STRUCTURAL ENGINEERING ASSESSMENTS OF EXISTING BUILDINGS

By Don Ireland, P.Eng., and Ron Koerth, MBA, P.Eng.

This document is also available as a practice bulletin at http://www.peo.on.ca/index.php/ci_id/22608/la_id/1.htm.

ENGINEERS CONDUCTING structural engineering assessments of existing buildings may face such challenges in the course of their work as the fact building codes focus on new buildings rather than existing ones; original design and construction documents of existing buildings are often not available; and the difficulties of estimating the reliability of existing buildings. The best practices described here are intended to guide engineers conducting these assessments, with special emphasis on duties to their employers, clients and the public.

Currently, the law does not require periodic structural engineering assessments of existing buildings. Nonetheless, there are circumstances where clients will hire individual engineers or engineering firms to conduct structural assessments of existing buildings or parts thereof. Generally, structural engineering assessments of existing buildings fall into one of two categories:

1. assessments of the overall integrity of buildings; or
2. assessments of buildings or parts thereof affected by structurally compromising events, such as fires, vehicle impact, or flooding.

Conducting structural engineering assessments of existing buildings is deemed to fall within the practice of professional engineering since they are:

1. acts of evaluating, advising and reporting;
2. wherein the safeguarding of life, health, property or the public welfare is concerned; and
3. require the application of engineering principles.

Consequently, structural engineering assessments of existing buildings can be conducted only by engineers or people supervised by engineers.

AGREEMENTS

Engineers conducting structural engineering assessments of existing buildings should work with written agreements with their clients that specify, but are not limited to:

1. access to all documents and drawings they say they require to conduct the assessments, such as original design and construction documents and drawings. Alternatively, if these documents and drawings are not available, engineers may determine that they require additional field work, such as obtaining measurements of the structural elements, to obtain the needed information to conduct their assessments;
2. access to copies of prior building assessments, as well as maintenance and repair records of buildings being assessed;
3. access to buildings being assessed and all the critical areas engineers identify; and
4. additional investigations engineers determine to be required after reviewing preliminary data.

ORIGINAL DOCUMENTS

Engineers conducting structural engineering assessments of existing buildings should review original design and construction documents and drawings, including as-built drawings, if available, prior to visiting buildings for inspection. This review will help engineers to:

- understand buildings' structural systems and layouts;
- identify critical areas for inspection;
- identify the specified loads to assess usage and possibility of overloading; and
- verify if unauthorized additions or alteration works that affect the structure of buildings have been carried out.

When assessments are limited to specific areas, due to incidents suspected to have caused damage to buildings in those areas, it might not be necessary to review original design and construction documentation. For example, if a forklift struck a steel column, it might be sufficient to inspect the column and any connections and/or connected members to determine if those elements were affected.

INSPECTION

Engineers must notify their employers and clients if during the course of their inspections they encounter a situation that endangers the safety or welfare of the public, for example, if hazardous materials that were previously unreported are found during the course of inspections. If situations are serious and must be attended to immediately, engineers should notify their clients orally and in writing and obtain confirmation from clients that appropriate actions will be taken in a timely manner. Otherwise, local authorities having jurisdiction (e.g. local building departments) must be notified. It might be necessary to provide such written notices in a short letter in advance of complete reports, so notices are provided in a timely fashion. Engineers must bear in mind that their duty to protect the public welfare is their highest duty, superseding confidentiality issues between clients and engineers.

Engineers conducting structural engineering assessments of existing buildings are expected to visit the buildings and carry out, with due diligence, visual inspections of:

- the condition of building structures–to identify types of structural defects, signs of structural distress and deformation, and signs of material deterioration;
- the loading on building structures–to identify deviations from their intended uses, and/or misuse and abuse, which can result in overloading;
- additions or alteration works affecting building structures–to identify additions or alteration works that can result in overloading or adverse effects on structures; and
- non-structural components that might affect structural systems.

If signs of structural deterioration or defects are present, engineers should provide opinions on the severity of the deteriorations or defects and recommend appropriate actions to be taken. Such actions might involve repair works or full structural investigation to parts or the whole of buildings.

Conducting visual inspections can be difficult, as main structural elements in buildings may have been covered up by finishes. It is, therefore, important that engineers exercise professional judgment to determine which covered areas should be exposed for inspection. Reference to structural layout plans to determine the presence of critical structural elements is crucial under such circumstances.

Inspections will, on occasion, yield information that indicates a structural problem might exist, requiring testing that was not included in the original scope of the inspection. Engineers should not hesitate to recommend to clients additional tests to uncover potential structural problems.

If inspections are being conducted because buildings were affected by potential structurally compromising events, such as fires, vehicle impact or flooding, engineers may choose to limit the scope of their assessments to the structural elements that were affected by the events, as determined by their visual inspections. In such situations, invasive inspections and testing might be required.

ANALYSIS

If there are signs of structural distress and their causes are not apparent, structural analyses would be warranted to determine whether original designs were adequate or if structures have since become overloaded. These analyses should be based on reviews of original documents and drawings and/or measurements of existing members. Such structural analysis should be done according to the latest building codes.

Engineers may need to obtain information about construction materials, such as the strength of concrete, which may be obtained using non-destructive tests. Engineers with expertise in materials might need to be retained. For example, an engineer expert in wood materials might be retained to determine the type of lumber used in a building.

Engineers need to quantify observed structural deterioration or defects and analyze their potential impact on structures, as well as provide engineering opinions on the potential impacts of the deterioration or defects. For example, a structural steel element under corrosion should be measured for section loss and the engineer should provide an engineering opinion on the potential impact of the measured loss.

There is a school of thought that existing buildings should be considered to be "grandfathered," so that engineers may ignore the latest climatic loads and design codes, referencing instead the original design codes. For climatic loads, for example, one could argue that if structures have withstood climatic loads to date, they have passed a type of load test. However, such an approach is not always reliable. For instance, a poorly insulated building might not have experienced very high snow loads, since the building's heat loss melted the snow on the roof. In this situation, a relatively simple modification, such as upgrading the insulation, might potentially result in an increase in the snow loads, leading eventually to structural distress. Such problems can be avoided by using the latest climatic loads and the latest design codes. The latest design codes also have the advantage of incorporating the most up-to-date technology.

In situations where only specific areas are being inspected due to known incidents, one need not analyze overall structures; elements suspected to have been affected should, however, be thoroughly assessed to ensure their structural integrity has not been compromised or, if

compromised, the remaining structural integrity is sufficient for the loads they will be exposed to.

REPORT

Engineers should present their findings in reports addressed to their clients. The level of appropriate report detail depends on the original reasons for assessments and will, by necessity, match the degree of complexity of the inspections and analyses. Reports should include, but not be limited to:

- reasons for conducting structural engineering assessments;
- names of clients;
- addresses of buildings assessed;
- descriptions of buildings' main usages;
- clear descriptions of the actions performed, including when they were performed, and by whom;
- descriptions of areas not covered by visual inspections, why they were not covered, and engineering opinions about whether such areas are critical to the overall structural integrity of buildings;
- records of, and comments on, observations of loading conditions, indicating usages at different parts of buildings, and identifying misuse, abuse or deviations from intended uses;
- records of and comments on findings of additions and alteration works to building structures;
- records of observations of signs of structural defects, damage, distress, deformation or deterioration;
- engineering opinions about whether existing usages and loading conditions are compatible with structures' intended usages;
- engineering opinions on the extent, possible causes and seriousness of identified problems;
- engineering opinions about whether identified problems are:
    - defects of no structural significance,
    - defects requiring remedial action and/or monitoring, or
    - suspected defects of structural significance requiring full structural investigation and immediate action;
- recommendations on remedial actions and/or monitoring to be undertaken by clients to ensure buildings' structural integrity, for example, restricting usage, relocating heavy machineries, removing additions, further investigation on structural adequacy, or phasing buildings out of service. Such recommendations should include timeframes within which repairs are recommended;
- relevant sketches, plans and photographs with titles, explanations and references to written portion of reports;
- disclaimers that limit the liability of C of A holders to the specific intent and content of reports;
- limitations and restrictions on engineers' work; and
- additional recommended tests or investigations.

All opinions expressed in reports should be supported by relevant analyses or discussions. For example, if the opinion on a particular problem is that it is of no structural significance, the report should provide sufficient explanation to support that opinion.

The *Professional Engineers Act* requires engineers to affix their seals to final documents containing engineering content provided as part of services to the public. Reports of structural engineering assessments of existing buildings contain statements of professional opinion and therefore must be sealed. For further information on the use of seal, refer to the guideline *Use of the Professional Engineer's Seal* at http://peo.on.ca/index.php/ci_id/22148/la_id/1.htm.Σ

Don Ireland, P.Eng., is president, Ireland Engineering Associates Ltd. Ron Koerth, MBA, P.Eng., is principal, Giffin Koerth Forensic Engineering.