

GENERAL CONSIDERATIONS & GUIDELINES



Scope of Structural Inspection

The fundamental purpose of the required milestone inspection and report is to confirm in a reasonable fashion that the building or structure under consideration is safe for continued use under present occupancy.

As implied by the title of this document, this is a recommended procedure, and under no circumstances are these minimum recommendations intended to supplant proper professional judgment.

Such inspection shall be for the purpose of determining the general structural condition of the building or structure to the extent reasonably possible of any part, material, or assembly of a building or structure which affects the safety of such building or structure and/or which supports any dead or live load, or wind load.

In general, unless there is obvious overloading or significant deterioration of important structural elements, there is little need to verify the original design. It is obvious that this has been time-tested if still offering satisfactory performance. Rather, it is important that the effects of time with respect to the degradation of the original construction materials be evaluated. It will rarely be possible to visually examine all concealed construction, nor should such be generally necessary. However, a sufficient number of typical structural members should be examined to permit reasonable conclusions to be drawn.



Visual Inspection

Visual inspection will, in most cases, be considered adequate when executed systematically. The inspecting professional must conduct the visual examination throughout all habitable and non-habitable areas of the building, as deemed necessary, to establish compliance. Surface imperfections such as cracks, distortion, sagging, excessive deflections, significant misalignment, signs of leakage, and peeling of finishes should be viewed critically as indications of possible difficulty.



Testing Procedures

Testing procedures and quantitative analysis will not generally be required for structural members or systems except in cases where visual examination has revealed such a need or where apparent loading conditions may be critical.



Manual Procedures

Manual procedures such as chipping small areas of concrete and surface finishes for closer examinations are encouraged in preference to sampling and/or testing where visual examination alone is deemed insufficient. Generally, unfinished areas of buildings, such as utility spaces, maintenance areas, stairwells, and elevator shafts, should be utilized for such purposes. In some cases, to be held to a minimum, ceilings or other construction finishes may have to be opened for selective examination of critical structural elements. In that event, such locations should be carefully located to be least disruptive, most easily repaired, and held to a minimum. In any event, a sufficient number of structural members must be examined to afford reasonable assurances that such are representative of the total structure.

Evaluating an existing structure for the effects of time must take into account two basic considerations: movement of structural components with respect to each other and deterioration of materials. With respect

to the former, volume change considerations, principally from ambient temperature changes and possibly long-time deflections, are likely to be most significant. Foundation movements will frequently be of importance, usually settlement, although upward movement due to expansive soils may occur, although infrequently in this area. Older buildings on spread footings may exhibit continual, even recent settlements if founded on deep unconsolidated fine-grained or cohesive soils or from subterranean losses or movements from several possible causes.

With very little qualifications, such as rather rare chemically reactive conditions, deterioration of building materials can only occur in the presence of moisture, largely related to metals and their natural tendency to return to the oxide state in the corrosive process.

In this marine climate, highly aggressive conditions exist year-round. For most of the year, outside relative humidity may frequently be about 90 or 95%, while within air-conditioned building, relative humidity will normally be about 55 to 60%. Under these conditions moisture vapor pressures ranging from about 1/3 to 1/2 pounds per square inch will exist much of the time. Moisture vapor will migrate to lower pressure areas. Common building materials such as stucco, masonry, and even concrete, are permeable even to these slight pressures. Since most of construction does not use vapor barriers, condensation will occur within the enclosed walls of the building. As a result, deterioration is most likely adjacent to exterior walls or wherever else moisture or direct leakage has been permitted to penetrate the building shell.

Structural deterioration will always require repair. The type of repair, however, will depend upon the importance of the member in the structural system, and the degree of deterioration. Cosmetic type repairs may suffice in certain non-sensitive members such as tie beams and columns, provided that the remaining sound material is sufficient for the required function. For members carrying assigned gravity or other loads, cosmetic-type repairs will only be permitted if it can be demonstrated by rational analysis that the remaining material, if protected from further, can still perform its assigned function at acceptable stress levels. Failing that, adequate repairs or reinforcement will be considered mandatory.

Written reports shall be required attesting to each required inspection. Each such report shall note the location of the structure, a description of the type of construction and general magnitude of the structure, the existence of drawings and location thereof, the history of the structure to the extent reasonably known, and a description of the type and manner of the inspection, noting problem areas and recommended repairs, if required to maintain structural integrity.



Evaluation

Each report shall include a statement to the effect that the building or structure is structurally safe, unsafe, safe with qualifications, or has been made safe. It is suggested that each report also include the following information indicating the actual scope of the report and limits of liability. This paragraph may be used:

"As a routine matter, in order to avoid possible misunderstanding, nothing in this report should guarantee for any portion of the structure. To the best of my knowledge and ability, this report represents an accurate appraisal of the present condition of the building based upon careful evaluation of observed conditions to the extent reasonably possible."





Building Structural Members

This section provides safety inspection guidance to the various members of the building's structural elements.



Foundations

If all the supporting subterranean materials were completely uniform beneath a structure, with no significant variations in grain size, density, moisture content, or other mechanical properties, and if dead load pressures were completely uniform, settlements would probably be uniform and of little practical consequence. In the real world, however, neither is likely. Significant deviations from either of these two idealisms are likely to result in unequal vertical movements.

Monolithic masonry structures are generally incapable of accepting such movements and large openings. Since, in most cases, differential shears are involved, cracks will typically be diagonal.

Small movements, in themselves, are most likely to be structurally important only if long-term leakage through fine cracks may have resulted in deterioration. In the event of large movements, contiguous structural elements such as floor and roof systems must be evaluated for possible fracture or loss of bearing.

Pile foundations are, in general, less likely to exhibit such difficulties. Where such does occur, special investigation will be required.



Roofs

Sloping roofs, typically covered with clay or cement tiles, become a concern if the membrane deflects due to deteriorated rafters or joists. This situation is a significant concern and requires attention. Valley flashing and base flashing at roof penetration will also be matters of concern.

Flat roofs with built-up membrane roofs will be similarly critical with respect to deflection considerations. Additionally, since they will generally be approaching expected life limits at the age when building recertification is required, careful examination is important. Blisters, wrinkling, alligatoring, and gravel loss are usual signs of difficulty. Punctures or loss of adhesion of base flashings, coupled with loose counter-flashing, may also indicate the possibility of other debris accumulation. If left unaddressed, the situation may lead to ponding, which, if permitted, may become critical.



Masonry Bearing Walls

Random cracking—or if discernible, definitive patterns of cracking—will of course, be of interest. Bulging, sagging, or other signs of misalignment may also indicate related problems in other structural elements. Masonry walls are commonly constructed of either concrete masonry units, or scored clay tile. They may have been constructed with either reinforced concrete columns and tie beams, or lintels.

Of most probable importance and observation will be the vertical and horizontal cracks where masonry units abut tie columns or other frame elements, such as floor slabs. Although the raw materials from which these masonry materials are made may have mechanical properties similar to the reinforced concrete framing, their actual behavior in the structure is likely to differ, with respect to volume change resulting from moisture content and variations in ambient thermal conditions.

Moisture vapor penetration, sometimes abetted by salt-laden aggregate and corroding rebars, will usually be the most common cause of deterioration. Tie columns are rarely structurally sensitive, and a fair amount of deterioration may be tolerated before structural impairment becomes important. Cosmetic-type repair

involving cleaning, and parching to effectively seal the member, may often suffice. A similar approach may not be unreasonable for tie beams, provided they are not also serving as lintels. In that event, a rudimentary analysis of load capability using the remaining actual rebar area may be required.



Floor and Roof Systems

Cast-in-place reinforced concrete slabs and/or beams and joists may often show problems due to corroding rebars resulting from cracks or merely inadequate protection cover of concrete. Patching procedures will usually suffice where such damage has not been extensive. Where corrosion and spalling have been extensive in structurally critical areas, competent analysis with respect to the remaining structural capacity, relative to actually supported loads, will be necessary. The type and extent of repair depend upon the investigation results.

Pre-cast members may present similar deterioration conditions. End support conditions may also be important. Bearing adequacy, indications of end shear problems, and restraint conditions are important and should be evaluated in at least a few typical locations.

Steel bar joists are, of course, sensitive to corrosion. Most critical locations will be web member welds, especially near supports, where shear stresses are high and possible failure may be sudden and without warning.

Cold-formed steel joists, usually of relatively light gauge steel, are likely to be critically sensitive to corrosion and highly dependent upon at least nominal lateral support to carry designed loads. Bridging and the floor or roof system itself, if in good condition, will serve the purpose.

Wood joists and rafters are most often in difficulty due to "dry rot" or the presence of termites. The former (a misnomer) is most often prevalent in the presence of sustained moisture or lack of adequate ventilation. A member may usually be deemed in acceptable condition if a sharp-pointed tool penetrate no more than about one-eighth of an inch under moderate hand pressure. Sagging floors will most often indicate problem areas.

Gypsum roof decks will usually perform satisfactorily except in the presence of moisture. Disintegration of the material and the form-board may result from sustained leakage. Anchorage of the supporting bulb tees against uplift may also be of importance.

Floor and roof systems of cast-in-place concrete with self-centering reinforcing, such as paper-backed mesh and rib-lath, may be critical with respect to corrosion of the unprotected reinforcing. Loss of uplift anchorage on roof decks will also be important if significant deterioration has taken place, in the event that dead loads are otherwise inadequate for that purpose. Expansion joints exposed to the weather must also be checked.



Steel Framing System

Corrosion, obviously enough, will be the determining factor in the deterioration of structural steel. Most likely, suspect areas will be fasteners, welds, and the interface area where bearings are embedded in masonry. Column bases may often be suspect in areas where flooding has been experienced, especially if salt water has been involved. Concrete fireproofing will, if it exists, be the best clue indicating the condition of the steel.



Concrete Framing Systems

Concrete deterioration will, in most cases, similarly be related to rebar corrosion, possibly abetted by the presence of saltwater aggregate or excessively permeable concrete. In this respect, honeycomb areas may contribute adversely to the rate of deterioration. Columns are frequently the most suspect. Extensive honeycomb is most prevalent at the base of columns, where fresh concrete was permitted to segregate, dropping into form boxes. This type of problem has been known to be compounded in areas where flooding has occurred, especially involving saltwater.

Thin cracks usually indicate only minor corrosion and require minor patching. Extensive spalling may indicate a much more serious condition requiring further investigation.

In small areas, chipping away a few small loose samples of concrete may be very revealing. Especially, since loose material will have to be removed even for cosmetic-type repairs, anyway. Fairly reliable quantitative conclusions may be drawn with respect to the quality of the concrete. Even though our cement and local aggregate are essentially derived from the same sources, cement will have a characteristically dark grayish-brown color in contrast to the almost white aggregate. A typically white, almost alabaster-like coloration will usually indicate reasonably good overall strength.

Based on preliminary findings from the National Institute of Standards and Technology on the collapse of Champlain Towers South in Surfside, Florida, in April of 2022, special attention should be paid to deck slabs and plaza decks. Often, additional load has been added to these structures, so it is incumbent upon the inspecting design professional to look closely at slabs, columns, and other transfer members for evidence of distress. This evidence may manifest as efflorescence from water passing through the concrete structures as a white or light-colored powdery substance on the underside of slabs and at the base of columns.



Windows and Doors

Window and door condition is of considerable importance with respect to two considerations. Continued leakage may have resulted in other adjacent damage and deteriorating anchorage may result in loss of the entire unit in the event of severe windstorms even short of hurricane velocity. Perimeter sealants, glazing, seals, and latches should be examined with a view toward deterioration of materials and anchorage of units for inward as well as outward (suction) pressure, most importantly in high buildings.



Wood Framing

Older wood framed structures, especially of the industrial type, are of concern in that long term deflections may have opened important joints, even in the absence of deterioration. Corrosion of ferrous fasteners will, in most cases, be obvious enough. Dry rot must be considered suspect in all sealed areas where ventilation has been inhibited, and at bearings and at fasteners. Here, too, penetration with a pointed tool greater than about one-eighth inch with moderate hand pressure will indicate the possibility of further difficulty.



Building Façade

Appurtenances on an exterior wall of a building are elements including, but not limited to, any cladding material, precast appliques, exterior fixtures, ladders to rooftops, flagpoles, signs, railings, copings, guardrails, curtain walls, balcony and terrace enclosures, including greenhouses or solariums, window guards, window air conditioners, flower boxes, satellite dishes, antennae, cell phone towers, and any equipment attached to or protruding from the façade that is mechanically and/or adhesive attached.



Loading

It is important to note that even in the absence of any observable deterioration, loading conditions must be viewed with caution. Recognizing that there will generally be no need to verify the original design since it will have already been "time tested", this premise has validity only if loading patterns and conditions remain **unchanged**. Any material change in type and/or magnitude or loading in older buildings should be viewed as sufficient justification to examine load-carrying capability of the affected structural system.



Historical Documents and Permitting

An attempt should be made to investigate the existence of documents with the local jurisdiction to assist with the overall inspection of the building.

Understanding the structural system, building components, and intended design may guide the design professional in investigating certain critical areas of the structure.



Violations

Violations through the local jurisdiction's code compliance division should be investigated. Cases on file may lead to issues pre-existing with the building, especially any unsafe structure determinations. Depending on the nature of the violation, recertification inspections may be affected.



Unpermitted Activities

Unpermitted activities may also affect the outcome of a milestone inspection, especially with unpermitted additions to the building. Unpermitted additions found during the milestone inspection process present an unsafe situation and must be identified in the report, even if found to be properly built. Like a repair process identified by the report, legalizing an unpermitted addition would be a prerequisite to completing a successful milestone inspection report. Examples of unpermitted work include but are not limited to additions, alterations, balcony enclosures, etc.



Repairs

Repairs identified in the milestone inspection report will most likely require permits. Once the initial report is completed, it should be immediately submitted to the local jurisdiction for processing. Do not proceed to conduct repairs without permits. Some repairs, like changing a bulb in an exit sign, may not require a permit, but most other work will require permits. Proceeding without obtaining repair permits may lead to a violation of the code.



Reports

Completing the reports concisely is vital to the overall understanding of the conditions of the building and the successful completion of the milestone inspection process. The approved report forms provided must be used; proprietary forms will not be accepted. Where required, photos must be in color and with sufficient resolution to detail the conditions being shown. Milestone inspection reports may be audited, and the subject building may be inspected at the discretion of the Building Official. The Building Official reserves the right to rescind or revoke an approved milestone inspection report.

The Code in Effect at the time of the original construction is the baseline for the milestone inspections. Subsequent improvements to the original building should be inspected based on the code at the time of permitting. It is not the intent of the milestone inspection that buildings must be brought in compliance with current codes.



Structural Assessment Technologies and Techniques

Destructive and nondestructive structural assessment technologies and techniques that can, or have the potential to, aid in the structural assessment of buildings based on current development, applications, and industry guidance:

- (1) ASTM F1869 – Chloride test for concrete
- (2) ASTM C876 (half-cell) – Scan of concrete at a depth of 6" to measure rebar deterioration
- (3) ASTM C1153- Thermography
- (4) ASTM D8231 modified – Electronic Leak Detection of membrane roofing
- (5) AAMA 511 – Pressure Testing of Fenestrations
- (6) ASTM D4580 – Delam roller for Stucco and Concrete
- (7) ASCE 11-99
- (8) Acoustic Emission (*)
- (9) Sounding Techniques (*)
- (10) Stress Wave Methods – Ultrasonics (*)
- (11) Grund Penetrating Radar (GPR) (*)
- (12) Thermography (*)
- (13) Fiber Optic Sensors (*)
- (14) Imagery (*)
- (15) AR/VR Guided Inspection (*)
- (16) Vibration Sensors and Dynamic Analysis (*)
- (17) Integrated Sensors (*)
- (18) X-ray (*)
- (19) Core Sampling of Concrete (*)
- (20) In-situ Strength Testing Methods (*)
- (21) Corrosion Detection and Monitoring Techniques (*)
- (22) Analysis of Ingress and Transport Properties (*)

(*) For background information regarding building inspection technology, see research project. “Assessment of Inspection Reporting and Building Conditions in South Florida (Miami-Dade and Broward Counties) – Phase II” as available from the following link:

https://www.floridabuilding.org/fbc/publications/Technical_Research_FY2022-2023.html



Relevant Definitions

Good: No Substantial Structural Deterioration and No Dangerous Condition Observed.

Fair: Indication of Substantial Structural Deterioration Observed and No Dangerous Condition Observed.

Poor: Actual Substantial Structural Deterioration Observed and No Dangerous Condition Observed.

Significant: Any Observation which is an Indication of Dangerous Condition or Actual Dangerous Condition.

Major Structural Component. A building's load-bearing elements, primary structural members, and primary structural systems.

Substantial Structural Deterioration. A condition that negatively affects a building's structural condition and integrity or a major structural component whose condition meets the definition of Dangerous. The term does not include surface imperfections such as cracks, distortion, sagging, deflections, misalignment, signs of leakage, or peeling of finishes unless the licensed engineer or architect performing the phase one or phase two inspection determines that such surface imperfections are a sign of substantial structural deterioration.

Unsafe conditions. Buildings that are or hereafter become *unsafe*, insanitary or deficient because of inadequate means of egress facilities, inadequate light and ventilation, or that constitute a fire hazard, or are otherwise dangerous to human life or the public welfare, or that involve illegal or improper occupancy or inadequate maintenance, shall be deemed an *unsafe* condition. *Unsafe* buildings shall be taken down and removed or made safe as the *code official* deems necessary and as provided for in this code. A vacant building that is not secured against unauthorized entry shall be deemed *unsafe*. If an owner of the building fails to submit proof to the local enforcement agency that repairs have been scheduled or have commenced for substantial structural deterioration identified in a phase two milestone inspection report within the required timeframe, the local enforcement agency must review and determine if the building is unsafe for human occupancy.

Dangerous. Any building, structure or portion thereof that meets any of the conditions described below shall be deemed dangerous:

1. The building or structure has collapsed, has partially collapsed, has moved off its foundation or lacks the necessary support of the ground.
2. There exists a significant risk of collapse, detachment or dislodgment of any portion, member, appurtenance or ornamentation of the building or structure under permanent, routine, or frequent loads; under actual loads already in effect; or under wind, rain, flood, or other environmental loads when such loads are imminent.