Structural Building Condition Reviews: Beyond Distress

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Exploring Answers to the Question:
What is the appropriate level of investigation when conducting a structural building condition review?

Purposes of Structural Building Condition Reviews

• To observe and identify any areas of apparent damage, distress, or deterioration?
• To assess the adequacy of a building for future increased loading or new usage?
• To increase the level of confidence in a building’s future ability to structurally perform its intended function?

Part 1: What’s Out There
Structural Building Condition Reviews: Beyond Distress

Deterioration of Structural Elements

Deterioration of Structural Elements
Unstable Existing Conditions

Smith Road ES Cafeteria Roof - North Syracuse, NY

Aspects of Structural Building Condition Reviews

- Compilation - gather available and relevant information about the building and project
- Field reconnaissance
- Mathematical structural analysis *
- Conclusions and recommendations

* - may not be needed, depending on conditions
Part 2: The Context of Structural Condition Reviews

Structural Building Condition Reviews: Beyond Distress

Ten Considerations to Consider for structural condition reviews

1. Physical Condition
2. Environmental Exposure
3. Loading
4. Occupancy
5. Design Quality Confidence
6. Construction Quality Confidence
7. Concealed Defect Potential
8. Potential Failure States
9. Significance of Considered Assembly
10. Unusual Conditions
1. Physical Condition

A. Is there damage or deterioration present that may compromise structural integrity?

B. Is there distress or deformation that may indicate the onset of manifestation of a structural limit state?

2. Environmental Exposure

Has the structure been subject to environmental conditions that can cause deterioration such as moisture, chlorides, or high heat, or will it be exposed in the future?
3. Loading

A. Has the structure been subject to loading or loads in excess of that for which it was likely designed?

B. Will it be exposed to loading greater than that which it had previously been subject in the future?
4. Occupancy
   A. Is the building a high importance facility, or will it be?
   B. Will it be used for public occupancy?
   C. Is it a seldom used or unused structure?

5. Design Quality Confidence
   A. Is there a high degree of confidence that the design was performed competently?
   B. If not, are the structural elements visible and measurable?
6. Construction Quality Confidence

A. Is there a high degree of confidence that the construction was performed competently?

B. If not, is the level of quality of construction visually apparent?

7. Concealed Defect Potential

Does the type of construction have the possibility for concealed defects that may significantly limit the performance of the structure?

8. Potential Failure States

A. Is the system subject to failure mechanisms that can result in sudden failure with no warning signs?

B. If so, are there any secondary support systems?
9. Significance of Considered Assembly
A. Is the considered structural system or mechanism a local element or does it involve a primary structural element or large area of building?
B. Could the failure of the considered system result in a more widespread or progressive collapse?

10. Unusual Conditions
Are there structural conditions that are unusual or disproportionate, or significant spans, load collection elements, or other conditions that just don’t "seem" right?

Recommendations
Structural Building Condition Reviews: Beyond Distress
Types of Reviews

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<th>Visual Assessment</th>
<th>Reroofing in Snow Country</th>
<th>Comprehensive Assessment</th>
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Purposes of Field Reconnaissance Visits

1. Overview of building and usage
2. Identification of structural systems
3. Identification of loading
4. Identification of damage or deterioration
5. Identification of distress or deflection that may indicate a manifestation of a structural limit state
6. Corroboration of drawing information
7. Identification of secondary support mechanisms

Types of Mathematical Analysis for existing structures

1. Comparative loading – comparing original service loads to proposed or future loads
2. Comparative stresses - comparing original service stresses in structural elements to proposed or future stresses
3. Adequacy of original design or construction*
4. Adequacy of elements for proposed or future loads*
   * using presumptive allowable stress values

Types of Physical Investigations

1. Visual
2. Non-Intrusive, e.g.:
   A. Percussive: Hammer, Chain, etc.
   B. Magnetic, Ground Penetrating Radar, X-ray, Infrared, etc.
3. Intrusive, e.g. test pits, observation cuts
4. Laboratory, e.g.:
   A. Concrete cores and testing; steel coupon testing
   B. Petrographic analysis
5. Load testing

Selection of type and extent of physical investigations depends on the project.

Recommendations for Structural Building Condition Reviews

1. Take all ten considerations into consideration.
2. Include an experienced structural engineer on the review team.
3. Clarify expectations at the beginning with a clear scope. Consider:
   - the use of engineering judgement to develop a professional opinion about the structure, with the goal of increasing the level of confidence in its future performance.
4. Compile information in advance of field reconnaissance.
5. Perform an effective field reconnaissance (clear on the purpose).
6. Be clear about purpose and extent of mathematical analysis.
7. Provide conclusions and recommendations with reasons for each.

QUIZ

True or False?

1. When performing a structural condition review, it is always necessary to perform a mathematical structural analyze the elements to verify that they are adequate.
FALSE
2. All structural failures present themselves with visually evident damage, distress, or deterioration prior to their failure.
FALSE
3. All design limit states correspond to a well-defined failure state.
FALSE
4. Many buildings have never been exposed to the maximum wind or seismic force that they should have been designed to resist.
TRUE
5. A through structural analysis of the structural elements on an as-built drawing eliminates the need for field reconnaissance.
FALSE
Ten Considerations to Consider for structural condition reviews

1. Physical Condition
2. Environmental Exposure
3. Loading
4. Occupancy
5. Design Quality Confidence
6. Construction Quality Confidence
7. Concealed Defect Potential
8. Potential Failure States
9. Significance of Considered Assembly
10. Unusual Conditions

12 Considerations to Consider for structural condition reviews

1. Physical Condition
2. Environmental Exposure
3. Known Cautionary Conditions
4. Load Path
5. Loading
6. Occupancy
7. Design Quality Confidence
8. Construction Quality Confidence
9. Concealed Defect Potential
10. Potential Failure States
11. Significance of Considered Assembly
12. Unusual Conditions

A. Is there damage, deterioration, or obvious defect present that may compromise structural integrity?
B. Is there distress or deformation that may indicate the onset of manifestation of a structural limit state?

A. Has the structure been subject to environmental conditions that can cause deterioration such as moisture, chlorides, or high heat, or will it be exposed in the future?

A. Are there pre-1975-era glued laminated beams, or other systems with known limitations?
B. Are there unbraced conditions such as supports at cantilever beam lines, long compressive beam flanges, or long truss compression members?

A. Does the structure have well-defined load paths for gravity, lateral, and applied loads?

A. Has the structure been subject to loading or loads in excess of that for which it was likely designed?
B. Will it be exposed to loading greater than that which it had previously been subject in the future?

A. Is the building a high importance facility, or will it be?
B. Will it be used for public occupancy?
C. Is it a seldom used or unused structure?

A. Is there a high degree of confidence that the design was performed competently?
B. If not, are the structural elements visible and measurable?

A. Is there a high degree of confidence that the construction was performed competently?
B. If not, is the level of quality of construction visually apparent?

A. Does the type of construction have the possibility for concealed defects that may significantly limit the performance of the structure?

A. Is the system subject to failure mechanisms that can result in sudden failure with no warning signs?
B. If so, are there any secondary support systems?

A. Is the considered structural system or mechanism a local element or does it involve a primary structural element or large area of building?
B. Could the failure of the considered system result in a more widespread or progressive collapse?

A. Are there structural conditions that are unusual or disproportionate, significant spans, load collection elements, or other conditions that just don’t "seem" right?