, multi-facility owners, engineering firms and even individuals often have their own report format to which the consultant may have to adhere.



They don't build them like they used to

The following are some important elements that should be kept in mind when rendering a report:

- Keep in mind that the report will be read by "all sorts of people". Keep the language of the general sections understandable to the non-technical reader, but direct the detailed discussions and results to engineers who will review and use them.
- It is not unreasonable to write a well-considered and carefully worded disclaimer to limit your liability to the specific intent and content of the report.
- Beware of pronouncing the structure "safe." Safety, or the lack of safety of a structure, is not inherent but rather it is an opinion based on observations, calculations and tests, all of which may be performed and judged differently by different investigators. In addition, "safe" for a particular exposure, use or load that is known may not be "safe" for another exposure, use or load that is either known or unknown.

- Be aware that your condition assessment report may have serious financial and legal consequences to the client! At the same time, however, be mindful of your own professional liabilities as well as your responsibilities for public safety.

Recording a sign of distress in a precast prestressed concrete double-tee

Challenge and Reward

Structural condition assessment is a challenging and rewarding field of practice with much responsibility to the client and high risk to the consultant. It should be undertaken by professionals with appropriate experience and good engineering judgment.▪

Robert T. Ratay, Ph.D., P.E., is a structural engineer in private practice in Manhasset, NY, and an Adjunct Professor at Columbia University. His current consulting work, lecturing, and publications focus on forensic structural engineering and condition assessment. He is the Editor of the books Structural Condition Assessment, Handbook of Temporary Structures in Construction, and Forensic Structural Engineering. Dr. Ratay is a Fellow of ASCE and serves on the Board of Governors of the Structural Engineering Institute (SEI). He can be reached at ***Structures@RobertRatay.com***

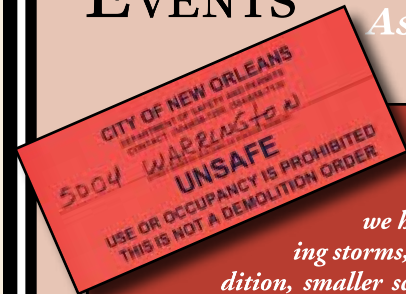
See Page 9 for references to this article

the BAD

Catastrophic Events

Strategies for Structural Condition Assessments of Damaged Buildings

By David B. Peraza, P.E.



Structural engineers can provide crucial expertise following natural disasters, terrorist attacks and other catastrophes. In recent years we have experienced major terrorist attacks, devastating storms, and singular collapses of public structures. In addition, smaller scale situations develop every day that require an engineer's immediate evaluation.

When faced with an emergency situation, even highly qualified engineers often have initial difficulty dealing with the situation and knowing where to start. There is very little training on this topic that is targeted at the engineer.

This article discusses strategies from the author's experience. It is hoped that this will assist other engineers in conducting damage assessment of structures in emergency situations.

Emergency Response

Public Safety Issues

The engineer's initial task after an incident may be to determine if there is still a threat. Is there a possibility of further collapse or of debris falling? If so, then further consideration is required to determine the possible consequences. Is the general public threatened? Could it damage important public property, such as mass transit or communications facilities? Once the potential risk has been involved, an initial response should be developed. Possible responses include:

- Restrict public access: This may mean the temporary evacuation of residences and businesses, closing of streets, or the cordoning off of large areas or neighborhoods.
- Stop construction: If the incident occurs on a construction site, construction will usually be halted until the situation is under control. There are situations, however, where it would be prudent to continue work, if that work will bring added stability.
- Stabilization: Shoring or bracing may be needed in order to prevent further movement or further collapse of a structure.
- Demolition: If shoring or bracing cannot be safely installed, demolition of the structure, or of a portion, may be the only option.
- Protection: If the hazard cannot be immediately removed, the installation of barriers to protect the public may be appropriate. Netting can provide a useful means of containing loose debris, and sidewalk sheds can shield pedestrians from falling objects.

Most of these techniques were used during the rescue and recovery work at "Ground Zero" in New York following the 9/11 attacks.

Risk versus Reward

The reward should justify the risk. What is the risk, both in terms of probability and of consequence? Obviously, a risk that may injure a rescuer or the public is weighed differently than one that may cause additional property damage. And, if successful, what will the reward be? If, for example, there is a reasonable potential that a trapped victim's life may be saved, a high level of risk is justified. Or, if the goal is to recover victim's bodies, a much lower level of risk is acceptable. If there is no rescue or recovery involved, then it will be hard to justify unusual risks and the normal safety measures that are in-place on a typical construction site would be appropriate.

Speed Matters

In emergency situations, a rapid response is crucial. One way to accomplish this is to use materials that are already on site or that are readily obtainable. At the World

Figure 1: This monitoring system uses inclinometers and digital radio technology to detect abnormal building movement and to alert nearby personnel. It was developed by Exponent in partnership with the California Urban Search and Rescue Task Force 3.

Trade Center, undamaged core columns from the collapsed towers were gathered to create a dunnage platform for a large crane. At a hoist collapse at a high-rise building, mast sections from the hoist elevator were bolted together to serve as outriggers, and the elevator cables were used to cinch the unstable scaffold to the building.

Another concept that may be helpful in a rapid response situation is to realize that precise answers may not always be needed. Fuzzy answers may suffice. If an emergency worker asks if it is safe to enter a building, an acceptable answer might be, "I'm not sure. But if you need to go in, I would suggest staying on the left side, under the girder."

Figure 2: The loss of a column to 130 Liberty Street in New York City is an excellent example of how redundancy can prevent progressive collapse. The façade was a wind moment frame that, once a column was destroyed, acted as a vierendeel truss to span over the opening.

Monitoring

Many conditions defy analysis. Multiple secondary load paths may be active and their reliability is uncertain. For these conditions, the best course of action may be to monitor the questionable structure for movement. The engineer can assist in determining the type of equipment to be used, setting the intervals of readings, and determining the thresholds that trigger action. In some cases, taking readings at regular intervals using professional surveying equipment would be appropriate. In other cases, continuous automated monitoring with reporting via the internet may be required. *Figure 1* shows a system that monitors building movement and provides wireless alerts to nearby emergency responders.

> "Engineering societies play a crucial role... These organizations can help provide trustworthy and unbiased information to the media"

Back to Basics

Assessing damaged buildings is not a precise science. There is usually insufficient information with which to conduct a rigorous analysis. It is helpful to keep in mind some fundamental engineering concepts:

- Ductility: If further failure were to occur, is it more likely to occur in a brittle manner or a ductile manner? This depends on several factors, such as the material, the mode of failure (e.g., flexural, buckling), and the type of component.
- Alternate Load Paths: What secondary load paths have been engaged, or are likely to be engaged if further failure occurs? If the secondary load path passes through structural elements, it may be possible to evaluate the reliability of the load path. For example, loss of a column may activate vierendeel action over the opening (*Figure 2*), or it could activate catenary action of beams. On the other hand, if the secondary load path is relying on non-structural elements, such as partitions or warehouse shelving, the situation is more difficult to assess. *Figure 3* illustrates this condition.
- Redundancy: Redundancy is the presence of a reliable alternate load path. The load path is typically through structural elements that have reserve strength. It may be an intended or unintended path.

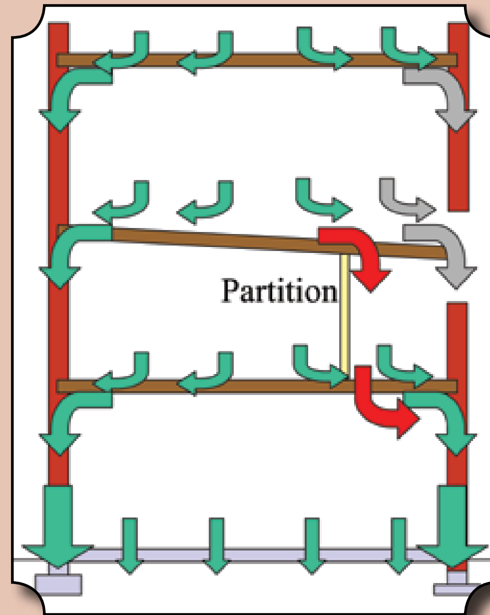


Figure 3: The loads paths in damaged buildings may be difficult to identify, and may rely on non-structural elements.

- Determinate and Indeterminate Structures: Just because a structure is indeterminate, does not mean that it is redundant. If load is transferred to a member that has no reserve capacity, it may trigger a progressive collapse. For example, if snow load causes failure of a bay of roof purlins, and the purlins are designed as continuous members, it is likely that the failure will progress to adjacent bays. In cases where all of the elements are highly stressed, determinate structures offer the advantage that they tend to isolate the failure to a particular area.

Hurricane Damage Assessments

The 2005 hurricane season set records both in terms of the number of named storms and their severity. As commonly published and referenced, hurricanes Katrina, Wilma, and Rita were among the strongest to hit the US.

Engineers played, and continue to play, an important role in the recovery of hard hit areas. The Army Corps of Engineers spearheaded an assessment of levee performance and implementation of emergency repairs; transportation engineers labored to rapidly restore critical routes; and structural engineers assisted private owners and insurance firms.

Engineering inspections of damaged buildings were needed to determine the extent of damage, to assess safety, to determine causation, and to develop needed repairs. In some cases, such as the curtainwall damage shown in *Figure 4*, the cause of the damage is immediately obvious. In other cases, it is not. Was the damage caused by wind, by storm surge, by flood, or by a combination of these? Were there construction defects that allowed the damage to occur, or was the damage pre-existing? Is it sufficient to replace the curtainwall in-kind, or should it be upgraded? An objective assessment requires looking at all of the available information, and evaluating it using sound scientific and engineering principles. This requires a review of storm surge maps (*Figure 5*), meteorological data, a detailed site inspection, patterns of damage on neighboring buildings, eyewitness reports, aerial photographs, and other information.

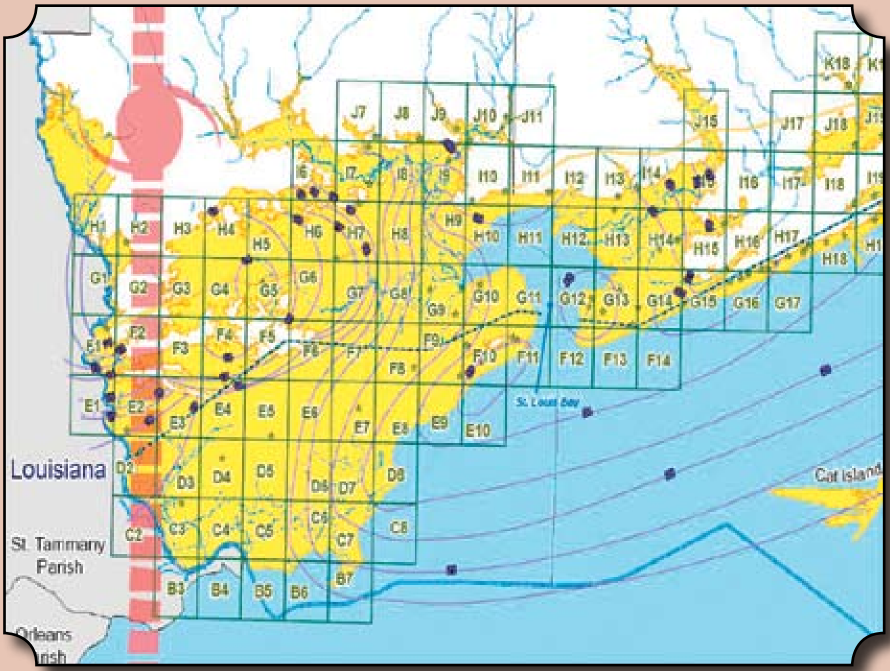


Figure 5: Determination of causation requires a comprehensive review by the engineer of all available information. Storm surge maps, such as this one from FEMA, are one important source of information.

Role of Engineering Societies

Engineering societies can play a crucial role in these types of situations. These organizations can help provide trustworthy and unbiased information to the media. Often after a newsworthy event, news media reach out for experts who can comment on the situation. The local engineering society can help by identifying those individuals. Also, the engineering society may consider preparing an informational press release.

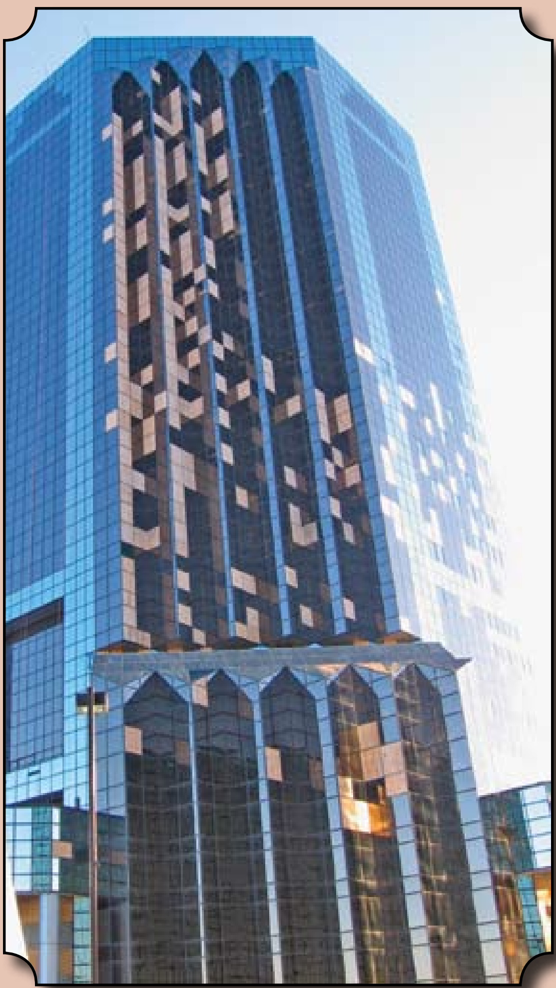


Figure 4: Curtainwall damage from Hurricane Katrina.

Engineering societies can sponsor programs that help train their members. These programs might include training in the use of ATC-20 *Procedures for Postearthquake Safety Evaluation of Buildings* and ATC-45 Safety Evaluation of Buildings After Windstorms and Floods.

Engineering societies can also develop their own emergency response plan. Shortly after the 9/11 attacks, the National Council of Structural Engineers Association (NCSEA) formed a committee that eventually produced a model document titled *SEERPlan Manual* (Structural Engineers Emergency Response Plan). Local societies can use this as a basis for developing their own plan.

Engineering societies can also assist FEMA Urban Search and Rescue (US&R) teams, by provide building-specific information and by facilitating contact with the engineers or architects familiar with the building's design. Drawings of the World Trade Center complex provided to the US&R teams in the days following 9/11 were of invaluable assistance in the search and rescue efforts at Ground Zero.

An Important Role

Natural and man-made catastrophes will continue to occur. Structural engineers can play an important role in minimizing loss of life and property damage, and in assisting with rapid recovery. Local and national engineering societies can take the initiative to help prepare their members so that they can respond rapidly and effectively when needed.▪

David Peraza, P.E. is a structural engineer in the New York office of Exponent (Failure Analysis Associates). He specializes in structural failure investigations, condition assessments, and the development of remedial measures for distressed structures. He led the emergency structural

See Page 9 for references to this article

and the INEVITABLE

Assessing Liability

Key Legal Aspects of Structural Condition Assessments

By Michael Zetlin and Chris Fladgate

Several the key legal aspects are likely to arise in relation to structural condition assessments ("Assessments"). The primary focus of the consultant undertaking the Assessment ("the Engineer") must be its potential liability. In particular, the Engineer needs to be aware of its potential liability which may arise out of the consultancy agreement with the Owner ("Agreement") and/or the Assessment report that the Engineer provides to the Owner ("Report"). How the Engineer addresses and manages its potential liability in these two documents is critical. In general, the Engineer's liability is primarily dependant on: (1) its scope of services; (2) any contractual risk shifting to the Engineer; and (3) the representations made by the Engineer in the Report. An Engineer can manage these risks by making suggestions in relation to contract terms and language an Engineer should try to use when writing its Report.

The Agreement

The risk that an Engineer accepts is more likely to be proportionate to the value of the transaction necessitating the Assessment, rather than the Engineer's compensation. This means that an Engineer must be very careful before entering into an agreement to perform an Assessment.

The primary concern of an Engineer in this regard should be in relation to potential future liability, both to the Owner and also to third parties. Generally, the Engineer's liability will be split between liability pursuant to the Engineer's indemnification obligations under the Agreement and all other liability, whether arising elsewhere in the Agreement, in tort, under statute or otherwise. In both cases, the Engineer will be exposed to liabilities, some of which are insurable and some which are not insurable.

> The Engineer may enter into the Agreement with the owner of the building or another design professional engaged by the owner. For simplicity, we refer to the other party to the Agreement as "Owner"

Scope of Services and Information Relied Upon by Engineer

The scope of services that the Engineer will be required to perform is critical, as it needs to be well defined in the Agreement in order to avoid misunderstandings between the Owner's expectations of the Engineer and what the Engineer believes the Owner is expecting. When these misunderstandings occur, the Owner is likely to blame the Engineer for later-arising problems and, accordingly, the Engineer's potential liability increases. For example, consider an Owner who wants the Engineer to provide a report advising whether a building owned by the Owner is suitable for vertical expansion by three floors. However, if the scope of services in the Agreement simply states that the Engineer is to report on "the expansion of the building," the Owner may rely on the Report to expand the building beyond three floors claiming it never understood the Engineer's opinion was limited to a three floor analysis.

Similarly, it is important that the Engineer advises the Owner in writing of any restrictions or limitations which have prevented the Engineer from performing a full Assessment of the building. The Owner, usually for budgetary reasons, does not want a full Assessment performed. For example, after receiving a quote that a full Assessment may cost $20,000, the Owner may say to the Engineer, "What do I get for $10,000?" and the parties proceed on that basis. Other examples could be that the Owner may not allow any invasive testing to be performed by the Engineer, or the Owner may require the Assessment Report in a short period of time. Whenever these types of restrictions are placed on the Engineer, the Engineer should ensure that these restrictions are either expressly set out in the Agreement and, if not, the Engineer should write a record letter to the Owner setting out the restrictions and qualifying any opinions accordingly. In terms of managing the Owner's expectations, the Engineer will be better served if these restrictions are set out early in the process, rather than appearing for the first time in the Engineer's Report.

> For simplicity, we refer to the person undertaking the Assessment as the Engineer. We refer to the Engineer in the second person as "it" or "its" because, in litigation, the Owner is more likely to sue the consultant's firm rather than the individual consultant.

Finally, the Engineer should ensure that all information it intends to rely upon that will be provided by the Owner or third parties is set out explicitly in the Agreement. Information provided by other parties directly impacts the Engineer's ability to perform the scope of services, and the accuracy of that information may affect the accuracy of the Engineer's Report. Again, by setting this information out early in the process, the Engineer is managing its own potential liability by managing the Owner's expectations.

Representations

The Engineer must be aware of the representations, whether implied or expressed, that it makes under the Agreement and ensure that all representations are accurate and consistent with the scope of services. Owners will seek certain representations by the Engineer in the Agreement, not only to provide clarity in the Agreement but also because, if the Owner becomes aggrieved, it will look to the Engineer's representations in the Agreement to determine whether it has a potential claim against the Engineer.

For example, the Engineer should not agree to a higher standard of care for its services than is applicable at law. This means striking out any language that imposes the "highest" or "higher" standard of care on the Engineer beyond the customary standard of care.

While it is relatively common for an Engineer to represent that it has the requisite experience on similar projects in order to perform the services, the wording of such a provision sets

Consequential damages are those damages which the Owner suffers but do not arise directly from the Engineer's fault (for example, loss of profits is usually considered to be consequential damage). Because of their nature, the quantum of consequential damages can be both extremely large and difficult to accurately anticipate. For example, if the Engineer negligently fails to detect a structural problem which causes a casino to cease operations for two months, the direct damages are likely to be the cost to repair the structural problem, while the consequential damages are likely to include the lost profits that would have been taken by the casino during that period.

the standard by which the Engineer will be judged when performing the services. For example, if the Engineer represents that it is aware of the specific purpose for which the Owner has engaged its services, then a higher standard may be applicable to the Engineer's services. To some degree, this issue can be managed by including a disclaimer at the Report stage.

As a final note, Engineers should try to avoid using the words "warrants" or "warranties" in relation to representations. These taboo words may lead the professional indemnity insurance carrier to refuse coverage in cases where the Engineer expressly "warrants" that its services will be to a certain standard.

Indemnification Obligations

The Engineer should also be aware of the scope and terms of the indemnity that it is providing to the Owner; the indemnity is a primary method of transferring risk from the Owner to the Engineer. Obviously, as more risk is shifted to the Engineer, the greater the Engineer's potential liability under the Agreement. An indemnity is a promise to pay all of a party's defined expenses in certain circumstances and may even include attorney's fees. Any indemnity provided by the Engineer should be limited to direct damages caused by the Engineer's negligent acts or omissions. Accordingly, the Agreement should expressly waive the Owner's right to consequential damages. Further, the Engineer should avoid any indemnity that puts a no-fault indemnity obligation on the Engineer, and the Engineer should insist that it should not be responsible for any damages suffered by the Owner which are caused in part by the Owner's negligence.

Assessment Report

As stated above, the Owner is more likely to be more interested in the Report than the Assessment itself, because the Report lets the Owner plan more effectively for the future. Accordingly, the Engineer needs to draft the Report in such a way that it reflects accurately the opinions rendered by the Engineer as well as setting out all qualifications to that opinion. The Engineer should strive to avoid ambiguity or other ways in which the Owner may be misled, so that the potential for miscommunication between the Engineer and the Owner is eliminated.

Nature of Report

The Engineer should identify the nature of the Report specifically. For example, if the Report is a preliminary assessment, that should be made clear in the Report.

A "no fault" indemnity obligation may, for example, be in the form of an indemnification "for any loss, damages or expenses (including attorneys' fees) suffered by the Owner arising out of the Engineer's performance of the Services." This type of provision does not require any negligence on the part of the Engineer in order for the Engineer to be liable to the Owner.

Qualifications and Assumptions

The Engineer should include any qualifications or assumptions that the Engineer has made in preparing the Report, including a list of all documents (reports, drawings, photographs etc): (a) that the Engineer has reviewed; (b) that were provided by third parties which the Engineer is relying on; and (c) that the Engineer was not able to review (for example, if some as-built drawings were not made available to the Engineer, this should be stated).

It is particularly important for the Engineer to identify all of the information it has relied upon that was provided by third parties. The Engineer may also want to add, when true, that it has not independently investigated and verified the accuracy of these documents. In doing so, the Engineer will reduce its potential liability in the event that it is discovered there were errors in the documents that the Engineer relied upon. The danger the Engineer faces if it does not make such a disclaimer is that the Engineer may be impliedly representing to the Owner that the Engineer has checked and verified the accuracy of all documents relied upon in the Report. Where the Owner makes a claim based on the Report, the Engineer may find it difficult to demonstrate that it was not vouching for the accuracy of the third party documents.

Further, given that Assessments, by their very nature, target existing structures created by another person's design, elements of the building will undoubtedly be hidden, obscured or unknown, whether due to finishes that conceal the structural frame or due to documents, such as as-built or contract drawings, not made available or provided to the Engineer. Accordingly, the Report should state whether the Engineer is aware of any substantial past or current renovations of the building for which related documents have been reviewed and/or not provided.

Non-Conclusive Findings

If this is not already covered by qualifications and assumptions, the Report should set out the areas where the Engineer simply cannot form a firm conclusion. This should be done in the "Findings" section of the Report. More importantly, it is better to put the Owner on notice as to areas of doubt in the Report than to either guess or to avoid addressing the issue altogether.

Disclaimer

As mentioned earlier, the Report should contain a disclaimer of some form. The Council of American Structural Engineers (CASE), in its *National Practice Guidelines for the Preparation of Structural Engineering Reports for Buildings*, gives guidance on wording and appropriateness of disclaimers. The importance of a disclaimer is that, in a written report, it is the one opportunity that the Engineer has to set out the purpose of the Report and clearly state the party or parties who may rely on the Report. As such, the Engineer may reduce its liability to third parties. It should be noted, however, that there will be occasions where the Owner will want third parties to be able to rely on the Report. For example, in a sale transaction, the Report may form part of the sale documents and be a representation by the vendor. Accordingly, this again underlies the importance of clarity in both the Agreement and the Report in order to prevent the Engineer from assuming potential liability to additional third parties.

Managing Potential Liability

Two points should be emphasized: (1) this article is only a very brief summary of the key legal aspects of Assessments. It not a comprehensive legal analysis of Assessments and should be not considered such; and (2) every project is different, as each building is different and the Owner's requirements will not always be the same. Accordingly, the legal issues that arise will necessarily differ from project to project.

In general, the greater the clarity with the Agreement (including the scope of services) and the Report, and assuming the Engineer performs its services with due diligence, the less likely the Engineer will be exposed to future claims. However, if the Engineer is exposed to claims, the manner in which the Engineer has managed its potential liability in both the Agreement (for example, in the representations made by the Engineer) and the Report (for example, in the disclaimer) will be influential in determining the Engineer's ultimate liability.▪

Michael S. Zetlin is a founding member of Zetlin & De Chiara LLP, a New York, New Jersey, Connecticut and California based law firm that represents design professionals, contractors, construction managers, owners, developers, and other parties in the construction industry. A graduate civil engineer as well as an attorney, Mr. Zetlin represents national and multi-national firms in a wide range of construction and real estate matters.

Chris Fladgate is an associate at Zetlin & DeChiara LLP. Mr. Fladgate has represented and advised owners, contractors and design professionals in a wide range of construction related matters (both litigation and non-litigation) in New York, Hong Kong and Australia.

References

The GOOD

Reference 1 is a comprehensive reference book on the subject addressing technical, business, and legal matters – suitable for use by the novice as a text to learn the necessary basics, and by the expert as an authoritative reference, as well as a guide to all to assist in the step-by-step conduct of structural condition assessment. Reference 2 is a valuable guide to material properties, tests, and recognition of inadequacies.

Defects, deterioration and durability are discussed in useful detail by Nicastro and Surovek in Chapter 1 of Reference 1.

The most common types of defects, deterioration, and damage to look for in structures of the four major construction materials are discussed in much detail in References 1, 2 and 3.

References 1, 2 and 4 are good sources for formatting structural condition assessment reports.

1. Structural Condition Assessment, Robert T. Ratay, Ed., John Wiley and Son, New York, NY, 2005
2. SEI/ASCE 11-99 Guideline for Structural Condition Assessment of Existing Buildings, American Society of Civil Engineers, Reston, VA, 1999
3. Forensic Structural Engineering, Robert T. Ratay, Ed., McGraw-Hill, Inc., New York, NY, 2000
4. *National Practice Guidelines for the Preparation of Structural Engineering reports for Buildings*, Council of American Structural Engineers (CASE), 1995, Washington, DC

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Ashcraft, H. "*Legal Aspects of Condition Assessment and Reporting*", in Ratay, R. (ed.) (2005) *Structural Conditions Assessment*, John Wiley & Sons, Inc., Hoboken, 115-126.

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